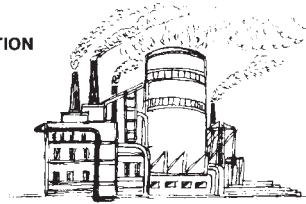


UNIT 5: Pollution

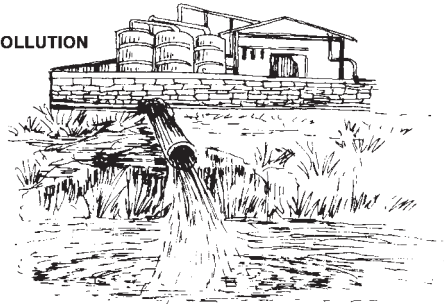
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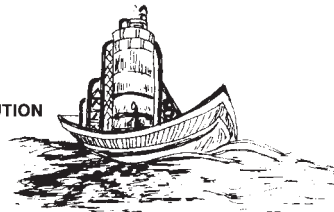
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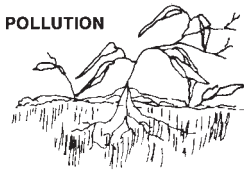
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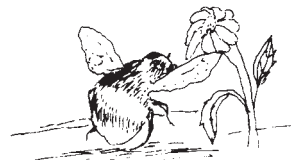
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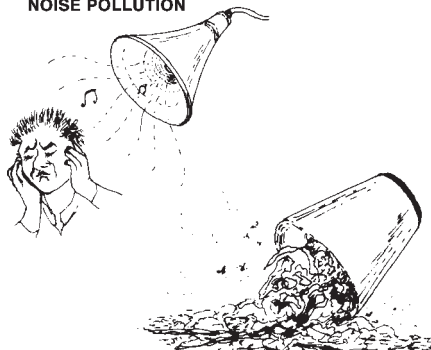
SOIL POLLUTION



LOSS OF RENEWABLE RESOURCES



NOISE POLLUTION



POLLUTION DUE TO GARBAGE

'We spray our elms, and the following spring, trees are silent of robin song, not because we sprayed the robins directly but because the poison traveled step by step through the now familiar elm-earthworm-robin cycle'

– Rachael Carson

This quotation appeared in Rachael Carson's book entitled *Silent Spring*. In the years following the publication of *Silent Spring* in 1962, the

book has inspired controversy and has initiated a major change in thinking about the safety of using pesticides and other toxic chemicals.

5.1 DEFINITION

Pollution is the effect of undesirable changes in our surroundings that have harmful effects on plants, animals and human beings. This occurs

Environmental Studies for Undergraduate Courses

when only short-term economic gains are made at the cost of the long-term ecological benefits for humanity. No natural phenomenon has led to greater ecological changes than have been made by mankind. During the last few decades we have contaminated our air, water and land on which life itself depends with a variety of waste products.

Pollutants include solid, liquid or gaseous substances present in greater than natural abundance produced due to human activity, which have a detrimental effect on our environment. The nature and concentration of a pollutant determines the severity of detrimental effects on human health. An average human requires about 12 kg of air each day, which is nearly 12 to 15 times greater than the amount of food we eat. Thus even a small concentration of pollutants in the air becomes more significant in comparison to the similar levels present in food. Pollutants that enter water have the ability to spread to distant places especially in the marine ecosystem.

From an ecological perspective pollutants can be classified as follows:

Degradable or non-persistent pollutants: These can be rapidly broken down by natural processes. Eg: domestic sewage, discarded vegetables, etc.

Slowly degradable or persistent pollutants: Pollutants that remain in the environment for many years in an unchanged condition and take decades or longer to degrade. Eg: DDT and most plastics.

Non-degradable pollutants: These cannot be degraded by natural processes. Once they are released into the environment they are difficult to eradicate and continue to accumulate. Eg: toxic elements like lead or mercury.

5.2 CAUSES, EFFECTS AND CONTROL MEASURES OF POLLUTION

5.2.1 Air Pollution

History of air pollution: The origin of air pollution on the earth can be traced from the times when man started using firewood as a means of cooking and heating. Hippocrates has mentioned air pollution in 400 BC. With the discovery and increasing use of coal, air pollution became more pronounced especially in urban areas. It was recognized as a problem 700 years ago in London in the form of smoke pollution, which prompted King Edward I to make the first antipollution law to restrict people from using coal for domestic heating in the year 1273. In the year 1300 another Act banning the use of coal was passed. Defying the law led to imposition of capital punishment. In spite of this air pollution became a serious problem in London during the industrial revolution due to the use of coal in industries. The earliest recorded major disaster was the 'London Smog' that occurred in 1952 that resulted in more than 4000 deaths due to the accumulation of air pollutants over the city for five days.

In Europe, around the middle of the 19th century, a black form of the Peppered moth was noticed in industrial areas. Usually the normal Peppered moth is well camouflaged on a clean lichen covered tree. However the peppered pattern was easily spotted and picked up by birds on the smoke blackened bark of trees in the industrial area, while the black form remained well camouflaged. Thus while the peppered patterned moths were successful in surviving in clean non-industrial areas, the black coloured moths were successful in industrial areas. With the spread of industrialization, it has been observed that the black forms are not only seen in Peppered moth, but also in many other moths. This is a classic case of pollution leading to adaptation.

Air pollution began to increase in the beginning of the twentieth century with the development of the transportation systems and large-scale use of petrol and diesel. The severe air quality problems due to the formation of photochemical smog from the combustion residues of diesel and petrol engines were felt for the first time in Los Angeles. Pollution due to auto-exhaust remains a serious environmental issue in many developed and developing countries including India.

The Air Pollution Control Act in India was passed in 1981 and the Motor Vehicle Act for controlling the air pollution, very recently. These laws are intended to prevent air from being polluted.

The greatest industrial disaster leading to serious air pollution took place in Bhopal where extremely poisonous methyl isocyanide gas was accidentally released from the Union Carbide's pesticide manufacturing plant on the night of December 3rd 1984. The effects of this disaster on human health and the soil are felt even today.

Structure of the atmosphere

The atmosphere is normally composed of 79 percent nitrogen, 20 percent oxygen and one percent as a mixture of carbon dioxide, water vapour and trace amounts of several other gases such as neon, helium, methane, krypton, hydrogen and xenon. The general structure of the atmosphere has several important features that have relevance to environmental problems. The atmosphere is divided into several layers.

The innermost layer the *troposphere* extends 17 kilometers above sea level at the equator and about 8 kilometers over the poles. It contains about 75 percent of the mass of the earth's air. The fragility of this layer is obvious from the fact that if the earth were an apple this particular layer would be no thicker than an apple's skin.

Temperature declines with altitude in the troposphere. At the top of the troposphere temperatures abruptly begin to rise. This boundary where this temperature reversal occurs is called the tropopause.

The tropopause marks the end of the troposphere and the beginning of the *stratosphere*, the second layer of the atmosphere. The stratosphere extends from 17 to 48 kilometers above the earth's surface. While the composition of the stratosphere is similar to that of the troposphere it has two major differences. The volume of water vapour here is about 1000 times less while the volume of ozone is about 1000 times greater. The presence of ozone in the stratosphere prevents about 99 percent of the sun's harmful ultraviolet radiation from reaching the earth's surface thus protecting humans from cancer and damage to the immune system. This layer does not have clouds and hence airplanes fly in this layer as it creates less turbulence. Temperature rises with altitude in the stratosphere until there is another reversal. This point is called the stratopause and it marks the end of the stratosphere and the beginning of the atmosphere's next layer, the mesosphere.

In the *mesosphere* the temperature decreases with altitude falling up to -110°C at the top. Above this is a layer where ionization of the gases is a major phenomenon, thus increasing the temperature. This layer is called the *thermosphere*. Only the lower troposphere is routinely involved in our weather and hence air pollution. The other layers are not significant in determining the level of air pollution.

Types and sources of Air Pollution

What is air pollution?

Air pollution occurs due to the presence of undesirable solid or gaseous particles in the air in quantities that are harmful to human health and the environment. Air may get polluted by natu-

ral causes such as volcanoes, which release ash, dust, sulphur and other gases, or by forest fires that are occasionally naturally caused by lightning. However, unlike pollutants from human activity, naturally occurring pollutants tend to remain in the atmosphere for a short time and do not lead to permanent atmospheric change.

Pollutants that are emitted directly from identifiable sources are produced both by natural events (for example, dust storms and volcanic eruptions) and human activities (emission from vehicles, industries, etc.). These are called *primary pollutants*. There are five primary pollutants that together contribute about 90 percent of the global air pollution. These are carbon oxides (CO and CO₂), nitrogen oxides, sulfur oxides, volatile organic compounds (mostly hydrocarbons) and suspended particulate matter.

Pollutants that are produced in the atmosphere when certain chemical reactions take place among the primary pollutants are called *secondary pollutants*. Eg: sulfuric acid, nitric acid, carbonic acid, etc.

Carbon monoxide is a colourless, odorless and toxic gas produced when organic materials such as natural gas, coal or wood are incompletely burnt. Vehicular exhausts are the single largest source of carbon monoxide. The number of vehicles has been increasing over the years all over the world. Vehicles are also poorly maintained and several have inadequate pollution control equipment resulting in release of greater amounts of carbon monoxide. Carbon monoxide is however not a persistent pollutant. Natural processes can convert carbon monoxide to other compounds that are not harmful. Therefore the air can be cleared of its carbon monoxide if no new carbon monoxide is introduced into the atmosphere.

Sulfur oxides are produced when sulfur containing fossil fuels are burnt.

Nitrogen oxides are found in vehicular exhausts. Nitrogen oxides are significant, as they are involved in the production of secondary air pollutants such as ozone.

Hydrocarbons are a group of compounds consisting of carbon and hydrogen atoms. They either evaporate from fuel supplies or are remnants of fuel that did not burn completely. Hydrocarbons are washed out of the air when it rains and run into surface water. They cause an oily film on the surface and do not as such cause a serious issue until they react to form secondary pollutants. Using higher oxygen concentrations in the fuel-air mixture and using valves to prevent the escape of gases, fitting of catalytic converters in automobiles, are some of the modifications that can reduce the release of hydrocarbons into the atmosphere.

Particulates are small pieces of solid material (for example, smoke particles from fires, bits of asbestos, dust particles and ash from industries) dispersed into the atmosphere. The effects of particulates range from soot to the carcinogenic (cancer causing) effects of asbestos, dust particles and ash from industrial plants that are dispersed into the atmosphere. Repeated exposure to particulates can cause them to accumulate in the lungs and interfere with the ability of the lungs to exchange gases.

Lead is a major air pollutant that remains largely unmonitored and is emitted by vehicles. High lead levels have been reported in the ambient air in metropolitan cities. Leaded petrol is the primary source of airborne lead emissions in Indian cities.

Pollutants are also found indoors from infiltration of polluted outside air and from various chemicals used or produced inside buildings. Both indoor and outdoor air pollution are equally harmful.

Types of particulates

Term	Meaning	Examples
Aerosol	General term for particles suspended in air	Sprays from pressurized cans
Mist	Aerosol consisting of liquid droplets	Sulfuric acid mist
Dust	Aerosol consisting of solid particles that are blown into the air or are produced from larger particles by grinding them down	Dust storm
Smoke	Aerosol consisting of solid particles or a mixture of solid and liquid particles produced by chemical reaction such as fires	Cigarette smoke, smoke from burning garbage
Fume	Generally means the same as smoke but often applies specifically to aerosols produced by condensation of hot vapors of metals.	Zinc/lead fumes
Plume	Geometrical shape or form of the smoke coming out of a chimney	
Fog	Aerosol consisting of water droplets	
Smog	Term used to describe a mixture of smoke and fog.	

What happens to pollutants in the atmosphere?

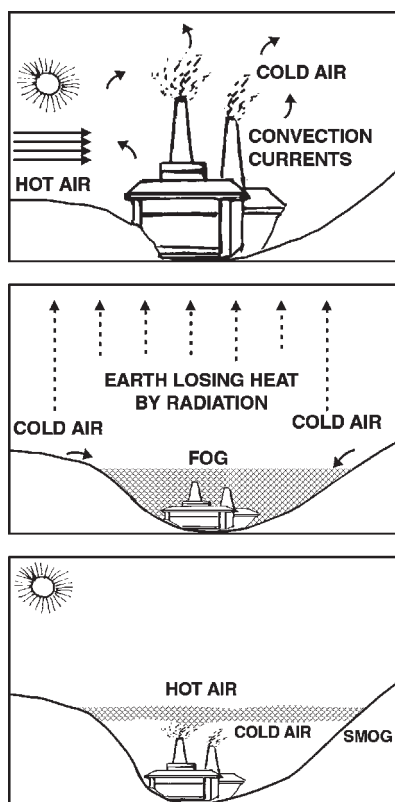
Once pollutants enter the troposphere they are transported downwind, diluted by the large volume of air, transformed through either physical or chemical changes or are removed from the atmosphere by rain during which they are attached to water vapour that subsequently forms rain or snow that falls to the earth's surface. The atmosphere normally disperses pollutants by mixing them in the very large volume of air that covers the earth. This dilutes the pollutants to acceptable levels. The rate of dispersion however varies in relation to the following aspects:

Topography

Normally as the earth's surface becomes warmed by sunlight the layer of air in contact with the ground is also heated by convection. This warmer air is less dense than the cold air above it, so it rises. Thus pollutants produced in the surface layer are effectively dispersed.

However on a still evening, the process is reversed. An hour or two before sunset after a sunny day, the ground starts to lose heat and the air near the ground begins to cool rapidly. Due to the absence of wind, a static layer of cold air is produced as the ground cools. This in turn induces condensation of fog. The morning sun cannot initially penetrate this fog layer. The

cold air being dense cannot rise and is trapped by the warm air above. It cannot move out of the area due to the surrounding hills. The topographic features resemble a closed chemical reactor in which the pollutants are trapped. This condition often continues through the cool night and reaches its maximum intensity before sunrise. When the morning sun warms the ground the air near the ground also warms up and rises within an hour or two. This may be broken up by strong winds. In cold regions this situation can persist for several days. Such a situation is known as smog (smoke + fog).

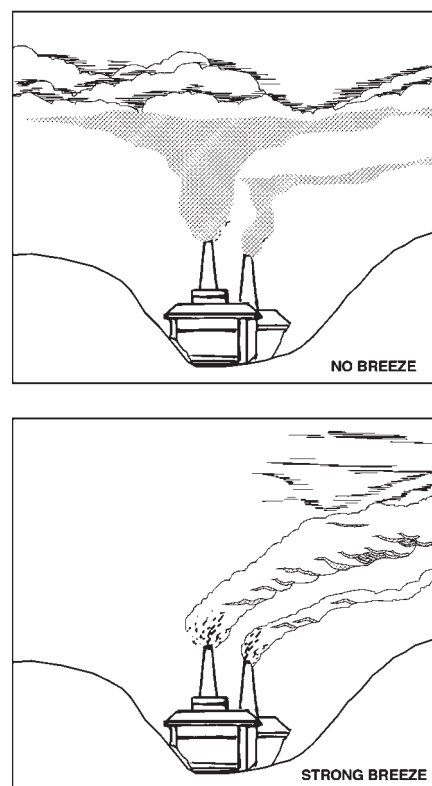


The most well known example is that of the 'London Smog' that occurred in 1952. The city used large quantities of sulphur containing coal for domestic heating that released smoke, along with smoke from thermal power plants and

other industrial establishments. This used to lead to the generation of high levels of smoke containing sulphur oxides. Due to a sudden adverse meteorological condition air pollutants like smoke and sulphur oxides started to build-up in the atmosphere. The white fog accumulated over the city turned black forming a 'pea-soup' smog with almost zero visibility. Within two days of the formation of this smog, people started suffering from acute pulmonary disorders which caused irritation of bronchi, cough, nasal discharges, sore throat, vomiting and burning sensations in the eyes. This event led to several deaths.

Meteorological conditions

The velocity of the wind affects the dispersal of pollutants. Strong winds mix polluted air more rapidly with the surrounding air diluting the pollutants rapidly. When wind velocity is low mixing takes place and the concentration of pollutants remains high.



When sulphur dioxide and nitrogen oxides are transported by prevailing winds they form secondary pollutants such as nitric acid vapour, droplets of sulfuric acid and particles of sulphate and nitrate salts. These chemicals descend on the earth's surface in two forms: wet (as acidic rain, snow, fog and cloud vapour) and dry (as acidic particles). The resulting mixture is called acid deposition, commonly called *acid rain*.

Acid deposition has many harmful effects especially when the pH falls below 5.1 for terrestrial systems and below 5.5 for aquatic systems. It contributes to human respiratory diseases such as bronchitis and asthma, which can cause premature death. It also damages statues, buildings, metals and car finishes. Acid deposition can damage tree foliage directly but the most serious effect is weakening of trees so they become more susceptible to other types of damage. The nitric acid and the nitrate salts in acid deposition can lead to excessive soil nitrogen levels. This can over stimulate growth of other plants and intensify depletion of other important soil nutrients such as calcium and magnesium, which in turn can reduce tree growth and vigour.

Effects of air pollution on living organisms

Our respiratory system has a number of mechanisms that help in protecting us from air pollution. The hair in our nose filters out large particles. The sticky mucus in the lining of the upper respiratory tract captures smaller particles and dissolves some gaseous pollutants. When the upper respiratory system is irritated by pollutants sneezing and coughing expel contaminated air and mucus. Prolonged smoking or exposure to air pollutants can overload or breakdown these natural defenses causing or contributing to diseases such as lung cancer, asthma, chronic bronchitis and emphysema. Elderly people, infants, pregnant women and people with heart disease, asthma or other res-

piratory diseases are especially vulnerable to air pollution.

Cigarette smoking is responsible for the greatest exposure to carbon monoxide. Exposure to air containing even 0.001 percent of carbon monoxide for several hours can cause collapse, coma and even death. As carbon monoxide remains attached to hemoglobin in blood for a long time, it accumulates and reduces the oxygen carrying capacity of blood. This impairs perception and thinking, slows reflexes and causes headaches, drowsiness, dizziness and nausea. Carbon monoxide in heavy traffic causes headaches, drowsiness and blurred vision.

Sulfur dioxide irritates respiratory tissues. Chronic exposure causes a condition similar to bronchitis. It also reacts with water, oxygen and other material in the air to form sulfur-containing acids. The acids can become attached to particles which when inhaled are very corrosive to the lung.

Nitrogen oxides especially NO_2 can irritate the lungs, aggravate asthma or chronic bronchitis and also increase susceptibility to respiratory infections such as influenza or common colds.

Suspended particles aggravate bronchitis and asthma. Exposure to these particles over a long period of time damages lung tissue and contributes to the development of chronic respiratory disease and cancer.

Many volatile organic compounds such as (benzene and formaldehyde) and toxic particulates (such as lead, cadmium) can cause mutations, reproductive problems or cancer. Inhaling ozone, a component of photochemical smog causes coughing, chest pain, breathlessness and irritation of the eye, nose and the throat.

Effects on plants

When some gaseous pollutants enter leaf pores they damage the leaves of crop plants. Chronic exposure of the leaves to air pollutants can break down the waxy coating that helps prevent excessive water loss and leads to damage from diseases, pests, drought and frost. Such exposure interferes with photosynthesis and plant growth, reduces nutrient uptake and causes leaves to turn yellow, brown or drop off altogether. At a higher concentration of sulphur dioxide majority of the flower buds become stiff and hard. They eventually fall from the plants, as they are unable to flower.

Prolonged exposure to high levels of several air pollutants from smelters, coal burning power plants and industrial units as well as from cars and trucks can damage trees and other plants.

Effects of air pollution on materials

Every year air pollutants cause damage worth billions of rupees. Air pollutants break down exterior paint on cars and houses. All around the world air pollutants have discoloured irreplaceable monuments, historic buildings, marble statues, etc.

Effects of air pollution on the stratosphere

The upper stratosphere consists of considerable amounts of ozone, which works as an effective screen for ultraviolet light. This region called the ozone layer extends up to 60 kms above the surface of the earth. Though the ozone is present upto 60 kms its greatest density remains in the region between 20 to 25 kms. The ozone layer does not consist of solely ozone but a mixture of other common atmospheric gases. In the most dense ozone layer there will be only one ozone molecule in 100,000 gas molecules. Therefore even small changes in the ozone con-

centration can produce dramatic effects on life on earth.

The total amount of ozone in a 'column' of air from the earth's surface upto an altitude of 50 km is the *total column ozone*. This is recorded in *Dobson Units (DU)*, a measure of the thickness of the ozone layer by an equivalent layer of pure ozone gas at normal temperature and pressure at sea level. This means that 100 DU=1mm of pure ozone gas at normal temperature and pressure at sea level.

Ozone is a form of oxygen with three atoms instead of two. It is produced naturally from the photodissociation of oxygen gas molecules in the atmosphere. The ozone thus formed is constantly broken down by naturally occurring processes that maintain its balance in the ozone layer. In the absence of pollutants the creation and breakdown of ozone are purely governed by natural forces, but the presence of certain pollutants can accelerate the breakdown of ozone. Though it was known earlier that ozone shows fluctuations in its concentrations which may be accompanied sometimes with a little ozone depletion, it was only in 1985 that the large scale destruction of the ozone also called the Ozone Hole came into limelight when some British researchers published measurements about the ozone layer.

Soon after these findings a greater impetus was given to research on the ozone layer, which convincingly established that CFC's were leading to its depletion. These CFCs (chloro-fluorocarbons) are extremely stable, non-flammable, non-toxic and harmless to handle. This makes them ideal for many industrial applications like aerosols, air conditioners, refrigerators and fire extinguishers. Many cans, which give out foams and sprays, use CFCs. (eg: perfumes, room fresheners, etc.) CFCs are also used in making foams for mattresses and cushions, disposable Styrofoam cups, glasses, packaging material for insulation, cold storage etc. However their sta-

bility also gives them a long life span in the atmosphere.

Halons are similar in structure to the CFCs but contain bromine atoms instead of chlorine. They are more dangerous to the ozone layer than CFCs. Halons are used as fire extinguishing agents as they do not pose a harm to people and equipment exposed to them during fire fighting.

The CFCs and the halons migrate into the upper atmosphere after they are released. As they are heavier than air they have to be carried by air currents up to just above the lower atmosphere and then they slowly diffuse into the upper atmosphere. This is a slow process and can take as long as five to fifteen years. In the stratosphere unfiltered UV-radiation severs the chemical bonds releasing chlorine from the rest of the CFC. This attacks the ozone molecule resulting in its splitting into an oxygen molecule and an oxygen atom.

Despite the fact that CFCs are evenly distributed over the globe, the ozone depletion is especially pronounced over the South Pole due to the extreme weather conditions in the Antarctic atmosphere. The presence of the ice crystals makes the Cl-O bonding easier. The ozone layer over countries like Australia, New Zealand, South Africa and parts of South America is also depleted.

India has signed the Montreal Protocol in 1992, which aims to control the production and consumption of Ozone Depleting Substances.

Ozone depletion-What does it do?

Changes in the ozone layer have serious implications for mankind.

Effects on human health: Sunburn, cataract, aging of the skin and skin cancer are caused by

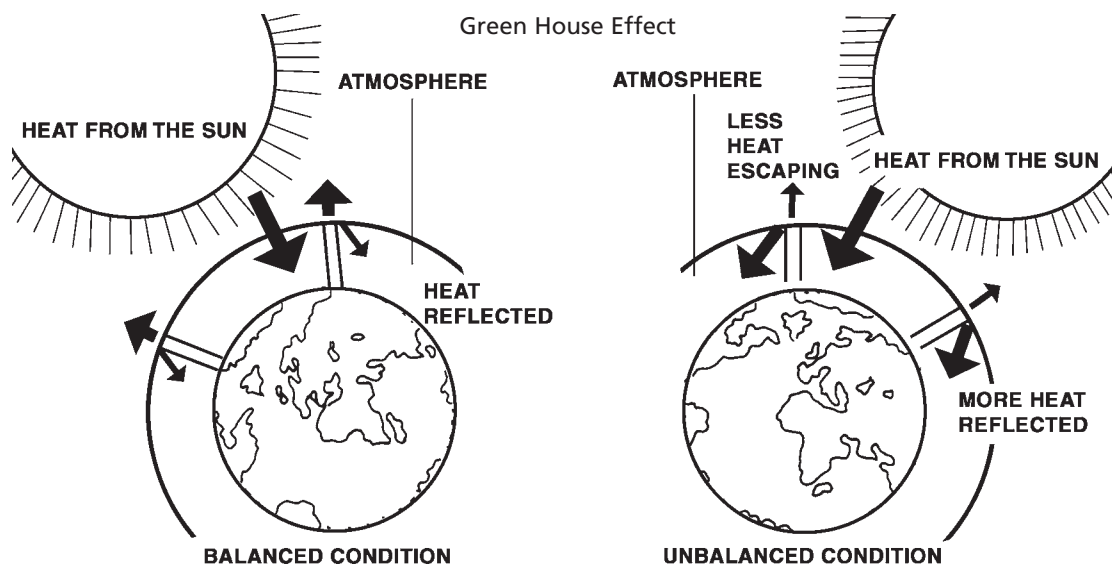
increased ultra-violet radiation. It weakens the immune system by suppressing the resistance of the whole body to certain infections like measles, chicken pox and other viral diseases that elicit rash and parasitic diseases such as malaria introduced through the skin.

Food production: Ultra violet radiation affects the ability of plants to capture light energy during the process of photosynthesis. This reduces the nutrient content and the growth of plants. This is seen especially in legumes and cabbage.

Plant and animal planktons are damaged by ultra-violet radiation. In zooplanktons (microscopic animals) the breeding period is shortened by changes in radiation. As planktons form the basis of the marine food chain a change in their number and species composition influences fish and shell fish production.

Effect on materials: Increased UV radiation damages paints and fabrics, causing them to fade faster.

Effect on climate: Atmospheric changes induced by pollution contribute to global warming, a phenomenon which is caused due to the increase in concentration of certain gases like carbon dioxide, nitrogen oxides, methane and CFCs. Observations of the earth have shown beyond doubt that atmospheric constituents such as water vapour, carbon dioxide, methane, nitrogen oxides and Chloro Fluoro Carbons trap heat in the form of infra-red radiation near the earth's surface. This is known as the '**Greenhouse Effect**'. The phenomenon is similar to what happens in a greenhouse. The glass in a greenhouse allows solar radiation to enter which is absorbed by the objects inside. These objects radiate heat in the form of terrestrial radiation, which does not pass out through the glass. The heat is therefore trapped in the greenhouse increasing the temperature inside and ensuring the luxuriant growth of plants.



There could be several adverse effects of global warming.

- With a warmer earth the polar ice caps will melt causing a rise in ocean levels and flooding of coastal areas.
- In countries like Bangladesh or the Maldives this would be catastrophic. If the sea level rises by 3m., Maldives will disappear completely beneath the waves.
- The rise in temperature will bring about a fall in agricultural produce.
- Changes in the distribution of solar energy can bring about changes in habitats. A previously productive agricultural area will suffer severe droughts while rains will fall in locations that were once deserts. This could bring about changes in the species of natural plants, agricultural crops, insects, livestock and micro-organisms.
- In the polar regions temperature rises caused by global warming would have disastrous effects. Vast quantities of meth-

ane are trapped beneath the frozen soil of Alaska. When the permafrost melts the methane that will be released can accelerate the process of global warming.

Control measures for air pollution

Air pollution can be controlled by two fundamental approaches: preventive techniques and effluent control.

One of the effective means of controlling air pollution is to have proper equipment in place. This includes devices for removal of pollutants from the flue gases through scrubbers, closed collection recovery systems through which it is possible to collect the pollutants before they escape, use of dry and wet collectors, filters, electrostatic precipitators, etc. Providing a greater height to the stacks can help in facilitating the discharge of pollutants as far away from the ground as possible. Industries should be located in places so as to minimize the effects of pollution after considering the topography and the wind directions. Substitution of raw material that causes more

pollution with those that cause less pollution can be done.

Air pollution in India

The World Health Organization (WHO) which rates only mega cities of the world has rated Delhi the fourth most polluted city in the world. However compared to other cities in India, Delhi is not at the top of the list of polluted cities. Our country has several pollution hotspots. The recent release from the Central Pollution Control Board (CPCB), *Parivesh*, January 2003 states that Ahmedabad's air is most noxious followed by Kanpur, Solapur and Lucknow with small particulate levels (PM₁₀) 3-4 times the standard of 60 microgram per cubic meter (mg/m³). The report has ranked 29 cities according to Respirable Particulate Matter (RSPM) levels recorded during the year 2000. This report thus confirms the fact that Indian cities show high particulate pollution with 14 cities hitting critical levels.

Nitrogen dioxide levels in most major cities are generally close to the acceptable annual standard of 60 mg/m³. However sharp increases have been noticed in a few cities with heavy vehicular traffic and density as in a few locations in Kolkata and Delhi indicating stronger impact of traffic. The CPCB indicates vehicles as one of the predominant sources of air pollution. However the impact of hard measures implemented in Delhi over the last few years such as introduction of Euro II standards, lowering the sulphur content in fuel to 500 ppm and implementing Compressed Natural Gas program has succeeded in improving the quality of air. Rapid urbanization of smaller cities especially those situated near the big commercial centers have an enormous increase in traffic load especially in the most polluted segment such as two and three wheelers and diesel vehicles combined with poor quality fuel contribute to the deteriorating air quality in a big way.

It is alarming to note that residential locations in India are fast outpacing industrial locations in air pollution implying that vehicular fumes are responsible for this trend. The Supreme Court's order of April 5, 2002 has directed the Central Government for an action plan for other polluted cities. Absence of any local initiatives for action and delay in air pollution control measures will only make the situation worse.

The Supreme Court also played a vital role protecting the Taj Mahal. Being exposed to sulphur dioxide and suspended particulate matter, the Taj had contracted 'marble cancer', a fungal growth that corroded its surface giving it a yellowish tinge. The SPM deposits blackened it. Shri MC Mehta an environmental lawyer filed a public interest litigation in 1984 expressing concern over the havoc the polluting units in Agra were wreaking on the Taj Mahal. Twelve years later the Supreme Court ordered 292 industries in the vicinity to either adopt pollution control measures or shut down. It also made it mandatory for these units to either switch over to eco-friendly fuels like natural gas or shift out of the area.

Air quality monitoring

India does not presently have a well established system of monitoring air pollution. When air quality monitoring began in India in the late 1960s planners focused only on a few pollutants namely sulphur dioxide, nitrogen oxides and suspended particulate matter. Other pollutants such as carbon monoxide and lead were monitored only on a limited scale. The threat from other air toxins such as benzene, ozone, other small particulates is not known as these are not monitored at all. A database on ambient air quality in Indian cities has been prepared by the monitoring networks of the National Environmental Engineering Research Institute (NEERI), Nagpur. The Central Pollution Control Board (CPCB) initiated its own national Ambient Air Quality Monitoring (NAAQM) program in 1985.

Ambient air quality standards in India developed by the Central Pollution Control Board

Area Category	SPM $\mu\text{g}/\text{m}^3$	SO ₂ $\mu\text{g}/\text{m}^3$	Co $\mu\text{g}/\text{m}^3$	NO _x $\mu\text{g}/\text{m}^3$
Industrial and mixed use	500	120	5000	120
Residential and rural	200	80	2000	80
Sensitive	100	3	1000	30

Data to the NAAQM is supplied by the respective state pollution control boards, which is then transmitted to the CPCB. Experts feel that the present air quality-monitoring network cannot capture the true profile of urban air pollution due to the lack of adequate monitoring stations. Moreover critical toxins have still not been included in the list of pollutants to be monitored.

Legal aspects of air pollution control in India

The Air (Prevention and Control of Pollution) Act was legislated in 1981. The Act provided for prevention, control and abatement of air pollution. In areas notified under this Act no industrial pollution causing activity could come up without the permission of the concerned State Pollution Control Board. But this Act was not strong enough to play a precautionary or a corrective role. After the Bhopal disaster, a more comprehensive Environment Protection Act (EPA) was passed in 1986. This Act for the first time conferred enforcement agencies with necessary punitive powers to restrict any activity that can harm the environment. To regulate vehicular pollution the Central Motor Vehicles Act of 1939 was amended in 1989. Following this amendment the exhaust emission rules for vehicle owners were notified in 1990 and the mass emission standards for vehicle manufacturers were enforced in 1991 for the first time. The mass emission norms have been further revised for 2000.

Air quality management as a well-defined program has yet to emerge in India. We need a much more strengthened air quality management with continuous monitoring of air if we are to have a better quality of air. This would also need an integrated approach with strict air pollution control laws. Some of the suggestions for doing this include:

- Putting a greater emphasis on pollution prevention rather than control
- Reducing the use of fossil fuels
- Improving the quality of vehicular fuel
- Increasing the use of renewable energy

5.2.2 Water Pollution

Our liquid planet glows like a soft blue sapphire in the hard-edged darkness of space. There is nothing else like it in the solar system. It is because of water.

– John Todd

Introduction: Water is the essential element that makes life on earth possible. Without water there would be no life. We usually take water for granted. It flows from our taps when they are turned on. Most of us are able to bathe when we want to, swim when we choose and water

our gardens. Like good health we ignore water when we have it.

Although 71% of the earth's surface is covered by water only a tiny fraction of this water is available to us as fresh water. About 97% of the total water available on earth is found in oceans and is too salty for drinking or irrigation. The remaining 3% is fresh water. Of this 2.997% is locked in ice caps or glaciers. Thus only 0.003% of the earth's total volume of water is easily available to us as soil moisture, groundwater, water vapour and water in lakes, streams, rivers and wetlands.

In short if the world's water supply were only 100 litres our usable supply of fresh water would be only about 0.003 litres (one-half teaspoon). This makes water a very precious resource. The future wars in our world may well be fought over water. By the middle of this century, almost twice as many people will be trying to share the same amount of fresh water the earth has today. As freshwater becomes more scarce access to water resources will be a major factor in determining the economic growth of several countries around the world.

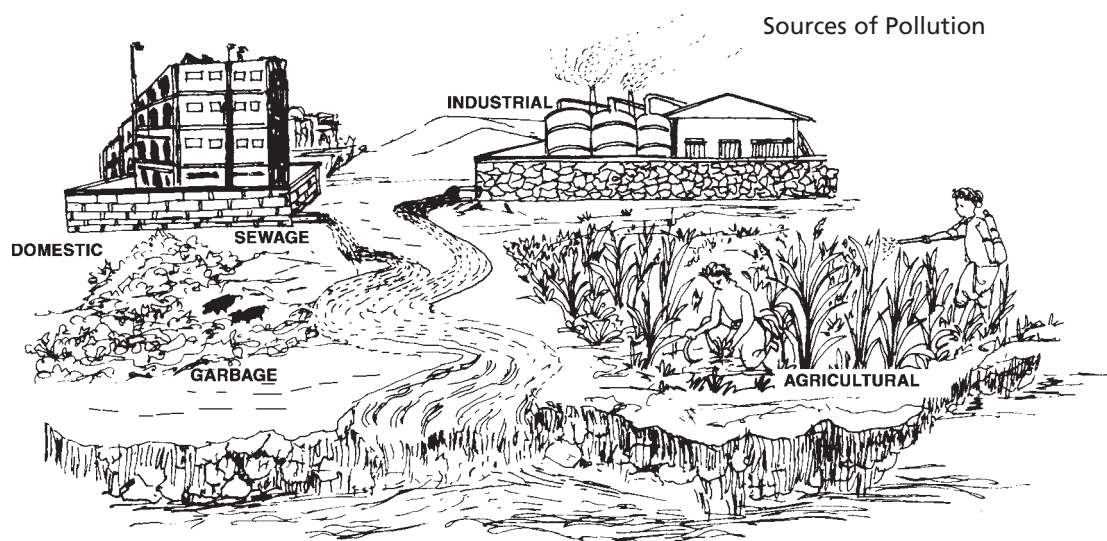
Water availability on the planet: Water that is found in streams, rivers, lakes, wetlands and artificial reservoirs is called surface water. Water that percolates into the ground and fills the pores in soil and rock is called groundwater. Porous water-saturated layers of sand, gravel or bedrock through which ground water flows are called aquifers. Most aquifers are replenished naturally by rainfall that percolates downward through the soil and rock. This process is called natural recharge. If the withdrawal rate of an aquifer exceeds its natural recharge rate, the water table is lowered. Any pollutant that is discharged onto the land above is also pulled into the aquifer and pollutes the groundwater resulting in polluted water in the nearby wells.

India receives most of her rainfall during the months of June to September due to the seasonal winds and the temperature differences between the land and the sea. These winds blow from the opposite directions in the different seasons. They blow into India from the surrounding oceans during the summer season and blow out from the subcontinent to the oceans during the winter. The monsoon in India is usually reasonably stable but varies geographically. In some years the commencement of the rains may be delayed considerably over the entire country or a part of it. The rains may also terminate earlier than usual. They may be heavier than usual over one part than over another. All these may cause local floods or drought. However in India even areas that receive adequate rainfall during the monsoon suffer from water shortages in the post monsoon period due to lack of storage facilities.

When the quality or composition of water changes directly or indirectly as a result of man's activities such that it becomes unfit for any purpose it is said to be polluted.

Point sources of pollution: When a source of pollution can be readily identified because it has a definite source and place where it enters the water it is said to come from a **point source**. Eg. Municipal and Industrial Discharge Pipes.

When a source of pollution cannot be readily identified, such as agricultural runoff, acid rain, etc, they are said to be **non-point sources** of pollution.



Causes of water pollution

There are several classes of common water pollutants. These are **disease-causing agents** (pathogens) which include bacteria, viruses, protozoa and parasitic worms that enter water from domestic sewage and untreated human and animal wastes. Human wastes contain concentrated populations of coliform bacteria such as *Escherichia coli* and *Streptococcus faecalis*. These bacteria normally grow in the large intestine of humans where they are responsible for some food digestion and for the production of vitamin K. These bacteria are not harmful in low numbers. Large amounts of human waste in water, increases the number of these bacteria which cause gastrointestinal diseases. Other potentially harmful bacteria from human wastes may also be present in smaller numbers. Thus the greater the amount of wastes in the water the greater are the chances of contracting diseases from them.

Another category of water pollutants is **oxygen depleting wastes**. These are organic wastes that can be decomposed by aerobic (oxygen requiring) bacteria. Large populations of bacteria use up the oxygen present in water to

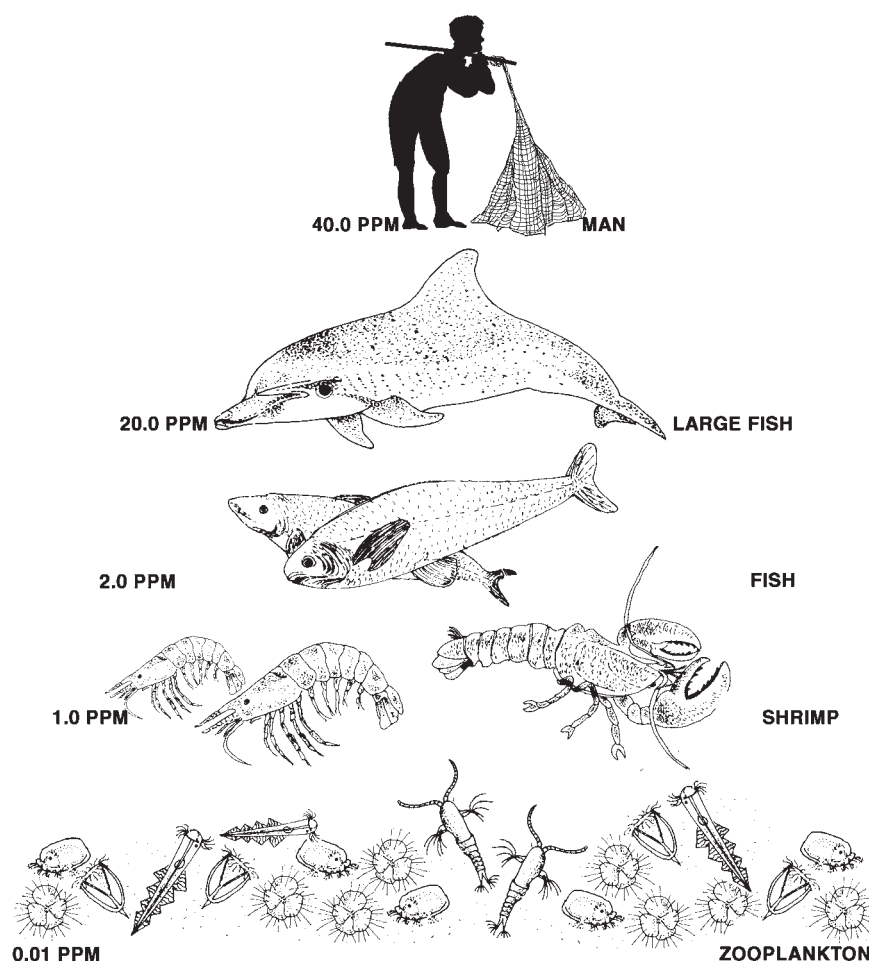
degrade these wastes. In the process this degrades water quality. The amount of oxygen required to break down a certain amount of organic matter is called the biological oxygen demand (BOD). The amount of BOD in the water is an indicator of the level of pollution. If too much organic matter is added to the water all the available oxygen is used up. This causes fish and other forms of oxygen dependent aquatic life to die. Thus anaerobic bacteria (those that do not require oxygen) begin to break down the wastes. Their anaerobic respiration produces chemicals that have a foul odour and an unpleasant taste that is harmful to human health.

A third class of pollutants are **inorganic plant nutrients**. These are water soluble nitrates and phosphates that cause excessive growth of algae and other aquatic plants. The excessive growth of algae and aquatic plants due to added nutrients is called eutrophication. They may interfere with the use of the water by clogging water intake pipes, changing the taste and odour of water and cause a buildup of organic matter. As the organic matter decays, oxygen levels decrease and fish and other aquatic species die.

The quantity of fertilizers applied in a field is often many times more than is actually required by the plants. The chemicals in fertilizers and pesticides pollute soil and water. While excess fertilizers cause eutrophication, pesticides cause bioaccumulation and biomagnification. Pesticides which enter water bodies are introduced into the aquatic food chain. They are then absorbed by the phytoplanktons and aquatic plants. These plants are eaten by the herbivorous fish which are in turn eaten by the carnivorous fish which are in turn eaten by the water birds. At each link in the food chain these chemicals which do not pass out of the body are accumulated and increasingly concentrated resulting in biomagnification of these harmful substances.

One of the effects of accumulation of high levels of pesticides such as DDT is that birds lay eggs with shells that are much thinner than normal. This results in the premature breaking of these eggs, killing the chicks inside. Birds of prey such as hawks, eagles and other fish eating birds are affected by such pollution. Although DDT has been banned in India for agricultural use and is to be used only for malaria eradication, it is still used in the fields as it is cheap.

A fourth class of water pollutants is **water soluble inorganic chemicals** which are acids, salts and compounds of toxic metals such as mercury and lead. High levels of these chemicals can make the water unfit to drink, harm



fish and other aquatic life, reduce crop yields and accelerate corrosion of equipment that use this water.

Another cause of water pollution is a variety of **organic chemicals**, which include oil, gasoline, plastics, pesticides, cleaning solvents, detergent and many other chemicals. These are harmful to aquatic life and human health. They get into the water directly from industrial activity either from improper handling of the chemicals in industries and more often from improper and illegal disposal of chemical wastes.

Sediment of suspended matter is another class of water pollutants. These are insoluble particles of soil and other solids that become suspended in water. This occurs when soil is eroded from the land. High levels of soil particles suspended in water, interferes with the penetration of sunlight. This reduces the photosynthetic activity of aquatic plants and algae disrupting the ecological balance of the aquatic bodies. When the velocity of water in streams and rivers decreases the suspended particles settle down at the bottom as sediments. Excessive sediments that settle down destroys feeding and spawning grounds of fish, clogs and fills lakes, artificial reservoirs etc.

Water soluble radioactive isotopes are yet another source of water pollution. These can be concentrated in various tissues and organs as they pass through food chains and food webs. Ionizing radiation emitted by such isotopes can cause birth defects, cancer and genetic damage.

Hot water let out by power plants and industries that use large volumes of water to cool the plant result in rise in temperature of the local water bodies. Thermal pollution occurs when industry returns the heated water to a water source. Power plants heat water to convert it into steam, to drive the turbines that generate electricity. For efficient functioning of the steam

turbines, the steam is condensed into water after it leaves the turbines. This condensation is done by taking water from a water body to absorb the heat. This heated water, which is at least 15°C higher than the normal is discharged back into the water body. The warm water not only decreases the solubility of oxygen but changes the breeding cycles of various aquatic organisms.

Oil is washed into surface water in runoff from roads and parking lots which also pollutes groundwater. Leakage from underground tanks

CASE STUDY

One of the worst oil spill disasters that have occurred is that of the Exxon Valdez. On 24th march 1989 the Exxon Valdez, a tanker more than three football fields wide went off course in a 16 kilometer wide channel in Prince William Sound near Valdez in Alaska. It hit submerged rocks, creating an environmental disaster. The rapidly spreading oil slick coated more than 1600 kilometers of shoreline killing between 300,000 and 645,000 water birds and a large number of sea otters, harbor seals, whales and fishes. Exxon spent \$ 2.2. billion directly on the clean-up operations. However some results of the cleanup effort showed that where high pressure jets of hot water were used to clean beaches coastal plants and animals that had survived the spill were killed. Thus it did more harm than good. Exxon pleaded guilty in 1991 and agreed to pay the Federal Government and the state of Alaska \$ 1 billion in fines and civil damages. This \$8.5 billion accident might have been prevented if Exxon had spent only \$22.5 million to fit the tanker with a double hull-one inside the other. Such double hulled vessels would be less likely to rupture and spill their contents. The spill highlighted the need for marine pollution prevention.

is another source of pollution. Accidental oil spills from large transport tankers at sea have been causing significant environmental damage.

Though accidents such as the *Exxon Valdez* get worldwide attention, much more oil is released as a result of small, regular releases from other less visible sources. Nearly two thirds of all marine oil pollution comes from three sources: run-off from streets, improper discharge of lubricating oil from machines or automobile crankcases and intentional oil discharges that occur during the loading and unloading of tankers. Oil tankers often use sea water as ballast to stabilize the ship after they have discharged their oil. This oil contaminated water is then discharged back into the sea when the tanker is refilled.

Groundwater pollution: While oil spills are highly visible and often get a lot of media attention, a much greater threat to human life comes from our groundwater being polluted which is used for drinking and irrigation. While groundwater is easy to deplete and pollute it gets renewed very slowly and hence must be used judiciously. Groundwater flows are slow and not turbulent hence the contaminants are not effectively diluted and dispersed as compared to surface water. Moreover pumping groundwater and treating it is very slow and costly. Hence it is extremely essential to prevent the pollution of groundwater in the first place. Ground water is polluted due to:

- Urban run-off of untreated or poorly treated waste water and garbage
- Industrial waste storage located above or near aquifers
- Agricultural practices such as the application of large amounts of fertilizers and pesticides, animal feeding operations, etc. in the rural sector

- Leakage from underground storage tanks containing gasoline and other hazardous substances
- Leachate from landfills
- Poorly designed and inadequately maintained septic tanks
- Mining wastes

Severe cases of arsenic poisoning from contaminated groundwater have been reported from West Bengal in what is known today as the worst case of groundwater pollution. The School of Environmental Sciences, Jadavpur University, West Bengal has been involved in the task of surveying the magnitude of the arsenic problem in West Bengal for the last fourteen years. According to a report in the *Down to Earth* (Vol. 11, No.22), arsenic poisoning was first noticed by K C Saha, former professor of dermatology at the School of Tropical Medicine, Kolkata when he began to receive patients with skin lesions that resembled the symptoms of leprosy which was in reality not leprosy. Since all the patients were from the district of 24-Parganas, Saha along with others began to look for the cause and found it to be arsenic toxicity. Thus groundwater arsenic contamination in West Bengal was first reported in a local daily newspaper in December 1983 when 63 people from three villages located in different districts were identified by health officials as suffering from arsenic poisoning.

There are two theories that have been put forth to explain this unusually high content of arsenic in groundwater. One group of researchers suggested that the cause is natural while the other stated that the cause is man-made.

According to the first hypothesis, arsenic probably originates in the Himalayan headwaters of the Ganga and the Brahmaputra rivers and has been lying undisturbed beneath the surface of

the region's deltas for thousands of years in the thick layers of fine alluvial mud across the banks of these rivers. Most of the arsenic affected areas of West Bengal lie in the alluvial plains formed in the quaternary period (last 1.6 million years). The Purulia district of West Bengal is part of the extensive area of the Precambrian era (last 570 million year) having metamorphic rocks and granites with widespread sulphide mineralisation. Researchers from the UK based British Geological Survey (BGS) suggested that their position close to where the river Ganga enters Bangladesh (geologically) may be the primary source of arsenic in the Bengal alluvium. According to David Kinniburgh project leader with BGS the main factor is time. The mud in these areas is thicker, wider and flatter than almost anywhere else on earth. It can thus take hundreds or thousands of years for underground water to percolate through the mud before reaching the sea and thus it absorbs arsenic for a long period.

Other researchers feel that the excess amount of arsenic in groundwater can be contributed to by the high rate of groundwater extraction. Their hypothesis called the pyrite oxidation thesis describes how arsenic can get mobilized in the groundwater. In this hypothesis arsenic is assumed to be present in certain minerals (pyrites) that are deposited within the aquifer sediments. Due to the lowering of the water table below the deposits, arseno-pyrite which is oxidized in a zone of the aquifer called the Vadose zone releases arsenic as arsenic adsorbed on iron hydroxide. During the subsequent recharge period, iron hydroxide releases arsenic into groundwater. This theory is supported by two arguments. The first is the intensive irrigation development in West Bengal using deep tube wells and shallow tube wells. This method of extraction, which was exactly in the 20m to 100m below ground level ensured, increased contribution of groundwater to irrigation. The other argument that supports the pyrite oxidation theory is that prior to irrigation develop-

ment and drinking water supply schemes based on groundwater there were no reported cases of arsenic poisoning.

Arsenicosis or arsenic toxicity develops after two to five years of exposure to arsenic contaminated drinking water depending on the amount of water consumption and the arsenic concentration in water. Initially the skin begins to darken (called diffuse melanosis) which later leads to spotted melanosis when darkened spots begin to appear on the chest, back and limbs. At a later stage leucomelanosis sets in and the body begins to show black and white spots. In the middle stage of arsenicosis the skin in parts becomes hard and fibrous. Rough, dry skin with nodules on hands or the soles of feet indicate severe toxicity. This can lead to the formation of gangrene and cancer. Arsenic poisoning brings with it other complications such as liver and spleen enlargement, cirrhosis of the liver, diabetes, goiter and skin cancers.

The state of India's rivers

India has always had a tradition of worshipping rivers. Most of the rivers in India are named after gods, goddesses or saints. However a large majority of the Indian population including those who worship the rivers do not think twice before polluting a river. Urbanization, industrialization, excess withdrawal of water, agricultural run-off, improper agricultural practices and various religious and social practices all contribute to river pollution in India. Every single river in India be it the Ganga, Yamuna, Cauvery or the Krishna have their own share of problems due to pollution. Waters from the Ganga and the Yamuna are drawn for irrigation through the network of canals as soon as these rivers reach the plains reducing the amount of water that flows downstream. What flows in the river is water from small nalas, and streams that carry with them sewage and industrial effluents. The residual freshwater, is unable to dilute the pol-

lutants and the rivers turn into stinking sewers. In spite of data from scientifically competent studies conducted by the Central Pollution Control Board (CPCB), the Government has not been able to tackle this issue. Sewage and municipal effluents account for 75% of the pollution load in rivers while the remaining 25% is from industrial effluents and non-point pollution sources.

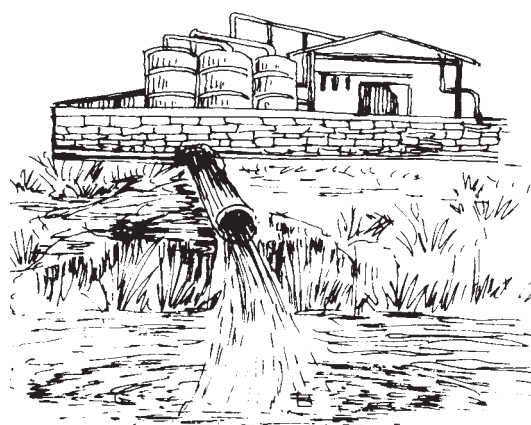
In 1985, India launched the Ganga Action plan (GAP) the largest ever river clean-up operation in the country. The plan has been criticized for, overspending and slow progress. The GAP Phase II in 1991 included cleaning operations for the tributaries of the Ganga, ie; the Yamuna, Gomti and the Damodar. Thus the Yamuna Action Plan (YAP), Gomti Action Plan and the Damodar Action plan were added.

In 1995 the National River Conservation plan was launched. Under this all the rivers in India were taken up for clean-up operations. In most of these plans, attempts have been made to tap drains, divert sewage to sewage treatment plants before letting out the sewage into the rivers. The biggest drawback of these river cleaning programs was that they failed to pin responsibilities as to who would pay for running the treatment facilities in the long run. With the power supply being erratic and these plants being heavily dependent on power, most of these facilities lie underutilized. Moreover the problem of river pollution due to agricultural run-off has not been addressed in these programs. NRCP is scheduled to be completed by March 2005. The approved cost for the plan is Rs. 772.08 crores covering 18 rivers in 10 states including 46 towns. The cost is borne entirely by the Central Government and the Ministry of Environment and Forests is the nodal agency that co-ordinates and monitors the plan. Under this plan the major activities include treating the pollution load from sewer systems of towns and cities, setting up of Sewage treatment plants, electric crematoria, low cost sanitation facilities,

riverfront development, afforestation and solid waste management.

Control measures for preventing water pollution

While the foremost necessity is prevention, setting up effluent treatment plants and treating waste through these can reduce the pollution load in the recipient water. The treated effluent can be reused for either gardening or cooling purposes wherever possible. A few years ago a new technology called the Root Zone Process has been developed by Thermax. This system involves running contaminated water through the root zones of specially designed reed beds. The reeds, which are essentially wetland plants have the capacity to absorb oxygen from the surrounding air through their stomatal openings. The oxygen is pushed through the porous stem of the reeds into the hollow roots where it enters the root zone and creates conditions suitable for the growth of numerous bacteria and fungi. These micro-organisms oxidize impurities in the wastewaters, so that the water which finally comes out is clean.



Water Pollution

5.2.3 Soil Pollution

Introduction: We can no more manufacture a soil with a tank of chemicals than we can invent a rain forest or produce a single bird. We may enhance the soil by helping its processes along, but we can never recreate what we destroy. The soil is a resource for which there is no substitute. (Environmental historian Donald Worster reminds us that fertilizers are not a substitute for fertile soil).

Soil is a thin covering over the land consisting of a mixture of minerals, organic material, living organisms, air and water that together support the growth of plant life. Several factors contribute to the formation of soil from the parent material. This includes mechanical weathering of rocks due to temperature changes and abrasion, wind, moving water, glaciers, chemical weathering activities and lichens. Climate and time are also important in the development of soils. Extremely dry or cold climates develop soils very slowly while humid and warm climates develop them more rapidly. Under ideal climatic conditions soft parent material may develop into a centimeter of soil within 15 years. Under poor climatic conditions a hard parent material may require hundreds of years to develop into soil.

Mature soils are arranged in a series of zones called soil horizons. Each horizon has a distinct texture and composition that varies with different types of soils. A cross sectional view of the horizons in a soil is called a soil profile.

The top layer or the surface litter layer called the O horizon consists mostly of freshly fallen and partially decomposed leaves, twigs, animal waste, fungi and other organic materials. Normally it is brown or black.

The uppermost layer of the soil called the A horizon consists of partially decomposed organic matter (humus) and some inorganic mineral particles. It is usually darker and looser than the

deeper layers. The roots of most plants are found in these two upper layers. As long as these layers are anchored by vegetation soil stores water and releases it in a trickle throughout the year instead of in a force like a flood. These two top layers also contain a large amount of bacteria, fungi, earthworms and other small insects that form complex food webs in the soil that help recycle soil nutrients and contribute to soil fertility.

The B horizon often called the subsoil contains less organic material and fewer organisms than the A horizon. The area below the subsoil is called the C horizon and consists of weathered parent material. This parent material does not contain any organic materials. The chemical composition of the C-horizon helps to determine the pH of the soil and also influences the soil's rate of water absorption and retention.

Soils vary in their content of clay (very fine particles), silt (fine particles), sand (medium size particles) and gravel (coarse to very coarse particles). The relative amounts of the different sizes and types of mineral particles determine soil texture. Soils with approximately equal mixtures of clay, sand, silt and humus are called loams.

Causes of soil degradation

Erosion

Soil erosion can be defined as the movement of surface litter and topsoil from one place to another. While erosion is a natural process often caused by wind and flowing water it is greatly accelerated by human activities such as farming, construction, overgrazing by livestock, burning of grass cover and deforestation.

Loss of the topsoil makes a soil less fertile and reduces its water holding capacity. The topsoil, which is washed away, also contributes to water pollution clogging lakes, increasing turbidity of the water and also leads to loss of aquatic

life. For one inch of topsoil to be formed it normally requires 200-1000 years depending upon the climate and soil type. Thus if the topsoil erodes faster than it is formed the soil becomes a non-renewable resource.

Thus it is essential that proper soil conservation measures are used to minimize the loss of top soil. There are several techniques that can protect soil from erosion. Today both water and soil are conserved through integrated treatment methods. Some of the most commonly employed methods include the two types of treatment that are generally used.

- Area treatment which involves treating the land
- Drainage line treatment which involves treating the natural water courses (nalas)

Continuous contour trenches can be used to enhance infiltration of water reduce the run-off and check soil erosion. These are actually shallow trenches dug across the slope of the land and along the contour lines basically for

the purpose of soil and water conservation. They are most effective on gentle slopes and in areas of low to medium rainfall. These bunds are stabilized by fast growing tree species and grasses. In areas of steep slopes where the bunds are not possible, continuous contour benches (CCBs) made of stones are used for the same purpose.

Gradonies can also be used to convert wastelands into agricultural lands. In this narrow trenches with bunds on the downstream side are built along contours in the upper reaches of the catchment to collect run-off and to conserve moisture from the trees or tree crops. The area between the two bunds is use for cultivation of crops after development of fertile soil cover.

Some of the ways in which this can be achieved are:

Live check dams which barriers created by planting grass, shrubs and trees across the gullies can be used for this purpose.

A **bund constructed out of stones** across the stream can also be used for conserving soil and water.

Area Treatment

Purpose	Treatment Measure	Effect
Reduces the impact of rain drops on the soil	Develop vegetative cover on the non arable land	Minimum disturbance and displacement of soil particles
Infiltration of water where it falls	Apply water infiltration measures on the area	In situ soil and moisture conservation
Minimum surface run off	Store surplus rain water by constructing bunds, ponds in the area	Increased soil moisture in the area, facilitate ground water recharge
Ridge to valley sequencing	Treat the upper catchment first and then proceed towards the outlet	Economically viable, less risk of damage and longer life of structures of the lower catchments

Drainage line treatment

Purpose	Treatment measure	Effect
Stop further deepening of gullies and retain sediment run-off	Plug the gullies at formation	Stops erosion, recharges groundwater at the upper level.
Reduce run-off velocity, pass cleaner water to the downstream side	Crate temporary barriers in nalas	Delayed flow and increased groundwater recharge
Minimum sedimentation in the storage basins	Use various methods to treat the catchments	
Low construction cost	Use local material and skills for constructing the structures	Structures are locally maintained

An Earthen checkbund is constructed out of local soil across the stream to check soil erosion and flow of water.

A **Gabion structure** is a bund constructed of stone and wrapped in galvanized chainlink.

A Gabion structure with ferrocement impervious barrier has a one inch thick impervious wall of ferrocement at the center of the structure which goes below the ground level upto the hard strata. This ferrocement partition supported by the gabion portion is able to retain the water and withstand the force of the runoff water.

An Underground bandhara is an underground structure across a nalla bed to function as a barrier to check the ground water movement.

Excess use of fertilizers: Approximately 25 percent of the world's crop yield is estimated to be directly attributed to the use of chemical fertilizers. The use of chemical fertilizes has increased significantly over the last few decades

and is expected to rise even higher. Fertilizers are very valuable as they replace the soil nutrients used up by plants. The three primary soil nutrients often in short supply are potassium, phosphorus and nitrogen compounds. These are commonly referred to as macronutrients. Certain other elements like boron, zinc and manganese are necessary in extremely small amounts and are known as micronutrients. When crops are harvested a large amount of macronutrients and a small amount of micronutrients are removed with the crops. If the same crop is grown again depleted levels of thee nutrients can result in decreased yields. These necessary nutrients can be returned to the soil through the application of fertilizers. In addition to fertilizers a large amount of pesticides (chemicals used to kill or control populations of unwanted fungi, animals or plants often called pests) are also used to ensure a good yield. Pesticides can be subdivided into several categories based on the kinds of organisms they are used to control. *Insecticides* are used to control insect populations while *fungicides* are used to control unwanted fungal growth. Mice and rats are killed by *rodenticides* while plant pests are controlled by *herbicides*.

Problems with pesticide use

Pesticides not only kill the pests but also a large variety of living things including humans. They may be persistent or non-persistent. Persistent pesticides once applied are effective for a long time. However as they do not break down easily they tend to accumulate in the soil and in the bodies of animals in the food chain.

For example, DDT which was one of the first synthetic organic insecticide to be used was thought to be the perfect insecticide. During the first ten years of its use (1942-1952) DDT is estimated to have saved about five million lives primarily because of its use to control disease carrying mosquitoes. However after a period of use many mosquitoes and insects became tolerant of DDT, thus making it lose its effectiveness. DDT in temperate regions of the world has a half life (the amount of time required for half of the chemical to decompose) of 10 to 15 years. This means that if 100 kilograms of DDT were to be sprayed over an area, 50 kilograms would still be present in the area 10 to 15 years later. The half-life of DDT varies according to the soil type, temperature, kind of soil organisms present and other factors. In tropical parts of the world the half life may be as short as six months. The use of DDT has been banned in some countries. India still however permits the use of DDT though for purposes of mosquito control only. Persistent pesticides become attached to small soil particles which are easily moved by wind and water to different parts thus affecting soils elsewhere. Persistent pesticides may also accumulate in the bodies of animals, and over a period of time increase in concentration if the animal is unable to flush them out of its system thus leading to the phenomenon called bioaccumulation. When an affected animal is eaten by another carnivore these pesticides are further concentrated in the body of the carnivore. This phenomenon of acquiring increasing levels of a substance in the bodies of higher trophic level organisms is known as biomagnification. This process especially in the

case of insecticides like DDT have been proved to be disastrous. DDT is a well known case of biomagnification in ecosystems. DDT interferes with the production of normal eggshells in birds making them fragile.

Other problems associated with insecticides is the ability of insect populations to become resistant to them thus rendering them useless in a couple of generations. Most pesticides kill beneficial as well as pest species. They kill the predator as well as the parasitic insects that control the pests. Thus the pest species increase rapidly following the use of a pesticide as there are no natural checks to their population growth. The short term and the long-term health effects to the persons using the pesticide and the public that consumes the food grown by using the pesticides are also major concerns. Exposure to small quantities of pesticides over several years can cause mutations, produce cancers, etc.

Thus the question that comes to mind is that if pesticides have so many drawbacks then why are they used so extensively and what are the substitutes for them? There are three main reasons for the use of pesticides. Firstly the use of pesticides in the short term has increased the amount of food that can be grown in many parts of the world as the damage by pests is decreased. The second reason for its extensive use is based on an economic consideration. The increased yields more than compensates the farmer for cost of pesticides. Thirdly current health problems especially in developing countries due to mosquitoes are impossible to control without insecticides.

However more and more farmers are increasingly opting to replace chemical fertilizers and use different methods of controlling pests without affecting their yield. Thus several different approaches that have slightly varying and overlapping goals have been developed. Alternative agriculture is the broadest term that is used that includes all non-traditional agricultural methods

and encompasses sustainable agriculture, organic agriculture, alternative uses of traditional crops, alternative methods for raising crops, etc.

Sustainable agriculture advocates the use of methods to produce adequate safe food in an economically viable manner while maintaining the state of the ecosystem. Organic agriculture advocates avoiding the use of chemical fertilizers and pesticides. A wide variety of techniques can be used to reduce this negative impact of agriculture. Leaving crop residue on the soil and incorporating it into the soil reduces erosion and increase soil organic matter. Introduction of organic matter into the soil also makes compaction less likely. Crop rotation is an effective way to enhance soil fertility, reduce erosion and control pests. There have been arguments both for and against organic farming. Critics argue that organic farming cannot produce the amount of food required for today's population and it is economically viable only in certain conditions. However supporters for organic farming feel that if the hidden costs of soil erosion and pollution are taken into account it is a viable approach. Besides organic farmers do not have to spend on fertilizers and pesticides and also get a premium price for their products thus making it financially viable for them.

Another way to reduce these impacts is through the use of *integrated pest management*. This is a technique that uses a complete understanding of all ecological aspects of a crop and the particular pests to which it is susceptible to establish pest control strategies that uses no or few pesticides. IPM promotes the use of biopesticides. Biopesticides are derived from three sources: microbial, botanical and biochemical. Microbial pesticides are micro-organisms such as bacteria, fungus, virus or protozoa that fight pests through a variety of ways. They produce toxins specific to the pests and produce diseases in them. Biochemical pesticides contain several chemicals that affect the reproductive and digestive mechanisms of the pests. The most

commonly used biopesticides are *Bacillus thuringiensis* (Bt), neem (*Azadirachta indica*) and trichogramma. Although they are available in the market they are yet to become market favourites.

Excess salts and water

Irrigated lands can produce crop yields much higher than those that only use rainwater. However this has its own set of ill effects. Irrigation water contains dissolved salts and in dry climates much of the water in the saline solution evaporates leaving its salts such as sodium chloride in the topsoil. The accumulation of these salts is called salinization, which can stunt plant growth, lower yields and eventually kill the crop and render the land useless for agriculture. These salts can be flushed out of the soil by using more water. This practice however increases the cost of crop production and also wastes enormous amounts of water. Flushing salts can also make the downstream irrigation water saltier.

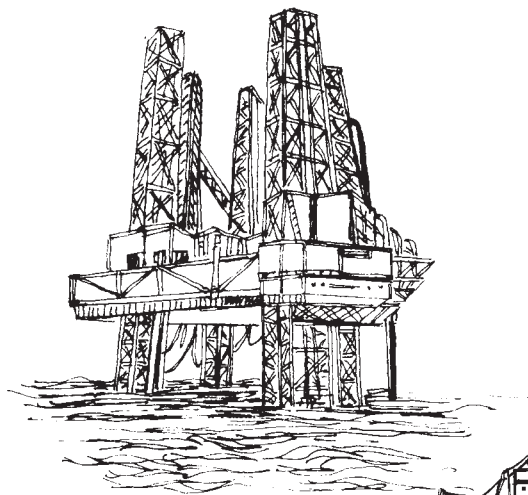
Another problem with irrigation is water logging. This occurs when large amounts of water is used to leach the salts deeper into the soil. However if the drainage is poor this water accumulates underground gradually raising the water table. The roots of the plants then get enveloped in this saline water and eventually die.

Thus in the long run it is better for us to adopt sustainable farming practices so as to prevent the degradation of soil.

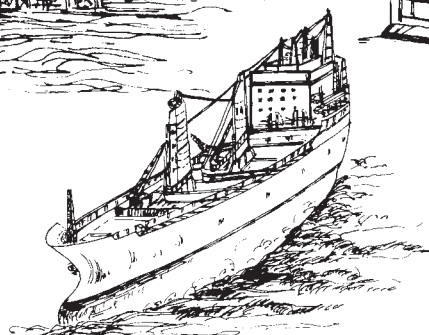
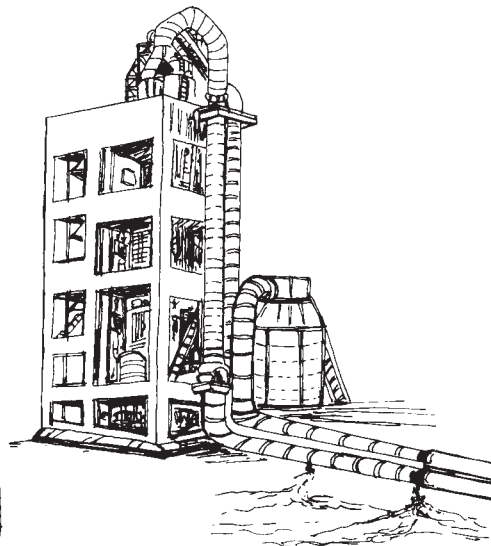
5.2.4 Marine Pollution

Marine pollution can be defined as the introduction of substances to the marine environment directly or indirectly by man resulting in adverse effects such as hazards to human health, obstruction of marine activities and lowering the quality of sea water. While the causes of ma-

SPILLAGE FROM OIL RIGS



SPILLAGE FROM OIL PIPELINES



SPILLAGE FROM TANKERS

rine pollution may be similar to that of general water pollution there are some very specific causes that pollute marine waters.

- The most obvious inputs of waste is through pipes directly discharging wastes into the sea. Very often municipal waste and sewage from residences and hotels in coastal towns are directly discharged into the sea.
- Pesticides and fertilizers from agriculture which are washed off the land by rain, enter water courses and eventually reach the sea.
- Petroleum and oils washed off from the roads normally enter the sewage system but stormwater overflows carry these materials into rivers and eventually into the seas.
- Ships carry many toxic substances such as oil, liquefied natural gas, pesticides, industrial chemicals, etc. in huge quantities sometimes to the capacity of 350,000 tonnes. Ship accidents and accidental spillages at sea therefore can be very damaging to the marine environment. Shipping channels in estuaries and at the entrances to ports often require frequent dredging to keep them open. This dredged material that may contain heavy metals and other contaminants are often dumped out to sea.
- Offshore oil exploration and extraction also pollute the seawater to a large extent.

Pollution due to organic wastes

The amount of oxygen dissolved in the water is vital for the plants and animals living in it. Wastes, which directly or indirectly affect the oxygen concentration, play an important role in determining the quality of the water. Normally the greatest volume of waste discharged to watercourses, estuaries and the sea is sewage, which is primarily organic in nature and is degraded by bacterial activity. Using the oxygen present in the water these wastes are broken down into stable inorganic compounds. However as a result of this bacterial activity the oxygen concentration in the water is reduced. When the oxygen concentration falls below 1.5 mg/lit, the rate of aerobic oxidation is reduced and their place is taken over by the anaerobic bacteria that can oxidize the organic molecules without the use of oxygen. This results in end products such as hydrogen sulphide, ammonia and methane, which are toxic to many organisms. This process results in the formation of an anoxic zone which is low in its oxygen content from which most life disappears except for anaerobic bacteria, fungi, yeasts and some protozoa. This makes the water foul smelling.

Control measures: One way of reducing the pollution load on marine waters is through the introduction of sewage treatment plants. This will reduce the biological oxygen demand (BOD) of the final product before it is discharged to the receiving waters.

Various stages of treatment such as primary, secondary or advanced can be used depending on the quality of the effluent that is required to be treated.

Primary treatment: These treatment plants use physical processes such as screening and sedimentation to remove pollutants that will settle, float or, that are too large to pass through simple screening devices. This includes, stones, sticks, rags, and all such material that can clog pipes. A *screen* consists of parallel bars spaced 2 to 7cms apart followed by a wire mesh with smaller

openings. One way of avoiding the problem of disposal of materials collected on the screens is to use a device called a comminuter which grinds the coarse material into small pieces that can then be left in the waste water. After screening the wastewater passes into a *grit chamber*. The detention time is chosen to be long enough to allow lighter, organic material to settle. From the grit chamber the sewage passes into a *primary settling tank* (also called as sedimentation tank) where the flow speed is reduced sufficiently to allow most of the suspended solids to settle out by gravity. If the waste is to undergo only primary treatment it is then chlorinated to destroy bacteria and control odours after which the effluent is released. Primary treatment normally removes about 35 percent of the BOD and 60 percent of the suspended solids.

Secondary treatment: The main objective of secondary treatment is to remove most of the BOD. There are three commonly used approaches: trickling filters, activated sludge process and oxidation ponds. Secondary treatment can remove at least 85 percent of the BOD.

A *trickling filter* consists of a rotating distribution arm that sprays liquid wastewater over a circular bed of 'fist size' rocks or other coarse materials. The spaces between the rocks allow air to circulate easily so that aerobic conditions can be maintained. The individual rocks in the bed are covered with a layer of slime, which consists of bacteria, fungi, algae, etc. which degrade the waste trickling through the bed. This slime periodically slides off individual rocks and is collected at the bottom of the filter along with the treated wastewater and is then passed on to the secondary settling tank where it is removed.

In the *activated sludge process* the sewage is pumped into a large tank and mixed for several hours with bacteria rich sludge and air bubbles to facilitate degradation by micro-organisms. The water then goes into a sedimentation tank

where most of the microorganisms settle out as sludge. This sludge is then broken down in an anaerobic digester where methane-forming bacteria slowly convert the organic matter into carbon dioxide, methane and other stable end products. The gas produced in the digester is 60 percent methane, which is a valuable fuel and can be put to many uses within the treatment plant itself. The digested sludge, which is still liquid, is normally pumped out onto sludge drying beds where evaporation and seepage remove the water. This dried sludge is potentially a good source of manure. Activated sludge tanks use less land area than trickling filters with equivalent performance. They are also less expensive to construct than trickling filters and have fewer problems with flies and odour and can also achieve higher rates of BOD removal. Thus although the operating costs are a little higher due to the expenses incurred on energy for running pumps and blowers they are preferred over trickling filters.

Oxidation ponds are large shallow ponds approximately 1 to 2 metres deep where raw or partially treated sewage is decomposed by microorganisms. They are easy to build and manage and accommodate large fluctuations in flow and can provide treatment at a much lower cost. They however require a large amount of land and hence can be used where land is not a limitation.

Advanced sewage treatment: This involves a series of chemical and physical process that removes specific pollutants left in the water after primary and secondary treatment. Sewage treatment plant effluents contain nitrates and phosphates in large amounts. These contribute to eutrophication. Thus advanced treatment plants are designed to specifically remove these contaminants. Advanced treatment plants are very expensive to build and operate and hence are rarely used.

Pollution due to oil: Oil pollution of the sea normally attracts the greatest attention because of its visibility. There are several sources though which the oil can reach the sea.

Tanker operations

Half the world production of crude oil which is close to three billion tones a year is transported by sea. After a tanker has unloaded its cargo of oil it has to take on seawater as ballast for the return journey. This ballast water is stored in the cargo compartments that previously contained the oil. During the unloading of the cargo a certain amount of oil remains clinging to the walls of the container and this may amount to 800 tonnes in a 200,000 tonne tanker. The ballast water thus becomes contaminated with this oil. When a fresh cargo of oil is to be loaded, these compartments are cleaned with water, which discharges the dirty ballast along with the oil into the sea. Two techniques have substantially reduced this oil pollution. In the *load-on-top* system, the compartments are cleaned by high pressure jets of water. The oily water is retained in the compartment until the oil floats to the top. The water underneath that contains only a little oil is then discharged into the sea and the oil is transferred to a slop tank. At the loading terminal, fresh oil is loaded on top of the oil in the tank and hence the name of the technique. In the second method called '*crude oil washing*', the clingage is removed by jets of crude oil while the cargo is being unloaded. Some modern tankers have *segregated ballast* where the ballast water does not come in contact with the oil. Thus with the introduction of these new methods of deballasting, the amount of oil entering the sea has been considerably reduced.

Dry docking

All ships need periodic dry docking for servicing, repairs, cleaning the hull, etc. During this period when the cargo compartments are to

completely emptied, residual oil finds its way into the sea.

Bilge and fuel oils

As ballast tanks take up valuable space, additional ballast is sometimes carried in empty fuel tanks. While being pumped overboard it carries oil into the sea. Individually the quantity of oil released may be small but it becomes a considerable amount when all the shipping operations are taken into consideration.

Tanker accidents

A large number of oil tanker accidents happen every year. Sometimes this can result in major disasters such as that of the Exxon Valdez described in the section on water pollution.

Offshore oil production

Oil that is extracted from the seabed contains some water. Even after it is passed through oil separators the water that is discharged contains some oil, which adds to marine pollution. Drilling muds which are pumped down oil wells when it is being drilled normally contain 70 to 80 percent of oil. They are dumped on the seabed beneath the platform thus heavily contaminating the water. Uncontrolled release of oil from the wells can be catastrophic events resulting in oil pollution.

Control measures for oil pollution: Cleaning oil from surface waters and contaminated beaches is a time consuming labour intensive process. The natural process of emulsification of oil in the water can be accelerated through the use of *chemical dispersants* which can be sprayed on the oil. A variety of *slick-lickers* in which a continuous belt of absorbent material dips through the oil slick and is passed through rollers to extract the oil have been designed. Rocks, harbour walls can be cleaned with high-

pressure steam or dispersants after which the surface must be hosed down.

Effects of marine pollution: Apart from causing eutrophication a large amount of organic wastes can also result in the development of red tides. These are phytoplankton blooms of such intensity that the area is discolored. Many important commercially important marine species are also killed due to clogging of gills or other structures.

When liquid oil is spilled on the sea it spreads over the surface of the water to form a thin film called an *oil slick*. The rate of spreading and the thickness of the film depends on the sea temperature and the nature of the oil.

Oil slicks damage marine life to a large extent. Salt marshes, mangrove swamps are likely to trap oil and the plants, which form the basis for these ecosystems thus suffer. For salt marsh plants, oil slicks can affect the flowering, fruiting and germination.

If liquid oil contaminates a bird's plumage its water repellent properties are lost. Water thus penetrates the plumage and displaces the air trapped between the feathers and the skin. This air layer is necessary as it provides buoyancy and thermal insulation. With this loss the plumage becomes water logged and the birds may sink and drown. Even if this does not happen loss of thermal insulation results in exhaustion of food reserves in an attempt to maintain body temperature often followed by death. Birds often clean their plumage by preening and in the process consume oil which depending on its toxicity can lead to intestinal, renal or liver failure.

Drill cuttings dumped on the seabed create anoxic conditions and result in the production of toxic sulphides in the bottom sediment thus eliminating the benthic fauna.

Fish and shellfish production facilities can also be affected by oil slicks. The most important commercial damage can however also come from tainting which imparts an unpleasant flavour to fish and seafood and is detectable at extremely low levels of contamination. This reduces the market value of seafood.

5.2.5 Noise Pollution

Noise may not seem as harmful as the contamination of air or water but it is a pollution problem that affects human health and can contribute to a general deterioration of environmental quality.

Noise is undesirable and unwanted sound. Not all sound is noise. What may be considered as music to one person may be noise to another. It is not a substance that can accumulate in the environment like most other pollutants. Sound is measured in a unit called the 'Decibel'.

There are several sources of noise pollution that contribute to both indoor and outdoor noise pollution. Noise emanating from factories, vehicles, playing of loudspeakers during various festivals can contribute to outdoor noise pollution while loudly played radio or music systems, and other electronic gadgets can contribute to indoor noise pollution. A study conducted by researchers from the New Delhi based National Physical Laboratory show that noise generated by firecrackers (presently available in the market) is much higher than the prescribed levels. The permitted noise level is 125 decibels, as per the Environment (Protection) (second amendment) Rules, 1999.

The differences between sound and noise is often subjective and a matter of personal opinion. There are however some very harmful effects caused by exposure to high sound levels. These effects can range in severity from being extremely annoying to being extremely painful and hazardous.

Decibel levels of common sounds

dB	Environmental Condition
0	Threshold of hearing
10	Rustle of leaves
20	Broadcasting studio
30	Bedroom at night
40	Library
50	Quiet office
60	Conversational speech (at 1m)
70	Average radio
74	Light traffic noise
90	Subway train
100	Symphony orchestra
110	Rock band
120	Aircraft takeoff
146	Threshold of pain

Effects of noise pollution on physical health

The most direct harmful effect of excessive noise is physical damage to the ear and the temporary or permanent hearing loss often called a temporary threshold shift (TTS). People suffering from this condition are unable to detect weak sounds. However hearing ability is usually recovered within a month of exposure. In Maharashtra people living in close vicinity of Ganesh mandals that play blaring music for ten days of the Ganesh festival are usually known to suffer from this phenomenon. Permanent loss, usually called noise induced permanent threshold shift (NIPTS) represents a loss of hearing ability from which there is no recovery.

Below a sound level of 80 dBA hearing loss does not occur at all. However temporary effects are noticed at sound levels between 80 and 130 dBA. About 50 percent of the people exposed

to 95 dBA sound levels at work will develop NIPTS and most people exposed to more than 105 dBA will experience permanent hearing loss to some degree. A sound level of 150 dBA or more can physically rupture the human eardrum.

The degree of hearing loss depends on the duration as well as the intensity of the noise. For example, 1 hour of exposure to a 100 dBA sound level can produce a TTS that may last for about one day. However in factories with noisy machinery workers are subjected to high sound levels for several hours a day. Exposure to 95 dBA for 8 hours everyday for over a period of 10 years may cause about 15 dBA of NIPTS. In addition to hearing losses excessive sound levels can cause harmful effects on the circulatory system by raising blood pressure and altering pulse rates.

Effects of noise pollution on mental health:

Noise can also cause emotional or psychological effects such as irritability, anxiety and stress. Lack of concentration and mental fatigue are significant health effects of noise. It has been observed that the performance of school children is poor in comprehension tasks when schools are situated in busy areas of a city and suffer from noise pollution.

As noise interferes with normal auditory communication, it may mask auditory warning signals and hence increases the rate of accidents especially in industries. It can also lead to lowered worker efficiency and productivity and higher accident rates on the job.

Thus noise is just more than a mere nuisance or annoyance. It definitely affects the quality of life. It is thus important to ensure mitigation or control of noise pollution.

Permitted noise levels

Ambient Noise Levels dB

Zone	Day-time	Night-time
Silent Zone	50	40
Residential Zone	55	45
Commercial Zone	65	55
Industrial Zone	70	70

A standard safe time limit has been set for exposure to various noise levels. Beyond this 'safe' time continuing exposure over a period of a year will lead to hearing loss.

Duration	dBA
8 hours	90
4 hours	93
2 hours	96
1 hour	99
30 minutes	102
15 minutes	105
7 minutes	108
4 minutes	111
2 minutes	114
1 minute	117
30 seconds	120
Instantaneous rupture of membrane	150

Noise Control techniques

There are four fundamental ways in which noise can be controlled: Reduce noise at the source, block the path of noise, increase the path length and protect the recipient. In general, the best control method is to reduce noise levels at the source.

Source reduction can be done by effectively muffling vehicles and machinery to reduce the noise. In industries noise reduction can be done by using rigid sealed enclosures around machinery lined with acoustic absorbing material. Isolating machines and their enclosures from the floor using special spring mounts or absorbent mounts and pads and using flexible couplings for interior pipelines also contribute to reducing noise pollution at the source.

However one of the best methods of noise source reduction is regular and thorough maintenance of operating machinery. Noise levels at construction sites can be controlled using proper construction planning and scheduling techniques. Locating noisy air compressors and other equipment away from the site boundary along with creation of temporary barriers to physically block the noise can help contribute to reducing noise pollution. Most of the vehicular noise comes from movement of the vehicle tires on the pavement and wind resistance. However poorly maintained vehicles can add to the noise levels. Traffic volume and speed also have significant effects on the overall sound. For example doubling the speed increases the sound levels by about 9 dBA and doubling the traffic volume (number of vehicles per hour) increases sound levels by about 3 dBA. A smooth flow of traffic also causes less noise than does a stop-and-go traffic pattern. Proper highway planning and design are essential for controlling traffic noise. Establishing lower speed limits for highways that pass through residential areas, limiting traffic volume and providing alternative routes for truck traffic are effective noise control measures. The path of traffic noise can also be blocked by construction of vertical barriers alongside the highway. Planting of trees around houses can also act as effective noise barriers. In industries different types of absorptive material can be used to control interior noise. Highly absorptive interior finish material for walls, ceilings and floors can decrease indoor noise levels significantly. Sound levels drop significantly with increasing

distance from the noise source. Increasing the path length between the source and the recipient offers a passive means of control. Municipal land-use ordinances pertaining to the location of airports make use of the attenuating effect of distance on sound levels. Use of earplugs and earmuffs can protect individuals effectively from excessive noise levels. Specially designed earmuffs can reduce the sound level reaching the eardrum by as much as 40 dBA. However very often workers tend not to wear them on a regular basis despite company requirements for their use.

5.2.6 Thermal Pollution

Sources: The discharge of warm water into a river is usually called a **thermal pollution**. It occurs when an industry removes water from a source, uses the water for cooling purposes and then returns the heated water to its source. Power plants heat water to convert it into steam, to drive the turbines that generate electricity. For efficient functioning of the steam turbines, the steam is condensed into water after it leaves the turbines. This condensation is done by taking water from a water body to absorb the heat. This heated water, which is at least 15°C higher than the normal is discharged back into the water body.

Effects: The warmer temperature decreases the solubility of oxygen and increases the metabolism of fish. This changes the ecological balance of the river. Within certain limits thermal additions can promote the growth of certain fish and the fish catch may be high in the vicinity of a power plant. However sudden changes in temperature caused by periodic plant shutdowns both planned and unintentional can change result in death of these fish that are acclimatized to living in warmer waters.

Tropical marine animals are generally unable to withstand a temperature increase of 2 to 3°C

and most sponges, mollusks and crustaceans are eliminated at temperatures above 37°C. This results in a change in the diversity of fauna as only those species that can live in warmer water survive.

Control measures: Thermal pollution can be controlled by passing the heated water through a cooling pond or a cooling tower after it leaves the condenser. The heat is dissipated into the air and the water can then be discharged into the river or pumped back to the plant for reuse as cooling water. There are several ways in which thermal pollution can be reduced. One method is to construct a large shallow pond. Hot water is pumped into one end of the pond and cooler water is removed from the other end. The heat gets dissipated from the pond into the atmosphere. A second method is to use a cooling tower. These structures take up less land area than the ponds. Here most of the heat transfer occurs through evaporation. Here warm waters coming from the condenser is sprayed downward over vertical sheets or baffles where the water flows in thin films. Cool air enters the tower through the water inlet that encircles the base of the tower and rises upwards causing evaporative cooling. A natural draft is maintained because of the density difference between the cool air outside and the warmer air inside the tower. The waste heat is dissipated into the atmosphere about 100 m above the base of the tower. The cooled water is collected at the floor of the tower and recycled back to the power plant condensers. The disadvantage in both these methods is however that large amounts of water are lost by evaporation.

5.2.7 Nuclear Hazards

Nuclear energy can be both beneficial and harmful depending on the way in which it is used. We routinely use X-rays to examine bones for fractures, treat cancer with radiation and diagnose diseases with the help of radioactive iso-

topes. Approximately 17 % of the electrical energy generated in the world comes from nuclear power plants. However on the other hand it is impossible to forget the destruction that nuclear bombs caused the cities of Hiroshima and Nagasaki. The radioactive wastes from nuclear energy have caused serious environmental damage.

Nuclear fission is the splitting of the nucleus of the atom. The resulting energy can be used for a variety of purposes. The first controlled fission of an atom was carried out in Germany in 1938. However the United States was the first country to develop an atomic bomb which was subsequently dropped on the Japanese cities of Hiroshima and Nagasaki. The world's first electricity generating reactor was constructed in the United States in 1951 and the Soviet Union built its first reactor in 1954. In December 1953, President Dwight D. Eisenhower in his 'Atoms for Peace' speech made the following prediction: *'Nuclear reactors will produce electricity so cheaply that it will not be necessary to meter it. The users will pay a fee and use as much electricity as they want. Atoms will provide a safe, clean and dependable source of electricity.'*

Today however though nuclear power is being used as a reliable source of electricity the above statement sounds highly optimistic. Several serious accidents have caused worldwide concern about safety and disposal of radioactive wastes.

In order to appreciate the consequences of using nuclear fuels to generate energy it is important to understand how the fuel is processed. Low-grade uranium ore, which contains 0.2 percent uranium by weight, is obtained by surface or underground mining. After it is mined the ore goes through a milling process where it is crushed and treated with a solvent to concentrate the uranium and produces yellow cake a material containing 70 to 90 percent uranium oxide. Naturally occurring uranium contains only 0.7 percent of fissionable U-235, which is not

high enough for most types of reactors. Hence it is necessary to increase the amount of U-235 by enrichment though it is a difficult and expensive process. The enrichment process increases the U-235 content from 0.7 to 3 percent. Fuel fabrication then converts the enriched material into a powder, which is then compacted into pellets. These pellets are sealed in metal fuel rods about 4 meters in length which is then loaded into the reactor. As fission occurs the concentration of U-235 atoms decreases. After about three years, a fuel rod does not have enough radioactive material to sustain a chain reaction and hence the spent fuel rods must be replaced by new ones. The spent rods are however still very radioactive containing about one percent U-235 and one percent plutonium. These rods are a major source of radioactive waste material produced by a nuclear reactor.

Initially it was thought that spent fuel rods could be reprocessed to not only provide new fuel but also to reduce the amount of nuclear waste. However the cost of producing fuel rods by reprocessing was found to be greater than the cost of producing fuel rods from ore. Presently India does operate reprocessing plants to reprocess spent fuel as an alternative to storing them as nuclear waste. At each step in the cycle there is a danger of exposure and poses several health and environmental concerns.

Although nuclear power has significant benefits an incident which changed people's attitudes towards nuclear power plants was the Chernobyl disaster that occurred in 1986. Chernobyl is a small city in Ukraine near the border with Belarus north of Kiev. At 1.00 am April 25, 1986 a test to measure the amount of electricity that the still spinning turbine would produce if steam were shut off was being conducted at the Chernobyl Nuclear Power Station-4. This was important information since the emergency core cooling system required energy for its operation and the coasting turbine could provide some of that energy until another source

became available. The amount of steam being produced was reduced by lowering the control rods into the reactor. But the test was delayed because of a demand for electricity and a new shift of workers came on duty. The operators failed to program the computer to maintain power at 700 megawatts and the output dropped to 30 megawatts. This presented an immediate need to rapidly increase the power and many of the control rods were withdrawn. Meanwhile an inert gas (xenon) had accumulated on the fuel rods. The gas absorbed the neutrons and slowed the rate of power increase. In an attempt to obtain more power the operators withdrew all the control rods. This was a second serious safety violation.

At 1.00am, the operators shut off most of the emergency warning signals and turned on all the eight pumps to provide adequate cooling for the reactor following the completion of the test. Just as the final stages for the test were beginning a signal indicated excessive reaction in the reactor. In spite of the warning the operators blocked the automatic reactor shutdown and began the test. As the test continued the power output of the reactor rose beyond its normal level and continued to rise. The operators activated the emergency system designed to put the control rods back into the reactor and stop the fission. But it was already too late. The core had already been deformed and the rods would not fit properly thus the reaction could not be stopped. In 4.5 seconds the energy level of the reactor increased two thousand times. The fuel rods ruptured the cooling water turned into steam and a steam explosion occurred. The lack of cooling water allowed the reactor to explode. The explosion blew the 1000 metric ton concrete roof from the reactor and the reactor caught fire. This resulted in the world's worst nuclear accident and it took ten days to bring the runaway reaction under control.

There were of course immediate fatalities, but the long-term consequences were devastating. 116,000 people were evacuated of which 24,000 had received high doses of radiation. Even today many people suffer from illnesses they feel are related to their exposure to the fallout from Chernobyl. In 1996 ten years after the accident it was clear that one of the long-term effects was the increased frequency of thyroid cancer in children.

The degree and the kind of damage from nuclear accidents vary with the kind of radiation, the amount of radiation, the duration of exposure and the types of cells irradiated. Radiation can also cause mutations which are changes in the genetic makeup of the cells. Mutations can occur in the ovaries or the testes leading to the formation of mutated eggs or sperms which in turn can lead to abnormal offspring. Mutations can also occur in the tissues of the body and may manifest themselves as abnormal tissue growths known as cancer. Two common cancers that are linked to increased radiation exposure are leukemia and breast cancer.

5.3 SOLID WASTE MANAGEMENT: CAUSES, EFFECTS AND CONTROL MEASURES OF URBAN AND INDUSTRIAL WASTE

In ancient cities, food scraps and other wastes were simply thrown into the unpaved streets where they accumulated. Around 320 B.C. in Athens, the first known law forbidding this practice was established and a system of waste removal began to evolve in several eastern Mediterranean cities. Disposal methods were very crude and often were just open pits outside the city walls. As populations increased, efforts were made to transport the wastes out further thus creating city dumps. Until recently the disposal of municipal solid waste did not attract much public attention. The favoured

means of disposal was to dump solid wastes outside the city or village limits.

Around most towns and cities in India the approach roads are littered with multi-coloured plastic bags and other garbage. Waste is also burnt to reduce its volume. Modern methods of disposal such as incineration and the development of sanitary landfills, etc. are now attempting to solve these problems. Lack of space for dumping solid waste has become a serious problem in several cities and towns all over the world. Dumping and burning wastes is not an acceptable practice today from either an environmental or a health perspective. Today disposal of solid waste should be part of an integrated waste management plan. The method of collection, processing, resource recovery and the final disposal should mesh with one another to achieve a common objective.

Characteristics of municipal solid waste

Solid wastes are grouped or classified in several different ways. These different classifications are necessary to address the complex challenges of solid waste management in an effective manner. The term municipal solid waste (MSW) is generally used to describe most of the non-hazardous solid waste from a city, town or village that requires routine collection and transport to a processing or disposal site. Sources of MSW include private homes, commercial establishments and institutions as well as industrial facilities. However MSW does not include wastes from industrial processes, construction and demolition debris, sewage sludge, mining wastes or agricultural wastes.

Municipal solid waste contains a wide variety of materials. It can contain food waste such as vegetable and meat material, left over food, egg shells, etc which is classified as wet garbage as well as paper, plastic, tetrapacks, plastic cans, newspaper, glass bottles, cardboard boxes, alu-

minum foil, metal items, wood pieces, etc. which is classified as dry garbage.

Control measures of urban and industrial wastes: An integrated waste management strategy includes three main components:

1. Source reduction
2. Recycling
3. Disposal

Source reduction is one of the fundamental ways to reduce waste. This can be done by using less material when making a product, reuse of products on site, designing products or packaging to reduce their quantity. On an individual level we can reduce the use of unnecessary items while shopping, buy items with minimal packaging, avoid buying disposable items and also avoid asking for plastic carry bags.

Recycling is reusing some components of the waste that may have some economic value. Recycling has readily visible benefits such as conservation of resources reduction in energy used during manufacture and reducing pollution levels. Some materials such as aluminum and steel can be recycled many times. Metal, paper, glass and plastics are recyclable. Mining of new aluminum is expensive and hence recycled aluminum has a strong market and plays a significant role in the aluminum industry. Paper recycling can also help preserve forests as it takes about 17 trees to make one ton of paper. Crushed glass (cullet) reduces the energy required to manufacture new glass by 50 percent. Cullet lowers the temperature requirement of the glassmaking process thus conserving energy and reducing air pollution. However even if recycling is a viable alternative, it presents several problems.

The problems associated with recycling are either technical or economical. Plastics are difficult to recycle because of the different types of polymer resins used in their production. Since each type has its own chemical makeup differ-

ent plastics cannot be recycled together. Thus separation of different plastics before recycling is necessary. Similarly in recycled paper the fibers are weakened and it is difficult to control the colour of the recycled product. Recycled paper is banned for use in food containers to prevent the possibility of contamination. It very often costs less to transport raw paper pulp than scrap paper. Collection, sorting and transport account for about 90 percent of the cost of paper recycling. The processes of pulping, deinking and screening wastepaper are generally more expensive than making paper from virgin wood or cellulose fibers. Very often thus recycled paper is more expensive than virgin paper. However as technology improves the cost will come down.

Disposal of solid waste is done most commonly through a sanitary landfill or through incineration. A modern sanitary landfill is a depression in an impermeable soil layer that is lined with an impermeable membrane. The three key characteristics of a municipal sanitary landfill that distinguish it from an open dump are:

- Solid waste is placed in a suitably selected and prepared landfill site in a carefully prescribed manner.
- The waste material is spread out and compacted with appropriate heavy machinery.
- The waste is covered each day with a layer of compacted soil.

The problem with older landfills are associated with groundwater pollution. Pollutants seeping out from the bottom of a sanitary landfill (leachates) very often percolate down to the groundwater aquifer no matter how thick the underlying soil layer. Today it is essential to have suitable bottom liners and leachate collection systems along with the installation of monitoring systems to detect groundwater pollution. The organic material in the buried solid waste

will decompose due to the action of microorganisms. At first the waste decomposes aerobically until the oxygen that was present in the freshly placed fill is used up by the aerobic microorganisms. The anerobes take over producing methane which is poisonous and highly explosive when mixed with air in concentrations between 5 and 15 percent. The movement of gas can be controlled by providing impermeable barriers in the landfill. A venting system to collect the blocked gas and vent it to the surface where it can be safely diluted and dispersed into the atmosphere is thus a necessary component of the design of sanitary landfills.

Even though landfilling is an economic alternative for solid waste disposal, it has become increasingly difficult to find suitable landfilling sites that are within economic hauling distance and very often citizens do not want landfills in their vicinity. Another reason is that no matter how well engineered the design and operation may be, there is always the danger of some environmental damage in the form of leakage of leachates.

Incineration is the process of burning municipal solid waste in a properly designed furnace under suitable temperature and operating conditions. Incineration is a chemical process in which the combustible portion of the waste is combined with oxygen forming carbon dioxide and water, which are released into the atmosphere. This chemical reaction called oxidation results in the release of heat. For complete oxidation the waste must be mixed with appropriate volumes of air at a temperature of about 815o C for about one hour. Incineration can reduce the municipal solid waste by about 90 percent in volume and 75 percent in weight. The risks of incineration however involve air-quality problems and toxicity and disposal of the fly and bottom ash produced during the incineration process. Fly ash consists of finely divided particulate matter, including cinders, mineral dust and soot. Most of the incinerator ash is

bottom ash while the remainder is fly ash. The possible presence of heavy metals in incinerator ash can be harmful. Thus toxic products and materials containing heavy metals (for example batteries and plastics) should be segregated. Thus extensive air pollution control equipment and high-level technical supervision and skilled employees for proper operation and maintenance is required.

Thus while sanitary landfills and incinerators have their own advantages and disadvantages, the most effective method of solid waste management is source reduction and recycling.

Vermi – Composting

Nature has perfect solutions for managing the waste it creates, if left undisturbed. The biogeochemical cycles are designed to clear the waste material produced by animals and plants. We can mimic the same methods that are present in nature. All dead and dry leaves and twigs decompose and are broken down by organisms such as worms and insects, and is finally broken down by bacteria and fungi, to form a dark rich soil-like material called compost.

These organisms in the soil use the organic material as food, which provides them with nutrients for their growth and activities. These nutrients are returned to the soil to be used again by trees and other plants. This process recycles nutrients in nature.

This soil can be used as a manure for farms and gardens.

Steps for Vermi-Compost

- Dig a pit about half a meter square, one meter deep.
- Line it with straw or dried leaves and grass.
- Organize the disposal of organic waste into the pit as and when generated.
- Introduce a culture of worms that is now produced commercially.
- Ensure that the contents are covered with a sprinkling of dried leaves and soil everyday.
- Water the pit once or twice a week to keep it moist.
- Turn over the contents of the pit ever 15 days.
- In about 45 days the waste will be decomposed by the action of the microorganisms.
- The soil derived is fertile and rich in nutrients.

Hazardous wastes

Modern society produces large quantities of hazardous waste which are generated by chemical manufacturing companies, petroleum refineries, paper mills, smelters and other industries. Hazardous wastes are those that can cause harm to humans or the environment. Wastes are normally classified as hazardous waste when they cause or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness or pose a sub-

stantial present or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of.

Characteristics of hazardous wastes

A waste is classified as a hazardous waste if it exhibits any of the four primary characteristics based on the physical or chemical properties of toxicity, reactivity, ignitability and corrosivity. In addition to this waste products that are either infectious or radioactive are also classified as hazardous

Toxic wastes are those substances that are poisonous even in very small or trace amounts. Some may have an acute or immediate effect on humans or animals causing death or violent illness. Others may have a chronic or long term effect slowly causing irreparable harm to exposed persons. Acute toxicity is readily apparent because organisms respond to the toxin shortly after being exposed. Chronic toxicity is much more difficult to determine because the effects may not be seen for years. Certain toxic wastes are known to be carcinogenic, causing cancer and others may be mutagenic causing biological changes in the children of exposed people and animals.

Reactive wastes are those that have a tendency to react vigorously with air or water, are unstable to shock or heat, generate toxic gases or explode during routine management. For example, gunpowder, nitroglycerine, etc.

Ignitable wastes are those that burn at relatively low temperatures (less than 60 C) and are capable of spontaneous combustion during storage, transport or disposal. For example, gasoline, paint thinners, and alcohol.

Corrosive wastes are those that destroy materials and living tissue by chemical reaction. For example, acids and bases.

Infectious wastes include human tissue from surgery, used bandages and hypodermic needles, microbiological materials, etc.

Radioactive waste is basically an output from the nuclear power plants and can persist in the environment for thousands of years before it decays appreciably.

Environmental problems and health risks caused by hazardous wastes.

As most of the hazardous wastes are disposed of on or in land the most serious environmental effect is contaminated groundwater. Once groundwater is polluted with hazardous wastes it is very often not possible to reverse the damage.

Pesticides are used increasingly to protect and increase food production. They form residues in the soil which are washed into streams which then carry them forwards. The residues may persist in the soil or in the bottom of lakes and rivers. Exposure can occur through ingestion, inhalation and skin contact resulting in acute or chronic poisoning. Today we have an alternative to the excess use of pesticides through the use of Integrated Pest Management (IPM). The IPM system uses a wide variety of plants and insects to create a more natural process. The natural balance between climate, soil and insect populations can help to prevent an insect from overpopulating an area and destroying a particular crop.

Lead, mercury and arsenic are hazardous substances which are often referred to as heavy metals. Lead is an abundant heavy metal and is relatively easy to obtain. It is used in batteries, fuel, pesticides, paints, pipes and other places where resistance to corrosion is required. Most of the lead taken up by people and wildlife is stored in bones. Lead can affect red blood cells by reducing their ability to carry oxygen and

shortening their life span. Lead may also damage nerve tissue which can result in brain disease.

Mercury occurs in several different forms. Mercury is used in the production of chlorine. It is also used as a catalyst in the production of some plastics. Industrial processes such as the production of chlorine and plastics are responsible for most of the environmental damage resulting from mercury. Our body has a limited ability to eliminate mercury. In the food web mercury becomes more concentrated as it is taken up by various organisms. In an aquatic environment, mercury can be absorbed by the plankton which are then consumed by fish. In addition, fish take up mercury through their gills and by eating

Minamata-An important lesson about mercury

A case of human mercury poisoning which occurred about forty years ago in the Minamata bay in Japan taught the world an important lesson about the dangers of mercury poisoning. A large plastics plant located near the Minamata bay used a mercury containing compound in a reaction to produce vinyl chloride a common plastic material. The left over mercury was dumped into the Bay along with other wastes from the plant. Though the mercury was in its less toxic inorganic state when dumped microorganisms at the bottom of the bay converted the mercury into its organic form. This organic mercury then entered into the tissues of fish which were in turn consumed by the people living in the area. The contaminated fish thus caused an outbreak of poisoning killing and affecting several people. Mothers who had eaten the contaminated fish gave birth to infants who showed signs of mercury poisoning. Mercury poisoning is thus called Minamata Disease.

other fish contaminated with mercury. Generally older the fish greater is the mercury concentration in its body. Birds that eat the fish concentrate even more mercury in their bodies. It is a cumulative poison (it builds up in the body over long periods of time) and is known to cause brain damage.

Thousands of chemicals are used in industry everyday. When used incorrectly or inappropriately they can become health hazards. PCBs (Polychlorinated biphenyls) are resistant to fire and do not conduct electricity very well which makes them excellent materials for several industrial purposes. Rainwater can wash PCBs out of disposal areas in dumps and landfills thus contaminating water. PCBs do not break down very rapidly in the environment and thus retain their toxic characteristics. They cause long term exposure problems to both humans and wildlife. PCBs are concentrated in the kidneys and liver and thus cause damage. They cause reproductive failure in birds and mammals.

Vinyl chloride is a chemical that is widely used in the manufacture of plastic. Usually people are only exposed to high levels of vinyl chloride if they work with it or near it but exposure can also occur from vinyl chloride gas leaks. After a long continuous exposure (one to three years) in humans, vinyl chloride can cause deafness, vision problems, circulation disorders and bone deformities. Vinyl chloride can also cause birth defects.

It is essential to substitute the use of PCBs and vinyl chloride with chemicals that are less toxic. Polyvinyl chloride use can be lowered by reducing our use of plastics. Thus by reducing waste, encouraging recycling and using products that are well made and durable we can greatly reduce our consumption of these chemicals thus curtailing our exposure to these substances.

We may not realize it but many household chemicals can be quite toxic to humans as well

as wildlife. Most of the dangerous substances in our homes are found in various kinds of cleaners, solvents and products used in automotive care. When these products are used incorrectly they have the potential to be harmful.

Today the most common methods for disposing off hazardous wastes are land disposal and incineration. In countries where there is abundant land available for disposal for example, North America land disposal is the most widely used method. In countries like Europe and Japan where land is not readily available and is expensive, incineration is the preferred method for disposal. In spite of strong laws however illegal dumping of these wastes continues. Hazardous waste management must move beyond burying and burning. Industries need to be encouraged to generate less hazardous waste in their manufacturing processes. Although toxic wastes cannot be entirely eliminated, technologies are available for minimizing, recycling and treating wastes. An informed public can also contribute in a big way towards this end. It is essential for us to understand the ill effects of chemical substances so that we can make informed decisions about its use. We might decide that the benefits of the use of a toxic substance do not outweigh the risks and choose not to use it at all or we may decide that it is acceptable to use a substance under certain specific circumstances where it is adequately controlled and exposure to toxic levels is prevented.

5.4 ROLE OF AN INDIVIDUAL IN PREVENTION OF POLLUTION

There are a host of environmental problems caused by human actions on the environment. If we are to respond to these problems we have to recognize that each of us is individually responsible for the quality of the environment we live in. Our personal actions can either worsen or improve our environmental quality. Several

people may feel that environmental problems can be solved with quick technological fixes. While a majority of individuals would want a cleaner environment, not many of them want to make major changes in their lifestyle that could contribute to a cleaner environment. Decisions and actions taken by individuals to a very large extent determine the quality of life for everyone. This necessitates that individuals should not only be aware of various environmental issues and the consequences of their actions on the environment but should also make a firm resolve to develop environmentally ethical lifestyles.

With the help of solar energy, natural processes developed over billions of years can indefinitely renew the topsoil, water, air, forests, grasslands and wildlife on which all forms of life depend, but only as long as we do not use these potentially renewable resources faster than they are replenished. Some of our wastes can be diluted, decomposed and recycled by natural processes indefinitely as long as these processes are not overloaded. Natural processes also provide services of flood prevention, erosion control at no costs at all. We must therefore learn to value these resources and use them sustainably.

Concepts that help individuals contribute towards a better quality of our environment and human life.

- Develop respect or reverence for all forms of life.
- Each individual must try to answer four basic questions:
 - Where do the things that I consume come from?
 - What do I know about the place where I live?
 - How am I connected to the earth and other living things?
 - What is my purpose and responsibility as a human being?

- Try to plant trees wherever you can and more importantly take care of them. They reduce air pollution.
- Reduce the use of wood and paper products wherever possible. Manufacturing paper leads to pollution and loss of forests which releases oxygen and takes up carbon dioxide. Try to recycle paper products and use recycled paper wherever possible.
- From the mail you receive reuse as many envelopes that you can.
- Do not buy furniture, doors, window frames made from tropical hardwoods such as teak and mahogany. These are forest based.
- Help in restoring a degraded area near your home or join in an afforestation program.
- Use pesticides in your home only when absolutely necessary and use them in as small amounts as necessary. Some insect species help to keep a check on the populations of pest species.
- Advocate organic farming by asking your grocery store to stock vegetables and fruits grown by an organic method. This will automatically help to reduce the use of pesticides.
- Reduce the use of fossil fuels by either walking up a short distance using a car pool, sharing a bike or using public transport. This reduces air pollution.
- Shut off the lights and fans when not needed.
- Don't use aerosol spray products and commercial room air fresheners. They damage the ozone layer.

- Do not pour pesticides, paints, solvents, oil or other products containing harmful chemicals down the drain or on the ground.
- Buy consumer goods that last, keep them as long as possible and have them repaired as far as possible instead of disposing them off. Such products end up in landfills that could pollute ground water.
- Buy consumer goods in refillable glass containers instead of cans or throwaway bottles.
- Use rechargeable batteries.
- Try to avoid asking for plastic carry bags when you buy groceries or vegetables or any other items. Use your own cloth bag instead.
- Use sponges and washable cloth napkins, dish towels and handkerchiefs instead of paper ones.
- Don't use throwaway paper and plastic plates and cups when reusable versions are available.
- Recycle all newspaper, glass, aluminum and other items accepted for recycling in your area. You might have to take a little trouble to locate such dealers.
- Set up a compost bin in your garden or terrace and use it to produce manure for your plants to reduce use of fertilizers.
- Try to lobby and push for setting up garbage separation and recycling programs in your localities.
- Choose items that have the least packaging or no packaging.
- Start individual or community composting or vermicomposting plants in your neighborhood and motivate people to join in.
- Do not litter the roads and surroundings just because the sweeper from the Municipal Corporation will clean it up. Take care to put trash into dustbins or bring it back home with you where it can be appropriately disposed.
- You must realize that you cannot do everything and have solutions for every problem in the world. You can however concentrate on issues that you feel strongly about and can do something about. Focusing your energy on a particular issue will help you get better results.
- You could join any of the several NGOs that exist in our country or become volunteers. Organize small local community meetings to discuss positive approaches of pollution prevention.
- Learn about the biodiversity of your own area. Understand the natural and cultural assets. This would help you to develop a sense of pride in your city/town/village and will also help you understand the problems facing their survival.
- You cannot improve your world by not voting. You have the option to make a choice rather than complain later on.
- It is important that you do not get discouraged at the first sign of trouble. Do not dwell on the negative aspects. But take positive actions wherever you can to make the world a better place to live in.
- When talking to elected officials always be courteous and reasonable. You may disagree with a particular position but be re-

spectful in doing so as you will gain little by being hostile and brash.

- Take care to put into practice what you preach. Remember environment protection begins with YOU.

5.5 POLLUTION CASE STUDIES

A case study of groundwater pollution in India

An example of groundwater pollution caused by excessive extraction is that fluoride contamination. Fluorosis is not a localized problem. It has spread across 19 states and across a variety of ecological regions ranging from the Thar desert, the Gangetic plains and the Deccan plateau. Each of these regions are distinct in terms of rainfall, soil type, groundwater recharge regime, climatic conditions and hydrology. High fluoride concentration in groundwater is a natural phenomenon in several countries such as China, Sri Lanka, West Indies, Spain, Holland, Italy and Mexico. Experts claim that a fluoride belt stretches across the Middle East across Pakistan and India and then into Southeast Asia and the South of China. According to a report of the Rajiv Gandhi National Drinking Water mission, the bedrock of the Indian peninsula consists of a number of fluoride bearing minerals. When the bedrock weathers the fluoride leaches into water and the soil. Although the Indian peninsular bedrock has always been the same, this problem has only surfaced during the last three decades. This is related to the over extraction of groundwater which has resulted in the tapping of aquifers with high fluoride concentrations.

The beginnings of this phenomenon can be traced back to the 1970s and the 1980s when there was massive state investment in rural water development for irrigation as well as for drinking. Encouraged by state subsidies on diesel and electricity, people invested in diesel and

submersible pumps in a bid to extract groundwater through borewells. This policy aggravated the fluoride problem.

Fluoride mainly enters the human body through drinking water where 96 to 99 percent of it combines with the bones as it has an affinity for calcium phosphate in the bones. Excess intake of fluoride can lead to dental fluorosis, skeletal fluorosis or non-skeletal fluorosis. Dental fluorosis is characterized by discoloured, blackened, mottled or chalky white teeth. Skeletal fluorosis leads to severe and permanent bone and joint deformities. Non-skeletal fluorosis leads to gastro-intestinal problems and neurological disorders. Fluoride can damage the foetus and adversely affect the IQ of children.

Once fluoride is detected in water, the only solution is to defluoridate it. Various technologies are available for this process. However the type of technology to be selected depends upon the fluoride levels in the water and the volume of water to be defluoridated. None of the Indian technologies are however fool-proof. Defluoridation plants and household water treatment kits are stop-gap solutions.

A case study of pesticide pollution in India

One of the most terrifying effects of pesticide contamination of ground water came to light when pesticide residues were found in bottled water. Between July and December 2002, the Pollution Monitoring Laboratory of the New Delhi based Center for Science and Environment (CSE) analysed 17 brands of bottled water both packaged drinking water and packaged natural mineral water commonly sold in areas that fall within the national capital region of Delhi. Pesticide residues of organochlorine and organophosphorus pesticides which are most commonly used in India were found in all the samples. Among organochlorines, gamma-hexachlorocyclohexane (lindane) and DDT were

prevalent while among organophosphorus pesticides, Malathion and Chlorpyrifos were most common. All these were present above permissible limits specified by the European Economic Community, which is the norm, used all over Europe.

One may wonder as to how these pesticide residues get into bottled water that is manufactured by several big companies. This can be traced to several facts. There is no regulation that the bottled water industry must be located in 'clean' zones. Currently the manufacturing plants of most brands are situated in the dirtiest industrial estates or in the midst of agricultural fields. Most companies use bore wells to pump out water from the ground from depths varying from 24m to even 152 m below the ground. The raw water samples collected from the plants also revealed the presence of pesticide residues. This clearly indicated that the source of pesticide residues in the polluted groundwater are used to manufacture the bottled water. This is despite the fact that all bottled water plants use a range of purification methods. Thus obviously the fault lies in the treatment methods used.

These plants use the membrane technology where the water is filtered using membranes with ultra-small pores to remove fine suspended solids and all bacteria and protozoa and even viruses. While nanofiltration can remove insecticides and herbicides it is expensive and thus rarely used. Most industries also use an activated charcoal adsorption process, which is effective in removing organic pesticides but not heavy metals. To remove pesticides the plants use reverse osmosis and granular activated charcoal methods. Thus even though manufacturers claim to use these process the presence of pesticide residues points to the fact that either manufacturers do not use the treatment process effectively or only treat a part of the raw water.

The low concentration of pesticide residues in bottled water do not cause acute or immediate effect. However repeated exposure even to extremely miniscule amounts can result in chronic effects like cancer, liver and kidney damage, disorders of the nervous system, damage to the immune system and birth defects.

Similarly six months after CSE reported pesticide residues in bottled water it also found these pesticides in popular cold drink brands sold across the country. This is because the main ingredient in a cold drink or a carbonated non-alcoholic beverage is water and there are no standards specified for water to be used in these beverages in India.

There were no standards for bottled water in India till on September 29, 2000 the Union Ministry of Health and Family Welfare issued a notification (no759(E)) amending the Prevention of Food Adulteration Rules, 1954. The BIS (Bureau of Indian Standards) certification mark became mandatory for bottled water from March 29, 2001. However the parameters for pesticide residues remained ambiguous. Following the report published by CSE in *Down to Earth*, Vol 11, no. 18, a series of Committees were established and eventually on 18th July 2003 amendments were made in the Prevention of Food Adulteration Rules stating that pesticide residues considered individually should not exceed 0.0001mg.lit and the total pesticide residues will not be more than 0.0005 mg/lit that the analysis shall be conducted by using internationally established test methods meeting the residue limits specified herein. This notification came into force from January 1, 2004.

A case study of river pollution in India

Almost all the rivers in India are polluted. The causes of pollution may also be more or less similar. This is a case study of the river Damodar as reported in *Down to Earth*. The 563 km long

Damodar river originates near Chandwa village in the Chhotanagpur hills in Bihar's Palamau district. It flows through one of the richest mineral belts in the world before draining into the Hooghly, about 50 km south of Calcutta. Indian industry depends heavily on this region as 60 percent of the coal consumed in our country comes from the Chhotanagpur belt. Coal based industries of all types dot the area because of locational advantages and the easy availability of water and power. In addition various industries such as the steel, cement, fertilizer and explosive plants are also located here. The river Damodar is polluted with minerals, mine rejects and toxic effluents. Both its water and its sand are infested by coal dust and waste from these industries. There are seven thermal power plants in the Damodar valley. The states of Bihar and West Bengal depend almost entirely on this area for their power requirements. These power plants not only consume a lot of water but also dump ash in the valley.

Mining

As underground mines cannot keep pace with the rising demand, 60 percent of the coal extracted from the area comes from open cast mines which are responsible for serious land degradation. The disposal of rock and soil extracted along with the coal only adds to the problem.

Industries

The industries in the area do not have proper effluent treatment plants. Among the big coal based industries the washeries account for the bulk of the pollution in terms of the total suspended solids (TSS), oil and grease. About 20 percent of the coal handled goes out in the form of slurry which is deposited in the ponds outside. After the slurry settles, coalfine (the sediment) is collected manually. Due to inadequate retrieval methods very often the water discharges into the river from the pond carries high

amounts of fine coal particles and oil thus polluting the river. The other major coal based pollutants are the coke oven plants that heat coal to temperatures as high as 1100°C in the absence of oxygen to prepare it for use in blast furnaces and foundries. The volatile components in the coal are removed, leaving hot, non-volatile coke in the oven which is washed with huge quantities of water. This water that contains oil and suspended particles is then discharged into the river.

Flyash from the thermal power plants

Only one of the thermal power plants has an electrostatic precipitator to collect the fly ash while the other just make do with mechanical dust collectors. As most of these plants are located on the banks of the river the fly ash eventually finds its way into the river. The bottom ash from the boilers is mixed with water to form a slurry which is then drained into ash ponds. Most of the ponds are full and in several cases the drainage pipes are choked. The slurry is therefore directly discharged into the river.

Effects

The river and its tributaries are the largest source of drinking water for the huge population that lives in the valley. On April 2, 1990 about 200,000 litres of furnace oil spilled into the river from the Bokaro Steel Plant. This oil traveled 150 km downstream to Durgapur. For a week after the incident five million people drank contaminated water in which the oil levels were 40 to 80 times higher than the permissible value of 0.03 mg/l.

The Damodar Action Plan an end-of-the pipe pollution treatment scheme seeks to tackle effluents. One viable option could be to switch to less polluting industries and cleaner technology. This would need strong Government initiative and also a mass movement by people.

Pollution

5.6 DISASTER MANAGEMENT: FLOODS, EARTHQUAKES, CYCLONES, LANDSLIDES

The Indian subcontinent is very vulnerable to droughts, floods, cyclones, earthquakes, landslides, avalanches and forest fires. Among the 36 states and Union territories in the country, 22 are prone to disasters.

Among all the disasters that occur in the country, floods are the most frequently occurring natural disasters, due to the irregularities of the Indian monsoon. About 75 percent of the annual rainfall in India is concentrated in three to four months of the monsoon season. As a result there is a very heavy discharge from the rivers during this period causing widespread floods. Approximately 40 million hectares of land in the country has been identified as being prone to floods. Major floods are mainly caused in the Ganga-Brahmaputra-Meghna basin which carries 60 percent of the total river flow of our country.

India has a long coastline of 5700 kms, which is exposed to tropical cyclones arising in the Bay of Bengal and the Arabian sea. The Indian Ocean is one of the six major cyclone prone regions of the world. In India, cyclones occur usually between April and May and also between October and December. The eastern coastline is more prone to cyclones as it is hit by about 80 percent of the total cyclones generated in the region.

Droughts are a perennial feature in some states of India. Sixteen percent of the country's total area is drought prone. Drought is a significant environmental problem as it is caused by a lower than average rainfall over a long period of time. Most of the drought prone areas identified by the Government lie in the arid and semi-arid areas of the country.

Earthquakes are considered to be one of the most destructive natural hazards. The impact of

this phenomenon occurs with so little warning that it is almost impossible to make preparations against damages and collapse of buildings. About 50 to 60 percent of India is vulnerable to seismic activity of varying intensities. Most of the vulnerable areas are located in the Himalayan and sub-Himalayan regions.

From management to mitigation of disasters

Till very recently the approach towards dealing with natural disasters has been post disaster management involving problems such as evacuation, warnings, communications, search and rescue, fire-fighting, medical and psychiatric assistance, provision of relief, shelter, etc. After the initial trauma and the occurrence of the natural disaster is over and reconstruction and rehabilitation is done by people, NGOs and the Government, its memories are relegated to history.

It is evident today that human activities are responsible for accelerating the frequency and severity of natural disasters. Natural occurrences such as floods, earthquakes, cyclones, etc. will always occur. They are a part of the environment that we live in. However destruction from natural hazards can be minimized by the presence of a well functioning warning system combined with preparedness on part of the community that will be affected. Thus though traditionally disaster management consisted primarily of reactive mechanisms, the past few years have witnessed a gradual shift towards a more proactive, mitigation based approach.

Disaster management is a multidisciplinary area in which a wide range of issues that range from forecasting, warning, evacuation, search and rescue, relief, reconstruction and rehabilitation are included. It is also multi-sectoral as it involves administrators, scientists, planners, volunteers and communities. These roles and activities span

the pre-disaster, during disaster and post disaster plans. Since their activities are complementary as well as supplementary to each other there is a critical need for coordinating these activities.

In order to transfer the benefits of scientific research and development to the communities links must be developed between scientific communities and field agencies. Coordination between Government agencies and NGOs needs to be built up so that overlap of activities may be avoided and linkages between the Government and communities are established.

Today we have a range of early warning systems for a range of natural hazards. Although they are more accurate than before and can help in prediction it is not enough to ensure communities are safe from disasters. This is where disaster mitigation can play an important role. Mitigation means lessening the negative impact of the natural hazards. It is defined as sustained action taken to reduce long term vulnerability of human life and property to natural hazards. While the preparatory, response and the recovery phases of emergency management relate to specific events, mitigation activities have the potential to produce repetitive benefits over time.

Certain guidelines if followed can result in an effective mitigation program.

- Pre-disaster mitigation can help in ensuring faster recovery from the impacts of disasters.
- Mitigation measures must ensure protection of the natural and cultural assets of the community.
- Hazard reduction methods must take into account the various hazards faced by the affected community and their desires and priorities.

- Any mitigation program must also ensure effective partnership between Government, scientific, private sector, NGOs and the community.

The main elements of a mitigation strategy are as follows:

Risk assessment and Vulnerability analysis

This involves identification of hot spot areas of prime concern, collection of information on past natural hazards, information of the natural ecosystems and information on the population and infrastructure. Once this information is collected a risk assessment should be done to determine the frequency, intensity, impact and the time taken to return to normalcy after the disaster. The assessment of risk and vulnerabilities will need to be revised periodically. A regular mechanism will therefore have to be established for this. The use of Geographical Information Systems (GIS) a computer program can be a valuable tool in this process as the primary data can be easily updated and the corresponding assessments can be made.

Applied research and technology transfer

There is a need to establish or upgrade observation equipment and networks, monitor the hazards properly, improve the quality of forecasting and warning, disseminate information quickly through the warning systems and undertake disaster simulation exercises.

Thus space technologies such as remote sensing, satellite communications and Global Positioning Systems have a very important role to play. Government organizations like ISRO (Indian Space Research Organization) can play a vital role. Similarly Government organizations the National Building Research Organization, the Meteorological Department, Irrigation Department, etc. can undertake applied research for devising locale specific mitigation strategies in

collaboration with educational institutions or Universities.

Such steps could lead to the formulation of locale specific mitigation measures. A combination of scientific knowledge and expertise with the community based mitigation measures would not only enhance the database but would also form the basis of a successful mitigation strategy.

Public awareness and training

One of the most critical components of a mitigation strategy is the training to be imparted to the officials and staff of the various departments involved at the state and the district level. This enables sharing of information and methodology. The success of a mitigation strategy will depend to a large extent on the inter-sectional, inter-departmental coordination and efficient teamwork. Thus a training program that is designed after assessment of gaps in knowledge, skills and attitude with respect to the various tasks that need to be undertaken is a vital component.

Institutional mechanisms

The most important need at the National level is to strengthen or develop the capacity to undertake disaster mitigation strategies. There is a need to emphasize on proactive and pre-disaster measures rather than post disaster response. It is thus essential to have a permanent administrative structure which can monitor the developmental activities across departments and provides suggestions for necessary mitigation measures. The National Disaster Management Center (NDMC) can perform such a task. Professionals like architects, structural engineers, doctors, chemical engineers who are involved with management of hazardous chemicals can be asked to form groups that can design specific mitigation measures.

Incentives and resources for mitigation

To a very large extent the success of mitigation programs will depend upon the availability of continued funding. There is thus a need to develop mechanisms to provide stable sources of funding for all mitigation programs. This will include incentives for relocation of commercial and residential activities outside the disaster prone areas. Housing finance companies should make it mandatory for structures in such hazard prone areas to follow special building specifications. The introduction of disaster linked insurance should be explored and should cover not only life but also household goods, cattle, structures and crops.

Landuse planning and regulations

Long term disaster reduction efforts should aim at promoting appropriate land-use in the disaster prone areas. Separation of industrial areas from residential areas, maintaining wetlands as buffer zones for floods, creation of public awareness of proper land practices and formation of land-use policies for long term sustainable development is imperative.

Hazard resistant design and construction

In areas that are prone to disasters protection can be enhanced by careful selection of sites and the way the buildings are built. Thus it is essential to promote the knowledge of disaster resistant construction techniques and practices among engineers, architects and technical personnel.

Structural and Constructional reinforcement of existing buildings

It is also possible to reduce the vulnerability of existing buildings through minor adaptations or alterations thereby ensuring their safety. This can be done by insertion of walls on the outside of the building, buttresses, walls in the interior of the building, portico fill-in-walls, specially an-

chored frames, covering of columns and beams, construction of new frame system, placing residential electrical equipment above flood level, designing water storage tanks to be able to withstand cyclonic winds, earthquakes and floods, etc.

Floods and mitigation measures

The lower plain regions of India in particular Bihar, Uttar Pradesh and West Bengal in respect of the Ganga and Assam in respect of the Brahmaputra suffer from the adverse effects of floods every year. The Ganga Brahmaputra basin receives maximum run off within the three monsoon months. Based on hydrological studies carried out, it is estimated that only 18 percent of the rainwater can be stored in dams, reservoirs, etc. while 82 percent of the rainwater flows through rivers ultimately into the sea. Floods are therefore a recurring phenomenon in our country.

Floods can be caused by natural, ecological or anthropogenic factors either individually or as a combined result. Anthropogenic activities such as deforestation and shifting cultivation can also contribute to floods. Forests on the hill slopes normally exert a sponge effect soaking up the abundant rainfall and storing it before releasing it in small amounts over a period of time. However when the forests are cleared the rivers turn muddy and swollen during the wet monsoon season and run dry later on in the year during the drier periods. An increasing proportion of the rainfall is therefore released shortly after precipitation in the form of floods.

The mitigation measures for floods include both structural and non-structural measures. The structural measures include:

- Reservoirs for impounding monsoon flows to be released in a regulated manner after the peak flood flow passes.

- Prevention of over-bank spilling by the construction of embankments and floodwalls.
- Improvement of flow conditions in the channel and anti-erosion measures.
- Improved drainage.

The non-structural measures include:

- Flood plain management such as Flood Plain Zoning and Flood Proofing including Disaster Preparedness
- Maintaining wetlands
- Flood forecasting and warning services
- Disaster relief, flood fighting and public health measures
- Flood insurance

Earthquakes and mitigation measures

It has been several years since the earthquake struck Gujarat on January 26, 2001. In these years rehabilitation has been done on a massive scale. Gujarat's experience has taught that building shelters with less vulnerability to earthquakes should also take into consideration the specific needs of the victims instead of being a top down approach. The role of NGOs in this is very important. Their strength lies in their manpower, informality in operations and valuable human resources. Their ability to reach out to the community and sensitivity to local traditions is an asset in such situations. A report on the various initiatives in Gujarat reported in Down to Earth (Vol 12, No. 2) by Mihir Bhatt throws light on the various developments that have taken place after the earthquake. According to the report the initiatives of the International Fund for

Agriculture Development in supporting the Self Employed Women's Association and the Government's initiative in community based livelihood security for earthquakes and drought victims have the potential to shape future disaster response and development projects in Gujarat. Similarly the Gujarat Woman's Economic Development Corporation initiative in reviving women's businesses after the calamity also provides many practical lessons in regenerating local economies and artisan markets. This project supported by the Asian Development Bank, puts premium on investments in income generation and asset building after a natural disaster. The farming kits provided to affected farmers by Gujarat's agriculture ministry is also showing promising results after two seasons. The author however states that coordination between Government, local NGOs and local community initiatives both for rescue as well as rehabilitation needs to be strengthened as this can cause delays, overlaps and waste of relief material and efforts.

Cyclones and mitigation measures

Tropical cyclones are the worst natural hazards in the tropics. They are large revolving vortices in the atmosphere extending horizontally from 150 to 1000 km and vertically from the surface to 12 to 14 km. These are intense low-pressure areas. Strong winds spiraling anti clockwise in the Northern Hemisphere blow around the cyclone center at the lower level. At the higher levels the sense of rotation is just opposite to that at the lower level. They generally move 300 to 5000 km per day over the ocean. While moving over the ocean they pick up energy from the warm water of the ocean and some of them grow into a devastating intensity. On an average about 5 to 6 tropical cyclones form in the Bay of Bengal and the Arabian Sea every year out of which 2 to 3 may be severe. More cyclones form in the Bay of Bengal than in the Arabian Sea. The main dangers from cyclones

are very strong winds, torrential rains and high storm tides. Most of the casualties are caused by coastal inundation by storm tides. This is often followed by heavy rainfall and floods. Storm surges cause the greatest destruction.

Although one cannot control cyclones, the effects of cyclones can be mitigated through effective and efficient mitigation policies and strategies. A brief description of the same is given below.

Installation of early warning systems: Such systems fitted along the coastlines can greatly assist forecasting techniques thus helping in early evacuation of people in the storm surge areas.

Developing communication infrastructure: Communication plays a vital role in cyclone disaster mitigation and yet this is one of the first services that gets disrupted during cyclones. Amateur Radio has today emerged as a second line unconventional communications systems and is an important tool for disaster mitigation.

Developing shelter belts: Shelter belts with plantations of trees can act as effective wind and tide breakers. Apart from acting as effective windbreakers and protecting soil crops from being damaged they prevent soil erosion.

Developing community cyclone shelters: Cyclone shelters at strategic locations can help minimizing the loss of human life. In the normal course these shelters can be used as public utility buildings.

Construction of permanent houses: There is a need to build appropriately designed concrete houses that can withstand high winds and tidal waves.

Training and education: Public awareness programs that inform the population about their response to cyclone warnings and preparedness can go a long way in reducing casualties.

Landuse control and settlement planning: No residential and industrial units should be ideally permitted in the coastal belt of 5 km from the sea as it is the most vulnerable belt. No further growth of settlements in this region should allowed. Major settlements and other important establishments should be located beyond 10 km from the sea.

Landslides and mitigation measures

Landslides are recurring phenomena in the Himalayan region. In the recent years however intensive construction activity and the destabilizing forces of nature have aggravated the problem. Landslides occur as a result of changes on a slope, sudden or gradual, either in its composition, structure, hydrology or vegetation. The changes can be due to geology, climate, weathering, land-use and earthquakes.

A significant reduction in the hazards caused by landslides can be achieved by preventing the exposure of population and facilities to landslides and by physically controlling the landslides. Developmental programs that involve modification of the topography, exploitation of natural resources and change in the balance load on the ground should not be permitted. Some critical measures that could be undertaken to prevent further landslides are drainage measures, erosion control measures such a bamboo check dams, terracing, jute and coir netting and rock-fall control measures such as grass plantation, vegetated dry masonry wall, retaining wall and most importantly preventing deforestation and improving afforestation.

Disasters cannot be totally prevented. However early warning systems, careful planning and preparedness on part of the vulnerable community would help in minimizing the loss of life and property due to these disasters.

Pollution

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6.1 FROM UNSUSTAINABLE TO SUSTAINABLE DEVELOPMENT

Until two decades ago the world looked at economic status alone as a measure of human development. Thus countries that were economically well developed and where people were relatively richer were called advanced nations while the rest where poverty was widespread and were economically backward were called developing countries. Most countries of North America and Europe which had become industrialized at an earlier stage have become economically more advanced. They not only exploited their own natural resources rapidly but also used the natural resources of developing countries to grow even larger economies. Thus the way development progressed, the rich countries got richer while the poor nations got poorer. However, even the developed world has begun to realise that their lives were being seriously affected by the environmental consequences of development based on economic growth alone. This form of development did not add to the quality of life as the environmental conditions had begun to deteriorate.

By the 1970s most development specialists began to appreciate the fact that economic growth alone could not bring about a better way of life for people unless environmental conditions were improved. Development strategies in which only economic considerations were used, had begun to suffer from serious environmental problems due to air and water pollution, waste management, deforestation and a variety of other ill effects that seriously affected peoples' well being and health. There were also serious equity issues between the "haves and the have nots" in society, at the global and national levels. The disparity in the lifestyles between the rich and the poor was made worse by these unsustainable development strategies.

Many decades ago, Mahatma Gandhi envisioned a reformed village community based on

sound environmental management. He stressed on the need for sanitation based on recycling human and animal manure and well-ventilated cottages built of recyclable material. He envisioned roads as being clean and free of dust. His main objective was to use village made goods instead of industrial products. All these principles are now considered part of sound long-term development. Gandhiji had designed a sustainable lifestyle for himself when these concepts were not a part of general thinking.

A growing realization of the development strategy that Mahatma Gandhi had suggested many decades earlier is now accepted by experts on development across the world. This is based on his concept that the world could support people's needs but not their greed. It has become obvious that the quality of human life has worsened as economies grew. The world now appears to be at a crossroad. It has taken the path of short term economic growth and now suffers the consequences of environmental degradation at the cost of loss of 'quality of human life'. The earth cannot supply the amount of resources used and wasted by the economically well off sectors of society as well as that required for day to day sustenance of the ever growing population in less developed countries. Society must thus change its unsustainable development strategy to a new form where development will not destroy the environment. This form of sustainable development can only be brought about if each individual practices a sustainable lifestyle based on caring for the earth.

It was also realized that these were not simple issues. Indira Gandhi said in the Stockholm Conference in 1972 that poverty was the greatest polluter. This meant that while the super rich nations had serious environmental problems, the under-developed in Asia, Africa and South America had a different set of environmental problems linked to poverty. Developing countries were suffering the consequences of a rapidly expanding human population with all its

effects on the over utilization of natural resources.

Thus increasingly the world began to see the need for a more equitable use of earth resources. The control over natural resources and the wealth that it produces also begins to create tensions between people that can eventually lead to both strife within a country and wars between nations. This is also a major cause for the loss of quality of life. How then could a new form of development be brought about that could solve the growing discontent in the world? It has become obvious that development must begin to change from aiming at short term economic gains to a long term sustainable growth that would not only support the well being and quality of life of all people living in the world today but that of future generations as well.

The current strategies of economic development are using up resources of the world so rapidly that our future generations, the young people of the world, would have serious environmental problems, much worse than those that we are facing at present. Thus current development strategies have come to be considered unsustainable for the world's long-term development. The newer concept of development has come to be known as "Sustainable Development". The nations of the world came to clearly understand these issues at the Rio Conference in 1992. Several documents were created for the United Nations Conference on Environment and Development (UNCED), which brought out the fact that environment and development were closely connected and that there was a need to 'care for the Earth'.

Sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It also looks at the equity between countries and continents, races and classes, gender and ages. It includes social development and

economic opportunity on one hand and the requirements of environment on the other. It is based on improving the quality of life for all, especially the poor and deprived within the carrying capacity of the supporting ecosystems. It is a process which leads to a better quality of life while reducing the impact on the environment. Its strength is that it acknowledges the interdependence of human needs and environmental requirements.

To ensure sustainable development, any activity that is expected to bring about economic growth must also consider its environmental impacts so that it is more consistent with long term growth and development. Many 'development projects', such as dams, mines, roads, industries and tourism development, have severe environmental consequences that must be studied before they are even begun. Thus for every project, in a strategy that looks at sustainable development, there must be a scientifically and honestly done EIA, without which the project must not be cleared.

Large dams, major highways, mining, industry, etc. can seriously damage ecosystems that support the ecological health of a region. Forests are essential for maintaining renewable resources, reducing carbon dioxide levels and maintaining oxygen levels in the earth's atmosphere. Their loss impairs future human development. Loss of forests depletes biodiversity which has to be preserved to maintain life on earth. Major heavy industries if not planned carefully lead to environmental degradation due to air and water pollution and generate enormous quantities of waste that lead to long term environmental hazards. Toxic and Nuclear wastes can become serious economic problems as getting rid of them is extremely costly. Thus the economic benefits of a project must be weighed against the possible environmental costs before a project is permitted.

We as citizens of our Nation, and increasingly as citizens of one common future at the global level, must constantly monitor the pattern of development. If we see that a development project or an industry is leading to serious environmental problems, it is our duty to bring this to the attention of authorities such as the local administration, the Forest Department or the Pollution Control Board, to look into the issue. Further if new development projects are being planned in and around the place where we live it is our duty to see that this is brought about in accordance with environmental safeguards. While we all need to think globally, we need to act locally. We have to see to it that we change development from its present mandate of rapid economic growth without a thought for future ecological integrity, to a more sustainable ecologically appropriate strategy.

If new projects of a large size are to be passed Government has made it compulsory to publish the summary report of the Environmental Impact Assessment (EIA) and conduct a 'Public Hearing'. It is essential that all of us as responsible citizens read, evaluate and respond to such public hearings held in our area and make comments on the possible impacts of the project. In many situations there are proponents of the project who only look at their own rapid economic gains. It is for citizens as concerned individuals and groups to counter these vested interests so that our environment is not degraded further. Life has to be made more livable for all. We cannot support the economic growth of one sector of society while we permit environmental degradation to destroy the lives of the less fortunate.

6.2 URBAN PROBLEMS RELATED TO ENERGY

Urban centers use enormous quantities of energy. In the past, urban housing required relatively smaller amounts of energy than we use at present. Traditional housing in India required

very little temperature adjustments as the materials used, such as wood and bricks handled temperature changes better than the current concrete, glass and steel of ultra modern buildings.

Embodied energy

Materials like iron, glass, aluminium, steel, cement, marble and burnt bricks, which are used in urban housing, are very energy intensive. The process of extraction, refinement, fabrication and delivery are all energy consuming and add to pollution of earth, air and water. This energy consumed in the process is called embodied energy.

Until the 1950s many urban kitchens were based on fuelwood or charcoal. This was possible and practical when homes had chimneys and kitchens were isolated from the rest of the house. Smoke became a problem once this changed to apartment blocks. Kerosene thus became a popular urban fuel. This changed to electrical energy and increasingly to natural gas by the 1970s in most parts of urban India.

Urban centers in hot climates need energy for cooling. The early systems of fans changed into air-conditioning, which consumes enormous quantities of energy. New buildings in our country have taken to using large areas covered by glass. While in cold climates this uses the green house effect to trap the warmth of the sun inside, in our hot climate this adds several degrees to the temperature inside. Thus it requires even more energy to run large central air conditioning units. High rise buildings in urban centers also depend on energy to operate lifts and an enormous number of lights.

CASE STUDY

Energy efficiency

Urban residential and commercial facilities are responsible for approximately 35% of USA's greenhouse gas emissions. Buildings need to be made energy efficient and reduce carbon dioxide emissions, which cause 'heat islands' or pockets of high temperature over these urban areas.

Urban transport depends on energy mainly from fossil fuels. Most urban people use their own individual transport rather than public transport systems for a variety of reasons. Urban transport in different cities and even different parts of a city are either inefficient or overcrowded. Thus even middle income groups tend to use their own private vehicles. This means more and more vehicles on the road which leads to traffic congestion, waste of time for all the commuters, and a great load of particulate matter and carbon monoxide from the exhaust of vehicles. This causes a rise in the number of people having serious respiratory diseases. Thus there is a need to develop a more efficient public transport system and discourage the use of individual vehicles in all our urban areas.

Each of us as an environmentally conscious individual must reduce our use of energy. An unnecessary light left on carelessly adds to energy use. Imagine the amount of energy wasted by thousands of careless people. If we learned to save electricity, we would begin to have a more sustainable lifestyle.

6.3 WATER CONSERVATION, RAINWATER HARVESTING, WATERSHED MANAGEMENT

6.3.1 Water Conservation:

Conserving water has become a prime environmental concern. Clean water is becoming increasingly scarce globally. With deforestation surface runoff increases and the sub soil water table drops as water has no time to seep slowly into the ground once vegetation is cleared.

As many areas depend on wells, it has become necessary to go on making deeper and deeper wells. This adds to the cost and further depletes underground stores of water. This could take years to recharge even if the present rate of extraction is reduced which seems hardly possible in most situations.

As deforestation and desertification spreads due to extensive changes in land use the once perennial rivers are becoming increasingly seasonal. In many areas the small streams run dry soon after the monsoon as the water table drops further and further below the surface. To this is added serious problems caused by rapid surface flow of water during the rains, which leads to extensive floods with loss of life and property.

When we waste water, we do not realise that it is affecting the lives of all of us in so many different ways. Water has to be equitably and fairly distributed so that household use, agriculture and industry all get a share of the water. It's over use and misuse due to various activities that waste water or cause pollution has led to a serious shortage of potable drinking water. Thus water conservation is linked closely with overall human well being.

Traditional systems of collecting water and using it optimally have been used in India for many generations. These have been forgotten in the recent past. Conserving water in multiple small percolation tanks and 'jheels' was important in

traditional forms of agriculture. Villages all over the country had one or more common 'talabs' or tanks from which people collected or used water carefully.

As women had to carry water to their homes over long distances, this was a time consuming and laborious activity, thus the water could not be wasted. Many homes had a kitchen garden that was watered by the wastewater. Conservation of water was done in traditional homes through a conscious effort.

CASE STUDY

Pani Panchayat – Pune District, Maharashtra

Mahur village in Pune District of Maharashtra is situated in a drought prone area. People were not able to grow a good crop in most years. Clean drinking water was also scarce. Vilasrao Salunkhe initiated a movement known as Pani Panchayat, to conserve water in this drought prone area. Watershed development was initiated on a barren and uncultivated piece of land belonging to a temple. Conservation of soil and water harvesting through a comprehensive micro-watershed management program gradually led to a surplus of water. Out of the 16 hectares of land in the village, 9.6 hectares were brought under irrigation, 2.4 hectares was afforested and 4 hectares was converted into percolation tanks. Wells and field bunds were built. While 200 quintals of grains were produced on 24 acres of Salunkhe's land, 40 acres in the same area yielded only 10 quintals. This made other villagers follow suit. The area rapidly turned green and productive.

During the British period many dams were built across the country to supply water especially to growing urban areas. Post independence, India's policy on water changed towards building large dams for expanding agriculture to support the green revolution. While this reduced the need to import food material and removed starvation in the country, the country began to see the effects of serious water shortages and problems related to its distribution. The newer forms of irrigated agriculture such as sugarcane and other water hungry cash crops required enormous quantities of water. Finally however, such irrigated areas become waterlogged and unproductive. As excess water evaporates rapidly from the surface of heavily irrigated croplands, it pulls up subsoil water along with salts to the surface of the soil. This leads to salinization by which the land becomes unproductive. Reducing the high salinity levels in soil is extremely expensive and frequently impossible.

With all these ill effects of the poorly conceived management of water at the national and local level there is a need to consider a new water policy for the country.

Saving water in agriculture: Drip irrigation supplies water to plants near its roots through a system of tubes, thus saving water. Small percolation tanks and rainwater harvesting can provide water for agriculture and domestic use. Rainwater collected from rooftops can be stored or used to effectively recharge subsoil aquifers.

Saving water in urban settings: Urban people waste large amounts of water. Leaking taps and pipes are a major source of loss of water. Canals and pipes carrying water from dams to the consumer lead to nearly 50% loss during transfer. Reducing the demand for water by saving it is more appropriate than trying to meet growing demands.

6.3.2 Rain water Harvesting

As our world faces serious water shortages, every drop of water we can use efficiently becomes of great value. One method is to manage rain water in such a way that it is used at the source. If as much water as possible is collected and stored this can be used after the rainy season is over. In many parts of the world especially in very dry areas this has been traditionally practiced. However the stored water has to be kept pollution free and clean so that it can be used as drinking water. Stored water can grow algae

and zooplankton (microscopic animals). This can be pathogenic and cause infections. Thus keeping the water uncontaminated is of great importance.

Current technologies of rainwater harvesting require that all roof and terrace water passes down into a covered tank where it can be stored for use after the monsoon. This is most advantageous in arid areas where clean water is very scarce. However there are practical difficulties such as constructing large storage tanks which are expensive.

CASE STUDY

Mewar, Rajasthan

The Mewar region of Rajasthan has a rich legacy of traditional water harvesting systems to share the available water for cultivation. There are various types of rainwater harvesting systems.

Medhbandi: This is a stone embankment built on a hill slope to help create a level field for cultivation. It controls erosion and conserves moisture.

Naada/bandha: These are stone check dams across streams or gullies that are constructed to capture runoff on a stretch of fertile land that is submerged in water during the monsoon. The land not only becomes more fertile after trapping silt, but also retains substantial quantities of water in the soil. These dams are constructed in phases over several years. The height is slowly increased up to the right height of the check dam which determines the size of the *naada*.

Hembar: These are small temporary dams constructed with stones, twigs and mud over a seasonal stream when water flows in it is re-

duced to a point that it cannot be taken directly to the fields for irrigation.

Chak: Chak is a big plot of land, usually a *charnot* or village pasture land, enclosed by a stone boundary wall called *kot*. Tree plantations, seeding of grass for fodder, contour bunds with trenches and loose stone check dams are developed in the chak. The *chak* is used for fodder and fuel wood. It reduces soil erosion and enhances recharge of ground water.

Talab: The Mewar region is well-known for its built reservoirs (*talabs*). Udaipur City is famous for its large number of *talabs*, and is called the lake city. A small reservoir of less than five *bighas* is called *talai*, a medium sized lake is called *bandh* or *talab* and a bigger lake is called *sagar* or *samand*.

Saza kuva: This is an open dug well which has several owners. In *Mewari* language, *saza* means partner. This is an important method for irrigation in the Aravalli hills. About 70,000 wells in the Udaipur District provide water for 80% of the area under irrigation and provide water for their owners. These are considered common property resources.

Another way of using rooftop rainwater harvesting is to collect it so that it percolates into the ground to recharge wells instead of flowing over the ground into rivers. Thus by recharging ground water harvested from rooftops, the water table rises and the surrounding wells retain water throughout the year.

6.3.3 Watershed Management:

Rivers originate in streams that flow down mountains and hill slopes. A group of small streams flow down hillsides to meet larger streams in the valley which forms the tributaries of major rivers. The management of a single unit of land with its water drainage system is called watershed management. It is a technique that has several components. This includes soil and water management and developing vegetative cover. The natural drainage pattern of a watershed unit if managed appropriately can bring about local prosperity by a year round abundance of water that improves the quality of human life in the area.

As it provides water throughout the year, this improves health in the community, as clean water becomes available. Watershed management enhances the growth of agricultural crops and even makes it possible to grow more than one crop in a year in dry areas.

Watershed management begins by taking control over a degraded site through local participation. People must appreciate the need to improve the availability of water both in quantity and quality for their own area. Once this is adequately demonstrated, the community begins to understand the project, people begin to work together in the activities that lead to good watershed management.

The first technical step is to take appropriate soil conservation measures. This is done by constructing a series of long trenches and mounds

along contours of the hill to hold the rainwater and allow it to percolate into the ground. This ensures that underground stores of water are fully recharged. This is enhanced by allowing grasses and shrubs to grow and by planting trees (mainly local species) which hold the soil and prevents it from being washed away in the monsoon. Local grass cover can however only increase if free grazing of domestic animals is prevented by stall feeding.

The next measure is to make 'nala' plugs in the streams so that the water is held in the stream and does not rush down the hillside. In selected sites, several small check dams are built which together hold back larger amounts of water. All these measures constitute sound watershed management. It improves the water table and keeps the streams and nalas flowing throughout the year.

Watershed management principles:

This is a land management program that looks at a region from the perspective of all its water related issues. It can be used to manage a river from its source to its termination. Watershed management could also consider the management of a single valley as a unit, based on its small streams. Saving water from its local source by allowing it to percolate into the ground by nala plugs and check dams instead of allowing it to run off rapidly along the surface during the monsoon, is a major aspect of good watershed management. This allows underground aquifers to fill so that ground water is recharged. Deforestation is a major cause of poor water supply. Afforesting such degraded areas is an important aspect of watershed management.

6.4 RESETTLEMENT AND REHABILITATION OF PEOPLE: ITS PROBLEMS AND CONCERNS

Major projects such as dams, mines, expressways, or the notification of a National Park disrupts the lives of the people who live there and may also require moving them to an alternative site. None of us would like to give up the home we grew up in. Uprooting people is a serious issue. It reduces their ability to subsist on their traditional natural resource base and also creates great psychological pressures. Especially tribal people, whose lives are woven closely around their own natural resources, cannot adapt to a new way of life in a new place. Thus no major project that is likely to displace people can be carried out without the consent of the local people. In India, lakhs of people have been unfairly displaced by thousands of dams created since independence to drive the green revolution. The dams have been built virtually at the cost of these poor local people who have been powerless to resist the Government's will. The Government is expected to find 'good' arable land to resettle displaced persons and provide them with an adequate rehabilitation package to recover from the disruption. This has rarely occurred to the satisfaction of the project affected individuals. In many cases across the country, this has not been implemented satisfactorily for decades.

Resettlement requires alternate land. However, in our overpopulated country, there is no arable high quality land available. Thus most project affected persons are given unusable wasteland. Rehabilitation involves more than just giving land. In most cases this is also not adequately done. The greatest battle to save their own precious land has been carried out by the tribal people of the Narmada River. They have fought to save their lands for decades. The Narmada Bachao Andolan has shown how bitter people can get over this issue.

CASE STUDY

The Tehri Project

The Tehri Dam in the outer Himalayas in Uttar Pradesh, when finished will submerge Tehri town and nearly 100 villages. Since the dam was sanctioned in 1972, local people have been opposing the dam and resisting its construction. Scientists, environmentalists and other groups have also opposed this dam.

Little is done to ensure proper rehabilitation and compensation for nearly a lakh of people who will be uprooted from their homes as a result of this dam, with little hope of rehabilitation, as no alternative land is available. There is also emotional and psychological trauma caused by forcibly removing people from their homeland where their families have lived for centuries.

Resettlement not only puts pressure on the project affected people but also on the people who have been living in the area that has been selected for resettlement. Thus both the communities suffer and conflict over resources is a distinct possibility in future.

CASE STUDY

Indigenous tribes

It is not flora and fauna alone that is under the threat of extinction. Among the many tribes across the globe, the Jarawa of the Andamans in the Indian Ocean are dwindling. Dispossession of their customary rights over land has put their survival at risk. They have been compelled to give up their traditional lifestyles resulting in rapidly diminishing indigenous population.

There are however situations where communities request for shifting to a new site. This is often observed where people live inside or on the periphery of a National Park or Wildlife Sanctuary. In these situations, such as the Gir in Gujarat, the local people have asked to be given alternate land where they could live peacefully away from lions that kill their cattle, but the Government has been unable to find suitable areas where they can be shifted for decades.

6.5 ENVIRONMENTAL ETHICS: ISSUES AND POSSIBLE SOLUTIONS

Environmental ethics deals with issues related to the rights of individuals that are fundamental to life and well being. This concerns not only the needs of each person today, but also those who will come after us. It also deals with the rights of other living creatures that inhabit our earth.

6.5.1 Resource consumption patterns and the need for their equitable utilisation:

Environmental ethics deals with issues that are related to how we utilise and distribute resources. Can individuals justifiably use resources so differently that one individual uses resources many times more lavishly than other individuals who have barely enough to survive? In a just world, there has to be a more equitable sharing of resources than we encounter at present. The just distribution of resources has global, national and local concerns that we need to address. There are rich and poor nations. There are rich and poor communities in every country. And there are rich and poor families. In this era of modern economic development, the disparity between the haves and have-nots is widening. Our human environments in the urban, rural and wilderness sectors, use natural resources that shift from the wilderness (forests, grasslands, wetlands, etc.) to the rural sector, and from there

to the urban sector. Wealth also shifts in the same direction. This unequal distribution of wealth and access to land and its resources is a serious environmental concern. An equitable sharing of resources forms the basis of sustainable development for urban, rural and wilderness dwelling communities. As the political power base is in the urban centers, this itself leads to inequalities and a subsequent loss of sustainability in resource management in the rural and even more so for forest dwelling people.

In 1985, Anil Agarwal published the first report on the Status of India's Environment. It emphasized that India's environmental problems were caused by the excessive consumption patterns of the rich that left the poor poorer. It was appreciated for the first time that tribals, especially women and other marginalized sectors of our society, were being left out of economic development. There are multiple stakeholders in Indian society who are dependent on different natural resources which cater directly or indirectly to their survival needs. Anil Agarwal brought forth a set of 8 propositions which are of great relevance to the ethical issues that are related to environmental concerns. These include:

1. Environmental destruction is largely caused by the consumption of the rich.
2. The worst sufferers of environmental destruction are the poor.
3. Even where nature is being 'recreated', as in afforestation, it is being transformed away from the needs of the poor and towards those of the rich.
4. Even among the poor, the worst sufferers are the marginalised cultures and occupations, and most of all, women.

5. There cannot be proper economic and social development without a holistic understanding of society and nature.
6. If we care for the poor, we cannot allow the Gross Nature Product to be destroyed any further. Conserving and recreating nature has become our highest priority.
7. Gross Nature Product will be enhanced only if we can arrest and reverse the growing alienation between the people and the common property resources. In this we will have to learn a lot from our traditional cultures.
8. It is totally inadequate to talk only of sustainable rural development, as the World Conservation Strategy does. We cannot save the rural environment or rural people dependent on it, unless we can bring about sustainable urban development.

Equitable use of forest resources: We think of forests as being degraded due to fuelwood collection by poor rural communities, but forget that the rich use much greater quantities of timber. Biomass based industries include cotton textiles, paper, plywood, rubber, soap, sugar, tobacco, jute, chocolate, food processing and packaging. These need land, energy, irrigation and forest resources. Do each of us realise this when we utilise, use excessively or waste these resources that we get indirectly from the forests?

Who pays for the cost of environmental degradation? Most sections of society do not feel the direct effects of degradation of the environment till it is too late. Those who suffer most are the poor, especially rural women, and tribal people who are dependent on forests. Traditional fishermen who are dependent on streams and rivers, and coastal people who fish and catch

crustacea, are seriously affected by the degradation of aquatic ecosystems. Fuelwood gatherers from different types of forests, and pastoralists who are dependent on common grazing lands suffer when their resources are depleted.

Several marginalised sectors of society are most affected by deforestation, or the loss of grassland tracts, or the deterioration of perennial water sources. All these effects can be linked to unsustainable increasing pressures on land and natural resources.

"I am often amazed and extremely angry, when people talk about Environment Education for the villages. It is the so-called, educated people who need Environment Education more than anyone else".

– Anil Agarwal, 'Human-Nature Interactions in a Third World Country'.

The well to do educated urban dweller consumes much larger quantities of resources and energy, than the traditional rural individual. Urban dwellers who are far removed from the source of natural resources that sustain their lives thus require exposure to a well-designed environment education program to appreciate these issues. While the rural people have a deep insight on the need for sustainable use of natural resources and know about methods of conservation, there are however several newer environmental concerns that are frequently outside their sphere of life experiences. Their traditional knowledge of environmental concerns cannot be expected to bring about an understanding of issues such as global warming, or problems created by pollution, pesticides, etc. These people thus require a different pattern of environment education that is related to their gaps in information. With the rapidly changing rural scenario the development that is thrust on unsuspecting rural communities needs to be ad-

dressed through locale specific environment awareness programs designed specifically for rural school children and adults. This must also use their local traditional knowledge systems as a base on which modern concepts can be built, rather than by fostering concepts that are completely alien to their own knowledge systems.

Common property resources in India once included vast stretches of forests, grazing lands and aquatic ecosystems. When the British found that they were unable to get enough wood for ship building and other uses they converted forest areas into Government 'Reserved Forests' for their own use to grow timber trees. This alienated local people from having a stake in preserving these resources. This in turn led to large-scale losses in forest cover and the creation of wasteland. In the past, in traditional villages that were managed by local panchayats, there were well defined rules about managing grazing lands, collecting forest resources, protecting sacred groves, etc. that supported conservation. There was a more or less equitable distribution that was controlled by traditional mechanisms to prevent misuse of common property resources. Any infringement was quickly dealt with by the panchayat and the offender was punished. Common property resources were thus locally protected by communities. As land use patterns changed, these mechanisms were lost and unsustainable practices evolved, frequently as a result of an inadequately planned development strategy.

6.5.2 Equity – Disparity in the Northern and Southern countries

Environmental ethics are concerned with, who owns resources and how they are distributed. This can be looked upon at different levels. At the global level it deals with the great North – South divide between the rich industrialized nations of North America and Europe, as against the needs of developing countries of the South

such as in South and Southeast Asia and South America. People living in the economically advanced nations use greater amounts of resources and energy per individual and also waste more resources. This is at the cost of poor people who are resource dependant and live in developing nations.

The economically advanced West has exploited their own natural resources to such an extent that they have exhausted them nearly everywhere. They now buy their resources from resource rich but economically deprived nations at a low cost. This depletes the developing nations of natural resources on which their poor depend for their livelihood.

Changing this unfair economic practice to a more just and fair way in managing trade would require a new thinking on the part of people who live in the super rich countries.

6.5.3 Urban – rural equity issues

The common property of rural communities has increasingly been used to supply the needs of the urban sector. Land itself that was once held as a common property resource of villages is being taken over by the urban and industrial sectors as it expands. The rural sector not only supplies food, but also a part of the energy needs (mainly fuelwood) to most towns and cities in India, at a pittance. As a result, the commons of the rural sector are being depleted of their resources. Thus while the cities get richer, the rural sector, especially the landless, get poorer. The urban rich must appreciate where their resources are derived from and be willing to pay a fair price for using them.

6.5.4 The need for Gender Equity

All over India, especially in the rural sector, women work on the whole longer hours than

men. The life of a woman is enmeshed in an inextricable cycle of poverty. In attempting to eke out a living from their environment, they must constantly collect fuelwood for their homes and for sale to nearby urban areas. They laboriously collect fodder for their cattle. They have to trudge several kilometers to reach a reasonably clean water source. And finally must cook meals in a smoky unhealthy atmosphere on crop waste or other inefficient sources of energy. All this can take 10 to 12 hours a day of very hard work, every day of the year. There is thus the question of who should control the environmental resources of a rural community. Unfortunately it is the men who play a decisive role in managing the village commons and its resources whereas it should be the local women whose lives are deeply linked with the utilisation and conservation patterns of natural resources, who should be decision makers at the local level. Unfortunately women have not been given an equal opportunity to develop and better their lot. This begins with the lack of attention given to girls whose education is always given less attention than the boys in the family. Unless society begins to see that development cannot be planned by a male dominated society from the male perspective alone, will we be able to create a better living environment for women and their children?

The great divide between women and men is most apparent in communities that live near forests and have by tradition made the woman play a greater role than men in collection of natural resources. Women fetch water, collect fuelwood, fruit, medicinal products, etc. day in and day out, while the men work only sporadically in the fields. This disparity in the lives of women and men has also led to a lower access to education and health care for girl children.

This has deep implications for the rate of utilization of natural resources and its conservation. Rural women who are intimately connected to resources, appreciate the value of conserving

natural resources more deeply than men. Thus several environmental movements such as Chipko have been more strongly supported by local women folk rather than men.

6.5.5 Preserving resources for future generations:

Can we use up all the resources of the world, leaving nothing for our future generations? This ethical issue must be considered when we use resources unsustainably. If we overuse and misuse resources and energy from fossil fuels, our future generations would find survival much more difficult. A critical concern is to preserve species and natural undisturbed ecosystems that are linked with bioresources, which must be protected for the use of future generations. Our generation does not own the world's resources to do whatever we please with them. Just as our ancestors have left resources for us, it is our duty to leave them behind for our future generations. These unborn people have a right to these resources. We only hold the world as trustees so that future generations can also survive.

Our current development strategies have led to environmental resources being overused and misused by our present generation, without a thought for the needs of future unborn generations. We need to appreciate that the next generation and those that will come later also have a right to the earth's natural resources. As they are not here today to exercise their rights, it is our generation's responsibility to appreciate the needs of future generations. We have no right to destroy their claim to the use of the earth's resources just because of the accident of being born before them. Development strategies have not looked at the sustainable levels at which we can use resources so that the rights of future generations are protected. We are not given the earth so that we can use up its resources. It is given to us to hold in trust so that

future generations are given their just share of the earth's resources.

6.5.6 The rights of animals:

Can man, a single species, use and severely exploit the earth's resources which we share with billions of other plant and animal species? Within our world there are a variety of living beings. The plants and animals that share the earth with us too have a right to live and share our earth's resources and living space. We have no right to push a species that has taken millions of years to evolve towards extinction. Not only do wild and domesticated animals have a right to life, but have the right to a dignified existence. Cruelty to an animal is no different ethically from cruelty to another human being.

Mahatma Gandhi's philosophy was based on the assumption that human beings were not masters of the other forms of life. He believed that humans were 'trustees of the lower animal kingdom'.

Human beings are one small cog in the wheel of life on earth. We frequently forget that man has learned to exploit nature and other species well beyond what we should use justifiably. Every plant and animal has a right to life as a part of our earth's community of living things. While

nature by itself has natural prey-predator relationships, left to itself, nature maintains a balance in each ecosystem. While evolution has developed a system whereby species become extinct and new ones evolve to fill the world's ecosystems with new plant and animal species, it is man alone that has been responsible for the recent rapid decline in the number of species on earth. Much more important man is now reducing the abundance levels of so many species that in the near future we will in all probability create a major extinction spasm on earth that will seriously endanger the existence of mankind. Thus endangering the existence of wild plants and animals and bringing them close to the brink of extinction is not only unfair to a species but also to future generation of people who may find them of great use. Quite apart from the use of these species, there is a strong ethical basis for the rights of animals and plants to exist on earth. Every individual, human or animal, that is living has feelings and emotions. Cruelty to animals is a crime that must be regarded seriously and action must be taken against offenders. Animals have a right to a dignified existence, and their life, well-being and liberty must be respected. While dominating over the animal world due to his superior intelligence, man cannot remain unfeeling to the right to life and well being of other species. There is a growing awareness of animal rights in our country and cruelty to animals is being increasingly regarded as a criminal offence.

CASE STUDY

Chipko movement

About 300 years ago, a ruler in Rajasthan decided to fell 'khejri' trees in his State to create lime. Local women led by a Bishnoi woman, Amrita Devi, clung to the trees to prevent the felling of the trees that formed the basis of the scarce resources on which they were dependent. The women were ruthlessly massacred. It is said that the ruler later realised his mistake. The story however has been remembered and was revived in the 1970s when severe tree felling for timber in the Himalayas prompted local women, supported by people such as Sunderlalji Bahuguna and Chandi Prasad Bhat, led a people's movement to prevent deforestation by timber contractors. They called their movement the 'Chipko' movement in memory of the event during which women had clung to their trees and given up their lives. The movement followed the path the 300 Bishnoi women had taken three centuries ago in Rajasthan.

Chipko is a movement primarily begun and supported by local women in the hills of Uttarakhand and Garhwal, where the women have had to bear the brunt of deforestation. They have not only realised that their fuelwood and fodder resources have receded away from their 'resource use areas' around their settlements due to commercial timber extraction,

but that this has led to serious floods and loss of precious soil.

Chipko activists have made long padyatras across the Himalayas protesting against deforestation. The movement has been highly successful and has been primarily supported by empowering local women's groups who are the most seriously affected segment of society by deforestation. The movement has proved to the world that the forests of the hills are the life support systems of local communities of immense value in terms of local produce that is essential for the survival of local people and that the forest has less quantifiable but even more important ecological services such as soil conservation and the maintenance of the natural water regime of the whole region.

The ability of local women to band themselves together in the foothills of the Himalayas goes back to the pre Independence days when women such as Miraben, a disciple of Gandhiji, moved to this region and understood that it was the deforestation that led to floods and devastation of villages in the valleys and in the Gangetic plains below. They also appreciated that substitutions of oak and other broadleaved forests of the Himalayas by planting fast growing pine for timber and resin was an ecological and social disaster which reduced the forest resources used by traditional hill communities.

6.5.7 The ethical basis of environment education and awareness:

Perhaps the most important concern is related to creating an ethos that will support a sustainable lifestyle in society. This brings us to the need for environmental education. The Honorary Supreme Court of our country has thus ordered that every young individual at school and col-

lege level be exposed to a course on environment. It is not to create only an awareness of environmental issues, but also to bring about pro environmental action. Among the variety of tools that can bring home the ethical issues of the environment, no solution is as powerful as real life experiences in nature. Creating a love for nature brings about strong pro environmental action. Our current educational processes at

school and college level are being reoriented to bring this about.

The Gandhian way of life

Mahatma Gandhi had deep insights into the need to conserve resources. 'Mans needs but not his greed can be supported by our earth' was an important concept that was initiated by him when people had not realized how short the world would be of resources in future. At the time natural resources seemed to be limitless to most people. This was thus a new concept and suggested the need for a uniquely different pattern of living.

Gandhiji believed in simplistic living to save our earth's resources. He once said that if India was to become an industrial nation on the lines of England, the world itself would be stripped bare of its resources by India's people alone.

Education in nature – The Shantiniketan model

Rabindranath Tagore founded Shantiniketan and taught an environment-based philosophy. Tagore's philosophy of education focused attention on the need for a harmonious association between human beings and their environment. To achieve this he relied on exposing young people to nature. This went back to our roots where in ancient India, learning centers were established in remote forests. Tagore linked these concepts with celebrations of nature through music, dance, drama and poetry. At Shantiniketan, there were celebrations for each season and ceremonial tree planting. He started Vriksha ropan way back in 1928. In fact much of what was initiated in Shantiniketan is now accepted as the route to environment education and sustainable living and is essentially based on preserving nature.

There are two aspects that are closely connected with ethical issues that are related to our environment. These are based on valuing nature and appreciating the beauty of nature and treasuring the magnificence of the wilderness.

Valuing nature as a resource: It is essential that a value system that is based on environmental concern becomes a part of the thinking that we as responsible citizens of our country and our earth need to bring into our own daily lives. For our ancestors, Nature was considered to be like a mother. This has been essentially forgotten. In ancient India, forests were considered sacred. We now know that forests clean up our air, and act like a sponge that can hold water for the dry season. In the Hindu scriptures, Buddhist philosophy and especially in the Jain religion, each and every species on earth is supposed to have a place in the scheme of life.

Many species were not only valued, but also venerated.

In today's world where many of us are far removed from nature, we need to remind ourselves that everything we use, if tracked back to its source, has come from nature. We depend on an intact unpolluted world which is based on nature's goods and services. No life is possible without this. If we as citizens begin to again respect Nature and all its varied species forming a complex web of life, and appreciate Nature's functions and services, it will continue to support our lives. If we disrespect nature one cannot expect her to continue to support our well being. Nature's resources that we all use and depend on can only be optimized if they are equitably shared by all of us. If the disparity is too great it can only result in anarchy. The 'have not's' cannot be expected to remain in

abject poverty, making a bare minimum living from the meager resources they can get, while the 'haves', who are already rich become richer through unsustainable consumer oriented, short-term economic development strategies.

Bringing back an ethic for nature conservation requires environment education and conservation awareness. The best way to do so is to expose young people not only to our dependence on natural resources from the wilderness, but by bringing about an appreciation of the beauty and wondrous aspects of nature. This forms a sharp contrast to the sad plight of degraded areas and polluted sites in which most of humanity now lives in the developed and developing world.

Appreciating the beauty of Nature and treasuring the magnificence of the Wilderness: We often take Nature for granted. We rarely take the opportunity to gaze at a scenic sunset, or spend the time to sit in the incredible silence of the forest, or listen to the songs of birds and the sound of the wind rustling through the leaves. Or take the trouble to watch the magic of a seed germinating from the ground and gradually growing into a seedling over several days. Or observe a tree through a round of seasons as it gets new leaves, flowers, fruit and seeds. Or reflect on the incredibly large number of linkages between all the different animals and birds that depend on the seasonal changes in their habitat. It is the beauty of Nature that gives it an intrinsic value which we tend to ignore. These are not mundane day to day events, they are magical and mystical aspects of nature's clock that is ticking silently all around us. They are part of our living throbbing earth. If we fail to enjoy these wondrous aspects of Nature our lives will always remain empty.

Once we realise that the wilderness has a value all its own, this puts man in his rightful role as a custodian of nature rather than an exploiter. Visit a wilderness area, a forest, lakeside, waterfall,

or seashore where man's hand has not made drastic changes to the ecosystem and one begins to value its beauty. It is there to heal the human soul and elevate his spirit. Without the wilderness, the earth would be a sad bleak human dominated landscape. The problem is how much of the wilderness can we preserve in the presence of an ever-growing hunger for land and resources for its utilitarian values. Unless we begin to see the ecological values of the wilderness, an ethic for its conservation cannot become part of our daily lives. And without the wilderness the earth will eventually become unlivable.

The concept of '*Karma*' is based on a thinking that the soul moves from man to animal and in reverse depending on ones actions. This itself brings about a concept of the oneness of all forms of life. *Ahimsa* or non-violence towards life which includes all plants and animals provides India with its basic philosophy which early Hindu philosophers and later sages such as Buddha, Mahavir and Mahatma Gandhi spoke of. Buddhist and Jain philosophy is intrinsically woven around non-violence and the great value of all forms of 'life'. It brings in the notion that animals are not to be viewed purely for their utility value but are a part of the earth's oneness which is linked with our own lives as well. In Hindu philosophy the earth itself is respected and venerated. In contrast, in Western thought Nature is to be subjugated and used. These are basic differences in thinking processes. Several modern philosophers in the West have now begun to see these eastern patterns of thought as a new basis for human development. This shift however, from a purely utilitarian or scientific exploitation of Nature, to one of harmony with Nature, can only occur if each of us loves and respects nature's great 'oneness'.

6.5.8 The conservation ethic and traditional value systems of India

In ancient Indian traditions people have always valued mountains, rivers, forests, trees and several animals. Thus much of nature was venerated and protected. Forests have been associated with the names of forest gods and goddesses both in the Hindu religion as well as in tribal cultures. 'Tree' goddesses have been associated with specific plant species. *Ficus religiosa*, the peepal tree, is venerated and is thus not to be cut down. The Banyan tree in some regions such as Maharashtra, is venerated once a year by tying a thread around it as a symbol of respect. The Tulsi plant is grown on the doorstep outside every home.

Patches of forest have been dedicated to a deity in many Indian cultures especially in tribal areas. These traditionally protected forest patches depict the true nature of undisturbed vegetation and have a large number of indigenous plant species as their exploitation has been controlled through local sentiments.

Certain species of trees have been protected as they are valued for their fruit or flowers. The mango tree is protected for its fruit around most farms even when wood becomes scarce. The Mohua tree (*Madhuca indica*) is protected by tribal people as it provides edible flowers, oil from its seeds and is used to make a potent alcohol. Many plants, shrubs and herbs have been used in Indian medicines which were once available in the wild in plenty. These are now rapidly vanishing. Many species of animals are venerated as being the 'vahan' or vehicle of different gods on which they are said to travel through the cosmos.

In Indian mythology, the elephant is associated with Ganesha. The elephant headed Ganesha is also linked to the rat. Vishnu is associated with the eagle. Rama is linked to monkeys. In mythology, Hanuman, the monkey god, rendered

invaluable help to Rama during his travels to Lanka. The Sun god, Surya, rides a horse and has a superb chariot on which he moves through the sky. The lion is linked to Durga and the blackbuck to the moon goddess. The cow is associated with Krishna. Vishnu's incarnations have been represented as taking various animal forms which serially include, fish, tortoise, a boar and a dwarf, and a half man half lion form.

The associations to various plants that have been given a religious significance include Tulsi, which is linked to Lakshmi and Vishnu. The Tulsi plant is also linked to the worship of one's own ancestors. The peepal tree is said to be the tree under which Buddha attained enlightenment. It is also associated with Vishnu and Krishna. Several trees are associated with the goddess Laxmi, including Amalaki, Mango and the Tulsi shrub.

Traditions also held that these species, which were considered as an important aspect of Nature, were the basis of local life support systems and were integral to bringing about a harmonious life. In traditional societies of the past, these examples were all a part of ethical values that protected nature. As modern science based on the exploitation of nature spread into India, many of these traditions began to lose their effectiveness as measures that led to conserving nature.

Concepts that support nature's integrity must thus become a part of our modern educational systems. This constitutes a key solution to bring about a new ethic of conserving nature and living sustainable lifestyles.

6.6 CLIMATE CHANGE, GLOBAL WARMING, ACID RAIN, OZONE LAYER DEPLETION, NUCLEAR ACCIDENTS AND HOLOCAUST

6.6.1 Climate change:

The average temperature in many regions has been increasing in recent decades. The global average surface temperature has increased by $0.6^{\circ} + 0.2^{\circ}$ C over the last century. Globally, 1998 was the warmest year and the 1990s the warmest decade on record. Many countries have experienced increases in rainfall, particularly in the countries situated in the mid to high latitudes.

In some regions, such as parts of Asia and Africa, the frequency and intensity of droughts have been observed to increase in recent decades. Episodes of El Niño, which creates great storms, have been more frequent, persistent and intense since mid-1970s compared with the previous 100 years. All these are signs that the earth is sick. Its climate is changing, making it more difficult for mankind to survive. The earth is losing its ability to balance itself due to the imbalances created by human activities.

Projections of future climate change are derived from a series of experiments made by computer based global climate models. These are worked out on estimates of aspects such as future population growth and energy use. Climatologists of the Intergovernmental Panel on Climate Change (IPCC) have reviewed the results of several experiments in order to estimate changes in climate in the course of this century. These studies have shown that in the near future, the global mean surface temperature will rise by 1.4° to 5.8° C. Warming will be greatest over land areas, and at high latitudes. The projected rate of warming is greater than has occurred in the last 10,000 years. The frequency of weather extremes is likely to increase leading to floods or drought. There will be fewer cold spells but more heat waves. The frequency and intensity of El

Niño is likely to increase. Global mean sea level is projected to rise by 9 to 88 cm by the year 2100. More than half of the world's population now lives within 60km of the sea. They are likely to be seriously impacted by an ingress of salt water and by the rising sea. Some of the most vulnerable regions are the Nile delta in Egypt, the Ganges-Brahmaputra delta in Bangladesh, and many small islands including the Marshall Islands and the Maldives, (WHO, 2001).

Human societies will be seriously affected by extremes of climate such as droughts and floods. A changing climate would bring about changes in the frequency and/or intensity of these extremes. This is a major concern for human health. To a large extent, public health depends on safe drinking water, sufficient food, secure shelter, and good social conditions. All these factors are affected by climate change. Fresh water supplies may be seriously affected, reducing the availability of clean water for drinking and washing during drought as well as floods. Water can be contaminated and sewage systems may be damaged. The risk of spread of infectious diseases such as diarrhoeal diseases will increase. Food production will be seriously reduced in vulnerable regions directly and also indirectly through an increase in pests and plant or animal diseases. The local reduction in food production would lead to starvation and malnutrition with long-term health consequences, especially for children. Food and water shortages may lead to conflicts in vulnerable regions, with serious implications for public health. Climate change related impacts on human health could lead to displacement of a large number of people, creating environmental refugees and lead to further health issues.

Changes in climate may affect the distribution of vector species (e.g. mosquitoes) which in turn will increase the spread of disease, such as malaria and filariasis, to new areas which lack a strong public health infrastructure. The seasonal transmission and distribution of many diseases

that are transmitted by mosquitoes (dengue, yellow fever) and by ticks (Lyme disease, tick-borne encephalitis) may spread due to climate change.

CASE STUDIES

Damage to coral reefs, Pacific

The severity of periodic warming due to El Nino in 1997 in the Pacific led to the most serious death in coral ever known. It is estimated that about 10% of the Earth's coral reefs were dead, another 30 % were seriously affected and another 30% were degraded.

The Global Coral Reef Monitoring Network Townsville, Australia, has predicted that all the reefs could be dead by 2050.

Butterfly populations in the United Kingdom

Global warming is leading to an early arrival of butterflies in Britain. Scientists say that butterflies can now be spotted much earlier every year in the last two decades. Some, like the red admiral, can now be seen a month earlier than was the case in the mid – 1970s. Others, like the peacock and the orange tip are appearing between 15 and 25 days earlier than in the past. Future rise in temperature is likely to have a detrimental effect on these butterflies. Some butterflies which need cooler temperatures might suffer.

A Task Group set up by WHO has warned that climate change may have serious impacts on human health. Climate change will increase various current health problems, and may also bring

new and unexpected ones. Strategies aimed at reducing potential health impacts of anticipated climate changes should include monitoring of infectious diseases and disease vectors to detect early changes in the incidence of diseases and the geographical distribution of vectors; environmental management measures to reduce risk; disaster preparedness for floods or droughts; and their health related consequences. It will be necessary to create early warning systems and education for epidemic preparedness. Improved water and air pollution control will become increasingly essential for human health. Public education will have to be directed at changes in personal behaviour. Training of researchers and health professionals must become an essential part of the world becoming more responsible towards the expected outcome of Global Climate Change (GCC).

6.6.2 Global warming:

About 75% of the solar energy reaching the Earth is absorbed on the earth's surface which increases its temperature. The rest of the heat radiates back to the atmosphere. Some of the heat is trapped by greenhouse gases, mostly carbon dioxide. As carbon dioxide is released by various human activities, it is rapidly increasing. This is causing global warming.

The average surface temperature is about 15°C. This is about 33°C higher than it would be in the absence of the greenhouse effect. Without such gases most of the Earth's surface would be frozen with a mean air temperature of -18°C.

Human activities during the last few decades of industrialisation and population growth have polluted the atmosphere to the extent that it has begun to seriously affect the climate. Carbon dioxide in the atmosphere has increased by 31% since pre-industrial times, causing more heat to be trapped in the lower atmosphere. There is evidence to show that carbon dioxide

levels are still increasing. Many countries have signed a convention to reduce greenhouse gases under the United Nations Convention on Climate Change. Current international agreements are however not still effective to prevent the significant changes in climate and a rise in sea levels.

Global warming is accelerating faster than what climatologists had calculated a few years ago. In 1995, the Intergovernmental Panel on Climate Change predict that global warming would rise temperatures by 3.5 to 10 degrees Centigrade during the 21st century, if the present trends continue. It is now believed that this could be much greater. This would lead to not only temperature changes but in the amount of rainfall. India may see great annual fluctuations in rainfall leading to floods and drought.

6.6.3 Acid rain:

When fossil fuels such as coal, oil and natural gas are burned, chemicals like sulfur dioxide and nitrogen oxides are produced. These chemicals react with water and other chemicals in the air to form sulfuric acid, nitric acid and other harmful pollutants like sulfates and nitrates. These acid pollutants spread upwards into the atmosphere, and are carried by air currents, to finally return to the ground in the form of acid rain, fog or snow. The corrosive nature of acid rain causes many forms of environmental damage. Acid pollutants also occur as dry particles and gases, which when washed from the ground by rain, add to the acids in the rain to form a more corrosive solution. This is called acid deposition.

Damage from acid rain is widespread in North America, Europe, Japan, China and Southeast Asia. In the US coal burning power plants contribute to about 70% of sulfur dioxide. In Canada oil refining, metal smelting and other

industrial activities account for 61% of sulfur dioxide pollution. Motor vehicle exhaust fumes are the main source of nitrogen oxides. The acids in acid rain chemically react with any object they come in contact with. Acids react with other chemicals by giving up hydrogen atoms.

Effects: Acid rain is known to cause widespread environmental damage.

1. Acid rain dissolves and washes away nutrients in the soil which are needed by plants. It can also dissolve naturally occurring toxic substances like aluminium and mercury, freeing them to pollute water or poison plants.
2. Acid rain indirectly affects plants by removing nutrients from the soil in which they grow. It affects trees more directly by creating holes in the waxy coating of leaves, causing brown dead spots which affect the plant's photosynthesis. Such trees are also more vulnerable to insect infestations, drought and cold. Spruce and fir forests at higher elevations seem to be most at risk. Farm crops are less affected by acid rain than forests.
3. Acid rain that falls or flows as ground water to reach rivers, lakes and wetlands, causes the water in them to become acidic. This affects plant and animal life in aquatic ecosystems.
4. Acid rain also has far reaching effects on wildlife. By adversely affecting one species, the entire food chain is disrupted, ultimately endangering the entire ecosystem. Different aquatic species can tolerate different levels of acidity. For instance clams and mayflies have a high mortality when water has a pH of 6.0, while frogs can tolerate more acidic water, although with the decline in supply of mayflies, frog populations may also decline. Land animals that are de-

pendent on aquatic organisms are also affected.

5. Acid rain and dry acid deposition damages buildings, automobiles, and other structures made of stone or metal. The acid corrodes the materials causing extensive damage and ruins historic buildings. For instance the Parthenon in Greece and the Taj Mahal in India have been affected by acid rain.
6. Although surface water polluted by acid rain does not directly harm people, the toxic substances leached from soil can pollute water supply. Fish caught in these waters may be harmful for human consumption. Acid, along with other chemicals in the air, produces urban smog, which causes respiratory problems.

Solutions: The best way to stop the formation of acid rain is to reduce the emissions of sulfur dioxide and nitrogen oxides into the atmosphere. This can be achieved by using less energy from fossil fuels in power plants, vehicles and industry. Switching to cleaner burning fuels is also a way out. For instance using natural gas which is cleaner than coal, using coal with lower sulfur content, and developing more efficient vehicles. If the pollutants have already been formed by burning fossil fuels, they can be prevented from entering the atmosphere by using scrubbers in smokestacks in industry. These spray a mixture of water and limestone into the polluting gases, recapturing the sulfur.

In catalytic converters, the gases are passed over metal coated beads that convert harmful chemicals into less harmful ones. These are used in cars to reduce the effects of exhaust fumes on the atmosphere. Once acid rain has affected soil, powdered limestone can be added to the soil by a process known as liming to neutralize the acidity of the soil.

6.6.4 Ozone layer depletion:

Ozone is formed by the action of sunlight on oxygen. It forms a layer 20 to 50kms above the surface of the earth. This action takes place naturally in the atmosphere, but is very slow. Ozone is a highly poisonous gas with a strong odour. It is a form of oxygen that has three atoms in each molecule. It is considered a pollutant at ground level and constitutes a health hazard by causing respiratory ailments like asthma and bronchitis. It also causes harm to vegetation and leads to a deterioration of certain materials like plastic and rubber. Ozone in the upper atmosphere however, is vital to all life as it protects the earth from the sun's harmful ultraviolet radiation. The ozone layer in the upper atmosphere absorbs the sun's ultraviolet radiation, preventing it from reaching the earth's surface.

This layer in the atmosphere protects life on earth from the dangerous UV radiation from the sun. In the 1970s, scientists discovered that chemicals called chlorofluorocarbons or CFCs, which were used as refrigerants and aerosol spray propellants, posed a threat to the ozone layer. The CFC molecules are virtually indestructible until they reach the stratosphere, where UV radiation breaks them down to release chlorine atoms. The chlorine atoms react with ozone molecules which break down into oxygen molecules, which do not absorb UV radiations. Since the early 1980s, scientists detected a thinning of the ozone layer in the atmosphere above Antarctica. This phenomenon is now being detected in other places as well including Australia. Although the use of CFCs has been reduced and now banned in most countries, other chemicals and industrial compounds such as bromine, halocarbons and nitrous oxides from fertilizers may also attack the ozone layer.

The destruction of the ozone layer is seen to cause increased cases of skin cancer and cataracts. It also causes damage to certain crops and

to plankton, thus affecting nature's food chains and food webs. This in turn causes an increase in carbon dioxide due to the decrease in vegetation.

With the signing of the Montreal Protocol in 1987, a treaty for the protection of the ozone layer, the use of CFCs was to be banned by the year 2000. After 2000, the ozone layer is expected to recover slowly over a period of about 50 years.

6.6.5 Nuclear Accidents and Nuclear Holocaust:

Nuclear energy was researched and discovered by man as a source of alternate energy which would be clean and cheap compared to fossil fuels. And although this did happen, along with the benefits of nuclear energy came its downfalls. In the short history of nuclear energy there have been accidents that have surpassed any natural calamity or other energy source extraction in their impacts. A single nuclear accident can cause loss of life, long-term illness and destruction of property on a large scale for a long period of time. Radioactivity and radioactive fallout leads to cancer, genetic disorders and death in the affected area for decades after, thus affecting all forms of life for generations to come.

CASE STUDY

Nuclear disasters and leakages

In 1986 the Nuclear Power Station at Chernobyl in USSR developed a problem that led to a fire and a number of explosions in its Nuclear Reactor. The radioactive dust spread over many kilometers and covered not only Europe but North America as well. Three people died in the explosion and 28 shortly after due to radiation exposure. Some 259 sick were hospitalized. As the area had to be evacuated 1,35,000 people had to be moved immediately and another 1.5 lac by 1991. As radioactive fallout continued even more people had to be moved. An estimated 6.5 lakh people may have been seriously affected. They may get cancer, thyroid tumours, and cataracts, and suffer from a lowered immune mechanism.

As radioactivity passes from grass to herbivores, sheep in Scotland and Reindeer in Lapland were affected and were unfit for human consumption. Vegetable, fruit and milk were contaminated in Europe.

A French Nuclear Waste Processing Center in Normandy may have affected the lives of children playing nearby. They may develop leukemia (blood cancer) in later life.

Nuclear holocaust:

The use of nuclear energy in war has had devastating effects on man and earth. The Hiroshima and Nagasaki incident during World War II, the only use of nuclear power in war in history, is one of the worst disasters in history. In 1945, the United States dropped atomic bombs in Japan over the towns of Hiroshima and Nagasaki. These two atomic bombs killed thousands of people, left many thousands injured and devastated everything for miles

around. The effects of the radiation from these nuclear bombs can still be seen today in the form of cancer and genetic mutations in the affected children and survivors of the incident.

6.7 WASTELAND RECLAMATION

Loss of vegetation cover leads to loss of soil through erosion, which ultimately creates wastelands. This is one of the pressing problems of the country. Loss of soil has already ruined a large amount of cultivable land in our country. If it remains unchecked, it will affect the remaining land. Unless we adequately safeguard our 'good' lands, we may eventually face a serious shortage of food grains, vegetables, fruit, fodder and fuel wood. Hence, conservation of soil, protecting the existing cultivable land and reclaiming the already depleted wastelands figures prominently among the priority tasks of planning for the future. Some of the wasteland reclamation programs have been unsuccessful because after sometime the land reverts to its original poor condition due to mismanagement and unscientific ways in which the reclamation has been carried out.

In choosing wasteland reclamation methods attention must be paid to the cost factor. This has to be taken into account before deciding on a particular method for reclamation of wastelands. A proper study of environmental aspects and human impacts which are responsible for the development of wastelands have to be looked into.

Wasteland can be classified into three forms: (1) Easily reclaimable, (2) Reclaimable with some difficulty, (3) Reclaimable with extreme difficulty.

Easily reclaimable wastelands can be used for agricultural purposes. Those which can be reclaimed with some difficulty can be utilized for agro forestry. Wastelands that are reclaimed

with extreme difficulty can be used for forestry or to recreate natural ecosystems.

Agriculture: Wasteland can be reclaimed for agriculture by reducing the salt content which can be done by leaching and flushing. Gypsum, urea, potash and compost are added before planting crops in such areas.

Agro forestry: This involves putting land to multiple uses. Its main purpose is to have trees and crops inter- and /or under planted to form an integrated system of biological production within a certain area. Thus, agro forestry implies integration of trees with agricultural crops or live-stock management simultaneously.

Forestry: Attempts to grow trees in highly non alkaline saline soils have been largely unsuccessful. Field experiments have shown that species like Eucalyptus, Prosopis and Acacia Nilotica could not be grown in highly alkaline soil. Studies have shown that if tree seedlings are planted with a mixture of original soil, Gypsum, and manure, better growth can be achieved. It is however important to use indigenous species of trees so that the program recreates the local ecosystem with all its species.

Need for wasteland development:

Wasteland development provides a source of income for the rural poor. It ensures a constant supply of fuel, fodder and timber for local use. It makes the soil fertile by preventing soil erosion and conserving moisture. The program helps maintain an ecological balance in the area. The increasing forest cover helps in maintaining local climatic conditions. Regenerated vegetation cover helps in attracting birds which feed on pests in the surrounding fields and function as natural pest controllers. The trees help in holding back moisture and reduce surface run off rates thus helping in the control of soil erosion.

Components of wasteland reclamation:

The first major task is the identification of the problem at the micro level. For this it is necessary to have District, Village and plot level surveys of the wasteland. A profile of the maps indicating the detailed distribution and information on the wasteland is essential. With the help of local government institutions such as the village Panchayats, along with Block Development Officers, Revenue Department functionaries, a plan based on the community needs must be produced. This must be done through a participatory exercise that involves all the different stakeholders in the community. A think-tank of administrators, ecologists, and local NGOs must also be involved in the process.

The next step is to identify the factors that are responsible for the formation of wastelands. Based on these factors the wasteland is classified into: marginally, partially or severely deteriorated lands. Locale specific strategies for reclaiming the wasteland must be worked out. Government officials along with the local NGOs must assist the farmers by demonstrating improved methods of cultivation, arranging for loans for the small, marginal and landless farmers and the people from the weaker sections of the society. Involving local women has proved to be of great value. Another essential component of the program is to organize publicity campaigns, integrated with training farmers and frontline Government and Forest Department staff on the various aspects of wasteland utilization. Environmental scientists can help by suggesting the necessary changes in cropping patterns particularly for drought prone areas. Other tasks that should be addressed include the selection of appropriate crops for fodder and trees that provide local people with non-wooded forest products according to the nature of the wasteland. Testing soil in laboratories provides guidance to the farmers on the proper land management to be used. Irrigation and other expertise needed for improving productivity without creating unsustainable patterns of de-

velopment provide the local people with newer technological advances. Guidelines regarding control of water logging must be provided. Appropriate technologies must be made available to people belonging to the weaker sections and landless farmers. Collective efforts have to be made to check soil losses through water and wind erosion to prevent the collapse of the irrigation system through siltation. Plans concerning wasteland reclamation and utilization prepared at various stages must be properly integrated for a successful long-term outcome.

CASE STUDY

Tehri, Uttar Pradesh

Nagchaund village in Tehri District of Uttar Pradesh was once an eroded and deforested land. When Soban Singh Bhandari returned to his village after retirement from the army in 1987 he was struck by this degradation. After six months he became the *pradhan* of the village and decided to implement various village development schemes differently. Through the Jawahar Rozgar Yojana, he gained immense community support. In 1990 the Forest Department selected a 30-hectare barren piece of community land for a micro-watershed development program. The villagers controlled grazing in the area, undertook plantations for fuel and fodder. Bhandari helped the village raise money by selling the fodder from the area to a neighboring village and the money was used for development and maintenance work. This community effort has had a great impact on the ecology of the area. The moisture content of the area increased and the water sources of the villages were recharged. Local people now have access to all the natural resources they need for their daily lives.

The demands of our increasing human population for environmental goods and services has imposed severe pressures on the available land resources especially on the forests and green cover. This is closely linked to the wellbeing of the rural population which constitutes a large percent of the population which depends on local natural resources for their survival. The increasing demand for food, fodder, fuel wood, etc. has led to activities that are responsible for increasing environmental degradation. This is responsible for the extension of wastelands. Thus the development of agro forestry based agriculture and forestry has become the prime prerequisite for an overall development of the economy in the country. The pressure on land is already very high and the only hope of increasing productivity lies in bringing appropriate improvement in the various categories of wasteland spread over the country.

6.8 CONSUMERISM AND WASTE PRODUCTS

Modern societies that are based on using large amounts of goods, especially those that are manufactured for one time use, are extremely wasteful. The increasing consumption of natural resources has led to serious environmental problems around the world. Current consumption patterns are depleting non-renewable resources, poisoning and degrading ecosystems, and altering the natural processes on which life depends. The present pattern of consumption, especially in affluent societies, is mainly responsible for the high level of utilization of resources. People in the industrialized countries make up 20% of the world population but consume 80% of the world's resources and produce 80% of wastes. This is due to a pattern of economic development that ensures that people go on consuming even more than they actually need. India is rapidly moving into this unsustainable pattern of economic growth and development. The rich in such a society get richer often at the cost of the poor whose lives are not improved

by the process of development. It is seen that today's consumption patterns are depleting natural resources at a rapid rate and widening the inequalities in consumption in different societies. Consumerism causes wasteful use of energy and material far beyond that needed for everyday living at a comfortable level. Money is not the only way to measure the cost of an item that we use. When one adds up all the raw material and energy that goes into the manufacture of goods or the services provided by nature that one uses during a day's activities, the toll on the environment is large. When this cost is multiplied over a lifespan, the amount is staggering. If one considered the overutilisation in each family, city or a country, the impacts are incredibly high. For example: two hundred billion cans, bottles, plastic cartons and paper cups, are thrown away each year in the "developed" world. "Disposable" items greatly increase this waste. Rather than compete on quality or reliability, many industrial consumer products are made for one-time use. Buying quality products that are warranted against failure or wearing out, learning about the raw materials that things are made of, and an appreciation of their origin from nature's storehouse, as well as knowing the conditions of the workers that make them, are some ways of resisting consumerism and decreasing waste.

CASE STUDY

Himachal Pradesh was the first State in India to regulate the manufacture and use of plastics. The State proposed a ban on all types of polythene packing.

While there may be some new appliances and cars that are more productive and energy efficient, discarding the old often leads to an almost total waste of the energy and material already invested in these products. This alone

may more than nullify the energy savings of the new product. This is a tricky problem.

Consumerism is related to the constant purchasing of new goods, with little attention to their true need, durability, product origin, or the environmental consequences of their manufacture and disposal. Consumerism is driven by huge sums spent on advertising designed to create both a desire to follow trends, and a personal feeling of satisfaction based on acquisition. Materialism is one of the end results of consumerism.

Consumerism interferes with the sustainable use of resources in a society by replacing the normal common sense desire for an adequate supply of life's necessities, with an insatiable quest for things that are purchased by larger and larger incomes to buy them. There is little regard for the true utility of what is bought. An intended consequence of this strategy which is promoted by those who profit from consumerism, is to accelerate the discarding of the old, either because of lack of durability or a change in fashion. Especially in developed countries, landfills are being rapidly filled with cheap discarded products that fail to work within a short time and cannot be repaired. In many cases consumer products are made psychologically obsolete by the advertising industry long before they actually wear out.

The inordinate amount of waste that is generated by consumer-oriented societies around the world is now a serious environmental issue. Most human activities are related to production and consumption cycles which produce excessive amounts of waste in the form of solid, liquid and gaseous waste products. The problems of waste management in the urban and rural sectors are different. Rural communities that were smaller, once had a limited amount of waste which was recycled as the communities used them effectively. With the advent of an industrial civilization the highly complex technologi-

cal processes for production of goods has rapidly increased problems due to inadequate waste disposal. This creates a heavy burden on natural resources, degrades the environment and creates health hazards. With the rapid increase in population, the amount of waste in terms of quantity and quality has increased waste management pressures many fold in recent years. If the high quantities of waste generated continues, mankind will be drowned under heaps of garbage, and streams of sewage. His health will be affected by dangerous industrial effluents, and he will be smothered by clouds of smoke and unhealthy gases. Human civilisation will run out of resources, preventing further development.

The increasing demands of consumption on the finite resources of the planet, increasing level of environmental pollution, and the problems of waste disposal must be changed to the careful utilization of resources, recovery of used material by waste recycling. Therefore reuse of goods and waste utilization should become a part of the production-consumption cycle. Utilizing various forms of waste must be made a part of the planning and development process. Current patterns in the industrial sector have led to the disposal of waste in a careless uneconomical manner. Burning or dumping wastes into streams and oceans, or creating more landfills damages the environment. For example it is estimated that the per capita production of domestic waste is many times higher in a developed country when compared to a developing country. Unfortunately, many developing countries are now working out similar wasteful trends through development, but do not have the same economic potential to handle the waste this new unsustainable strategy produces. Large quantities of solid, liquid and gaseous waste is produced by urban industrial communities in the form of plastic, paper, leather, tin cans, bottles, mineral refuse, and pathological waste from hospitals. Dead animals, agricultural wastes, fertilizer and pesticide overuse, and human and

animal excreta are essentially rural concerns. The waste is either discharged into the atmosphere, into water sources, or buried underground. These wastes are not considered to have any economic value. This attitude towards waste has led to disastrous effects on the environment besides over exploiting natural resources.

Reduce, reuse, recycle

Reduce, Reuse, Recycle, or the 3Rs principle, is the new concept in waste management. But what does it actually mean? Although some waste is inevitable in any society, we must minimize the generation of waste at the source by using minimal resources. Do not use what you do not need. The goal of every society should be to reach a low-waste or no waste society.

Eg. Fancy packaging of consumer products in two or three layers is not necessary.

Use your own reusable cloth/ jute bags instead of plastic bags.

The residual waste can be converted into a useable resource. In developed countries waste is used to produce energy.

Several technological breakthroughs have recently been made to recover material from industrial waste such as heavy metals and chemicals such as mercury and nitric acid. Thus the waste does not remain a waste product anymore, but becomes a useful resource.

Eg. Using kitchen wet waste to make compost that can be used as an organic fertilizer.

Using sewage in a biogas plant to make fuel.

One industry's waste could be a valuable resource for another industry.

Eg. Cloth rags from the textile industry are bought and used by paper and other industries.

Social Issues and The Environment

Bagasse, a waste product of the sugar industry, is used in the paper, ply industries.

The material left over after extraction of oil from seeds is used as cattle feed.

CASE STUDY

Plastic to oil

The Indian Oil Corporation Limited and the Department of Science and Technology are expected to establish India's first plant to convert waste plastic into petrol, diesel and LPG.

The generated waste or discarded material that cannot be used again in its original form can be sent back to the industry to be broken down and used as a resource to be made into a new product of the same type or into something entirely different.

Eg. Plastic items are recycled into new plastic products.

Metal scrap and broken glass is used to make new metal products.

Finally, the waste material generated which can neither be reused or recycled, must be disposed off in a proper manner with minimum impact to the environment.

- Non toxic solid waste should be properly segregated and disposed off in landfills that are properly sealed to avoid leakage and contamination of surrounding land and groundwater.
- Toxic wastes should be treated or disposed off separately in a proper manner.

- Sewage and industrial wastewater should be adequately treated and raw materials recovered from it where possible before it is released into our rivers and waterways.

The 3R principle of Reduce, Reuse, Recycle, should be followed in that order.

- Reduction is the best option. If we reduce at source, there is a smaller chance of waste generation and the pressure on our already stretched natural resources is reduced.
- Reuse is the next best option, as the product is reused in its current form without any energy expended to convert it into a new item.
- Recycling is the last option, as although it converts a waste into a resource, it uses energy to transform that resource into a new useable product.

Thus by following the 'Reduce, Reuse, Recycle' principle, i.e. by reducing use at source, by re-using and recycling whatever possible and finally by proper disposal of residual waste, we can cut down on the waste generated and ensure that the minimal residual waste does not harm our environment. This principle can be followed by everyone, from an individual or an industry to a whole country.

What can I do? You can follow the 3Rs principle in the following ways:

1. Use only as much as you need, be it any resource – water, food, paper, etc.

2. Next time you throw away something, think about whether it is really a waste. If it is of no use to you, could someone else use it?

Reuse rinse water to water your garden, etc.

Donate old clothes to the needy, instead of throwing them away.

3. If you are sure the item is not usable in its present form, can it be recycled? Paper, plastics, glass, metal can all be recycled.

4. Segregate your waste into wet and dry garbage. Wet garbage includes most kitchen wastes. Most of this can be used for composting. Most dry garbage is recyclable.

The amount of dry waste generated in your household is an indicator of how well you are following the 3Rs principle. A lot of dry waste means you should go back to the 'Reduce and Reuse' principles and try to follow them better.

5. Avoid the use of non-biodegradable materials such as Styrofoam and certain types of plastics.

Although most plastics are recyclable, recycling still takes up energy, which is another precious resource not to be wasted. If thrown away as waste, Styrofoam and plastics can take hundreds of years to decompose.

6. Do not litter or throw garbage in public places. Garbage and litter is a visual contaminant and can cause diseases health problems. Proper disposal of garbage is an important part of waste management.

7. Be a conscious consumer and do not buy products that are over packaged. Try choosing products that are made from recycled material or are organically grown.

Suggestions for better waste management:

- 1) Every country must survey all the different forms of waste generation along with its sources. They must set up priorities concerning waste utilization. Most waste can be converted to resources which can enhance the economy of the country.
- 2) Plans should be prepared for controlling waste at the source. This must include segregation of wet and dry waste, where the wet waste can be converted to compost and used and the dry waste is recycled.
- 3) Research and developmental programs to find innovative methods of waste recycling must be encouraged. Recycling should be a part of conservation and environmental protection programs. Private and public organizations for waste recycling and management should be set up.
- 4) Uneconomical methods of waste disposal like land filling, or incineration must be reduced to a minimum. Plans for appropriate disposal of non-utilizable hazardous waste from chemical industries must be implemented and strictly monitored.
- 5) Every community should organize extensive programs on education and demonstration on the reduction of waste, and the proper disposal and effective reutilization of waste material. People should be informed of the need for waste management to protect the quality of the environment. This should be included in the curriculum at school and college level.
- 6) Every society should make efforts to design peoples' life styles and cultural patterns based on low waste production. The goal of every society should be to reach a low-waste or no waste society.

Resources must be conserved by proper selection, production technologies, recovering and recycling what is usable and reducing unnecessary demands for consumption and inventing technologies which would make it possible for reusing the waste resources so as to reduce over-exploiting of our existing resources.

6.9 THE ENVIRONMENT (PROTECTION) ACT

The Environment (Protection) Act, 1986 not only has important constitutional implications but also an international background. The spirit of the proclamation adopted by the United Nations Conference on Human Environment which took place in Stockholm in June 1972, was implemented by the Government of India by creating this Act.

Although there were several existing laws that dealt directly or indirectly with environmental issues it was necessary to have a general legislation for environmental protection because the existing laws focused on very specific types of pollution, or specific categories of hazardous substances or were indirectly related to the environment through laws that control landuse, protect our National Parks and Sanctuaries and our wildlife. However there were no overarching legislation and certain areas of environmental hazards were not covered. There were also gaps in areas that were potential environmental hazards and there were several inadequate linkages in handling matters of industrial and environmental safety. This was essentially related to the multiplicity of regulatory agencies. Thus there was a need for an authority which could assume the lead role for studying, planning and implementing long term requirements of environmental safety and give directions to, as well as coordinate a system of speedy and adequate response to emergency situations threatening the environment.

This Act was thus passed to protect the environment, as there was a growing concern over the deteriorating state of the environment. As impacts grew considerably environmental protection became a national priority in the 1970s. The decline in the environmental quality, was evidenced by increasing pollution, loss of forest cover and an increasing threat to biodiversity.

The presence of excessive concentrations of harmful chemicals in the atmosphere and aquatic ecosystems leads to the disruption of food chains and a loss of species. These are symptoms of a rapidly deteriorating environment. The growing risks of environmental accidents and threats to life support systems now looms threateningly over our civilisation. The decision taken at the conference in Stockholm strongly voiced these environmental concerns and several measures were made possible for environmental protection. While the need for a wider general legislation to protect our environment is now in place, it has become increasingly evident that our environmental situation continues to deteriorate. We need to implement this Act much more aggressively if our environment is to be protected.

Public concern and support is crucial for implementing the EPA. This must be supported by an enlightened media, good administrators, highly aware policy makers, informed judiciary and trained technocrats who together can influence and prevent further degradation of our environment. Each of us has a responsibility to make this happen.

6.10 THE AIR (PREVENTION AND CONTROL OF POLLUTION) ACT

The Government passed this Act in 1981 to clean up our air by controlling pollution. Sources of air pollution such as industry, vehicles, power plants, etc. are not permitted to release particulate matter, lead, carbon monoxide, sulfur

dioxide, nitrogen oxide, volatile organic compounds (VOCs) or other toxic substances beyond a prescribed level. To ensure this, Pollution Control Boards (PCBs) have been set up by Government to measure pollution levels in the atmosphere and at certain sources by testing the air. This is measured in parts per million or in milligrams or micrograms per cubic meter. The particulate matter and gases that are released by industry and by cars, buses and two wheelers is measured by using air sampling equipment. However, the most important aspect is for people themselves to appreciate the dangers of air pollution and reduce their own potential as polluters by seeing that their own vehicles or the industry they work in reduces levels of emissions.

This Act is created 'to take appropriate steps for the preservation of the natural resources of the earth which among other things includes the preservation of high quality air and ensures controlling the level of air pollution.

The main objectives of the Act are as follows:

- (a) To provide for the Prevention, Control and abatement of air pollution.
- (b) To provide for the establishment of Central and State Boards with a view to implement the Act.
- (c) To confer on the Boards the powers to implement the provisions of the Act and assign to the Boards functions relating to pollution.

Air pollution is more acute in heavily industrialized and urbanized areas, which are also densely populated. The presence of pollution beyond certain limits due to various pollutants discharged through industrial emission are monitored by the Pollution Control Boards set up in every State.

Powers and Functions of the Boards

Central Board: The main function of the Central Board is to implement legislation created to improve the quality of air and to prevent and control air pollution in the country. The Board advises the Central Government on matters concerning the improvement of air quality and also coordinates activities, provides technical assistance and guidance to State Boards and lays down standards for the quality of air. It collects and disseminates information in respect of matters relating to air pollution and performs functions as prescribed in the Act.

State Pollution Control Boards: The State Boards have the power to advise the State Government on any matter concerning the prevention and control of air pollution. They have the right to inspect at all reasonable times any control equipment, industrial plant, or manufacturing process and give orders to take the necessary steps to control pollution. They are expected to inspect air pollution control areas at intervals or whenever necessary. They are empowered to provide standards for emissions to be laid down for different industrial plants with regard to quantity and composition of emission of air pollutants into the atmosphere. A State Board may establish or recognize a laboratory to perform this function.

The State Governments have been given powers to declare air pollution control areas after consulting with the State Board and also give instructions for ensuring standards of emission from automobiles and restriction on use of certain industrial plants.

Penalties: Persons managing industry are to be penalized if they produce emissions of air pollutants in excess of the standards laid down by the State Board. The Board also makes applications to the court for restraining persons causing air pollution.

Whoever contravenes any of the provision of the Act or any order or direction issued is punishable with imprisonment for a term which may extend to three months or with a fine of Rs.10,000 or with both, and in case of continuing offence with an additional fine which may extend to Rs 5,000 for every day during which such contravention continues after conviction for the first contravention.

What can an individual do to control air pollution?

- 1) When you see a polluting vehicle take down the number and send a letter to the Road Transport Office (RTO) and the Pollution Control Board (PCB).
- 2) If you observe an industry polluting air, inform the Pollution Control Board in writing and ascertain if action is taken.
- 3) Use cars only when absolutely necessary. Walk or cycle as much as possible instead of using fossil fuel powered vehicles.
- 4) Use public transport as far as possible, as more people can travel in a single large vehicle rather than using multiple small vehicles which add to pollution.
- 5) Share a vehicle space with relatives and friends. Carpools minimise the use of fossil fuels.
- 6) Do not use air fresheners and other aerosols and sprays which contain CFCs that deplete the ozone layer.
- 7) Do not smoke in a public place. It is illegal and endangers not only your own health but also that of others.
- 8) Coughing can spread bacteria and viruses. Use a handkerchief to prevent droplet in-

fection which is air borne. It endangers the health of other people.

It is a citizen's duty to report to the local authorities such as the Collector or the Pollution Control Board, and the press about offences made by a polluter so that action can be taken against the offender. It is equally important to prevent and report to the authorities on cutting down of trees, as this reduces nature's ability to maintain the carbon dioxide and oxygen levels. preventing air pollution and preserving the quality of our air is a responsibility that each individual must support so that we can breathe air that will not destroy our health.

6.11 THE WATER (PREVENTION AND CONTROL OF POLLUTION) ACT

The Government has formulated this Act in 1974 to be able to prevent pollution of water by industrial, agricultural and household wastewater that can contaminate our water sources. Wastewater with high levels of pollutants that enter wetlands, rivers, lakes, wells as well as the sea are serious health hazards. Controlling the point sources by monitoring levels of different pollutants is one way to prevent pollution by giving a punishment to a polluter. However it is also the responsibility of people in general to inform the relevant authority when they see a likely source of pollution. Individuals can also do several things to reduce water pollution such as using biodegradable chemicals for household use, reducing use of pesticides in gardens, and identifying polluting sources at workplaces and in industrial units where oil or other petroleum products and heavy metals are used. Excessive organic matter, sediments and infecting organisms from hospital wastes can also pollute our water. Citizens need to develop a watchdog force to inform authorities to take appropriate actions against different types of water pollution. A polluter must pay for his actions. How-

ever, preventing pollution is better than trying to cure the problems it has created, or punishing offenders.

The main objectives of the Water Act are to provide for prevention, control and abatement of water pollution and the maintenance or restoration of the wholesomeness of water. It is designed to assess pollution levels and punish polluters. The Central Government and State Governments have set up Pollution Control Boards that monitor water pollution.

Functions of the Pollution Control Boards:

The Government has given the necessary powers to the PCBs to deal with the problems of water pollution in the country. The Government has also suggested penalties for violation of the provisions of the Act.

Central and State water testing laboratories have been set up to enable the Boards to assess the extent of water pollution and standards have been laid down to establish guilt and default.

The Central and State Boards are entitled to certain powers and functions which are as follows:

Central Board: It has the power to advise the Central Government on any matters concerning the prevention and control of water pollution. The Board coordinates the activities of the State Boards and also resolves disputes. The Central Board can provide technical assistance and guidelines to State Boards to carry out investigations and research relating to water pollution, and organizes training for people involved in the process. The Board organizes a comprehensive awareness program on water pollution through mass media and also publishes data regarding water pollution. The Board lays down or modifies the rules in consultation with the State Boards on standards of disposal of waste.

The main function of the Central Board is to promote the cleanliness of rivers lakes streams and wells in the country.

State Boards: They have the power to advise the State Government on any matters concerning water pollution. It plans a comprehensive program for the prevention of water pollution. It collects and disseminates information on water pollution and participates in research in collaboration with the Central Board in organizing training of people involved in the process. The Board inspects sewage or trade effluents, treatment plants, purification plants and the systems of disposal and also evolves economical and reliable methods of treatment of sewage and other effluents. It plans the utilization of sewage water for agriculture. It ensures that if effluents are to be discharged on land the waste is diluted. The State Board advises State Governments with respect to location of industries. Laboratories have been established to enable the Board to perform its functions.

The State Boards have the power to obtain information from officers empowered by it who make surveys, keep records of flow, volume, and other characteristics of the water. They are given the power to take samples of effluents and suggest the procedures to be followed in connection with the samples. The concerned board analyst is expected to analyze the sample sent to him and submit a report of the result to the concerned Board. The Board is required to send a copy of the result to the respective industry. The Board also has the power of inspecting any plant record, register, document or any material object, and can conduct a search in any place in which there is reason to believe that an offence has been conducted under the Act.

Penalties are charged for acts that have caused pollution. This includes failing to furnish information required by the Board, or failing to inform the occurrence of any accident or other unforeseen act. An individual or organisation

that fails to comply with the directions given in the subsections of the law can be convicted or punished with imprisonment for a term of three months or with a fine of Rs10,000 or both and in case failure continues an additional fine of Rs.5,000 everyday. If a person who has already been convicted for any offence is found guilty of the same offence again, he/she after the second and every subsequent conviction, would be punishable with imprisonment for a term not less than two years but which may extend to seven years with fine.

What can individuals do to prevent water pollution?

1. Inform the Pollution Control Board of any offender who is polluting water and ensure that appropriate action is taken. One can also write to the press.
2. Do not dump wastes into a household or industrial drain which can directly enter any water body, such as a stream, river, pond, lake or the sea.
3. Do not use toilets for flushing down waste items as they do not disappear but reappear at other places and cause water pollution.
4. Use compost instead of chemical fertilizers in gardens.
5. Avoid use of pesticides at home like DDT, Melathion, Aldrin, and use alternative methods like paste of boric acid mixed with gram flour to kill cockroaches and other insects. Use dried neem leaves to help keep away insects.

6.12 THE WILDLIFE PROTECTION ACT

This Act passed in 1972, deals with the declaration of National Parks and Wildlife Sanctuaries

and their notification. It establishes the structure of the State's wildlife management and the posts designated for Wildlife Management. It provides for setting up Wildlife Advisory Boards. It prohibits hunting of all animals specified in Schedules I to IV of the Act. These are notified in order of their endangeredness. Plants that are protected are included in schedule VI.

The Amendment to the Wildlife Protection Act in 2002 is more stringent and prevents the commercial use of resources by local people. It has brought in new concepts such as the creation of Community Reserves. It has also altered several definitions. For instance in animals, fish are now included. Forest produce has been redefined to ensure protection of ecosystems.

While there are several changes, the new Act still has serious issues concerned with its implementation. Laws are only as good as the ones that can be complied with. The Act is expected to deter people from breaking the law. However, there are serious problems due to poaching. One cannot expect to use the Act to reduce this without increasing Forest Staff, providing weapons, jeeps, radio equipment, etc. for establishing a strong deterrent force.

Penalties: A person who breaks any of the conditions of any license or permit granted under this Act shall be guilty of an offence against this Act. The offence is punishable with imprisonment for a term which may extend to three years or with a fine of Rs 25,000 or with both. An offence committed in relation to any animal specified in Schedule I, or Part II of Schedule II, like the use of meat of any such animal, or animal articles like a trophy, shall be punishable with imprisonment for a term not less than one year and may extend to six years and a fine of Rs 25,000.

In the case of a second or subsequent offence of the same nature mentioned in this sub-section, the term of imprisonment may extend to

six years and not less than two years with a penalty of Rs.10,000.

What can an individual do?

- 1) If you observe an act of poaching, or see a poached animal, inform the local Forest Department Official at the highest possible level. One can also report the event through the press. Follow up to check that action is taken by the concerned authority. If no action is taken, one must take it up to the Chief Wildlife Warden of the State.
- 2) Say 'no' to the use of wildlife products and also try to convince other people not to buy them.
- 3) Reduce the use of wood and wood products wherever possible.
- 4) Avoid misuse of paper because it is made from bamboo and wood, which destroys wildlife habitat. Paper and envelopes can always be reused.
- 5) Create a pressure group and ask Government to ensure that the biodiversity of our country is conserved.
- 6) Do not harm animals. Stop others from inflicting cruelty to animals.
- 7) Do not disturb birds nests and fledglings.
- 8) When you visit the Zoo do not tease the animals by throwing stones or feeding them, and prevent others from doing so.
- 9) If you come across an injured animal do what you can to help it.
- 10) If the animal needs medical care and expert attention contact the Society for the Prevention of Cruelty to Animals in your city.

- 11) Create awareness about biodiversity conservation in your own way to family and friends.
- 12) Join organizations, which are concerned with protection of biodiversity, such as Worldwide Fund For Nature –India (WWF-I), Bombay Natural History Society (BNHS), or a local conservation NGO.

6.13 FOREST CONSERVATION ACT

To appreciate the importance of the Forest Conservation Act of 1980, which was amended in 1988, it is essential to understand its historical background. The Indian Forest Act of 1927 consolidated all the previous laws regarding forests that were passed before the 1920's. The Act gave the Government and Forest Department the power to create Reserved Forests, and the right to use Reserved Forests for Government use alone. It also created Protected Forests, in which the use of resources by local people was controlled. Some forests were also to be controlled by a village community, and these were called Village Forests.

The Act remained in force till the 1980s when it was realised that protecting forests for timber production alone was not acceptable. The other values of protecting the services that forests provide and its valuable assets such as biodiversity began to overshadow the importance of their revenue earnings from timber. Thus a new Act was essential. This led to the Forest Conservation Act of 1980 and its amendment in 1988.

India's first Forest Policy was enunciated in 1952. Between 1952 and 1988, the extent of deforestation was so great that it became evident that there was a need to formulate a new policy on forests and their utilisation. Large tracts of forestland had already been diverted to other uses. The earlier forest policies had focused attention on revenue generation only. In the 1980s

it became clear that forests must be protected for their other functions such as maintenance of soil and water regimes centered around ecological concerns. It also provided for the use of goods and services of the forest for its local inhabitants.

The new policy framework made conversion of forests into other uses much less possible. Conservation of the forests as a natural heritage finds a place in the new policy, which includes the preservation of its biological diversity and genetic resources. It also values meeting the needs of local people for food, fuelwood, fodder and non-wood forest products that they subsist on. It gives priority to maintaining environmental stability and ecological balance. It expressly states that the network of Protected Areas should be strengthened and extended.

In 1992, the 73rd and 74th Amendments to the Constitution furthered governance through panchayats. It gives States the ability to provide power to the local panchayats to manage local forest resources.

The Forest Conservation Act of 1980 was enacted to control deforestation. It ensured that forestlands could not be de-reserved without prior approval of the Central Government. This was created as States had begun to de-reserve the Reserved Forests for non-forest use. States had regularized encroachments and resettled 'Project Affected People' from development projects such as dams in these de-reserved areas. The need for a new legislation became urgent. The Act made it possible to retain a greater control over the frightening level of deforestation in the country and specified penalties for offenders.

Penalties for offences in Reserved Forests: No person is allowed to make clearings or set fire to a Reserved Forest. Cattle are not permitted to trespass into the Reserved Forest. Felling, collecting of timber, bark or leaves, quarries or

collecting any forest product is punishable with imprisonment for a term of six months, or with a fine which may extend to Rs.500, or both.

Penalties for offences in Protected Forests: A person who commits any of the following offences like felling of trees, or strips off the bark or leaves from any tree or sets fire to such forests, or kindles a fire without taking precautions to prevent its spreading to any tree mentioned in the Act, whether standing or felled, or fells any tree, drags timber, or permits cattle to damage any tree, shall be punishable with imprisonment for a term which may extend to six months or with a fine which may extend to Rs.500, or both.

When there is a reason to believe that a forest offence has been committed pertaining to any forest produce, the produce together with all tools used in committing such offences may be seized by any Forest Officer or Police Officer. Every officer seizing any property under this section shall put on the property a mark indicating the seizure and report the seizure to the Magistrate who has the jurisdiction to try the offence. Any Forest Officer, even without an order from the Magistrate or a warrant, can arrest any person against whom a reasonable suspicion exists.

What can an individual do to support the Act?

- 1) Be alert to destructive activities in your local green areas such as Reserved Forests and Protected Forests, and in Protected Areas (National Parks and Wildlife Sanctuaries). Report any such act to the Forest Department as well as the Press. Report of violations can be made to the Conservator of Forest, District Forest Officer, Range Forest Officer, Forest Guard or the District Commissioner, or local civic body.
- 2) Acquaint yourself with the laws, detailed rules and orders issued by the Government.

- 3) Be in touch with concerned local NGOs and associations. Organize one with other like minded people if none exist in your area.
- 4) Create awareness about the existence and value of National Parks and Sanctuaries and build up a public opinion against illegal activities in the forest or disturbance to wildlife.
- 5) Pressurize the authorities to implement the forest and wildlife laws and rules to protect green areas.
- 6) Take legal action if necessary and if possible through a Public Interest Litigation (PIL) against the offending party. Use the help of NGOs who can undertake legal action.
- 7) Help to create public pressure to change rules laws and procedures when necessary.
- 8) Use better, ecologically sensitive public transport and bicycle tracks. Do not litter in a forest area.
- 9) Participate in preservation of greenery, by planting, watering and caring for plants.

Whom should forest offences be reported to? If you as a citizen come across anyone felling trees, encroaching on forest land, dumping garbage, cutting green wood, lighting a fire, or creating a clearing in Reserved Forests, Protected Forests, National Park, Sanctuary or other forest areas, you must report it to the forest / wildlife officers concerned. For urgent action one can contact the police. In fact you should file an FIR in any case because it serves as an important proof that you have made the report.

6.14 ISSUES INVOLVED IN ENFORCEMENT OF ENVIRONMENTAL LEGISLATION

Environmental legislation is evolved to protect our environment as a whole, our health, and the earth's resources. The presence of a legislation to protect air, water, soil, etc. does not necessarily mean that the problem is addressed. Once a legislation is made at the global, National or State level, it has to be implemented. For a successful environmental legislation to be implemented, there has to be an effective agency to collect relevant data, process it and pass it on to a law enforcement agency. If the law or rule is broken by an individual or institution, this has to be punished through the legal process. Information to law enforcement officials must also come from concerned individuals. In most situations, if no cognizance is given, the interested concerned individual must file a Public Interest Litigation (PIL) for the protection of the environment. There are several NGOs in the country such as WWF-I, BEAG and the BNHS which take these matters to court in the interest of conservation. Anyone can request them to help in such matters. There are also legal experts such as MC Mehta who have successfully fought cases in the courts to support environmental causes. A related issue is the fact that there are several irregular practices for which a bribe to an unscrupulous official is used to cover up an offence. Thus the general public must act as a watch dog not only to inform concerned authorities, but also to see that actions are taken against offenders.

6.14.1 Environment Impact Assessment (EIA):

For all development projects, whether Government or Private, the MoEF requires an impact assessment done by a competent organisation. The EIA must look into physical, biological and social parameters. EIAs are expected to indicate what the likely impacts could be if the project is

passed. The Ministry of Environment and Forests (MoEF) has identified a large number of projects that need clearance on environmental grounds. The EIA must define what impact it would have on water, soil and air. It also requires that a list of flora and fauna identified in the region is documented and to specify if there are any endangered species whose habitat or life could be adversely affected. Most development projects such as industries, roads, railways and dams may also affect the lives of local people. This must be addressed in the EIA. There are 30 different industries listed by MoEF that require a clearance before they are set up.

Impacts created by each type of industry differs and the proposed sites also vary in their sensitivity to impacts. Some areas are more fragile than others. Some have unique ecosystems. Others are the habitats of wildlife and some may be the home of endangered species of plants or animals. All these aspects require evaluation before a development project or an industry site is cleared.

New projects are called 'green field projects' where no development has been done. Projects that already exist but require expansion must also apply for clearance. These are called 'brown field projects'.

After the Environmental Protection Act of 1986 was passed, an EIA to get an environmental clearance for a project became mandatory.

Project proponents are expected to select a competent agency to undertake an EIA. Projects can be classified into those with a mild impact, a moderate impact or a serious impact. Some may have temporary major impacts, during the construction phase, which could later become less damaging, or be mitigated by a variety of measures. In other situations the impact may continue and even increase, for example where toxic solid waste will be constantly generated. Some

projects could thus cause temporary reversible damage while others can have irreversible or even permanent impacts.

To get an environmental clearance the proposer of the project is expected to apply to the State Pollution Control Board. The PCB checks and confirms that the EIA can be initiated. The Agency that does the assessment submits a Report to the proposer. This may take several months. A Report of the Environmental Statement is forwarded to the MoEF, which is the impact assessment authority.

After 1997, the MoEF has stipulated that a public hearing should be done at the local level. The Pollution Control Board puts an advertisement about the hearing in the local vernacular press. An Environmental Impact Statement which is an Executive Summary of the EIA is kept for the public to read. The venue and time of the Public Hearing is declared. Once the hearing is held and opinions have been expressed, both for and against the project, the minutes of the meeting are sent to the MoEF. Though this is done, it is evident that the voices of project affected people are still not heard. In some cases NGOs have taken up the cause of local people. Until educational levels and environmental awareness becomes a part of public thinking and is objectively based on the facts of the case, these hearings will remain an inadequate tool to control possible impacts of new development projects.

Experience shows that a large number of EIAs are inadequately researched and frequently biased as they are funded by the proposer of the project. While most EIAs are adequate for studies on the possibilities of air, water and soil pollution, they generally deal inadequately with issues such as preservation of biodiversity and the social issues that may arise from future environmental impacts.

Biodiversity concerns frequently are sketchily considered and mostly consist of a listing of spe-

cies without population assessments, or census figures of wildlife, or a study of the effects on the ecosystem as a whole. Changes in landuse patterns effect whole communities of living organisms. This is rarely taken into account, as such issues are difficult to assess in quantifiable terms.

Issues related to equity of resources that are inevitably altered by development related projects are also not fully addressed. These cryptic concerns must be dealt with more seriously in environmental assessments and the public at large should know and appreciate these inadequacies. It is not sufficient to say that an EIA has been done. It is the quality and sincerity of the EIA that is of importance.

An EIA is not intended to stop all types of development. The siting of an industry can be selected carefully and if it is likely to damage a fragile area an alternate less sensitive area must be selected.

In some cases it is essential to drop projects altogether if the anticipated impacts are likely to be very severe. In other cases it is necessary for the project to counter balance its effects by mitigating the ill effects on the environment. This means compensating for the environmental damage by afforestation or creating a Protected Area in the neighbourhood at the cost of the project. Rehabilitation and resettlement of project affected people is a key concern which should be given adequate funds and done after a consent is clearly obtained from the people living in the area. In most cases it is advisable to avoid resettlement altogether. If an area's vegetation is being affected project costs must include the cost of compensatory afforestation and other protective measures.

6.14.2 Citizens actions and action groups:

Citizens must learn to act as watch dogs to protect their own environment from the conse-

quences of unsustainable projects around them. Well informed citizens not only have rights but also have a duty to perform in this regard. They can join action groups to develop a lobby to strengthen the environmental movements in the country, their State, town or village.

Individuals can take one or several possible actions when they observe offenders who for their own self interest damage the environment for others living in the area. An individual has the right to bring an environmental offence or nuisance to the attention of concerned authorities. This ranges from Government line agencies such as the Police, the Forest Department, the Collector or Commissioner of the area as the case may be. At times the concerned officials may not be able to easily appreciate complex environmental concerns and the individual may have to learn how to communicate these issues in a way in which it becomes essential for the concerned officer to act in a pro environmental fashion. If this does not work a citizen can seek legal redressal under relevant statutes of law. The Environment Protection Act and the Wildlife Protection Act are the most frequently used legal instrument for these purposes. It is possible to move courts by a Public Interest Litigation, and take this up to the Hon. Apex Court – the Supreme Court of India, which in the recent past has given several highly enlightened pro-conservation judgements.

Citizen groups can resort to alternate means of pressure such as 'rasta rokos', 'dharnas', etc. to draw attention to important environmental concerns. They can also elicit public support through the press and electronic media.

CASE STUDY

The Narmada Issue

The controversy over the plan to build several dams on the Narmada River and its tributaries symbolizes the struggle for a just and equitable society in India. The construction of these dams displaces many poor and underprivileged communities, destroying their relatively self-sufficient environmentally sound economy and culture and reducing a proud people to the status of refugees or slum dwellers.

The Narmada Bachao Andolan (Save the Narmada Movement) is one of the most dynamic people's movements fighting for the rights of these underprivileged people who are being robbed of their homes, livelihoods and way of living in the name of 'national interest'.

One such dam, the Sardar Sarovar Dam, when completed will drown 37,000 hectares of fertile land and displace 200,000 adivasis and cause incomprehensible loss to the ecology.

CASE STUDY

Silent Valley

The proposed Hydel project at Silent valley, a unique pocket of tropical biodiversity in South India, in the 1970s was stopped and the area declared a National Park in 1984. This was achieved by several dedicated individuals, groups and organisations lobbying to save the area from being submerged and protect its rich biodiversity.

Among the many environmental battles that have been fought in this country some have been won while many others have been lost. These projects have led to serious environmental degradation in spite of the laws intended to control such damage.

6.15 PUBLIC AWARENESS

Environmental sensitivity in our country can only grow through a major public awareness campaign. This has several tools. The electronic media, the press, school and college education, adult education, are all essentially complementary to each other. Green movements can grow out of small local initiatives to become major players in advocating environmental protection to the Government. Policy makers will only work towards environmental preservation if there is a sufficiently large bank of voters that insist on protecting the environment. Orienting the media to project pro environmental issues is an important aspect. Several advertising campaigns frequently have messages that are negative to environmental preservation.

6.15.1 Using an Environmental Calendar of Activities:

There are several days of special environmental significant which can be celebrated in the community and can be used for creating environmental awareness.

February 2: World Wetland Day is celebrated to create awareness about wetlands and their value to mankind. On February 2nd 1971, the Ramsar Convention on Wetlands of International importance was signed at Ramsar in Iran. You can initiate a campaign for proper use and maintenance of wetlands in the vicinity of the city or village.

March 21: World Forestry Day can be used to initiate a public awareness campaign about the extremely rapid disappearance of our forests. The program must be action oriented and become an ongoing process with activities such as tree plantation.

April 7: World Health Day – The World Health Organisation (WHO) came into existence on this day in 1948. A campaign for personal sanitation and hygiene to understanding issues of public health, occupational health, etc. can be carried out. Topics that deal with environment related diseases and their spread can be discussed and preventive measures suggested.

April 18: World Heritage Day can be used to arrange a visit to a local fort or museum. Environment also includes our cultural monuments. Students could use this opportunity to create awareness among the local people about their very valuable heritage sites.

April 22: Earth Day was first celebrated in 1970 by a group of people in the USA to draw attention to increasing environmental problems caused by humans on earth. This day is now celebrated all over the world with rallies, festivals, clean-ups, special shows and lectures.

June 5: World Environment Day marks the anniversary of the Stockholm Conference on Human Environment in Sweden in 1972, where nations of the world gathered to share their concern over human progress at the expense of the environment. This day can be used to project the various environmental activities that the college has undertaken during the year. New pledges must be made to strengthen an environmental movement at the college level.

June 11: World Population Day is a day when the vital link between population and environment could be discussed in seminars held at college and other NGOs.

August 6: Hiroshima Day could be used to discuss our own Bhopal Gas Tragedy and the Chernobyl disaster.

September 16: World Ozone Day was proclaimed by the United Nations as the International Day for the preservation of the ozone layer. This is a good occasion for students to find out more about the threats to this layer and initiate discussion on what they can do to help mitigate this global threat. The day marks the Montreal Protocol signed in 1987 to control production and consumption of ozone depleting substances.

September 28: Green Consumer Day could be used to create an awareness in consumers about various products. Students could talk to shopkeepers and consumers about excess packaging and a campaign to use articles which are not heavily packaged could be carried out.

October 1-7: Wildlife Week can consist of seminars on conserving our species and threatened ecosystems. The State forest Departments organize various activities in which every student should take part. A poster display, a street play to highlight India's rich biodiversity can be planned. Wildlife does not only mean animals, but includes plants as well.

6.15.2 What can I do?

Most of us are always complaining about the deteriorating environmental situation in our country. We also blame the government for inaction. However how many of us actually do anything about our own environment?

You can think about the things you can do that support the environment in your daily life, in your profession and in your community. You can make others follow your environment friendly actions. A famous dictum is to 'think

globally and act locally' to improve your own environment. 'You' can make a difference to our world.

Biodiversity Conservation: A great proportion of the residual wilderness of India is now under great threat. Its unique landscapes are shrinking as the intensive forms of agriculture and industrial growth spreads through a process called 'development'. Modern science has serious doubts about the possibility of the long-term survival of the human race if man continues to degrade natural habitats, extinguishes millions of years of evolution through an extinction spasm, and looks only at short-term gains. The extinction of species cannot be reversed. Once a species is lost, it is gone forever. Future generations will hold us responsible for this great loss.

We frequently forget that we are a part of a great complex web of life and our existence depends on the integrity of 1.8 million species of plants and animals on earth that live in a large number of ecosystems.

The following are some of the things you can do to contribute towards our ecological security and biodiversity conservation.

Dos:

1. Plant more trees of local or indigenous species around your home and your workplace. Encourage your friends to do so. Plants are vital to our survival in many ways.
2. If your urban garden is too small for trees, plant local shrubs and creepers instead. These support bird and insect life that form a vital component of the food chains in nature. Urban biodiversity conservation is feasible and can support a limited but valuable diversity of life.

3. If you live in an apartment, grow a terrace or balcony garden using potted plants. Window boxes can be used to grow small flowering plants, which also add to the beauty of your house.
4. Whenever and wherever possible prevent trees from being cut, or if it is not possible for you to prevent this, report it immediately to the concerned authorities. Old trees are especially important.
5. Insist on keeping our hills free of settlements or similar encroachments. Degradation of hill slopes leads to severe environmental problems.
6. When shopping, choose products in limited packaging. It will not only help cut down on the amount of waste in landfills, but also helps reduce our need to cut trees for paper and packaging.
7. Look for ways to reduce the use of paper. Use both sides of every sheet of paper. Send your waste paper for recycling.
8. Buy recycled paper products for your home. For example sheets of paper, envelopes, etc.
9. Reuse cartons and gift-wrapping paper. Recycle newspaper and waste paper instead of throwing it away as garbage.
10. Donate used books and magazines to schools, hospitals, or libraries. The donations will not only help these organizations, but also will reduce the exploitation of natural resources used to produce paper.
11. Participate in the events that highlight the need for creating Sanctuaries and National Parks, nature trails, open spaces, and saving forests.

12. Support Project Tiger, Project Elephant, etc. and join NGOs that deal with environmental protection and nature conservation.
13. Involve yourself and friends in activities carried out during Wildlife Week and other public functions such as tree plantation drives and protests against destruction of the environment.

Don'ts

1. Do not present flower bouquets instead give a potted plant and encourage your friends to do so.
2. Do not collect unnecessary pamphlets and leaflets just because they are free.
3. Do not use paper plates and tissues or paper decorations when you hold a party.

Habitat preservation: The rapid destruction of forests, and the growth of human habitations and activities have reduced the natural habitats of animals and birds. Loss of habitat is one of the major pressures on several species and has led to the extinction of several rare and endemic species. Many others are seriously threatened. We therefore have the responsibility to preserve remaining habitats and their inhabitants.

The following are some 'dos and don'ts' that can help preserve threatened ecosystems.

Dos:

1. Visit forests responsibly. Remember to bring out everything you take in, and clean up litter left by others. Stay on marked trails, and respect the fact that wildlife need peace and quiet. Study the ecosystem; it gives one a greater sense of responsibility to conserve it.

2. Be kind to animals. Stop friends from disturbing or being cruel to wild creatures such as birds, frogs, snakes, lizards and insects.
3. Learn about birds. Identify birds that are common in your area. Understand their food requirements and feeding habits. Construct artificial nesting boxes for birds. This will encourage birds to stay in your neighborhood, even if their nesting habitat is scarce.

You can learn more about birds by making a birdbath. Birds need water to drink and to keep their feathers clean. You can make a birdbath out of a big ceramic or plastic saucer. Having birds around your home, school or college can even help increase species diversity in the area.

4. Attract wildlife such as small mammals, such as squirrels, to your garden by providing running or dripping water. Make a hole in the bottom of a bucket and poke a string through to serve as a wick. Hang a bucket on a tree branch above your birdbath to fill it gradually with water throughout the day.
5. Protect wildlife, especially birds and insects that are insectivorous and live in your neighborhood by eliminating the use of chemicals in your garden. Instead, use organic measures from vermicomposting and by introducing natural pest predators. Do your gardening and landscaping using local plants, to control pests in your garden.
6. If you have pets, feed them well and give them a proper home and in an emergency proper medical care.
7. When you visit a zoo learn about the animals that are found there but do not tease or hurt them through the bars of their cage.

They have a right to a peaceful existence. The zoo is in any case not an ideal home for them.

Don'ts

1. Do not disturb, tease, hurt or throw stones at animals in a Protected Area and stop others from doing so. If you see an injured animal contact the Forest Officials.
2. Do not disturb or destroy the natural habitats of birds or animals.
3. Do not use articles like leather handbags and lipsticks, which are made from animal products. No wildlife products should be used.
4. Do not catch or kill butterflies or other insects. Butterflies, moths, bees, beetles and ants are important pollinators.
5. Do not kill small animals and insects like dragonflies and spiders as they act as biological pest control mechanisms.
6. Do not bring home animals or plants collected in the wild. You could be seriously harming wild populations and natural ecosystems where they were collected.
7. Do not buy products like purses, wallets, boots and that are made from reptile skins. If you are not certain that a product is made from a wild species, its better to avoid using it.
8. Do not buy products made from ivory. Elephants are killed for their tusks, which are used to make a variety of ivory products.
9. Do not use any wild animal or plant products that are collected from the wild and

have dubious medicinal properties. You may be endangering a species and even your own health.

Soil conservation: Soil degradation affects us all in some way, either directly or indirectly. There are many ways that each of us can help in solving environmental problems due to loss of soil.

Following are some of the dos and don'ts for conserving soil.

Dos:

1. Cover the soil in your farm or garden with a layer of mulch to prevent soil erosion in the rains and to conserve soil moisture. Mulch can be made from grass clippings or leaf litter.
2. If you plan to plant on a steep slope in your farm or garden, prevent soil erosion by first terracing the area. Terraces help in slowing the rain water running downhill so it can soak into the soil rather than carry the soil away.
3. Help prevent soil erosion in your community by planting trees and ground-covering plants that help hold the soil in place. You might organize a group of citizens to identify places that need planting, raise funds, work with the local government to plant trees, shrubs and grasses, and maintain them over the long term.
4. If your college is surrounded by open space, evaluate how well the soil is being conserved. Look for places where soil can run off, like on an unplanted steep slope or stream bank, or where soil is exposed rather than covered with mulch. These areas need special care and must be carefully replanted.

5. Add organic matter to enrich your garden soil. For example compost from kitchen scraps and manure from poultry, cows are good sources of nutrients. Make sure manure is not too fresh and that you do not use too much. Healthy soil grows healthy plants, and it lessens the need for insecticides and herbicides.
6. In your vegetable garden, rotate crops to prevent the depletion of nutrients. Legumes such as peas and beans put nitrogen back into the soil.
7. Set up a compost pit in your college or garden, so that you can enrich your soil with the organic waste from the kitchen and cut down on the amount of waste it sends to a landfill. Set up buckets in your college or lunchroom where fruit and left-over food can be put. Empty the buckets daily into a compost pit, and use the rich compost formed in a few weeks to enrich the soil around the college. Kitchen scraps, leaves and grass clippings are excellent compost.
8. Encourage your local zoo, farms, and other organizations or people that house a large number of animals to provide your community with biofertilizer made from animal manure. This can be composted to make a rich fertilizer, and it forms an additional source of income for the animal owners.
9. Buy organically grown produce to help reduce the amount of toxic pesticides used in farms that harm soil organisms. Look for organically grown produce in your grocery shop, or try growing some yourself if you have the space.
10. Support environmental campaigns in your State and community. Cutting down on irresponsible development can protect soil, biodiversity, and enhance our quality of life.

Don'ts:

1. Do not remove grass, leave it on the lawn. Cuttings serve as moisture-retention mulch and a natural fertilizer.
2. Do not use toxic pesticides in your garden—they often kill the beneficial organisms, your soil needs to stay healthy.

Conserving water: Most of India has good average annual rainfall, however we still face a water shortage nearly everywhere. This is one of the major environmental problems in our country. Conservation of this very precious natural resource is very important and it is the need of the hour. It should start with every individual. It must start with you! Following are some of the things you can do to conserve this precious natural resource.

Dos:

1. Reduce the amount of water used for daily activities. For example - turn off the tap while brushing your teeth to save water.
2. Reuse the rinsing water for house-plants. Reuse the water that vegetables are washed in to water the plants in your garden or your potted plants.
3. Always water the plants early in the morning to minimize evaporation.
4. Soak the dishes before washing them to reduce water and detergent usage.
5. Look for leaks in the toilet and bathroom to save several litres of water a day.
6. While watering plants, water only as rapidly as the soil can absorb the water.

7. Use a drip irrigation system to water more efficiently.
8. When you need to drink water, take only as much as you need to avoid wastage. So many people in our country don't even have access to clean drinking water!
9. Saving precious rainwater is very important. Harvest rainwater from rooftops and use it sustainably to recharge wells to reduce the burden on rivers and lakes.
10. Monitor and control wastes going into drains for preventing water pollution.
11. Replace chemicals like phenyl, strong detergents, shampoo, chemical pesticides and fertilizers used in your home, with environment friendly alternatives, such as neem and biofertilisers. Groundwater contamination by household chemicals is a growing concern.
12. For Ganesh Chaturthi, bring home a 'Shadu' idol instead of a Plaster of Paris idol and donate it instead of immersing it in the river to reduce river pollution.

Don'ts:

1. Do not turn your tap on full force, instead maintain a slow flow.
2. Do not use a shower, instead use a bucket of water for bathing. A 10 minute shower wastes many liters of water as compared to using water from a bucket.
3. Do not over water garden plants, water them only when necessary.
4. Do not pollute sources of water or water bodies by throwing waste into them. This is the water you or someone else has to drink!

5. Do not throw waste into toilets because finally it goes into water bodies.

Conserving energy: Coal, petroleum and oil are mineral resources and are non-renewable sources of energy. At the current rate of fossil fuel consumption, the present oil reserves on the earth will last only for the next 30 to 50 years. Crores of rupees are being spent to extract, process and distribute coal, petroleum and electricity. Experiments are being carried out to generate energy from wind, and photovoltaic cells. They are highly successful. At an individual level, every one of us should try to conserve energy. Following are some of the things you can do to conserve energy.

Dos:

1. Turn off the lights fans and air conditioning when not necessary.
2. Use low voltage lights.
3. Use tube lights and energy saver bulbs as they consume less electricity.
4. Switch off the radio and television when not required.
5. Use alternative sources of energy like solar power for heating water and by cooking food in a solar cooker.
6. Cut down on the use of electrical appliances.
7. In summer, shut windows, curtains and doors early in the morning to keep the house cool.
8. Use a pressure cooker as much as possible to save energy.

9. Turn off the stove immediately after use.
10. Plan and keep things ready before you start cooking.
11. Keep vessels closed while cooking and always use small, narrow mouthed vessels to conserve energy.
12. When the food is almost cooked, switch off the gas stove and keep the vessel closed. It will get completely cooked with the steam already present inside.
13. Soak rice, pulses etc., before cooking to reduce cooking time and save fuel.
14. Get your family to eat together, it will save re-heating fuel.
15. Select a light shade of paint for walls and ceilings, as it will reflect more light and reduce electrical consumption.
16. Position your reading tables near the window and cut down on your electricity bill by reading in natural light.
17. Use a bicycle—it occupies less space, releases no pollutant and provides healthy exercise.
18. Try using public transport systems like trains and buses as far as possible.
19. Plan your trips and routes before setting out.
20. Walk rather than drive wherever possible. Walking is one of the best exercises for your health.
21. Get vehicles serviced regularly to reduce fuel consumption and reduce pollution levels.

Don'ts:

1. Do not use unnecessary outdoor decorative lights.
2. Do not use a geyser during summer. Instead, heat water naturally with the help of sunlight.
3. Do not use halogen lamps as they consume a lot of electricity.
4. Do not put food in the refrigerator when they are still hot.