Teachers Mannual

ENVIRONMENTAL IMPACT ASSESSMENT

For

Science, Art, Management and Other Post Graduate Courses

For Department of Technical Education
Govt. of Uttarakhand

ALTERNATE HYDRO ENERGY CENTRE
INDIAN INSTITUTE OF TECHNOLOGYR, ROORKEE

July 2007

LIST OF CONTENTS

PREFACE

Lecture notes for the proposed Engineering Degree Level Course entitled "Environmental Impact Assessment" for all branches is in accordance with the approved syllabus. These have been prepared by Prof RP Mathur, Former Professor (Environment Engg), Deptt. of Civil (1963-1995). Modern trends in design are brought out. Copies of some relevant published/ unpublished papers on various aspects of design are included. It may be noted that published design papers are relevant to the design practice at the time of publication/ design and must be used/ modified with relevant to current practice as per references given in the text. The material in these notes is also part of a book entitled 'Hydro-electric Engineering Practice in India' being complied by author.

(ARUN KUMAR)
HEAD, AHEC, IIT, ROORKEE

FOR MASTERS' DEGREE LEVEL COURSES

All Master Level Courses except Management and Commerce

1. Course Title: Environmental Impact Assessment

2.* Contact Hours: L:48 T:0 P:0

3.* Examination Duration (Hrs.): Theory: Practical:

4.* Relative Weightage : CWS PRS MTE ETE PRE

5.* Credit: **6.* Semester:** ☐ **Autumn** ☐ **Spring** ☐ **Both**

7. Pre-requisite: NIL

8. Details of Course:

Sl. No.	Particulars	Contact Hours
1.	Introduction To Environment: Definition, scope, components, structure and composition. Environmental quality, monitoring and base line data.	5
2.	Sustainable Development: Present and future development needs; exploitation of natural resources, environmental harmony, economic efficiency and social justice. Symbiotic relationship. Concept of carrying capacity.	4
3.	Environmental pollution due to increasing growth rate, population and human interaction. Water, land and air pollution.	6
4.	Environmental Protection acts, Rules and Standards, EIA guidelines.	6
5.	Environmental Impact Assessment: Definition and scope, preliminary screening requiring EIA of projects. Impact identification, Assessment of Impact; Impact Evaluation. Types of EIA, rapid and comprehensive.	5
6.	Methods of environment impact assessment; ad-hoc method, maps and overlays, check lists, matrix, cause condition impacts.	4
7.	Procedure For EIA Clearance: EIA review and screening; state level screening, clearance from DOE and MOEF.	2
8.	Environmental Management: Preventive policy of environment, waste minimisation, conservation of water and energy, use of renewable, sources, pollution audit, pollution control strategy, disposal of treated effluents, solid waste disposal concept of green cities, green belt development – Case history.	8
9.	Post Project Monitoring	2

Suggested Readings:

1. Jain, R.K., Urban, L.V. and Stacey, G.S., Environment Impact Analysis, Von Nostrand Reinhold Company.
2. Lawrence, David P., Environmental Impact Assessment (Practical Solutions to Recurrent Problems), Wiley International, New Jersey.

** These are to be decided by the respective University/Board*

3. MoEF, GoI, Environment Impact Assessment, Impact Assessment Division, January 2001 (Manual).
4. Water (Prevention and Control of Pollution) Act 1974. Air (Prevention and Control of Pollution) Act 1981.
5. Trivedi, P.R., Natural Resources Conservation, APH Publishing Corporation, New Delhi.
6. Westman, Walter E., "Ecology, Impact Assessment and Environment Planning" John Wiley and Sons, Canada, 1985.

ABOUT THE COURSE

Environmental Impact Assessment

Environmental Impact Assessment (EIA) is a planning tool generally accepted as an integral component of decision making in Sustainable Development. The course is aimed at providing comprehensive information, on Environment (physical and biological), its degradation due to developmental activities, methods of determining consequences or impacts and possible methods of mitigation, to a group of post graduate, students in Arts, Science and Management. The students who have undergone studies both in theory and practice in respective disciplines and are knowledgeable in specific subjects may not be fully aware on the consequences of developmental projects being planned and executed in the vicinity. They are also anxious to know the world of futurology, so that they are able to visualize the dreams of next generation.

The rapid growth of population, improvements in standards of living and concomitant growth of infrastructure have altered the environment, sometimes beyond its power of resilience. These changes have resulted in ecological crisis and have become a matter of grave concern to managers and decision makers throughout the world. The issues both at national and global levels are focussing concern of nodal agencies (Regulatory Departments, Ministries and Boards) to support sustainable development and curb and restrain such acts which tend to produce adverse impacts on living conditions of human, animals, plants and geographical environment.

In India, Ministry of Environment and Forests (MOEF) has been recognized by Govt. of India as the nodal agency to regulate through its functionaries the provision of water Act, 1974, Air Act, 1981 and Environmental Protection Act of 1986 and provide guidelines for its implementation.

As per the procedures outlined, EIA is required to provide a comprehensive account of the state of existing environment, the stresses produced by diverse activities and the impacts these will have on various components of environment. The proponents of the development projects also need to suggest and provide the measures to mitigate the adverse effects.

The EIA has been defined (David P Lawrence, 2003, EIA Practical Solutions to Recurrent Problems) as:

"* Determining and managing (identifying, describing, measuring, predicting, interpreting, integrating, communicating, involving and controlling) the,

* Potential (or real) impacts (direct and indirect, individual and cumulative, likelihood of occurrence) of,

* Proposed (or existing) human actions (projects, plans, programs, legislation, activities) and their alternatives on the,

* Environment (Physical, Chemical, biological, human health, cultural, social, economic, built and interactions)"

Environment will cover, the existing condition in or/and around the area is as much as:

(i) Physical environment to include:
   (a) Land and Climate: Weather conditions to include temperature (ambient), humidity, wind velocity, precipitation, land use, topography, geology and seismic considerations.
   (b) Atmospheric conditions: Ambient air quality at the site and around specially in down wind direction
   (c) Water bodies: Laks, rivers, ponds and canals. Hydrology and existing quality. Ground water availability and flow regime
   (d) Noise level

(ii) Chemical Environment to include:
   (a) Industrial activities, types of industries at the site and around (10 km radius), types of wastes produced and methods of treatment and disposal of effluents.
   (b) City dumping sites, land fill sites

(iii) Infrastructure: Public, Services, Water Supply, Waste Treatment Plants, Energy resources, distribution system, Transport system, communication, important buildings, heritage, sites etc.

(iv) Biological environment: Vegetation, forests, flora, fauna. Natural vegetation, parks, cultivated land, crops, threatened and endangered species.

CHAPTER - 1

1.0 Introduction to Environment

Environment is a comprehensive term meaning surroundings. It includes the gaseous envelope surrounding earth, the **Atmosphere**, the mass of water above and below the earth, the **Hydrosphere**, the land masses that support life, the **Lithosphere**, and the whole plethora of microbes, plants, and animals, collectively referred as, **Biosphere**. The living world has been sustained for over 200million years by other components. According to Mason and Langenhim "Environment is the sum of all substances and forces external to an organism which determines its existence and regulate its processes". Earth is a unique planet of Solar System which has free water, oxygen and life. The pyramid of life (Fig. 1.1) is supported by a complex set of interactions and exchanges between water, air, land and life. The study of environment is important to

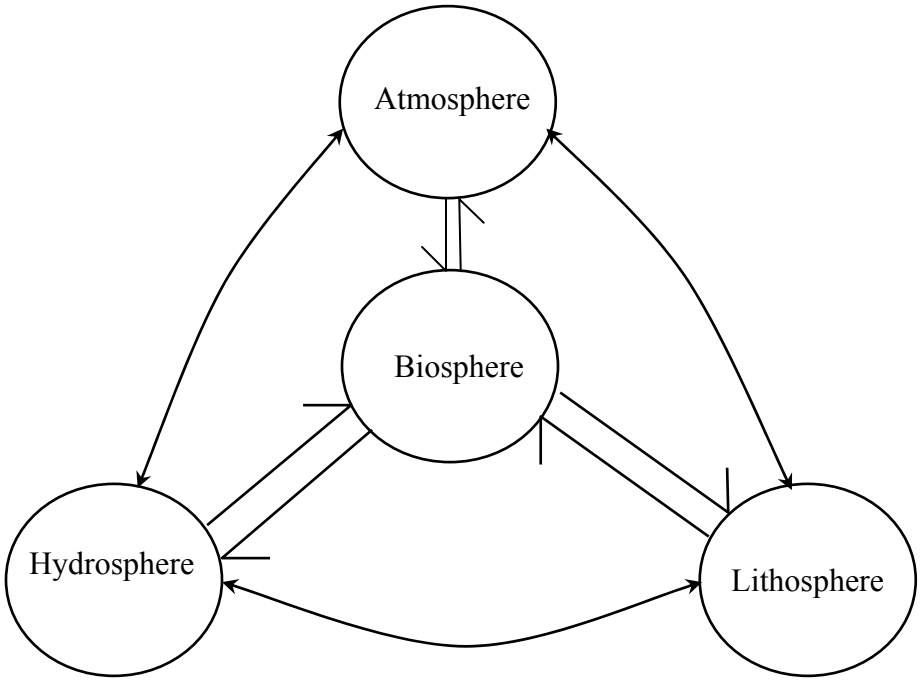

Fig. 1.1 Pyramid of life

Scientists, Engineers, Technologists, Managers and Conservationist in affording solutions of interactions of human activity.

Man is often said to be his own enemy. This is perhaps true in the consequence of what seems to be very legitimate human activities to provide food, shelter, amenities and transport. While products of industry and agriculture make human existence more bearable and pleasant, they give rise to waste effluents and emissions. Some of the interactions of human existence relate to:

- utilization of a resource without impairing its use,
- disposal of wastes without creating problems,
- degradation of forest wealth and
- exploitation of biota

The study of environment in totality is an arduous task. The age of earth is nearly 6000×10^6 years and the story of life is only 2×10^6 years which shows that for a very long time no life existed on earth. Some of the concepts of origin of earth and life are legendry and beyond the scope of present course.

1.1 Atmosphere

The atmosphere constitutes a gaseous envelope that surrounds the earth and held in place by the forces of gravity. It is essential to life in terms of supplying oxygen for breathing and circulating carbon-di-oxide. The composition of atmosphere is generally uniform upto an altitude of 80 km. This portion of atmosphere is called **Homosphere** and is made up of 78.084% Nitrogen and 20.946% oxygen (by volume). The rest is made up of Hydrogen (0.5 ppm) and inert gases viz. (expressed as parts per million (by volume) and not%):

Argon (Ar)	9340 ppm, inert
Neon (Ne)	182 ppm, inert
Helium (He)	53 ppm, inert
Krypton (Kr)	1.2 ppm, inert
Xenon (Xe)	1.0 ppm, inert
Radon (Rn)	Traces (Radio active)
Carbon dioxide	(CO_2) 340 ppm, essential for life
Ozone (O_3)	Traces Toxic

Other materials which are highly variable are, Sulfur-di-oxide (SO_2) Carbon-mono-oxide (CO), Methane (CH_4), Nitrous oxide (N_2O). The concentration of water

vapor is highly variable near the earth's surface. The atmosphere will also have particulate matter (dust) in varying amounts. Other emissions may also add, hydro carbons (HC), oxides of Nitrogen ($NO + NO_2$), Chloro flouro carbons, spores and pollens (from molds and plants).

The layer beyond homosphere extends upto 10,000 km (80 km – 10,000 km) is called **Heterosphere**. The composition of this layer is different at different levels.

Molecular Nitrogen layer	(N_2)	80 km – 200 km
Atomic Oxygen layer	(O)	200 km – 1100 km
Helium layer	(He)	1100 km – 3500 km
Hydrogen layer	(H_2)	3500 km – 10,000 km

The limit of each layer is arbitrary. Beyond 10,000 km the space is interplanetary space, which has Hydrogen in approximately the same concentration as in Hydrogen layer.

The atmospheric pressure decreases with altitude almost exponentially. This determines the characteristics of upper atmosphere. The pressure at sea level is one atmosphere. At high altitudes the pressure is low as gases expand and normal reactive species persists for long periods of time.

1.1.1 Thermal Structure of Atmosphere

The thermal structure of atmosphere is distinct and well defined. It consists of three layers in Homosphere and one in Heterosphere.

The atmosphere is stratified on the basis of temperature and densities. The lowest layer of atmosphere is **Troposphere**. It extends from 10-16 km (10 km at poles and 16 km at equator) and is characterized by a gradual reduction in temperature, termed as **lapse rate**. The cooling is because a parcel of air looses heat when it rises due to reduction in pressure. A dry parcel of air (if neither gains nor looses temperature from surroundings) cools at the rate of 0.96°C/100 m and is known as **Dry Adiabatic Lapse Rate or DALR**. Such conditions of atmosphere are rare. Troposphere has highly variable water vapor. It contains most of water and clouds. Therefore the cooling could be higher or lower than DALR. The troposphere ends at **tropopause**. The temperature of

tropopause at poles and equator are different, and is much smaller at poles, due to equatorial bulge.

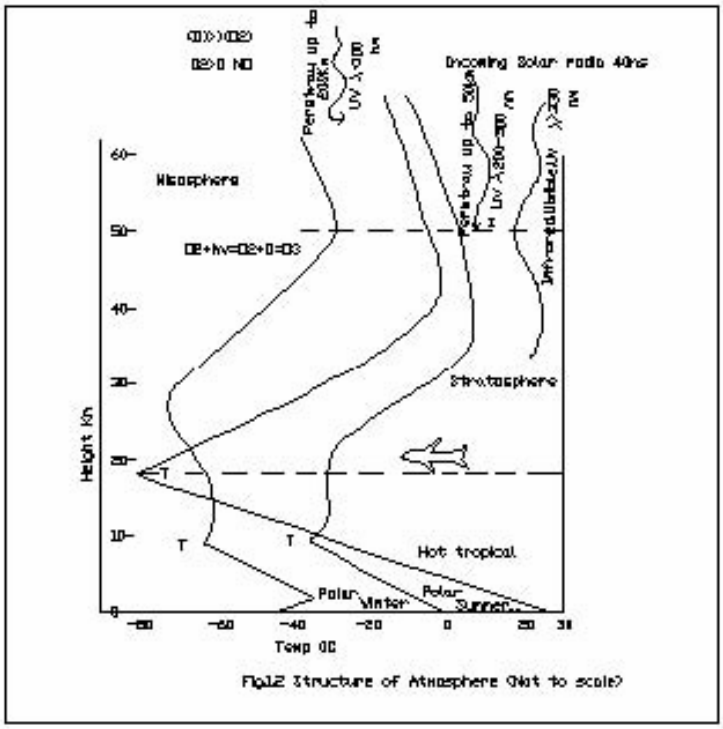

Fig. 1.2 Structure of Atmosphere (Not to scale)

Temperature of atmosphere at pole if is 0°C than at tropopause it will be - 96°C, where as if the temperature of atmosphere at equator is 40°C the temperature at tropopause will be - 113°C.

The intense cold conditions at tropopause serves as a barrier that causes water vapor to condense to ice and the so the water vapor does not reach the next layer.

At tropopause (10 – 16 km), there is a gradual change of temperature reduction. The temperatures beyond rise to as high as ground temperatures. This layer is known as **Stratosphere**. The rise in temperature is due to the presence of Ozone, which absorbs UV radiations. At an altitude of ≈ 50 km and more, ions are more active and the region is also called ionosphere. Ultraviolet radiations are responsible for this phenomenon.

The stratosphere gradually through **Stratapause** changes over to **Mesosphere**. It extends upto 80-85 km and is very windy and turbulent. The mesosphere is characterized by decrease in temperature. The absence of high levels of radiation absorbing species in mesosphere results in decrease in temperature to about - 83° to - 92°C. The upper regions

of Mesosphere defines a region called **Exosphere** from which molecules and ions do not escape. This is the last layer of Homosphere. Mesosphere is followed by a region with rarified gases which absorb high energy radiations (≈ 100 nm) and reach temperatures as high as 1100°C - 1650°C. This is known as **Thermosphere**. Troposphere, Stratosphere and Mesosphere lie in Homosphere and Thermosphere in Heterosphere. The structure of atmosphere is depicted in Fig. 1.2.

1.1.2 Air Pressure

The air pressure exerted by atmosphere on objects at the surface of earth is equal to the weight of overlying air. At sea level, it is 10.3 metric tons /m^2 and is defined as 1 atmosphere. It is measured as 1013.25 millibar or 1000 mb. Since air pressure acts in all directions it is not noticed as a force. The density of air increase with increase in pressure. (If the temperature of dry air is kept constant, the density of air varies in direct proportion to pressure). The density of air at an altitude of 12 km where most of, subsonic jets fly is about 1/4^{th} the density at sea level.

At any location, the variation in pressure is small, but these variations can abruptly change the weather. During high pressure the skies are clear but low pressures indicate strong weather. The density and pressure drop rapidly with increasing altitude. Pressure may become negligible but does not end (Fig. 1.3).

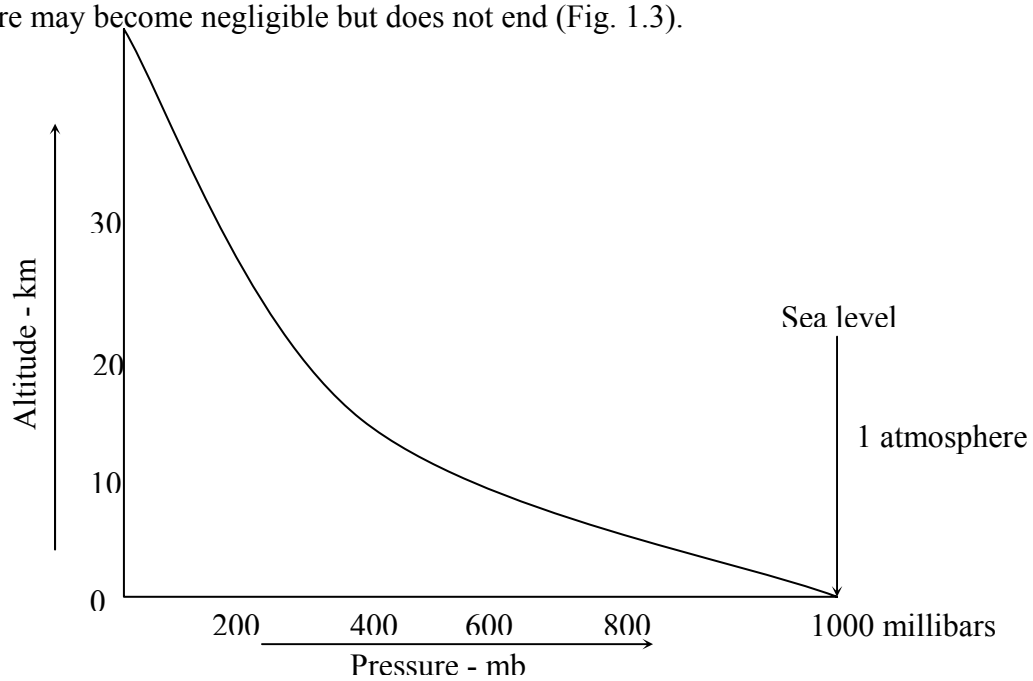

Fig. 1.3 Variations in pressure with altitude

1.1.3 Dynamism of Atmosphere (Energy)

Dynamism of atmosphere is maintained by a ceaseless flow of energy. The sun is the source of all energy and it drives the atmosphere. The energy in the form of electromagnetic radiations reaching the top of earth's atmosphere is distributed over a wide range of wave lengths.

Type of Radiation	***Wavelength***	***Fate of Radiations***
Infra red (50%)	0.71 – 100 μ	Absorbed by CO_2 and H_2O mostly below 10 km
Visible (41%)	0.40 – 0.71 μ	Transmitted to earth undiminished
Ultraviolet (9%)	0.10 – 0.40 μ	
	< 0.12 μ	All absorbed by O_2 and N_2 above 100 km
	0.12 – 0.18 μ	All absorbed by O_2 above 50 km
	0.18 – 0.30 μ	All absorbed by O_3 between 25 – 50 km
	0.30 – 0.34 μ	Part absorbed by O_3
	0.34 – 0.40 μ	Transmitted to earth undiminished

The total energy emanating from Sun is 4×10^{27} cal/min. A significant amount of energy is prevented from reaching the earth's surface by gaseous constituents. The energy in the radiation is absorbed by gas molecule, warms the atmospheric layer. As given above uv-solar radiations (wave length < 0.3 μ) are completely absorbed high in the atmosphere (50 km) and infrared are substantially depleted through absorption by CO_2 and water vapor at low altitudes (< 10.0 km). The visible solar radiations are able to pass through atmospheric gases. The atmospheric O_3 is able to absorb uv radiations in the wave length of 0.18 – 0.30 μ in stratosphere.

The fate of incoming solar radiations which are not absorbed by atmospheric gases is shown below in Fig. 1.4.

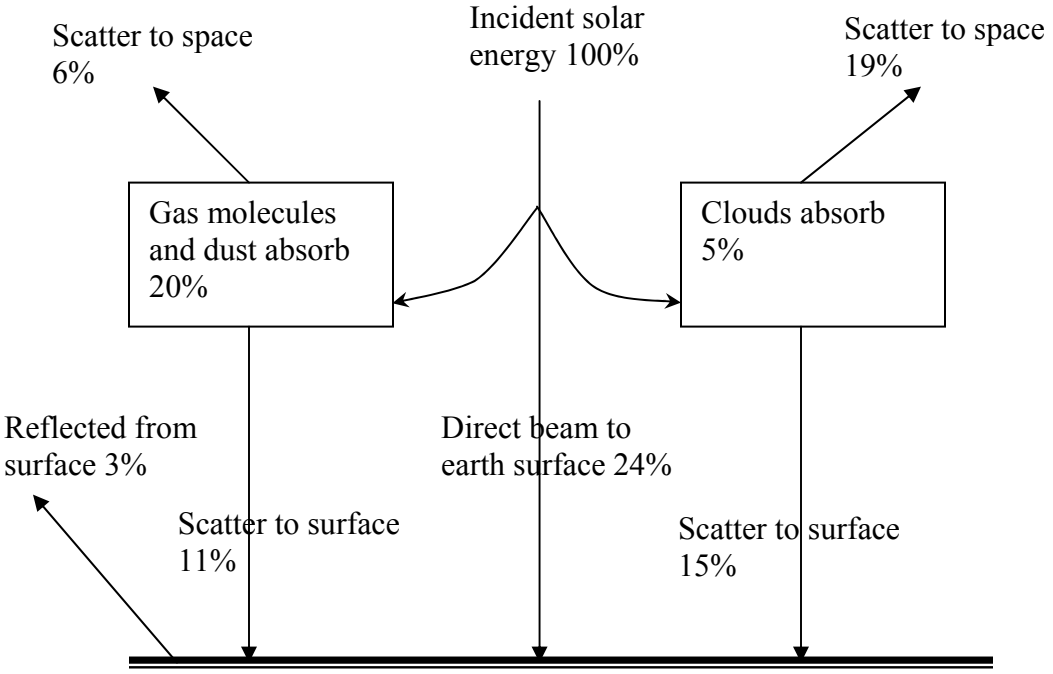

Fig. 1.4 Fate of Incoming Solar Radiations

Scattering and absorption is done by aerosols (aerosols are particles dispersed in gas) as well as gases. This depends on the size, composition, altitude and humidity.

The reflectivity of a surface is called **Albedo**. The albedo is equal to reflected energy divided by incoming radiation. The earth's albedo not only depends on characteristics of the surface but also the angle of incidence (of solar radiations). The albedo of various surfaces are:

Surface	**Albedo**
Snow	0.5 – 0.9
Water	0.03 – 0.8
Sand	0.2 – 0.3
Grass	0.2 – 0.25
Soil	0.15 – 0.25
Forest	0.05 – 0.25

The energy absorbed by earth is used up in driving the atmosphere in terms of wind, waves, ocean currents, hydrological cycle and photosynthesis and the rest is sent back to space as terrestrial radiations.

The peak intensity of these radiations occur at a wave length of 10μ (infra red). In contrast the peak intensity of solar radiations is 0.45 μ wave length. (Fig. 1.5)

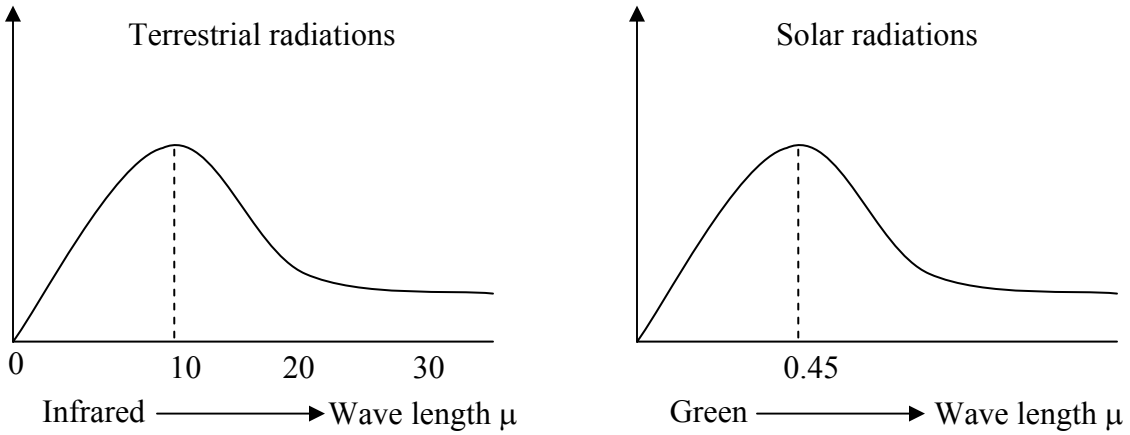

Fig. 1.5 Peak intensity of solar / Terrestrial radiations

Since solar radiations and terrestrial radiations represent different portions of electromagnetic spectrum, their interaction with atmosphere differ. Nineteen percent of solar radiations are absorbed by atmosphere whereas, bulk of terrestrial radiations are absorbed by CO_2, O_3 and water vapor. The atmosphere, therefore, through the properties of cloud, water vapor and CO_2 act as a thermal blanket. This thermal blanket is termed as **Green House Effect.**[**]

Other gases that absorbs infra-red radiations are methane (CH_4) hydrocarbons (HC), nitrogen oxides (NO + NO_2) and many free ions. They also contribute to Green House effect.

The amount of energy reaching the surface of earth after absorption, and reradiation varies between 1.88–2.01 cal/cm^2/min. The average being 1.94 cal/cm^2/min. This is known as Solar Flux and has been approximated to 2.0 cal/cm^2/min.

*** The presence of infra red absorbing gases and water vapor in the atmosphere contributes to **Global Warming** the **Green House effect** by allowing incoming, solar radiations to penetrate the atmosphere to the surface of earth (peak intensity (green), while reabsorbing infra red radiations emanating from it. The differential behaviour of the atmosphere towards out going radiations / incoming radiations play a Similar role like that of the glass roof in small horticulture system i.e. a green houses.*

1.1.4 Wind

The differential heating of air gives rise to horizontal pressure gradients leading to horizontal movement of air. The temperature differences between atmosphere at poles and at equator and between continents and over the oceans are responsible for large air movements. The earth's rotation modifies the horizontal movement. The air flow normally is from high pressure to low pressure (from cold area to hot areas).

Movement of the pressure system, diurnal heating and cooling of earth produces patterns of wind movement which are depicted on a polar diagram. This varies both temporally and spatially. This polar, diagram is called **wind rose** diagram. They depict frequencies of observed directions and distribution of wind speed. (Data is normally reported at eight primary and eight secondary directions of the compass.

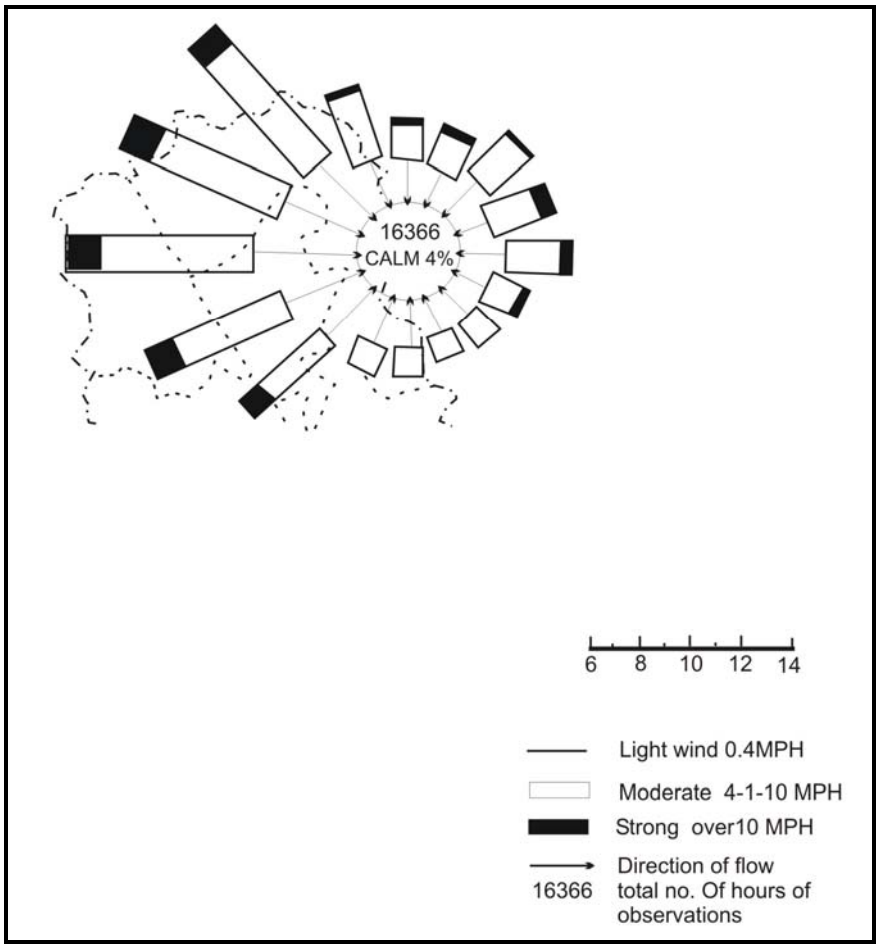

Fig. 1.6 Wind Rose

** The earths rotation modifies the horizontal movement.*

*** Climatologists have predicted a rise in temperature between 1.5 – 4.5℃ by 2025, which will be more pronounced in polar region and would induce melting of polar, caps, which will increase the sea level by about 0.5 – 1.5 m.*

(Lecture 1, 2)

1.2 Hydrosphere

The sum total of water bodies is termed **Hydrosphere**. Water is an essential element for all living beings. The amount of water in living individuals vary between 70 – 80% by weight. Nature has maintained the some ratio globally also. 71% of globe is covered by oceans which constitutes nearly 97.2% of total water. Two percent water is locked in the icy sheets of Arctic and Antarctic regions. The remaining ≈ 1.0% water represent the inland waters. On a global scale, total abundance of water is not a problem; the problem is availability at the right place, at the right time and in the right form. Water is a heterogeneous resource that can be found in either a liquid, solid or a gaseous form at number of locations on/or below the surface of earth. Depending on specific location of water, the residence time may vary from a few days to thousand of years. Further, more than 99% of earths water is unavailable for beneficial human use (because of salinity in sea water or location, icy sheets). The water budget is depicted below:

Location	***Surface area km^2***	***Water volume km^3***	***% of total water***	***Estimated residence time***
Oceans	361×10^6	1230×10^6 km^3	97.2	Thousands of years
Atmosphere	510×10^6	12700	0.001	9 days
Rivers and streams	-	1200	0.001	2 weeks
Ground Water upto the depth of 0.8 km	130×10^6	4×10^6	0.31	Hundreds of years
Lakes (Fresh Water)	855×10^3	123,000	0.009	Tens of years
Icy caps	282×10^5	286×10^5	2.15	Upto 10,000 years

The residence time of water in different components of Hydrosphere can be calculated from Box model (After Garrets and Mackenzie 1971) Fig. 1.7.

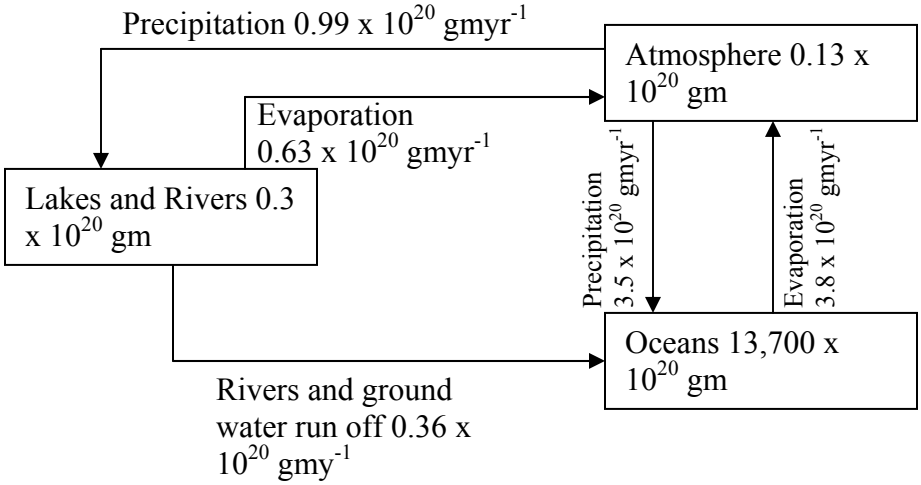

Fig. 1.7 Box model

$$\text{Residence time} = \frac{\text{Amount of water in Reservoir}}{\text{Flux into the reservoir}}$$

$$\text{Residence time in oceans} = \frac{13700 \times 10^{20}\,\text{gm}}{(0.36 + 3.5) \times 10^{20}\,\text{gm}} = 3550 \text{ years}$$

$$\text{Residence time in Lakes and Reservoirs} = \frac{0.3 \times 10^{20}\,\text{gm}}{(0.99 \times 10^{20}\,\text{gm})\,\text{yr}^{-1}} = 110 \text{ days}$$

1.2.1 Oceans

The oceans contain 1230 × 10^6 km^3 of water near the surface of earth upto varying depths (1.6 – 2.4 km). It contains, saline water of nearly uniform composition. The approximate concentration of salt is 34.45 gm/1000 gm.

Sodium chloride (NaCl)	23 gm/1000 gm
Magnesium chloride ($MgCl_2$)	5 gm/1000 gm
Sodium sulfate (Na_2SO_4)	4 gm/1000 gm
Calcium chloride ($CaCl_2$)	1 gm/1000 gm
Potassium chloride (KCl	0.7 gm/1000 gm

The Sea Water contains many other elements. Its composition has remained unchanged for thousands of years.

1.2.2 Glaciers and icy sheets

Glaciers are icy sheets formed on land when accumulated snow is compressed and hardened into ice by the weight of overlying layers. Sea ice is formed from sea water attached to the land and floats on the sea surface. The glaciers occur at high mountain ranges and may be km's long and few hundred meters thick.

Bulk of the world's ice is tied up in sheets that cover, Green land, and Antartica land masses. Formation is possible by intense cold climate. The icy sheets of Green land cover an area of 1.74×10^6 km^2 at an average thickness of 1600 m. The Antartic sheets cover 13.0×10^6 km^2 with the thickness of 2300 m. The icy sheets like glaciers are in motion carrying to oceans the ice formed about 10 m/year.

1.2.3 Hydrologic Cycle

Nearly 99% water of the globe is present in oceans or locked in icy sheets of artic and Antarctic regions. The remaining 1% resides in atmosphere, in river and lakes, in soil and subsurface layers. This fraction approximately 1000 km^3/yr is involved in cycling and maintaining flows in surface waters. This water determines the physical environment and terrestrial plant and animal life. The process that maintains the flow of water through the terrestrial and atmospheric components of hydrosphere is termed **Hydrological Cycle (Fig. 1.8)**.

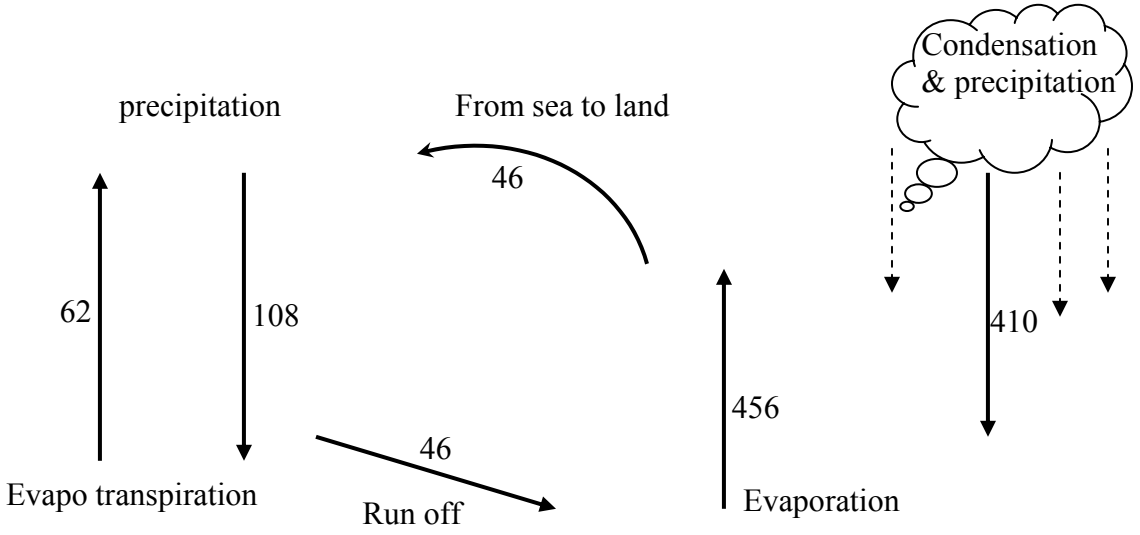

Fig. 1.8 Hydrologic Cycle

The Hydrological Cycle includes:

Evaporation of water from oceans, other water bodies and soil,

Evapotranspiration of water from plants,

Horizontal transport of atmospheric water from one place to another, either as vapor or as liquid droplets,

Precipitation in which atmospheric water condenses and fall on oceans, land as rain, sleet, hail or snow,

Runoff in which water that has fallen on continents as precipitation finds its way flowing on land and under the surface back to oceans,

1.2.4 The estimated distribution of Annual Water Resources of India 1974 (2025) as 10^6 ha. M is given in Fig. 1.9: (values in parenthesis are projected values of 2025).

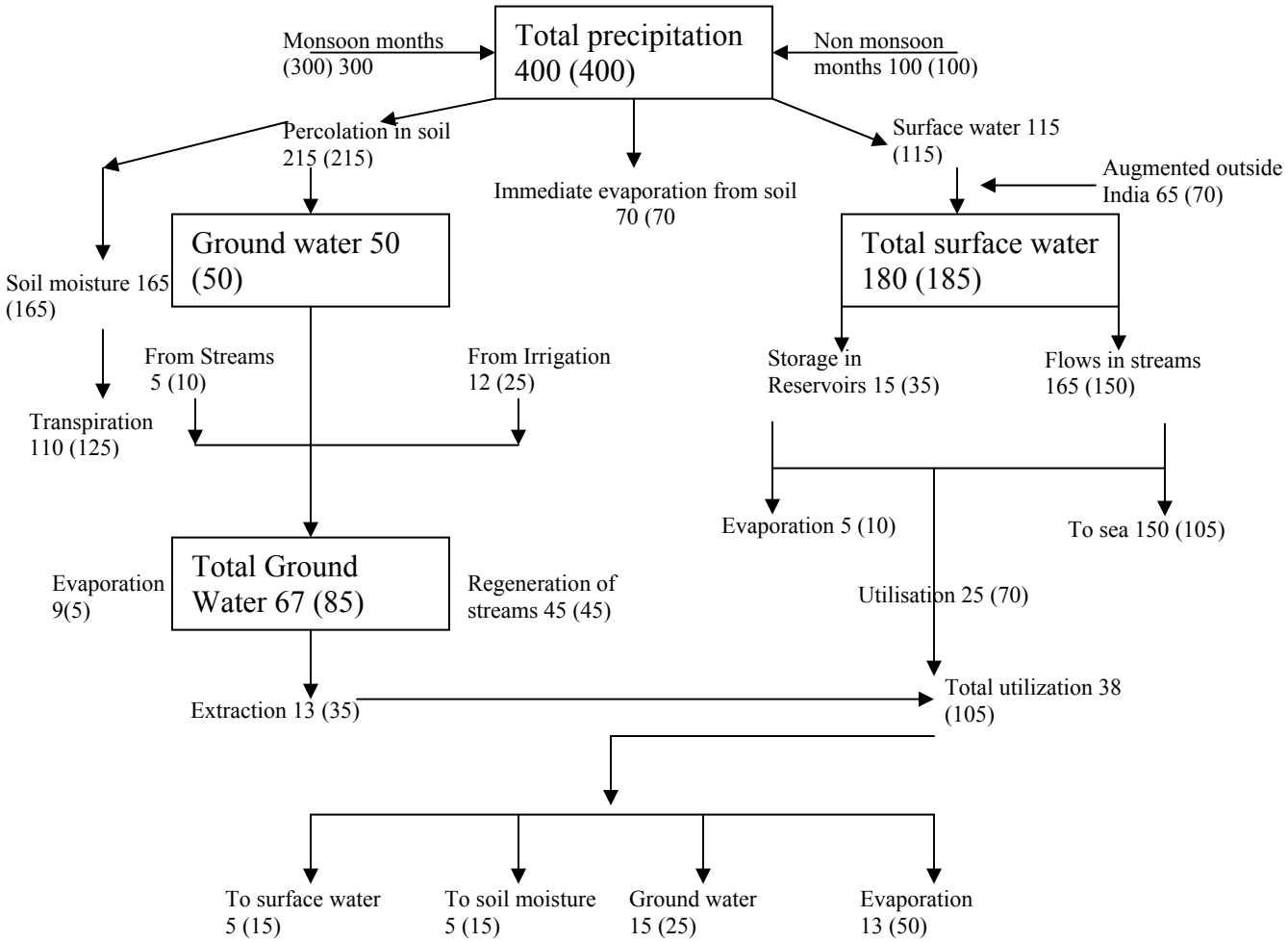

Fig. 1.9 Estimated Distribution of Water Resources (Annual) (India)

1.2.5 Water Quality

The water quality in nature is highly variable and depends on its source*. Water is an excellent solvent. It picks up impurities during flow. Other impurities are thrust upon it during its manifold use (to be discussed later) and misuse. The inland waters have varying amounts of salts present. The relative abundance of ions (by weight) make them hard or soft.

	Na^{++}	k^{+}	Ca^{++}	Mg^{++}	Cl^{-}	SO_4^{-}	CO_3^{-}
Soft	100	-	62.5	3.3	119	43.8	75.0
Hard	100	76	310	66.8	195	119	567

More precisely water quality is related to its use. The uses may be in stream or off stream.

In Stream : Navigation, hydroelectric power generation, recreation, taking away of waste waters and preservation of wild life and fish

Off Stream: Drinking and other domestic uses, washing, industry, agriculture and other consumptive uses

There are well designed criteria of water quality for different uses. These criteria are based on physical, chemical and bacteriological parameters

1. **Physical parameters :** Temperature; Conductance; Total, suspended, dissolved, volatile and fixed residues.
2. **Chemical parameters:** pH; acidity; alkalinity; hardness; chlorides; sulfates; □luorides; phosphates; dissolved gases, oxygen and CO_2; organic material, BOD, COD; Nitrogen, saline, Kjeldahl, nitrates and metals.
3. **Badriological parameters:** Total bacterial count, MPN Coliform, MPN faecal Coliform, MPN Streptococcus.

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* *Fresh water: Water with Salt concentration of less than 0.01%*

Salt water: *Water with salt concentration around 3.0%*

Brackish water: *Water in estuaries, a mixture of fresh and seawater where rivers enter sea.*

Designated Best uses (DBU) of water

A. Drinking water source without conventional treatment but use after disinfection.

B. Out-door organized bathing

C. Drinking water source with conventional treatment

D. Propagation of wild life, fish

E. Irrigation, industrial cooling and controlled waste disposal

The Criteria for each category have been defined and will be discussed later.

(Lectures 3)

1.3 Lithosphere

The outermost layer of Earth's surface is called crust. It ranges in thickness from about 6 km beneath the oceans to as much as 75 km below the mountain ranges. This layer floats over a dense material "mantle" beneath. The combination of crust and hard upper layer of mantle is called **Lithosphere**. In general, land systems which supports biota and human life is referred as Lithosphere. They comprise an ecosystem which is subjected to maximum onslaught by anthropogenic activities.

Lithosphere is composed of four subsystems viz.

- minerals
- sedimentary strata
- clays and
- soils

Each system differs from others in physical and chemical properties. They respond differently to pollution.

1.3.1 Minerals:

Minerals are commonly occurring inorganic solids with well defined crystalline structures. The crust consists of rocks (Rocks are conglomerate of one or more minerals). Most land systems consist of Silica, Oxygen (75% w/w), Aluminium (8%), Iron (5%)

Calcium (4%), Sodium (3%), Potassium (3%) and Magnesium (2%) Together they constitute 99% of earths crust.

1.3.2 Sedimentary Strata:

The sediments consist of mixture of clays, silt, sand, minerals and organic matter. Land, sediments of lakes and rivers are made up of sedimentary rocks. The characteristics of the strata depends on its origin and transport. The matter is predominantly carried by water and some time by wind. The sediments at the bottom of a water body is determined by physical, physico-chemical and biological processes. Many minerals, organic matter, recalcitrant compounds exist in sediments. Rivers carry sedimentary material through erosion and transport through flows and transfers them to the bottom. These deposits are called “alluvium”.

The sediments are important repositories for trace metals. They may exist in mobile (ionic) form or in the form of complexes or chelates of insoluble hydroxides.

1.3.3 Clays:

Clays are silicate materials containing Aluminium and are defined by size and other inorganic constituents. In water they are distributed as colloidal material. They are largely hydrated aluminium and silicon oxides. The most common clay minerals are “illite”, “chlorite” and “kaolinite”

$[Al\ Mg\ Na\ (OH)_2\ Si_4O_{10}]$, $[Al_3\ k\ SiO_3.\ (OH)_4]$, $[Al_2.\ Si_2O_5\ (OH)_4]$

montomorillonite illite kaolinite

Clays are made up of very fine grains having layered structure of sheets of SiO_2 alternating with sheets of Al_2O_3. Two or three sheets make up a unit layer. Some clays may absorb water and cause swelling of clays. Clays bind cations, such as Ca, Mg, Al, which protect them from leaching.

1.3.4 Soil

Soil constitutes the most important component of land system. It grades into the parent bed material. The soil is a finely divided rock derived material containing organic matter, capable of supporting vegetation. Each soil has a unique morphology resulting from interaction of climate, living plants, animals and parent rock material. The organic

content consists of biomass in various stages of decay, varying population of bacteria / fungi. The pores in the soil are filled with oxygen, CO_2 whose concentration vary between 15 – 35% and 0.1 – 3% v/v respectively.

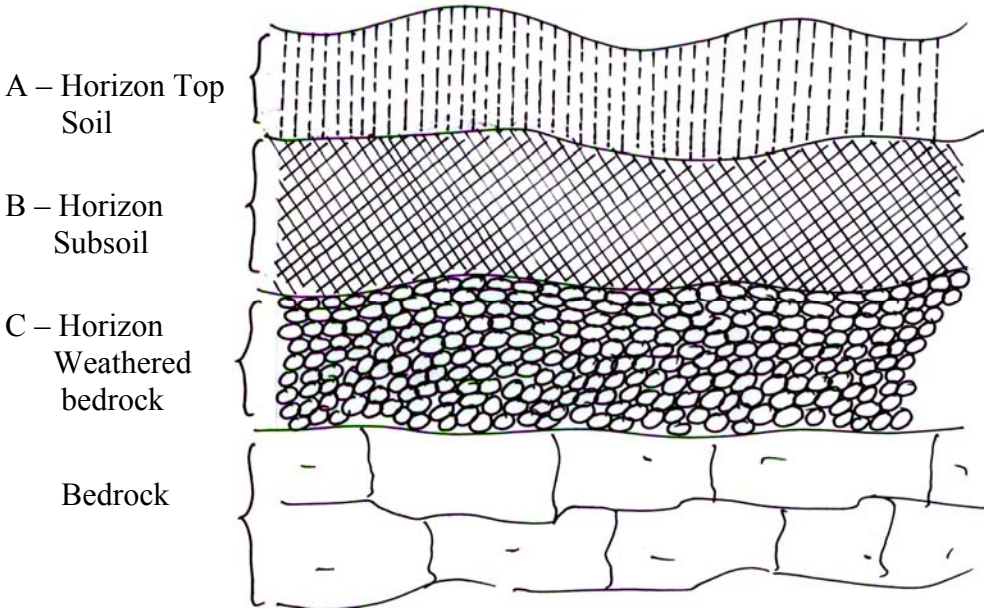


Fig. 1.10 Soil Profile

Soil is arranged in Horizons (layers) Fig. 1.10. The arrangement of horizons is termed soil profile. They are more or less parallel to surface and differ from another by texture, color, porosity and consistency. The top layer of the soil is A–Horizon. Maximum biological activity takes place in this layer. It contains most of the organic matter ≈ 5% of solid fraction. The next layer is B-Horizon or subsoil. This receives organic matter and salts from top soil by leaching. The C-Horizon is the weathered layer of parent rock material.

The mechanical properties of soil are particle size. The major categories are:

Gravel	2 – 64 mm
Sand	0.06 – 2 mm
Silt	0.006 – 0.06 mm
Clay	< 0.006 mm

The soil also provides nutrients for plants

(Lecture 4)

1.4 Biosphere

Biosphere comprises a very large component of environment and includes a vast array of living beings. The biological spectrum is:

Cell → Tissue → Organ → Organ system → Organism → Population → Community

The living organization exist at cellular level (algale, bacteria, fungi and protozoa) or at multi cellular level (all other animals and plants). Entities which exist at sub cellular (molecular) level are phages, plant and animal viruses.

Every living being has its defined metabolic needs for maintenance, growth and perpetuation. They exist where these needs are fulfilled. The existence in a particular set of conditions bring about constant interaction with non-biotic components and among themselves. Plants produce organic matter from mineral matter utilizing, solar energy, stored as food on which animals, survive. For them the need of energy is also fulfilled by food (Chemically bound energy).

The plants on death and decay and animals also on death and decay and waste products, produce organic matter. This matter is the basic need of decomposers. They thrive and convert organic matter to minerals. Minerals are picked up by plants for their sustenance. Thus a cycle is established between producers (plants) consumers (animals) and decomposers (bacteria and fungi) and between biotic and a biotic components.
This is the basic principle of **Ecology**.

Producers, consumers and decomposers live together, and constitute a well established community in a defined **Habitat**. Human indulgence has produced stresses by their legitimate as well as illegitimate activities of life. The environment which is least stressed support a good diversity. The diversity reduces as stresses increase. A good biological population or good biodiversity is indicative of good pristine environment. A low biodiversity is indicative of a stressed environment in extreme cases, the stresses/ often become so large that the population of a sensitive species of (plant or animal) gets reduced in a region or even disappear. These species are termed Threatened or Endangered species. In India alone 583 plant species and 158 animal species are identified as threatened (CSO, GOI, 1999).

(Lecture 4)

Suggested Reading

1. Ecology, Impact Assessment and Environment Planning, Walter E. Westman, John Wiley, Sons, Canada, 1985.
2. Ecology and the Quality of Our Environment, Charles H. Southwick, D. Van No strand Co New York.
3. Fundamental of Ecology by Eugene P. Odum., W.B. Sounders Co. Ltd.
4. Hand book of Environmental Pollution (3 volumes) by Bela G. Liptak.
5. Air Pollution by Arthur C. stern (2 volumes).
6. Introduction to Environmental Engineering, M.L. Davis, David A. Cornwell, WCB Mc Graw Hill (1998).

CHAPTER - 2

2.0 Sustainable Development

The increasing impact of anthropogenic activities on physical and biological environment specially in reference to ecological changes are a matter of great concern to environmentalists. The concept that man lives in close relationship with biotic and biotic components of nature - symbiotic living, has been established, since man become aware of his surroundings. The progress made in science and technology-biotechnology, genetic engineering, communication engineering, and industry has brought additional pressure on the fragile ecosystem stability. The increase in population in the last three decades has multiplied the impacts. The world's population was 2.0 billion in 1927 and has become triple, 6.0 billion in 2000 and is expected to reach 11 billion by 2050.

It is known that population growth and economic development are affecting the environment. There is a close relationship between Population growth and environmental damage (Erlich Equation)

$I = P \times A \times T$ where I = Impact on environment

P = Population

A = Affluence (Consumption)

T = Technology Coefficient

India's population has crossed one billion mark. More people mean more pressure on resources, more consumption of energy, more production of wastes and more effect on environment.

Sustainable Development is a concept that underscores that rate of consumption or use of natural resources should approximate the rate at which these resources can be substituted or replaced. It further requires that a nation is able to satisfy its requirements social, economic and others without jeopardizing the interests of future generations. Realization must come to us that nature is fragile and is finite. (It is believed that we have reached a Critical Threshold beyond which ecological decline would lead to disaster). This was the religious wish of "Earth Summit" held at RIO in 1992, where it was discussed in great detail. The theory was finally accepted that earth has limited capacity to carry population growth, urbanization and its pressure, technical innovation

industrialization and thus adverse effect of pollution on the Air, Water and Land. The world commission gave the most acceptable definition of Sustainable Development (U N Sponsored Commission), as **"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs"**.

2.1 Fundamentals Concerning Environment and Sustainable Development

Population and Implications

The pressure of population tended to increase rapidly over the last 250-300 years with world's population doubling almost every 25-30 years, the pressure on natural resources became greater, in order to meet the ever increasing requirement of food, shelter, transport, industry, through out the world. Every increase in human population calls for greater availability of goods and services through the process of resource development and utilization. Thus rapidly increasing human population compelled and inspired man to develop new resource and evolve new and quicker techniques for their utilization and even exploitation.

Sustainable Development is about integrational equity. But if future equity is of great concern, it is not legitimate to ignore the equity occurring in the present population in different parts of the globe. Sustainability should, therefore reflect equity, environmental concerns and social responsibilities vis-à-vis population regardless of time or location.

Limits to Growth

The management of environment is not possible unless there is a change in perception and attitude, consumption patterns, manufacturing and marketing practices and gel into a technological world that is less intensive in terms of materials and energy. Improvements in efficiency alone will not be enough. "Earth's Carrying Capacity" concept must be adopted.

Global warming can only be combated if the world can make a rapid transition to a non carbon energy economy. The world needs an international mechanism that not only provides incentives to all nations to live within their entitled amounts but also helps to promote a rapid transition to a non carbon energy economy. "An ecology of means has to

be accompanied by an ecology of ends". The efficiency revolution will remain counter productive if it is not accompanied by a sufficiency revolution.

The world faces an enormous challenge in the coming years. But the world's civil society and changing social system will have the capacity to turn around to convince all the stake holders that nature has its own rules and it will take a revenge if its capacity is stretched too much.

2.2 Economy

Rate of Gross National Product (GNP) is considered to be an indicator of economy. Increase in GNP indicate that economic health of the country is good. Such increase in GNP is based on high rate of consumption of natural resources, which ultimately results in environmental degradation.

India since early 1990 opted for free market economy. Major economic advantages are expected to follow this transition. However, economists would have to take into account the idea of ecological disadvantage inherent in such an economic shift. The production cost must internalize the eco-costs.

High economic growth means high rate of extraction, transformation, and utilization of non renewable resources. One must realize that though higher rate of GNP is important, equally important is the rate of regeneration of natural resources. Conservation of natural resources is discussed later in chapter 8.

The concept of sustainable development was advocated by Brundtland Commission, 1987. It states that economic growth has to be environmentally sustainable. There is no economic growth without ecological costs.

2.3 Poverty

Poverty is a complex problem and is a major challenge all over the globe. Solution to poverty are country specific and must be tackled along with development and environmental issues. While managing environment and resources, due consideration has to be given to the fact that below poverty line (bpl) people directly depend on natural resources for their livelihood. Therefore, an effective strategy for tackling the problems of environment, development and poverty is to begin with economic conditions of the

people, their resources and productivity. Thus sustainable development must take into consideration the eradication of poverty also.

2.4 Human Settlement Issues

The conditions of human settlements in developing countries is deteriorating mainly due to low investments in housing and social welfare. The environmental implications are poor living in slums and colonies / clusters of economically poor / below poverty line, are that unsanitary conditions prevail, lack living conditions and direct dependence on natural resources like forests. Sustainable development would involve:

- Providing shelter to all
- Investing in infra structure for providing water and managing sewage and solid wastes
- Promoting sustainable energy and transport system
- Promoting sustainable land use management

2.5 Land Resources

Planning and management of land resources constitute another area of concern for environment. Land use not only include physical entity but also soil, minerals and biota. These components provide services essential for life.

2.6 Forests

Nature has provided bountiful resource as forests. Forests not only provide wealth of flora and fauna but also is a sink of CO_2 and source of Oxygen. UN mandate is that at least 33% forest cover must be maintained by member countries. Since forests provide timber a necessity for wood products, forests once felled by unscrupulous persons aided and abetted by Govt. means loss of an important resource. Deforestation has brought in global warming and weather shift. A separate management of forest by Forest Acts is prevalent in many countries and is one of the most important element of sustainable development.

2.7 Mountains

It is estimated that 10% of World's population is dependent directly on mountain resources. This mountain (Hill) ecosystem is undergoing fast deterioration and is

effecting the resources of valleys and plains. Erosion of mountain slopes for various purposes has brought in untold misery by landslides and flow of sediment / nutrients in run off. This resource maintenance also constitutes an important element of sustainable development.

2.8 Agriculture

The phenomenal growth of population, which requires food to sustain, has brought in immense pressure on agriculture. This has been met by using better farming technology, good seed and use of chemical fertilizers and pesticides. Agricultural out put of the land masses under cultivation has increased. Since population is gradually increasing the food requirements are also on the increase. This requires bringing more land under cultivation. The need of irrigation will also increase simultaneously. All these aspects would bring more pressure on environment (residues of chemicals and pesticides). An increased interaction between agriculture and land use ecosystem is required specially when modern technologies are used. This is a challenge for Sustainable Development.

2.9 Biodiversity

Diversity of living species in any natural habitat, **biodiversity,** is an indicator of presence or absence of natural / anthropogenic stresses on the ecosystem. Higher the, variety lesser are the, stresses. Presence, absence or richness determines the state of biological wealth. Decline in biodiversity due to human activities is a threat to our environment. High biodiversity is needed to maintain the natural order.

2.10 Protection of Oceans

Ocean's which account for 97.2% of the globe is an important resource as well as an important sink. The wealth that is possessed by oceans is far greater than that maintained on land. Nature also has kept the ratio of 30:70 (land vs oceans) to maintain an order. Coastal areas contain diverse and productive habitats of human settlement. Many of the World's poor are crowded in coastal areas. These areas are in constant threat of erosion. The marine environment is being constantly polluted by sewage, plastic, metals and more recently radioactive materials.

2.11 Industry and Business

Business and industry are directly related to environment. Industries use many of the non renewable resources and the production processes leads to discharge of unutilized resources as waste emissions and effluents. Most of these discharges are strong enough to warrant treatment. Though it is mandatory under Water Act 1974, to treat the liquid wastes before discharge on land or a water body and Under Air Act 1981 to treat the air emissions but the records show that most of them do not meet the mandatory provisions. Thus there is a direct impact on environment. Some promising and environmentally conscious industries have adopted measures like waste minimization / effluent treatment technologies and conservation measures, yet more is needed.

It is time now that business and industry is driven by the requirements of sustainable development. The Earth Summit did suggest programmes that would promote environment protection and resource conservation for business.

Like economic deficit, we are creating a deficit of renewable resources on account of production and other direct and indirect developments, this is termed as **"ecological deficit"**. To reduce the ecological deficit, projects, programmes and regulatory mechanisms are necessary both at Govt. level as well as at corporate level. The implementation of the policies should be without bias and prejudice.

Think Global and Act Local.

(Lectures 5, 6)

Suggested Reading

1. Ecology, Impact Assessment and Environmental Planning, Walter E. Westman, John Wiley & Sons.

2. Sustainable Development of Water Resources – A Revisit, Thatte C.D. Proceedings Symp. Hydrological Perspective for Sustainable Development Vol. 1 (HYDESD), Deptt. Of Hydrology, IIT Roorkee Allied Publishers, New Delhi – 2005.

3. Environmental Impact Assessment, Barthwal, R.R., New Age International, New Delhi – 2002.

CHAPTER – 3

3.0 Environment Pollution and Quality

Environmental Quality its degradation and management are closely related. It is a balance between human systems and nature. As long as the balance is maintained, the quality of envronment remains conducive to the health and well being. Imbalances produce disorders and even calamities. An environmentalists role in maintaining order can not be over emphasized. It is true that high quality environment means differently to different people. It varies from habitat of a natural order, agrarian and pastoral scene to a beautiful city rich in culture and works of man. But all gree that trash, dirt disease noise, strife, poverty and pollution reduce the quality of environment.

Environment of the highest quality is one, which is conducive to good health and well being, where human needs are fulfilled, where there is solitude as well as sociality, where needs of food and shelter, education and recreation are fulfilled, where there is aesthetic stimulus and where all biological variable are intact and healthy.

Abuse of environment today is our main concern. It may be pollution of water, air and land or over exploitation of natural resources. According to Oodum (1971) “Pollution is an undsirable change in the physical, chemical or biological characteristics of environment that may or will harmfully effect human life or that of desirable species or industrial processes, living conditions and cultural assets or that may or will waste or deteriorate raw material resources”.

3.1 Atmospheric Pollution

A polluted atmosphere is generally considered as unnatural atmosphere. It is an over burden on the air without changing its natural properties. It may be due to addition of pollutants from nature or due to the activities of man in terms of population growth, expansion in industry and technology and social change like urbanization and rising standards of living. Atmosphere, is a very suitable mixture of Oxygen and Nitrogen. In addition, there are some other gases and aerosols, vapor varying in content and concentration. Polluted atmosphere may have gases, dusts, aerosols, spores, pollens as overburden. Some of these material are physiologically inert but others may produce

reactions which range from mild inconvenience to severe toxicity. When we breathe in they reach our respiratory system. Our sense of smell does not respond to all harmful pollutants. Some of them are perceived (H_2S, HCN) in low concentrations but do not induce defence reactions. The effects appear much later. The basic objectives of air pollution monitoring are:

i) Investigations of the atmosphere in residential areas in the interest of large population.

ii) Investigations in the industries and workshops subjected to hazards of waste gases.

iii) Investigation in the neighbour hood of industries

iv) Investigations of emissions belching out of stack / ventilators from factories / industries

Five substances, known as Primary pollutants account for more than 90% of air pollution. They are:

i) Oxides of Carbon, CO

ii) Oxides of Nitrogen, NO, NO_2

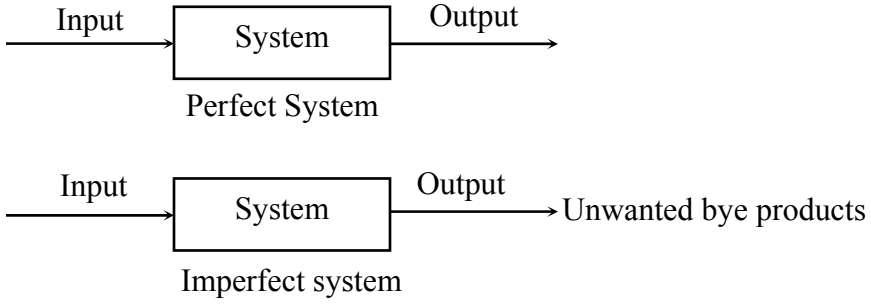
iii) Oxides of Sulfur, SO_2, SO_3

iv) Hydro Carbon, HC

v) Particulate matter, SPM dust

3.1.1. Origin of pollution

The air pollutants are constantly being added to atmosphere are generated by human activities. Any activity considered as system, is capable of producing a desired product. No system can be called a perfect system (inputs = output). A real system is imperfect as it produces one or more unwanted bye products



Some typical examples of imperfect systems are as under:

Input	***System***	***Desired activity***	***Unwanted bye products***
Petrol, air	Automobiles	Transportation	Exhaust gases CO, NO, NO_2, HC dust
Coal, air	Fire	Power generation	Smoke CO, CO_2, NO, NO_2, HC, SO_2, dust (unburnt Carbon)

The five important activities generate pollution as

Activities	***Over all***	***CO***	***Nox***	***Sox***	***HC***	***Dust***
Transportation	***42%***	***64.0%***	***48.0%***	***5.0%***	***51.0***	***4.2***
Fuel Combustion (stationary sources)	21%	2.0%	40.0%	72.7%	2.5	26.0
Industrial process	14%	10.0%	1.0	22.0%	14.0	31.0
Solid waste disposal	5.2%	8.0%	3.0%	5.0%	9.0%	3.8
Miscellaneous	17.4%	16.0%	8.0	4.0%	23.5	35.0

Perusal of the data reveals that transportation is the major culprit and Carbon mono oxide is the most severe pollutant.

3.1.2. Carbon mono oxide is produced chiefly through incomplete combustion.

Some carbon mono oxide is also produced (natural sources) by geophysical processes and biological processes like volcanic eruptions, natural gas emissions, electrical discharges, marsh gas and seed germination.

3.1.3 Oxides of Nitrogen:

Oxides of Nitrogen are produced due to combustion but a larger quantity is generated by natural processes. Of the man made activities producing oxides of Nitrogen (NO and NO_2) are the combustion both from transportation as well as from stationary

sources. Oxides of Nitrogen also play a significant role in photochemical smog and ozone formation.

3.1.4 Oxides of Sulfur:

Oxides of sulfur include SO_2 and SO_3. They are chiefly produced by combustion of fossil fuel in stationary sources. Thermal power plants contribute a large share. Transportation and Industrial processes also generate them. They are corrosive in nature.

3.1.5. Hydrocarbons

An organic compound containing only Hydrogen and Carbon and are gaseous at room temperature are designated as Hydrocarbons. In unpolluted areas, methane (CH_4, a natural decay gas) is most abundant. Other hydrocarbons normally noticeable are petroleum products and gasoline viz. Olefin, acetylene, benzene, ethylene and toluene. They are highly reactive and cause smog formation.

3.1.6 Particulate Matter

Include any dispersed matter smaller than 500 μg but larger than 0.002 μ. They are classified according to size and biological properties.

Settleable	> 10 μ	The particles of the size between 100 μ - 0.001 μ are of interest in pollution
Suspended	< 10 μ	
Biological		Spores, pollen and bacteria

The particles less than 10.0 μ are referred as Respiratory suspended particulate Matter (RSPM). Particles < 1.0 μ are retained) in the lungs.

3.1.7 Effect of Air Pollutants on man material and Vegetation

All pollutants released in the atmosphere do not produce adverse effects, though some of them are intensely toxic. Other's cause mild in convenience Some common pollutants causing physiological effects are listed below:

A.	**Biological Pollutant**	**Effect**
i)	Aeroallergens (Pollen, danders, spores, mold, yeast, hair, feathers, vegetative fibers, grain dust cosmetics, paint and glues	Bronchial asthma, hay fever, body rash and even eczyma
ii)	Biological aerosols, bacteria, fungus, virus	Pulmonary tuberculosis, anthrax. Throat infections, whooping cough, Diphtheria, common cold, Influenza
B.	**Non biological**	
i)	Ammonia (from Chemical industries refineries, Coke Ovens)	Corrosive to mucous lining, damage to eyes
ii)	Asbestos (air conditioning insulation)	Pulmonary fibrosis
iii)	Chlorine (manufacture, and use in water treatment)	Irritative to eyes / nose/ throat
iv)	Carbon-mono-oxide←(Combustion, stationary, sources)	Asphyxiation
v)	Sulfur-di-oxide	Irritation and Cardiac ailments
vi)	Oxides of Nitrogen (Combustion)	Asphyxiation, pulmonary edema
vii)	Hydro-carbons (combustion, petrochemical establishments)	Anasthesing effect Vomiting, vertigo

3.1.8 Guidelines of Sampling and Monitoring

The guidelines for selection of ambient air monitoring stations are given in IS-5182 part IV.

The guidelines state that "when objective of air sampling is to identify the contribution from specific sources of pollution, the sampling locations should be located in upwind and downwind of such sources". The location of air quality monitoring stations should satisfy the following conditions.

1. The site should be representative of the area selected.
2. The station should be set up and operated so as to yield data that can be compared with those from stations within the network, and

3. Certain physical requirements should be satisfied at the site

(Lectures 7, 8)

3.2 Water Pollution and Water Quality

The water, pollution may be caused by the addition of physical and chemical impurities, through addition of wastes from houses, industries or by surface runoff from agriculture and forests. It is essentially an ecological phenomenon involving interaction of organisms and the inanimate environment.

The direct measure of pollution, however, is the effect the polluting substances have on flora and fauna of the water body although physico chemical and biochemical tests may be necessary to explain these effects.

The sources of pollution may be classified into (a) Point sources and (b) non point sources

3.2.1. Point Sources:

Point sources are discrete and confined. They emanate either from houses, offices, other commercial buildings or from industries.

a) **Sewage or Domestic Waste:** Waste water emanating from house hold activities including toilets, bathrooms and kitchen, offices, commercial centers is termed as sewage. This has mostly biodegradeable impurities. Some nonbiological chemicals viz. detergents, phenols may also be present. Some of the important properties are:

i) Chemical Properties :

Color – Natural decay of organic materials

Odor – Decomposing waste waters

Solids – Residues of domestic products, salts, soil erosion

ii) Chemical properties (Residues of material used)

Organic – Carbohydrates, Proteins, Hydrocarbons

iii) Primary pollutions:

Organic and inorganic compounds selected on the basis of their suspected carcinogencity, tetragenicity or high toxicity

Surfactants : Soaps and detergents

Volatile organic compounds.

iv) Inorganic:

Alkalinity

Chloridies

Heavy metals (trace quantities)

Nitrogen

pH

Phosphates

Sulfates

v) Gases

Hydrogen, Sulfide

Methane

Oxygen

vi) Biological

Animals	:	Protozoans, Nematodes
Plants	:	Algae
	:	Pathogenic bacteria
		Indicator bacteria
Virus	:	Phages and animal virus

Important Pollutants of Concern

i) Solids / Residue : Total Solids, Suspended Solids, Dissolved Solids

ii) Biodegradeable : Biochemical Oxygen Demand, Chemical Oxygen Demand (B.O.D./C.O.D.)

iii) Pathogens : ***Salmonella, Shigella*** *and* ***Cholera vibro***

iv) Non Pathogens : Indicator bacteria – Coliform / Faecal Coliform

v) Nutrients : Nitrogen saline, Organic, nirite and nitrate; phosphates

vi) Priority pollutants : Known to produce cancer and other disabilities

vii) Refractory organics – Surfactants, Phenols

viii) Heavy metals : Fe, Ca, Mg, Hg, Pb

b) Industrial Wastes: The volume, strengths of industrial wastes entirely depends on the type of raw material used and the processes involved. Some components of industrial wastes would be.

Inorganic Salts	:	Chlorides (Salinity), Hardness (Scale forming)
	:	Acids / alkalies
Organic Compounds	:	Organic materials used
		Suspended
		dissolved
Floating Solids	:	oil and grease
Toxic Chemicals	:	Pb, F, As, Se, Cr, Cu, Fe, Mg, Zn. Hg
		Phenols, pesticides
Microbes	:	Tanneries, Slaughter house waste and food industries will have variety of microbes.
Radio active nucleotides	:	Atomic energy units.

The volume and strength is expressed in terms of kL waste produced, BOD and suspended solids.

3.2.2 Non Point Sources

Non point sources are diffused and intermittent. They are picked up and carried by run off. The important sources are:

Dairies, dhobhi ghats, motor garrages, cattle wallowing, carcass disposal, open defecation, crematorium, river fronts. They have sediment, nutrients and decomposable Compounds

3.2.3 Areas of Concern in Water Pollution

There have been seven areas of concern over the years which have pre occupied individuals with water pollution and contamination and ecological manifestations (i) Oxygen demanding wastes, (ii) Pathogens (iii) Nutrients, (iv) Salts and minerals (v) heated discharges (vi) Trace metals and (vii) Pesticides and other volatile organic compounds.

(i) Oxygen demanding wastes

Oxygen demanding wastes are biodegradable and require oxygen from receiving waters. The demand is exercised by microbial population in stabilizing the organic matter. Since the amount of oxygen dissolved is limited, it get depleted quickly and degradation proceeds under anaerobic (non toxic) conditions. The amount of oxygen

required to degrade the organic matter is measured as Biochemical oxygen demand and / or Chemical Oxygen Demand (BOD/COD). A quantitative relationship exists between the amount of Oxygen required to convert a definite amount of Organic matter to Carbon dioxide, water and ammonia.

$$C_n H_a O_b N_c + \left(n + \frac{a}{4} - \frac{b}{2} - \frac{3}{4} c \right) O_2 \rightarrow n\, CO_2 + \left(\frac{a}{2} - \frac{3}{2} c \right) H_2O + CNH_3$$

For a fully biodegrable waste which is also chemically oxidisable BOD : COD ratio would be 0.6 : 1.0

ii) Pathogens :

It is long established that domestic waste / sewage carry a plethora of micro organisms of intestinal origin which maybe bacteria / virus / protozoa or helminthes. They produce disease by growing and multiplying in the body of host. Some of these pathogens or ***Salmonella typhi*** (Typhoid), ***Salmonella paratyphi*** (Paratyphoid), ***Salmonella enteritidis*** (gastro enteritis). ***Shigella*** (bacillary dysentery), ***Cholera vibro*** (Cholera), Hepatities, Jaundice Poliomyelitis (virus), Protozoans produce amoebic dysentery and giardiasis, worms (helminthes) cause significant disorders. The intestinal discharges of persons suffering, carriers, contain billions of these pathogens.

A group of bacteria which are not pathogenic but are always associated with pathogens and unsanitary and unhygienic conditions are non pathogens (Coliform, faecal Coliform, Streptococcus). In routine waster and waste water examination the number of non pathogens (also known as indicator bacteria) is estimated.

iii) Nutrients

Nutrients are essential plant requirements such as nitrogen and phosphates, carbon, sulfates, potassium, iron, manganese, boron and cobalt. Some of these chemicals present in water accelerate the growth of plants (hydrophytes) and algae. Some times they can lead to blooms. The decay of blooms when, nutrients are exhausted depletes dissolved oxygen and add color and odor to water body (termed as Eutrophication).

In water pollution control strategy, Nitrogen and Phosphorus are important and need to be controlled to combat eutrophication and / or after growth. Nitrogen as NO_3 in excess of 40 – 45 mg/l are toxic to infants (methemoglobinemia–blue babies). Such concentrations are more frequent in ground waters.

iv) Salts and Minerals

Water is a very good solvent. It gathers a variety of dissolved salts during flow on geologic strata. These include cations viz. calcium (Ca^{++}), Sodium (Na^{+}), Magnesium (Mg^{++}), Potassium (k^{+}) and anions viz chlorides (Cl^{-}), carbonates (CO^{-}_{3}), bicarbonates (HCO_3^{-}) and sulfates ($SO^{=}_{4}$). The normal method of their measurement is as total dissolved solids (TDS) or conductance. The fresh water normally have TDS < 1500 mg/l; brackish waters upto 5000 mg/l and sea water normally in the range of 30,000 – 35000 mg/l. TDS is an important criterion to determine the usefulness of water. In public water supplies the recommended value is 500 mg/l.

Acid mine drainage is another mineral pollution problem. The major ions as pollutants in it are Fe^{++}, $SO^{=}_{4}$, H^{+}.

v) Thermal pollution

Thermal power generation is the main source of pollution due to heat, as it uses enormous amounts of water for cooling. The heat from fossil fuels and nuclear fuels is not fully converted into useful power and reaches cooling waters. For each kilowatt – hour energy produced in an efficient coal fired plant $2/3^{rd}$ heat is dissipated in cooling water.

Consequent to the discharge of heated water the ecology is altered.

vi) Trace metals

There are ≈ 80 elements in nature which are classed as metals. (heavy metals have sp. Gravity > 4 – 5). More often heavy metals are those which are toxic. The list includes:

Aluminium (Al), Arsenic (As), Beryllium (Be), Bismuth (Bi), Cadmium (Cd), Chromium (Cr), Cobalt (CO), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Mercury (Hg), Nickel (Ni), Selenium (Se) and Zinc (Zn).

The source of these metals in waters is through industrial discharges. They may undergo change to produce more toxic substances (Hg Salts). Excess of metal in body through ingestion and accumulation damages, liver and kidneys.

vii) Pesticides and other Volatile Organic Compounds

There are large majority of synthetic compounds which are manufactured to kill pests. (animals / plants harmful to man and plants) (Insecticides, herbicides, rodenticides and fungicides).

The commonly used pesticides are washed out in waste waters and may be found in trace quantities in water bodies (organo chlorines, organophosphates, (carbamates)

Other volatile organic compounds include Vinyl Chloride (used in manufacture of resins) Chloroethylene (Solvent used in heat transfer). Chlorofluorocarbons (air conditioning), dichloromethane (metal degreaser), Carbon tetra chloride (domestic degreaser). Some of them are carcinogenic and can damage nervous system.

3.2.4 Natural Water Quality Criteria

As per the Water Policy of India, natural water bodies have been classified based on water quality, which decides the Designated Best Use (DBU).

	Designated use	Nomenclature	Criteria
1	Drinking water source without any conventional treatment but after disinfection	A	pH – 6.5 to 8.5 DO – 6.0 or more BOD – < 2.0 mg/L MPN – < 50/100 ml
2	Organized out door bathing	B	pH – 6.5 to 8.5 DO – 5.0 mg/L or more BOD – ≤ 3.0 mg/L MPN – < 500/100 ml
3	Drinking water source with conventional treatment followed by disinfection	C	pH – 6.5 to 9.0 DO – 4.0 mg/L or more BOD – ≤ 5.0 mg/L MPN – < 5000/100 ml
4.	Propagation of wild life, Fisheries	D	pH – 6.5 to 8.5 DO – 4.0 mg/L or more NH_4 – N ≤ 1.2 mg/L
5.	Irrigation, Industrial cooling and controlled water disposal		pH – 6.5 to 8.5 Na absorption ratio max 20 Conductance 2250 μS/cm^2

3.2.5 Sampling Program

It is an axiom that the results of analysis can never be more reliable than the sample upon which the tests are performed. The quality appraisal is related to its use. The successful programme implementation is dependent or an understanding of complex

physico chemical and biological phenomenon and assembling this understanding into a coherent model (Fig. 3.1 & 3.2).

Design of Measurement System

A step by step procedure for the optimal design of measurement system is given below

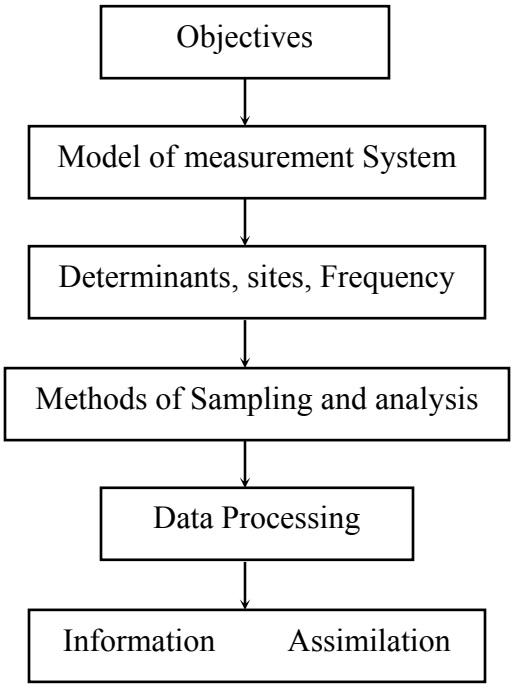


Fig. 3.1: Measurement System

Model of Measurement System

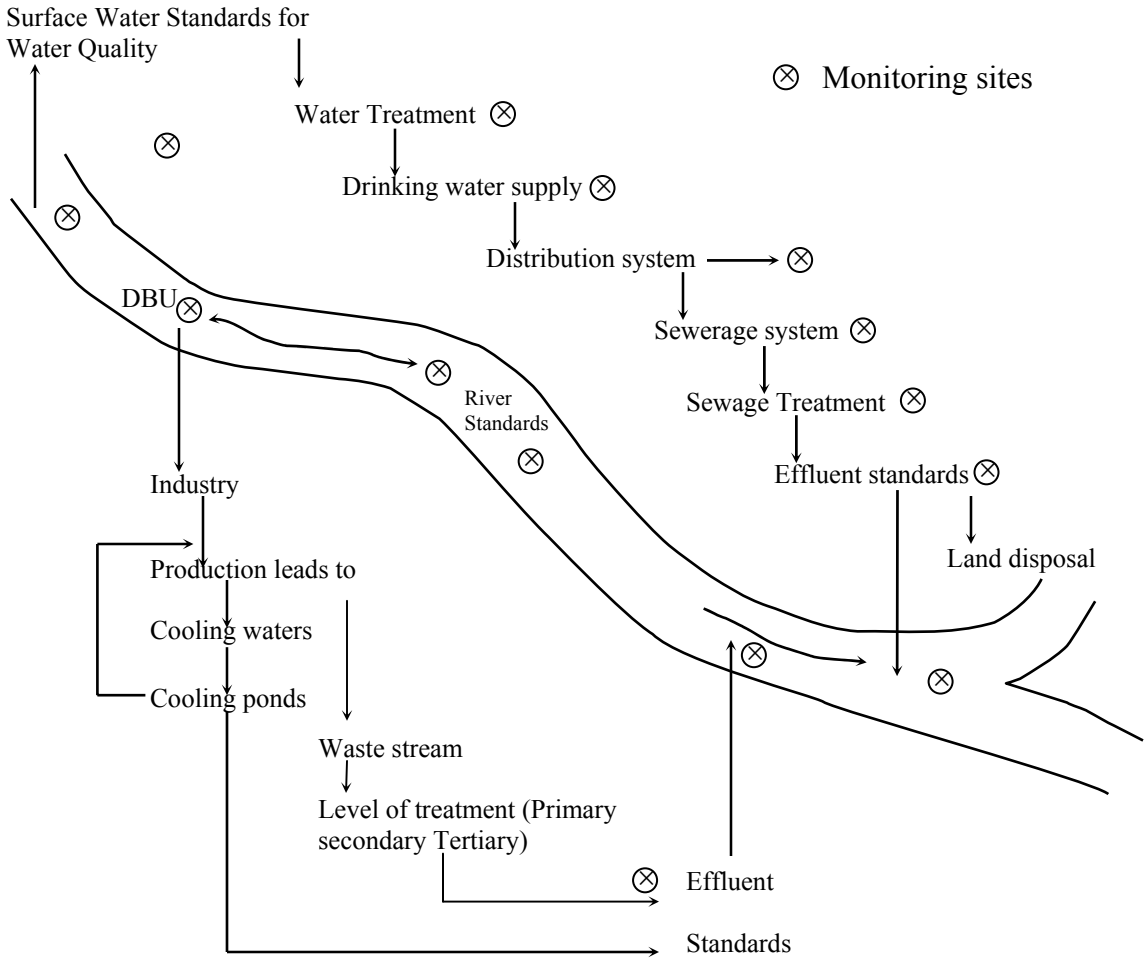


Fig. 3.2: Model of Measurement System

River Standards – Based on DBU

Protect and preserve stream on equitable basis

Upstream → down stream

– Flow (minimum flow to be maintained

If less augmentation

Effluent Standards – Need / meet required standards

No control on volume / day

Stream Specification B Class

Determinants Site and Frequency

The selection of determinants are solely based on the need to satisfy the objectives of measurements. Some important determinants are:

a) To determine background of source

Temperature (air and water), flow; hourly variation, precipitation, flow pattern (storage, equalization, pumping).

b) Physico Chemical determinants

Turbidily (NTU), transparency (Secchi's disc), color (Ni, Cobalt – Scale), total, suspended, dissolved, volatile and fixed solids; pH, alkalinity, acidity; dissolved gases (CO_2 and O_2)

c) Non Specific Organic Compounds

Biochemical Oxygen Demand (BOD 20^oC 5 days or equivalent)

Chemical Oxygen Demand (COD), Total Organic Carbon

d) Major elements:

Sodium (Na^+) Potassium (k^+), Calcium (Ca^{++}), Magnessium (Mg^{++}), Carbonates (CO_3), Bicarbonates (HCO_3), Chlorides (Cl^-), Sulfates (SO_4)

e) Nutrients : Total Nitrogen (kjeldahl), free ammonical nitrogen (NH_4^+) Nitrite – Nitrogen (NO_2), Nitrate Nitrogen (NO_3), Total and Dissolved Phosphates (PO_4).

f) Specific Pollutants : Copper (Cu), Zinc (Zn), Lead (Pb), Cadmium (Cd), Arsenic (As), Chromium (Cr), Mercury (Hg), Phenols, Surfactants, pesticides.

g) Biological form : Macrophytes, plankton, Nekton and Benthos

h) Microbiological pollutants: Total plate count (total bacterial, coliform (MPN), faecal Coliform (MPN), Streptococcus (MPN)

Sites and Frequency of Sampling

The main requirement of water quality determination is to collect a small portion of water / waste water which can be transported easily and handled in laboratory, while still representing accurately the parameters. A valid sample must be collected from the site at such times that analytical results are representative of the quality both spatially and temporally. The site may be predetermined such that it is approachable at all seasons commensurate with objectives. Samples be so collected / handled that they do not

deteriorate / become contaminated before it reaches the laboratory. The sampling bottles may be completely filled (except for bacterial examination) to avoid loss of volatile matter. There are defined procedures (Standard Methods for Examination of Water and Waste Water 20^{th} edition APHA/AWWA) for sampling for metals and biological, bacteriological examination. For routine analysis three type of samples are collected depending on the objectives.

Grab Sample: Grab sample is a small amount of sample collected at one place at a given time. Where changes in quality are anticipated a number of grab samples collected at suitable intervals and analyzed. Seasonal variations require collection at different times.

Composite Samples : Composite sample is a combination of number of grab samples collected at the place over a period of time (one, two or four hourly) proportional to the flow. (Not advisable for pH, DO, CO_2 and H_2S). Composite samples are required where quality varies with time (sewage and industrial waste)

Integrated Sample: Integrated samples are such samples which are collected at a time from different places (both banks and middle) and mixed in equal volume. Detailed methods of collection, storage and transportation will not be needed at this stage.

3.2.6 Objectives

The objectives of Water Analysis which constitute an understanding of the impacts and the effects on status of water body are:

i) To determine the potability of water

ii) To determine the suitability of Designated Best Use (DBU) of water body

iii) To determine the carrying capacity (waste load) of water and capacity of self cleaning.

iv) To determine the extent of treatment required for off site usage

v) To determine the possible determinable effects of waste effluents, point sources (domestic / Industrial) and non point sources

vi) To determine the type and quantities of waste discharge in municipal sewers

vii) Assess reasons of toxicity and fish kill

(Lectures 9, 10)

3.3 Land Pollution

Pollution of land and land degradation has been occurring extensively the world over. It could be largely due to soil erosion or accumulation of waste products. Some of the major causes of land degradation are soil erosion, desertification, salinization, discharge of liquid and solid wastes on land, penetration of harmful chemicals through leaching or under ground disposal. Though soil erosion may also be due to natural processes but other processes are anthropogenic.

3.3.1 Soil erosion

Refers to removal of top soil from the earth's surface. The topsoil is rich in useful organic matter and plant nutrients and its stripping would mean depriving the producers of basic minerals. The soil is washed away by surface runoff from catchment. Major irrigation projects and other construction projects are responsible for its acceleration. During construction large quantities of soil is transported to and from the site. Other projects of rail / road construction are also responsible for soil erosion. Impounding water and later releasing it for irrigation also contributes to it.

Land slides caused by inappropriate slope stability in developmental projects, land subsistence by over withdrawl of ground water and quarrying and mining activities also add up to the gravity of the problem. Though not very noticeable, over grazing by cattle also aggravate, soil erosion.

3.3.2 Desertification: Desertification also accounts for soil degradation. Deserts are fragile ecosystems which have harsh climate and poor productive land and less of water. Desserts have grown beyond their limits due to extensive land use for grazing of cattle. Deforestation in adjoining areas also have extended the limits of deserts.

3.3.3 Salination is common in areas where ground water level rises to the level of soil profile. These waters contain more salts than surface water due to larger contact with deposits. When the top water evaporates during summers, large deposits of salts are left in the topsoil. This has been happening around Indira Canal in Rajasthan. This soil gradually looses its productivity.

Another, wide spread process of water disposal both liquid and solid has added to the problems of land pollution. Sewage irrigation is very common in some states of India, UP, Haryana, Punjab where partially treated waste waters are spread on land. The residual organic matter decays on soil and makes them acidic. Constant flow of these waters make the soil sick.

3.3.4 Solid Wastes: are also being disposed on land almost every where in the country. Larger the town bigger is the problem. The urban land is under threat from solid wastes including a sizeable load of non biodegradable plastic.

In addition to domestic wastes industrial solid wastes also pose a grave problem. The generation is highly variable and the composition depends on the type of industries. The wastes may be inert biodegradable, toxic and even hazardous. In general the solid waste generating industries are:

a)	Extractive industries	-	Minning, bulk is inert material and is piled up
		-	Quarrying, 5% of minning is solid waste material
		-	Agriculture, produce large amount wastes crop residues, straw, stubbles, leaves, hulls
b)	Process industries	-	Metallurgical, active material is extracted and the rests is left as solid wastes
	Chemical Processing	-	Slurries, sludges or solid cakes
	Paper	-	Paper boards, boiler cinder, chip screen dust, lime, sludges from bleach plants
	Plastics	-	Wastes emanate from trimmings and processing
	Textiles	-	Cotton fibers, cotton seeds, comber wastes, lime, flax polyesters
	Thermal Power Plants	-	Fly ash,
c)	Fabricating Industries		
	Packaging	-	Aluminium sheets, steel, glass, plastic card boards, corrugated paper boards, plastic and paper laminates

	Automobile	-	Shipping and packaging materials, components of tyres, batteries, generators, carburetors, wheels, bumpers etc.
	Electronics	-	Though small but produces plastic, broken glass, wire, backalite sheets
	Construction	-	Residues of building materials, cement, sand, bricks, lime, gravel.
	Food Processing	-	Moderate quantities of biodegradeable wastes as seed, peelings and pulp, milk and dairy products, slaughter house wastes, hides, skin, blood, cartillage, bones, offals.
d)	Hospital Wastes	-	Most dangerous

At most places, these wastes are piled up outside the municipal limits. On decay they produce acids and when it rains soluble chemicals leach into soil and create nuisance conditions. Laechates even reach ground waters.

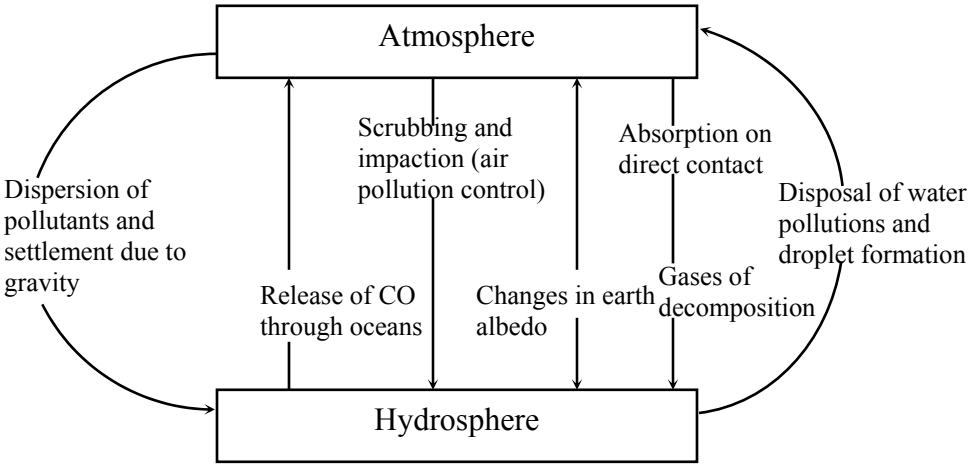
Sanitary landfills also contribute to pollution of land but substantially smaller than open dumps.

Medical wastes even transmit pathogens in underground layers.

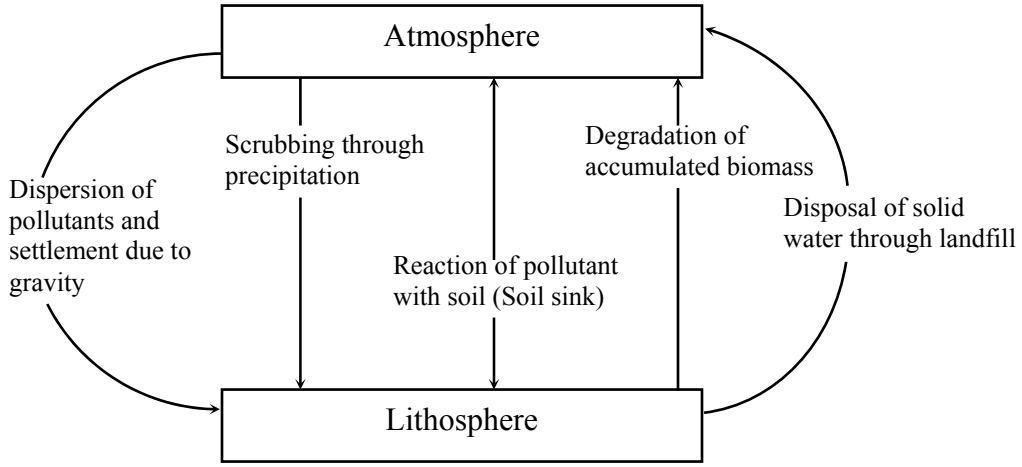
Quantitative data of land pollution is not available due to the low priority given to it by scientists and researchers.

3.4 Pollution Cycle

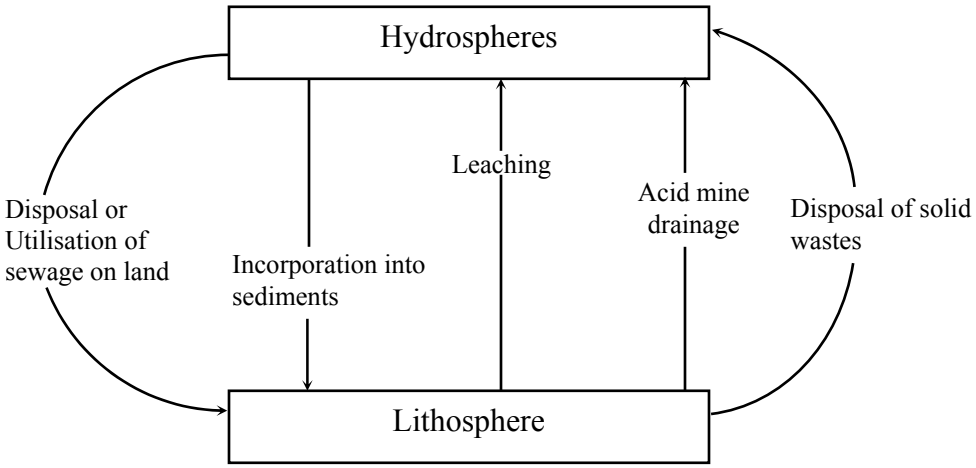
Pollution of air, water and land are not independent manifestations. The levels have now reached alarming proportions and have started threatening human existence. The pollution of environment has been complicated by interactions and exchanges. Many reactions are subtle and their true impact has yet to be determined. Some possible interactions are depicted here in Fig. 3.3.



Interaction of Atmosphere and Hydrosphere



Interactions of Atmosphere and Lithosphere



Interactions of Hydrosphere and Lithosphere

Fig. 3.3: Interactions of Atmosphere Hydrosphere and Lithosphere

Suggested Reading

1. Introduction to Environmental Engineering, M.L. Davis, David a. Cornwell. WCB Mc Graw Hill (1998).
2. Hand book of Environmental Pollution, (3 volumes) Edited by Bela G. Liptak.
3. Air Pollution control by Faith.
4. Practical Handbook on Public Health Engineering G.S. Bajwa, Deep Publisher, Shimla (2003).

(Lecture 11, 12)

CHAPTER – 4

4.0 Environmental Protection Acts, Rules, Regulations and Standards

4.1 Environment is everybody concern, however, a person's perception as well as concern, is subject to change as a result of an effect, or proposed change on personal environment or neighbourhood environment, or economic circumstance. There have been global efforts in focusing on problems facing humanity. They relate to sustainable development, conservation of resources, maintaining biodiversity, protection of regional, seas, and global problems related to Global Warming and Ozone depletion.

One f the most important conference of United Nations, held in Stockholm (1972) focused on Human Environment in which India's PM Ms. Indira Gandhi delivered the kenote address. This was followed by UNEP (United Nations Environment Protection), Agency and Earth's Summit in 1982. The concern in these global efforts was on:

- Human health and settlements
- Territorial ecosystems
- Environment and development (Sustainable Development),
- Protection of natural resources,
- Prevention of environmental disturbance,
- Promotion of chemical safety,
- Global climatic changes
- Risk to Ozone layer
- Depletion of genetic resources

In India we are also concerned about them but our problems are different in magnitude. Population growth and poverty pose the most serious challenge. Poverty itself pollute the environment.

India, is the first country, which has made provisions for the protection and improvement of environment, in its constitution (through 42nd amendment, in 1972, made effective from Jan. 03, 1977).

Govt. of India has addressed itself to the concerns of environment and have enacted. “The Water (Prevention and Contract of Pollution) Act, 1974; Air pollution (Prevention and Control of Pollution) Act, 1981 and the Environment (Protection) Act of 1986, with corresponding Rules and Regulations.

The salient features of these acts have been described later in the chapter, a summary of provisions made therein are listed under para 4.2 (Table 4.1)

4.2 Table 4.1 Summary of Provisions in the Water (Prevention and Control (Act), Air (Prevention and Control Act) and Environment (Protection) Act

Sl. No.	Title	The Water (Prevent and Control) Act, 1974	The Air (Prevention and Control) Act, 1981	The Environment (Protection) Act, 1986
	Chapter/ section (1)	(2)	(3)	(4)
1.	Enactment date	March 23, 1974 Has Eight Chapters and 64 Sections	March 29, 1981 Has Seven Chapter and 54 Sections	May 23, 1986 Has Four Chapters and 26 Sections
2.	Chapter 1 Preliminaries – Title and Definitions	Section (1) Water (Prevention and Control) Act, 1974 It applies to the States of Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, M.P., Rajasthan, Tripura, W. Bengal and in Union Territories. It shall apply to such other States which adopts this Act by resolution passed in this behalf under clause (1) of article 252 of constitution. The date on which the Act comes into force.	Section (1) Air (Prevention and Control) Act, 1981 It extends to the whole of India. Has come into force w.e.f. 16.05.1981 vide notification GSR 351 (E) Dt. 15.05.1981	Section (1) Environment (Protection) Act, 1986 It extends to the whole of India. Has come into force w.e.f. 19.11.1986 vide notification no. GSR 1198 (E) Dt. 12.11.1986
		Section (2) Definitions of Control Board, member (Chairman and others), occupier, pollution, prescribed, sewage effluent, State Boards, stream, inland water, subterranean water, sea, tidal waters, trade effluent, have been made.	Section (2) Definitions of Act (air pollution) approved appliance, approved fuel, automobile, Control Board Chimney, control equipment, emission, industrial plant, member, occupier, State Board,	Section (2) Definitions: environment, environment pollutant, environmental pollution, hazardous substance, occupier, prescribed are presented.

Sl. No.	Title Chapter/ section (1)	The Water (Prevent and Control) Act, 1974 (2)	The Air (Prevention and Control) Act, 1981 (3)	The Environment (Protection) Act, 1986 (4)
			have been incorporated.	
3.	Chapter II The Central and State Boards for Prevention and Control of Water Pollution.	Section (3) The Constitution of Central and State Boards: Central Board a) full time Chairman b) five officials nominated by Central Govt. to represent Govt. c) not exceeding five to be nominated by Central Govt. from among members of State Boards d) three non officials to represent the interests of industry, fishery and agriculture e) two persons to represent the companies or corporations, owned controlled or managed by Central Govt. f) full time member secretary (1 + 5 + 5 + 3 + 2 + 1 = 17)	Section (3) The Central Board Constituted under Water (Prevention & Control) Act. will perform functions of the Central Board for the Prevention and Control of Air Pollution under this Act. Same as for Water Act	Section (3) The Central Govt. shall have the power to take all such measures for protecting the environment including measure to co-ordinate with State Govt., laying down standard, declaration of sensitive areas, laying down procedures and safeguards of accidents causing environmental pollution and hazardous substances and such related measures of inspection of premises, establishment of laboratories. May constitute an authority to exercise powers and functions of the EPA.
		Section (4) State Board a) full time Chairman b) five officials of State Govt. nominated by State Govt. c) five persons nominated by State Govt. from local bodies	Section (4 & 5) State Board State Board constituted under water (prevention and control) Atc, shall be deemed to be State Board for the prevention and control of air pollution under this	Section (4) Central Govt. may constitute authority to exercise powers and functions Section (5) Central Govt. may issue directions

Sl. No.	Title	The Water (Prevent and Control) Act, 1974	The Air (Prevention and Control) Act, 1981	The Environment (Protection) Act, 1986
	Chapter/ section (1)	(2)	(3)	(4)
		functioning within the state. d) three non officials to be nominated by State Govt. to represent the interests of agriculture, industry and fishery. e) two persons to represent company or corporation controlled, owned, managed by State Govt. f) a full time member secretary (1 + 5 + 5 + 3 + 2 + 1 = 17) Section (5) Terms and conditions of service of members Section (6) Provisions of disqualifications Section (7) Vacation of seats by members Section (8) Meeting of Boards Section (9) Constitution of Committees Section (10) Temporary association of persons with boards for particular purpose	Act. Section (6) Central Board to exercise the powers and functions of State Boards in the union territories Section (7) Terms and conditions of service of members. Section (8) Vacation of seat by members Section (9) Meeting of Boards Section (10) Constitution of Committees. Section (11) Temporary association of persons with boards Section (12) Same as in Water Act. Section (13)	to any person/officer/authority in exercise of its power and performance of its functions. Section (6) Central Govt. may make rules in respect of all matters referred in Section (3) viz. standards of air, water or soil for various areas, maximum allowable limits of various pollutants (including noise) for different areas, procedures and safeguards of hazardous, substances, location of industries, accidents and remedial measures.

Sl. No.	Title	The Water (Prevent and Control) Act, 1974	The Air (Prevention and Control) Act, 1981	The Environment (Protection) Act, 1986
	Chapter/ section (1)	(2)	(3)	(4)
		Section (11) Vacancy in Board Section (12) Member Secretary and officers and other employees of Boards	Similar to Water Act.	
4.	Chapter III Joint Boards	Powers and Functions of Joint Boards Under Section (13, 14, 15), there are provisions of Joint Boards, with full time Chairman, members from participating States and a full time Member Secretary	Same as Water Act	Prevention, control and Abatement of Environmental Pollution. Section (7) No person carrying on any industry, operation, process shall discharge/emit any pollutant in excess of such standards.
5.	Chapter IV	Powers and Functions of Boards Section (16) Central Board may - advise Central Govt. on any matter concerning prevention and control of water pollution - co-ordinate activities of State Boards - provide technical assistance to State Boards, Carryout/Sponsor research Section (17) State Board may - plan a comprehensive programme for the prevention of water pollution - advise State Govt. on any matter	Chapter III Powers and Functions of Boards Section (16) As in Water Act Section (16) for air pollution prevention and control. Section (17) Same as in Water Act but for air	Section (8) No person shall handle any hazardous substance except in accordance with procedures and safeguards Section (9) In case of accidents or apprehension of accident, the person shall be bound to prevent and mitigate environmental pollution and intimate to authorities of such occurrence. Section (10) Empowered persons by Central

Sl. No.	Title	The Water (Prevent and Control) Act, 1974	The Air (Prevention and Control) Act, 1981	The Environment (Protection) Act, 1986
	Chapter/ section (1)	(2)	(3)	(4)
		concerning prevention and control of water pollution - collect, disseminate information - encourage, conduct and participate in research <u>Section (18)</u> Alter any water pollution, prevention and control area and define a new water pollution area	pollution prevention and control <u>Section (18)</u> Power to give directions	Govt. will have the right of entry for examining and listing any equipments plant, record, document at all places and all times. <u>Section (11)</u> Central Govt. or an officer empowered shall have the power to take samples for analysis of air, water-soil or other substance from a factory promise.
6.	Chapter V	Prevention and Control of Water Pollution (Sectons 19-33) <u>Section (19)</u> - Power of the State Govt. to restrict the application of Act to certain areas - Such areas may be defined by referring to a map or geographical boundaries - Alter any pollution area by extension or reduction or by defining a new area in merging with another area <u>Section (20)</u> - State Board or an officer	Chapter IV Prevention and Control of Air Pollution (Sections 19-31) <u>Section (19)</u> Power State Govt. to declare air pollution areas <u>Section (20)</u>	<u>Section (12)</u> Central Govt. may establish laboratories or recognize laboratories/institutes for the purpose of environmental pollution analysis. Under Sections 13, 14, 15, 16, 17 Central Govt. may recognize persons as Govt. analysts and any document signed by them may be used as evidence in court. Whoever fails with or contravenes the provisions of this act shall be punishable with imprisonment for

Sl. No.	Title	The Water (Prevent and Control) Act, 1974	The Air (Prevention and Control) Act, 1981	The Environment (Protection) Act, 1986
	Chapter/ section (1)	(2)	(3)	(4)
		designated may make survey of any area and keep record of flow and characteristics - Give direction on abstraction/addition of waste from a stream/well - Give direction to industry to furnish details about construction/operation or disposal system <u>Section (21)</u> - Board or an officer designated to collect and analyze samples of sewage and trade effluent as per procedures prescribed. <u>Section (22)</u> - Report of results of an analysis on samples as per details stipulated <u>Section (23)</u> - An empowered person by State Board to enter for inspection any premise <u>Section (24)</u> - Prohibition on use of stream or well for disposal of polluting	Power to give instructions to concerned authorities (under Motor Vehicles Act, 1939) for ensuring emissions from automobiles. <u>Section (21)</u> Restricting on the use of industrial units in an air pollution control area. Industries already operating before the commencement of section (9) of Air Act (may continue for 3 months and apply for consent, subsequently as per norms specified. <u>Section (22)</u> No person operating an industrial plant in any pollution control area shall discharge emission in excess of standards laid down by State Boards Board may make application to court in restraining persons from causing air pollution. <u>Section (23)</u> Furnishing information to State	five years with fine which may extend to Rs. 1.0 lac or both. If the contravention continuous beyond a period of one year the offender, shall be punishable with imprisonment upto 7 years. If the offence is proved to be committed by a Govt. Deptt. Head of the Deptt. shall be deemed to be guilty and liable to be punished accordingly.

Sl. No.	Title	The Water (Prevent and Control) Act, 1974	The Air (Prevention and Control) Act, 1981	The Environment (Protection) Act, 1986
	Chapter/ section (1)	(2)	(3)	(4)
		matter (poisonous noxious or polluting matter) - Restrict persons in constructing a water regulating structure, adding/depositing material on bank Section (25) Restraining persons on constructing new outlets and new discharges Section (26) Restraining a person from altering old drains as per clause (25) Sections 27, 28, 29 ,30 and 31 Define restraints on sampling, appeals and revisions. Section (32) Defines measures for discharge of polluting matter by accident. Section (33) Power of the Board to make application to court for restraining pollution in streams and wells.	Board of apprehension due to accident in exceeding limits of air pollution standards. Section (24) Provision of entry and inspection concerning functions, testing and control equipment/documents and any other offence and any other information (Section 25) Section (26) State Board or an officer designated can take samples of air, emission (Chimney, flue or duct or any other outlet) as per procedures outlined. Section 27, 28, 29, 30, 31 Samples so collected will be analyzed in State Laboratory or a laboratory recognized by Analysts of State Board or recognized by State Govt. submit report and accept appeals concerning sampling and analysis	

Sl. No.	Title	The Water (Prevent and Control) Act, 1974	The Air (Prevention and Control) Act, 1981	The Environment (Protection) Act, 1986
	Chapter/ section (1)	(2)	(3)	(4)
7.	Chapter VI	Funds Accounts and Audit Sections (34-40) Funds, Accounts and Audit Contributions to Central Board, State Boards by Central, State Govts. will be made. Accounts will be maintained as per budget, and annual accounts will be audited.	Will be maintained as under Water Act (Sections 32-36)	
8.	Chapter VII	Penalties and Procedures (Sections 41-50) Whosoever fails to comply with orders under the Act shall on conviction punishable with imprisonment upto 3 months or fine upto Rs. 5000/- or both. For continued contraventions additional fine of Rs. 1000/- per day may be imposed. Penalty for actions are also outlined. Conviction under section 25, 26 may be upto six years with fine but not less than six months. Provisions for enhanced penalty has been made in Section 45-47.	Penalties and Procedures are outlined under (Sections 37-46) Whosoever fails to comply with provisions of section 21-22 or directions under 31 shall on conviction be punishable with imprisonment not less than one year and six months but may extend to six years with fine if failure continues penalties for certain acts and contravention of provisions of the act have been made under sections 38, 39. Offences by companies and Govt. departments have been mentioned under section 40, 41. Protection of Action in good faith	

Sl. No.	Title	The Water (Prevent and Control) Act, 1974	The Air (Prevention and Control) Act, 1981	The Environment (Protection) Act, 1986
	Chapter/ section (1)	(2)	(3)	(4)
			(Section 42), cognizance of offences (Section 43), members officers and employees of Board to be public servants, reports and return and Bar of Jurisdiction are also provided.	
9.	Chapter VIII	Miscellaneous (Sections 51-60) Provisions under section 51 exist for the establishment of a Central Laboratory and under 52 a State Water Laboratory with functioning rules and other provisions. Section 53 deals with the appointment of persons as Govt. analysts, other provisions include about local authorities to assist (55), compulsory acquisition of land for the State Board (56), Returns and Reports (57), Bar of Jurisdiction (58), Protection of action taken in good faith (59), overriding effect (60), Powers to supercede Central and State Boards by Central and State Boards and make rules for the functioning (61-63).	Powers of State Govt. to supersede and special provisions of super session, dissolution of State Board Powers to amend the schedule and other powers of Central State Govts. are provided under Sections 47-54.	

(Lecture 13 & 14)

4.3 The Water (Prevention and Control of Pollution) Act, 1974

"An Act to provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water, for the establishment, with a view to carrying out the purposes aforesaid, of Boards for the prevention and control of water pollution, for conferring on and assigning to such Boards powers and functions relating thereto and for matters connected therewith".

[23rd March, 1974]

WHEEREAS it is expedient to provide for the prevention and control of water pollution and the maintaining or restoring. The wholesomeness of water, for the establishment, with a view to carrying out the purposes aforesaid, of Boards for the prevention and control of water pollution and for conferring on and assigning to such Boards powers and functions relating thereto:

AND WHEREAS Parliament has no power to make laws for the States with respect to any of the matters aforesaid except as provided in articles 249 and 250 of the Constitution;

AND WHEREAS in pursuance of clause (1) of article 252 of the Constitution resolutions have been passed by all the Houses of the Legislatures of the States of Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Rajasthan, Tripura and West Bengal to the effect that the matters aforesaid should be regulated in those States by Parliament by law;

BE it enacted by Parliament in the Twenty-fifth Year of the Republic of India as follows:-

It has eight Chapters and sixty three sections:

1. Chapter 1. Preliminaries – Title and definitions (sections 1 + 2)
2. Chapter 2. Constitution of Central and State Boards (sections 3 – 12)
3. Chapter 3. Joint Boards (sections 13 – 15)
4. Chapter 4 Powers and Functions of Boards (sections 16 – 18)
5. Chapter 5. Prevention and Control of Water Pollution (sections 19 – 33)
6. Chapter 6. Funds Accounts and Audit (sections 34 – 40)
7. Chapter 7. Penalties and Procedures (sections 41 – 50)
8. Chapter 8. Miscellaneous (sections 51 – 64)

The Salient features of each Chapter are mentioned below:

CHAPTER 1 PRELIMINARY

1. Short title, application, commencement

1. (1) This Act maybe called the Water (Prevention and Control of Pollution) Act, 1974.
2. It applies to the whole of the States of Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Rajasthan, Tripura and West Bengal and the Union territories; and it shall apply to such other States which adopts this Act by resolution passed in that behalf under clause (1) of article 252 of the Constitution.
3. It shall come into force, at once in the States of Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Rajasthan, Tripura and West Bengal and in the Union territories, and in any other State which adopts this Act under clause (1) of article 252 of the Constitution on the date of such adoption and any reference in this Act to the commencement of this Act shall, in relation to any State or Union territory, mean the date on which this Act comes into force in such State or Union territory.

2. Definitions: (The following terms have been defined)

Board, Central Board, member (Chairman and others) occupier (in relation to factory, industry), pollution, prescribed, sewage effluent, State Boards, Stream (river, water course), inland water, subterranean water, sea, tidal waters, trade effluent.

CHAPTER II THE CENTRAL AND STATE BOARDS FOR PREVENTION AND CONTROL OF WATER POLLUTION

3. Constitution of Central Board

Appointment of Central and State Boards (Within six months of Commencement) and notification in official Gazette

The Central Board shall consist of the following

a) a full time Chairman, a person having special knowledge or practical experience in respect of matters relating to use and conservation of water resources or the prevention and control of water pollution.

b) five officials to be nominated by the Central Government to represent that Government;

c) such number of persons, not exceeding five, to be nominated by the Central Government, from amongst the members of the State Boards,

d) three non-officials to be nominated by the Central Government to represent the interests of agriculture, fishery or industry

e) two persons to represent the companies or corporations owned, controlled or managed by the Central Government;

f) a full-time member-secretary qualified in public health engineering and having administrative experience, to be appointed by the Central Government.

4. Constitution of State Boards

The State Government shall w.e.f. such date as notified in the Gazette appoint a State Board of the following;

(a) a full time chairman, a person having knowledge …. water pollution (as for Central Board)

(b) five officials to be nominated by the State Government to represent that Government

(c) five persons to be nominated by the State Government from amongst the members of the local authorities functioning within the State;

(d) three non officials to be nominated by the State Government to represent the interests of agriculture, fishery or industry or trade or any other

(e) two persons to represent the companies or corporations owned, controlled or managed by the State Government.

(f) a full-time member-secretary qualified in public health engineering and having administrative experience, to be appointed by the State Government.

5. Terms and Conditions of Service of Members

If a State Board is not constituted as provided, the Central Board shall exercise the powers and perform functions of a State Board.

Members of a Board other then Member Secretary shall hold office for term of three years.

The terms of office of a Board Member shall come to on end as soon as he ceases to hold the office under Central / State Government by virtue of which he was nominated.

The Central Government / State Government may, if it thinks fit, remove any number before the expiry of his term of office after giving him a reasonable opportunity of showing cause against the same.

A member of a Board other than member secretary may at any time resign his office by writing to Chairman Central / State Government.

6. Stipulates provisions of disqualifications

7. Vacation of seats by members

8. Meeting of Boards

9. Constitution of Committees

10. Temporary association of persons with Boards for particular purpose

11. Vacancy in Board

12. Member Secretary and officers and other employees of Boards

CHAPTER III – JOINT BOARDS

In **13, 14, 15** sections there are provisions for the constitution of Joint Boards, with full time Chairman, members from participating states, a full time member secretary with full powers.

CHAPTER IV POWERS AND FUNCTIONS OF BOARDS

16.1 The main function of the Central Board shall be to promote cleanliness of streams and wells in different areas of the State.

16.2 The Central Board may perform all or any of the following functions, namely:-

(a) advise the Central Government on any matter concerning the prevention and control of water pollution;

(b) Co-ordinate the activities of the State Boards and resolve disputes among them;

(c) Provide technical assistance and guidance to the State Boards, carryout and sponsor investigations and research relating to problems of water pollution and prevention, control or abatement of water pollution;

(d) Plan and organize the training of persons engaged or to be engaged in programmes for the prevention, control or abatement of water pollution.

(e) Organise through mass media a comprehensive programme regarding the prevention and control of water pollution;

(f) Collect, compile and publish technical and statistical data relating to water pollution and the measures devised for its effective prevention and control and prepare manuals, codes or guides relating to treatment and disposal of sewage and trade effluents and disseminate information connected therewith;

(g) Lay down, modify or annul, in consultation with the State Government concerned, the standards for a stream or well:

(h) Plan and cause to be executed a nation-wide programme for the prevention, control of abatement of water pollution;

(i) Perform such other functions as may be prescribed

16.3 The Board may establish or recognize a laboratory or laboratories to enable the Board to perform its functions under this section efficiently, including the analysis of samples of water from any stream or well or of samples of any sewage or trade effluents.

17.1 The functions of a State Board shall be –

(a) to plan a comprehensive programme for the prevention, control or abatement of pollution of streams and wells in the State and to secure the execution thereof;

(b) to advise the State Government on any matter concerning the prevention, control or abatement of water pollution;

(c) to collect and disseminate information relating to water pollution and the prevention, control or abatement thereof;

(d) to encourage, conduct and participate in investigations and research relating to problems of water pollution and prevention, control or abatement of water pollution;

(e) to collaborate with the Central Board in organizing the training of persons engaged or to be engaged in programmes relating to prevention,

(f) to inspect sewage or trade effluents, works and plants for the treatment of sewage and trade effluents and grant of any consent as required by this Act;

(g) to lay down, modify or annul effluent standards for the sewage and trade effluents and for the quality of receiving waters resulting from the discharge of effluents and to classify waters of the state;

(h) to evolve economical and reliable methods of treatment of sewage and trade effluents;

(i) to evolve methods of utilization of sewage and suitable trade effluents in agriculture;

(j) to evolve efficient methods of disposal of sewage and trade effluents on land, as are necessary on account of conditions of scant stream flows that do not provide for major part of the year the minimum degree of dilution;

(k) to lay down standards of treatment of sewage and trade effluent to be discharged into any particular stream taking into account the minimum fair weather dilution available in that stream and the tolerance limits of pollution permissible in the water of stream, after the discharge of such effluents;

(l) to make or revoke any order –

i) for the prevention, control or abatement of discharges of wastes into streams or wells.

ii) Requiring any person to construct new systems for the disposal of sewage and trade effluents

(m) to lay down standards to be complied with persons while causing discharge of sewage or sullage or both or laydown, modify or annual effluent standards for sewage and industrial effluents;

(n) to advise the State Govt. with respect to the location of any industry to carrying on which is likely to pollute a stream or well

(o) Perform such other functions as may be prescribed;

17.2. The Board may establish or recognize a laboratory to enable the Board to perform its functions

18. In the performance of its functions under this Act

(a) alter any water pollution, prevention and control area whether by way of extension or reduction; or

(b) define a new water pollution, prevention and control area in which may be merged one or more water pollution, prevention and control areas, or any part or parts thereof.

CHAPTER V PREVENTION AND CONTROL OF WATER POLLUTION

19. (Power of the State Government to restrict the application of Act to Certain areas)

(1) If the State Government, after consultation with, or on the recommendation, of the State Board, is of opinion that the provisions of this Act need not apply to the entire State. It may, by notification in the Official Gazette, restrict the application of this Act to such area or areas as may be declared therein as water pollution, prevention and control area or areas and thereupon the provisions of this Act shall apply only to such area or areas.

(2) Each water pollution, prevention and control area may be declared either by reference to a map or by reference to the line of any water shed or the boundary of any district or partly by one method and partly by another.

(3) The State Govt. may, by notification in the Gazette,

(a) alter any water pollution and control area whether by way of extension or reduction; or

(b) define a new water pollution, prevention and control area in which may be merged one or more water pollution, prevention and control areas, or any part or parts there of.

20 Power to Obtain information

(1) The State Board or any officer empowered by it in this behalf, may make surveys of any area and gauge and keep records of the flow or volume and other characteristics of any stream or well in such area.

(2) A State Board may give directions requiring any person who in its opinion is abstracting water from any such stream or well in the area in quantities which are substantial in relation to the flow or volume of that stream or well or is

discharging sewage or trade effluent into any such stream or well, to give such information as to be abstraction or the discharge at such times and in such form as may be specified in the directions.

(3) A State Board may, with a view to preventing or controlling pollution of water, give direction requiring any person in charge of any establishment where any industry or trade is carried on, to furnish to it information regarding the construction, installation or operation of such establishment or of any disposal system or of any extension or addition thereto in such establishment and such, other particulars as may be prescribed.

21. Power to take Samples of effluents and procedure to be followed

21.(1) A State Board or any officer empowered by it in this behalf shall have power to take for the purpose of analysis samples of water from any stream or well or samples of any sewage or trade effluent which is passing from any plant or vessel or from or over any place into any such stream or well.

(2) The result of any analysis of a sample of any sewage or trade ffluent taken shall be admissible in evidence in any legal proceeding unless the provisions of sub-sections (3), (4) and (5) are compiled with.

(3) Subject to the provisions of sub-sections (4) and (5), when a sample of any sewage or trade effluent is taken for analysis under sub-section (1), the person taking the sample shall

(a) serve on the person in charge of, or having control over, the plant or vessel or in occupation of the place or any agent of such occupier, a notice, then and there in such form as may be prescribed of his intention to have it so analyzed;

(b) in the presence of the occupier or his agent, divide the sample into two parts;

(c) cause each part to be placed in a container which shall be marked and sealed and shall also be signed both by the person taking the sample and the occupier or his agent:

(d) send one container forthwith -

(i) in a case where such sample is taken from any area situated in a Union territory, to the laboratory established or recognized by the Central Board; and

(ii) in any other case, to the laboratory established or recognized by the State Board

(e) on the request of the occupier or his agent, send the second container -

(i) in a case where such sample is taken from any area situated in a Union territory, to the laboratory established or specified and

(ii) in any other case, to the laboratory established or specified

(4) When a sample of any sewage or trade effluent is taken for analysis and the person taking the sample serves on the occupier or his agent, a notice then, the sample so taken shall be placed in a container which shall be marked and sealed and shall also be signed by the person taking the sample and the same shall be sent forthwith by such person for analysis to the laboratory referred.

(5) When a sample of any sewage or trade effluent is taken for analysis and the person taking the sample serves on the occupier or his agent a notice and the occupier or his agent who is present at the time of taking the sample does not make a request for dividing the sample into two parts then, the sample so taken shall be placed in a container which shall be marked and sealed and shall also be signed by the person taking the sample and the same shall be sent forthwith by such person for analysis to the laboratory referred to

22. Reports of Results of analysis on samples

(1) Where a sample of any sewage or trade effluent has been sent for analysis to the laboratory established the concerned Board analyst shall analyse the sample and submit a report in the prescribed form in triplicate to the Central Board or the State Board, as the case may be.

(2) On receipt of the report one copy of the report shall be sent by the Central Board or the State Board, as the case may be, to the occupier another copy shall be preserved for production before the court in case any legal proceedings are taken against

(3) Where a sample has been sent for analysis to any laboratory mentioned therein, the Government analyst shall analyse the sample and submit a report in the prescribed form of the result of the analysis in triplicate to the central board or, as the case may be, the State Board

(4) If there is any inconsistency or discrepancy between, or variation in the results of the analysis carried out by the laboratory established or recognized by the Central Board or the State Board, as the case may be, and that of the laboratory established or specified as the case may be the report of the latter shall prevail.

23 Power of entry for inspection

(1) Subject to the provisions of this section, any person empowered by a State Board in this behalf shall have a right at any time to enter, with such assistance as he considers necessary, any place -

(a) for the purpose of performing any functions of the Board entrusted to him.

(b) for the purpose of determining any such functions are to be performed

(c) for the purpose of examining any plant, record, register, document or any other material for conducting a research of any place.

24. Prohibition on use of Stream or well for disposal of Polluting matter

24. (1) Subject to the provisions of this section -

(a) no person shall knowingly cause or permit any poisonous, noxious or polluting matter determined in accordance with such standards as may be laid down by the State Board to enter (whether directly or indirectly) into any stream or well; or

(b) no person shall knowingly cause or permit to enter into any stream any other matter which may tend, either directly or in combination with similar matters, to impede the proper flow of the water of the stream in a manner leading or likely to lead to a substantial aggravation of pollution due to other causes or of its consequences.

(2) A person shall not be guilty of an offence by reason only of having done or caused to be done any thing of following acts

(a) constructing any water regulating structure

(b) adding / depositing material for bank protection

(c) putting any stream sand or gravel or any other natural deposit

25. Destruction on New outlets and New discharges.

(1) No person shall, without the previous consent of the State Board, bring into use any or altered outlet for the discharge of sewage or trade effluent into a stream or well or begin to make any new discharge of sewage or trade effluent into a stream or well.

(2) An application for consent of the State Board shall be made in the prescribed form and shall contain particulars regarding the proposed construction, installation operation of the industrial or commercial establishment or of any treatment and disposal system or of any extension or addition thereto and such other particulars as may be prescribed.

26. Where immediately before the commencement of this Act any person was discharging any sewage or trade effluent into a stream or well, the provisions of section 25 shall, apply in relation to such person as they apply in relation to the person referred to in that section subject to the modification that the application for consent to be made under sub-section (2) of that section shall be made within a period of three months of the constitution of the State Board.

27.(1) A State Board shall not grant its consent to the bringing into use of a new or altered outlet unless the outlet is so constructed as comply with any conditions to imposed by the Board to enable it to exercise its right to take samples of the effluent.

Under **section 28 (1) to (5)** provisions have been made for appeals by aggrieved persons under **section 25, 26 and 27**. The appeal will be considered by appellate authority of three members. Under **section 29** Revisions to appeals under **sections 25-27** can be made.

Power of State Board to carry out works on new and altered outlet for discharged are included in **Section 30**.

Furnishing of information regarding accidental discharge are made out in **Section 31**.

Emergency Measures for discharge of pollution by accident

32. Where it appears to the State Board that any poisonous, noxious or polluting matter is present in any stream or well or has entered into that stream or well due to any accident or other unforeseen act or event, and if the Board is of opinion

that it is necessary or expedient to take immediate action, it may for reasons to be recorded in writing, carry out such operations as it may consider necessary for all or any o the following purposes, that is to say -

(a) removing that matter from the stream or well and disposing it of in such manner as the Board considers appropriate:

(b) remedying or mitigating any pollution caused by its presence in the stream or well;

(c) issuing orders immediately restraining or prohibiting the person concerned from discharging any poisonous, noxious or polluting matter into the stream or well, or from making unsanitary use of the stream or well.

33. Power of Board to make application to courts for restraining Water Pollution in Streams and wells

(1) Where it is apprehended by a Board that the water in any stream or well is likely to be polluted by reason of the disposal of any mater therein or of any likely disposal of any matter therein, or otherwise, the Board may make an application to a court, not inferior to that of a Presidency Magistrate or a Magistrate of the first class, for restraining the person who is likely to cause such pollution from so causing.

(2) One receipt of an application under sub-section (1) the court may make such order as it deems fit.

CHAPTER VI FUNDS, ACCOUNTS AND AUDIT

Provisions of allocation of funds by central and State Governments and expenditure incurred and procedure of keeping records and audits have been made under sections **34, 35, 36, 37, 38, 39 and 40.**

41. CHAPTER VII PENALTIS AND PROCEDURE

(1) Whoever fails to comply with any direction given within such time as may be specified in the direction or fails to comply with any orders issued shall, on conviction, be punishable with imprisonment for a term which may extend to three months or with fine which may extend to five thousand rupees or with both and in case the failure continues, with an additional fine which may extend to one

thousand rupees for every day during which such failure continues after the conviction for the first such failure.

(2) Whoever fails to comply with any direction issued by a court under sub-section (2) of section 33 shall, on conviction, be punishable with imprisonment for a term which may extend to three months or with fine which may extend to five thousand rupees or with both and in case the failure continues, with an additional fine which may extend to one thousand rupees for every day during which such failure continues after the conviction for the first such failure.

42. Penalty for Certain Acts

1) Whoever -

(a) destroys, pulls down, removes, injures or defaces any pillar, post or stake fixed in the ground or any notice or other matter put up, inscribed or placed, by or under the authority of the Board, or

(b) obstructs any person acting under the orders or directions of the Board from exercising his powers and performing his functions under this Act, or

(c) fails to intimate the occurrence of any accident or other unforeseen act or event under section 31 to the Board and other authorities or agencies as required by that section, or

(d) in giving any information which he is required to give under this Act, knowingly or willfully makes a statement which is false in any material particular, or

(g) for the purpose of obtaining any consent under section 25 or section 26, knowingly or willfully makes a statement which is false in any material particular,

43. Whoever contravenes the provisions of section 24, 25 and 26 shall be punishable with imprisonment for a term which shall not be less than six months but which may extend to six years and with fine.

44. Whoever contravenes the provisions of section 25 or section 26 shall be punishable with imprisonment for a term which shall not be less than six months but which may extend to six years and with fine.

Provisions for Enhanced penalty after previous conviction have been made in section 45. **Section 46 and 47** defines the procedure of publication of names of offenders and of companies where an offence has been committed by a Government Department the Head of department shall be deemed to be guilty of the offence and shall be liable to proceeded and punished (48). **Section 49** discusses cognizance of offences and **section 50** of Members, officers and Servants of the Board to be Public Servants.

CHAPTER VIII MISCELLANEOUS

51.(1) The Central Government may, by notification in the Official Gazette –

(a) establish a Central Water Laboratory; or

(b) specify any laboratory or institute as a Central Water Laboratory, to carry out the functions entrusted to the Central Water Laboratory under this Act.

(2) The Central Government may, after consultation with the Central Board, make rules prescribing -

(a) the functions of the Central Water Laboratory;

(b) the procedure for the submission to the said laboratory of samples of water or of sewage or trade effluent for analysis or tests, the form of the laboratory's report there under and the fees payable in respect of such report;

(c) such other matters as may be necessary or expedient to enable that laboratory to carry out its functions.

52.(1) The State Government may, by notification in the, Official Gazette-

(a) establish a State Water laboratory; or

(b) specify any laboratory or institute as a State Water Laboratory, to carry out the functions entrusted to the State Water Laboratory under this Act.

(2) The State Government may, after consultation with the State Board, make rules prescribing -

(a) the functions of the State Water Laboratory

(b) the procedure for the submission to the said laboratory of samples of water or of sewage or trade effluent for analysis or tests, the form of the laboratory's report thereon and the fees payable in respect of such report;

53.(1) The Central Government may, by notification in the Official Gazette, appoint such persons as it thinks fit and having the prescribed qualifications to be Government analysis for the purpose of analysis of samples of water or of sewage or trade effluent sent for analysis to any laboratory established or specified.

(2) The State Government may, by notification in the Official Gazette, appoint such persons as it thinks fit and having the prescribed qualifications to be Government analysts for the purpose of analysis of samples of water or of sewage or trade effluent sent for analysis to any laboratory established or specified under sub-section (1) of section 52.

(3) Without prejudice to the provisions of sub-section (3) of section 12, the Central Board or, as the case may be, the State Board may, by notification in the Official Gazette, and with the approval of the Central Government or the State Government, as the case may be, appoint such persons as it thinks fit and having the prescribed qualifications to be Board analysts for the purpose of analysis of samples of water or of sewage or trade effluent sent for analysis to any laboratory established or recognized under section 16, or as the case may be, under section 17.

54. Any document purporting to be a report signed by a Government analyst or, as the case may be, a Board analyst may be used as evidence of the facts stated therein in any proceeding under this Act.

Other provision include

55. Local authorities to assist
56. Compulsory acquisition of land for the State Board
57. Returns and Reports
58. Bar of Jurisdiction
59. Protection of action taken in good faith
60. Overriding effect
61. Power of Central Government to supercede the Central Board
62. Power of State Government to supercede the State Board
63. Power of Central and State Government to make rules

(Lectures 15 & 16)

CHAPTER -1
INTRODUCTION

1.1 Preamble

The basic objective of Environmental Management (EM) is to maintain, the quantity and sustain the quality of natural resources commensurate with the needs of society. Sustainable development is a process change in which the exploitation of resources, the direction of investment, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential of human needs and aspirations. Environmental Impact Assessment (EIA) is a statement which integrates them. It has now become a mandatory tool to assess the impact of proposed activity with reference to deforestation, land and soil use, urban congestion and pollution, water resources and industrial process.

1.2 Objectives Of Diversified Agriculture Support Project (DASP)

The main objectives of the DASP are:

a) Achieve sustained agricultural development with increased productivity.

b) Provide adequate and safe mobility for the rural population, agricultural produce and inputs, access to market through "All Weather Roads", service and information, which in turn will foster Rural Development.

c) Establishment of Agribusiness and service industries within the project area

DASP Uttaranchal has identified roads in Dehradun, Udham Singh Nagar and Nainital districts for construction/improvement to ease the mobilisation of agricultural produce from Farm to Market. Before taking up the task it is to be established that due to upgradation/construction of proposed roads, the environment will not be adversely affected. The present proposal concerns a 5.0 km road between Kotabagh and Rani Kota in the Tehsil Ramnagar in Nainital district.

1.3 Work Plan

The roads will be improved along the existing alignments, where no additional land is required to complete the work. The road upgradation includes cross drainage works, namely culverts, cause ways and small and medium bridges also. Permanent land available is enough

and no extra land is required for roads.

The road works would be as per Ministry of Surface Transport/India Road Congress specifications and would be carried out by State PWD. As per the project design, rural roads will be constructed only after carrying out a detailed EIA.

The upgradation as indicated by the State PWD staff means provision of 2 layers of ballast (10 cm each compacted to 7.5 ems) and painting PI & P2. The roads will have 3 m carriage passage and 1.0 to 1.5 m shoulder on each side. Cross drainage to be provided by a suitable system every 200 m of road. These provisions will be made wherever required and would be shown clearly marked on the respective DPR. For construction of these roads additional land, wherever required, will be made available by Gram Panchayats

For identification of impact during construction of proposed rural roads the network method has been adopted (Fig. 1.1) which involves analysis of cause/condition -- effect relationship between an activity and environmental parameters.

The EIA of the proposed road under the DASP has been conducted by the Alternate Hydro Energy Centre, Indian Institute of Technology, Roorkee. The study includes environmental review of the proposed road/bridges, documentation of baseline environmental features, assessment of possible environmental impacts during and after road construction, development of an environmental screening criteria and design of mitigation measures of adverse impacts.

It would appear that the proposed road project is necessary to improve the quality of life of the affected villagers and to improve their economic condition. The improvement of road will convert it to all weather metalled road reducing travel time and making travel possible through out the year with increased comfort. To the residents of the affected villages, the improved roads will ensure year round access to basic amenities such as schools, hospitals, public offices, institutions and markets. Movement of raw materials, inputs, finished goods and agricultural and other produce to and from the villages will become easy, quick and economic. Consequently, the proposed project for improving the roads has the support of all sections of population.

1.4 Sequential Phases of Eia

EIA has three sequential phases

i) Identification

ii) Prediction and

iii) Assessment

i) Identification involves characterisation of existing physical, economic, ecological and social environment. It also involves listing of such activities as may have ill effects on one or more of the components of environment.

ii) Prediction is to forecast the nature and extent of identified environmental impacts and those of measures proposed to mitigate the adverse environmental impacts.

iii) Assessment judges the beneficial/adverse impacts of project. The result is communicated to decision makers to determine the cost and benefits of user groups and the population.

CHAPTER - 2
DESCRIPTION OF PROPOSED ROAD

2.1 Diversified Agricultural Support Project (DASP)

Uttaranchal (Project Coordination Unit), Dehradun vide its letter no. 1728/6/2/DASP dated 7.9.2002 has entrusted the work of EIA in respect of rural road Kotabagh to Ranikota of 5 km stretch to AHEC.

The block Kotabagh has eight motorable roads.

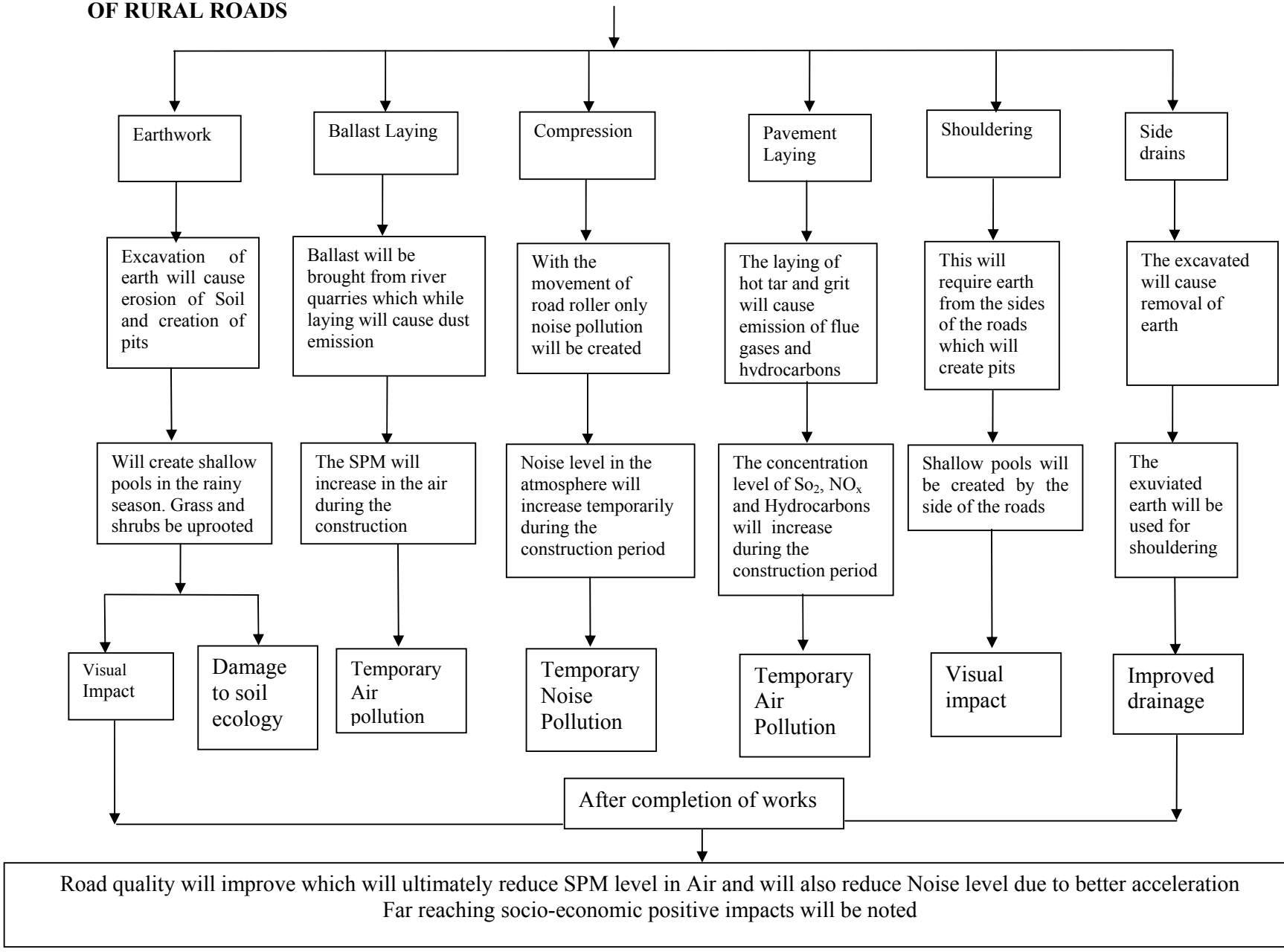
1	Nainital - Kaladungi - Bazpur motor road	33.40 km
2.	Haldwani - Ramnagar motor road	23.50 km
3.	Bailparao - Kotabagh motor road	12.00 km
4.	Kaladungi - Dechauri - Kotabagh motor road	17.25 km
5.	Gurabangar - Baiunia Haldu marg	04.70 km
6.	Aonlakot - Kotabagh	04.70 km
7.	Aonlakot - Kotabagh via Patlia marg	04.70 km
8.	Nainital - Tanki - Kilvari - Pangot motor bagh	04.00 km
	TOTAL	**102.30 km**

The proposed road is located in the Ramnagar Tehsil under Kotabagh Block. The exact location is shown in the block Map Figure 2.1. The road is located at an altitude of = 800 m between 29°24' North and 79°18' East longitude and latitude. The road is motorable with difficulty for 1.5 km only. The rest of the road is not motorable. It is stony with soil debris. The road is already provided with a number of cross drainage works. Thirteen culverts of the following dimensions exist (Kotabagh-Ranikota)

Culvert No.	1	1.0 m
	2	1.0 m
	3	1.0 m
	4	1.0 m
	5	1.0 m
	6	1.0 m
	7	1.0 m
	8	1.0 m
	9	3.0 m
	10	3.0 m
	11	1.0 m
	12	1.0 m
	13	4.60 m

A number of scuppers also exist, most of them about 1.0 m width. The gradient of the road varies but on an average it is about 1:18. The actual survey work is on and the details will be known shortly. A number of cause ways also exist. At one place the covering on a canal exists (6.4 m) and this need to be increased to 12.0 m. There are yet a few sites which need to be developed as causeway and other cross drainage works. At majority of locations a clear road width of 6-10 m is available, however, at some places, where more space is required, cutting of hill side slope may be necessary. This needs extra care because of slope stability. This proposed road later, at Ranikota will be connected to a bridge on river Dabka and link road of 5.0 km sanctioned by Uttaranchal Govt. under state budget.

FIGURE 1.1: NETWORK DIAGRAM FOR IDENTIFICATION OF ENVIRONMENT AL IMPACTS CONSTRUCTION OF RURAL ROADS



CHAPTER – 3
INFRASTRUCTURAL FACILITIES AROUND THE PROPOSED ROAD SITE

3.1 The proposed road Kotabagh - Ranikota falls within NAINITAL district in Ramnagar Tehsil in Kotabagh block. The road is close to Kotabagh town and block. The facilities of education, higher education, health centre upgraded hospital are available in Kotabagh, Ramnagar, Haldwani and Nainital towns. The villages are electrified. The details are given in Table 3.1. The details of population, agricultural facilities as obtained from Block Kotabagh are given in Table 3.2. The population data of Govt. of India census (1991) and the one made available by block office has been analysed and reproduced in "Abstract of Demographic data in Table 3.3 and the details in five Nyay Panchayats of Block Kotabagh" in Table 3.4.

Table 3.1 Infrastructural Facilities

1	Name of Proposed Road	-	Kotabagh- Ranikota road
2	Length of Road	-	5km
3	Distance from nearest town	-	Ramnagar 31 Km
4	Distance from nearest mandi	-	Kotabagh 21 Km
5	Facilities of Education	-	a) Primary school at Pandeygaon and Kotabagh b) Junior school at Kotabagh c) High school for boys at Kotabagh d) High school for girls at Kotabagh
6	Bridges/culverts on the way	-	Culverts 13 nos. Scuppers 13 nos Bridge over 1 no. Canal
7	Covering villages	-	Pandey gaon, Baluti, Ranikota
8	Facilities of communication	-	Available upto Kotabagh only and not beyond.
		-	Haldwani to Kotabagh
		-	Ramnagar to Kotabagh by buses, Jeep /

			taxi tempo and trucks.
		-	No transport and means of communication are available on
		-	Kotabagh - Ranikota road.
9	Health care	-	Primary Health Centre - Kotabagh community health centre
	Hospital	-	Nearest hospital ─ Ramnagar
	Upgraded Hospital	-	Base Hospital ─ Haldwani
	Private Doctors	-	At Kotabagh
10	Status of electrification	-	Kotabagh Pandey gaon, Baluti - Electrified
11	Status of drinking water (No water borne disease in epidemic form reported)	-	Spring water sources. Chlorinated at Kotabagh Non-chlorinated at Pandey gaon / Baluti / Ranikota
12	Mode of entertainment	-	Television / Radio
13	Outdoor games for Children	-	in schools a) Primary School at Kotabagh b) Triveni Hill Academy at Pandey gaon c) Govt. Inter College for boys and Govt. Inter College for Girls at Kotabagh
14	Banking facilities	-	Bank of Baroda at Kotabagh
15	Post office	-	P.O. at Kotabagh
16	Agricultural extension service	-	At Ramnagar and Haldwani Village Sabha at Pandey gaon Mini dairy corporation at Lalkuan
17	Availability of veterinary service	-	Veterinary doctor at Block - 2
	a) Cattle Population	-	Kotabagh - Dr. P.S. Rawat
	Big animals	-	16891

	Small animals	-	4949
	Poultry	-	8439
	b) Facilities for artificial insemination available		
	No. of cattle per family	□	3
	No. of epidemic reported		
18	Facilities of irrigation	-	Through springs, canals from Dabka river
19	Societies for social welfare	-	Mahila works Samiti at Kotabagh

Table 3.2 Summary of Information of Block Kotabagh

1	Population of all villages		
	In block Kotabagh		
	Males	-	17653
	Females	-	16676
	Total	-	34329
	Scheduled tribes	-	7515
2	Opening date of block office	-	9.2.1980
3	Total geographic area	-	24582 ha
4	Total cultivable area	-	15801 ha
5	Forest area	-	7633 ha
6	Agricultural area	-	6365 ha
7	More than once sown area	-	4907 ha
8	Not culitivable land (Banjar)	-	85 ha
10	Land used for other purpose from cultivale land	-	815 ha
11	Permanent grazing land	-	65 ha
12	Tress and bushes grown on	-	5911 ha
13	Total irrigated land	-	10007 ha
14	Sugar cane and Jayad	-	1494.65 ha
15	Total village committees	-	40

16	Nyay Panchayat	-	5
17	Total inhabited villages	-	115
18	Non inhabited villages	-	2
19	Agriculture safety unit	-	1
20	Garden mobile team	-	1
21	Education		
	i) Primary schools	-	70
	ii) Junior high school	-	15
	iii) High school girls	-	2
	iv) High school general	-	2
	v) Inter college	-	3
22	Govt. services		
	i) Primary health centre		8
	ii) Cooperative societies		1
	iii) Cooperative bank		2
23	Bank of Baroda	-	3
24	Animal husbandry		
	Veterinary hospital	-	1
	Primary insemination	-	8
	Artificial insemination	-	8
	Centre	-	2
	Veterinary hospital	-	7

Table 3.3 Abstract of Demographic Data

S. No.	Nyay Panchayat	General			Sch. Caste			Sch. Tribes			Backward		
		M	F	Total	M	F	Total	M	F	Total	M	F	Total
A.	Ginti Gaon	4750	4675	9425	-	-	-	1002	900	1902	152	154	306
B.	Sayat	987	922	1909	-	-	-	324	304	628	-	-	-
C.	Kaladungi. Bandobasti	4873	4366	9239	08	05	13	1649	1502	3151	351	310	661
O.	Amgarhi	958	1083	2041	-	-	-	504	495	1001	-	-	-
E.	Dola	1645	1541	3186	-	-	-	432	401	833	16	18	34

S. No.		Total			Ratio	
		M	F	Total	M	F
A.	Ginti Gaon	5904	5729	11633	100	97
B.	Sayat	1311	1226	2537	100	935
C.	Kaladungi Bandobasti	688	6183	13064	100	89.8
O.	Amgarhi	1464	1578	3042	100	107.7
E.	Oola	2093	1960	4053	100	93.6
	TOTAL	17653	16676	34329	100	94.5

Table 3.4 Demographic Data of Block Kotabagh Nyay Panchayat

S. No	Nyay Panchayat	Gram Panchayat	Total Population			Sch. Tribes			Sch. Caste			Backward Class			General		
			M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total
A.	**Ginti Gaon**																
1.		Aonla Kot	1149	1006	2155	200	116	316	-	-	-	31	34	65	918	856	1774
2.		Sanratala	399	424	826	34	32	66	-	-	-	-	-	-	365	392	756
3.		Dohania	236	246	482	18	11	29	-	-	-	11	8	19	207	227	434
4.		Devirampur	221	228	449	11	12	23	-	-	-	14	13	27	196	203	399
5.		Mayarampur	362	365	727	99	102	201	-	-	-	02	02	04	261	261	522
6.		Gintigaon	416	418	834	165	167	332	-	-	-	45	48	93	206	203	409
7.		N auda	472	463	935	80	78	158	-	-	-	08	08	16	384	377	761
8.		Patlia	902	888	1790	218	217	435	-	-	-	03	05	08	681	666	1347
9.		Bajunia haldu	825	820	1645	79	80	159	-	-	-	06	06	12	740	734	1474
10.		Degavdatorie	168	153	321	-	-	-	-	-	-	-	-	-	168	153	321
11.		Khemuapipal	298	278	576	49	37	86	-	-	-	32	30	62	217	211	428
12.		Kaptanganj	456	440	896	49	48	97	-	-	-	-	-	-	407	392	799
B.	**Sayat**																
13.		Sayat	179	171	350	35	30	85	-	-	-	-	-	-	144	141	285
14.		Fatehpur	213	190	403	31	27	58	-	-	-	-	-	-	182	163	345
15.		Pandegaon	185	191	376	15	18	33	-	-	-	-	-	-	170	173	343
16.		Mahrora	268	268	536	34	40	74	-	-	-	-	-	-	234	228	462
17.		Gurabangar	466	406	872	209	189	398	-	-	-	-	-	-	257	217	474
C	**Kaladungi Bandobasti**																
18.		Kaladungi	974	954	1928	142	139	281	-	-	-	54	50	104	778	765	1543
19.		Rooppur	395	433	828	36	40	76	-	-	-	-	-	-	389	362	751
20.		Devipur	677	569	1246	127	150	277	-	-	-	18	13	31	532	406	938
21.	.	Puranpur	1383	1206	2589	414	362	776				37	34	71	932	810	1742

									-	-	-						
22.		Vidrampur	1199	1072	2271	181	153	334	-	-	-	115	95	210	902	824	1727
23.		Chapla	192	142	334	140	105	245	08	05	13	-	-	-	44	32	76
24.		Kamela	1069	1027	2096	240	231	491	-	-	-	47	41	88	782	755	1537
25.		Urdpuri	183	170	353	173	160	333	-	-	-	-	-	-	12	08	20
26.		Dhamola	777	643	1420	96	162	358	-	-	-	80	77	57	501	404	905
D.	Amgarhi																
27.		Amgarhi	268	249	517	59	56	115	-	-	-	-	-	-	209	193	402
28.		Donparewa	302	310	612	48	50	98	-	-	-	-	-	-	254	260	514
29.		Kankhel	170	167	337	164	163	327	-	-	-	-	-	-	06	04	10
30.		Amtoli	296	281	577	170	158	328	-	-	-	-	-	-	126	233	359
31.		Gauryadev	150	155	305	06	03	09	-	-	-	-	-	-	145	151	296
32.		Okhaldonga	277	307	584	59	65	124	-	-	-	-	-	-	218	242	460
E.	Dola																
33.		Dola	446	458	904	55	57	112	-	-	-	08	06	14	383	395	778
34.		Ranikota	185	158	343	05	04	09	-	-	-	06	03	09	174	151	325
35.		Ghoghosigri	213	192	403	98	88	186	-		-	-	-	-	115	102	325
36.		Saur	486	478	964	89	88	177	-	-	-	-	-	-	397	390	787
37.		Vasi.	349	293	642	106	90	196	-	-	-	-	-	-	243	203	446
38.		Chara	147	129	276	05	03	08	-	-	-	-	-	-	142	126	268
39.		Riyand	12	185	377	65	64	129	-	-	-	02	09	11	115	112	227
40.		Sanoda	85	69	154	09	07	16	-	-	-	-	-	-	76	62	138

CHAPTER - 4
METHODOLOGY

4.1 A team consisting of the following made reconnaissance and detailed survey

Prof. R.P. Mathur
Er. S.K. Rai, Assistant Engineer, PWD accompanied
Er. H.Joshi, Junior Engineer, PWD

The team visited, Kotabagh block, three villages Pandey Gaon, Baluti and Ranikota and walked on the full stretch of the road. The road, Kotabagh to Ranikota is motorable (with difficulty) for about 1.5 km. The rest of the road is not motorable. They spoke to people of the area, school principal, Jal Sansthan officials and the forest staff (Ranger of Dechauri Range) to elicit the views of their perception of the problems, the benefits and the impact of proposed upgradation. The relevant information of environmental aspects was collected from officials records of Executive Engineer (PWD), Jal Nigam, Jal Sansthan, BDO and the Veterinary Centre block-2, Kotabagh.

The proposed upgradation work has been planned on the existing hil1 road to establish the suitability and feasibility.

The road is located on the hill slopes and is a link road between Kotabagh and Ranikota. The villages Pandey gaon, Baluti and Ranikota will be served by the link road. Another proposal of Uttaranchal state government of constructing a bridge on river Dabka and a link road of 5 km will provide access to other villages of the block as well.

No acquisition of land is involved. Interference on any significant scale with land use, drainage, vegetation, quarrying other than from designated quarries (Ramnagar, Haldwani) is not involved. However, in small sections where the available plain land is not sufficient for shoulders, cutting of hills is required. Hill slope stability in such areas is the most important consideration and must be seriously attended to. As any large scale construction is not involved, the activity of construction would be restricted and localised. The biological components would not be affected as the vegetation in the form of bushes (herbs and shrubs) will be removed for dressing and making shoulders and berms. These bushes alongwith some Bryophytes, Pteriodophytes and *Mimosa,* which are otherwise in plenty, will be removed. Thus the impact on natural resources and environment is minor. However, it is necessary to examine the likely environmental impact of the project and to see whether any impact will

need mitigative measures.

Keeping in view the above facts, the EIA studies have been restricted to the area of construction only. The components of environment which may get affected have only been included in the scope viz. air, water land biological and socio-economic environment.

4.2 Air Environment

The air environment of the proposed road is of pristine level. There are no industries in the area (Kotabagh). In the Ramnagar block also only a few wood based industries are located, which do not produce any air borne pollutants. The vehicular traffic also is restricted between Ramnagar and Kotabagh. In the proposed stretch, no vehicle, automobiles, not even two wheelers ply on the road. The load is carried either as head load or on horses and ponies which does not produce any air pollutant. Thus, the air in the area is clean with no dust (SPM), oxides of nitrogen and sulfur, below detection limits.

4.3 Water Environment

The major source of water is springs. The water of springs is sparkling clear and is consumed by villagers directly. The analysis report of one such source is given later in Chapter-5. The perusal of the report reveals the presence of inorganics which depends on geology of the area and no trace of any organic pollutants. At number of places of the hill slopes, it was noticed that sulfur springs exist and brown patches of deposits are visible. Even, calcareous outflows are noticed (white deposits).

The regional office of Pollution Control Board also does not maintain any record of water as well as air quality. An irrigation canal passes through the area and the river Dabka flows at the end of the proposed road.

4.4 Noise Environment

Since, no activity of any concern exist in the area, recourse to values in literature has been made. During construction the noise levels will increase because of earth moving machinery, road rollers and trucks to transport construction material. After construction also limited vehicular movement is anticipated.

4.5 Land Environment

The road exists but is not motorable for about 3.5 km. This is because of stone/hill

debris. A clear stretch of 6-10m available althrough. In certain regions the land available is much more, about 12 m while in others some cutting is needed. The soil texture varies from loamy sand, fine loamy to silty clay.

4.6 Biological Environment

The basic information available with forest officials and block officials has been collected and utillised. The flora and fauna has been described later in the report. No impact of the project on biological environment is anticipated. The project involves only marginal uprooting of herbs and shrubs in the areas on the shoulders of roads and in small stretches where cutting of slopes is required. These herbs and shrubs alongwith ferns and mosses will soon grow in the area and colonise the berms. The impact of such activity will also be not significant.

4.7 Socio-Economic Environment

Data on population, infrastructural facilities agricultural pattern, living habitats has been collected and analysed.

CHAPTER - 5
BASELINE ENVIRONMENTAL STATUS

5.1 The base line environmental status presented here includes the various components of environments, air including micrometeorology, water, biological and sociological environment.

5.2 **Air Environment**

The existing ambient Air Quality status (AAQS) within the impact zone has been characterized from the data already existing for the specific areas. This has been done to establish the existing regional background levels of air pollution status in the vicinity of area. The area under review is typical in the sense that it does not have any industry producing air pollutants and no vehicular movement on the road and in the contiguous area. The vehicular traffic is restricted from Ramnagar / Haldwani to Kotabagh and not beyond

The weather data is maintained either at Nainital, which is located at an altitude of 1938 m above msl or at Pant Nagar which is in the plains. The weather characteristics of Ram Nagar are more akin to Pant Nagar and the same has been reproduced in Table. 5.1

The climate of the region showns mixed character of Tarai region and upper gangetic plains. The periodica adjustment of the atmospheric factors form a monsoon type of tropical climate. The rhythmic changes in the climate brings about three cyclic seasons namely rainy, winter and summer.

The mean maximum temperature varies between 36°C (April, May and June) and15°C (Dec. and Jan) and mean minimum temperature between 25°C (May and June) and 4.5 °c (January). The rainfall is restricted to the three months of July - September and constitutes about 75% of rain and two months in January and February (20%). The rest is accounted for non monsoon months. In the year 2000 the total rainfall was 3218.5 mm in 74 rainy days. The wind direction is variable. In winter months it is prevalent in WSW and in Summers ESE. A typical wind rose diagram is depicted in Figure 5.1. The records of ambient air quality from UPPCB Haldwani (industrial area is given in Table 5.2) reconfirms that in areas away from the vicinity of industries like Kotabagh will have values much lower, mostly in negligible ranges.

5.3 Water Environment

Base line data of water is represented by the spring water in the area. The analysis of one such sample is given in Table 5.3. The following generalization can be made.

The water is slightly alkaline and carries a low level of minerals. The values of alkalinity, hardness, chlorides, TDS and conductivity all corroborate the observation. As expected the value of calcium is more than sodium and potassium. There is no trace of nitrogen to indicate availability of organic compounds. The bacterial numbers as borne out by MPN values is nil. The water is suitable for drinking purposes.

Table 5.1 Standard Meteorological Weekly Average Weather Data of 2000 at G.B Pant University of agriculture & Technology, Pantnager-283145 (Uttaaranchal)

Sl. No.	Week No. & Month	Date with Duration	Max. Temp (°C)	Min. Temp. (°C)	Rel. Humidity (%)		Rainfall (mm)	No. of rainy days	No. of sunshine Hours	Wind speed (km/hr)	Wind direction		Pan water evap. (mm)
					I Hr	II Hrs							
1.	Jan.	0]-7J	14.4	06.3	94	79	0.0		2.4	2.5	Var	WSW	20.6
2.	Jan.	08-14	18.7	8.2	93	67	.8	2	2.8	3.5	Var	Var	1.1
3.	Jan.	]5-21	19.1	4.5	96	54	0.0	0	6.3	5.4	Var	WSW	I.5
4.	Jan.	22-28	22	7.7	90	52	4.6	0	7.3	4.4	Var	Var	2.2
5.	Jan.	29-4F	21.1	9.0	89	53	64.4	I	6.6	7.7	Var	ESE	5.1
6.	Feb.	05-11	18.9	9.9	95	67	30.8	2	5.4	5.0	C	ESE	5.1
7.	Feb.	12-]8	20.8	6.6	93	49	0.0	0	8.3	3.6	C	WSW	2.2
8.	Feb.	19-25	22.3	4.5	82	38	Tr	0	10.2	5.7	Var	WSW	3.5
9.	Feb.	26-4M	24.6	7.9	86	42	9.6	0	08.9	5.2	ENE	WSW	3.8
]0.	Mar.	05-1 I	26.5	9.3	89	38	0.0	0	9.9	5.5	WNW	WNW	4.2
II.	Mar.	12-18	27.3	10.8	79	40	5.0	I	9.4	6.1	C	WNW	4.9
12.	Mar.	19-25	27.5	9.8	81	37	9.0	I	8.5	5.4	Var	WSW	4.9
13.	Mar.	26-IA	32.9	14.2	8]	32	0.0	0	10.2	4.7	C	WSW	5.6
14.	Apr.	2-08	34.6	12.1	79	20	0.0	0	11.1	7.4	C	WNW	8.2
15.	Apr.	9-15	35.7	17.0	67	28	3.8	1	10.8	5.9	Var	Var	7.7
16.	Apr.	18-22	36.3	21.6	67	33	1.0	0	9.5	6.5	Var	Var	8.4
17.	Apr.	23-29	35.1	21.6	66	33	2.0	0	9.6	8.1	ENEN	ESE	9.0
18.	Apr.	30-6M	35.6	21.2	65	34	124	2	8.8	10.2	ESE	ESE	10.8
19.	May	7-13	35.3	24.4	64	40	37.4	1	9.7	7.5	ESE	CE	8.9

Sl. No.	Week No. & Month	Date with Duration	Max. Temp (°C)	Min. Temp. (°C)	Rel. Humidity (%)		Rainfall (mm)	No. of rainy days	No. of sunshine Hours	Wind speed (km/hr)	Wind direction		Pan water evap. (mm)
					I Hr	II Hrs							
20.	May	14-20	36.0	24.3	76	44	47.8	2	9.4	8.5	ENE	Var	10.8
21.	May	21-27	32.5	24.8	79	56	45.0	3	4.3	8.3	ESE	ESE	8.2
22.	May	28-3J	33.4	23.6	83	54	169.8	3	7.8	7.9	Var	Var	6.7
23.	June	4-10	30.2	24.1	83	71	263.6	4	4.2	11.1	ESE	ESE	7.1
24.	June	11-17	33.5	25.4	82	61	47.2	3	6.5	5.7	Var	Var	7.1
25.	June	18-24	32.1	25.8	88	68	92.0	3	5.2	6.9	Var	Var	7.5
26.	June	25-11	31.5	23.7	90	75	47.8	3	3.8	6.5	ESE	Var	6.4
28.	July	02-08	31.8	25.0	87	76	109.6	3	05.8	5.3	Var	WSM	5.1
29.	July	09-15	32.5	26.0	85	69	98.2	3	06.9	7.3	ESE	ESE	8.2
30.	July	23-29	31.3	25.2	92	74	70.4	3	04.5	4.2	Var	WSM	7.1
31.	July	30-54	31.3	24.8	92	74	I] 1.5	3	06.0	5.0	WNW	Var	5.3
32.	Aug	06-12	31.1	25.0	91	74	443.2	4	05.9	5.9	.ENE	Var	6.7
33.	Aug	13-19	30.4	24.4	93	80	220.6	6	03.6	3.8	Var	ENE	5.9
34.	Aug	20-26	31.3	25.1	90	74	88.8	3	04.3	4.2	Var	ESE	6.7
35.	Aug	27-25	30.5	24.3	94	83	4]3.2	5	05.2	4.1	Var	Var	7.6
36.	Sep	03-09	31.3	24.2	96	71	353.2	4	04.]	3.5	ENE	ESE	4.5
37.	Sep	10-16	32.7	23.8	91	84	71	0	09.4	3.8	C	WNW	4.4
38.	Sep	17-23	20.2	22.8	94	75	168.3	3	06.0	4.5	ESE	Var	4.8
39.	Sep	24-30	31.7	22.2	84	55	Tr	0	09.9	2.8	C	WNW	4.2
40.	Oct	01-07	32.5	20.7	79	51	00.0	0	09.9	2.]	Var	WNW	3.8
41.	Oct	08-14	32.2	17.8	86	54	00.0	0	09.8	2.9	Var	WSW	4.0
42.	Oct	15-21	31.2	17.0	87	47	00.0	0	09.5	2.8	Var	ESE	3.7

Sl. No.	Week No. & Month	Date with Duration	Max. Temp (°C)	Min. Temp. (°C)	Rel. Humidity (%)		Rainfall (mm)	No. of rainy days	No. of sunshine Hours	Wind speed (km/hr)	Wind direction		Pan water evap. (mm)
					I Hr	II Hrs							
43.	Oct	22-28	30.5	17.7	83	53	00.0	0	07.6	2.5	Var	Var	3.0
44.	Oct	29-4N	26.4	17.0	86	58	01.6	0	06.3	2.8	Var	WNW	2.7
45.	Nov	05-11	28.8	13.8	91	51	00.0	0	06.9	2.4	Var	WNW	2.8
46.	Nov	12-18	27.6	12.0	90	44	00.0	0	08.2	2.4	C	Var	2.6
47.	Nov	19-15	26.3	11.5	91	51	00.0	0	08.0	3.2	C	Var	2.6
48.	Nov	26-20	24.5	08.4	84	45	01.0	0	08.2	3.2	C	WNW	2.2
49.	Dec		23.7	07.8	93	32	00.0	0	07.6	2.1	C	WSW	1.9
50.	Dec	16-17	22.7	05.4	53	42	00.0	0	05.3	2.1	C	ESE	1.9
51.	Dec	17-23	23.1	07.5	92	44	00.0	0	44.6	3.4	C	WNW	1.7
52.	Dec		22.2	07.1	42	40	Tr	0	05.6	2.4	C	WSW	1.5

Note: Total rainfall received at rainwater during 2000 was 3218.5 mm in 74 rainy days.

Tr – Trace
C – Calm wind
Var – Variable wind

Table 5.2 : The Records of Ambient Air Quality from UPPCD Haldwani

		(in 2/N m3)	
	SPM	**Nox**	**S02**
SRP Ltd.	360	56.0	41.0
Goraiya Strawboard	412	-	-
SRF	420	-	-
Naini Papers	60	-	-
Moradabad	108	-	-
Kashipur Road	110	-	-
Modi Paper Mill	308	48	-
	222	29	-
	338	55	10
	226	25	2
	241	135	37
	104	87	16
Indian Glycol	66-876	8- 3 7.4	6.1-25.2

Table 5.3 Test Report of Water Sample(s)

Authority	:	Head Alternate ydro Energy Center indian institute of technology roorkee Roorkee- 247667
Sample Mark	:	--
Source of Sample	:	Spring water
Date of sample collection	:	Sept.2002
Sample collected by	:	By the party himself

Test Conducted

pH	:	7.3
Conductance μs/cm	:	240
TDS, mg/L	:	154
Alkalinity, mg/L	:	82
Hardness, mg/L	:	100
Sodium mg/L	:	2.4
Potassium, mg/L	:	0.4
Calcium, mg/L	:	30
Magnesium, mg/L	:	6.0

Chloride, mg/L	:	12
Sulphate, mg/L	:	ND
Nitrate-nitrogen, mg/L	:	ND
ND-Not detected	:	
MPN	:	Nil

5.4 Land Environment

Soil plays a central role in the ecology and development of mountainous lands. They provide a vital substratum for humans, animals, plants and micro-organisms. They are a key component of the mountainous ecosystem, in particular for water and nutrient cycling. In addition they constitute a major regulation and transformation process. Soils have always occupied a key position in the cultural and economic life of human communities. In particular they constitute the basis of agriculture and foresty including livestock raising.

The texture of soil varies form loamy sand, fine loamy to silty clay. Textural variation is so great that within small area sand content may vary from 4.5 to 65%, silt content from 6.6 to 46.7% and clay from 3.1 to 65%. Variations are explained by change of parental material. Sand stones and shale's occur together, where as limestone may be found erratically . Alluvium derive forms may vary within short distances depending on the nature of streams. Differences in structural stability and strong sealing of pores at the soil surface, especially in the soils of silty loam, lead to heavy run off from hill slope.

The soil profiles include

F2 MI	Comprises degraded forests and Shrubs
M2	It is identified below 1500 and covers most of the areas
	Represents middle reaches of the slopes, usually covered by forests, cultivated field, shrubs and bushes
M3	Unit sloping area found in the foot hills usually covered by shrubs, open forest and scattered cultivation
VI V2	These are the bottom lands having gentle slopes
PI	These are flat occasionally shrubs occupied by grass
	Moderate sloping lands
	The mineralogy is mixed

5.5 Biological Environment

The proposed road is restricted to a hilly area on the slopes. The water available is in plenty all the year round. It is in the form of atmospheric precipitation, springs, canals and river Dhabka. River Kosi also flows in the region but is away from the area. The availability of water promotes a good growth of flora. On the basis of data reproduced in Table 3.2 it is clear that total cultivable area is about 64% of the geographical area (24582 ha) which includes 6365 ha (40% of cultivable area) of agricultural area and 7633 ha (48% of cultivable area) of forest area. It also has 65 ha of grazing land. The total area under green cover is about 57% of the geographical area. The main agricultural produce include:

i. Paddy
ii Sugar cane
iii Turmeric
iv. Ginger
v Colcasia
vi. Beans and pulses
(Soyabean, moong, urd, lobhia)

It has been repeatedly informed by local population that Kathal Jack fruit), Adrak (Ginger) are two main support products in addition to paddy and sugar cane

The cultivated trees include.

i	Kathhal	Jack fruit
ii	Mangoes	*mangifera*
iii	Banana	
iv	Aonla	*Emblica officials*

The forest cover is typically of Sal forest. As informed by the ranger (Mr. N.S. Karki of Dechauri range) the forest is both Reserve forest and social or Village area forestry. The dominant forest- species include:

i	Sal	*Shorea robusts*
ii	Sain	*Terminalia tomentotia*
iii	Tun	*Cederala tuna*
iv	Shesham	*Dalbergia sissoo*
v	Kher	*Acacia Catcha*

The common bushes are:

i. Lentana
ii. Gunny
iii Basim

At the hill slopes a large variety of Bryophytes (moss) and Pteridophytes exist.

Mimosa (Touch me not) also was noticed in wild growths.

The wild animals reported are:

i. Lions
ii. Elephants
iii Deer
iv. Cheetal
v. Wild boar
vi. Guldar
vii. Sambhar
viiil. Neel gai
ix. Wild bear

The avian fauna was typical of valleys.

No crown fire has been reported, however, ground fires do take place in summers.

5.6 Socio-Economic Envirvirnment

The area shows a well marked growth and imprints of urbanization in rural areas.

The socio-economic environment incorporates the demographic structure of the area, facilities available and their economic status with the sources of income and features of aesthetic importance. All of this information has been collected with the help of the 1991 census data and information provided by BDO

5.6.1 Demographic Status

The population of villages in Kotabagh block has been grouped in five Nyay panchayats.

i. Gintigaon
ii. Sayat
iii. Kaladungi bandobasti
iv. Amgarhi
v. Dola

The abstract of the demographic data is given in Table 4.3 and the details in Table 4.4. The population is mixed with unreserved (general), scheduled tribes, scheduled castes and back wards as below:

General	75.15%
Scheduled tribes	21.89%
Scheduled castes	0.038%
Backward	2.91%

Like any other population recorded (census data) the gender ratio's are represented by

a low female figure except in Amgarhi Nyay Panchyat

	Male to Female		
Ginti gaon	100	:	97
Sayat	100	:	93.5
Ka]adungi Bandobasti	100	:	89.8
Amgarhi	100	:	107.7
Do]a	100	:	93.6
Total	100	:	94.5

The literacy ratio is on the rise. The information given by schools indicate that almost all children in age group of 6-12 attend school. There is no gender bias in education. The girls out number boys in colleges.

5.6.2 Basic Amenities

Under the infrastructural facilities, the basic amenities have been summarized in Chapter 4. The salient observations are as follows:

- The villages have water supply of spring water. It is stored in tanks, chlorinated and supplied or it is used as it is. In Kotabagh it is under the control of Jal Santhan, where as in Pandeygaon and Baluti it is privately managed.
- Villages are electrified.
- Transport facilities are available upto Kotabagh and for other villages, transportation is not available.
- Primary Health centre is available at Kotabagh, hospital at Ram Nagar and base hospital at Ha]dwani. Private RMP are available at Kotabagh.
- Education facilities are available at Kotabagh upto High School. Primary School is available at Pandeygaon also.
- Postal facilities and PCO's are available at Kotabagh
- Shopping facilities are available at Kotabagh but shops in each village keep items of general use.
- Animals are kept in every family. Each family has about 3-4 animals. One or two milch animals and horses/ponies/bulls for transportation.
- Milk is transported to Kotabagh from most of the families for marketing.
- There are no pits on the road side but hill debris often gets accumulated which interferes in water flow across the road.

- Sanitation is fairly good.
- The environment in terms of quality is pristine and pleasant

5.6.3 Socio-Economic Status

The Socio economic survey not only reflects the life style of people within the project area but also expresses their feelings about the need for construction of the proposed road. The villagers are very concerned about the transport of perishable commodities, milk, adrak etc. for which they incur heavy costs. One quintal of adrak is transported to Kotabagh and costs about Rs. 100/-. With the road in position, their cost will be saved and add up to their incomes. Majority of villagers work as labourers and agricultural workers. Some of them live in pucca houses where as others in kuccha houses with thatched roofs covered by tin sheets.

CHAPTER - 6
IMPACT ASSESSMENT

6.1 As indicated in Chapter I, the EIA has three-sequential phases. The identification and characterization of physical, ecological and socio-economic environment existing in the villages and near the site of proposed road to be upgraded has been discussed in the preceding chapter. Prediction and Assessment are discussed here.

6.2 The impact has been evaluated in two stages:

A- During construction

B- After Construction

A. During construction

The construction and upgradation involves clearing the site of extra load burden in the form of stones, boulders, soil debris and removal of bushes and shrubs. Since the road is on the hill-slope, removal may involve earth moving machinery. Cutting of rocks in areas where width available is small and where rounding of curves is to be done, may be resorted to. This would be followed by laying of 2 ballast layers of 10 cm each and compacting to 7.5 cm. The material will be brought from Ram Nagar and Haldwani by trucks. These trucks will move in slow gear. The road rollers will also move slowly. The transportation and compaction would add to exhaust gases and some dust. The compacted ballast layers will be over laid by painting PI and P2. Though the material will be transported from Ramnagar/Haldwani but heating of bitumen and mixing of gravel will be done at the site. This seems unavoidable as hot mix will not be practical. This will, however, generate air pollutants including oxides of carbon, nitrogen and sulfur alongwith some soot, unburnt carbon and dust. The impacts are generalized below:

S.No.	Activity	Impact	Increase/decrease
1.	Clearing the road of stones/soil debris and bushes	- Generation of dust - uprooting of bushes - Release of exhaust gases from earth moving machinery	- dust will increase - bushes will be uprooted and get collected as biomass - increase in oxides of C, N,S and SPM
2.	Laying of ballast and compaction	Generation of dust and increase in exhaust gases by trucks and road rollers	Increase

S.No.	Activity	Impact	Increase/decrease
3.	Coal tarring	Soot and exhaust gases	Increase
4.	Drainage	Provision of cross drainage in the form of culverts, cause ways and scuppers	Drainage will improve
5.	Arboriculture	The bushes will colonise soon on-shoulders	When grown the environment will improve.
6.	Land along the road	Land use will get altered.	Over all benefit

These impacts will be restricted during the construction period and will be of temporary nature.

B. After Construction

After the road is upgraded the environment will improve. Non paved roads can have substantial impact, often more than paved and existing roads. The dust load would be reduced. Wear and tear would be lesser. The traffic would move faster on high gears. Noise level would reduce. The exhaust gases will be reduced. After completion and upgradation the impacts will be on positive side.

- The perishable commodities will be transported fast in all weathers. Will mean economic gain
- The population (students, service personnels and labourers) will be benefited. The travel time will be reduced.
- With road construction/upgradation it is likely that bus/taxi-service may start which will facilitate communication.
- With efficient cross drainage works, pools and puddles will not be formed and water will flow freely.
- The air quality will change with vehicular movement and should be taken as negative impact but the change will be very small almost negligible which the air environment will be able to assimilate.

The summary of anticipated impact is given in Table 6.1

Table 6.1 Anticipated Impacts

S.No.	Activity	Parameters	Anticipated Impacts		
			Phase I	Phase II	Over all
1.	Public convenience Travel/Transport	Time of Movement better communication	+>	+<<	+<<
2.	Bioaesthetics		+>	+<<	+<<
3.	Vegetation		+>	+<	+<
4.	Air quality	SPM CO CO2 NOX SOX HC	+<< +<< +<< +<< +<< +<<	+< +< +< +< +< +<	+* +* +* +* +* +*
5.	Water recharge/discharge	No-significant change during construction- will drain faster after completion			
6.	Water quality	No change in quality			
7.	Land/soil		+	+	+
8.	Noise	db	+<<	+<	+

+	Normal existing	Phase I During Construction
+*	marginal change	Phase II After Construction
+>	Reduce	
+<	Increase	
+<<	Increase-significantly	

CHAPTER- 7
SIMMARY AND CONCLUSIONS

Environmental Impact Assessment of Kotabagh → Ranikota road in Ramnagar tehsil of District Nainital was entrusted to AHEC, Indian Institute of Technology, Roorkee by the Diversified Agricultural Support Project of Uttaranchal Govt. Basic data of the activities was provided by State PWD and DASP. Additional information of base line data was collected from the records of various organizations. Primary data of water quality, biological environment and socio-economic environment was also collected. A cause effect network method was adopted in determining the impacts for road during construction and after construction. The impacts during construction will be for a short time and the stress on the environment in terms of generation of dust, exhaust gases, uprooting of herbs and shrubs, earth work will be small and will be assimilated in the pristine environment. The increase in transport after construction will ease the problems of local population in terms of communication and access to nearby market. The children, working population and women will be benefited by the availability of all weather movable road. The movement of automobiles though limited would generate dust and exhaust gases and would be a burden on the air environment. This is a negative impact, but the quantity of this intervention will be very negligible and can be negated vis-a-vis other positive impacts.

Some salient recommendations and mitigation measures are listed below:

i) There will be negligible effect on the environment by upgradation of the road. The stress during construction can be negated in terms of short time for which the activity will persist.

ii) The project will benefit the rural economy as the agricultural produce would reach market/mandis quicker all the year round and in better condition, therefore fetching a better price.

iii) The upgradation of road and construction of cross drainage will help the general movement of population to places of work.

iv) Convenience to school children and women will go a long way in improving the standards and opportunities for development.

v) There will be a marginal increase in the air pollutants due to vehicular movement but

this burden will be so small that the environment will not be stressed beyond its power of resillience. The sinks of these pollutant around the road are so pronounced (soil and vegetation sink) that the residence time in the environment will be negligible.

vi) Aesthetic in general would improve.

Recommendation

During construction, in narrow-section, the cutting of hill slopes is unavoidable. Great care is necessary in stabilizing the hill slopes, vegetative stabilization methods may be necessary to be followed.

The impact of upgradation over all will be positive.

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4.4 Air (Prevention and Control of Pollution) Act, 1981 (Act No. 14 of 1981)

An Act to provide for prevention control and abatement of air pollution for the establishment, with a view to carrying out the aforesaid purposes, of Boards, for conferring on and assigning to such Boards powers and functions relating thereto and for matters connected therewith

Whereas decisions were taken at the United Nations Conference on the Human Environment held in Stockholm in June 1972, in which India participated, to take appropriate steps for the preservation of the natural resources of the earth which, among other things, include the preservation of the quality of air and control of air pollution;

And whereas it is considered necessary to implement the decisions aforesaid in so far as they relate to the preservation of the quality of air and control of air pollution;

Be it enacted by Parliament in the Thirty-second Year of the Republic of India as follows:-

Statement of Objective

In the United Nations Conference on Human Environment held in Stockholm in June 1972, in which India participated, decisions were taken to take appropriate steps for the preservation of natural resources of the earth which, among other things include the preservation of the quality of air and control of air pollution. The Government of India decided to implement these decisions of the said Conference in so far as they relate to the preservation of the quality of air and control of air pollution.

The Air (Prevention and Control Act) 1981 has VII Chapters defining Chapter I, (Preliminary), Chapter II (Central and State Boards for the Prevention and Control of Air Pollution), Chapter III (Powers and Functions of Boards), Chapter IV (Prevention and Control of Air Pollution), Chapter V (Funds, Accounts and Audit), Chapter VI (Penalties and Procedure) and Chapter VII (Miscellaneous).

CHAPTER – I
PRELIMINARY

1. Short title, extent and commencement

This Act may be called the Air (Prevention and Control of Pollution) Act 1981

2. Definitions

The definitions of the Act (air pollution, approved appliance, approved fuel, automobile, Board, Central Board (means the Central Board for the Prevention and Control of Water Pollution constituted under Section 3 of the Water Act of 1974), Chimney, Control equipment, emission, industrial plant, member occupier, prescribed, State Board (means State Board of Water Pollution Control Act of 1974).

CHAPTER – II
CENTRAL AND STATE BOARD FOR THE PREVENTION AND CONTROL OF AIR POLLUTION

3. Central Board for the Prevention and Control for Air Pollution

The Central Board for the Prevention and control of water pollution constituted under Section 3 of the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974), shall without prejudice to the exercise and performance of its powers and functions under that Act, exercise the powers and perform the functions of the Central Board for the Prevention and Control of Air Pollution under this Act.

4. State Boards for the Prevention and Control of Water Pollution to be State Boards for the Prevention and Control of Air Pollution

In any State in which the Water (Prevention and Control of Pollution) Act, 1974 is in force and State Government has constituted for that State a State Board for the Prevention and Control of Water Pollution under Section 4 of that Act, such State Board shall be deemed to be the State Board for the Prevention and Control of Air Pollution constituted under Section 5 of this Act and accordingly that State Board for the Prevention and Control of Water Pollution shall, without prejudice to the exercise and

performance of its powers and functions under that Act, exercise the powers and perform that functions of the State Board for the Prevention and Control of Air Pollution under this Act.

5. Constitution of State Boards

(1) In any State in which the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974), is not in force, or that Act is in force but the State Government has not constituted a State Board for the Prevention and Control of Water Pollution under that Act, the State Government shall, with effect such date as it may, by notification in the Official Gazette, appoint, constitute a State Board for the Prevention and Control of Air Pollution under such name as may be specified in the notification, to exercise the powers conferred on, and perform the functions assigned to, that Board under this Act.

(2) A State Board constituted under this Act shall consist of the following members namely:-

(a) a Chairman, being a person having special knowledge or practical experience in respect of matters relating to environmental protection, to be nominated by the State Government:

Provided that the Chairman may be either whole-time or part-time as the State Government may think fit;

(b) such number of officials, not exceeding five, as the State Government may think fit, to be nominated by the State Government to represent that Government;

(c) such number of persons, not exceeding five, as the State Government may think fit, to be nominated by the State Government from amongst the members of the local authorities functioning within the State;

(d) such member of non-officials, not exceeding three, as the State Government may think fit, to be nominated by the State Government to represent the interests of agriculture, fishery or industry or trade or labour or any other interest which, in the opinion of that Government, ought to be represented;

(e) two persons to represent the companies or corporations owned, controlled or managed by the State Government, to be nominated by that Government;

(f) a full-time member-secretary having practical experience in respect of matters relating to environmental protection and having administrative experience, to be appointed by the State Government:

Provided that the State Government shall ensure that not less than two of the members are persons having special knowledge or practical experience in respect of matters relating to the improvement of the quality of air or the prevention, control or abatement of air pollution.

(3) Every State Board constituted under this Act shall be a body corporate with the name specified by the State Government in the notification issued under sub-section (1), having perpetual succession and a common seal with power, subject to the provisions of this Act, to acquire and dispose of property and to contract, and may by the said name sue or be sued.

6. Central Board to exercise the powers and perform the functions of a State Board in the Union Territories

7. Terms and Condition of Service of members

A member of a State Board constituted under this Act, other than Member Secretary shall hold office for a period of three years. The term shall come to on end as soon as he ceases to hold the office of the State Government/Company/Corporation, by virtue of which he was nominated. The member may at any time resign his office by writing under his hand to Chairman of the State Board.

A casual vacancy shall be filled by a fresh nomination (for the remaining term)

A member shall be eligible for renomination but not more than two times.

8. Vacation of Seat by members

If a member under any clause has been disqualified his seat will be taken as vacant

9. Meeting of the Board

The Board shall meet at least once in every 3 months.

10. Constitution of committees

A Board may constitute committees consisting of wholly or partially of members and other persons as it may think fit.

11. A Board may associate any person whose assistance and advice it may desire to obtain.

12. Vacancy in Board not to invalidate acts or proceedings

13. Member Secretary and officers of the State Board

1) The terms and conditions shall be such as may be prescribed,
2) Exercise such powers and perform such duties as may be prescribed,
3) A State Board may from time to time appoint any qualified person as consultant

14. A State Board delegate to the Chairman, Member Secretary or any other officer, such of its powers under the Act as it may deem necessary

CHAPTER – III
POWER AND FUNCTIONS OF BOARDS

15. Functions of Boards

1) Subject to the provisions of the Act, the main functions of the Central Board shall be to improve the quality of air and to prevent, control or abate air pollution in the country.
2) The Central Board may
   (a) advise the Central Government on any matter concerning the improvement of the quality of air and the prevention, control or abatement of air pollution;
   (b) plan and cause to be executed a nationwide programme for the prevention, control or abatement of air pollution;

(c) co-ordinate the activities of the State Board and resolve disputes among them;

(d) provide technical assistance and guidance to the State Boards, carry out and sponsor investigations and research relating to problems of air pollution and prevention, control or abatement of air pollution;

(e) plan and organize the training of person engaged or to be engaged in programmes for the prevention, control or abatement of air pollution;

(f) organize through mass media a comprehensive programme regarding the prevention, control or abatement of air pollution;

(g) collect, compile and publish technical and statistical data relating to air pollution and measures devised for its effective prevention, control or abatement and prepare manuals, codes or guides relating to prevention, control or abatement of air pollution;

(h) lay down standards for the quality of air;

(i) collect and disseminate information in respect of matters relating to air pollution;

(j) perform such other function as may be prescribed.

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

4) 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.

16. Functions of State Boards

(1) Subject to the provisions of this Act, the functions of a State Board shall be-

(a) to plan a comprehensive programme for the prevention, control or abatement of air pollution and to secure the execution thereof;

(b) to advise the State Government on any matter concerning the prevention, control or abatement of air pollution;

(c) to collect and disseminate information relating to air pollution;

(d) to collaborate with the Central Board in organizing the training of persons engaged or to be engaged in programmes relating to prevention, control or abatement of air pollution and to organize mass-education programme relating thereto;

(e) to inspect, at all reasonable times, any control equipment, industrial plant or manufacturing process and to give, by order, such directions to such persons as it may consider necessary to take steps for the prevention, control or abatement of air pollution;

(f) to inspect air pollution control areas at such intervals as it may think necessary, assess the quality of air therein and take steps for the prevention, control or abatement of air pollution in such areas;

(g) to lay down, in consultation with the Central Board and having regard to the standards for the quality of air laid down by the Central Board, standard for emission of air pollutants into the atmosphere from industrial plants and automobiles or for the discharge of any air pollutant into the atmosphere from any other source whatsoever not being a ship or an aircraft:

(h) 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;

(i) to perform such other functions as may be prescribed or as may, from time to time, be entrusted to it by the Central Board or the State Government;

(j) to do such other things and to 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.

(2) A State Board may establish or recognize a laboratory or laboratories to enable the State Board to perform its functions under this section efficiently.

CHAPTER – IV
PREVENTION AND CONTROL OF AIR POLLUTION

19. Power to declare air pollution control areas

(1) The State Government may, after consultation with the State Board, by the 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 for the purpose of this Act.

(2) The State Government may, after consultation with the State Board, by notification in the Official Gazette-

(a) alter any air pollution control area whether by way of extension or reduction;

(b) declare a new air-pollution control area in which may be merged one or more existing air pollution control areas or any part or parts thereof.

(3) If the State Government, after consultation with the State Board, is of opinion that the use of any fuel, other than an approved fuel, in any air pollution control area or part there of may cause or likely to cause air pollution, it may prohibit the use of such fuel in such area with effect from such date as may be specified.

(4) The State Government may after consultation with State Board by notification direct that with effect from such date, no appliance, other than approved shall be used in the premises situation air pollution control area.

20. Power to give instructions for ensuring standards for emission from automobiles

21. Restrictions on use of certain industrial plant

No person without the previous consent operate any industrial plant for the purpose of any industry specified in schedule in air pollution control area.

Every person to whom consent has been granted shall comply with the following conditions:

(i) the control equipment of such specification as State Board may approve shall be installed and operated

(ii) the existing control equipment shall be altered or replaced according to the directions of State Board

(iii) the control equipment shall be kept at all times in good running condition

(iv) chimneys of such specifications as the State Board may approve shall be erected in such premises

(v) other conditions which Board may specify.

22. Persons carrying on industry not to allow emission of air pollutants in excess of standards laid down by State Board

No person carrying on industry 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 standards laid down by State Board.

23. Furnishing of information to State Board and other agencies in certain cases

(1) Where in any air pollution control area the emission of any air pollutant into the atmosphere in excess of the standards laid down by the State Board occurs or is apprehended to occur due to accident or other unforeseen act or event, the person in charge of the premises from where such emission occurs or is apprehended to occur shall forthwith intimate

the fact of such occurrence or the apprehension of such occurrence to the State Board and to such authorities or agencies as may be prescribed.

(2) On receipt of information with respect to the fact or the apprehension of any occurrence of the nature whether through intimation under that sub-section or otherwise, the State Board and the authorities or agencies shall, as early as practicable, cause such remedial measures to be taken as are necessary to mitigate the emission of such air pollutants.

24. Power of entry and inspection

(1) Subject to the provisions of this section, any person empowered by a state Board in this behalf shall have a right to enter, at all reasonable times with such assistance as he considers necessary, any place for the purpose of performing any of the functions of the State Board entrusted to him.

(2) Every person carrying on any industry specified in the Schedule and every person operating any control equipment or any industrial plant, in an air pollution control area shall be bound to render all assistance to the person empowered by the State Board under sub-section (1) for carrying out the functions under that sub-section and if he fails to do so without any reasonable cause or excuse, he shall be guilty of an offence under this Act.

25. Power to obtain information

For carrying out the functions entrusted to State Board from the occupier or any other person, the State Board will have the right to inspect the premises where such industry, control equipment or industrial plant is being carried on or operated.

26. Power to take samples of air or emission and procedure to be followed in connection there with

(1) A State Board or an officer empowered shall have power to take, for the purpose of analysis, sample of air or emission from any chimney, flue or duct or any other outlet is such member as may be prescribed.

(2) The results of any analysis of sample of emission taken shall not be admissible in evidence in legal proceedings unless the provisions of (3) and (4) are complied with.

(3) The person taking the sample shall

a) serve on the occupier or his agent a notice, in such a form as may be prescribed of his intentions to have it so analyzed;

b) in the presence of occupier or his agent, collect a sample of emission for analysis;

c) cause the sample to be placed in a container which shall be marked and sealed and shall also be signed by both;

d) send, without delay the container to the laboratory established or recognized by State Board.

27. Report of the result of analysis on samples taken

(1) Where a sample of emission has been sent for analysis to the established and recognized laboratory shall analyze the sample and submit a report in triplicate in the prescribed form.

(2) One copy of the report shall be sent to the occupier, another copy shall be preserved for the court and the third copy shall be kept by the Board.

(3) The same procedure will be followed for reports taken by Board in the absence of occupier.

28. State Air Laboratory

(1) The State Government may

a) establish one or more State Air Laboratories or

b) specify one or more Laboratories as State Laboratories to carry out the functions entrusted to the State Air Laboratory under this act.

(2) State Government may after consultation with the State Board, make rules prescribing

a) the functions of State Laboratory;

b) procedure for the submission of samples of air for analysis or tests

c) such other matters expedient to enable the laboratory to carryout its functions.

29. Analysts

(1) The State Government by notification appoint such persons as it think fit and the prescribed qualifications to be Government analysts

(2) The State Government appoint such persons, having the prescribed qualifications for the purpose of analysis to any laboratory established.

30. Reports of analysis

31. Appeals

CHAPTER – V
FUNDS, ACCOUNTS AND AUDIT

32. Contributions by Central Govt.

33. Fund of Board

34. Budget

35. Annual Report

36. Accounts and Audit

CHAPTER – VI
PENALTIES AND PROCEDURES

37. Failure to comply with provisions of Section 21 or Section 22 or with orders or directions issued under the Act, shall in respect of each failure be punishable with imprisonment for a term to three months or with fine which can extend to Rs. 10,000.00 or with both, in case of failure continues, with an additional fine which may extend to Rs. 100/- per day during which, the failure continues.

If the failure continues beyond a period of one year, the offensive will be punishable with imprisonment for a term which may extend to six months. Penalties for other certain acts, contravention of certain provisions, offence by

companies, Government offices and protection against action taken in good faith are stipulated under Sections 38-42.

43. Congnizance of offences

44. Members officers and employees of Board to be Public Servants

45. Reports and Returns

46. Bar of Jurisdiction

CHAPTER – VII
MISCELLANEOUS

47. Power of State Government to supersede State Board

If at any time the State Government is of opinion-

(a) that a State Board constituted under this Act has persistently made default in the performance of the functions imposed on it by or under this Act, or

(b) that circumstances exist which render it necessary in the public interest to do, the State Government may, by notification in the Official Gazette, supersede the State Board for such period, not exceeding six months, as may be specified in the notification.

48. Special provisions in the case of supersession of the Central Board or State Boards constituted under the Water Act, 1974

49. Dissolution of State Boards constituted under the Act as and when the Water Act comes into force in any State the Board constituted under Air Act shall stand dissolved.

50. Power to amend the schedule

51. Maintenance of register

52. Effect of other laws

53. Power of Central Government to make rules and

54. Power of State Government to make rules

(Lectures 17, 18)

4.5 THE ENVIRONMENT (PROTECTION) ACT, 1986 No. 29 of 1986

[23rd May, 1986]

An Act to Provide for the Protection and Improvement of Environment and for Matters Connected therewith

WHEREAS decisions were taken at the United Nations Conference on the Human Environment held at Stockholm in June, 1972 in which India participated, to take appropriate steps for the protection and improvement of human environment;

AND WHEREAS it is considered necessary further to implement the decisions aforesaid in so far as they relate to the protection and improvement of environment and the prevention of hazards to human beings, other living creatures, plants and property;

BE it enacted by Parliament in the Thirty seven Year of the Republic of India as follows:

CHAPTER – I
PRELIMINARY

1. (1) This Act may be called the Environment (Protection) Act, 1986.

(2) It extends to the whole of India.

(3) It shall come into force on such date as the Central Government may, by notification in the Official Gazette, appoint and different dates may be appointed for different provisions of this Act and for different areas.

2. Definitions

In this unless the context otherwise requires

(a) environment, (b) environmental pollutant, (c) environmental pollution (d) handling, (e) hazardous substance (f) occupier (g) prescribed.

CHAPTER – II
GENERAL POWERS OF THE CENTRAL GOVERNMENT

3. (1) The Central Government shall have the power to take all such measures as it deems necessary for the purpose of protecting and improving the quality of the environment and preventing, controlling and abetting environmental pollution.

(2) In particular, such measures may include measures with respect to all or any of the following matters, namely

(i) co-ordination of actions by the State Government officers and other authorities;

(ii) planning and execution of a nation-wide programme for the prevention, control and abatement of environmental pollution;

(iii) laying down standards for the quality of environment in its various aspects;

(iv) laying down standards for emission or discharge of environmental pollutants from various sources whatsoever;

(v) restriction of areas in which any industries operations, or processes or class of industries, operations or processes shall not be carried out or shall be carried out subject to certain safeguards;

(vi) laying down procedures and safeguards for the prevention of accidents which may cause environmental pollution and remedial measures for such accidents;

(vii) laying down procedures and safeguards for the handling of hazardous substances;

(viii) examination of such manufacturing processes, materials and substances as are likely to cause environmental pollution;

(ix) carrying out and sponsoring investigations and research relating to problems of environmental pollution;

(x) inspection of any premises, plant, equipment, machinery, manufacturing or other processes, materials or substances and

giving, by order, of such directions to such authorities, officers or persons as it may consider necessary to take steps for the prevention, control and abatement of environmental pollution;

(xi) establishment or recognition of environmental laboratories and institutes to carry out the functions entrusted to such environmental laboratories and institutes under this Act;

(xii) collection and dissemination of information in respect of matters relating to environmental pollution;

(xiii) preparation of manuals codes or guides relating to the prevention control and abatement of environmental pollution;

3. The Central Government may constitute an authority to exercise the powers and perform the functions as mentioned in the order

4. (a) The Central Govt. may appoint officers with such designations as it thinks fit for the purposes of this Act and may entrust to them such of the powers and functions under this act as it may deem fit.

(b) The officers appointed under subsection (1) shall be subject to the general control and direction of the Central Govt. or, if so directed by that Govt. also of the authority, constituted under subsection (3) of section 3 or of any other authority or officer.

5. The Central Govt. may, in the exercise of its powers and performance of its functions under this Act, issue directions in writing to any person, officer or any authority and such person, shall be bound to comply with such directions.

6. (1) The Central Government may make rules in respect of all or any of the matters referred to in section 3:

(a) the standards of quality of air, water or soil for various areas and purposes;

(b) the maximum allowable limits of concentration of various environmental pollutants (including noise) for different areas;

(c) the procedures and safeguards for the handling of hazardous substances;

(d) the prohibition and restrictions on the handling of hazardous substances in different areas;

(e) the prohibition and restrictions on the location of industries and the carrying on of processes and operations in different areas;

(f) the procedures and safeguards for the prevention of accidents which may cause environmental pollution and for providing for remedial measures for such accidents.

CHAPTER – III
PREVENTION, CONTROL AND ABATEMENT OF ENVIRONMENTAL POLLUTION

7. No person carrying on any industry, operation or process shall discharge or emit or permit to be discharged or emitted any environmental pollutant in excess of such standards as may be prescribed.

8. 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.

9. (1) Where the discharge of any environmental pollution in excess of the prescribed standards occurs or is apprehended to occur due to any accident or other unforeseen act or event, the person responsible for such discharge and the person in charge of the place at which such discharge occurs or is apprehended to occur shall be bound to prevent or mitigate the environmental pollution caused as a result of such discharge and shall also forthwith:-

(a) intimate the fact of such occurrence or apprehension of such occurrence; and

(b) be bound, if called upon, to render all assistance, to such authorities or agencies as may be prescribed.

(2) On receipt of information with respect to the fact or apprehension of any occurrence of the nature referred to in sub-section (1), shall as early as

practicable, cause such remedial measures to be taken as are necessary to prevent or mitigate the environmental pollution.

10. (1) Subject to the provisions of this section, any person empowered by the Central Government in this behalf shall have a right to enter, at all reasonable times with such assistance as he considers necessary, any place:-

(a) for the purpose of performing any of the functions of the Central Government entrusted to him;

(b) for the purpose of determining whether and if so in what manner, any such functions are to be performed or whether any provisions of this Act or the rules made there under or any notice, order, direction or authorization served, made, given or granted under this Act is being or has been complied with;

(c) for the purpose of examining and testing any equipment, industrial plant, record, register, document or any other material object or for conducting a search of any building in which he has reason to believe that an offence under this Act or the rules made there under has been or is being or is about to be committed and for seizing any such equipment, industrial plant, record, register, document or other material object if he has reasons to believe that it may furnish evidence of the commission of an offence punishable under this Act or the rules made there under or that such seizure is necessary to prevent or mitigate environmental pollution.

(2) Every person carrying on any industry, operation or process or handling any hazardous substance shall be bound to render all assistance to the person empowered by the Central Government for carrying out the functions under that sub-section and if he fails to do so without any reasonable cause or excuse, he shall be guilty of an offence under this Act.

(3) If any person willfully delays or obstructs any person empowered by the Central Government in the performance of his functions, shall be guilty of an offence under this Act.

11. (1) 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 factory, premises or other place in such manner as may be prescribed.

(2) The result of any analysis of a sample taken shall not be admissible in evidence in any legal proceeding unless the provisions of section (3) or (4) are complied with.

(3) Subject to the provisions of sub-section (4), the person taking the sample under sub-section (1) shall:-

(a) serve on the occupier or his agent or person in charge of the place, a notice, in such form as may be prescribed, of his intention to have it so analysed;

(b) in the presence of the occupier or his agent or person, collect a sample for analysis.

(c) cause the sample to be placed in a container or containers which shall be marked and sealed and shall also be signed both by the person taking the sample and the occupier or his agent or person;

(d) send without delay, the container or the containers to the laboratory established or recognized by the Central Government.

(4) When a sample is taken for analyses and the person taking the sample serves on the occupier, a notice then:-

(a) in case where the occupier or his agent absents himself, the person taking the sample will collect the sample, seal and sign and send for analysis

(b) if the occupier refuses to sign the marked contains the container shall be signed by the person taking the sample and the containers shall be sent to Laboratory for analysis.

12. (1) The Central Government may, by notification in the Official Gazette:-

(a) establish one or more environmental laboratories;

(b) recognize one or more laboratories or institutes as environmental laboratory under this Act.

(2) The Central Government may, make rules specifying:-

(a) the functions of the environmental laboratory;

(b) the procedure for the submission of the said laboratory of samples of air, water, soil or other substance for analysis or tests, the form of the laboratory report thereon and the fees payable for such report;

(c) such other matters as may be necessary or expedient to enable that laboratory to carry out its functions.

13. The Central Government may by notification in the Official Gazette, appoint or recognize such persons as it thinks fit and having the prescribed qualifications to be Government Analysts for the purpose of analysis of samples of air, water, soil or other substance sent for analysis to any environmental laboratory established or recognized under section 12.

14. Any document purporting to be a report signed by a Government analyst may be used as evidence of the facts stated therein in any proceeding under this Act.

15. (1) Whoever fails to comply with or contravenes any of the provisions of this Act, or the rules made or orders or directions issued there under, shall, in respect of each such failure or contravention, be punishable with imprisonment for a term which may extend to five years or with fine which may extend to one lakh rupees, or with both and in case the failure or contravention continues, with additional fine which may extend to five thousand rupees for every day during which such failure or contravention continues after the conviction for the first such failure or contravention.

(2) If the failure or contravention referred to in sub-section (1) continues beyond a period of one year after the date of conviction, the offender shall be punishable with imprisonment for a term, which may extend to seven years.

16. Where any offence under this Act has been committed by a company, every person who, at the time the offence was committed was directly in charge of, and was responsible to, the company for the conduct of the business of the company, as well as the company, shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly.

17. (1) Where an offence under this Act has been committed by and department of government, the head of the department shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly.

(2) Where an offence under this Act has been committed by a Department of Government 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, such officer shall also be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly.

CHAPTER – IV
MISCELLANEOUS

18. No suit, prosecution or other legal proceeding shall be against the Government or any officer or other employee of the Government or which is done or intended to be done in good faith in pursuance of this Act or the rules made or orders or directions issued there under.

19. No court shall take cognizance of any offence under this Act except on a complaint made by:-

(a) the Central Government or any authority or officer authorized in this behalf by that Government; or

(b) any person who has given notice of not less than sixty days, in the manner prescribed, of the alleged offence and of his intention to make a complaint, to the Central Government or the authority or officer authorized as aforesaid.

20. The Central Government in relation to functions under this Act can obtain information, reports returns, statistics and accounts from, such persons, officers and State Government.

21. All officers, constituted under Section 3, shall be deemed to be public servants (Section 21 of the IPC)

22. No civil court shall have jurisdiction to entertain any suit or proceedings in respect of action taken or direction issued by Central Government/authority in pursuance of power conferred by this Act.

23. The Central Government can delegate its powers/functions to any officer, State Government or authority.

24. The provisions of the Act shall have effect not with standing any thing in - consistent contained in any enactment other than this Act.

25. The Central Government may make rules for carrying out the purpose of this Act.

(a) standards in excess of which environmental pollutants shall not be discharged or emitted

(b) the procedure and the safeguards in compliance with which hazardous substances shall be handled

(c) the authorities/agencies to which intimation of occurrence or apprehension of occurrence of the discharge of any environmental pollution in excess of the prescribed standards shall be given and to whom assistance shall be bound to be rendered

(d) the manner in which samples of air, water, soil or the other substances for the purpose of analysis shall be taken.

(e) the form in which notice of intention to have a sample analysed shall be served

(f) the functions of environmental laboratories, the procedure for the submission of samples for analysis, the form of laboratory report

(g) the qualifications of Government analysts appointed or recognized for the purpose of analysis of samples

(h) the authority to whom any reports, returns, statistics, accounts and other information shall be furnished.

(Lectures 19, 20)

4.6 Provisions of Environmental Impact Assessment Under Environmental (Protection) Act, 1986

Ministry of Environment Forests, Government of India have taken several policy initiatives and made provisions of **Water (Prevention and Control) Act, 1974**; **Air (Prevention and control of pollution) Act, 1981** and **Environment (Protection) Act, 1986**. These acts are aimed in controlling environmental pollution with legislative provisions to prevent exploitation of natural resources and to promote integration of environmental concerns. One such initiative is notification on **Environmental Impact Assessment** issued on 27th January 1994 under the provisions of Environment Protection Act.

The salient features of the notification are given below:

Environment Impact Assessment Notification

Ministry of Environment and Forests

Notification

New Delhi, the 27th January, 1994

(incorporating amendments made on 04/05/1994, 10/04/1997, 27/01/2000, 13/12/2000, 01/08/2001 and 21/11/2001)

1. Note: A notification, under clause (a) of subrule (3) of rule 5 of the EPA Rules, 1986 (SO.60(E)) was issued by MOEF, Government of India inviting objections from the public within 60 days from the date of notification, against the intentions of the Central Government to impose restriction and prohibitions on the expansion and modernization of any activity or new projects being undertaken in any part of India unless environmental clearance has been accorded by the Central Government or the State Government in accordance with procedures specified in the notification, was published as SO NO. 80(E) dated 28th January 1993.

   All objections received were duly considered.

The Central Government, in exercise of the powers conferred by sub-section (1) and clause (v) of sub-section (2) of Section (3) of the Environmentation Protection Act, Environmental Protection Rules, 1986, directed that on the form and date of publication

of notification in official Gazette, expansion or modernization of any activity (if pollution load is to exceed the existing one), or new projects listed in **Schedule - I** to the notification, shall not be undertaken in any part of India unless it has been accorded **Environmental Clearance** by Central Government.

2. **Requirements and Procedures for Seeking Environmental Clearance of Projects**

I. a) Any person who desires to undertake any **New Project** in any part of India or the expansion or modernization of any existing industry or project listed in **Schedule – I**, shall, submit an application to the Secretary, Ministry of Environment and Forests, New Delhi

The application shall be made in the proforma specified in **Schedule –II** of this notification and shall be accompanied by a project report which, should include an **Environmental Impact Assessment Report**, an **Environmental Management Plan and details of public hearing as specified in **Schedule – IV** prepared in accordance with the guidelines issued by Central Government in the MOEF from time to time (public hearing is not required in respect of (i) small scale industrial undertakings located in (a) notified/designated industrial areas/industrial estates (b) areas earmarked for industries under the jurisdiction of industrial development authorities, (ii) widening and strengthening of highways, iii) mining projects (major minerals) with lease areas upto 25 ha. iv) units located in export processing zones, special economic zones and v) modification existing irrigation projects).

b) Cases rejected due to submission of inadequate data and plans may be reviewed as and when submitted with complete data and plans submission of incomplete data or plans for the second time would itself be a sufficient reason for the Impact Assessment Agency to reject the case summarily.

II. In case of the following site specific projects:

a) mining;

b) pit head, thermal power stations

c) hydro power major irrigation projects and/or combination including flood control

d) ports and harbours (excluding minor ports)

e) prospecting and exploration of major minerals in areas > 500 ha.

The project authorities will intimate the location of the project site to the Central Government MOEF while initiating any investigation or surveys. The Central Government MOEF will convey a decision regarding suitability or otherwise of the proposed site within a maximum period of 30 days. The said site clearance shall be granted for a sanctioned capacity and shall be valid for **five year** for commencing the construction, operation or mining.

III. a) The reports submitted with the application shall be evaluated by **Impact Assessment Agency** (IAA). The IAA may consult experts (Schedule – III). The IAA will be MOEF.

a) The committee of experts shall have right of entry and inspection of the site at any time prior to, during or after the commencement of the operations relating to the project.

b) The IAA shall prepare a set of recommendations based on technical assessment of documents and data furnished by project authorities, supplemented by data collected during visit to the sites if undertaken and details of public hearing.

The Assessment will be completed within a period of 90 days from the receipt of requisite documents and data from project authorities and decision conveyed within 30 days thereafter. The clearance granted shall be valid for a period of five years for commencement of construction or operation of project. No construction work, preliminary or otherwise, relating to setting up of the project may be undertaken till the clearance is obtained.

IV. In order to enable the Impact Assessment Agency to monitor effectively the implementation of the recommendations and conditions subject to

which the Environmental clearance has been given, the project authorities shall submit a half yearly report to the IAA, subject to the public interest, the IAA shall make compliance reports publically available.

V. If no comments from IAA are received within time limit, the project would be deemed to have been approved as proposed by project authorities.

3. Nothing contained in this notification shall apply to

a) any item falling under entry No. 3 (ports harbours, air ports) 17 (tourism projects) and 20 (mining projects) of Schedule – I to be located in the areas covered by the Notification of February 1989, February 1991, June 1991 and May 1992.

b) any items falling under entry Nos. 1 – 5, 9 – 10, 13, 16, 18, 19, 21, 25 and 27 of Schedule – I if the investment is less than 50 crores (marked *)

c) any item reserved for Small Scale Industries (SSI) sector with investment less than 1.0 crore.

d) defence related road construction projects in border areas.

e) any item falling under entry 8 of Schedule – I (Bulk drugs and Pharmaceuticals) covered by the notification GSR 1037 (E) dated December 5, 1989.

4. Concealing factual data or submission of false, misleading data/reports, decisions or recommendations would lead to the project being rejected. Approval if granted earlier on the basis of false data would be revoked.

[No. 2-12013/4/89-1A-1]

Schedule – I

List of Projects Requiring Environmental Clearance From

The Central Government

* 1. Nuclear Power and related projects such as Heavy Water Plants, nuclear fuel complex, Rare Earths.
* 2. River valley projects including hydel power, major irrigation and their combination including flood control.
* 3. Ports, Harbours, Air Ports (except minor ports and harbours)
* 4. Petroleum Refineries include crude and product pipelines.
* 5. Chemical Fertilisers (Nitrogenous and Phosphatic other than single superphosphate)
6. Pesticides (technical)
7. Petrochemical complexes (both olefinic and aromatic) and petrochemical intermediates such as DMT, caprolactum, LAB etc. and production of basic plastics such as LLDPE, HDPE, PP, PVC.
8. Bulk drugs and pharmaceuticals
* 9. Exploration for oil and gas and their production, transportation and storage.
* 10. Synthetic Rubber
11. Asbestos and asbestos products.
12. Hydrocyanic acid and its derivatives.
*13. a) Primary metallurgical industries (production of iron and steel, aluminum, copper, zinc, lead and ferroalloys)
    b) Electric arc furnaces (mini steel plates)
14. Chlor-alkali industry
15. Integrated paint complexes including manufacture of resins and basic raw materials required in manufacture of paints.
* 16. Viscose staple fibres and filament yarn.
17. All tourism projects between 200 m – 500 m of High Water line and at locations with an elevation of > 1000 m with investment of > Rs. 5.0 crores

*18. Storage batteries integrated with manufacture of oxides of lead and lead antimony alloys

19. Thermal Power plants

20. Mining projects (major minerals)* with leases > 5 Ha.

* 21. Highway projects, **except projects related to improvement works include widening and strengthening of roads with marginal land acquisition along the existing alignments provided it does not pass through ecologically sensitive areas such as National Parks, Sanctuaries, Tiger Reserves, Reserve Forests**

22. Tarred roads in Himalyas and forest areas

23. Distilleries

24. Raw skin and hides

* 25. Pulp, paper and newsprint

26. Dyes

27. Cement

28. Foundries (individual)

29. Electroplating

30. Meta aminophenol

The MOEF vide notification dated 7th July 2004, included the new construction at Sl. No. 31 in the above notification of 1994. With this notification it is mandatory for construction fulfilling any one of the following requirements to get the environmental clearance from MOEF.

a) Any construction project including new township, settlement colonies, commercial complexes, hotel complexes, hospitals and office complexes for 1000 (one thousand) persons or more or discharging sewage of 50,000 (fifty thousand) liters per day or more or with an investment of Rs. 50,00,00,000 (Rupees fifty crors) or above.

b) Any industrial estate falling entry 32 of Schedule – I including industrial estate accommodating industrial units in an area of 50 hectares or below but excluding the industrial estates irrespective of area if their pollution potential is high.

SCHEDULE – II

APPLICATION FORM

1. a) Name and Address of the Project Proposed:
   b) Location of Project
      Name of the place
      District, Tehsil
      Latitude/Longitude
      Nearest Airport/Railway Station
   c) Alternate sites examined and reasons for selecting the site
   d) Does the site conform to stipulated land use plan:
2. Objectives of the project
3. a) Land requirement:
      Agricultural land
      Forest land and density of vegetation
      Other (specify)
   b) i) Land use, in the catchment within 10 km radius of proposed site
      ii) Topography of the area indicating gradient, aspects and altitude
      iii) Erodibility classification of the proposed land
   c) Pollution sources existing with in 10 km radius and their impact on quality of air, water and land.
   d) Reserve/Monument/heritage site/reserve forest
   e) Distance of the nearest National Park/ Sanctuaries/Biosphere Reserve/ Monument/ Heritage site/ Reserve forest
   f) Rehabilation plan for quarries/borrow areas:
   g) Green belt plan
   h) Compensatory afforestation plan
4. Climate and Air Quality
   a) Wind Rose at site:
   b) Maximum/Minimum/Mean annual temperature
   c) Frequency of inversion

d) Frequency of cyclones/Tornadoes/Cloudburst

e) Ambient air quality data:

f) Nature and concentration of emission of SPM, Gas (CO, CO_2, NO_x, CH_n etc) from the project

5. Water balance:

a) Water balance at site:

b) Lean season water availability

Water requirement

c) Source to be tapped with competing users (River, Lake, Ground, Public Water Supply):

d) Water Quality:

e) Changes observed in quality and quantity of ground water in the last five years and present charging and extraction details

f) i) Quantum of waste water to be released with treatment details:

ii) Quantum of quality of water in the receiving body before and after disposal of wastes

iii) Quantum of waste water to be released on land and type of land

g) i) Details of reservoir water quality with necessary catchment treatment plan.

ii) Command Area Development Plan

6. Solid Wastes

a) nature and quantity of solid waste generated

b) solid waste disposal method

7. Noise and Vibrations

a) sources of noise and vibrations

b) ambient noise level

c) noise and vibration control measures proposed

d) subsidence problem if any with control measures

8. Power requirement indicating source of supply complete environmental details to be furnished separately if captive power unit proposed

9. Peak labor force to be deployed giving details of:

- Endemic health problems in the area due to waste water/air/soil borne diseases:
- Health care system existing and proposed:

10. a) Number of villages and population to be displaced:
    b) Rehabilitation master plan:
11. Risk Assessment Report and Disaster Management plan:
12. a) Environmental Impact Assessment
    b) Environmental Management plan
    c) Detailed feasibility report
    d) Duly filled in questionnaire
13. Details of Environmental Management Cell

I hereby give above an undertaking that the data and information given above are due to the best of my knowledge and belief and I am aware that if any part of the data/information submitted is found to be false or misleading at any stage, the project be rejected and clearance given if any, to the project is likely to be revoked at our risk and cast.

Signature of the applicant

Date:

Place:

Schedule – III

Composition of the Expert Committees for Environmental Impact Assessment

1. The committee will consist of experts in the following disciplines
   - i) ECO System Management
   - ii) Air/Water Pollution Control
   - iii) Water Resources Management
   - iv) Flora/Fauna Conservation and Management
   - v) Land use planning
   - vi) Social Science/rehabilitation
   - vii) Project appraisal
   - viii) Ecology
   - ix) Environmental Health
   - x) Subject Area Specialist
   - xi) Representatives of NGOs/persons concerned with environmental issues
2. Chairman will be an outstanding and experienced ecologist or environmentalist or technical professional with wide managerial experience in the relevant development sector
3. The representative of Impact Assessment Agency will act as Member Secretary
4. Chairman and members will serve in their individual capacities except those specifically nominated as representatives.
5. The membership of a committee shall not exceed 15.

SCHEDULE – IV

PROCEDURE FOR PUBLIC HEARING

1. Process of Public Hearing – Whoever apply for environmental clearance of projects, shall submit to concerned State Pollution Control Board 20 sets of following documents:
   - i) Executive summary containing salient features of the project both in English and local language

ii) Form XII prescribed under Water (prevention and control of pollution) rules, 1975 where discharge of waste water is required

iii) Form I prescribed under Air (prevention and control of pollution) under Territory rules, 1983 where discharge of emissions are involved

iv) Any other document, which is necessary in the opinion of the Board for final disposal of the application

2. Notice of Public Hearing:

i) The State Pollution Control Board shall cause a notice for Public Hearing which shall be published it at least two newspapers, mentioning date, time and place. Suggestion and views shall be invited within 30 days.

ii) All persons including residents, environmental groups, likely to be affected can participate and or make oral/written suggestions

3. Composition of Public Hearing Panel:

Panel way consist of the following

i) Representative of Pollution Control Board

ii) District collector or his nominee

iii) Representative of State Government dealing with environment

iv) Three representatives of local bodies

v) Three senior citizens of the area nominated by D.C.

4. Time Period. The Public Hearing shall be completed within 60 days from the date of receipt of complete documents.

(Lectures 21)

4.7 Under Water Act, Air Act and EPA, CPCB has notified the Air quality Standards, General Standards for discharge of Environmental Pollutions and Noise Standards. They are given below under separate heads (Tables 4.1 – 4.3)

Table 4.1 The Central Pollution Control Board Under Section 16 (2) h of the Air Act Notified National Ambient Air Quality Standards Note on April 11, 1994 (Schedule I).

Pollutant	**Time Weighted Average**	**Concentration in Ambient Air**		
		Industrial Area	**Residential, Rural, Other**	**Sensitive Areas**
(1)	(2)	(3)	(4)	(5)
Sulphur Di oxide (SO_2)	Annual Average°	80 μg/m^3	60 μg/m^3	15 μg/m^3
	24 hours$^{\Theta}$	120 μg/m^3	80 μg/m^3	30 μg/m^3
Oxides of Nitrogen as NO_2	Annual Average°	80 μg/m^3	60 μg/m^3	15 μg/m^3
	24 hours$^{\Theta}$	120 μg/m^3	80 μg/m^3	30 μg/m^3
Suspended Particulate Matter (SPM)	Annual Average°	360 μg/m^3	140 μg/m^3	70 μg/m^3
	24 hours$^{\Theta}$	500 μg/m^3	200 μg/m^3	100 μg/m^3
Respirable* Particulate Matter (RPM)	Annual Average°	120 μg/m^3	60 μg/m^3	50 μg/m^3
	24 hours$^{\Theta}$	150 μg/m^3	100 μg/m^3	75 μg/m^3
Lead (Pb)	Annual Average°	1.0 μg/m^3	0.75 μg/m^3	0.5 μg/m^3
	24 hours$^{\Theta}$	1.5 μg/m^3	1.00 μg/m^3	0.75 μg/m^3
Carbon Mono oxide (CO)	24 24 hours$^{\Theta}$	1.5 μg/m^3	1.0 μg/m^3	0.75 μg/m^3
	8 hour^{ff}	5.0 μg/m^3	2.0 μg/m^3	1.00 μg/m^3
	1 hour	10.0 μg/m^3	4.0 μg/m^3	2.0 μg/m^3
Ammonia** NH_3	Annual Average°	0.4 mg/m^3*		
	24 hours$^{\Theta}$	0.1 mg/m^3*		

° Annual Arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.

$^{\Theta}$24 hourly/8 hourly should be met 98% of the time in a year, 2% of times it may exceed but not on consecutive days.

* RPM size less than 10 μm.

** Notification of Oct. 14, 1998.

Table 4.2 Ambient Air Quality Standards in Respect of Noise

Area Code	Category of Area	Limits in dB (A) log	
		Day Time (6.0 am – 9.0 pm)	Night time (9.0 pm – 6.0 am)
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone*	50	40

* Areas upto 100 m around hospitals/educational institutions courts.

Table 4.3: General Standards for Discharge of Environmental Pollutants Part A Effluents

Sl. No. (1)	Parameter (2)	Inland Surface Water	Standards (3)		
			Public Sewers	Land for Irrigation	Marine Coastal Areas
		(a)	(b)	(c)	(d)
1	Color and odor	All efforts should be made to remove color and unpleasant odor as far as practicable.			
2	Suspended Solids, mg/L (max)	100	600	200	For process Waste Water 100
3	Particle size	Shall pass 850 μ, IS Sieve	-	-	Floatable Solids max. 850 μ
4	pH value	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0
5	Temperature	Shall not exceed 5^0C above the receiving water	-	-	Shall not exceed 5^0C above the receiving water
6	Oil and grease, mg/L max.	10	20	10	20
7	Total Residual Chlorine max mg/L	1.0	-	-	1.0
8	Amm. Nitrogen, mg/L, max.	50	50	-	50
9	Total Kjeldahl N as NH_3 mg/L, max.	100	-	-	100
10	Free Ammonia(NH_3), mg/L max.	5.0	-	-	5.0
11	B.O.D. (3 days 27^0C),	30	350	100	100

Sl. No. (1)	Parameter (2)	Inland Surface Water	Standards (3)		
			Public Sewers	Land for Irrigation	Marine Coastal Areas
		(a)	(b)	(c)	(d)
	mg/L, max.				
12	C.O.D., mg/L max.	250	-	-	250
13	Arsenic (as AS), mg/L, max.	0.2	0.2	0.2	0.2
14	Mercury (as Hg), mg/L, max.	0.01	0.01	-	0.01
15	Lead (as Pb), mg/L, max.	0.1	1.0	-	2.0
16	Cadmium (as Cd), mg/L, max.	2.0	1.0	-	2.0
17	Hexavalent Chromium (as Cr^{6+}), mg/L, max.	0.1	2.0	-	1.0
18	Total Chromium (as Cr), mg/L, max.	2.0	2.0	-	2.0
19	Copper (as Cu), mg/L, max.	3.0	3.0	-	3.0
20	Zinc (as Zn), mg/L, max.	5.0	15.0	-	15.0
21	Selenium (as Se), mg/L, max.	0.05	0.05	-	0.05
22	Nickel (as Ni) mg/L, max.	3.0	3.0	-	5.0
23	Cyanide as (CN), mg/L, max.	0.2	0.2	0.2	0.2
24	Flouride (as F), mg/L, max.	2.0	15.0	-	15.0
25	Dissolved Phosphate (asp), mg/L, max.	5.0	-	-	-
26	Sulphides (as S), mg/L, max.	2.0	-	-	5.0
27	Phenolic Compounds, (as C_6H_5OH), mg/L, max.	1.0	5.0	-	5.0
28	Radio active material a) α-emitter b) β-emitter Curie/ml	 10^{-7} 10^{-6}	 10^{-7} 10^{-6}	 10^{-8} 10^{-7}	 10^{-7} 10^{-6}
29	Bioassay Test	90%	90%	90%	Same

Sl. No. (1)	Parameter (2)	Inland Surface Water	Standards (3)		
			Public Sewers	Land for Irrigation	Marine Coastal Areas
		(a)	(b)	(c)	(d)
		Survival of fish after 96 hrs. in 100% effluent	Survival of fish after 96 hrs. in 100% effluent	Survival of fish after 96 hrs. in 100% effluent	
30	Manganese (as Mn), mg/L, max.	2.0	2.0	-	2.0
31	Iron (as Fe), mg/L, max.	3.0	3.0	-	3.0
32	Vanadium (as V), mg/L, max.	0.2	0.2	-	0.2
33	Nitrate (as N), mg/L, max.	10.0	-	-	20.0

4.8 Govt. of Indian under EIA requirements issued to limit the activities in the following areas

- Prohibiting location of industries except those related to tourism in a belt of 1.0 km from high tide mark from Ravanda creek upto Devgarh, as well as in 1.0 km belt along the banks of Rajpura creek in in Murud Janjira areas in Raigarh district of Mahrashtra (6.1.1989)
- Restricting location of industries, mining operation and regulating other activities in Doon Valley (1.2.1989)
- Restricting activities is coastal stretches of the country by classifying them as coastal Regulation Zone and prohibiting certain activities (19.2.1991)
- Restricting location of industries and regulating other activities in Dhanu Taluka of Mahrashtra (6.6.1991)
- Restricting certain activities in specified areas of Aravalli Range in Gurgaon district of Haryana and Alwar District of Rajasthan (7.5.1992)
- Regulating industrial and other activities in an area noth west of Numaligarh in Assam (5.7.1996)

Suggested Reading

1. Water (Prevention and control of Pollution) Act. 1074, GoI, Ministry of Law Justice and Company Affairs, New Delhi.
2. Air (Prevention and Control of Pollution) Act, 1981 Eastern Book Agency, Lucknow.
3. Environment (Protection) Act, 1986, Ministry of Environment and Forests, Department of Environment Forest and Wild Life, New Delhi.
4. International Laws, Trivedi, P.R., APH Publishing Corporation, New Delhi – 1996.
5. Environment Impact Assessment, Impact Assessment Division, MoEF, GoI, January 2001.

(Lecture 22)

CHAPTER - V
Environmental Impact Assessment

5.1 All anthropogenic activities have some impact on environment. The impacts may be significant or controversial, positive or negative. The negative, harmful, effects are often far more common than useful. There is thus a pressing need to evaluate the potentialities of a proposed project before it is undertaken. There is no danger to environment if the impacts are within the sustainability of environment but when they exceed the carrying capacity and produce ecological changes that the alarm bells start ringing. These ecological changes must be characterized early in the project cycle and corrective steps taken. The need to foresee the problems of a development project is the primary objective of Environmental Impact Assessment (EIA). It is an exercise to document the consequences of a proposed project in totality alongwith measures necessary to keep the environment clean and healthy. Administrative and legislative decisions are needed to go ahead with the project or to curb/restrain activities. These provisions have been made in the Environment (Protection) Act, 1986[*]. Similar steps have been taken elsewhere in the world. The National Environmental Policy Act of USA (NEPA), 1970 is a forerunner of such efforts. An inter relationship between EIA and EIS (Environment Impact Statement) was indicated by Jain et. al (1977).

In order to prepare an EIA/EIS document, number of steps are needed. They are represented in the Fig. 5.1.

[*] Impact Assessment Notification of January 27, 1994 (2, III, a) and Manual of EIA produced by Ministry of Environment and Forest January 2001.

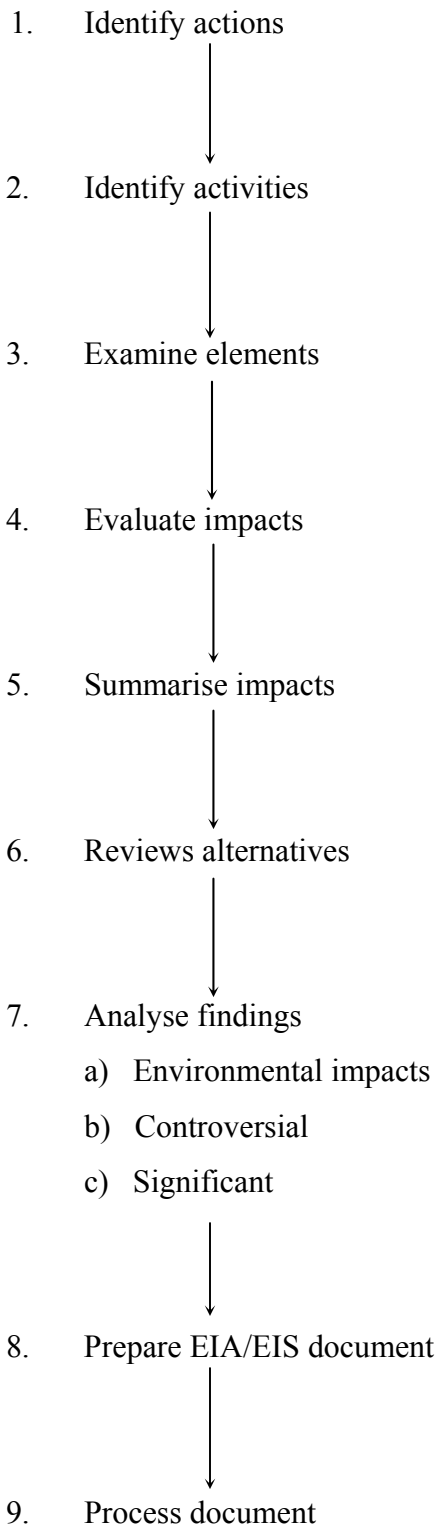


Fig. 5.1 Step By Step Procedure

The first step in the series requires identification of actions on the part of proponents. Ministry of Environment and Forests have identified 30 + 2 category of actions which need to be examined. If the project requires EIA document, it requires identification of activities in Step 2. All project specific activities shall be listed and those elements/attributes which are important and can have an impact must be examined and evaluated. Alternatives to the project must also be reviewed and the one with least environmental disturbance selected. The environmental impacts, controversial, significant, positive, negatives analysed. All possible mitigation measures, environmental management programmes worked out and documented in EIA/EIS.

The basic premise in preparing the document/statement is to promote Sustainable Development without/or least impairing the quality of environment, protection and restoration of resources and leaving a good quality settings for future generations. If by a proposed project a component of environment is in danger, the document will also alert the concerned agencies. The document can also predict short/long term effects and can be used in the planning process.

In order that all/most of the issues are addressed in the document/statement, it should have the following:

1. Project details

a) Definition, objectives, goals and purpose of action.

b) Area, magnitude of action during planning, construction, maintenance and operation.

c) Total requirement of man, material and time required.

d) Energy requirements during construction, operation and maintenance.

e) Complete environment settings, present population of area and rate of growth, biophysical and socio-economic.

f) Historical data and topography.

g) Water bodies in and around.

h) Any religious or tourist resort, sensitive area around like hospital, academic institutes and air port.

i) Forest cover in the vicinity (core zone refers to the area where the project has to be undertaken and buffer zone within 10 km radius).

2. Land use plan

a) Existing land use in terms of agriculture, forest, green cover, water bodies, community and commercial uses.

b) Land use projections in Master Plan.

c) Changes anticipated in land use.

3. Probable Impacts of Proposed Actions

a) Anticipated changes in environmental attributes, air, water, land, noise, vibration, ecology and natural settings.

b) Effects of changes on human health, welfare and surroundings (Impacts include, direct, indirect, primary and secondary).

4. Alternatives to the present, proposed actions

For every proposed project, there are a few alternatives which may include another site, another technology, mitigation measures and costs. All possible alternatives with merits, demerits, risks and cost benefit analysis must be put forth and the one with least effects, least risks and positive cost benefit ratio must be recommended.

5. Adverse impact which can not be avoided

Despite all possible precautions in avoiding impacts on one or more of environmental attribute, some adverse effects on air, water, land, human health can not be avoided. All these must be discussed with all conceived mitigation measures. These could be by Waste Water Treatment (Municipal or package plants), Scrubber, system for air pollution control, high rise stacks to abet pollutant dispersion, acoustic housing for DG sets for noise control, green belt for aesthetic and many more.

6. Conservation of Natural Resources

The irreversible commitment to natural resources must be discussed and include

i) Human Resources, labor and other technical workmen

ii) Local materials

iii) Natural ecosystem imbalance

iv) Change in natural land use pattern

v) Consumption of natural energy sources, fossil fuel, natural gas

vi) Cultural

- destruction of human interest sites
- archeological sites
- scenic view
- open space
- social and economic effects
- aesthetics

(Lecture 23)

5.2 Environment Impacts

Having visualized the composition, structure and quality of various components of environment and their likely deterioration, it is prudent to assess which of the multitudes of attributes influences the environment in relation to the execution of a planned project. The projects could be of various types. However, World Bank (1989) have categorized them into:

i) Projects related to highway construction

ii) Large Water Resources Developmental Projects

iii) Construction of Thermal Power Plants

iv) Residential construction projects

v) Petrochemical and fertiliser projects and

vi) Mining and metallurgical projects.

5.2.1 Environmental Impacts involves the study of various attributes, their complex interrelationship and consequent changes in the attributes. Jain, Urban and Stacey in the book on EIA (1977) have listed the **attributes** as:

Air

1. Diffusion factor
2. Particulates
3. Sulfur oxides
4. Hydrocarbon
5. Nitrogen oxide
6. Carbon mono oxide
7. Photo chemical oxidants
8. Hazardous oxidants
9. Odor

Water

10. Aquifer yield
11. Flow variations
12. Oil
13. Radio activity
14. Suspended solids
15. Thermal pollution
16. Acid and Alkali
17. Biochemical oxygen demand
18. Dissolved oxygen
19. Dissolved solids
20. Nutrients
21. Toxic compounds
22. Aquatic life
23. Faecal coli form

Land

24. Soil stability
25. Natural hazard
26. Land use patterns

Ecology

27. Large animals (Wild and domestic)
28. Predatory birds
29. Small game
30. Fish, shellfish and water fowl
31. Field crops
32. Threatened species
33. Natural vegetation
34. Aquatic plants

Noise

35. Physiological effects
36. Psychological effects
37. Communication effects
38. Performance effects
39. Social behaviour effects

Human Aspects

40. Life styles
41. Psychological needs
42. Physiological systems
43. Community needs

Economics		Resources	
44.	Regional economic stability	47.	Fuel resources
45.	Public sector review	48.	Non fuel resources
46.	Per capita consumption	49.	Aesthetics

5.2.2 Descriptor Package

These attributes, however, need some explanation. The importance of air and noise over water and land is because polluted air and exceeding noise can not be contained and centrally treated, while this is possible for water and land. The water drawn from a polluted source could be treated before utilization, similarly land can be controlled by localized treatment. The air attributes are thus more important.

The **diffusion factor** pertains to the dispersion of pollution from the source to the ambient environment. The dispersion depends on atmospheric conditions viz. wind structure, temperature profile and insulation. The amount of air available to dilute the pollutants is related to wind speed and the extent to which the emission can rise into the atmosphere. The atmospheric temperature profile and wind determines the stability and the vertical dispersion. The product of the mean maximum mixing depth (MMMD) and the average wind speed with the mixing depth is termed "Ventilation Coefficient" and is taken as an indicator of atmospheric diffusion capability.

The **particulate matter** (dust) is the amount of particulate matter present as aerosols in the ambient atmosphere. Particles which are larger than 10μ settle down gradually while those less than 10μ remain suspended in air and are inhaled along with air. The penetration and retention in the bronchi and lungs also depends on size. Particulates in the size range of 3 - 5μ are filtered out in the upper respiratory passage and those below 3μ penetrate into the alveoli. As particle size decreases the deposition increases (3 - 1μ). Particles less than 0.25 μ are exhaled out with air. Thus the respirable particulate matter between 1 - 3 μ are most important.

Hydro-Carbons are compounds containing only hydrogen and carbon and are gaseous at room temperatures. Methane is a natural decay product. The other hydrocarbons are present in natural gas, petroleum products and gasoline. Other hydrocarbons of importance are alkanes, alkenes, olefins and acetylenes. Aromatic

hydrocarbons viz benzene, toluene and xylene are also present in petroleum products. In automobile exhaust, ethylene and acetylene are the largest component of hydrocarbon. These hydrocarbons are highly reactive and are responsible for **Photochemical Smog**. The smog is common in winters and in industrial towns produce irritation of eyes and other mucous membranes.

Oxides of Nitrogen in polluted environment are NO + NO_2 predominantly. When oxides of nitrogen, various hydrocarbons and sunlight interact, they initiate a complex set of reactions that produce secondary pollutants like **Ozone (O_3) and PAN (per oxy acetyl nitrate)** which are highly reactive.

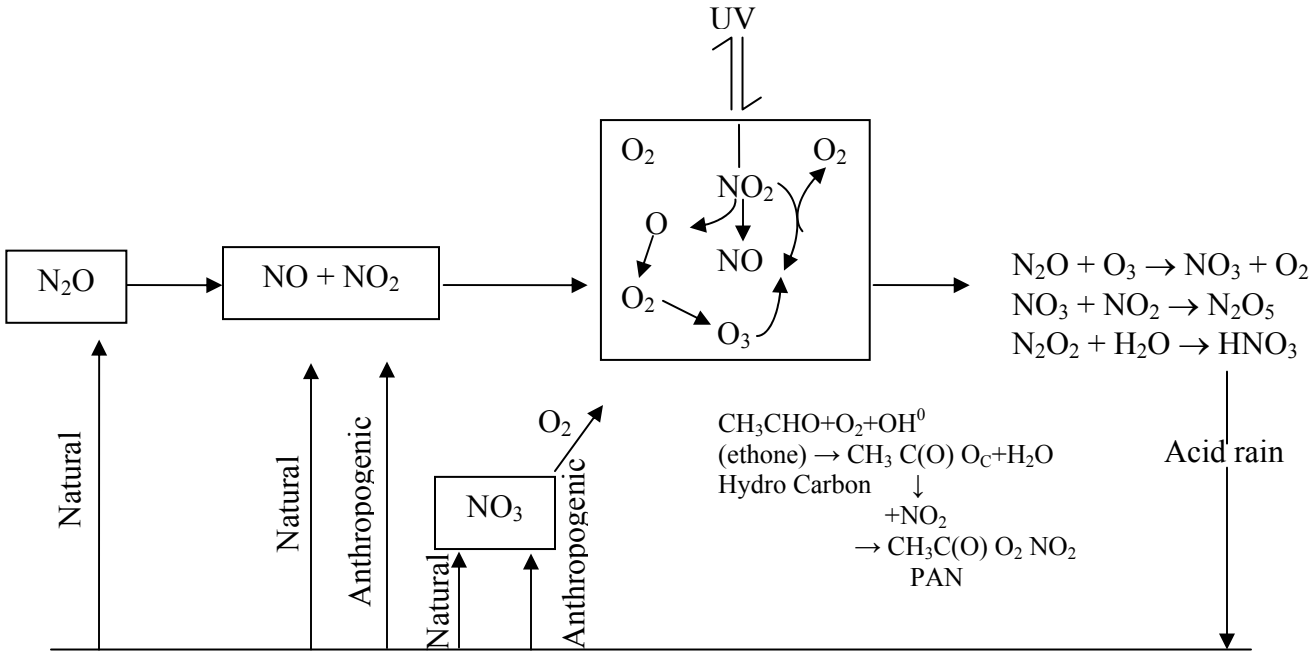


Fig. 5.2 Photo-chemical Reactions in the Environment

In addition the oxides of nitrogen are responsible for **Acid Rain**. Acid rain also has sulfuric acid produced by oxides of sulfur.

Carbon-mono-oxide is a product of incomplete combustion. (It is a colorless, odorless gas and not soluble in water) and is produced predominantly by all sources using carbon as fuel (stationary as well as mobile). The gas has soil as the biggest sink. Precisely for this reason carbon-mono-oxide does not exist in atmosphere for a prolonged period. Carbon-mono-oxide combines with haemoglobin in blood when inhaled for respiration and causes asphyxiation and even death.

The industrial emissions may some times have hazardous materials like pesticides, Arsenic, Ammonia, Aldehydes, Beryllium, Cadmium, Chlorine and Chromium. These materials are toxic and produce chronic / acute pneumonitis, even cancer.

Oxides of Sulfur are produced during combustion of fuel containing sulfur as an impurity. Thermal power plants are the chief contributors, followed by transportation and industrial process. They are very reactive and corrosive. Due to their solubility in water they are responsible for acid rain.

Attributes of water: Water is the life line of all living beings. Its quantity as well as quality is important. As indicated earlier, it is not that water is not available on earth but the right amount, at the right time and of right quality is important. Availability of water in terms of □tilization has been discussed in the distribution of Water Resources in India (page 15 Fig. 1.9). Out of total utilization 38 x 10^6 ha m, ground water constitutes a sizeable component (13 x 10^6 ha m). Surface water sources are not available every where but ground water does. **The yield from the aquifer** is thus very important. Similarly where surface water in utilizable form is available flow is important (the quality of many streams in the country has deteriorated to the extent that it can not be used for any purpose be cause it does not have good flows-Yamuna at Delhi, Gomti at Lucknow). The variation in flow during different seasons is thus of paramount importance.

When it comes to quality, variety of factors determine its utility for designated uses. Oil and grease, suspended solids, acid and alkali, dissolved oxygen, nutrients, BOD, toxic compounds bacterial species (coliform) dictate usefulness. The human activities including industries and domestic waste, the discharge of effluent in water bodies constitute an important impact.

Land as an attribute is crucial as all human activities take place on land. Utilization for agriculture, horticulture, forestry, human habitation, industrial activities need proper maintenance and operation. Soil stability, land slides pose dangers for human existence. Land utilization therefore needs to be optimal and realistic and is an important attribute. Utilization of land for commercial purposes should not be at the cost of natural uses for forests and agriculture. Encroachments of forest land for other uses have started

showing disastrous effects o human climate, weather pattern, global precipitation and natural calamities.

Ecology is the study of living forms interacting with the non living environment. The living organisms and the physical features of environment collective constitute an ecological complex or a system known as **Ecosystem**. Any unit that includes all living organisms in a given area interacting with physical environment so that there is flow of energy, biotic diversity and cycling of materials within a system. Ecosystem is thus a structural and a functional unit of nature. It is a gross study of nature's anatomy and physiology. Every ecosystem will have a source of energy, a population which can use this energy and minerals to build organic matter **producers,** a population which can thrive and eat the produce, the **consumers** and a population which can degrade organic matter produced during death and decay, **the decomposers**. The biotic community will also include Parasites and Scavengers. (Fig. 5.3 concept of an ecosystem)

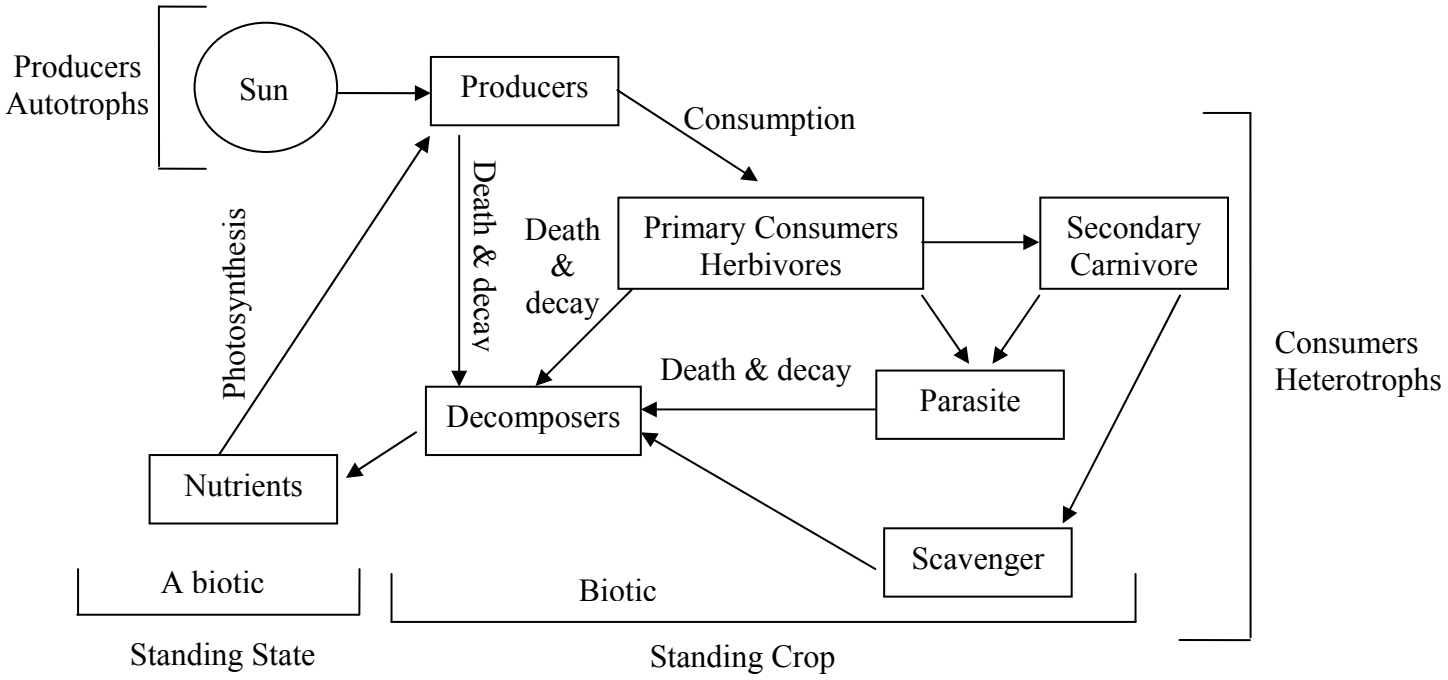


Fig. 5.3 Concept of an Ecosystem

Ecological balance is thus crucial. Any change in a component will effect all others including the inanimate environment. Diversity in an ecosystem is closely related to stability of that system, increasing diversity indicate increased ability of the system to resist disturbance. Evaluation of impacts on a given ecological system should include an

assessment of the effect of proposed alterations of the environment on the species diversity.

The interactions between various components of a biotic community was aptly described through a pictorial model by Odum in his book "Fundamentals of Ecology" where process and structures have been depicted as black boxes containing simple black boxes in a hierarchy of complexity. These can also be expressed in mathematical form to be called as a model (Fig. 5.4).

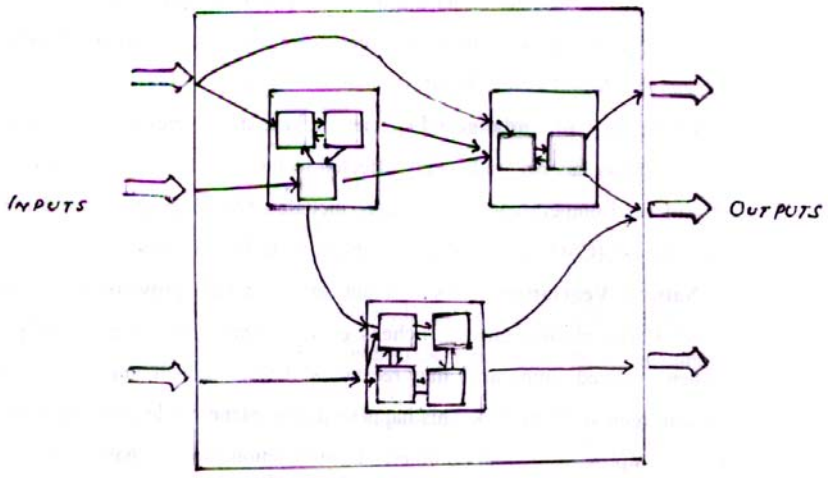


Fig. 5.4 Process and Structures

The ecological attributes have been defined as large animals. These animals are normally browsers (with few exceptions) and weigh more than 15 kg. The activities which effect them most, are construction, roads, buildings etc. which impinge on their habit of grazing, roaming, breeding and rearing of young ones. **Predatory birds** prey upon small animals and birds (hawks, owls, vultures). They normally nest on trees. Any activity which destroy their habitat would force them to shift to nearby areas or die. Reduction in numbers is taken as an impact of change of habitat. **Small Game** animals and birds (weighting less than 15 kg) (rabbits, squirrels, quail, pheasants) are tolerant of humans but activities destroying their habitat & land clearing, road and building construction adversely affect them. This diminishes their population or cause permanent abandonment of the area. The change in population is taken as an impact. **Fish, shell fish and** are cold blooded aquatic animals. They inhabit salt as well as fresh waters. Activities which affect water quality and water level have greatest impact on their well being.

Similarly presence of toxic chemicals/or heated waters have great impact. Dredging, stream channelisation also affect them.

Field crops include crops that are commercially grown like wheat, rice, barley, gram, pulses and sugar cane. Land acquisition for non agricultural purposes is likely to have the greatest impact. Multipurpose Water Resource Projects may result in flooding of large areas. This would adversely affect the biodiversity.

Threatened or endangered-species include all species of plants and animals whose procreation has been adversely affected to the extent of completely disappearing Ministry of Environment and Forests have included 583 plant species and 158 animals species in the list (CSO, GoI, 1999). This also reduces biodiversity.

Natural Vegetation refers to plant species which grow on land and are not cultivated. Herbs, shrubs, grasses, lichens grow naturally on soil and bind particles of soil. When removed temporarily they reestablish later. All such activities which remove the top soil, remove them also. This happens during planning, leveling and construction. Road and complex residential commercial construction projects have direct impacts on their existence. Like natural vegetation, water bodies (shallow) support the growth of **aquatic plants**. These are hydrophytes including rooted, floating and submerged vegetation. Plants like *Hydrilla, Valeseneria, Najas,* Duck Weed, *Lemna* and some times *Eichornia* are included in this category. In slightly deeper portions where such plants can not grow (>2.0 m depth) phytoplankton grows both filamentous and non filamentous. Changes in water quality due to discharge of domestic/industrial waste create problems where some species or all species degenerate, decay and disappear. Physical changes like dredging channelisation also disturb them and change their structure. Changes in biodiversity and or disappearance of sensitive species is an important impact and attribute under ecology.

Noise: Noise is unwanted sound and is a pollution having serious effects on human beings. Noise constitute pressure waves. The time taken by the air pressure to complete one cycle of propagation is called period of oscillation and its inverse frequency of oscillation which means cycles per second. Frequency is related to pitch. Higher frequency would mean higher pitch. Humans can detect frequency ranging from 16000 – 20,000 Hz (frequencies are measured as Hertz (Hz)). Noise is measured in a weighted

sound level dBA (indicates loudness experienced by people rather than physical magnitude).

dBA	0	=	Thresh hold of human hearing
	10	=	breathing in sleep
	40	=	quiet room
	50	=	residences
	60	=	conversational speech
	70	=	street traffic
	110	=	loud motor cycle
	140	=	jet plane take off

Noise measured for 24 hrs, midnight to midnight in termed LdN – dBA

Leq – determines fluctuating sound pressures, represented by a constant energy equivalent sound.

Noise in excess interferes with human activities specially hearing and health (A person working in a noise environment may change the threshold value), interferes in work tasks, interferes in speech communication, interferes in sleep and causes annoyance and irritation.

Central Pollution Control Board under Noise Act has notified limits of Ambient Noise.

Area code	**Category of Area**	**Limits in dBA**	
		Daytimes*	**Night time****
A	Industrial area	75	70
B	Commercial area	65	55
C	Residential area	55	45
D***	Silence zone	50	40

5.3 6.0 A.M. to 9.0 P.M.

** 9.0 P.M. to 6.0 A.M.

*** Area around (100 m) hospital, educational institutions and courts

(Horns, loudspeakers are banned).

ISI has also notified outdoor noise levels

Location	**Noise level dBA**
Rural	25 – 35
Sub urban	30 – 40
Residential urban	35 – 45
Residential and commercial urban	40 – 45
City urban	45 – 66
Industrial areas	50 – 60

In terms of impacts, assessment is necessary of ambient noise level at site and the noise potential of the planned activities.

Noise produces both physiological as well psychological effects on human health. Physiological effects mean effects on internal body system (increase pulse rate, increased respiration rate and increased tension which has bearing on cardio vascular systems) hearing threshold change and sleep disorders (depth, continuity and duration of sleep). Psychological effects include annoyance, anxiety, fear, mental well being, anger and irritability. Communication system also gets disturbed by increased noise.

Human Aspects It is an important attribute and is characterized by way in which man lives and interacts with other men and the environment. In view of complexities in life and interrelationships it is difficult to identify common parameters. Human aspects can be best analysed in view of **Changes in life styles**. Man by nature is social and the organizations largely depends on social activities which may vary in character, interests and objectives (racial, ethical, political, religious). The life styles so get fixed up that any change is not welcome. Attributes affects employment, job security and standards of living and interwoven communities develop. The needs of community resolves on housing, water supply, electricity, sewerage and solid waste generation haulage and disposal, communication among themselves and the outside world now takes centre stage. Close on life style are **Psychological needs** of human populations which are related to instinct, learning process and motivation and are emotional stability, security

and behaviour. Attributes affecting employment, job security, standards of living and modes of travel. Changes due to developmental activities of a larger scale disturbs the life style and psychological aspects. Two Water Resources Development Projects in the country viz. Tehri Dam (Uttarakhand) and Narmada (MP & Gujrat) Projects are live even today which has made large population to move as the towns have been inundated. Rehabilitation has yet not been completed and accepted. Another aspect deals with **Physiological effects** which are related to body function. Memory is fresh in regard to Bhopal tragedy where neighborhood calamities out number those of the project (Union Carbide).

(Lectures 24 & 25)

5.4 Identify Activities

Identify detailed activities associated with implementing a project. The activities may be categorized in functional areas. For each functional area detailed activities associated with implementation may be identified. For a construction of multiple housing system the basic activities will be:

Pre-construction

i) Site Access/delivery

a) Rail road
b) Water
c) Air
d) Pip line

ii) Support facilities operation

a) Asphalt plant
b) Aggregate production
c) Concrete operations
d) Foundry and metal shop
e) Fuel storage and dispensing
f) Material storage
g) Personnel support
h) Utilities provision
i) Solid waste disposal
j) Sewage disposal

iii) Site preparation

a) Clearing and grubbing
b) Tree removal
c) Removal of existing structure
d) Demolition debris disposal

iv) Excavation

a) Top soil stripping
b) Excavation
c) Backfill
d) Dredging
e) Hauling

Construction

v) Subsurface excavation

a) Cutting and drilling
b) Loosening
c) Hauling
d) Drainage

vi) Foundations

a) Base course
b) Footings
c) Compaction
d) Piling
e) Foundation mats
f) Ground water control

vii) Bituminous Construction

a) Hauling
b) Mixing
c) Placing and spreading
d) Compaction
e) Curing and sealing

viii) Concrete Construction

a) Hauling
b) Mixing
c) Placing
d) Finishing

ix) Masonry construction

a) Hauling
b) Forming
c) Motor mixing
d) Placing
e) Finishing

x) Timber construction

Construction

a) Hauling
b) Erecting
c) Finishing

xi) Steel construction

a) Hauling
b) Erecting
c) Finishing

Post Construction

xii) Furnishing

a) HVAC (Heating, Ventilation, Air, Conditioning)
b) Electrical
c) Plumbing
d) Cleanup operation
e) Land scoping
f) Painting

5.4 Examine Attri`butes to be reviewed

Using the activities as in 5.3, the attribute list 5.2.1, a matrix worksheet can be made with activities on one axis and attributes on the other. With descriptor package 5.2.2 identify potential impacts by placing "x" at appropriate element to the work sheet.

(Lecture 26)

5.5 Impact Identification

The elements/attributes of different environmental components are too many to consider for a project. Any characteristic may change and set off a chain reaction in other components. A change in physical-chemical environment may produce changes in ecological/biological environment. (Depicted in Fig. 5.5 as an example)

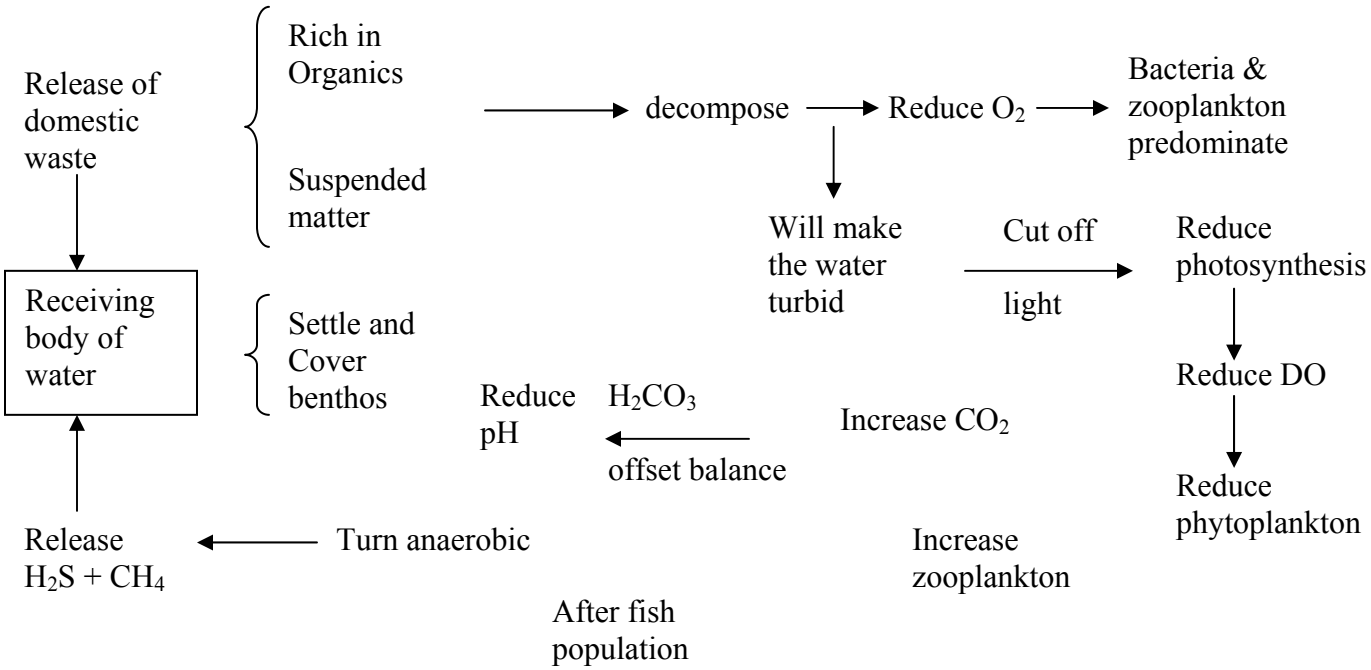


Fig. 5.5 Changes in the ecosystem due to discharge of domestic waste (only two parameters)

It is therefore advisable to reduce the number of attributes which are reflective of the change and are measurable also. All duplicative/redundant obscure elements, difficult to measure may be eliminated. It is also advisable to select those attributes for which base line data is available and where projection without the project is also possible, so that a comparison with or without projection can be made and they reflect the anticipated changes.

The effects are subject to geographical locations (plains, hills and valleys may behave differently) Spatial and temporal variations of an attribute are also detrimental. To the extent possible quantitative estimation of some attributes may be made: air pollution, water pollution and noise level. For other variables where measurements are not practical qualitative estimates can be made. There is a distinct difficulty in extending a largely descriptive ecological attribute into a predictive mode and complexity and interconnectedness of ecosystem themselves. In such situations the judgment of experts is crucial. Aggregation can also be attempted and represented graphically. A typical work sheet is shown in fig. 5.6 and summary of impacts in Fig. 5.7.

Environment / Attributes / Activities	Air					Water				
	Diffusion	Particulate	Carbondioricle	Carbon monoxide	Oxides of Nitrogen	Aquiferyield	Flow Variation	Oil and grease	Dissolved O_2	BOD
1. Site Preparation										
Clearing and grubbing	0	*	0	0	0	0	0	0	0	0
Tree removal	*	*	*	0	0	0	0	0	0	0
Removal of existing	0	*	0	*	**	0	0	0	0	0
Structure										
2. Excavation										
Top soil stripping	0	**	0	0	0	0	0	0	0	0
Excavation	0	**	0	*	**	0	0	0	0	0
Back fill	0	**	0	*	*	0	0	0	0	0
Removal of extra	0	**	*	*	**	0	0	0	0	0
Material										
3. Foundations										
Base course		*	0	0	0	0	0	0	0	0
Filling		**	0	0	0	0	0	0	0	0
Compaction		**	*	*	*	*	0	0	0	0

Figure 5.6 Work sheet

* Identify activities, List them in column (1)
* List possible attributes air
  water
  land
  biological
* Indicate 0 - No apparent effect
  * - Mild effect
  ** - Subtantial effect

	Air				Water					Land					Ecology			
Net positive impact (+)												+			+	+	+	+
No effect (O)					O	O							O					
Net negative impact (X)		x x x	x x	x x			x	x	x	x	x			x				
	Diffusion factor	Particulate	SOx	NOx	Aquifer yield	Oil and Grease	Suspended Solids	Dissolved Oxygen	B.O.D.	Erosion	Natural hazard	Land use pattern	Solid Wastes	Hazardous Wastes	Natural Vegetation	Large animals	Predatory birds	Small game
	1	2	3	4	1	2	3	4	5	1	2	3	4	5	1	2	3	4

OO – No effect

\+ positive effect

++ moderate positive

+++ intense positive

x moderate negative

xx intense negative

xxx serious negative

Fig. 5.7 Summary of Impacts

5.6 Impact Prediction

Impact prediction is a way of mapping the environmental consequences of the significant-aspects of the project and its alternatives. Environmental Impact can never be predicted with absolute certainity and this is all the more reason to consider all possible facts and take all possible precautions for reducing the degree of un-certainity.

(Lecture 27)

5.7 Methodologies

There are about six methodologies followed in literature for determining the impacts and to adhere to the stipulations of regulating agencies, which in our case is Ministry of Environment and Forests.

Choice of a Methodology

Choice of methodology will depend on the specific user and project being undertaken. The key considerations are:

i) Use: Whether the document is for information or a decision document
The decision document requires more details and greater emphasis is on key issues, quantification and comparison of alternatives.

ii) Alternatives: Much would depend on what alternatives to the project are available since these would require a more thorough quantification and comparison.

iii) Public involvement: The role of stake holders and their participation may also require issues which are relevant and need discussion and thus details.

iv) Resources: What resources are available for the document preparation in terms of experts available, data, time and money.

v) Familiarity: Familiarity with ground conditions will also be a keen element. Greater familiarity will improve the validity of subjective significance.

vi) Issue significance: If the issues involved are larger than more details are needed, quantification is important and hence the choice

vii) Administrative: Are the documents being prepared are dictated by procedure of implementing agency

Methodologies

Based on identified impacts, the methodologies will be:

Ad-HOC This method is only primary and provides impact of the project on larger issues only (Flora, Fauna, Forest, Lake). No specific parameters are discussed. Such projects are more for information.

Over lays

These methods are graphical and rely on a set of maps of the characteristics of the project area (physical, social, ecological, aesthetic). These maps are overlaid by projected alterations of the impacted environment.

Check list

A common method followed and involves the identification of environmental parameters for possible impacts. They do not require direct cause effect links to the project activities. They do not include guidelines about how parameter data are to be measured and interpreted.

Matrix method

A method which is widely followed and incorporates a list of activities related to the project with impacted environmental characteristics. The two lists are related in matrix which identifies cause effect relationship.

The method is able to identify the actions with environmental characteristics. The matrix method may indicate the actions which need to be taken into consideration for appropriate mitigation.

Net work

These methodologies work from a list of projected activities to establish cause-condition-effect relationship. They are an attempt to recognize that a series of impacts may be initiated by a project action. The approach generally define a set of possible network and allow the user to identify impacts by selecting appropriate project actions.

Combination Computer Aided

These methods use a combination of matrices, net work, analytical models and computer aided approach to identify activities associated with implementing program, identify potential environmental impacts and provide guidance for mitigation techniques.

5.8. Reviewing of EIA and EMP Reports*

a) Environmental Impact Assessment

Although it is the responsibility of the proponent of the project in a transparent and logical matter, the review will be based on technical grounds including:

- Description of Project and base line conditions
- Methods and models used
- Risk analysis and disaster management
- Public review
- Mitigation measures

Description of project and baseline conditions:

Base line conditions of the project area (site) known as core area and surrounding identified area known as buffer zone (within 10 km radius) are collectively referred as project impact area. The check list of key parameters will be:

Land

1. Landforms including coastal zone
2. Lithology and geomorphology
3. Soil composition and characteristics
4. Slope stability
5. Subsidence and compaction
6. Seismicity / zone
7. Flood plains/swamps
8. Land use
9. Mineral resources
10. Buffer zones (National park, wild life habitat)
11. Soil erosian
12. Catchments area treatment

Surface water

1. Shore line
2. Bottom interface

* The review details are as per Manual – EIA, MOEF

3. Flow variations
4. Water quality
5. Drainage pattern/water logging
6. Water balance
7. Flooding
8. Existing and planned future use
9. Siltation

Atmosphere

1. Air quality
2. Visibility
3. Meteorology

Noise and vibration

1. Intensity
2. Duration

Ground water potential

1. Water table
2. Flow regime
3. Water quality
4. Recharge rate
5. Aquifer characteristics
6. Existing use and proposed plans

Species and population

1. Terrestrial flora/fauna
2. Other terrestrial vegetation
3. Aquatic flora/fauna
4. Fish
5. Other aquatic flora/fauna

Habitat and communities

1. Terrestrial
2. Aquatic communities
3. Migratory path

4. Benthic flora and fauna

Health and safety

1. Physical
2. Psychological
3. Occupational
4. Parasitic diseases
5. Communicable diseases
6. Water born diseases
7. Disease vectors

Socio- Economic

1. Agricultural land
2. Employment/Training
3. Housing
4. Education
5. Utilities
6. Amenities (water, sanitation, electricity, transportation)
7. Community health

Aesthetic/Cultural

1. Landscape
2. Wilderness
3. Climate
4. Tranquility
5. Community structure
6. Religious places
7. Historical/Archaeological structures

When describing project base line conditions a good practice is mapping the impacted region on a 1:25000 scale. Mapping for critical themes of relevant environmental components may also be presented.

Site and process alternatives

Project description will need to address the main attributes during phase of the implementation process

- ❖ General siting, layout map, showing water resources, roads, sewage, storm drains, land use
- ❖ Project construction - Direct employment, water, power lines usage, earth work, dredging drilling, schedule of activity
- ❖ Operation – Direct employment, raw materials, transport, pollution control, utilities, stacks, vents, noise control, quantities of solid. Liquid and gaseous waste.

Risk Analysis and Disaster Management

Hazard identification, inventory analysis, natural hazards. Maximum credible accident analysis to identify hazardous scenarios, fire.

Preparation on site and offsite, disaster management plan.

Public Review

The state Pollution Control Boards provide the details of Public Hearing. The proponent is obliged to respond to the issues raised by stake holders. It is imperative to identify stake holders representing the sections as given in Schedule IV of the Notification.

Stake holders identification	Is the project proponent aware of all groups who will be directly affected by social/environmental impacts of the project.
Impact identification	Has the project proponent addressed to mitigation options on all social / environmental impacts of significance to local population.
Mitigation options	Has the project proponent addressed the issues of project compensation and rehabilitation as per procedure.
Monitoring	Has the project proponent involved the affected groups in monitoring the effectiveness of social/environmental impact mitigation.
Community development	Is the proponent working to promote local development within community.

Review of EMP and Monitoring

Environment Management Plan should include:

- ❖ Delineation of mitigation/compensation measures for all the identified significant impacts*

* The impact is significant and unacceptable if emission/discharge load and characteristics or the resulting environmental quality are in violation or exceed Ambient Environmental Quality Standards

- Environmental (Protection) Rules 1986 (Air Quality Standards)
- Environmental Production Act (Central Pollution Control No. 29 of (Ambient Noise Standards 23.05.1986))
- Indian Standard of drinking water (IS:2490:1982)
- Environment Protection Rules 1986 (Indian Standard Schedule VII Standards/prescribed for industrial and sewage effluent discharge)

Where standards are not prescribed in India the following may be referred

- Damage criteria for heat load and pressure (Deptt. Of Industrial Safety, the Netherlands)
- Risk acceptance criteria (Organisation for Applied scenario and Research (TNO), the Netherlands
- Damage Risk Criteria, OSHA of USA

❖ Delineation of unmitigated impacts

❖ Physical planning including work program, time schedule and locations for putting mitigation and compensation system in place

❖ Delineation of financial plan for implementing the mitigation measures (budgetary estimates).

Suggested Reading

1. Environmental Impact Analysis, Jain, R.K., Urban, L.V., and Stacey, G.S., Van Nostrand Rein hold Co. 1977.
2. Environment Impact Assessment, Barthwal, R.R. New Age International, New Delhi 2002.
3. Environment Impact Assessment (Practical Solutions to Recurrent Problems). David P. Lowrence. Wiley Interscience, New Jersey 2003.
4. Environment Impact Assessment, Srivastava, A.K., APH Publishing Corporation, New Delhi – 2003.
5. Ecology, Impact Assessment and environment Planning, Walter E. Westman., John Wiley & Sons, Canada 1985.

(Lecture 26 & 27)

CHAPTER – VI

6.0 Assessment of Socio-Economic Impacts

Socio-economic impacts are the influence of projects and/or progammes or policies on the human values, culture, living standard. Institutions undertaking large investment projects such as highways, air ports, sewerage systems, water resources projects (DOMS, reservoirs, water relating systems, diversions, canals) stimulates secondary impacts in the form of associated investments and changes in socio-economic activities. These effects include changes in the existing community facilities and activities, induced new facilities in the next round and changes in natural conditions. All such effects may be substantial than the primary impacts of the original actions.

(Displacement of people from a project area → reduction in permanent population from the project area → displaced people resettlement somewhere requiring economic cost, housing, water power, public services at new place, with cultural and psychological adjustments (Tehri Dam project, Narmada project). During construction of project temporary population (labourers and their families) will come to the project area. Such persons will be accommodated in the project area. They will need all kind of services for living. The area will undergo changes by the temporary population.

All such changes will come under socio-economic changes of the project or Socio-economic Impacts Assessment (SIA). The following should always be taken care of:

a)	Demographic impacts	Labour force, population shift, employment and multiplier effects, displacement and relocation and change in population make up
b)	Socio-economic Impacts	Includes income and multiplier effects, employment rates and patterns, prices of local goods and services, taxation effects and property value

c)	Institutional Impacts	Demands on Government and Social Services NGO's in the areas, housing, schools, policing, justice health and welfare
d)	Cultural Impacts	Such as those on traditional patterns of life and work, family structure, authority, religion, tribal factors, archaeological features and social work, community cohesion
e)	Gender Impacts	Implications of development projects on women's role in society, income generating opportunities access to resources and employment opportunities

Along with changes in physical environment due to a development project, there will be changes in Socio-economic environment. Social Impact Assessment should pay special attention to vulnerable sections of population (elderly, poor, children, minorities)

Some of the variable have measurement dimensions (both positive and negative) with increasing size of the variables population size, growth, rate of population growth, age dependency on community; job opportunity, job distribution, employment level, participation in labour force, price level, educational attainment, socio-economic status, housing availability public services; social well being; collective response). These are cumulative effects. These impacts can be put in (i) Social impacts and (ii) Public Services impacts

A very important aspect is displacement of population. They will have all types of problems and should go hand in hand with rehabilitation and resettlement policy of state and Central Government.

6.1 Socio-economic Impact Assessment Methodology

The general methodology will include the following

Step 1. Identification of potential socio-economic impact assessment. This is to identify the basic indicators to assess the environmental impacts of all kinds (air pollution, water pollution, noise pollution) which will effect human quality of life

Other important factors will be

a) demographic factors – population, density, literacy
b) economic variables – land use patterns, income levels, price levels, employment/unemployment level, commercial activities
c) social variables – patterns of life and work, ethnic composition, religious and tribal factors, public utilities
d) project specific variables – displacement, business, recruitment of manpower, project technology

Step 2. Description of existing socio-economic or human environment of the project area

Developing a social profile based on siting of projects

Step 3. Procurement of relevant standards, criteria and guidelines

There are direct effects of pollutants/emissions on the public and whenever people are affected, health and welfare socio economic considerations become important

Step 4. Prediction of Socio-economic Impacts

Prediction of Socio-economic Impacts with or without the project is an important technical exercise. There is no unique method for predicting the impacts yet four approache are indicated:

a) qualitative description
b) quantitative description
c) application specific prediction technique (may involve survey from secondary sources or qualitative descriptive approach like Delphi method or Historical analogies
d) comparison of the effects of alternatives

Step 5. **Assessment of Socio-economic Impact**

Assessment of socio-economic impacts with or without project in its

surrounding areas is difficult as there are no established standards for these. Some impacts may be clearly visible and assessable such as:

a) generation of employment for local people (+ve impact)
b) increase in earnings of people (+ve impact)
c) pressure on local services (-ve impact)
d) increase in business and trade (+ve impact)
e) increase in crime rate in the region (-ve impact)
f) interaction with outside people (+ve impact)
g) opening of attitudes of people (+ve impact)

There are no threshold levels of comparison for such impacts. They may be perceived on the basis of experience gained elsewhere about similar projects (historical analogy). Professional judgment may also be important. Some projects might have broader impacts on National economy (Tehri Dam, Narmada, Bhakhra Nangal) rather than local level impacts. The significance of such impacts may be judged by National goals, such as power generation, employment generation, income generation, irrigation, provision of food.

Step 6. **Mitigation Measures**

Though there is very little in the form of mitigation measure to reduce the adverse socio-economic impacts of the project. However, Some local benefits, particularly employment of the local people, rehabilitation and resettlement of project affected people will be mandatory by law. The project is a user of local resources and in lieu it has to give back some benefits to the local population otherwise they resent its activities and the project functioning is jeopardized.

Mitigation measures will include, providing housing schools, colleges, hospital, power and other social services.

(Lecture 28 & 29)

Information mentioned here in is largely based on "Environmental Impact Assessment" by R.R. Barthwal, New Age International Publishers, 2002

Suggested Reading

1. Environmental Impact Analysis, Jain, R.K., Urban, L.V., and Stacey, G.S., Van Nostrand Rein hold Co. 1977.
2. Environment Impact Assessment, Barthwal, R.R. New Age International, New Delhi 2002.
3. Environment Impact Assessment (Practical Solutions to Recurrent Problems). David P. Lowrence. Wiley Interscience, New Jersey 2003.
4. Environment Impact Assessment, Srivastava, A.K., APH Publishing Corporation, New Delhi – 2003.
5. Ecology, Impact Assessment and environment Planning, Walter E. Westman., John Wiley & Sons, Canada 1985.

CHAPTER – VII

7.0 Procedure for EIA clearance

Every human activity produces some effect on environment. The Consequential effect are more negative than positive. Ministry of Environment and Forests have outlined the procedure as below:

EIA Cycle and Procedures

The EIA processes in India is made up of eight phases

Phase I Screening

Screening is done to visualize whether a project requires Environmental Clearance or not as per the statutory notifications (as per Environment Protection Act (1986) MOEF Notification on EIA dated January 27, 1994 and July 7, 2004).

Screening is needed on the part of proponents and regulating agencies vis-a vis scales of investment, type of development and location of development. A project requires statutory environmental clearance only if the provisions of EIA notification cover it in as much as:

- Prohibiting locations of industries except those related to tourism in a belt of 1.0 km from high tide mark from the Revdanda Creek upto Devgarh point (near Shrivardhan) as well as in 1.0 km belt along the banks of Rajpure Creek in Murud Janjira area in the Raigarh district of Maharastra (6th January 1989)
- Restricting locations of industries, mining operations and other activities in Doon Valley (Uttaranchal) (1st February 1989)
- Regulating activities in the coastal stretches of the country by classifying them as coastal regulation zone and prohibiting certain activities (19th February 1991)
- Restricting location of industries and regulating other activities in Dhonu Taluka in Maharashtra (6th January 1991)
- Restricting certain activities in specified areas of Aravalle Range in the Gurgaon district of Hayana and Alwar district of Rajasthan (7th May 1992)

- Regulating industrial and other activities, which could lead to pollution and congestion in an area north west of Numaligarh in Assam (5th July 1992)

Phase II Scoping and consideration of Alternatives

Scoping is an important consideration of detailing terms of reference of EIA. The project proponent either by a team of experts (scientist and engineers) or consultants so appointed should work it out or may also be referred to the Environment Impact Agency.

The MOEF has published guidelines for different sectors signifying issues to be addressed in EIA studies. Quantifiable impacts are to be assessed on the basis of magnitude, prevalence, frequency and duration and non quantifiable impacts (such as aesthetic or recreational value). Significance is determined by socio-economic criteria.

After the area is identified, the base line data should be obtained and likely changes predicted for important attributes during construction and operation.

Phase III Base line data

Base line data denotes the existing conditions and environmental status of the identified area. The site specific primary data should be collected for identified attributes and supplemented by secondary data if available.

Phase IV Impact Prediction

Impact prediction is a way of mapping the environmental consequences of selected significant attributes of the project and its alternatives. The prediction can not be absolute and therefore it would be prudent to consider all the possible factors and take all precautions for reducing the degree of uncertainty.

The following impacts of the project should be assessed:

- Air – Changes in ambient levels and ground level conc. from point, line and area sources. Effects on soil, materials, vegetation and human health.
- Noise – Changes in ambient levels due to noise produced from equipment, DG sets and movement of vehicles.
- Water – availability to competing users, changes in quality, sediment transport and ingress of saline water.

- Land – Changes in land use, drainage pattern, changes in land quality including effects of waste disposal.
- Biological – Deforestation, tree felling and shrinkage in animal habitat. Impact on flora and fauna (including aquatic), impact on rare, threatened or endangered species endemic sp. or migratory animals. Impact on breeding on nesting sites.
- Socio-economic – Impact on local community including demographic changes, economic status, human health and increase traffic.

Phase V Assessment of alternatives, delineation of mitigation measures and Environmental Impact

For every project, alternatives should be identified and environmental attributes compared. This should include location, and technologies. One of the alternative could be no project. Alternatives should than be ranked in terms of predicted impacts, mitigation and socio-economic costs.

Once the alternative has been chosen, a mitigation plan be drawn with Environmental Management Plan (EMP). Risk factor should also be discussed.

Phase VI Public Hearing

The law requires that public must be informed and consulted in the proposed development after the completion of EIA report.

The stake holders are entitled to have access to executive summary of EIA. They may include:

- bonafide local residents
- local associations
- environmental groups
- any other person located at the site/site of displacement

  The State Pollution Control Board shall cause a notice for environmental public hearing (published in at least two news papers, one of them should be in local language) mentioning date, time and place. Suggestions, views, comments shall be invited within 30 days from the date of publication. Details are given in Schedule IV of notification (page 97).

Phase V Decision making

Decision making process involve consultation between the project proponents (assisted by Technical experts/consultants/and the impact assessment authority (assisted by an expert group/committee if necessary). The decision is arrived at through evaluation of EIA and EMP.

Phase VI Monitoring the Clearance conditions

Monitoring should be done during construction and operation phases of a project. This is to ensure that:

a) Commitments made are complied,
b) observe that whether the predictions made in the EIA reports were correct or not,
c) corrective measures have been made or not,
d) Environmental Management Plan is in place or not.

(Lecture 31)

Suggested Reading

1. Environmental Impact Assessment Impact Assessment Division, Ministry of Environment and forest, GoI, Jan. 2001 (Manual)

CHAPTER VIII

8.0 Environment Management

Environment Management is a comprehensive term which involves conservation of natural resources and energy (energy and resource saving), Pollution prevention, disposal of treated effluents (Waste regularization), Solid waste disposal, environmental audit and concept of green cities.

8.1 Natural Resource Conservation

A natural resource is a thing needed by on organism or group of Organisms (population, community) for well being. Its usefulness changes with growth of technology. The sum of all physical, Chemical, biological and social factors which comprise the surroundings constitutes a resource on which man draws to have a better living. Thus any part of our natural environment such as land, water, air, minerals, forest, rangeland, wild life, fish or even human population, that man can utilize to promote his welfare is regarded as a natural resource.

Ramade (1984) defined a resource as a form of energy and / or matter which is essential for the functioning of organisms, population and Ecosystem.

8.1.1. Classification of Natural Resources

The classic subdivisions of resources include renewable and non renewable resources.

Renewable sources are those which are reproducible and are obtained from the biomass of living organisms e.g. Forest & fish.

Non renewable sources are those which are not reproducible and are obtained from the finite non living reserves e.g. coal oil and minerals.

Solar energy although have a finite life, as a special use is considered as Renewable as it will in exhaustible on human scale.

Some authors classify resources, into biotic (living) and abiotic (non living). A broader classification is given below: (proposed by Owen 1971).

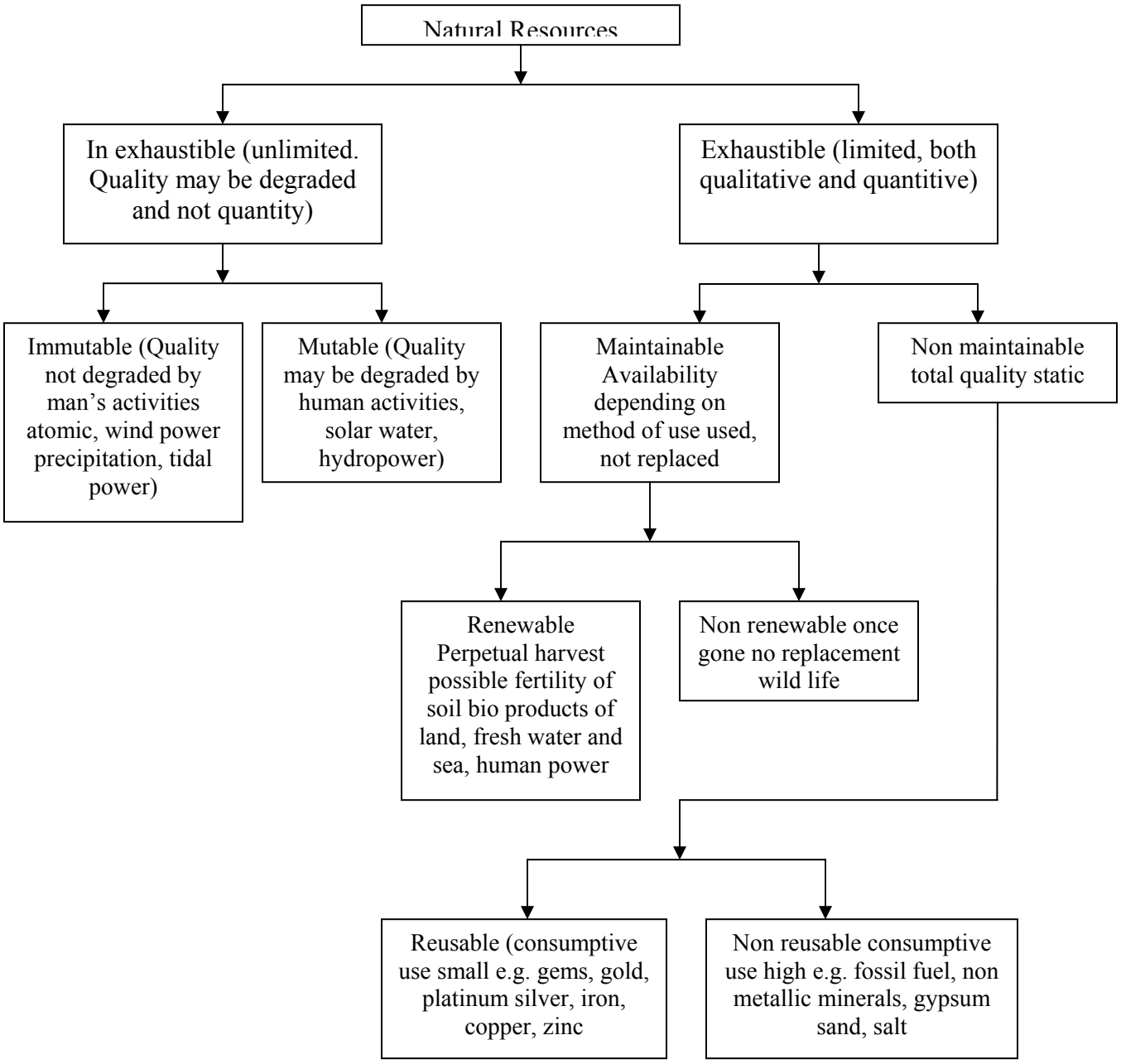


Fig. 8.1 Natural Resources

8.1.2 Conservation and Management of Natural Resources

The term conservation was proposed by Giffor Pinchot (1988) meaning conservers (given to British Officials in India appointed to look after protection of natural

resources). It is driven from two Latin words con (together) and Server (to keep guard) thus meaning to keep together. The dictionary meaning is to preserve. In 1967 John F. Kennedy (US President) looked upon Conservation as "The wish use of our Natural Environment …." The prevention of waste and despoilment while preserving and renewing the quality and usefulness of all our resources. The aim of conservation is two fold.

(i) preservation of quality of environment and

(ii) to ensure continuous yield of useful material- living or nonliving – by establishing a balanced cycle of harvest and renewal

The concept of resource conservation has become still wider now to cover Environmental Management, which is in essence, the process of allocating natural and man made resources, so that optimum use of environment is achieved for an idefinite future and at the same time preventing depletion and degradation of resources.

8.1.3 Conservation of Water

Water moves from the ocean to Air to land to ocean in set Cycling Pattern Called Hydrologic Cycle (discussed in para 1.2.3).

Goethe said "Every thing originated in the water and every thing is sustained by water". Water is needed to fulfill diverse requirements in so many diverse ways. It is vital to life since for all physiological activities of plants and animals. It constitutes 80% of protoplasm.

Flood plains of rivers have been the cradle of civilization and centers of population historically. Besides temperature, water is the other key factor that influences global ecology. Covering 70% of land surface and circulating in hydrologic cycle, water influences weather and climate on any region and thus its flora and fauna.

Agriculture is dependent on water may it be rainfall or surface or ground water irrigation. In India, agriculture being the most important economy critically depends on water.

The kinetic energy of gravitational flow of water is tapped and transformed into electricity hydropower. It leaves no pollution burden on nature as in case of thermal or atomic power generation.

Hardly any industry can do without water. It has many applications in industrial processes viz. a raw material, solvent, chemical reactant, Coolant and Cleaning reagent.

Water requirement for domestic needs cannot be over emphasized yet it is spoiled significantly by its usage, as it is the cheapest dilution medium for liquid and solid wastes.

Water at many places serves as convenient means of navigation. Besides it adds to the aesthetic, recreation and sports value.

Water being unevenly distributed over land influences, interstate (Punjab, Haryana, Rajasthan, M.P., Gujrat, Karanataka, Tamil Nadu), international relations (India – Bangladesh) and thus is the cause of Hydro politics.

It can thus be said that while water is essential for life it is significantly linked with social economic political and ecological intricacies.

8.1.4 Problems and Management of Water

Management of water implies making the best use of available resources for human benefit while not only preventing and controlling its depletion and degradation but also developing it for present and future needs. Water is a multipurpose resource and it is important that various uses are not in conflict and can be utilized by one and all. Its allocation and qualitative and quantitative conservation are primary tasks before managers.

Floods, droughts improper use, pollution and disease transmission are important problems related to water. Because usable inland water is a very minute fraction of world's total water and because largely depends upon this minute fraction, it is important to make efficient use of available water. This has to be considered in

(a) Irrigation projects

(b) Industrial usage

(c) Municipal process

(d) Daily utilization – domestic needs

The qualitative degradation of water is also in a way quantitative depletion of usable resources.

Thus recycling of waste water is very important.

8.1.5 Future Needs

The demand of fresh water is linked to the growth of population and improved methods of living.

Possible means of meeting out the impending water deficit include:

(i) Reclamation of sewage and waste water

(ii) Development of Ground water sources and surface storages

(iii) Rain water harvesting

(iv) Desalination of sea water

(Lecture 31)

8.2 Conservation of Energy

The energy crisis of 1970's has influenced the world at large and a realization has come that the depletion of fossil fuels is a reality. This was following the OPEC'S refusal to supply fossil fuel to USA (during Israel War). The developed countries thought that the crisis can reoccur at any time and that there is no one solution to energy crisis because the problem is multidimensional involving not only innovations in technology but also political and social issues.

8.2.1 Energy Production and Balance

Energy is derived from non renewable and renewable resources. The non-renewable resources are in the process of depletion and include fossil fuels – oil, coal and natural gas. These resources were built over geological time scale involving million's of years. Renewable sources are solar energy wind energy and biomass. It is opined that about 80% of the world's energy is produced from fossil fuels. Nuclear plants have been installed in many countries to tide over the problem. 70% of energy needs in France is met from Nuclear Power Plants.

An estimate of how much energy was avoidable, how much is available and how much will be available, is difficult. The most abundant fossil fuel (oil reserves) resource and production are in the middle East Saudi Arabia in general is the largest oil producing nation in the World. All fuel resources are in the processes of depletion because of great demand both by developed World and developing nations. The demand for oil, coal and Natural gas for the whole world is as below (UN estimate).

		World's Demand	
	1960	1977	1999
Oil	436 x 10^6 tons	2189 x 10^6 tons	3200 x 10^6 tons
Coal	1043 x 10^6 tons	1635 x 10^8 tons	2146 x 10^6 tons
Natural Gas	187 x 10^6 tons	1022 x 10^6 tons	2301 x 10^6 tons

U.S.A. is the leading country where per capita consumption is largest. China has the maximum consumption among the developing nations and India occupies the second slot. These are commercial figures and does not include non commercial products like wood picked and animal dung cakes.

8.2.2 Renewable Energy Resources

The emphasis on the use of non renewable resources (Solar, Wind and Wood) in developed countries is because of environmental concern while in developing countries it is due to economic reasons. Among the non conventional resources, hydropower is the largest. Hydropower projects are in operation both in developed and developing countries. Notable among the countries using hydropower potential are Brazil, China and India. Of the total Hydropower potential only 15% is being used at present (14000 Megawatt, 2000). Germany dominated wind installations in 1999 providing 10% of energy in wind dominated zones. The potential of wind energy is immense and can meet 10% of World's need (Estimates of Green peace International) by 2020.

The use of solar energy through photovoltaic cells is limited and World's production is around 2000 megawatts (1999). The progress is however limited though supported by Govt. and International agencies.

Biomass resources include mainly wood through various types of cultivated and uncultivated vegetation has been used. The major countries using biomass, primarily due to economic reasons are India and Africa. Excessive use of wood has led to depletion of forest reserves (in patches).

8.2.3 Energy Reserves in India

India is relatively endowed with both renewable and nonrenewable sources of energy. Coal (non coking coal with high ash content, 40-50% and low calorific value, 1300-4200 kcal/kg) is major nonrenewable resource in the country. India has substantial reserves of nuclear fuels (Thorium 368 x 10^3 tons. Uranium 34 x 10^3 tons) but only about 44% are economically exploitable. The country also has reserves of Natural gas. India ranks 3rd among the coal producing countries of the world. Coal production has grown 100 million tons in 1975-76 to 306 million tons in 1998-99.

Renewable sources are also expected to play an important role in decentralized locations and remote areas.

The potential of renewable energy is estimated to 10,000 Mega Watts (and include solar, wind, biomass and small hydroproject) of these 0.9% will be from animal wastes; solar, 2.6%; solar voltaic cells 13.1% hydropower, 16% biomass and 67.4% wind power.

Energy Consumption

Major energy consumers are industrial, sector, transport sector and domestic sectors.

The total consumption is estimated around 138 billion kWh (104 billion from utilities and 34 billion from captive plants to be met from

Industrial sector Coal lignite - 57% December `996-97
Oil and gas - 33%
Hydropower - 3%
Nuclear power - 0.2%

Transport Sector

Transport sector is one of the largest consumer of energy. The main fuel used in HSD and gasoline which accents for 50% of the total consumption. Consumption of HSD increased from 9 M tons usage in 1980/81 to 30 M tons in 1996/97. The consumption is continuously increasing.

Agricultural Sector

With mechanized agricultural activities, the consumption of commercial energy has grown, significantly. There is a decrease in human and animal labor. Electricity consumption has grown from 8.7 billion kwh in 1975 – 76 to 23.4 billion kWh in 1985/86 to 84 billion kWh in 1996/97.

Domestic Sector

In rural and Urban India the patterns of energy consumption are distinct. The rural sector is still utilizing biomass (fire wood and animal waste cakes) and kerosene. 78% of rural population is dependent on conventional sources. Urban population is using LPG and commercial energy.

8.2.4 Energy and Environmental Concerns

The combustion of various fuels are associated with production of SPM; SO_2, Nox and CO. They pose a threat to the human health. Recent reports (TERI/WHO) indicate that air quality standard are violated in most of the Indian cities. In addition large burden on land resources is due to huge quantities of fly ash accumulation. Electric power generation is also the largest source of green house gases.

The utilization of nuclear resources is limited. Uncertainties about safety and economics still persists. Accidents also are a major threat. Negotiations for use of nuclear energy for civilian purposes with USA is on the anvil.

Hydropower generation is the cleanest yet they are under controversy due to social and environmental costs including displacement and rehabilitation of populations (Kosi, Tehri). Submergence of forest and wild type habitatt is also of great concern. Destruction of estuaries and adverse effects on downstream hydrology also can not be easily wished away.

Industrial and vehicular emissions have become grave in urban area. Daily, the population of vehicles is increasing on roads. They constitute a big traffic and consequent social problem. Consumption of both traditional and commercial fuels add up to indoor pollution problems. Human health is under serious threat both outdoor and indoors.

At the Rio conference (Earth Summit 1992) a clear message was communicated for efficient use of energy by improving end use efficiency.

Some important developments in energy management are

- The contribution of natural gas to energy management.
- advanced technologies for electric power generation have resulted in energy efficient gains.
- fuel cells that combine H_2 and O_2 electrochemically to produce electricity, water and heat
- Development of biomass as fuel
- Photo voltaic power of energy for domestic and small scale Industrial sector is also promising.
- Use of biodiesel

(Lecture 31&32)

8.3 Pollution Prevention

Pollution of all components of environment is one of most important challenge facing the world today. Traditional pollution control, also called end of the pipe line treatment has not been found to deliver the goods. These approaches are not comprehensive or sustainable. There is a paradigm shift from pollution control to pollution prevention. This approach can be adopted within all sectors, domestic commercial or industrial "Pollution Prevention (PP) is the continuous application of on integrated preventive environmental and business strategy to procure resources, processes and produce or provide services at higher efficiency and increase profitability and reduce risks to the environment".

Pollution prevention provides a practical way to gather clues from the conceptual frame work of sustainable development towards action. It is a tool for industry to achieve environmental improvement while remaining competitive and profitable. It focuses on reducing volumes and toxicity of all emissions and waste streams rather than treating emissions. This approach is also called waste minimization waste avoidance, waste reduction, waste prevention, green productivity, eco-efficiency and cleaner production.

8.3.1 Waste Management hierarchy

Waste can be in the form of defective products, waste water discharges, air emissions, solid wastes, hazardous wastes (sometimes), production loss, excess consumption of water and energy, inefficient use of raw material and human resource. These are produced at different stages of life cycle as shown in Fig. 8.2.

The hierarchy of waste management as depicted in Fig. 8.3 puts pollution prevention as the highest priority through avoidance, minimization and closed loop recycling. Pollution prevention also gestures as "Waste as a misplaced source".

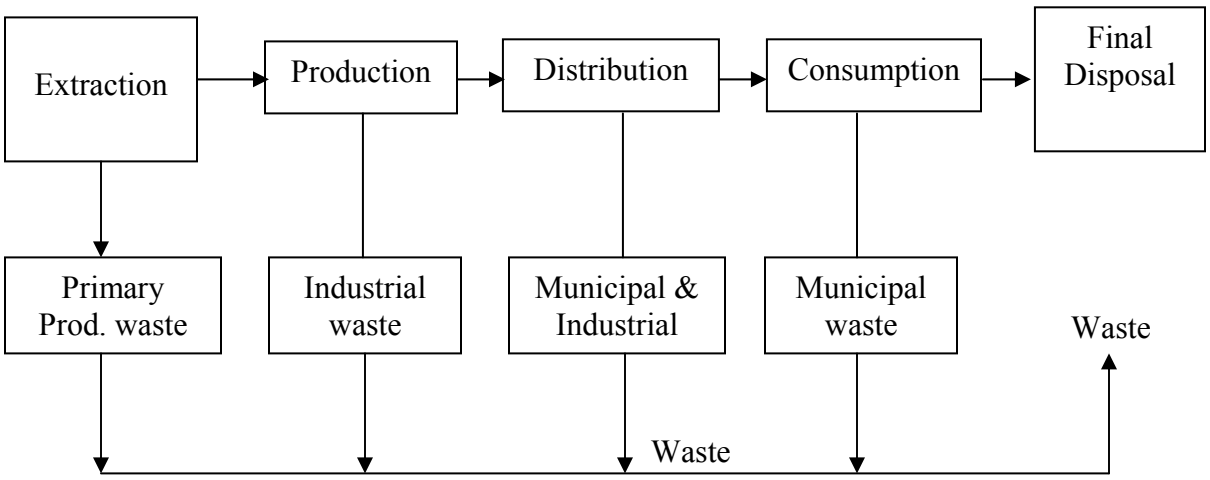


Fig. 8.2 Life Cycle of Waste Generation

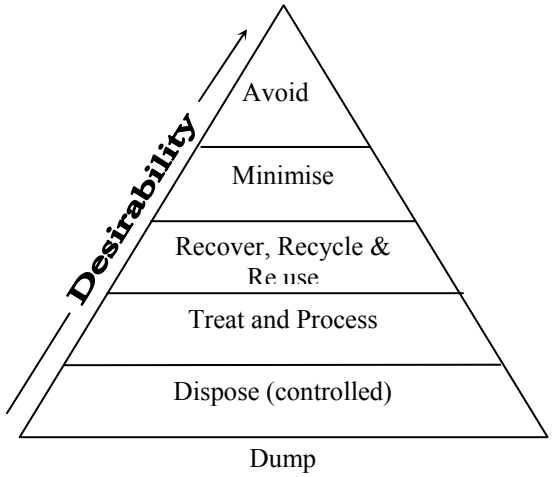


Fig. 8.3 Waste Management Hierarchy

Pollution prevention is a continuous endeavor for environmental management.

Pollution prevention emphasizes the elimination and / or reduction of waste at the source of generation. Energy efficiency is also a pollution prevention concept.

End of pipe line pollution control technologies focus on waste treatment. They tend to transform wastes from one to another rather than achieving genuine waste reduction. (Treatment of waste water → Sludge production → Land disposal → Leachate pollute ground water) Generally, industries consider waste treatment in isolation of manufacturing process and not together with improved production technologies.

8.4 Disposal of Treated Effluents

The treated waste water is either reused or disposed in the environment. This could be either by disposing in a water body or applied on land, where waste water, seeps through soil and recharges ground water. Regulating agencies viz State and Central Pollution Control Boards and Ministry of Environment and Forests under water Act 1974 have stipulated standards for discharge of treated wastes in inland waters and on Land.

A fundamental element of waste disposal is the impact on environment. The regulatory frame work affects not only the discharge regulations and outfall structures but also the level of treatment required.

8.4.1 Water Quality Parameters (Discharge/ Disposal in Water)

Important water quality parameters relating to waste water discharges are dissolved oxygen (D.O.), suspended solids, coliform bacteria, nutrients, pH, biochemical oxygen demand (BODs) and toxic chemicals including volatile organics, acid/base neutrals, metals, pesticides and PCBS. (Notifications Under EPA 1986 are mentioned under chapter 4 para 4.6)

Dissolved Oxygen is important to aquatic life as waters below 4.0 mg/L or 40%. saturation produces deterimental effect to fauna which depends on it for meeting the respiratory needs. This however, may vary is different species.

Suspended solids affect the water column by producing turbidity. The solids finely settle at the bottom and lead to benthic enrichment, toxicity and increased oxygen demand of the sediment. The solids in suspension also occlude light penetration. Nutrients, in the form of nitrogen in various forms and phosphates promote the growth of phytoplankton and other hydrophytes leading to Eutrophication and consequent D.O. depletion.

Coliform bactria, of enteric origin are indicators of the presence of water borne pathogens (Salmonella, Shigella and Vibro) of faecal Origin and as such provide a measure of safety of water for recreation and other uses.

The acid/basic or neutral character of the water is indicated by pH value. This also determines the chemical and ecological balance of water.

Biochemical Oxygen Demand (BOD) is a measure to indicate the Oxygen equivalence of organic matter. Higher the value would mean higher organics (of faecal origin).

Toxic Chemicals include a range of compounds that, at different concentrations, have deterimental effect on aquatic life or on humans, upon ingestion of water and / or fish and shell fish. Some of them are indicated in Table below:

Name	Use	Concern
Non metals Arsenic (As)	Alloying metal as additive lead and copper	Carcinogen/mutagen
Selenium (Se)	Electronics, Xerographic plates, TV camera	Red staining of finger teeth, hair, general weakness
Metals		
Barium (Ba)	Alloys, Spark Plugs	Leads to high blood pressure, nerve block
Cadmium (Cd)	Metal plating, metal hardening	Toxic by inhalation Carcinogen
Chromium (Cr)	Plating of metals leather, plastic	Carcinogenic (Cr^{6+}) Corrosive to Cartilage
Lead (Pb)	Storage batteries, Gasoline, Cable covering	Toxic by ingestion / inhalation, liver / kidney damage
Mercury (Hg)	Amalgams, mirror coating, arc lamps	Highly toxic by skin absorption effects CNS
Organic Compounds Benzene (C_6H_6)	Detergents, additive of gasoline	Highly toxic, carcinogen
Toluene ($C_6H_5H_3$)	High octane blend in petrol, paints gums, saccharine, medicines	Toxic by ingestion, inhalation and skin absorption

Name	Use	Concern
Chlorobenzene (C_6H_5Cl)	Phenol, pesticides	Toxic by inhalation
Endrin ($C_{12}H_8Ocl_6$)	Insecticide	Toxic by inhalation carcinogen

Water Quality Criteria: Tolerance limits for Inland Surface waters subject to pollution (IS:2296:1982)

Parameter	Class A	Class B	Class C	Class D	Class E
pH	6.5 – 8.4	6.5 – 8.4	6.5 – 8.4	6.5 – 8.4	6.5 – 8.4
Dissolved Oxygen mg/L min	6.0	5.0	4.0	4.0	-
BOD mg/L, max	2.0	3.0	3.0	-	-
Total coliform MPN/100 ml, max	50	500	5000	-	-
Dissolved Solids mg/L max.	500	-	1500	-	-
Total Hardness mg/L max.	300	-	300	-	-
Chlorides mg/l max	400	-	400	-	-

Class A: Drinking water source without conventional treatment but after disinfection

Class B: Organised out door bathing

Class C: Drinking water source with conventional treatment and disinfection

Class D: Fish culture and wild life propagation

Class E: Irrigation, industries, controlled waste disposal

8.4.2 Fate of Pollutants

The fate of pollution is decided by physical. Chemical and biological processes.

The physical processes include Transport Processes (advection and diffusion) which effect the quality parameters in a general way and can be termed as mass balance.

Rate of mass increase in control volume =	Rate of mass entering control volume (-)	Rate of mass leaving control volume (+)	Rate of mass general within control volume (-)	Rate of mass loss within control volume

The chemical processes or transformation processes are constituent dependent.

BOD Oxidation	:	Consumes oxygen, carbonaceous BOD is oxidized first followed by Nitrogenus. Organic mater is stabilized. These processes are sinks for D.O.
Surface re aeration	:	When the DO in a body of water with free surface is below saturation concentration a net flux occurs from atmosphere to water
Sediment Oxygen Demand	:	The suspended solids discharged with treated effluent are partly organic. In course of time they settle and accumulates at the bottom. This sediment decomposes anaerobically as well as aerobically (depending on conditions). Under aerobic conditions it is an oxygen sink.
Photo Synthesis and Respiration	:	Ambient DO can be affected by the growth of algae and hydrophytes. Algae and hydrophytes constitute an oxygen source during day (Photosynthesis) and oxygen sink during night (Respiration). For moderate nutrients enrichment level photosynthesis and Respiration compensate each other. However, higher enrichment level leads to high productivity (eutrophication) with strong effects on DO during night and day and after imbalances during high biomass growth and decay periods.
Solid deposition	:	The suspended solids discharged with waste water ultimately

		settle to the bottom. This settling is enhanced by flocculation and hindered by ambient turbulene.
Bactrial Die-off	:	The bacteria and virus die off in water due to salinity, temperature, and light intensity. The dead/live bacteria are also eaten by other forms of life.
Adsorption	:	Many chemical constituents tend to attach or sorb to solids and settle down
Volatilisation	:	Some organic compounds such as VOC (Volatile Organic Compounds) Volatilise in open atmosphere. This abetted by increase in temperature and turbulence.

b) Disposal on Land

Disposal on land is also expressed as Natural Treatment Systems where physical, chemical and biological processes occur when water, soil, plants microorganisms and atmosphere interact. Natural treatment systems are designed to take advantage of these processes. The processes involved are sedimentation, filtration, gas transfer, adsorption, ion exhcnage, chemical precipitation, chemical oxidation and reduction, biological conversion and degradation plus photosynthesis, photo oxidation, and plant uptake. These processes take place under a single ecosystem and include.

1. The soil based treatment systems – Slow rate, rapid infiltration over all land flow
2. Aquatic based system – Constructed and Natural wetlands

Advantage is often derived by using water and nutrients of waste water in growing crop a system known as “Sewage Farming”.

(Lecture 33 -34)

8.5 Environmental Audit

Environmental audit is a management tool comprising a systematic, documented periodic and objective evaluation of an organization performing functions of production within the mandated regulatory requirements.

The environmental audit studies serve the following three basic purposes.

(i) Compilation of the complete information on the operation of the industrial facility and its potential sources of pollution through technical inspection.

(ii) Evaluation of the conditions surrounding the industrial facility in order to estimate possible impacts which may be caused and suggested measures for such situations.

(iii) Preparation and implementation of action plans for better control of the environment and environmentally related industrial activities, including further developmental activities of the areas.

The obvious advantages of environmental auditing is to help safeguard the environment and to substantiate compliance with local, regional and national laws and regulations, and with the company policy and standards.

8.5.1 General Approach of Environmental Audit

The general approach cover three main phases:

(a) Collection of information

(b) Evaluation of information collected

(c) Formulation of conclusions including identification of aspects needing improvement

These phases cover, pre audit preparation, a site visit normally involving interviews with persons and inspection of facilities and post visit activities.

(i) Pre audit Activities :

- Selection and review of site by audit team
- Development of an audit plan, which defines the technical, geographic and time scope.
- Arranging for sample collection, preservation transport and analysis

- Obtaining background information on the plant as well as the Criteria to be used for evaluation
- Preparation of questionnaires

(ii) Activities at site

- Identification and assessment of the management control system
- Data collection, collation, compilation and evaluation
- Reporting audit findings

(iii) Post Audit Activities

- Preparation of the final report
- Development and follow up for implementation of a corrective action programme

8.5.2 Problems Encountered During Audit

Problems which the audit team may face are variable with respect to facility. However what is expected and needs attention are:

(i) Prior history of the site

(ii) Age of relevant equipment

(iii) Lack of records related to the relevant equipment

(iv) Attitude of concerned personnel on site towards audit studies

(v) Responses of the concerned management for implementation the corrective measures.

8.5.3 Audit Programmes in India

The environment audit programmes were initiated in early ninetys. The Central Pollution Control Board initiated a study in 18 major polluting industries in 1991-92. At the same time a paper on "Outline of Environmental Audits was prepared by MOEF and circulated for comments. This process resulted into issuing a gazette notification on March 13, 1992 through which submission of the Environmental Audit Report has been made mandatory. The term Audit Report was later changed to "Statement" through a revised notification of April 22, 1993. The industries are now supposed to submit their Auditing Statements to the concerned Boards on or before Sept. 30 every year beginning 1993.

(Lecture 35)

8.6 Solid Waste Disposal

The term "Solid Waste" as per USEPA includes any garbage, refuse, sludges and other discarded material, including solid, semi solid resulting from municipal, domestic, industrial, commercial and agricultural activities". This problem is not new. It existed even before man became aware of sanitation. The problem was initially very low. This was due to small population, large open spaces and primitive methods of living. It is only in the last three decades that the dragon of solid wastes raised its head. The problem was compounded by explosive population growth, rapid industrialization, throw away culture, discovery and use of plastic in daily life and decline in the concept of recycle.

8.6.1 Characteristics of Solid Wastes

The solid wastes can be categorized into:

(a) Municipal solid wastes

(b) Industrial solid wastes

Municipal solid wastes (MSN) include wastes generated in residential and commercial areas whereas industrial solid wastes (ISN) are those which are generated from industrial and agricultural operations.

(a) Municipal Solid Wastes: MSW includes wastes generated in residential areas, house hold, street wastes and wastes from construction sites. The amount generated per capita per day varies between 0.85 – 0.25 kg averaging about 0.5 kg. These values for USA are (2.25 kg), Canada (1.64 kg), U.K. (1.0 kg), Sweden (0.79 kg) and France (0.72 kg). In India the generated wastes from houses undergo change because of unauthorized picking and salvaging recyclable material by rag pickers and other scavengers. The quality and the quality at houses and at disposal sites is different. The wastes emanating from streets includes natural wastes viz. dust blown from unused lands, dead and decaying vegetation, seeds, leaf fall out and wastes from road traffic; dropping of animals and excrements.

The quantity of urban wastes also vary seasonally. During festivals the amount of refuse increases. Physical Characteristics of city refuse from some Indian cities is given below in Table 8.4.

Table 8.4 Characteristics of Solid Wastes

Cities	Characteristics %					
	Paper	**Plastic**	**Metals**	**Glass**	**Asha fine**	**Total decomposable**
Clacutta	3.18	0.65	0.66	0.38	34.0	47.0
Delhi	6.29	0.85	1.21	0.57	36.0	35.0
Chennai	7.85	0.88	0.95	0.96	28.0	48.0
Kanpur	2.97	0.62	0.45	0.37	46.0	41.0
Jaipur	3.02	0.80	0.64	0.39	50.0	26.0
Chandigard	6.17	0.33	0.22	0.20	39.0	35.0
Mumbai	4.89	2.92	2.46	0.72	26.6	59.78

Data based on NEERI, 1983

The data reveals that the characteristics depend on the type of life. In general the total decomposable matter and ash and fine inorganic matter is around 75% of the municipal refuse. The amount of plastic is gradually increasing. Consumables are now being extensively marketed in plastic pouches.

The chemical composition of data collected from 33 Indian Towns (Bhide and Sunderasan, 1983) indicate that the calorific value of waste is low (140 k cal/kg – 800 k cal/kg) as compared to US 3330 and Germany 2775 k cal/kg. Some values reported are

Moisture content 31.8 – 22.12 %

Organic matter 27.57 – 21.51%

Carbon as C 15.32 – 11.95%

Nitrogen as N 0.61 – 0.55%

Phosphorus as P_2O_5 0.71 – 0.59%

Potassium as K_2O 0.73 – 0.67%

C/N ratio 26.3 – 20.35%

In addition the refuse also show the presence of sufficient pathogens and intestinal parasites. Notable among them were *Ascaris lubricoides, T.trichura, Entamoeba histolytica, Salmonella typhi* and *Shigella*. This is ascribed to the practice of open defecation.

(b) Industrial Solid Wastes:

All industries generate wastes and the amount is highly variable. The composition depends on the type of industry. The wastes may be inert, biodegradable, toxic and even hazardous. There is no accepted method of categorization. The wastes from hospitals and pathology labs (bio-medical) are hazardous and categorized highly hazardous warranting separation and treatment. The industries are categorized in three broad categories:

(i) Extractive industries : Where material is extracted from earth, minning, quarrying and agriculture (including poultry, fruits, (crops)

(ii) Process industries: where raw materials are processed to useful products, metallurgical industries, chemicals (including oil refineries, pulp and paper, plastic, glass, textiles,

(iii) Fabricating industries: where processed products are converted to goods, packaging, automotive, electronics, construction, food processing.

8.6.2 Collection, Storage and Haulage

The problems of solid waste management lie more on collection and transportation than on final disposal. It is surmised and reported that 80% of the costs are on collection and transportation that on disposal. (In a community of 5.0 lac people in USA four million US dollars are spent on solid waste management of which 3.5 million dollars are spent on collection and transportation). It is a sad commentary that in India and many other developing countries even a fraction of the amount generated by local bodies / municipalities is spent on Solid Waste Management. Only a few cosmopolitan towns, tourist places, religious places have some arrangements. The result of this callous attitude are visible everywhere. Under Jawahar Lal Nehru National Urban Renewable Mission (JNNURM) and Urban Infrastructure Development Scheme for Small and medium towns (UIDSSMT), Ministry of Urban Development, GOI have made large provisions to improve sanitation including Solid Waste Management in 5161 urban agglomerates during 11^{th} Plan period.

Four arrangements are possible for the collection of solid waste.

(i) Municipal – City employees collect the refuse with city equipment under the supervision of Public Health Department.

(ii) Contract – Local govt. (municipality) hires an agency on contract to collect and transport the waste area wise or sector wise and pays to them. The agency utilizes its equipment and manpower.

(iii) Private – a private arrangement is a contracted to a private firm with the individual to collect the refuse. He collects payment directly. Govt./Municipality has no obligation. Many societies in metros have taken upon themselves to collect and transfer refuse to a designated site.

(iv) Franchise – In this arrangement local govt. authorizes a firm with exclusive rights of solid waste collection from an area or locality. He collects payment from the individuals under the scheme.

Out of all the four arrangements, municipal system should be the cheapest but less efficient. A contract/franchise system though is more costly but is more effective.

A couple of NGOs, utilizing the services of rag pickers have evolved a system in which a small levy is put on individuals. They sort out the wastes in separate containers so marked, biodegradable / recyclable / non biodegradable and keep them outside their houses in containers from where they are picked and transferred to the site of disposal (transferring station).

The solid wastes from houses (under municipal / contractual) is collected by one of the following methods.

(a) Curb-service: Collection at the curb of house holds on specified days

(b) Alley service: dust bins placed at the alley line

(c) Set out set back: workmen collect the refuse from houses

(d) backyard service: workment collect the refuse from backyards

Planning a Collection System

The collection system is cost intensive and must be planed in advance, no matter who owns the responsibility. The most important issue is co-ordination between collection and transportation system.

The elements are:

What to collect:	Segregated or mixed
Who will collect:	Municipal /contract /private /franchise, collection will be curb /alley /set out /set back /backyard
Frequency of collection:	Solid wastes must be collected before the organic content starts decomposing, daily /alternate days
Transfer Stations:	The routing depends on the transfer system. The transfer systems are provided with larger vehicles to carry large distances. A second step of transfer is economical which may be level or split level.

Before deciding the transfer system, the cost of bulk transportation to the final disposal site and cost of transportation system should be compared with the cost of conveying the refuse directly to disposal site in collection vehicle. A conceptual plan and costs involved is given in Fig. 8.4.

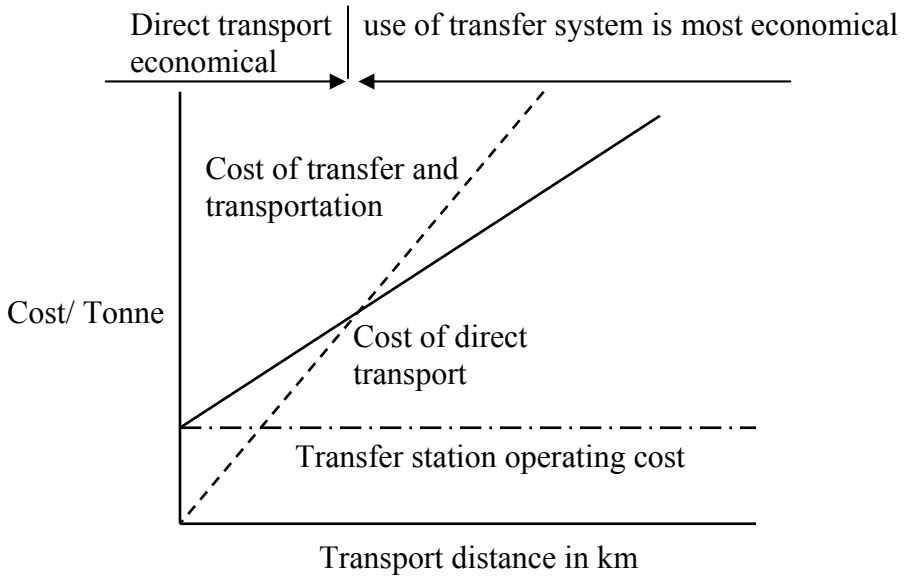


Fig. 8.4 Routing for Collection

Routing

By properly routing the vehicle, the cost can be reduced. Grouping of collection points is advisable. Route balancing also is feasible.

8.6.3 Treatment and Disposal

Treatment and disposal involve three methods:

(a) Direct disposal

(b) Processing to facilitate subsequent disposal

(c) Processing to recover materials and energy

(a) Direct disposal

(i) Open dumps: A primitive method in which waste is piled up in open dumps; common in small towns and rural areas. These dumps are hazardous as they promote breeding of rodents and flies. The bottom layers of dumps turn anaerobic and cause odor problems. Due to release of decay gas (methane) they may catch fires and produce obnoxious smoke.

(ii) Marine disposal: In coastal towns open dumping in sea is practiced. Though sea is a gigantic sink but the practice is not environmentally compatible. The littoral zone ecosystems are disturbed. High tide also returns a part of material on shores making them ugly and non aesthetic.

(iii) Grinding the garbage: The garbage is ground by domestic grinders and dumped in sewer system. This tends to choke the sewers completely or else partially. This increases the total solid concentration by 20-50% and oxygen demand by 10%.

(iv) Hog feeding: Hog feeding is selectively practiced on wastes collected from hotels / restaurants / institutions / industries (food processing) which are rich in organic matter. The method is risky and may increase Nematode infestation.

(v) Sanitary land fill: Land fill method is an improvement of open dumping of solid wastes in pits, ponds, depressions. It is an environmentally safe method of disposal. A sanitary land fill is defined as "a method of disposal of solid waste in a small confined area to reduce it to a small volume and to cover it with a layer of soil after each days operation". The following steps are necessary in the operation of a landfill:

(i) deposition in a prepared section

(ii) spreading and compaction in thin layers in order to get maximum density

(iii) covering the waste with a layer of compacted soil cover daily

(iv) final covering with 0.6-0.9 m soil

This method is environmentally safe since compaction achieves maximum density preventing reduction in volume. Soil cover makes it inaccessible for rodents and flies. Heat generated during decomposition makes it safe as fly larvae, pupae and other parasites are eliminated.

Land filling operations are brought about in three distinct ways depending on existing land conditions.

(a) **Trench method:** Suited for flat land and at places where ground water table is low. A trench of 2 m deep and 2 x 5m wide is cut. The solid waste is placed in the trench. Spread and compacted and covered by soil cover (15 cm) and compacted again. Soil is available as dug material.

(b) **Area method:** Suited where natural depressions exist (quarries, ravines, ponds and valleys). The solid waste is placed in the area compacted and covered by soil. This schedule is followed daily till the depression is filled. The earth required is taken from adjoining area.

(c) **Ramp method:** Modified trench method and area method. A trench is cut transversely across width. The collected solid waste is put through a ramp into the trench. It is spread compacted and covered by soil daily and compacted again.

The total settlement is summation of primary consolidation. Secondary Consolidation (or Creep) and decomposition. As a result of natural and artificial rearrangement of particles the densities of landfill increases. The value reported are 475-600 kg/m^3 (USA), 700 kg/m^3 (UK) and 1128 kg/m^3 (India). The land fill sites have been used to locate parks, playgrounds and parking lots. Before locating any activity it must be ensured that there is no gas production.

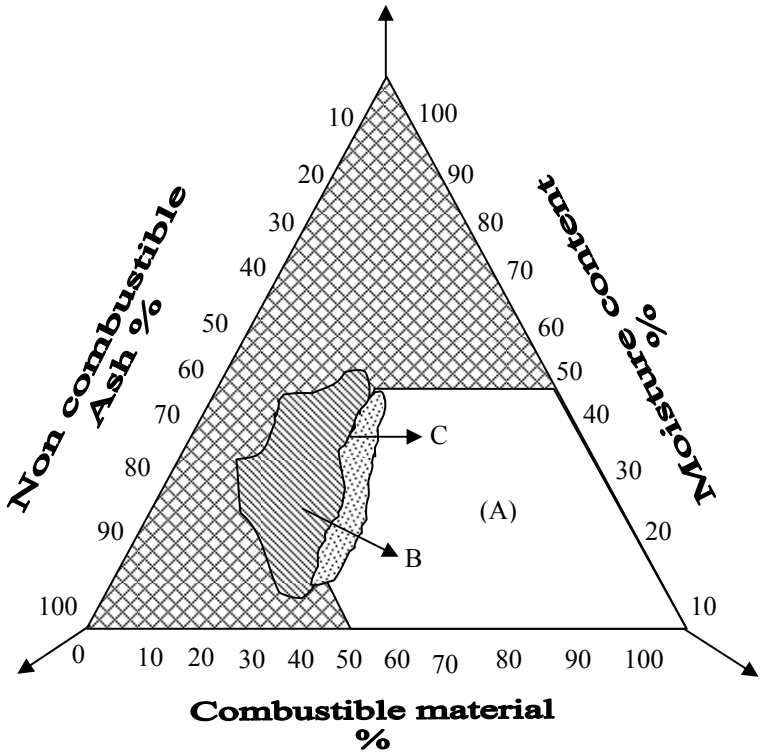
(d) **Processing to facilitate subsequent disposal**

The primary objective of processing before disposal is to reduce the volume which is intended to cut down haulage and disposal costs. Though volume reduction is advantageous, the capital and operating cost must be taken into consideration. The

common volume reducing processes are (1) Incinneration, (2) Pyrolysis, (3) Shredding and (4) Baling.

(1) Incineration: It is a process of controlled combustion, where in solid, liquid and gases are burnt to convert them to non combustible materials. Since combustion processes produce large amount of air pollutants, it is not a preferred practice. Yet in some rural, urban and defence area, the system is still practiced. Not much data and information is available in India on commercial / municipal incinerators.

The calorific value of the waste, ash content and moisture would indicate whether the waste can sustain combustion on its own or would require auxillary fuels to support combustion. The figure 8.5 (tri-linear diagram) indicate the potential of incineration of solid municipal wastes.



A - Zone in self - Sustaining combustion
B - Zone in which values from 33 Indian cities lie
C - zone in which value from some cities where self sustaining reaction is possible

Fig. 8.5: Trilinear diagram of Bhide and Sunderasan (1984) (33 towns data)

The products of Incinneration are

(i) Siftings – material that falls below the bed through gratings ash, metal pieces, glass ceramics etc.

(ii) Residue – Solid material after burning include clinker, ash tin cans, metal pieces, glass, rocks etc.

(iii) Clinker and fly ash – clinker from grates fused ash, metal

(iv) Suspended particles – SPM from flue gas

(2) Pyrolysis: It is a destructive distillation process – thermo chemical, brought about in the absence of added oxygen. The temperature ranges between 480 – 926^{o}C and the oxygen is 40% less than required. The process reduces the solid waste by 95% (metal and glass removed). The char (elemental carbon alongwith inert material), liquid (including light oil low boiling organics, acetone, acid methanol) and gas (mixture of Hydrogen, Co, CH_4, CO_2 and some hydrocarbons) have high calorific value. Port of this heat is used as a process heat for endothermic reactions and part exist to be exploited for other commercial processes. The mass balance is:

Input	**Products**	**Output**
Oxygen	Char	70-1000
Refuse	Tar & pitch	2 – 20 litres
	Light oil	6.0 litres
	Liquor	160 – 260 litres
	$(NH_4)_2 SO_4$	9-11 kg
	Gas	300-500 m^3

(3) Shredding: Shredding is a mechanical process to reduce the size of refuse. The most common device is hammer mill. It reduces the heterogenous mass to homogeneous mass. it is useful process to be adopted prior to landfill, pyrolysis and composting.

(4) **Bailing:** It is process to increase the density. The material is crushed under brute force to produce a compact bale. Its density ranges between 950 – 1070 kg/m^3. This is twice the density of a landfill. The bales can be transported to landfill site.

C. **Process to recover material and energy:** Variety of products can be salvaged from solid waste viz. metals, glass, ceramics, rubber, plastic. Organic matter can be stabilized to produce manure and biogas. The stabilization is brought about by composting.

Composting

The controlled decomposition process to produce stabilized organics is called composting and the end material as compost. In India, with agricultural base, composting is a very useful method of solid waste disposal. The compost is useful as a plant nutrient since it contains NPK in optimum amounts in such form that it can be gradually taken without leaching. It also contains other soil conditioner agents and improves the soil texture.

The organic matter in the solid waste is converted to CO_2, NO_3 and water during aerobic conditions. The reactions are exothermic and temperature of the mass increases. The Nitrogen is recycled and CO_2 is utilized. Under anaerobic conditions the decomposition proceeds under reductive conditions and the stabilization is partial. The products produced are NH_4, H_2S and CH_4.

The composting has some merits and demerits:

Merits

(i) Complete and effective disposal of refuse

(ii) It has great manure value

(iii) It destroys pathogens.

Demerits

(i) Composting mass requires large space.

(ii) Composting mass is associated with unsanitary conditions while turning.

Where preferred

(i) Where both refuse and animal dung are to be disposed together.

(ii) Where land is available.

(iii) Where there is market for compost.

(iv) Where ambient temperatures are high.

(Lecture 37 - 39)

8.7 Concept of Green Cities

Four types of Ecosystems exist on the planet earth. They are differentiated on the basis of utilization of energy. Ecosystems rely on two sources of energy i.e. solar energy and the energy from chemical fuels. The solar energy is a dilute form of energy as compared to chemical fuels which are concentrated.

(i) Subsidized Solar powered systems – with energy flow around 1000-10,000 kcal/m^2/year averaging about 2000 kcal. Examples – open seas, upland forests, grass lands, large deep lakes.

(ii) Naturally subsidized solar powered systems – with energy flow around 10,000-40,000 kcal/m^2/year, averaging about 20,000 kcal. Examples, coastal estuary, rainforests.

(iii) Mansubsidised solar powered Ecosystems - with energy flow of 10,000-40,000 kcal/m^2/year averaging about 20,000 kcal. Examples, Aqua culture, agriculture.

(iv) Fuel powered urban industrial systems – with energy flow 10,000-3000,000 kcal/m^2 Examples cities, Urban areas, industrial parks.

Every natural system is stable with production equaling consumption except the fuel powered urban industrial systems. They are not self sustaining. They survive only by importing food, water, energy and other resources from somewhere else and produce vast amounts of wastes and affect not only the health of inhabitants but also the environmental health of rural areas and health of the planet. They are heterotrophic systems. Following attributes make cities unique ecosystem.

(i) They are heterotrophic and extremely energy intensive.

(ii) They require large inputs of energy and materials,

(iii) They produce copious amount of wastes and lack effective assimilation mechanism to handle these wastes.

(iv) They function not by biophysical interactions but also by social and political forces.

(v) One keystone species humans exerts over whelming control on ecosystems process.

Although cities occupy just 2% of Earths surface, their inhabitants use 75% of the planets natural resources, contribute more than half of the total economy and in some developing countries upto 80% of their economic activity. On average, urban dwellers earn higher wages and live easier life than their rural counterparts.

Causes of Urbanization

Urbanization is an outcome of historical compulsions such as defence and establishment of trade routes. Social reasons include – extended opportunities of social interactions, and establishment of institutions representing a society (Govt., religion and education). Economic benefits such as linking with agricultural surpluses, increased economic opportunities due to access to labour. Specialization and economies of scale and of agglomeration facilitated setting of urban centers. Causes of rapid urban growth include natural centers. Causes of rapid urban growth include natural increase – more births than deaths, immigration (from rural areas). Cities are main centers of education, jobs higher income, innovation, culture, better health care and trade.

As cities and towns grow, their reliance on resources from afar increase, as well as their environmental impact ecological foot print. The foot print of city is the total area of productive land required to support its activities in a sustainable way. Cities imprints can be 10-100 times larger than their actual area (Food, water, energy requirements, industrial production, wastes production) Per capita requirement in a city of USA is 20 a cres of agricultural land, paper and wood products from 1.0 acre of forest and 2000 gallons of water per day. Therefore a city with 1.0 million inhabitants will require 2 million acres of land for food and 2 billion gallons of water.

Urbanization is also responsible for mushrooming of slums which thrive in most decongested space and unsanitary conditions.

Managing Urbanization

Cities need to be managed as local environments. For biodiversity, for human health and well being and for economic stability. In order to confront the challenges posed by unprecedented rate of urban growth and increasing urban poverty, cities need to plan ahead in order to make more informed choices about the future and they need to act now. Well planned cities can also be environmentally friendly is the concept of **green cities** where people can live in a clean and healthy environment. A major part of the strategy will have environmental focus. Designing effective land use, meeting the challenge of effective and environmentally friendly transportation, preserving open space, providing healthy air and water. Investing in the environment closest to them – urban parks, energy efficiency.

The message of Executive Director UNEP, Mr Klaus Toepfor on World Environment day sums up the concept of GREEN CITY "Imagine a City where buildings are solar powered to help generate their own energy, and waste less because they use power saving lighting and are well insulated, where public transport is affordable and efficient, where vehicles pollute less because they are powered by electricity or hydrogen. The city has became part of the solution, not the problem. It is the city of the future. With support of communities, business and, above all Governments, it can also be the city of today".

(Lecture 39)

Suggested Reading

1. Environmental Auditing, Srivastava, A.K. APH Publishing Corporation, New Delhi.
2. Natural Resources Conservation. Trivedi, P.R., APH Publishing Corporation, New Delhi.
3. Solid Waste Management in Developing Countries Bhide, A. D. and Sundaresan, B.B., INSDOC, New Delhi.
4. Waste Water Engineering Treatment Disposal Reuse, Metcalf & EDDY, Inc. Revised by George Techobanogloes and Franklin L. Burton McGraw – Hill, Inc.

CHAPTER IX

9.0 Post Project Monitoring Case History

9.1 Post Project Monitoring

Environment Impact Assessment (Statement) delineates all aspects of the project and predictable impacts of activities on environment. It provides detail of mitigation measures alongwith a detailed Environment Management Plan (EMP).

Post project monitoring is aimed at evaluating the progress of project implementation. Each project is Unique in terms of activities involved. The project proponents while submitting the projects claim to achieve and ameliorate the impacts of diverse environmental attributes. The regulatory agency also suggests additional measures for the protection of environment. The objectives of monitoring thus is to ascertain whether expressed and suggested measures have been incorporated in the project and to confirm that they satisfy all legal provisions vis. a vis. Environment (Protection) Rules 1986 (National Ambient Air Quality Standards; Environment Protection Act (CPCB) No 29 of 23.5.1986; Classification of Inland Surface Water (Central Pollution Control Board Standards, IS 10500 – 1983); Indian Standard / Specifications for Drinking Water (152490 – 1982); Environment (Protection) Rules, 1986, Schedule VI/Standard Prescribed by SPCB's (Indian Standards for Industrial and Sewage Discharge, General Standards for discharge of Environment Pollutants) and Govt. Policies (National Water Policy, 1987; National land use Policy, 1988; National Forest Policy, 1988, Policy Statement for Abatement of Pollution, 1991; Industrial Policy, 1991; National Conservation Strategy and Policy Statement on Environment and Development, 1992; National Rehabilitation and Resettlement Policy and National Mineral Policy 1993).

Every project has three defined phases

Phase I – Preconstruction phase, planning and development. It includes land procurement, Clearing and grubbing, removal of existing structures, top soil stripping excavation and back fill and removal of extra material. Procurement of all support facilities for the next phase.

Phase II – Construction phase. It involves plethora of jobs including excavation, foundations, bituminous construction. Concrete construction, masonry, timber and steel construction and furnishing.

The activities during these phases are transient and continue till the project is completed. They may be operated separately or jointly. The quantum would however, depend on the magnitude of the project. A close watch during the period is helpful. The construction phase can lead to significant impacts through high intensity pressures on the physico chemical environment in relation to air, ground and, surface water, soil and land. Risks to the sensitive systems are of particular importance.

Phase III – Operation and maintenance is very critical in monitoring. The agency identified for post project monitoring has to verify all significant impacts specially.

(a) Impacts on Public utilities:

Stress on distributive resources, water, transportation, traffic, loss of open space, visual impairment, sewage and drainage, solid wastes, noise and health.

(b) Impacts on Resources:

Downstream pollution arising out of use of water extraction of ground water, lowering of water table and on use of by population in the vicinity. Changes in land topography top soil and decrease in drainage.

(c) Ecological impacts:

Effect on plant and animal life changes in habitat requirements changes in biodiversity and occupational health.

The most critical parameters for monitoring would require

i) Water: - Changes in flow patterns, aquifer yield changes in the quality of water downstream of project progress of rainwater harvesting.

ii) Waste Water: - Collection, carriage, treatment and disposal. The use of treated waste water in green area development and or other indicated disposal methods.

iii) Solid Waste: - Collection, haulage and disposal as included in the project proposals of special consideration is changes in aesthetic environment.

iv) Air: - Quality of stack emissions and changes in the ambient air.

v) Land: - Subsistenance and noise.

vi) **Plantation: -** Green cover as envisaged.

vii) **Socio economic: -** Employment / Placement of stake holders, rehabilitation of displaced persons, provisions and facilities promised by the promoters of the affected population changes if any an economic conditions.

The monitoring programme be so drawn as to achieve the basic objectives and critical parameters.

Lecture 41

9.2 Case Histories

Case histories of some EIA studies should also be discussed. One such study undertaken by AHEC/I.I.T. Roorkee is appended.

(Lectures 41 - 43)