Environmental Studies

Paper Code: 114

Objective of this paper is to familiarize students of law with the basic concepts in environmental studies and to sensitize them towards the issues of environmental management.

Unit I: Introduction

a. Multidisciplinary nature of environmental studies
i Definition, scope and importance
ii Need for public awareness
b. Basic Concepts of Ecology
i Concept of an ecosystem
ii Structure and function of an ecosystem
iii Producers, consumers and decomposers
iv Energy flow in the ecosystem
v Ecological succession
vi Food chains, food webs and ecological pyramids
vii Characteristic features, structure and function of the following ecosystem:
viii Forest ecosystem; Grassland ecosystem; Desert ecosystem; Aquatic ecosystems (ponds, steams, lakes, rivers, oceans, estuaries)

Unit II: Natural Resources & Biodiversity

a. Renewable and non-renewable resources:
i Forest resources: Use and over-exploitation, deforestation.
ii Timber extraction, mining, dams and their effects on forest and tribal people.
iii Case study.
iv Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Cases.
v Mineral resources: Use and exploitation, environmental effects. Cases
vi Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Concept of Food Security.

vii Energy resources: Growing energy needs, Energy crisis, Renewable and non renewable energy sources, use of alternate energy sources, Case studies.
viii Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.
b. Biodiversity and its conservation
i Definition: genetic, species and ecosystem diversity
ii Bio-geographical classification of India
iii Value of biodiversity: consumptive use, productive use, social, ethical, and aesthetic and option values
iv Biodiversity at global, national and local levels
(With effect from the Academic Session 2008-2009) **28**
v India as a mega-diversity nation
vi Hot spots of biodiversity
vii Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts
viii Endangered and endemic species of India
ix Conservation of biodiversity : In-situ and ex-situ conservation of biodiversity

Unit III: Problems of Environmental Pollution, Control Measures and Acts

a. Causes and effects
i Air pollution
ii Water pollution
iii Soil pollution
iv Marine pollution
v Noise pollution
vi Thermal pollution
vii Nuclear hazards
b. Control measures of pollution
i Environment Protection Act
ii Air (Prevention and Control of Pollution) Act
iii Water (Prevention and Control of Pollution) Act
iv Wildlife Protection Act
v Forest Conservation Act
c. Management of environmental problems
i Solid waste Management: Causes, effects and control measures of urban and industrial wastes.
ii Role of an individual in prevention of pollution
iii Pollution case studies

iv Disaster management : floods, earthquake, cyclone and landslides
v Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies.
vi Concept of Sustainable development

Unit IV : Social Issues and the Environment

a. Urban problems related to energy
b. Water conservation, rain water harvesting, watershed management
c. Resettlement and rehabilitation of people; its problems and concerns. Case Studies
d. Wasteland reclamation
e. Consumerism and waste products
f. Population growth- variation among nations and population explosion- Family Welfare programme
g. Environment and human health- HIV/AIDS.
h. Human Rights and environment
i. Role of Women and Child in environmental protection
j. Environmental ethics: Issues and possible solutions
k. Value Education
l. Problems in enforcement of environmental legislation

UNIT-I

DEFINITION, SCOPE AND IMPORTANCE

Definition

Environmental studies deals with every issue that affects an organism. It is essentially a multidisciplinary approach that brings about an appreciation of our natural world and human impacts on its integrity. It is an applied science as its seeks practical answers to making human civilization sustainable on the earth's finite resources. Its components include biology, geology, chemistry, physics, engineering, sociology, health, anthropology, economics, statistics, computers and philosophy.

Scope

As we look around at the area in which we live, we see that our surroundings were originally a natural landscape such as a forest, a river, a mountain, a desert, or a combination of these elements. Most of us live in landscapes that have been heavily modified by human beings, in villages, towns or cities. But even those of us who live in cities get our food supply from surrounding villages and these in turn are dependent on natural landscapes such as forests, grasslands, rivers, seashores, for resources such as water for agriculture, fuel wood, fodder, and fish. Thus our daily lives are linked with our surroundings and inevitably affects them. We use water to drink and for other day-to-day activities. We breathe air, we use resources from which food is made and we depend on the community of living plants and animals which form a web of life, of which we are also a part. Everything around us forms our environment and our lives depend on keeping its vital systems as intact as possible.

Our dependence on nature is so great that we cannot continue to live without protecting the earth's environmental resources. Thus most traditions refer to our environment as 'Mother Nature' and most traditional societies have learned that respecting nature is vital for their livelihoods. This has led to many cultural practices that helped traditional societies protect and preserve their natural resources. Respect for nature and all living creatures is not new to India. All our traditions are based on these values. Emperor Ashoka's edict proclaimed that all forms of life are important for our well being in Fourth Century BC.

Over the past 200 years however, modern societies began to believe that easy answers to the question of producing more resources could be provided by means of technological innovations. For example, though growing more food by using fertilizers and pesticides, developing better strains of domestic animals and crops, irrigating farmland through mega dams and developing industry, led to rapid economic growth, the ill effects of this type of development, led to environmental degradation.

The industrial development and intensive agriculture
that provides the goods for our increasingly consumer oriented society uses up large amounts of **natural resources** such as water, minerals, petroleum products, wood, etc. **Nonrenewable resources,** such as minerals and oil are those which will be exhausted in the future if we continue to extract these without a thought for subsequent generations. **Renew-able resources,** such as timber and water, are those which can be used but can be regenerated by natural processes such as regrowth or rainfall. But these too will be depleted if we continue to use them faster than nature can replace them. For example, if the removal of timber and firewood from a forest is faster than the regrowth and regeneration of trees, it cannot replenish

the supply. And loss of forest cover not only depletes the forest of its resources, such as timber and other non-wood products, but affect our water resources because an intact natural forest acts like a sponge which holds water and releases it slowly. Deforestation leads to floods in the monsoon and dry rivers once the rains are over.

Such multiple effects on the environment resulting from routine human activities must be appreciated by each one of us, if it is to provide us with the resources we need in the long-term. Our natural resources can be compared with money in a bank. If we use it rapidly, the capital will be reduced to zero. On the other hand, if we use only the interest, it can sustain us over the longer term. This is called **sustainable utilisation or development**.

Importance

Environment is not a single subject. It is an integration of several subjects that include both Science and Social Studies. To understand all the different aspects of our environment we need to understand biology, chemistry, physics, geography, resource management, economics and population issues. Thus the scope of environmental studies is extremely wide and covers some aspects of nearly every major discipline. We live in a world in which natural resources are limited. Water, air, soil, minerals, oil, the products we get from forests, grasslands, oceans and from agriculture and livestock, are all a part of our life support systems. Without them, life itself would be impossible. As we keep increasing in numbers and the quantity of resources each of us uses also increases, the earth's resource base must inevitably shrink. The earth cannot be expected to sustain this expanding level of utilization of resources. Added to this is misuse of resources. We waste or pollute large amounts of nature's clean water; we create more and more material like plastic that we discard after a single use; and we waste colossal amounts of food, which is discarded as garbage. Manufacturing processes create solid waste byproducts that are discarded, as well as chemicals that flow out as liquid waste and pollute water, and gases that pollute the air. Increasing amounts of waste cannot be managed by natural processes. These accumulate in our environment, leading to a variety of diseases and other adverse environmental impacts now seriously affecting all our lives. Air pollution leads to respiratory diseases, water pollution to gastro-intestinal diseases, and many pollutants are known to cause cancer.

Improving this situation will only happen if each of us begins to take actions in our daily lives that will help preserve our environmental resources. We cannot expect Governments alone to manage the safeguarding of the environment, nor can we expect other people to prevent environmental damage. We need to do it ourselves. It is a responsibility that each of us must take on as ones own.

NEED FOR PUBLIC AWARENESS

As the earth's natural resources are dwindling and our environment is being increasingly degraded by human activities, it is evident that something needs to be done. We often feel that managing all this is something that the Government should do. But if we go on endangering our environment, there is no way in which the Government can perform all these clean-up functions. It is the prevention of environment degradation in which we must all take part that must become a part of all our lives. Just as for any disease, prevention is better than cure. To prevent ill-effects on our environment by our actions, is economically more viable than cleaning up the environment once it is damaged. Individually we can play a major role

in environment management. We can reduce wasting natural resources and we can act as watchdogs that inform the Government about sources that lead to pollution and degradation of our environment.

This can only be made possible through mass public awareness. Mass media such as newspapers, radio, television, strongly influence public opinion. However, someone has to bring this about. If each of us feels strongly about the environment, the press and media will add to our efforts. Politicians in a democracy always respond positively to a strong publicly supported movement. Thus if you join an NGO that supports conservation, politicians will make green policies. We are living on spaceship earth with a limited supply of resources. Each of us is responsible for spreading this message to as many people as possible.

Suggested further activities for concerned students:
• Join a group to study nature, such as WWFI or BNHS, or another environmental group.
• Begin reading newspaper articles and periodicals such as 'Down to Earth', WWF-I newsletter, BNHS Hornbill, Sanctuary magazine, etc. that will tell you more about our environment. There are also several environmental websites.
• Lobby for conserving resources by taking up the cause of environmental issues during discussions with friends and relatives. Practice and promote issues such as saving paper, saving water, reducing use of plastics, practicing the 3Rs principle of reduce, reuse, recycle, and proper waste disposal.
• Join local movements that support activities such as saving trees in your area, go on nature treks, recycle waste, buy environmentally friendly products.
• Practice and promote good civic sense such as no spitting or tobacco chewing, no throwing garbage on the road, no smoking in public places, no urinating or defecating in public places.
• Take part in events organised on World Environment Day, Wildlife Week, etc.
• Visit a National Park or Sanctuary, or spend time in whatever nature you have near your home.

Institutions in Environment

There have been several Government and Nongovernment organizations that have led to environmental protection in our country. They have led to a growing interest in environmental protection and conservation of nature and natural resources. The traditional conservation practices that were part of ancient India's culture have however gradually disappeared. Public awareness is thus a critical need to further environmental protection. Among the large number of institutions that deal with environmental protection and conservation, a few well-known organizations include government organizations such as the BSI and ZSI, and NGOs such as BNHS, WWF-I, etc.

Bombay Natural History Society (BNHS), Mumbai: the BNHS began as a small society of six members in 1883. It grew from a group of shikaris and people from all walks of life into a major research organisation that substantially influenced conservation policy in the country. The influence on wildlife policy building, research, popular publications and peoples action have been unique features of the multifaceted society. Undoubtedly its major contribution has been in the field of wildlife research.

It is India's oldest conservation research based NGO and one that has acted at the forefront of the battle for species and ecosystems. The BNHS publishes a popular magazine called Hornbill and also an internationally well-known Journal on Natural History. Its other publications include the Salim Ali

Handbook on birds, JC Daniel's book of Indian Reptiles, SH Prater's book of Indian Mammals and PV Bole's book of Indian Trees.One of its greatest scientists was Dr. Salim Ali whose ornithological work on the birds of the Indian subcontinent is world famous. The BNHS has over the years helped Government to frame wildlife related laws and has taken up battles such as the 'Save the Silent Valley' campaign.

World Wide Fund for Nature (WWF-I), New Delhi: The WWF-I was initiated in 1969 in Mumbai after which the headquarters were shifted to Delhi with several branch offices all over India. The early years focused attention on wildlife education and awareness. It runs several programs including the Nature Clubs of India program for school children and works as a think tank and lobby force for environment and development issues.

Center for Science and Environment (CSE), New Delhi: Activities of this Center include organising campaigns, holding workshops and conferences, and producing environment related publications. It published a major document on the 'State of India's Environment', the first of its kind to be produced as a Citizen's Report on the Environment. The CSE also publishes a popular magazine, 'Down to Earth', which is a Science and Environment fortnightly. It is involved in the publication of material in the form of books, posters, video films and also conducts workshops and seminars on biodiversity related issues.

CPR Environmental Education Centre, Madras:

The CPR EEC was set up in 1988. It conducts a variety of programs to spread environmental awareness and creates an interest in conservation among the general public. It focussed attention on NGOs, teachers, women, youth and children to generally promote conservation of nature and natural resources. Its programs include components on wildlife and biodiversity issues. CPR EEC also produces a large number of publications.

Centre for Environment Education (CEE), Ahmedabad: The Centre for Environment Education, Ahmedabad was initiated in 1989. It has a wide range of programs on the environment and produces a variety of educational material. CEE's Training in Environment Education {TEE} program has trained many environment educators.

Bharati Vidyapeeth Institute of Environment Education and Research (BVIEER), Pune: This is part of the Bharati Vidyapeeth Deemed University. The Institute has a PhD, a Masters and Bachelors program in Environmental Sciences. It also offers an innovative Diploma in Environment Education for in-service teachers. It implements a large outreach programme that has covered over 135 schools in which it trains teachers and conducts fortnightly Environment Education Programs. Biodiversity Conservation is a major focus of its research initiatives. It develops low cost Interpretation Centres for Natural and Architectural sites that are highly locale specific as well as a large amount of innovative environment educational material for a variety of target groups. Its unique feature is that it conducts environment education from primary school level to the postgraduate level. The BVIEER has produced several EE aids. It has developed a teacher's handbook linked to school curriculum, a textbook for UGC for its undergraduate course on environment. Its Director has developed a CD ROM on India's biodiversity published by Mapin Publishers, Ahmedabad.

Uttarkhand Seva Nidhi (UKSN), Almora: The Organisation is a Nodal Agency which supports NGOs in need of funds for their environment related activities. Its major program is organizing and training school teachers to use its locale specific Environment Education Workbook Program. The main targets

are linked with sustainable resource use at the village level through training school children. Its environment education program covers about 500 schools.

Kalpavriksh, Pune: This NGO, initially Delhi based, is now working from Pune and is active in several other parts of India. Kalpavriksh works on a variety of fronts: education and awareness; investigation and research; direct action and lobbying; and litigation with regard to environment and development issues. Its activities include talks and audio-visuals in schools and colleges, nature walks and outstation camps, organising student participation in ongoing campaigns including street demonstrations, pushing for consumer awareness regarding organic food, press statements, handling green alerts, and meetings with the city's administrators. It is involved with the preparation of site-specific, environmental manuals for schoolteachers. Kalpavriksh was responsible for developing India's National Biodiversity Strategy and Action Plan in 2003.

Salim Ali Center for Ornithology and Natural History (SACON), Coimbatore: This institution was Dr. Salim Ali's dream that became a reality only after his demise. He wished to support a group of committed conservation scientists on a permanent basis. Initially conceived as being a wing of the Bombay Natural History Society (BNHS) it later evolved as an independent organisation based at Coimbatore in 1990. It has instituted a variety of field programs that have added to the country's information on our threatened biodiversity.

Wildlife Institute of India (WII), Dehradun: This Institution was established in 1982, as a major training establishment for Forest Officials and Research in Wildlife Management. Its most significant publication has been 'Planning A Wildlife Protected Area Network for India' (Rodgers and Panwar, 1988). The organization has over the years added an enormous amount of information on India's biological wealth. It has trained a large number of Forest Department Officials and Staff as Wildlife Managers. Its M.Sc. Program has trained excellent wildlife scientists. It also has an Environment Impact Assessment (EIA) cell. It trains personnel in ecodevelopment, wildlife biology, habitat management and Nature interpretation.

Botanical Survey of India (BSI): The Botanical Survey of India (BSI) was established in 1890 at the Royal Botanic Gardens, Calcutta. However it closed down for several years after 1939 and was reopened in 1954. In 1952 plans were made to reorganise the BSI and formulate its objectives. By 1955 the BSI had its headquarters in Calcutta with Circle Offices at Coimbatore, Shillong, Pune and Dehra Dun. Between 1962 and 1979, offices were established in Allahbad, Jodhpur, Port Blair, Itanagar and Gangtok. The BSI currently has nine regional centres. It carries out surveys of plant resources in different regions.

Zoological Survey of India (ZSI): The ZSI was established in1916. Its mandate was to do a systematic survey of fauna in India. It has over the years collected 'type specimens' on the bases of which our animal life has been studied over the years. Its origins were collections based at the Indian Museum at Calcutta, which was established in 1875. Older collections of the Asiatic Society of Bengal, which were made between 1814 and 1875, as well as those of the Indian Museum made between 1875 and 1916 were then transferred to the ZSI. Today it has over a million specimens! This makes it one of the largest collections in Asia. It has done an enormous amount of work on taxonomy and ecology. It currently operates from 16 regional centers.

People in Environment

There are several internationally known environmental thinkers. Among those who have made landmarks, the names that are usually mentioned are Charles Darwin, Ralph Emerson, Henry Thoreau, John Muir, Aldo Leopald, Rachel Carson and EO Wilson. Each of these thinkers looked at the environment from a completely different perspective. **Charles Darwin** wrote the 'Origin of Species', which brought to light the close relationship between habitats and species. It brought about a new thinking of man's relationship with other species that was based on evolution. Alfred Wallace came to the same conclusions during his work. **Ralph Emerson** spoke of the dangers of commerce to our environment way back in the 1840s. **Henry Thoreau** in the 1860s wrote that the wilderness should be preserved after he lived in the wild for a year. He felt that most people did not care for nature and would sell it off for a small sum of money. **John Muir** is remembered as having saved the great ancient sequoia trees in California'a forests. In the 1890s he formed the Sierra club, which is a major conservation NGO in the USA. **Aldo Leopald** was a forest official in the US in the 1920s. He designed the early policies on wilderness conservation and wildlife management. In the 1960s **Rachel Carson** published several articles that caused immediate worldwide concern on the effects of pesticides on nature and mankind. She wrote a well known book called 'Silent Spring' which eventually led to a change in Government policy and public awareness. **EO Wilson** is an entomologist who envisioned that biological diversity was a key to human survival on earth. He wrote 'Diversity of Life' in 1993, which was awarded a prize for the best book published on environmental issues. His writings brought home to the world the risks to mankind due to man made disturbances in natural ecosystems that are leading to the rapid extinction of species at the global level.

There have been a number of individuals who have been instrumental in shaping the environmental history in our country. Some of the well known names in the last century include environmentalists, scientists, administrators, legal experts, educationists and journalists. **Salim Ali's** name is synonymous with ornithology in India and with the Bombay Natural History Society (BNHS). He also wrote several great books including the famous 'Book of Indian Birds'. His autobiography, 'Fall of a Sparrow' should be read by every nature enthusiast. He was our country's leading conservation scientist and influenced environmental policies in our country for over 50 years. **Indira Gandhi** as PM has played a highly significant role in the preservation of India's wildlife. It was during her period as PM, that the network of PAs grew from 65 to 298! The Wildlife Protection Act was formulated during the period when she was PM and the Indian Board for Wildlife was extremely active as she personally chaired all its meetings. India gained a name for itself by being a major player in CITES and other International Environmental Treaties and Accords during her tenure. BNHS frequently used her good will to get conservation action initiated by the Government.

S P Godrej was one of India's greatest supporters of wildlife conservation and nature awareness programs. Between 1975 and 1999, SP Godrej received 10 awards for his conservation activities. He was awarded the Padma Bhushan in 1999. His friendship with people in power combined with his deep commitment for conservation led to his playing a major advocacy role for wildlife in India. **M S Swaminathan** is one of India's foremost agricultural scientists and has also been concerned with various aspects of biodiversity conservation both of cultivars and wild biodiversity. He has founded the MS Swaminathan Research Foundation in Chennai, which does work on the conservation of biological diversity. **Madhav Gadgil** is a well known ecologist in India. His interests range from broad ecological issues such as developing Community Biodiversity Registers and conserving sacred groves to studies on the behavior of mammals, birds and insects. He has written several articles, published papers in journals and is the author of 6 books. **M C Mehta** is undoubtedly India's most famous environmental lawyer.

Since 1984, he has filed several Public Interest Litigations for supporting the cause of environmental conservation. His most famous and long drawn battles supported by the Supreme Court include protecting the Taj Mahal, cleaning up the Ganges River, banning intensive shrimp farming on the coast, initiating Government to implement environmental education in schools and colleges, and a variety of other conservation issues. **Anil Agarwal** was a journalist who wrote the first report on the 'State of India's Environment' in 1982. He founded the Center for Science and Environment which is an active NGO that supports various environmental issues. **Medha Patkar** is known as one of India's champions who has supported the cause of downtrodden tribal people whose environment is being affected by the dams on the Narmada river. **Sunderlal Bahugna's** Chipko Movement has become an internationally well known example of a highly successful conservation action program through the efforts of local people for guarding their forest resources. His fight to prevent the construction of the Tehri Dam in a fragile earthquake prone setting is a battle that he continues to wage. The Garhwal Hills will always remember his dedication to the cause for which he has walked over 20 thousand kilometers.

UNIT-II

RENEWABLE AND NON-RENEWABLE RESOURCES

Ecosystems act as resource producers and processors. Solar energy is the main driving force of ecological systems, providing energy for the growth of plants in forests, grasslands and aquatic ecosystems. A forest recycles its plant material slowly by continuously returning its dead material, leaves, branches, etc. to the soil. Grasslands recycle material much faster than forests as the grass dries up after the rains are over every year. All the aquatic ecosystems are also solar energy dependent and have cycles of growth when plant life spreads and aquatic animals breed. The sun also drives the water cycle.

Our food comes from both natural and agricultural ecosystems. Traditional agricultural ecosystems that depended on rainfall have been modified in recent times to produce more and more food by the addition of extra chemicals and water from irrigation systems but are still dependent on solar energy for the growth of crops. Moreover modern agriculture creates a variety of environmental problems, which ultimately lead to the formation of unproductive land.

These include irrigation, which leads to the development of saline soil, and the use of artificial fertilizers eventually ruin soil quality, and pesticides, which are a health hazard for humans as well as destroying components vital to the long-term health of agricultural ecosystems. To manufacture consumer products, industry requires raw materials from nature, including water, minerals and power. During the manufacturing process, the gases, chemicals and waste products pollute our environment, unless the industry is carefully managed to clean up this mess.

Natural resources and associated problems

The unequal consumption of natural resources:
A major part of natural resources are today consumed in the technologically advanced or 'developed' world, usually termed 'the North'. The 'developing nations' of 'the South', including India and China, also over use many resources because of their greater human population. However, the consumption of resources per capita (per individual) of the developed countries is up to 50 times greater than in most developing countries. Advanced countries produce over 75% of global industrial waste and greenhouse gases.

Energy from fossil fuels is consumed in relatively much greater quantities in developed countries. Their per capita consumption of food too is much greater as well as their waste of enormous quantities of food and other products, such as packaging material, used in the food industry. The USA for example with just 4% of the world's population consumes about 25% of the world's resources.

Producing animal food for human consumption requires more land than growing crops. Thus countries that are highly dependent on non-vegetarian diets need much larger areas for pastureland than those where the people are mainly vegetarian.

Planning Landuse: Land itself is a major resource, needed for food production, animal husbandry, industry, and for our growing human settlements. These forms of intensive landuse are frequently extended at the cost of 'wild lands', our remaining forests, grasslands, wetlands and deserts. Thus it is

essential to evolve a rational land-use policy that examines how much land must be made available for different purposes and where it must be situated. For instance, there are usually alternate sites at which industrial complexes or dams can be built, but a natural wilderness cannot be recreated artificially. Scientists today believe that at least 10 percent of land and water bodies of each ecosystem must be kept as wilderness for the long term needs of protecting nature and natural resources.

Land as a resource is now under serious pressure due to an increasing 'land hunger' - to produce sufficient quantities of food for an exploding human population. It is also affected by degradation due to misuse. Land and water resources are polluted by industrial waste and rural and urban sewage. They are increasingly being diverted for short-term economic gains to agriculture and industry. Natural wetlands of great value are being drained for agriculture and other purposes. Semi-arid land is being irrigated and overused.

The most damaging change in landuse is demonstrated by the rapidity with which forests have vanished during recent times, both in India and in the rest of the world. Forests provide us with a variety of services. These include processes such as maintaining oxygen levels in the atmosphere, removal of carbon dioxide, control over water regimes, and slowing down erosion and also produce products such as food, fuel, timber, fodder, medicinal plants, etc. In the long term, the loss of these is far greater than the short-term gains produced by converting forested lands to other uses.

The need for sustainable lifestyles: The quality of human life and the quality of ecosystems on earth are indicators of the sustainable use of resources. There are clear indicators of sustainable lifestyles in human life.

- Increased longevity
- An increase in knowledge
- An enhancement of income.

These three together are known as the '**Human development index'**.

The quality of the ecosystems have indicators that are more difficult to assess.

- A stabilized population.
- The long term conservation of biodiversity.
- The careful long-term use of natural resources.
- The prevention of degradation and pollution of the environment.

Non-renewable resources

These are minerals that have been formed in the lithosphere over millions of years and constitute a closed system. These non-renewable resources, once used, remain on earth in a different form and, unless recycled, become waste material.

Non-renewable resources include fossil fuels such as oil and coal, which if extracted at the present rate, will soon be totally used up. The end products of fossil fuels are in the form of heat and mechanical energy and chemical compounds, which cannot be reconstituted as a resource.

Renewable resources

Though water and biological living resources are considered renewable. They are in fact renewable only within certain limits. They are linked to natural cycles such as the water cycle.

• Fresh water (even after being used) is evaporated by the sun's energy, forms water vapour and is reformed in clouds and falls to earth as rain. However, water sources can be overused or wasted to such an extent that they locally run dry. Water sources can be so heavily polluted by sewage and toxic substances that it becomes impossible to use the water.

• Forests, once destroyed take thousands of years to regrow into fully developed natural ecosystems with their full complement of species. Forests thus can be said to behave like non-renewable resources if overused.

• Fish are today being over-harvested until the catch has become a fraction of the original resource and the fish are incapable of breeding successfully to replenish the population.

• The output of agricultural land if mismanaged drops drastically.

• When the population of a species of plant or animal is reduced by human activities, until it cannot reproduce fast enough to maintain a viable number, the species becomes extinct.

• Many species are probably becoming extinct without us even knowing, and other linked species are affected by their loss.

a) Forest Resources

Use and overexploitation: Scientists estimate that India should ideally have 33 percent of its land under forests. Today we have only about 12 percent. Thus we need not only to protect existing forests but also to increase our forest cover.

People who live in or near forests know the value of forest resources first hand because their lives and livelihoods depend directly on these resources.

However, the rest of us also derive great benefits from the forests which we are rarely aware of. The water we use depends on the existence of forests on the watersheds around river valleys. Our homes, furniture and paper are made from wood from the forest. We use many medicines that are based on forest produce. And we depend on the oxygen that plants give out and the removal of carbon dioxide we breathe out from the air.

Forests once extended over large tracts of our country. People have used forests in our country for thousands of years. As agriculture spread the forests were left in patches which were controlled mostly by tribal people. They hunted animals and gathered plants and lived entirely on forest resources. Deforestation became a major concern in British times when a large amount of timber was extracted for building their ships. This led the British to develop scientific forestry in India. They however alienated local people by creating Reserved and Protected Forests which curtailed access to the resources. This led to a loss of stake in the conservation of the forests which led to a gradual degradation and fragmentation of forests across the length and breadth of the country.

Another period of overutilisation and forest degradation occurred in the early period following independence as people felt that now that the British had gone they had a right to using our forests in any way we pleased. The following years saw India's residual forest wealth dwindle sharply. Timber extraction continued to remain the Forest Department's main concern up to the 1970s. The fact that forest degradation and deforestation was creating a serious loss of the important functions of the forest began to override its utilisation as a source of revenue from timber.

Deforestation: Where civilizations have looked after forests by using forest resources cautiously, they have prospered, where forests were destroyed, the people were gradually impoverished. Today logging and mining are serious causes of loss of forests in our country and all over the world. Dams built for hydroelectric power or irrigation have submerged forests and have displaced tribal people whose lives are closely knit to the forest. This has become a serious cause of concern in India.

One of India's serious environmental problems is forest degradation due to timber extraction and our dependence on fuelwood. A large number of poor rural people are still highly dependent on wood to cook their meals and heat their homes. We have not been able to plant enough trees to support the need for timber and fuelwood.

The National Forest Policy of 1988 now gives an added importance to JFM. Another resolution in 1990 provided a formal structure for community participation though the formation of Village Forest Committees. Based on these experiences, new JFM guidelines were issued in 2000. This stipulates that at least 25 per cent of the income from the area must go to the community. From the initiation of the program, until 2002, there were 63,618 JFM Committees managing over 140,953 sq. km of forest under JFM in 27 States in India.

The States have tried a variety of approaches to JFM. The share for village forest committees ranges from 25 per cent in Kerala to 100 percent in Andhra Pradesh, 50 per cent in Gujarat, Maharashtra, Orissa and Tripura. In many States 25 per cent of the revenue is used for village development. In many States non-timber forest products (NTFPs) are available for people free of cost. Some States have stopped grazing completely; some have rotational grazing schemes which have helped in forest regeneration.

Timber extraction, mining and dams are invariably parts of the needs of a developing country. If timber is overharvested the ecological functions of the forest are lost. Unfortunately forests are located in areas where there are rich mineral resources. Forests also cover the steep embankments of river valleys, which are ideally suited to develop hydel and irrigation projects. Thus there is a constant conflict of interests between the conservation interests of environmental scientists and the Mining and Irrigation Departments. What needs to be understood is that long-term ecological gains cannot be sacrificed for short-term economic gains that unfortunately lead to deforestation. These forests where development projects are planned, can displace thousands of tribal people who lose their homes when these plans are executed. This leads to high levels of suffering for which there is rarely a satisfactory answer.

b) Water resources

The water cycle, through evaporation and precipitation, maintains hydrological systems which form rivers and lakes and support in a variety of aquatic ecosystems. Wetlands are intermediate forms between terrestrial and aquatic ecosystems and contain species of plants and animals that are highly moisture

dependent. All aquatic ecosystems are used by a large number of people for their daily needs such as drinking water, washing, cooking, watering animals, and irrigating fields. The world depends on a limited quantity of fresh water. Water covers 70% of the earth's surface but only 3% of this is fresh water. Of this, 2% is in polar ice caps and only 1% is usable water in rivers, lakes and subsoil aquifers. Only a fraction of this can be actually used. At a global level 70% of water is used for agriculture about 25% for industry and only 5% for domestic use. However this varies in different countries and industrialized countries use a greater percentage for industry. India uses 90% for agriculture, 7% for industry and 3% for domestic use.

One of the greatest challenges facing the world in this century is the need to rethink the overall management of water resources. The world population has passed the 6 billion mark. Based on the proportion of young people in developing countries, this will continue to increase significantly during the next few decades. This places enormous demands on the world's limited freshwater supply. The total annual freshwater withdrawals today are estimated at 3800 cubic kilometers, twice as much as just 50 years ago (World Commission on Dams, 2000). Studies indicate that a person needs a minimum of 20 to 40 liters of water per day for drinking and sanitation. More than one billion people worldwide have no access to clean water, and to many more, supplies are unreliable. Local conflicts are already spreading to states. Eg. Karnataka and Tamil Nadu over the waters of the Krishna.

India is expected to face critical levels of water stress by 2025. At the global level 31 countries are already short of water and by 2025 there will be 48 countries facing serious water shortages. The UN has estimated that by the year 2050, 4 billion people will be seriously affected by water shortages. This will lead to multiple conflicts between countries over the sharing of water. Around 20 major cities in India face chronic or interrupted water shortages. There are 100 countries that share the waters of 13 large rivers and lakes. The upstream countries could starve the downstream nations leading to political unstable areas across the world. Examples are Ethopia, which is upstream on the Nile and Egypt, which is downstream and highly dependent on the Nile. International accords that will look at a fair distribution of water in such areas will become critical to world peace. India and Bangladesh already have a negotiated agreement on the water use of the Ganges.

Overutilization and pollution of surface and groundwater: With the growth of human population there is an increasing need for larger amounts of water to fulfill a variety of basic needs. Today in many areas this requirement cannot be met. Overutilization of water occurs at various levels. Most people use more water than they really need. Most of us waste water during a bath by using a shower or during washing of clothes. Many agriculturists use more water than necessary to grow crops. There are many ways in which farmers can use less water without reducing yields such as the use of drip irrigation systems.

Agriculture also pollutes surface water and underground water stores by the excessive use of chemical fertilizers and pesticides. Methods such as the use of biomass as fertilizer and non toxic pesticides such as neem products and using integrated pest management systems reduces the agricultural pollution of surface and ground water.

Industry tends to maximise short-term economic gains by not bothering about its liquid waste and releasing it into streams, rivers and the sea. In the longer term, as people become more conscious of using 'green products' made by ecosensitive industries, the polluter's products may not be used. The polluting industry that does not care for the environment and pays off bribes to get away from the cost needed to

use effluent treatment plants may eventually be caught, punished and even closed down. Public awareness may increasingly put pressures on industry to produce only eco-friendly products which are already gaining in popularity. As people begin to learn about the serious health hazards caused by pesticides in their food, public awareness can begin putting pressures on farmers to reduce the use of chemicals that are injurious to health.

Global climate change: Changes in climate at a global level caused by increasing air pollution have now begun to affect our climate. In some regions global warming and the El Nino winds have created unprecedented storms. In other areas, they lead to long droughts. Everywhere the 'greenhouse effect' due to atmospheric pollution is leading to increasingly erratic and unpredictable climatic effects. This has seriously affected regional hydrological conditions.

Floods: Floods have been a serious environmental hazard for centuries. However, the havoc raised by rivers overflowing their banks has become progressively more damaging, as people have deforested catchments and intensified use of river flood plains that once acted as safety valves. Wetlands in flood plains are nature's flood control systems into which overfilled rivers could spill and act like a temporary sponge holding the water, and preventing fast flowing water from damaging surrounding land.

Deforestation in the Himalayas causes floods that year after year kill people, damage crops and destroy homes in the Ganges and its tributaries and the Bramhaputra. Rivers change their course during floods and tons of valuable soil is lost to the sea. As the forests are degraded, rainwater no longer percolates slowly into the subsoil but runs off down the mountainside bearing large amounts of topsoil. This blocks rivers temporarily but gives way as the pressure mounts allowing enormous quantities of water to wash suddenly down into the plains below. There, rivers swell, burst their banks and flood waters spread to engulf peoples' farms and homes.

Drought: In most arid regions of the world the rains are unpredictable. This leads to periods when there is a serious scarcity of water to drink, use in farms, or provide for urban and industrial use. Drought prone areas are thus faced with irregular periods of famine. Agriculturists have no income in these bad years, and as they have no steady income, they have a constant fear of droughts. India has 'Drought Prone Areas Development Programs', which are used in such areas to buffer the effects of droughts. Under these schemes, people are given wages in bad years to build roads, minor irrigation works and plantation programs.

Drought has been a major problem in our country especially in arid regions. It is an unpredictable climatic condition and occurs due to the failure of one or more monsoons. It varies in frequency in different parts of our country. While it is not feasible to prevent the failure of the monsoon, good environmental management can reduce its ill effects. The scarcity of water during drought years affects homes, agriculture and industry. It also leads to food shortages and malnutrition which especially affects children.

Several measures can be taken to minimise the serious impacts of a drought. However this must be done as a preventive measure so that if the monsoons fail its impact on local people's lives is minimised.

In years when the monsoon is adequate, we use up the good supply of water without trying to conserve it and use the water judiciously. Thus during a year when the rains are poor, there is no water even for drinking in the drought area.

One of the factors that worsens the effect of drought is deforestation. Once hill slopes are denuded of forest cover the rainwater rushes down the rivers and is lost. Forest cover permits water to be held in the area permitting it to seep into the ground. This charges the underground stores of water in natural aquifers. This can be used in drought years if the stores have been filled during a good monsoon. If water from the underground stores is overused, the water table drops and vegetation suffers. This soil and water management and afforestation are long-term measures that reduce the impact of droughts.

Water for Agriculture and Power Generation:
India's increasing demand for water for intensive irrigated agriculture, for generating electricity, and for consumption in urban and industrial centers, has been met by creating large dams. Irrigated areas increased from 40 million ha. in 1900 to 100 million ha. in 1950 and to 271 million ha. by 1998. Dams support 30 to 40% of this area.

Although dams ensure a year round supply of water for domestic use, provide extra water for agriculture, industry, hydropower generation, they have several serious environmental problems.

They alter river flows, change nature's flood control mechanisms such as wetlands and flood plains, and destroy the lives of local people and the habitats of wild plant and animal species. Irrigation to support cash crops like sugarcane produces an unequal distribution of water. Large landholders on the canals get the lion's share of water, while poor, small farmers get less and are seriously affected.

Sustainable water management: 'Save water' campaigns are essential to make people everywhere aware of the dangers of water scarcity.
A number of measures need to be taken for the better management of the world's water resources. These include measures such as:
• Building several small reservoirs instead of few mega projects.
• Develop small catchment dams and protect wetlands.
Soil management, micro catchment development and afforestation permits recharging of underground aquifers thus reducing the need for large dams.
• Treating and recycling municipal waste water for agricultural use.
• Preventing leakages from dams and canals.
• Preventing loss in Municipal pipes.
• Effective rain water harvesting in urban environments.
• Water conservation measures in agriculture such as using drip irrigation.
• Pricing water at its real value makes people use it more responsibly and efficiently and reduces water wasting.
• In deforested areas where land has been degraded, soil management by bunding along the hill slopes and making 'nala' plugs, can help retain moisture and make it possible to re-vegetate degraded areas.

Managing a river system is best done by leaving its course as undisturbed as possible. Dams and canals lead to major floods in the monsoon and the drainage of wetlands seriously affects areas that get flooded when there is high rainfall.

Dams: Today there are more than 45,000 large dams around the world, which play an important role in communities and economies that harness these water resources for their economic development. Current

estimates suggest some 30-40% of irrigated land worldwide relies on dams. Hydropower, another contender for the use of stored water, currently supplies 19% of the world's total electric power supply and is used in over 150 countries. The world's two most populous countries – China and India – have built around 57% of the world's large dams.

Dams problems
• Fragmentation and physical transformation of rivers.
• Serious impacts on riverine ecosystems.
• Social consequences of large dams due to displacement of people.
• Water logging and salinisation of surrounding lands.
• Dislodging animal populations, damaging their habitat and cutting off their migration routes.
• Fishing and travel by boat disrupted.
• The emission of green house gases from reservoirs due to rotting vegetation and carbon inflows from the catchment is a recently identified impact.

Large dams have had serious impacts on the lives, livelihoods, cultures and spiritual existence of indigenous and tribal peoples. They have suffered disproportionately from the negative impacts of dams and often been excluded from sharing the benefits. In India, of the 16 to 18 million people displaced by dams, 40 to 50% were tribal people, who account for only 8% of our nation's one billion people.

Conflicts over dams have heightened in the last two decades because of their social and environmental impacts and failure to achieve targets for sticking to their costs as well as achieving promised benefits. Recent examples show how failure to provide a transparent process that includes effective participation of local people has prevented affected people from playing an active role in debating the pros and cons of the project and its alternatives. The loss of traditional, local controls over equitable distribution remains a major source of conflict.

c) Mineral Resources

A mineral is a naturally occurring substance of definite chemical composition and identifiable physical properties. An ore is a mineral or combination of minerals from which a useful substance, such as a metal, can be extracted and used to manufacture a useful product.

Minerals are formed over a period of millions of years in the earth's crust. Iron, aluminum, zinc, manganese and copper are important raw materials for industrial use. Important non-metal resources include coal, salt, clay, cement and silica. Stone used for building material, such as granite, marble, limestone, constitute another category of minerals. Minerals with special properties that humans value for their aesthetic and ornamental value are gems such as diamonds, emeralds, rubies. The luster of gold, silver and platinum is used for ornaments. Minerals in the form of oil, gas and coal were formed when ancient plants and animals were converted into underground fossil fuels. Minerals and their ores need to be extracted from the earth's interior so that they can be used. This process is known as mining. Mining operations generally progress through four stages:

(1) Prospecting: Searching for minerals.

(2) Exploration: Assessing the size, shape, location, and economic value of the deposit.

(3) Development: Work of preparing access to the deposit so that the minerals can be extracted from it.

(4) Exploitation: Extracting the minerals from the mines. In the past, mineral deposits were discovered by prospectors in areas where mineral deposits in the form of veins were exposed on the surface. Today, however, prospecting and exploration is done by teams of geologists, mining engineers, geophysicists, and geochemists who work together to discover new deposits. Modern prospecting methods include the use of sophisticated instruments like GIS to survey and study the geology of the area.

The method of mining has to be determined depending on whether the ore or mineral deposit is nearer the surface or deep within the earth. The topography of the region and the physical nature of the ore deposit is studied. Mines are of two types – surface (open cut or strip mines) or deep or shaft mines. Coal, metals and non-metalliferous minerals are all mined differently depending on the above criteria. The method chosen for mining will ultimately depend on how maximum yield may be obtained under existing conditions at a minimum cost, with the least danger to the mining personnel. Most minerals need to be processed before they become usable. Thus 'technology' is dependent on both the presence of resources and the energy necessary to make them 'usable'.

Mine safety: Mining is a hazardous occupation, and the safety of mine workers is an important environmental consideration of the industry. Surface mining is less hazardous than underground mining. Metal mining is less hazardous than coal mining. In all underground mines, rock and roof falls, flooding, and inadequate ventilation are the greatest hazards. Large explosions have occured in coal mines, killing many miners. More miners have suffered from disasters due to the use of explosives in metal mines.

Mining poses several long-term occupational hazards to the miners. Dust produced during mining operations is injurious to health and causes a lung disease known as black lung, or pneumoconiosis. Fumes generated by incomplete dynamite explosions are extremely poisonous. Methane gas, emanating from coal strata, is hazardous to health although not poisonous in the concentrations usually encountered in mine air. Radiation is a hazard in uranium mines.

Environmental problems: Mining operations are considered one of the main sources of environmental degradation. The extraction of all these products from the lithosphere has a variety of side effects. Depletion of available land due to mining, waste from industries, conversion of land to industry and pollution of land, water and air by industrial wastes, are environmental side effects of the use of these non-renewable resources. Public awareness of this problem is of a global nature and government actions to stem the damage to the natural environment have led to numerous international agreements and laws directed toward the prevention of activities and events that may adversely affect the environment.

d) Food resources

Today our food comes almost entirely from agriculture, animal husbandry and fishing. Although India is self-sufficient in food production, it is only because of modern patterns of agriculture that are unsustainable and which pollute our environment with excessive use of fertilizers and pesticides.

The FAO defines sustainable agriculture as that which conserves land, water and plant and animal genetic resources, does not degrade the environment and is economically viable and socially acceptable. Most of

our large farms grow single crops (monoculture). If this crop is hit by a pest, the entire crop can be devastated, leaving the farmer with no income during the year. On the other hand, if the farmer uses traditional varieties and grows several different crops, the chance of complete failure is lowered considerably. Many studies have shown that one can use alternatives to inorganic fertilizers and pesticides.

This is known as **Integrated Crop Management**. **World food problems:** In many developing countries where populations are expanding rapidly, the production of food is unable to keep pace with the growing demand. Food production in 64 of the 105 developing countries is lagging behind their population growth levels. These countries are unable to produce more food, or do not have the financial means to import it. India is one of the countries that have been able to produce enough food by cultivating a large proportion of its arable land through irrigation. The Green Revolution of the 60's reduced starvation in the country. However many of the technologies we have used to achieve this are now being questioned.

- Our fertile soils are being exploited faster than they can recuperate.
- Forests, grasslands and wetlands have been converted to agricultural use, which has led to serious ecological questions.
- Our fish resources, both marine and inland, show evidence of exhaustion.
- There are great disparities in the availability of nutritious food. Some communities such as tribal people still face serious food problems leading to malnutrition especially among women and children.

These issues bring in new questions as to how demands will be met in future even with a slowing of population growth. Today the world is seeing a changing trend in dietary habits. As living standards are improving, people are eating more non-vegetarian food. As people change from eating grain to meat, the world's demand for feed for livestock based on agriculture increases as well. This uses more land per unit of food produced and the result is that the world's poor do not get enough to eat. Women play an extremely vital role in food production as well as cooking the meal and feeding children. In most rural communities they have the least exposure to technical training and to health workers trained in teaching/learning on issues related to nutritional aspects. Women and girls frequently receive less food than the men. These disparities need to be corrected. In India there is a shortage of cultivable productive land. Thus farm sizes are too small to support a family on farm produce alone. With each generation, farms are being subdivided further.

Poor environmental agricultural practices such as slash and burn, shifting cultivation, or 'rab' (woodash) cultivation degrade forests. Globally 5 to 7 million hectares of farmland is degraded each year. Loss of nutrients and overuse of agricultural chemicals are major factors in land degradation. Water scarcity is an important aspect of poor agricultural outputs. Salinization and water logging has affected a large amount of agricultural land worldwide. Loss of genetic diversity in crop plants is another issue that is leading to a fall in agricultural produce. Rice, wheat and corn are the staple foods of two thirds of the world's people. As wild relatives of crop plants in the world's grasslands, wetlands and other natural habitats are being lost, the ability to enhance traits that are resistant to diseases, salinity, etc. is lost. Genetic engineering is an untried and risky alternative to traditional cross breeding.

Food Security: It is estimated that 18 million people worldwide, most of whom are children, die each year due to starvation or malnutrition, and many others suffer a variety of dietary deficiencies. The earth can only supply a limited amount of food. If the world's carrying capacity to produce food cannot meet the needs of a growing population, anarchy and conflict will follow. Thus food security is closely linked

with population control through the family welfare program. It is also linked to the availability of water for farming. Food security is only possible if food is equitably distributed to all. Many of us waste a large amount of food carelessly. This eventually places great stress on our environmental resources.

A major concern is the support needed for small farmers so that they remain farmers rather than shifting to urban centers as unskilled industrial workers. International trade policies in regard to an improved flow of food across national borders from those who have surplus to those who have a deficit in the developing world is another issue that is a concern for planners who deal with International trade concerns. 'Dumping' of underpriced foodstuffs produced in the developed world, onto markets in undeveloped countries undermines prices and forces farmers there to adopt unsustainable practices to compete.

Fisheries: Fish is an important protein food in many parts of the world. This includes marine and fresh water fish. While the supply of food from fisheries increased phenomenally between 1950 and 1990, in several parts of the world fish catch has since dropped due to overfishing. In 1995 FAO reported that 44% of the world's fisheries are fully or heavily exploited, 16% are already overexploited, 6% are depleted, and only 3% are gradually recovering. Canada had to virtually close down cod fishing in the 1990s due to depletion of fish reserves.

Modern fishing technologies using mechanized trawlers and small meshed nets lead directly to overexploitation, which is not sustainable. It is evident that fish have to breed successfully and need to have time to grow if the yield has to be used sustainably. The worst hit are the small traditional fishermen who are no match for organized trawlers.

Loss of Genetic diversity: There are 50,000 known edible plants documented worldwide. Of these only 15 varieties produce 90% of the world's food. Modern agricultural practices have resulted in a serious loss of genetic variability of crops. India's distinctive traditional varieties of rice alone are said to have numbered between 30 and 50 thousand. Most of these have been lost to the farmer during the last few decades as multinational seed companies push a few commercial types.

This creates a risk to our food security, as farmers can loose all their produce due to a rapidly spreading disease. A cereal that has multiple varieties growing in different locations does not permit the rapid spread of a disease. The most effective method to introduce desirable traits into crops is by using characteristics found in the wild relatives of crop plants. As the wilderness shrinks, these varieties are rapidly disappearing. Once they are lost, their desirable characteristics cannot be introduced when found necessary in future. Ensuring long-term food security may depend on conserving wild relatives of crop plants in National Parks and Wildlife Sanctuaries.

If plant genetic losses worldwide are not slowed down, some estimates show that as many as 60,000 plant species, which accounts for 25% of the world's total, will be lost by the year 2025. The most economical way to prevent this is by expanding the network and coverage of our Protected Areas. Collections in germplasm, seed banks and tissue culture facilities, are other possible ways to prevent extinction but are extremely expensive.

Scientists now believe that the world will soon need a second green revolution to meet our future demands of food based on a new ethic of land and water management that must be based on values which include environmental sensitivity, equity, biodiversity conservation of cultivars and insitu preservation of

wild relatives of crop plants. This must not only provide food for all, but also work out more equitable distribution of both food and water, reduce agricultural dependence on the use of fertilizers and pesticides (which have long term ill effects on human wellbeing) and provide an increasing support for preserving wild relatives of crop plants in Protected Areas. Pollution of water sources, land degradation and desertification must be rapidly reversed. Adopting soil conservation measures, using appropriate farming techniques, especially on hill slopes, enhancing the soil with organic matter, rotating crops and managing watersheds at the micro level are a key to agricultural production to meet future needs. Most importantly food supply is closely linked to the effectiveness of population control programs worldwide. The world needs better and sustainable methods of food production which is an important aspect of landuse management.

Alternate food sources: Food can be innovatively produced if we break out of the current agricultural patterns. This includes working on new avenues to produce food, such as using forests for their multiple non-wood forest products, which can be used for food if harvested sustainably. This includes fruit, mushrooms, sap, gum, etc. This takes time, as people must develop a taste for these new foods.

CASE STUDY

Israel began using drip irrigation systems as it is short of water. With this technique, farmers have been able to improve the efficiency of irrigation by 95%. Over a 20-year period, Israel's food production doubled without an increase in the use of water for agriculture. In India, some traditional communities in urban and semi urban towns used to grow their own vegetables in backyards on wastewater from their own homes. Calcutta releases its waste water into surrounding lagoons in which fish are reared and the water is used for growing vegetables.
Medicines, both traditional and modern, can be harvested sustainably from forests. Madagaskar's Rosy Periwinkle used for childhood leukemia's and Taxol from Western Yew from the American Northwest as an anticancer drug are examples of forest products used extensively in modern medicine. Without care, commercial exploitation can lead to early extinction of such plants.

Using unfamiliar crops such as Nagli, which are grown on poor soil on hill slopes is another option. This crop grown in the Western Ghats now has no market and is thus rarely grown. Only local people use this nutritious crop themselves. It is thus not as extensively cultivated as in the past. Popularising this crop could add to food availability from marginal lands. Several crops can be grown in urban settings, including vegetables and fruit which can be grown on waste household water and fertilizers from vermicomposting pits.

Several foods can be popularized from yet unused seafood products such as seaweed as long as this is done at sustainable levels. Educating women about nutrition, who are more closely involved with feeding the family, is an important aspect of supporting the food needs of many developing countries. Integrated Pest Management includes preserving pest predators, using pest resistant seed varieties and reducing the use of chemical fertilizers.

e) Energy resources

Energy is defined by physicists as the capacity to do work. Energy is found on our planet in a variety of forms, some of which are immediately useful to do work, while others require a process of transformation.

The sun is the primary energy source in our lives. We use it directly for its warmth and through various natural processes that provide us with food, water, fuel and shelter. The sun's rays power the growth of plants, which form our food material, give off oxygen which we breathe in and take up carbon dioxide that we breathe out. Energy from the sun evaporates water from oceans, rivers and lakes, to form clouds that turn into rain. Today's fossil fuels were once the forests that grew in prehistoric times due to the energy of the sun.

Chemical energy, contained in chemical compounds is released when they are broken down by animals in the presence of oxygen. In India, manual labour is still extensively used to get work done in agricultural systems, and domestic animals used to pull carts and ploughs. Electrical energy produced in several ways, powers transport, artificial lighting, agriculture and industry. This comes from hydel power based on the water cycle that is powered by the sun's energy that supports evaporation, or from thermal power stations powered by fossil fuels. Nuclear energy is held in the nucleus of an atom and is now harnessed to develop electrical energy. We use energy for household use, agriculture, production of industrial goods and for running transport. Modern agriculture uses chemical fertilizers, which require large amounts of energy during their manufacture.

Industry uses energy to p o w e r manufacturing units and the urban complexes that support it. Energy-demanding roads and railway lines are built to transport products from place to place and to reach raw materials in mines and forests.
No energy related technology is completely 'risk free' and unlimited demands on energy increase this risk factor many fold. All energy use creates heat and contributes to atmospheric temperature. Many forms of energy release carbon dioxide and lead to global warming. Nuclear energy plants have caused enormous losses to the environment due to the leakage of nuclear material. The inability to effectively manage and safely dispose of nuclear waste is a serious global concern.

At present almost 2 billion people worldwide have no access to electricity at all. While more people will require electrical energy, those who do have access to it continue to increase their individual requirements. In addition, a large proportion of energy from electricity is wasted during transmission as well as at the user level. It is broadly accepted that long-term trends in energy use should be towards a cleaner global energy system that is less carbon intensive and less reliant on finite non-renewable energy sources. It is estimated that the currently used methods of using renewable energy and non renewable fossil fuel sources together will be insufficient to meet foreseeable global demands for power generation beyond the next 50 to 100 years.

Thus when we use energy wastefully, we are contributing to a major environmental disaster for our earth. We all need to become responsible energy users. An electrical light that is burning unnecessarily is a contributor to environmental degradation.

Growing energy needs: Energy has always been closely linked to man's economic growth and development. Present strategies for development that have focused on rapid economic growth have used energy utilization as an index of economic development. This index however, does not take into account

the long-term ill effects on society of excessive energy utilisation. In 1998, the World Resources Institute found that the average American uses 24 times the energy used by an Indian.
Between 1950 and 1990, the world's energy needs increased four fold. The world's demand for electricity has doubled over the last 22 years!

The world's total primary energy consumption in 2000 was 9096 million tons of oil. A global average per capita that works out to be 1.5 tons of oil. Electricity is at present the fastest growing form of end-use energy worldwide. By 2005 the Asia-Pacific region is expected to surpass North America in energy consumption and by 2020 is expected to consume some 40% more energy than North America.

For almost 200 years, coal was the primary energy source fuelling the industrial revolution in the 19th century. At the close of the 20th century, oil accounted for 39% of the world's commercial energy consumption, followed by coal (24%) and natural gas (24%), while nuclear (7%) and hydro/renewables (6%) accounted for the rest.

Among the commercial energy sources used in India, coal is a predominant source accounting for 55% of energy consumption estimated in 2001, followed by oil (31%), natural gas (8%), hydro (5%) and nuclear (1%).

In India, biomass (mainly wood and dung) accounts for almost 40% of primary energy supply. While coal continues to remain the dominant fuel for electricity generation, nuclear power has been increasingly used since the 1970s and 1980s and the use of natural gas has increased rapidly in the 80s and 90s.
Types of energy: There are three main types of energy; those classified as **non-renewable;** those that are said to be **renewable;** and **nuclear energy,** which uses such small quantities of raw material (uranium) that supplies are to all effect, limitless. However, this classification is inaccurate because several of the renewable sources, if not used 'sustainably', can be depleted more quickly than they can be renewed.

Non renewable energy

To produce electricity from non-renewable resources the material must be ignited. The fuel is placed in a well contained area and set on fire. The heat generated turns water to steam, which moves through pipes, to turn the blades of a turbine. This converts magnetism into electricity, which we use in various appliances. Non-Renewable Energy Sources: These consist of the mineral based hydrocarbon fuels coal, oil and natural gas, that were formed from ancient prehistoric forests. These are called 'fossil fuels' because they are formed after plant life is fossilized. At the present rate of extraction there is enough coal for a long time to come. Oil and gas resources however are likely to be used up within the next 50 years. When these fuels are burnt, they produce waste products that are released into the atmosphere as gases such as carbon dioxide, oxides of sulphur, nitrogen, and carbon monoxide, all causes of air pollution. These have led to lung problems in an enormous number of people all over the world, and have also affected buildings like the Taj Mahal and killed many forests and lakes due to acid rain. Many of these gases also act like a green house letting sunlight in and trapping the heat inside. This is leading to global warming, a raise in global temperature, increased drought in some areas, floods in other regions, the melting of icecaps, and a rise in sea levels, which is slowly submerging coastal belts all over the world. Warming the seas also leads to the death of sensitive organisms such as coral.

Oil and its environmental impacts: India's oil reserves which are being used at present lie off the coast of Mumbai and in Assam. Most of our natural gas is linked to oil and, because there is no distribution system, it is just burnt off. This wastes nearly 40% of available gas. The processes of oil and natural gas drilling, processing, transport and utilisation have serious environmental consequences, such as leaks in which air and water are polluted and accidental fires that may go on burning for days or weeks before the fire can be controlled. During refining oil, solid waste such as salts and grease are produced which also damage the environment. Oil slicks are caused at sea from offshore oil wells, cleaning of oil tankers and due to shipwrecks. The most well-known disaster occurred when the Exxon Valdez sank in 1989 and birds, sea otters, seals, fish and other marine life along the coast of Alaska was seriously affected.

Oil powered vehicles emit carbon dioxide, sulphur dioxide, nitrous oxide, carbon monoxide and particulate matter which is a major cause of air pollution especially in cities with heavy traffic density. Leaded petrol, leads to neuro damage and reduces attention spans. Running petrol vehicles with unleaded fuel has been achieved by adding catalytic converters on all the new cars, but unleaded fuel contains benzene and butadene which are known to be carcinogenic compounds. Delhi, which used to have serious smog problems due to traffic, has been able to reduce this health hazard by changing a large number of its vehicles to CNG, which contains methane.
Dependence on dwindling fossil fuel resources, especially oil, results in political tension, instability and war. At present 65 percent of the world's oil reserves are located in the Middle East.

Coal and its environmental impacts: Coal is the world's single largest contributor of green house gases and is one of the most important causes of global warming. Many coal-based power generation plants are not fitted with devices such as electrostatic precipitators to reduce emissions of suspended particulate matter (SPM) which is a major contributor to air pollution. Burning coal also produces oxides of sulphur and nitrogen which, combined with water vapour, lead to 'acid rain'. This kills forest vegetation, and damages architectural heritage sites, pollutes water and affects human health.

Thermal power stations that use coal produce waste in the form of 'fly ash'. Large dumps are required to dispose off this waste material, while efforts have been made to use it for making bricks. The transport of large quantities of fly ash and its eventual dumping are costs that have to be included in calculating the cost-benefitsof thermal power.

CASE STUDY

Oil related disasters
During the Gulf War, oil installations burned for weeks polluting the air with poisonous gasses. The fires wasted 5 million barrels of oil and produced over a million tons of airborne pollutants, including sulphur dioxide, a major cause of acid rain. The gases moved to a height of 3km and spread as far as India. Oil also polluted coastlines, killing birds and fish.

CASE STUDY
The Exxon Valdez was wrecked in Prince William Sound in Alaska in 1989 and polluted large parts of the surrounding seas.

Renewable energy

Renewable energy systems use resources that are constantly replaced and are usually less polluting. Examples include hydropower, solar, wind, and geothermal (energy from the heat inside the earth). We also get renewable energy from burning trees and even garbage as fuel and processing other plants into biofuels. One day, all our homes may get their energy from the sun or the wind. Your car's gas tank will use biofuel. Your garbage might contribute to your city's energy supply. Renewable energy technologies will improve the efficiency and cost of energy systems. We may reach the point when we may no longer rely mostly on fossil fuel energy.

Hydroelectric Power

This uses water flowing down a natural gradient to turn turbines to generate electricity known as 'hydroelectric power' by constructing dams across rivers. Between 1950 and 1970, Hydropower generation worldwide increased seven times. The long life of hydropower plants, the renewable nature of the energy source, very low operating and maintenance costs, and absence of inflationary pressures as in fossil fuels, are some of its advantages

Drawbacks: Although hydroelectric power has led to economic progress around the world, it has created serious ecological problems.

• To produce hydroelectric power, large areas of forest and agricultural lands are submerged.
These lands traditionally provided a livelihood for local tribal people and farmers.
Conflicts over land use are inevitable.

• Silting of the reservoirs (especially as a result of deforestation) reduces the life of the hydroelectric power installations.

• Water is required for many other purposes besides power generation. These include domestic requirements, growing agricultural crops and for industry. This gives rise to conflicts.

• The use of rivers for navigation and fisheries becomes difficult once the water is dammed for generation of electricity.

• Resettlement of displaced persons is a problem for which there is no ready solution.
The opposition to many large hydroelectric schemes is growing as most dam projects have been unable to resettle people that were affected and displaced.

• In certain regions large dams can induce seismic activity which will result in earthquakes.
There is a great possibility of this occurring around the Tehri dam in the Himalayan foothills. Shri Sunderlal Bahuguna, the initiator of the Chipko Movement has fought against the Tehri Dam for several years.

With large dams causing social problems, there has been a trend to develop small hydroelectric generation units. Multiple small dams have less impact on the environment. China has the largest number of these - 60,000, generating 13,250 megawatts, i.e. 30% of China's electricity. Sweden, the US, Italy and France also have developed small dams for electrical power generation. The development of small hydroelectric power units could become a very important resource in India, which has steeply falling rivers and the economic capability and technical resources to exploit them.

Solar energy: In one hour, the sun pours as much energy onto the earth as we use in a whole year. If it were possible to harness this colossal quantum of energy, humanity would need no other source of energy. Today we have developed several methods of collecting this energy for heating water and generating electricity.

CASE STUDY

Narmada Project

The Narmada Bachao Andolan in India is an example of a movement against large dams. The gigantic Narmada River Project has affected the livelihoods of hundreds of extremely poor forest dwellers. The rich landholders downstream from the Sardar Sarovar dam will derive the maximum economic benefit, whereas the poor tribal people have lost their homes and traditional way of life. The dam will also destroy the livelihood of fishermen at the estuary. The disastrous impact that this project has on the lives of the poor, and the way in which they are being exploited, need to be clearly understood Solar heating for homes: Modern housing that uses air conditioning and/ or heating are extremely energy dependant. A passive solar home or building is designed to collect the sun's heat through large, south-facing glass windows. In solar heated buildings, sunspaces are built on the south side of the structure which act as large heat absorbers. The floors of sunspaces are usually made of tiles or bricks that absorb heat throughout the day, then release heat at night when its cold.

In energy efficient architecture the sun, water and wind are used to heat a building when the weather is cold and to cool it in summer. This is based on design and building material. Thick walls of stone or mud were used in traditional architecture as an insulator. Small doors and windows kept direct sunlight and heat out. Deeply set glass windows in colonial homes, on which direct sunlight could not reach, permitted the glass from creating a green house effect. Verandahs also served a similar purpose. Traditional bungalows had high roofs and ventilators that permitted hot air to rise and leave the room. Cross ventilation where wind can drive the air in and out of a room keeps it cool. Large overhangs over windows prevent the glass from heating the room inside. Double walls are used to prevent heating. Shady trees around the house help reduce temperature. Solar water heating: Most solar water-heating systems have two main parts: the solar collector and the storage tank. The solar energy collector heats the water, which then flows to a well insulated storage tank. A common type of collector is the flat-plate collector, a rectangular box with a transparent cover that faces the sun, usually mounted on the roof. Small tubes run through the box, carrying the water or other fluid, such as antifreeze, to be heated. The tubes are mounted on a metal absorber plate, which is painted black to absorb the sun's heat. The back and sides of the box are insulated to hold in the heat. Heat builds up in the collector, and as the fluid passes through the tubes, it too heats up. Solar water-heating systems cannot heat water when the sun is not shining. Thus homes must also have a conventional backup system. About 80% of homes in Israel have solar hot water heaters.

Solar cookers: The heat produced by the sun can be directly used for cooking using solar cookers. A solar cooker is a metal box which is black on the inside to absorb and retain heat. The lid has a reflective surface to reflect the heat from the sun into the box. The box contains black vessels in which the food to be cooked is placed. India has the world's largest solar cooker program and an estimated 2 lakh families that use solar cookers. Although solar cookers reduce the need for fuel wood and pollution from smoky wood fires, they have not caught on well in rural areas as they are not suitable to traditional cooking practices. However, they have great potential if marketed well. Other Solar-Powered Devices: Solar desalination systems (for converting saline or brackish water into pure distilled water) have been developed. In future, they should become important alternatives for man's future economic growth in areas where fresh water is not available.

Photovoltaic energy: The solar technology which has the greatest potential for use throughout the world is that of solar photo voltaic cells which directly produce electricity from sunlight using photovoltaic (PV) (also called solar) cells. Solar cells use the sun's light, not its heat, to make electricity. PV cells require little maintenance, have no moving parts, and essentially no environmental impact. They work cleanly, safely and silently. They can be installed quickly in small modules, anywhere there is sunlight. Solar cells are made up of two separate layers of silicon, each of which contains an electric charge. When light hits the cells, the charges begin to move between the two layers and electricity is produced. PV cells are wired together to form a module. A module of about 40 cells is enough to power a light bulb. For more power, PV modules are wired together into an array. PV arrays can produce enough power to meet the electrical needs of a home. Over the past few years, extensive work has been done in decreasing PV technology costs, increasing efficiency, and extending cell lifetimes. Many new materials, such as amorphous silicon, are being tested to reduce costs and automate manufacturing. PV cells are commonly used today in calculators and watches. They also provide power to satellites, electric lights, and small electrical appliances such as radios and for water pumping, highway lighting, weather stations, and other electrical systems located away from power lines. Some electric utility companies are building PV systems into their power supply networks. PV cells are environmentally benign, ie. they do not release pollutants or toxic material to the air or water, there is no radioactive substance, and no catastrophic accidents. Some PV cells, however, do contain small quantities of toxic substances such as cadmium and these can be released to the environment in the event of a fire. Solar cells are made of silicon which, al- Photovoltaic Cells

CASE STUDIES

• In 1981, a plane called 'The Solar Challenger' flew from Paris to England in 5 hours, 20 minutes. It had 16,000 solar cells glued to the wings and tail of the plane and they produced enough power to drive a small electric motor and propeller. Since 1987, every three years there is a World Solar challenge for solar operated vehicles in Australia where the vehicles cover 3000 kms.
• The world's first solar-powered hospital is in Mali in Africa. Being situated at the edge of the Sahara desert, Mali receives a large amount of sunlight. Panels of solar cells supply the power needed to run vital equipment and keep medical supplies cool in refrigerators.
• Space technology required solar energy and the space race spurred the development of solar cells. Only sunlight can provide power for long periods of time for a space station or long distance spaceship.
• Japanese farmers are substituting PV operated insect killers for toxic pesticides.
• In recent years, the popularity of building
integrated photovoltaics (BIPV's) has grown considerably. In this application, PV devices are designed as part of building materials (i.e. roofs and siding) both to produce electricity and reduce costs by replacing the costs of normal construction materials.

There are more than 3,000 BIPV systems in Germany and Japan has a program that will build 70,000 BIPV buildings though the second most abundant element in the earth's crust, has to be mined. Mining creates environmental problems. PV systems also of course only work when the sun is shining, and thus need batteries to store the electricity.

Solar thermal electric power: Solar radiation can produce high temperatures, which can generate electricity. Areas with low cloud levels of cover with little scattered radiation as in the desert are considered most suitable sites. According to a UNDP assessment, STE is about 20 years behind the wind

energy market exploitation, but is expected to grow rapidly in the near future. Mirror energy: During the 1980s, a major solar thermal electrical generation unit was built in California, containing 700 parabolic mirrors, each with 24 reflectors, 1.5 meters in diameter, which focused the sun's energy to produce steam to generate electricity.

Biomass energy: When a log is burned we are using biomass energy. Because plants and trees depend on sunlight to grow, biomass energy is a form of stored solar energy. Although wood is the largest source of biomass energy, we also use agricultural waste, sugarcane wastes, and other farm byproducts to make energy. There are three ways to use biomass. It can be burned to produce heat and electricity, changed to a gas-like fuel such as methane, or changed to a liquid fuel. Liquid fuels, also called biofuels, include two forms of alcohol: ethanol and methanol. Because biomass can be changed directly into liquid fuel, it could someday supply much of our transportation fuel needs for cars, trucks, buses, airplanes and trains with diesel fuel replaced by 'biodiesel' made from vegetable oils. In the United States, this fuel is now being produced from soybean oil. Researchers are also developing algae that produce oils, which can be converted to biodiesel and new ways have been found to produce ethanol from grasses, trees, bark, sawdust, paper, and farming wastes. Organic municipal solid waste includes paper, food wastes, and other organic non-fossil-fuel derived materials such as textiles, natural rubber, and leather that are found in the waste of urban areas. Currently, in the US, approximately 31% of organic waste is recovered from municipal solid waste via recycling and composting programs, 62% is deposited in landfills, and 7% is incinerated. Waste material can be converted into electricity by combustion boilers or steam turbines.

Note that like any fuel, biomass creates some pollutants, including carbon dioxide, when burned or converted into energy. In terms of air pollutants, biomass generate less relative to fossil fuels. Biomass is naturally low in sulphur and therefore, when burned, generates low sulphur dioxide emissions. However, if burned in the open air, some biomass feedstocks would emit relatively high levels of nitrous oxides (given the high nitrogen content of plan material), carbon monoxide, and particulates.

Biogas: Biogas is produced from plant material and animal waste, garbage, waste from households and some types of industrial wastes, such as fish processing, dairies, and sewage treatment plants. It is a mixture of gases which includes methane, carbon dioxide, hydrogen sulphide and water vapour. In this mixture, methane burns easily. With a ton of food waste, one can produce 85 Cu. M of biogas. Once used, the residue is used as an agricultural fertilizer. Denmark produces a large quantity of biogas from waste and produces 15,000 megawatts of electricity from 15 farmers' cooperatives. London has a plant which makes 30 megawatts of electricity a year from 420,000 tons of municipal waste which gives power to 50,000 families.

In Germany, 25% of landfills for garbage produce power from biogas. Japan uses 85% of its waste and France about 50%. Biogas plants have become increasingly popular in India in the rural sector. The biogas plants use cowdung, which is converted into a gas which is used as a fuel. It is also used for running dual fuel engines. The reduction in kitchen smoke by using biogas has reduced lung conditions in thousands of homes. The fibrous waste of the sugar industry is the world's largest potential source of biomass energy. Ethanol produced from sugarcane molasses is a good automobile fuel and is now used in a third of the vehicles in Brazil. The National Project on Biogas Development (NPBD), and Community/ Institutional Biogas Plant Program promote various biogas projects. By 1996 there were already 2.18 million families in India that used biogas. However China has 20 million households using biogas!

Wind Power: Wind was the earliest energy source used for transportation by sailing ships. Some 2000 years ago, windmills were developed in China, Afghanistan and Persia to draw water for irrigation and grinding grain. Most of the early work on generating electricity from wind was carried out in Denmark, at the end of the last century. Today, Denmark and California have large wind turbine cooperatives which sell electricity to the government grid. In Tamil Nadu, there are large wind farms producing 850 megawatts of electricity. At present, India is the third largest wind energy producer in the world.

The power in wind is a function of the wind speed and therefore the average wind speed of an area is an important determinant of economically feasible power. Wind speed increases with height. At a given turbine site, the power available 30 meters above ground is typically 60 percent greater than at 10 meters. Over the past two decades, a great deal of technical progress has been made in the design, siting, installation, operation, and maintenance of power-producing wind mills (turbines). These improvements have led to higher wind conversion efficiencies and lower electricity production costs.

Environmental Impacts: Wind power has few environmental impacts, as there are virtually no air or water emissions, or radiation, or solid waste production. The principal problems are bird kills, noise, effect on TV reception, and aesthetic objections to the sheer number of wind turbines that are required to meet electricity needs.

Although large areas of land are required for setting up wind farms, the amount used by the turbine bases, the foundations and the access roads is less than 1% of the total area covered by the wind farm. The rest of the area can also be used for agricultural purposes or for grazing. Siting windmills offshore reduces their demand for land and visual impact. Wind is an intermittent source and the intermittency of wind depends on the geographic distribution of wind. Wind therefore cannot be used as the sole resource for electricity, and requires some other backup or stand-by electricity source.

Tidal and Wave Power: The earth's surface is 70% water. By warming the water, the sun, creates ocean currents and wind that produces waves. It is estimated that the solar energy absorbed by the tropical oceans in a week could equal the entire oil reserves of the world – 1 trillion barrels of oil. The energy of waves in the sea that crash on the land of all the continents is estimated at 2 to 3 million megawatts of energy. From the 1970s several countries have been experimenting with technology to harness the kinetic energy of the ocean to generate electricity. Tidal power is tapped by placing a barrage across an estuary and forcing the tidal flow to pass through turbines. In a one-way system the incoming tide is allowed to fill the basin through a sluice, and the water so collected is used to produce electricity during the low tide. In a twoway system power is generated from both the incoming as well as the outgoing tide.
Tidal power stations bring about major ecological changes in the sensitive ecosystem of coastal regions and can destroy the habitats and nesting places of water birds and interfere with fisheries. A tidal power station at the mouth of a river blocks the flow of polluted water into the sea, thereby creating health and pollution hazards in the estuary. Other drawbacks include offshore energy devices posing navigational hazards. Residual drift current could affect spawning of some fish, whose larvae would be carried away from spawning grounds. They may also affect the migration patterns of surface swimming fish.

Wave power converts the motion of waves into electrical or mechanical energy. For this, an energy extraction device is used to drive turbogenerators. Electricity can be generated at sea and transmitted by cable to land. This energy source has yet to be fully explored. The largest concentration of potential wave energy on earth is located between latitudes 40 to 60 degreesin both the northern and southern

hemispheres, where the winds blow most strongly. Another developing concept harnesses energy due to the differences in temperature between the warm upper layers of the ocean and the cold deep sea water. These plants are known as Ocean Thermal Energy Conversion (OTEC). This is a high tech installation which may prove to be highly valuable in the future.

Geothermal energy: is the energy stored within the earth ("geo" for earth and "thermal" for heat). Geothermal energy starts with hot, molten rock (called magma) deep inside the earth which surfaces at some parts of the earth's crust. The heat rising from the magma warms underground pools of water known as geothermal reservoirs. If there is an opening, hot underground water comes to the surface and forms hot springs, or it may boil to form geysers. With modern technology, wells are drilled deep below the surface of the earth to tap into geothermal reservoirs. This is called direct use of geothermal energy, and it provides a steady stream of hot water that is pumped to the earth's surface. In the 20th century geothermal energy has been harnessed on a large scale for space heating, industrial use and electricity production, especially in Iceland, Japan and New Zealand. Geothermal energy is nearly as cheap as hydropower and will thus be increasingly utilised in future. However, water from geothermal reservoirs often contains minerals that are corrosive and polluting. Geothermal fluids are a problem which must be treated before disposal.

Energy Conservation: Conventional energy sources have a variety of impacts on nature and human society. India needs to rapidly move into a policy to reduce energy needs and use cleaner energy production technologies. A shift to alternate energy use and renewable energy sources that are used judiciously and equitably would bring about environmentally friendly and sustainable lifestyles. India must reduce its dependency on imported oil. At present we are under-utilizing our natural gas resources. We could develop thousands of mini dams to generate electricity. India wastes great amounts of electricity during transmission. Fuel wood plantations need to be enhanced and management through Joint Forestry Management (JFM) has a great promise for the future. Energy efficient cooking stoves or 'chulas' help the movement of air through it so that the wood is burnt more efficiently. They also have a chimney to prevent air pollution and thus reduce respiratory problems. While over 2 lakh improved chulas have been introduced throughout the country, the number in active use is unknown as most rural people find it to be unusable for several reasons. TERI in 1995 estimated that in India 95% of rural people and 60% of urban poor still depend on firewood, cattle dung and crop residue for cooking and other domestic purposes. Biomass can be converted into biogas or liquid fuels ie. ethanol and methanol. Biogas digesters convert animal waste or agricultural residues into gas. This is 60% methane and 40% CO2 generated by fermentation. The commonly used agri waste is dung of domestic animals and rice husk, coconut shells, straw or weeds. The material left after the gas is used acts as a fertilizer. Small hydrogeneration units are environment friendly. They do not displace people, destroy forests or wildlife habitats or kill aquatic and terrestrial biodiversity. They can be placed in several hill streams, on canals or rivers. The generation depends on flowing water due to gravity. However, this fails if the flow is seasonal. It is easy to waste energy but cheaper to save it than generate it. We can conserve energy by preventing or reducing waste of energy and by using resources more efficiently. People waste energy because government subsidises it. If the real cost was levied, people would not be able to afford to waste it carelessly. Industry and transport are the main growing users of energy in India. Industries that are known for generating pollution also waste the most energy. These include chemical industries, especially petrochemical units, iron and steel, textiles, paper, etc. Unplanned and inefficient public transport systems, especially in cities, waste large amount of energy. Using bicycles is an excellent method to reduce the use of energy. In agriculture,

irrigation pumps to lift water are the most energy intensive agricultural use. These are either electrical or run on fossil fuels.

CASE STUDIES

Indian industries use more energy than necessary. Steel and energy: To produce one tonne of steel, India spends 9.5 million kilocalories. In Italy it is 4.3 million kilocalories and for Japan it is only 4.1 million kilocalories. Cement industry: Over 2 million kilocalories are used to produce one tonne of cement in India. In Germany it is 0.82 million kilocalories, in USA, 0.92 million kilocalories. Vehicles: Lighter materials should be used for cars. Instead of steel we should use aluminum, fiber glass or plastics. These lighter materials can reduce the weight by 15 % and increase the fuel economy by 6 to 8%. Refrigerators: Better technologies reduced the annual energy needed by a typical Danish 200 liter refrigerator (with no freezer) from 350 kilo Watt hour (kWh) to 90 kWh. Lighting: An 18-watt modern, compact fluorescent lamp, can replace a standard 75-watt incandescent lamp.

f) Land resources:

Land as a resource: Landforms such as hills, valleys, plains, river basins and wetlands include different resource generating areas that the people living in them depend on. Many traditional farming societies had ways of preserving areas from which they used resources. Eg. In the 'sacred groves' of the Western Ghats, requests to the spirit of the Grove for permission to cut a tree, or extract a resource, were accompanied by simple rituals. The outcome of a chance fall on one side or the other of a stone balanced on a rock gave or withheld permission. The request could not be repeated for a specified period.

If land is utilized carefully it can be considered a renewable resource. The roots of trees and grasses bind the soil. If forests are depleted, or grasslands overgrazed, the land becomes unproductive and wasteland is formed. Intensive irrigation leads to water logging and salination, on which crops cannot grow. Land is also converted into a non-renewable resource when highly toxic industrial and nuclear wastes are dumped on it.
Land on earth is as finite as any of our other natural resources. While mankind has learnt to adapt his lifestyle to various ecosystems world over, he cannot live comfortably for instance on polar ice caps, on under the sea, or in space in the foreseeable future. Man needs land for building homes, cultivating food, maintaining pastures for domestic animals, developing industries to provide goods, and supporting the industry by creating towns and cities. Equally importantly, man needs to protect wilderness area in forests, grasslands, wetlands, mountains, coasts, etc. to protect our vitally valuable biodiversity.

Thus a rational use of land needs careful planning. One can develop most of these different types of land uses almost anywhere, but Protected Areas (National Park's and Wildlife Sanctuaries) can only be situated where some of the natural ecosystems are still undisturbed. These Protected Areas are important aspects of good landuse planning.

Land Degradation: Farmland is under threat due to more and more intense utilisation. Every year, between 5 to 7 million hectares of land worldwide is added to the existing degraded farmland. When soil is used more intensively by farming, it is eroded more rapidly by wind and rain. Over irrigating farmland leads to salinisation, as evaporation of water brings the salts to the surface of the soil on which crops cannot grow. Over irrigation also creates water logging of the topsoil so that crop roots are affected and

the crop deteriorates. The use of more and more chemical fertilizers poisons the soil so that eventually the land becomes unproductive. As urban centers grow and industrial expansion occurs, the agricultural land and forests shrink. This is a serious loss and has long term ill effects on human civilisation.

Soil erosion: The characteristics of natural ecosystems such as forests and grasslands depend on the type of soil. Soils of various types support a wide variety of crops. The misuse of an ecosystem leads to loss of valuable soil through erosion by the monsoon rains and, to a smaller extent, by wind. The roots of the trees in the forest hold the soil. Deforestation thus leads to rapid soil erosion. Soil is washed into streams and is transported into rivers and finally lost to the sea. The process is more evident in areas where deforestation has led to erosion on steep hill slopes as in the Himalayas and in the Western Ghats. These areas are called 'ecologically sensitive areas' or ESAs. To prevent the loss of millions of tons of valuable soil every year, it is essential to preserve what remains of our natural forest cover. It is equally important to reforest denuded areas. The linkage between the existence of forests and the presence of soil is greater than the forest's physical soil binding function alone. The soil is enriched by the leaflitter of the forest. This detritus is broken down by soil micro-organisms, fungi, worms and insects, which help to recycle nutrients in the system. Further losses of our soil wealth will impoverish our country and reduce its capacity to grow enough food in future.

CASE STUDY

Selenium – Punjab
In 1981-82, farmers from Hoshirapur and Nawanshehar Districts approached scientists of the Punjab Agricultural University (PAU), Ludhiana, as wheat crops had turned white. Soil analysis indicated selenium (Se) levels in the area were above toxic limits. Se is a naturally occurring trace element, essential for animal and human health, but the gap between requirement and excess is narrow. Soils containing 0.5 microgrammes (ug) of Se per kg or more are injurious to health. In some areas of Punjab, Se levels ranges from 0.31 ug/kg to 4.55ug/kg. Rice cultivation requires the presence of standing water. Being highly soluble, Se dissolves and comes to the surface. The water then evaporates leaving the Se behind.

Biodiversity

The great variety of life on earth has provided for man's needs over thousands of years. This diversity of living creatures forms a support system which has been used by each civilization for its growth and development. Those that used this "bounty of nature" carefully and sustainably survived. Those that overused or misused it disintegrated. Science has attempted to classify and categorize the variability in nature for over a century. This has led to an understanding of its organization into communities of plants and animals. This information has helped in utilizing the earth's biological wealth for the benefit of humanity and has been integral to the process of 'development'. This includes better health care, better crops and the use of these life forms as raw material for industrial growth which has led to a higher standard of living for the developed world. However this has also produced the modern consumerist society, which has had a negative effect on the diversity of biological resources upon which it is based. The diversity of life on earth is so great that if we use it sustainably we can go on developing new products from biodiversity for many generations. This can only happen if we manage biodiversity as a precious resource and prevent the extinction of species.

Definition:

'Biological diversity' or biodiversity is that part of nature which includes the differences in genes among the individuals of a species, the variety and richness of all the plant and animal species at different scales in space, locally, in a region, in the country and the world, and various types\ of ecosystems, both terrestrial and aquatic, within a defined area.

What is biodiversity?

Biological diversity deals with the degree of nature's variety in the biosphere. This variety can be observed at three levels; the genetic variability within a species, the variety of species within a community, and the organisation of species in an area into distinctive plant and animal communities constitutes ecosystem diversity.

Genetic diversity

Each member of any animal or plant species differs widely from other individuals in its genetic makeup because of the large number of combinations possible in the genes that give every individual specific characteristics. Thus, for example, each human being is very different from all others. This genetic variability is essential for a healthy breeding population of a species. If the number of breeding individuals is reduced, the dissimilarity of genetic makeup is reduced and in-breeding occurs. Eventually this can lead to the extinction of the species. The diversity in wild species forms the '**gene pool**' from which our crops and domestic animals have been developed over thousands of years. Today the variety of nature's bounty is being further harnessed by using wild relatives of crop plants to create new varieties of more productive crops and to breed better domestic animals. Modern biotechnology manipulates genes for developing better types of medicines and a variety of industrial products.

Species diversity

The number of species of plants and animals that are present in a region constitutes its species diversity. This diversity is seen both in natural ecosystems and in agricultural ecosystems. Some areas are more rich in species than others. Natural undisturbed tropical forests have a much greater species richness than plantations developed by the Forest Department for timber production. A natural forest ecosystem provides a large number of non-wood products that local people depend on such as fruit, fuel wood, fodder, fiber, gum, resin and medicines. Timber plantations do not provide the large variety of goods that are essential for local consumption. In the long-term the economic sustainable returns from non-wood forest products is said to be greater than the returns from felling a forest for its timber. Thus the value of a natural forest, with all its species richness is much greater than a plantation. Modern intensive agricultural ecosystems have a relatively lower diversity of crops than traditional agropastoral farming systems where multiple crops were planted. At present conservation scientists have been able to identify and categorise about 1.8 million species on earth. However, many new species are being identified, especially in the flowering plants and insects. Areas that are rich in species diversity are called 'hotspots' of diversity. India is among the world's 15 nations that are exceptionally rich in species diversity.

Ecosystem diversity

There are a large variety of different ecosystems on earth, which have their own complement of distinctive inter linked species based on the differences in the habitat. Ecosystem diversity can be described for a specific geographical region, or a political entity such as a country, a State or a taluka. Distinctive ecosystems include landscapes such as forests, grasslands, deserts, mountains, etc., as well as aquatic ecosystems such as rivers, lakes, and the sea. Each region also has man-modified areas such as farmland or grazing pastures.

An ecosystem is referred to as 'natural' when it is relatively undisturbed by human activities, or 'modified' when it is changed to other types of uses, such as farmland or urban areas. Ecosystems are most natural in wilderness areas. If natural ecosystems are overused or misused their productivity eventually decreases and they are then said to be degraded. India is exceptionally rich in its ecosystem diversity.

Evolution and the Genesis of Biodiversity:

The origins of life on earth some three and a half billion years ago are obscure. Life was probably initiated as a product of organic reactions in the Earth's primordial seas. Alternative possibilities such as life beginning in a muddy ooze, or of life having been seeded from outer space have also been suggested. Once life took hold on the planet, it began gradually to diversify. Unicellular unspecialized forms gradually evolved into complex multi-cellular plants and animals. Evolution is related to the ability of living organisms to adapt to changes in their environment. Thus the abiotic changes in nature such as climatic and atmospheric upheavals, repeated glaciations, continental drift and the formation of geographical barriers, segregated different communities of plants and animals and gradually lead to the formation of new species over millions of years.

Most species appear to have a life span extending over several million years. Their adaptability to gradual changes in their habitat, and interactions with newly formed species produce groups of inter linked organisms that continue to evolve together. Food chains, prey-predator relationships, parasitism (complete dependence on another species), commensalism (a partnership beneficial to both species), etc. are important examples. Behavioural patterns of the different species comprising a community of species links them to each other through their breeding biology, feeding patterns, migrations, etc. As ancient species became extinct due to geological upheavals, they left behind empty 'niches' in the habitat that stimulated existing species to fill them through the formation of new species. The Earth's ancient history has seen periods of mega extinctions, which have been followed by periods of formation of new species.

Though these repeatedly led to a drastic reduction in the number of species, the diversity of life recuperated each time by gradually increasing the number of species existing on earth. This however took millions of years, as evolution is a very slow process. Thus when man came on the scene some 2 million years ago the earth was more rich in species than ever before. During the recent past however, extinctions due to the activities of modern man have begun to take place so rapidly that nature has had no time to evolve new species. The earth is loosing species more rapidly than ever before. The diversity of life at all

three organizational levels, genetic, species and ecosystem, is thus being rapidly modified by modern man. This is a great loss to future generations who will follow us.

BIOGEOGRAPHIC CLASSIFICATION OF INDIA

Our country can be conveniently divided into ten major regions, based on the geography, climate and pattern of vegetation seen and the communities of mammals, birds, reptiles, amphibia, insects and other invertebrates that live in them. Each of these regions contains a variety of ecosystems such as forests, grasslands, lakes, rivers, wetlands, mountains and hills, which have specific plant and animal species.

India's Biogeographic Zones

1. The cold mountainous snow covered Trans Himalayan region of Ladakh.
2. The Himalayan ranges and valleys of Kashmir, Himachal Pradesh, Uttarakhand, Assam and other North Eastern States.
3. The Terai, the lowland where the Himalayan rivers flow into the plains.
4. The Gangetic and Bhramaputra plains.
5. The Thar Desert of Rajasthan.
6. The semi arid grassland region of the Deccan plateau Gujarat, Maharashtra, Andra Pradesh, Karnataka and Tamil Nadu.
7. The Northeast States of India,
8. The Western Ghats in Maharashtra, Karnataka and Kerala.
9. The Andaman and Nicobar Islands.
10. The long western and eastern coastal belt with sandy beaches, forests and mangroves.

VALUE OF BIODIVERSITY

Environmental services from species and ecosystems are essential at global, regional and local levels. Production of oxygen, reducing carbon dioxide, maintaining the water cycle, protecting soil are important services. The world now acknowledges that the loss of biodiversity contributes to global climatic changes. Forests are the main mechanism for the conversion of carbon dioxide into carbon and oxygen. The loss of forest cover, coupled with the increasing release of carbon dioxide and other gases through industrialization contributes to the '**greenhouse effect'.** Global warming is melting ice caps, resulting in a rise in the sea level which will submerge the low lying areas in the world. It is causing major atmospheric changes, leading to increased temperatures, serious droughts in some areas and unexpected floods in other areas. Biological diversity is also essential for preserving ecological processes, such as fixing and recycling of nutrients, soil formation, circulation and cleansing of air and water, global life support (plants absorb CO2, give out O2), maintaining the water balance within ecosystems, watershed protection, maintaining stream and river flows throughout the year, erosion control and local flood reduction. Food, clothing, housing, energy, medicines, are all resources that are directly or indirectly linked to the biological variety present in the biosphere.

This is most obvious in the tribal communities who gather resources from the forest, or fisher folk who catch fish in marine or freshwater ecosystems. For others, such as agricultural communities, biodiversity is used to grow their crops to suit the environment. Urban communities generally use the greatest amount of goods and services, which are all indirectly drawn from natural ecosystems.

It has become obvious that the preservation of biological resources is essential for the well-being and the long-term survival of mankind. This diversity of living organisms which is present in the wilderness, as well as in our crops and livestock, plays a major role in human 'development'. The preservation of 'biodiversity' is therefore integral to any strategy that aims at improving the quality of human life.

Consumptive use value

The direct utilisation of timber, food, fuelwood, fodder by local communities. The biodiversity held in the ecosystem provides forest dwellers with all their daily needs, food, building material, fodder, medicines and a variety of other products. They know the qualities and different uses of wood from different species of trees, and collect a large number of local fruits, roots and plant material that they use as food, construction material or medicines. Fisherfolk are highly dependent on fish and know where and how to catch fish and other edible aquatic animals and plants.

Productive use value

Marketable goods. Value of MFP>Timber (which is part of sustainable use). The biotechnologist uses biorich areas to 'prospect' and search for potential genetic properties in plants or animals that can be used to develop better varieties of crops that are used in farming and plantation programs or to develop better livestock. To the pharmacist, biological diversity is the raw material from which new drugs can be identified from plant or animal products. To industrialists, biodiversity is a rich store-house from which to develop new products. For the agricultural scientist the biodiversity in the wild relatives of crop plants is the basis for developing better crops.

Genetic diversity enables scientists and farmers to develop better crops and domestic animals through careful breeding. Originally this was done by selecting or pollinating crops artificially to get a more productive or disease resistant strain. Today this is increasingly being done by genetic engineering, selecting genes from one plant and introducing them into another. New crop varieties (cultivars) are being developed using the genetic material found in wild relatives of crop plants through biotechnology. Even today, species of plants and animals are being constantly discovered in the wild. Thus these wild species are the building blocks for the betterment of human life and their loss is a great economic loss to mankind. Among the known species, only a tiny fraction have been investigated for their value in terms of food, or their medicinal or industrial potential. Preservation of biodiversity has now become essential for industrial growth and economic development. A variety of industries such as pharmaceuticals are highly dependent on identifying compounds of great economic value from the wide variety of wild species of plants located in undisturbed natural forests. This is called **biological prospecting**.

Social values

While traditional societies which had a small population and required less resources had preserved their biodiversity as a life supporting resource, modern man has rapidly depleted it even to the extent of leading to the irrecoverable loss due to extinction of several species. Thus apart from the local use or sale of products of biodiversity there is the social aspect in which more and more resources are used by affluent societies. The biodiversity has to a great extent been preserved by traditional societies that valued it as a resource and appreciated that its depletion would be a great loss to their society. The consumptive and

productive value of biodiversity is closely linked to social concerns in traditional communities. 'Ecosystem people' value biodiversity as a part of their livelihood as well as through cultural and religious sentiments. A great variety of crops have been cultivated in traditional agricultural systems and this permitted a wide range of produce to be grown and marketed throughout the year and acted as an insurance against the failure of one crop. In recent years farmers have begun to receive economic incentives to grow cash crops for national or international markets, rather than to supply local needs. This has resulted in local food shortages, unemployment (cash crops are usually mechanised), landlessness and increased vulnerability to drought and floods.

Ethical and moral values

Ethical values related to biodiversity conservation are based on the importance of protecting all forms of life. All forms of life have the right to exist on earth. Man is only a small part of the Earth's great family of species. Don't plants and animals have an equal right to live and exist on our planet which is like an inhabited spaceship? We do not know if life as we know it exists elsewhere in the universe. Do we have the right to destroy life forms or do we have a duty to protect them?

Apart from the economic importance of conserving biodiversity, there are several cultural, moral and ethical values which are associated with the sanctity of all forms of life. Indian civilization has over several generations preserved nature through local traditions. This has been an important part of the ancient philosophy of many of our cultures. We have in our country a large number of sacred groves or **'deorais'** preserved by tribal people in several States. These sacred groves around ancient sacred sites and temples act as gene banks of wild plants.

Aesthetic value

Knowledge and an appreciation of the presence of biodiversity for its own sake is another reason to preserve it. Quite apart from killing wildlife for food, it is important as a tourist attraction. Biodiversity is a beautiful and wonderful aspect of nature. Sit in a forest and listen to the birds. Watch a spider weave its complex web. Observe a fish feeding. It is magnificent and fascinating. Symbols from wild species such as the lion of Hinduism, the elephant of Buddhism and deities such as Lord Ganesh, and the vehicles of several deities that are animals, have been venerated for thousands of years. Valmiki begins his epic story with a couplet on the unfortunate killing of a crane by a hunter. The 'Tulsi' has been placed at our doorsteps for centuries.

Option value

Keeping future possibilities open for their use is called option value. It is impossible to predict which of our species or traditional varieties of crops and domestic animals will be of great use in the future. To continue to improve cultivars and domestic livestock, we need to return to wild relatives of crop plants and animals. Thus the preservation of biodiversity must also include traditionally used strains already in existence in crops and domestic animals.

BIODIVERSITY AT GLOBAL, NATIONAL AND LOCAL LEVELS

There are at present 1.8 million species known and documented by scientists in the world. However, scientists have estimated that the number of species of plants and animals on earth could vary from 1.5 to 20 billion! Thus the majority of species are yet to be discovered. Most of the world's bio-rich nations are in the South, which are the developing nations. In contrast, the majority of the countries capable of exploiting biodiversity are Northern nations, in the economically developed world. These nations however have low levels of biodiversity.

Thus the developed world has come to support the concept that biodiversity must be considered to be a 'global resource'. However, if biodiversity should form a 'common property resource' to be shared by all nations, there is no reason to exclude oil, or uranium, or even intellectual and technological expertise as global assets. India's sovereignty over its biological diversity cannot be compromised without a revolutionary change in world thinking about sharing of all types of natural resources. Countries with diversities higher than India are located in South America such as Brazil, and South East Asian countries such as Malaysia and Indonesia. The species found in these countries, however, are different from our own. This makes it imperative to preserve our own biodiversity as a major economic resource. While few of the other 'megadiversity nations' have developed the technology to exploit their species for biotechnology and genetic engineering, India is capable of doing so.

Throughout the world, the value of biologically rich natural areas is now being increasingly appreciated as being of unimaginable value. International agreements such as the **World Heritage Convention** attempt to protect and support such areas. India is a signatory to the convention and has included several protected Areas as World Heritage sites. These include Manas on the border between Bhutan and India, Kaziranga in Assam, Bharatpur in U.P., Nandadevi in the Himalayas, and the Sunderbans in the Ganges delta in West Bengal. India has also signed the **Convention in the Trade of Endangered Species (CITES)** which is intended to reduce the utilization of endangered plants and animals by controlling trade in their products and in the pet trade.

INDIA AS A MEGA DIVERSITY NATION

Geological events in the landmass of India have provided conditions for high levels of biological diversity. A split in the single giant continent around 70 million years ago, led to the formation of northern and southern continents, with India a part of Gondwanaland - the southern landmass, together with Africa, Australia and the Antarctic. Later tectonic movements shifted India northward across the equator to join the Northern Eurasian continent. As the intervening shallow Tethis Sea closed down, plants and animals that had evolved both in Europe and in the Far East migrated into India before the Himalayas had formed. A final influx came from Africa with Ethiopian species, which, were adapted to the Savannas and semi-arid regions. Thus India's special geographical position between three distinctive centres of biological evolution and radiation of species is responsible for our rich and varied biodiversity.

Among the biologically rich nations, India stands among the top 10 or 15 countries for its great variety of plants and animals, many of which are not found elsewhere. India has 350 different mammals (rated eight highest in the world), 1,200 species of birds (eighth in the world), 453 species of reptiles (fifth in the world) and 45,000 plant species, of which most are angiosperms, (fifteenth in the world). These include especially high species diversity of ferns (1022 species) and orchids (1082 species). India has 50,000 known species of insects, including 13,000 butterflies and moths. It is estimated that the number of unknown species could be several times higher. It is estimated that 18% of Indian plants are **endemic** to

the country and found nowhere else in the world. Among the plant species the flowering plants have a much higher degree of endemism, a third of these are not found elsewhere in the world. Among amphibians found in India, 62% are unique to this country. Among lizards, of the 153 species recorded, 50% are endemic. High endemism has also been recorded for various groups of insects, marine worms, centipedes, mayflies and fresh water sponges.

Apart from the high biodiversity of Indian wild plants and animals there is also a great diversity of cultivated crops and breeds of domestic livestock. This is a result of several thousand years during which civilizations have grown and flourished in the Indian subcontinent. The traditional cultivars included 30,000 to 50,000 varieties of rice and a number of cereals, vegetables and fruit. The highest diversity of cultivars is concentrated in the high rainfall areas of the Western Ghats, Eastern Ghats, Northern Himalayas and the North-Eastern hills. Gene-banks have collected over 34,000 cereals and 22,000 pulses grown in India. India has 27 indigenous breeds of cattle, 40 breeds of sheep, 22 breeds of goats and 8 breeds of buffaloes.

HOTSPOTS OF BIODIVERSITY

The earth's biodiversity is distributed in specific ecological regions. There are over a thousand major ecoregions in the world. Of these, 200 are said to be the richest, rarest and most distinctive natural areas. These areas are referred to as the Global 200. It has been estimated that 50,000 endemic plants which comprise 20% of global plant life, probably occur in only 18 'hot spots' in the world. Countries which have a relatively large proportion of these hot spots of diversity are referred to as 'megadiversity nations'.

The rate at which the extinction of species is occurring throughout our country remains obscure. It is likely to be extremely high as our wilderness areas are shrinking rapidly. Our globally accepted national **'hot spots'** are in the forests of the **North-East** and the **Western Ghats,** which are included in the world's most biorich areas**.** The **Andaman and Nicobar Islands** are extremely rich in species and many subspecies of different animals and birds have evolved.

Among the endemic species i.e. those species found only in India, a large proportion are concentrated in these three areas. The Andaman and Nicobar Islands alone have as many as 2200 species of flowering plants and 120 species of ferns. Out of 135 genera of land mammals in India, 85 (63%) are found in the Northeast. The Northeast States have 1,500 endemic plant species. A major proportion of amphibian and reptile species, especially snakes, are concentrated in the Western Ghats, which is also a habitat for 1,500 endemic plant species. Coral reefs in Indian waters surround the Andaman and Nicobar Islands, Lakshadweep Islands, the Gulf areas of Gujarat and Tamil Nadu. They are nearly as rich in species as tropical evergreen forests!

THREATS TO BIODIVERSITY: HABITAT LOSS, POACHING OF WILDLIFE, MAN-WILDLIFE CONFLICTS

Man has begun to overuse or misuse most of these natural ecosystems. Due to this 'unsustainable' resource-use, once productive forests and grasslands have been turned into deserts and wasteland have increased all over the world. Mangroves have been cleared for fuelwood and prawn farming, which has led to a decrease in the habitat essential for breeding of marine fish. Wetlands have been drained to increase agricultural land. These changes have grave economic implications in the longer term.

The current destruction of the remaining large areas of wilderness habitats, especially in the super diverse tropical forests and coral reefs, is the most important threat worldwide to biodiversity. Scientists have estimated that human activities are likely to eliminate approximately 10 million species by the year 2050. There are about 1.8 million species of plants and animals, both large and microscopic, known to science in the world at present. The number of species however is likely to be greater by a factor of at least 10. Plants and insects as well as other forms of life not known to science are continually being identified in the worlds' 'hotspots' of diversity. Unfortunately at the present rate of extinction about 25% of the worlds' species will undergo extinction fairly rapidly. This may occur at the rate of 10 to 20 thousand species per year, a thousand to ten thousand times faster than the expected natural rate! Human actions could well exterminate 25% of the world's species within the next twenty or thirty years. Much of this mega extinction spasm is related to human population growth, industrialization and changes in land-use patterns. A major part of these extinctions will occur in 'biorich' areas such as tropical forests, wetlands, and coral reefs. The loss of wild habitats due to rapid human population growth and short term economic development are major contributors to the rapid global destruction of biodiversity. Island flora and fauna having high endemism in small isolated areas surrounded by sea have so far been most seriously affected by human activity, which has already led to extinction of many island plants and animals (the dodo is a famous example). Habitat loss also results from man's introduction of species from one area into another, disturbing the balance in existing communities. In the process, the purposely or accidentally introduced organisms (Eupatorium, Lantana, Hyacinth, Congress grass or Parthenium) have led to the extinction of many local species. Loss of species occurs due to the destruction of natural ecosystems, either for conversion to agriculture or industry, or by over-extraction of their resources, or through pollution of air, water and soil.

In India, forests and grasslands are continuously being changed to agricultural land. Encroachments have been legalized repeatedly. Similarly natural wetland systems have been drained to establish croplands resulting in loss of aquatic species. Grasslands that were once sustainably used by a relatively smaller number of human beings and their cattle are either changed to other forms of use or degraded by overgrazing.

CASE STUDY:

Kokkare Bellure – Karnataka: Co-existence (Man and Wildlife)

The pelican, which is an endangered species breeds in large numbers at Kokkare Bellur which is one of the ten known breeding sites in India. Kokkare Bellure is a village in Karnataka in Southern India. In December every year, hundreds of spot billed pelicans, painted storks, ibis and other birds migrate to this area to establish breeding colonies on the tall tamarind trees in the center of the village. The local people have protected the birds, believing that they bring good luck with regard to rain and crops. The villagers collect a rich supply of the natural fertilizer that collects below the nests – the guano. The droppings of fish-eating birds are rich in nitrates.

The owners of the trees inhabited by the birds dig deep pits under the trees, into which the guano falls. Silt from nearby lakes and ponds is mixed with the guano which is used in their fields and sold as fertilizer. They have now planted trees around their homes to encourage nesting. Our natural forests are being deforested for timber and replanted using teak, sal or other single species for their timber value.

Such plantations do not support the same biological diversity as a multi-storied natural forest, which has a closed canopy and a rich understorey of vegetation. When excessive firewood is collected from the forest by lopping the branches of trees, the forest canopy is opened up and this alters local biodiversity. Foraging cattle retard the regeneration of the forest as seedlings are constantly trampled.

Increasing human population on the fringes of our Protected Areas degrade forest ecosystems. This is a major factor to consider in evaluating the quality of the ecosystem. Repeated fires started by local grazers to increase grass growth ultimately reduces regeneration and lowers the diversity of plant species. Without alternate sources of fodder this pressure cannot be decreased. Another factor that disrupts forest biodiversity is the introduction of exotic weeds which are not a part of the natural vegetation. Common examples in India are lantana bushes, Eupatorium shrubs and 'congress' grass. These have been imported into the country from abroad and have invaded several large tracts of our natural forests. These weeds spread at the expense of the diverse range of indigenous undergrowth species. The impact on the diversity of insect, bird and other wildlife species, though not adequately studied, is quite obvious.

In our country a variety of traditional farming techniques have evolved over several centuries. Cultivation by slash and burn in the Himalayas, and 'rab' by lopping of tree branches to act as a wood-ash fertilizer in the Western Ghats, are two such systems. When human population in these areas was low, these were sustainable methods of agriculture. Unfortunately these areas now have a large number of people who subsist largely on forest agriculture. These methods are now unsustainable and are leading to a loss of forest biodiversity. Overharvesting of fish, especially by trawling is leading to serious depletion of fish stocks. Turtles are being massacred off the coast of Orissa. The rare whale shark, a highly endangered species, is being killed off the coast of Gujarat.

Poaching: Specific threats to certain animals are related to large economic benefits. Skin and bones from tigers, ivory from elephants, horns from rhinos and the perfume from the must deer are extensively used abroad. Bears are killed for their gall bladders. Corals and shells are also collected for export or sold on the beaches of Chennai and Kanyakumari. A variety of wild plants with real or at times dubious medicinal value are being over harvested. The commonly collected plants include Rauvolfia, Nuxvomica, Datura, etc. Collection of garden plants includes orchids, ferns and moss.

ENDANGERED AND ENDEMIC SPECIES OF INDIA

To appreciate the endemic and endangered species of India it is important to understand the wide variety of plant and animal species that are found in the country. Of the well-known species, there are several which are endangered by human activity. The endangered species in the country are categorised as Vulnerable, Rare, Indeterminate and Threatened. Other species are found only in India and are thus endemic or restricted to our country. Some of these may have very localized distribution and are considered highly endemic.

Several plant and animal species in the country are now found in only one or a few Protected Areas. Among the important endangered animals are charismatic species such as the tiger, the elephant, the rhino, etc. The less well-known major mammals restricted to a single area include the Indian wild ass, the Hangul or Kashmir stag, the Golden langur, the pygmy hog and a host of others. There are also endangered bird species such as the Siberian crane, the Great Indian Bustard, the Florican and several birds of prey. During the recent past, vultures which were common a decade ago, have suddenly

disappeared and are now highly threatened. Equally threatened are several species of reptiles and amphibia. Many invertebrates are also threatened, including a large number of species that inhabit our coral reefs.

Many plant species are now increasingly threatened due to changes in their habitats induced by human activity. Apart from major trees, shrubs and climbers that are extremely habitat specific and thus endangered, there are thousands of small herbs which are greatly threatened by habitat loss. Several orchids are yet another group of plants that are under threat. Many plants are threatened due to overharvesting as ingredients in medicinal products. To protect endangered species India has created the Wildlife Protection Act. This includes lists of plants and animals categorised according to the threat on their survival.

We know so little about the species diversity of our country. There are several groups of which we know very little. Most of us are only aware of the plight of a few glamorous large mammals, but we need to appreciate the threat to the less known species of plants and animals. We need to find ways to support the conservation of our incredible wildlife for future generations.

Common Plant species

Teak: This tree is from the Southwest parts of peninsular India. It is a common tree in deciduous forests. It yields a much sought after timber used for making excellent furniture. During the early British period it was cut down from many forest tracts to build ships. As the stocks were diminishing, the British selected areas which they called Reserved Forests where teak was planted for the Government's use. Teak is grown extensively by the Forest Department and is a highly priced wood.

The teak tree is identified by its large leaves, which grow to more than 40 or 50cms long and 20cms wide. It has tiny flowers and fruit. In the winter, the trees shed all their leaves. In the growing season, which begins in April and extends through the monsoon, teak forests are bright green and shady. Most natural teak forests have various other species of plants and have a large number of wild animals. Some areas of teak forests that have exceptional populations of wildlife have been included in our National Parks and Wildlife Sanctuaries.

Sal: This is a common species of several types of forests of the Northeastern region of India, extending into Madhya Pradesh and Orissa. It has bright green foliage and its canopy remains green nearly throughout the year. Sal wood is hard and durable. Sal gets a large number of seeds which are used in making cosmetics. The sal forests are rich in wild mammals, birds, reptiles and insect life. Several areas are included in our network of National Parks and Sanctuaries.

Mango: This has become one of our most popular horticultural species with different varieties grown all over the country. The wild mango tree has small tangy fruit and a big seed in comparison to the large pulpy fruit used in horticulture.

The mango tree is an evergreen species and gets small flowers that are pollinated by insects. In the forest, fruit dependent animals such as monkeys, squirrels and fruit eating birds relish its ripe fruit. berries on which the larvae feed and grow. The ficus trees bear berries throughout the year, thus supplying nutritious food to several animal species when other trees have no fruit. Ficus species are thus known as 'keystone'

species in the ecosystem and support a major part of the food web in several ecosystems. Ficus trees such as Peepal and Banyan are considered sacred and are protected in India.

Neem: This species is known as Azadirachta Indica. It has been traditionally used in indigenous medicine. It has small yellow fruit. The leaves and fruit are bitter to taste. It is used extensively as an environmentally friendly insecticide. It grows extremely well in semi-arid regions and can be planted in afforestation programs where soil is poor and rainfall is low.

Ficus sp.: Peepal, Banyan and many other ficus species form a part of this group of important trees. They are all ecologically of great importance as many different species of insects, birds and mammals live on ficus berries. The flowers are inside the berries. They are pollinated by a specific wasp which lays its eggs inside the Mango Ficus

Tamarind: One of the best known Indian trees, it grows to a large size and is known to live for over 200 years. Its familiar fruit is a curved pod with sour pulp and contains a number of squarish seeds. The pulp in the fresh fruit is either green or red. As it ripens, it turns sticky and brown and separates from the skin. The tree is commonly cultivated as a shade tree and for its edible sour fruit which contains high concentrations of vitamin C. It is used as an additive in food to give a tangy flavour. It is valued for its timber as well as for fuelwood.

Babul: This is a thorny species that is characteristic of semi arid areas of Western India and the Deccan plateau. It grows sparsely in tracts of grassland and around farms. It is used for fodder and fuelwood. It remains green throughout the year even under the driest conditions and is browsed by wild animals and cattle. It has small leaves and bright yellow flowers and small seedpods with multiple seeds. Its main characteristic is its long sharp, straight thorns which prevent excessive browsing of its older branches.

Zizyphus: These are the typical small trees and shrubs that are found in the arid and semi arid areas of India. Z. mauritiana and Z. jujuba are the most frequent species. It is a favourite of frugivorous birds. The tree fruits extensively and is eaten by a variety of birds and mammals. The popular fruit is commonly collected and sold in local markets.

Jamun: This tree is an evergreen species which has a tasty purple fruit. It is a favourite with not only people but also with many wild birds and mammals. It grows in many parts of India and has several varieties with fruit of different sizes. Branches profusely forming a dense crown. The leaves are elliptical and leathery and its young leaves are extensively used for making 'bidis'. The fruit is brownish yellow and astringent. Tendu leaf collection necessitates burning undergrowth and slashing the branches of the trees to get at the leaves. The resulting disturbance to wildlife is a serious issue in Protected Areas.

Jackfruit: A tree that is planted around many villages and has huge fruit growing from its branches. The fruit has a prickly skin. The fruit when unripe is cooked. Once ripe it is eaten raw after it turns into a sweet, sticky, golden-yellow fruit which has a strong smell.

Flame of the Forest (Butea monosperma):
This tree grows in many parts of India. It has bright orange flowers when it is leafless, thus it is called 'flame of the forest'. The flowers are full of nectar which attracts monkeys and many nectar dependent birds.

Common Animal species

Mammals:

The common deer species found in India include the sambar, chital, barasingha and barking deer. **Sambar** live in small family parties especially in hilly forested areas and feed mainly on shrubs and leaves of low branches. They are dark brown in colour and have large thick antlers, each having 3 branches. **Chital** or spotted deer live in large herds in forest clearings where they graze on the grass. They have a rust brown body with white spots which camouflages them in the forest. Each antler has three branches called tines. The rare **Hangul** deer is found only in Kashmir. It has a magnificent spread of antlers with 6 branches on each antler. The **Barasingha, or swamp deer**, has wide hoofs that enable this beautiful animal to live in boggy areas of the Terai. Each antler has 6 or more branches. The tiny **barking deer** lives in many forest areas all over India. It has two ridges on its face and a short antler with only 2 branches. Its call sounds like the bark of a dog. Chital Barasingha Blackbuck Chinkara Nilgai

The **blackbuck** is the only true antelope found in India. It lives in large herds. The males are black on top and cream below and have beautiful spiral horns that form a 'V' shape. The **chinkara**, also known as the **Indian gazelle**, is a smaller animal and is pale brown in colour it has beautiful curved horns. The rare **Chausingha**, **or four horned antelope**, is the only animal in the world that has four horns. The **nilgai** is the largest of the dryland herbivores. The males are blue-gray. Nilgai have white
markings on the legs and head. They have short strong spike-like horns.

A very special rare species is the **Indian wild ass**, endemic to the Little Rann of Kutch. Himalayan pastures support several species of wild goats and sheep, many of them restricted to the region, like the **goral** and the **Himalayan tahr**. A single species, the **Nilgiri tahr** is found in the Nilgiri and Annamalai hills in south India. The **rhinocerous** is now restricted to Assam but was once found throughout the Gangetic plains. The **wild buffalo** is now also restricted to the Terai. The **elephant** is distributed in the Northeastern and Southern States. It is threatened by habitat loss and poaching for ivory. **Gaur** is found in patches in several well-wooded parts of India.

The best known predator of our forests is the **tiger**. Its gold and black stripes hide it perfectly in the forest undergrowth. It preys on herbivores such as sambar or chital or less frequently on domestic animals. The tiger kills only three or four times a month. Its numbers have declined due to poaching for its superb skin, and for the supposed magical value of its teeth, claws and whiskers. In the recent past it has been extensively killed for the supposed medicinal properties of its bones that are used in Chinese medicine.

The **Asiatic lion** is now found only in the Gir forests of Gujarat.

The **leopard** is more adaptable than the tiger and lives both in thick forests and degraded forest areas. Its beautiful ring like markings camouflage it so perfectly that its prey cannot see its stealthy approach. The smaller **jungle cat**, which is a light brown animal and the **leopard cat**, which is a little bigger than a domestic cat are very rare. The most typical predator of the HImalayas is the **snow leopard**, which is very rare and poached for its beautiful skin which is pale grey with dark grey ring-like markings. The **wolf, jackal, fox** and the **wild dog or 'dhole'** form a group called canids. Another threatened predator is the

Himalayan wolf. The wolves are now highly threatened as they have become increasingly dependent on shepherd's flocks. Thus shepherds constantly find ways to kill the wolves.
One of the common monkey species of the forest is the **bonnet macaque**, which has a red face, a very long tail and a whorl of hair on the scalp which looks like a cap. Our other common monkey is the **rhesus macaque**, which is smaller and has a shorter tail than the bonnet. A rare macaque is the **lion-tailed macaque** found only in a few forests of the southern Western Ghats and Annamalai ranges. It is black in colour, has long hair, a grey mane and a tassel at the end of its tail that looks like a lion's tail. The **common langur** has a black face and is known as the Hanuman monkey. The rare **golden langur**, is golden yellow in colour and lives along the banks of the Manas River in Assam. The **capped langur** is an uncommon species of Northeast India. The rare black **nilgiri langur** lives in the southern Western Ghats, Nilgiris and Annamalais.

Birds:

There are over 1200 bird species found in India in different habitats. Most of our forest birds are specially adapted to life in certain forest types. Some Himalayan species however can also Wolf Fox Hornbill Paradise Flycatcher Bee-eater be seen in the Western Ghats. There are several species of **Hornbills** that live on fruit. They have heavy curved beaks with a projection on top. Frugivores such as **parakeets, barbets** and **bulbuls** live on fruit and are often seen eating Ficus fruits such as those of banyan and peepal. Bird of pray Insectivorous birds of many species live on forest insects. They include various species of **flycatchers, bee-eaters**, and others. The male paradise flycatcher is a small beautiful white bird with a black head and two long white trailing tail feathers. The female is brown and does not have the long tail feathers. There are several eagles, falcons and kites many of which are now endangered.

Grasslands support many species of birds. The most threatened species is the **Great Indian bustard**, a large, brown stately bird with long legs which struts about through grasslands looking for locusts and grasshoppers. Another rare group of threatened birds are the floricans. There are many species of **quails, partridges, larks, munias** and other grain eating birds that are adapted to grasslands. There are several species of aquatic birds such as **waders, gulls and terns,** which live along the seashore and go out fishing many kilometers to the sea. Many of these birds have lost their coastal habitats due to pollution. Aquatic birds in freshwater are those with long legs and are known as waders such as **stilts** and **sandpipers**. The other group form birds that swim on water such as several species of **ducks** and **geese**.

There are many species of spectacular large birds associated with water or marshy areas. These include different species of **storks, cranes, spoonbills,\ flamingo** and **pelicans**. Many aquatic species are migrants. They breed in Northern Europe or Siberia and come to India in thousands during winter.
Reptiles: India has a wide variety of lizards, snakes and turtles, with a high level of endemism. The lizards include the **common garden lizard, Fan throated l i z a r d , Chamelion, Skink, Common Monitor** and **Water Monitor**. Some of these are threatened due to trade in reptile skins. Indian snakes include the **Rock Python, Russell's viper** and the **Vine snake**. We rarely appreciate the fact that only a few species of snakes are poisonous and most snakes are harmless.

The **Star tortoise** And **Travancore tortoise** are now rare. The **Olive Ridley** and **Flapshell turtle** are the well-known turtles of India. Many turtles are becoming increasingly rare due to poaching of adults and eggs. The **crocodile** is our largest reptile which is poached for its prized skin. The **gharial** is endemic to India and is highly threatened. Amphibia:

Most of the amphibians found in India are frogs and toads. These include several species like the Indian **Bull frog, Tree frog**, etc. These amphibians are mostly found in the hotspots in the Northeast and the Western Ghats. It is now thought that global warming and increasing lev-

CONSERVATION OF BIODIVERSITY: INSITU AND EX-SITU

In-situ conservation
Biodiversity at all its levels, genetic species and as intact ecosystems, can be best preserved insitu by setting aside an adequate representation of wilderness as 'Protected Areas'. These should consist of a network of National Parks and Wildlife Sanctuaries with each distinctive ecosystem included in the network. Such a network would preserve the total diversity of life of a region.

In the past National Parks and Sanctuaries in India were notified to preserve major wildlife species such as tigers, lions, elephants, and deer. The objective of these areas should be expanded to the preservation of relatively intact natural
ecosystems, where biological diversity – from microscopic unicellular plants and animals, to the giant trees and major mammals – can all be\ preserved.

However species cannot be protected individually as they are all inter dependent on each other. Thus the whole ecosystem must be protected. The biologist's view point deals with areas that are relatively species rich, or those where rare, threatened or endangered species are found, or those with 'endemic' species which are not found elsewhere. As rare endemic species are found only in a small area these easily become extinct due to human activity. Such areas must be given an added importance as their biodiversity is a special feature of the region. Animals such as elephants require different types of habitat to feed in during different seasons. They utilize open grasslands after the rains when the young grass shoots are highly nutritious. As the grasses dry, the elephants move into the forest to feed on foliage from the trees. A Protected Area that is meant to protect elephants must therefore be large enough and include diverse habitat types to support a complete complement of inter linked species.

Wildlife Sanctuaries and National Parks of India: There are 589 Protected Areas in India of which 89 are National Parks and 500 are Wildlife Sanctuaries. They include a variety of ecosystems and habitats. Some have been created in order to protect highly endangered species of wild plants and animals found nowhere else in the world.

The Great Himalayan National Park is the largest sanctuary in this ecosystem and is one of the last homes of the beautiful snow leopard. **Dachigam Sanctuary** is the only place where the rare Hangul or Kashmir stag is found. There are several Sanctuaries in the Terai region, **Kaziranga National Park** is the most famous which has elephant, wild buffalo, gaur, wild boar, swamp deer, and hog deer, in large numbers, as well as tiger and leopard. Its bird life is extremely rich and includes ducks, geese, pelicans and storks. The **Manas Sanctuary**, in addition to the above Terai species, also includes the rare golden langur and the very rare pygmy hog, the smallest wild boar in the world. The florican is found only in a few undisturbed grasslands in the Terai sanctuaries.

In the sal forests of Madhya Pradesh, there are several Protected Areas. **Kanha** offers a wonderful opportunity to observe wild tigers from elephant back. It is the only Protected Area in which a sub species

of the Barasingha is found. **Bharatpur** is one of the most famous water bird sanctuaries in the world. Thousands of ducks, geese, herons, and other wading birds can be seen here. This is the only home of the very rare Siberian crane which migrates to India every winter. During the last 20 years, the 30 or 40 Siberian cranes have dwindled to only 2 or 3. During 2002-3 no cranes were seen and it is possible that this beautiful bird will never again come to India. In the Thar desert, the wild life is protected in the **Desert National Park.** Here large numbers of black buck, neelgai and chinkara can be seen. The Great Indian Bustard lives in these arid lands. **Ranthambor** was the most well known sanctuary for observing tigers in the wild till about 3 or 4 years ago. Since then many tigers have been killed by poachers.

The **Great and the Little Rann of Kutch** have been made into sanctuaries to protect the very rare wild ass, the flamingo, the star tortoise and the desert fox. In Gujarat, the **Gir Sanctuary** protects the last population of the majestic Asiatic lion. This thorn and deciduous forest is also the home of large herds of chital, sambhar, and nilgai. The Sanctuaries of the Western Ghats and associated hill ranges protect some of the most diverse forest types in the country. The few examples of highly threatened species include the Malabar giant squirrel, the flying squirrel and a variety of hill birds, several species of amphibians, reptiles and insects. These regions are also rich in highly endemic plant life. Sanctuaries such as **Bhimashankar, Koyana, Chandoli and Radhanagari** preserve this rich flora in Maharashtra, **Bandipur, Bhadra, Dandeli, Nagarhole,** etc. in Karnataka, and **Eraviculum, Perambiculum, Periyar, Silent Valley**, in Kerala.

In the Nilgiri Hills the rich forest Sanctuaries protect\ some of the last pockets of the Indian elephant in South India. Examples include **Bandipur, Madhumalai, Wynad** and **Bhadra.** During the last 10 years, a large number of the great tusker elephants of this region have been ruthlessly killed for their ivory. Now very few of these magnificent animals are left in these jungles.

Two important sanctuaries meant for preservation of coastal ecosystems are the **Chilka Lake** and **Point Calimere.** The **Sunderbans** protect the largest mangrove delta in India. The **Marine National Park** in Gujarat protects shallow areas in the sea, islands, coral reefs and extensive mudflats.
Over a hundred Protected Areas have been created in the Andaman and Nicobar Islands to preserve their very special island ecosystems.

The need for an Integrated Protected Area System (IPAS): Protected Areas, to be effective, must be established in every biogeographic region. A relatively larger representation must be included of highly fragile ecosystems, areas of high species diversity or high endemism. Protected Areas must also be integrated with each other by establishing corridors between adjacent areas wherever possible so that wildlife can move between them. In our country, which has a rapidly growing human population, it is not easily feasible to set aside more and more land to create Protected Areas. The need to provide a greater amount of land for agricultural and other needs has become an increasing cause of concern in land and resource management. This forms a major impediment for creating new Protected Areas. Having said this, there is an urgent need to add to our Protected Areas to preserve our very rich biological diversity. Much of the natural wilderness has already undergone extensive changes.

The residual areas that have high levels of species richness, endemism or endangered plants and animals must be notified as National Parks and Wildlife Sanctuaries. Other areas can be made into Community Conserved Areas which are managed by local people. The International Union for Conservation of Nature

and Natural Resources states that it is essential to include at least 10% of all ecosystems as Protected Areas if biodiversity is to be conserved in the long-term.

India has only 5% of land in its 589 Protected Areas in 2004. However much of this includes plantations of sal or teak, which were developed for timber in the past and are thus relatively poor in diversity and have a low level of 'naturalness'. There are only a few good grasslands left in our country that are notified as Protected Areas. Some are overgrazed wastelands in areas that were once flourishing grasslands. Most of these areas have a low biological value and need careful management to allow them to revert to a more 'natural' state, with their full complement of plants and animals. Only a few wetlands have been made into Sanctuaries. These require better management. A major strategy to reduce impacts on the biodiversity of the PAs should be to provide a sustainable source of resources for local people living around them. A Protected Area curtails their traditional grazing practices and access fuelwood sources. These resources must be provided by developing them in buffer areas. Plantations of fuel wood and good grassland management in areas outside Protected Areas can help reduce the pressure on the habitat of wildlife in the Protected Area. Management must ensure that local people derive a direct economic benefit from the presence of the PA. Involving local people in Protected Area management and developing tourist facilities that support the income generation for local people helps in involving their support for the Protected Area.

A carefully designed management plan which incorporates an **'ecodevelopment'** component aimed at providing a source of fuel wood, fodder and alternate income generation for local people, is an important aspect of PA management.

There are several species of plants and animals that survive without protection outside our current network of PAs. As it is not practical to notify more PAs without affecting the lives of people, alternate strategies such as Community Reserves or Community Conserved Areas need to be created. These should be managed by local people to bring about the conservation of biodiversity while using the area's resources in an equitable and sustainable way. A Community Conserved Area must have specific conservation goals that can be achieved without compromising the area's utilitarian potential.
A major drive for conservation of biological diversity can only come from a mass environmental education program on the value of protecting our dwindling biological resources.

Ex-situ conservation

Conservation of a species is best done by protecting its habitat along with all the other species that live in it in nature. This is known as in-situ conservation, which is conserving a species in its own environment by creating National Parks and Wildlife Sanctuaries. However, there are situations in which an endangered species is so close to extinction that unless alternate methods are instituted, the species may be rapidly driven to extinction. This strategy is known as ex-situ conservation, i.e. outside its natural habitat in a carefully controlled situation such as a botanical garden for plants or a zoological park for animals, where there is expertise to multiply the species under artificially managed conditions. These breeding programs for rare plants and animals are however more expensive than managing a Protected Area.

There is also another form of preserving a plant by preserving its germ plasm in a gene bank so that it can be used if needed in future. This is even more expensive.

When an animal is on the brink of extinction, it must be carefully bred so that inbreeding does not lead to the genetic makeup becoming weak. Breeding from the same stock can lead to poorly adapted progeny or even inability to get enough offspring.

Modern breeding programs are done in zoos that provide for all the animal's needs, including enclosures that simulate their wild habitats. There may also be a need to assist breeding artificially. Thus while most zoos are meant to provide visitors with a visual experience of seeing a wild animal close up, and provide the visitors with information about the species, a modern zoo has to go beyond these functions that include breeding of endangered species as a conservation measure.

In India, successful ex situ conservation programs have been done for all our three species of crocodiles. This has been highly successful. Another recent success has been the breeding of the very rare pygmy hog in Gauhati zoo. Delhi zoo has successfully bred the rare Manipur brow antlered deer.

However the most important step of a successful breeding program is the reintroduction of a species into its original wild habitat. This requires rehabilitation of the degraded habitat and removal of the other causes such as poaching, disturbance, or other manmade influences that have been the primary cause of reducing the population of the species.

Conservation of cultivars and livestock breeds: There were an estimated thirty thousand varieties of rice grown in India till about 50 years ago. Now only a few of these are still grown. The new varieties which are now being cultivated everywhere have been developed using germ plasm of these original types of rice. If all the traditional varieties vanish completely it will be difficult to develop new disease resistant varieties of rice in the future. Several varieties have been preserved in gene banks. However, this is both very expensive and risky. Encouraging farmers to continue to grow several traditional varieties is thus an important concern for the future of mankind. At present gene bank collections have over 34 thousand cereals and 22 thousand pulses.

CASE STUDY

Beej Bachao Andolan (Save the Seeds Movement)
This movement began in the Himalayan foothills. The members have collected seeds of diverse crops in Garhwal. The movement has successfully conserved hundreds of local rice varieties, rajma, pulses, millets, vegetables, spices and herbs. Many different varieties are being grown as an outcome of this program in local farmer's fields. This has also been supported by local women's groups who felt these varieties were better than those provided by the green revolution. In contrast, men who were interested in cash returns in a short time found it difficult to appreciate the benefits of growing indigenous varieties In the past, domestic animals were selected and bred for their ability to adapt to local conditions. Traditional agropastoralists in India have selectively bred livestock for 2 to 3 thousand years. India has 27 breeds of cattle, 40 breeds of sheep, 22 breeds of goats, and 8 breeds of buffaloes. These traditional breeds must be maintained for their genetic variability.

UNIT-III

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 ages 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 vemicomposting 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.

POLLUTION CASE STUDIES

A case study of groundwater pollution in India

An example of groundwater pollution caused by excessive extraction is that fluoride contamination. Fluorisis 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 deflouridate 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 deflouridated. None of the Indian technologies are however fool-proof. Deflouridation 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 organo phosphorus pesticides which are most commonly used in India were found in all the samples. Among organochlorines, gammahexachlorocyclohexane (lindane) and DDT were prevalent while among organophosphorus pesticides, Malathion and Chlorpyrifos were most common. All these were present above permissiblelimits 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 reveled 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 nonalcoholic 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 polluters are the coke oven plants that heat coal to temperatures as high as 1100oC 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.

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

Climate change:
The average temperature in many regions has been increasing in recent decades. The global average surface temperature has increased by 0.6° + 0.2° 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, tickborne encephalitis) may spread due to climate change 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).

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

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 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.

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.

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 natures 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.

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 fall out 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.

UNIT-IV

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.

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.

WATER CONSERVATION, RAINWATER HARVESTING, WATERSHED MANAGEMENT

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.

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.

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.
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.

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.

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.
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.

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.

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.

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.

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 reclaime 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 livestock 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 development 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.

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 lead 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 overutilization 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 warranteed 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 technological 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 patters 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. 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 reusing and recycling whatever possible and finally by proper disposal of residual waste, we can cut down or 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 overexploiting of our existing resources.

HUMAN RIGHTS

Several environmental issues are closely linked to human rights. These include the equitable distribution of environmental resources, the utilisation of resources and Intellectual Property Rights (IPRs), conflicts between people and wildlife especially around PAs, resettlement issues around development projects such as dams and mines, and access to health to prevent environment related diseases.

Equity

One of the primary concerns in environmental issues is how wealth, resources and energy must be distributed in a community. We can think of the global community, regional community issues, national concerns and those related to a family or at the individual level. While economic disparities remain a fact of life, we as citizens of a community must appreciate that a widening gap between the rich and the poor, between men and women, or between the present and future generations must be minimised if social justice is to be achieved. Today the difference between the economically developed world and the developing countries is unacceptably high.

The access to a better lifestyle for men as against women is inherent in many cultures. Last but not the least, we in the present generation cannot greedily use up all our resources leaving future generations increasingly impoverished.

Rights to land, water, food, housing are all a part of our environment that we all share. However, while some live unsustainable lifestyles with consumption patterns that the resource base cannot support, many others live well below the poverty line. Even in a developing country such as ours, there are enormous economic inequalities. This requires an ethic in which an equitable distribution becomes a part of everyone's thinking.

The people who live in the countries of the North and the rich from the countries in the South will have to take steps to reduce their resource use and the waste they generate. Both the better off sectors of society and the less fortunate need to develop their own strategies of sustainable living and communities at each level must bring about more equitable patterns of wealth.

The right to the use of natural resources that the environment holds is an essential component of human rights. It is related to disparities in the amount of resources available to different sectors of society. People who live in wilderness communities are referred to as ecosystem people. They collect food, fuelwood, and nonwood products, fish in aquatic ecosystems, or hunt for food in forests and grasslands. When landuse patterns change from natural ecosystems to more intensively used farmland and pastureland the rights of these indigenous people are usually sacrificed. Take the case of subsidies given

to the pulp and paper industry for bamboo which makes it several times cheaper for the industry than for a rural individual who uses it to build his home. This infringes on the human right to collect resources they have traditionally used free of cost. Another issue is the rights of small traditional fishermen who have to contend against mechanized trawlers that impoverish their catch and overharvest fish in the marine environment. These people's right to a livelihood conflicts with the powerful economic interests of large-scale organised fisheries.

There are serious conflicts between the rights of rural communities for even basic resources such as water, and industrial development which requires large amounts of water for sustaining its productivity. The right to land or common property resources of tribal people is infringed upon by large development projects such as dams, mining and Protected Areas. Movements to protect the rights of indigenous peoples are growing worldwide. Reversing actions that have already been taken decades ago is a complex problem that has no simple solutions. In many cases a just tradeoff is at best achieved through careful and sensitively managed negotiations. This needs a deep appreciation of local environmental concerns as well as a sensitivity to the rights of local people.

Nutrition, health and human rights

There are links between environment, nutrition and health which must be seen from a human rights perspective. Proper nutrition and health are fundamental human rights. The right to life is a Fundamental Right in our constitution. As a deteriorating environment shortens life spans, this in effect has an impact on our fundamental constitutional right.

Nutrition affects and defines the health status of all people, rich and poor. It is linked to the way we grow, develop, work, play, resist infection and reach our aspirations as individuals, communities and societies. Malnutrition makes people more vulnerable to disease and premature death. Poverty is a major cause as well as a consequence of ill-health. Poverty, hunger, malnutrition and poorly managed environments together affect health and weaken the socioeconomic development of a country. Nearly 30% of humanity, especially those in developing countries – infants, children, adolescents, adults, and older persons are affected by this problem. A human rights approach is needed to appreciate and support millions of people left behind in the 20th century's health revolution.
We must ensure that our environmental values and our vision are linked to human rights and create laws to support those that need a better environment, better health and a better lifestyle.

Health and sustainable human development are equity issues. In our globalized 21st century, equity must begin at the bottom, hand in hand with a healthy environment, improved nutrition, and sustainable lifestyles. Putting first things first, we must also realize that resources allocated to preventing and eliminating disease will be effective only if the underlying causes such as malnutrition and environmental concerns, as well as their consequences, are successfully addressed.

Intellectual Property Rights and Community Biodiversity Registers

Traditional people, especially tribals living in forests, have used local plants and animals for generations.

This storehouse of knowledge leads to many new 'discoveries' for modern pharmaceutical products. The revenue generated from such 'finds' goes to the pharmaceutical industry that has done the research and patented the product.
This leaves the original tribal user with nothing while the industry could earn billions of rupees. To protect the rights of indigenous people who have used these products, a possible tool is to create a Community

Biodiversity Register of local products and their uses so that its exploitation by the pharmaceutical industry would have to pay a royalty to the local community.
This however has still not been generally accepted. Mechanisms have to be worked out so that the local traditional users rights are protected.

Traditional Medicine: Traditional medicine refers to health practices, approaches, knowledge and beliefs that incorporate plant, animal and mineral based medicines, frequently of local or regional origin. It may be linked to spiritual therapies, manual techniques and exercises.
These may be used singly or in combination to treat, diagnose and prevent illnesses or maintain well-being. Traditional medicine is often handed down through the generations or may be known to a special caste or tribal group.
Traditional medicine has maintained its popularity in all regions of the developing world and its use is rapidly spreading in industrialized countries.
In India, some of our primary health care needs are taken care of entirely by traditional medicine, while in Africa, up to 80% of the population uses it for primary health care. In industrialized countries, adaptations of traditional medicine are termed "Complementary" or "Alternative" Medicine (CAM). While there are advantages to traditional medicine as it is cheap and locally available, there are diseases which it cannot treat effectively.

This is a risk, as patients who use these alternative medicinal practices may rely on an ineffective measure. The consequences could be a serious delay in diagnosis and effective treatment
of a treatable condition. There is a need to carefully research the claims of traditional practices to ensure that they are effective.
In addition to patient safety issues, there is the risk that a growing herbal market and its great commercial benefit poses a threat to biodiversity through the over harvesting of the raw material for herbal medicines and other natural health care products. This has been observed in the case of several Himalayan plants. If extraction from the wild is not controlled, this can lead to the extinction of endangered plant species and the destruction of natural habitats of several species.
Another related issue is that at present, the requirements for protection provided under international standards for patent law and by most national conventional patent laws are inadequate to protect traditional knowledge and biodiversity.
There are tried and tested scientific methods and products that have their origins in different tra- ditional medicinal methods. Twenty-five percent of modern medicines are made from plants first used traditionally. Yoga is known to reduce asthma attacks. Traditional Medicine has been found to be effective against several infectious diseases.

CASE STUDY

A US company was granted a patent for discovering extracts of arhar (pigeon pea or Cajanus cajan) in the treatment of diabetes, hypoglycemia, obesity and blockage of arteries. The use of pigeon pea extracts in India is well known. CSIR has challenged this patent as it infringes on India's traditional knowledge, although challenging the patent is difficult, as India's scientific documentation of its traditional knowledge is quite poor. Over one-third of the population in developing countries lack access to essential allopathic medicines.
The provision of safe and effective TM/ CAM therapies could become a tool to increase access to health care.

POPULATION GROWTH, VARIATION

AMONG NATIONS

Our global human population, 6 billion at present, will cross the 7 billion mark by 2015. The needs of this huge number of human beings cannot be supported by the Earth's natural resources, without degrading the quality of human life.

In the near future, fossil fuel from oil fields will run dry. It will be impossible to meet the demands for food from existing agro systems. Pastures will be overgrazed by domestic animals and industrial growth will create ever-greater problems due to pollution of soil, water and air. Seas will not have enough fish. Larger ozone holes will develop due to the discharge of industrial chemicals into the atmosphere, which will affect human health. Global warming due to industrial gases will lead to a rise in sea levels and flood all low-lying areas, submerging coastal agriculture as well as towns and cities. Water 'famines' due to the depletion of fresh water, will create unrest and eventually make countries go to war. The control over regional biological diversity, which is vital for producing new medicinal and industrial products, will lead to grave economic conflicts between biotechnologically advanced nations and the biorich countries. Degradation of ecosystems will lead to extinction of thousands of species, destabilizing natural ecosystems of great value.

These are only some of the environmental problems related to an increasing human population and more intensive use of resources that we are likely to face in future. These effects can be averted by creating a mass environmental awareness movement that will bring about a change in people's way of life. Increase in production per capita of agricultural produce at a global level ceased during the 1980's. In some countries, food shortage has become a permanent feature. Two of every three children in South Africa are underweight.

In other regions famines due to drought have become more frequent. Present development strategies have not been able to successfully address these problems related to hunger and malnutrition. On the other hand, only 15% of the world's population in the developed world is earning 79% of income! Thus the disparity in the extent of per capita resources that are used by people who live in a '**developed'** country as against those who live in a '**developing'** country is extremely large. Similarly, the disparity between the rich and the poor in India is also growing.
The increasing pressures on resources place great demands on the in-built buffering action of nature that has a certain ability to maintain a balance in our environment. However, current development strategies that essentially lead to short-term gains have led to a breakdown of our Earth's ability to replenish the resources on which we depend.

Global population growth

The world population is growing by more than 90 million per year, of which 93% is in developing countries. This will essentially prevent their further economic 'development'. In the past, population growth was a gradual phenomenon and the Earth's ability to replenish resources was capable of adjusting to this increase. In the recent past, the escalation in growth of human numbers has become a major cause of our environmental problems.

Present projections show that if our population growth is controlled, it will still grow to 7.27 billion by 2015. However, if no action is taken it will become a staggering 7.92 billion.

Human population growth increased from:
1 to 2 billion, in 123 years.
2 to 3 billion, in 33 years.

3 to 4 billion, in 14 years.
4 to 5 billion, in 13 years.
5 to 6 billion, in 11 years.

It is not the census figures alone that need to be stressed, but an appreciation of the impact on natural resources of the rapid escalation in the rate of increase of human population in the recent past. The extent of this depletion is further increased by affluent societies that consume per capita more energy and resources, that less fortunate people. This is of great relevance for developing a new ethic for a more equitable distribution of resources.

In the first half of the 1900s human numbers were growing rapidly in most developing countries such as India and China. In some African countries the growth was also significant. In contrast, in the developed world population growth had slowed down. It was appreciated that the global growth rate was depleting the Earth's resources and was a direct impediment to human development. Several environmental ill-effects were linked with the increasing population of the developing world. Poverty alleviation programs failed, as whatever was done was never enough as more and more people had to be supported on Earth's limited resources. In rural areas population growth led to increased fragmentation of farm land and unemployment. In the urban sector it led to inadequate housing and an increasing level of air pollution from traffic, water pollution from sewage, and an inability to handle solid waste. By the 1970s most countries in the developing world had realized that if they had to develop their economics and improve the lives of their citizens they would have to curtail population growth.

Though population growth shows a general global\ decline, there are variations in the rate of decline in different countries. By the 1990s the growth rate was decreasing in most countries such as China and India. The decline in the 90s was greatest in India. However, fertility continues to remain high in sub Saharan African countries.

There are cultural, economic, political and demographic reasons that explain the differences in the rate of population control in different countries. It also varies in different parts of certain countries and is linked with community and/ or religious thinking. Lack of Government initiatives for Family Welfare Program and a limited access to a full range of contraceptive measures are serious impediments to limiting population growth in several countries.

POPULATION EXPLOSION – FAMILY WELFARE PROGRAM

In response to our phenomenal population growth, India seriously took up an effective Family Planning Program which was renamed the Family Welfare Program. Slogans such as 'Hum do hamare do' indicated that each family should not have more than two children. It however has taken several decades to become effective. At the global level by the year 2000, 600 million, or 57% of women in the reproductive age group, were using some method of contraception. However the use of contraceptive measures is higher in developed countries – 68%, and lower in developing countries - 55%. Female sterilization is the most popular method of contraception used in developing countries at present. This is followed by the use of oral contraceptive pills and, intrauterine devices for women, and the use of condoms for men. India and China have been using permanent sterilization more effectively than many other countries in the developing world.

The best decision for the method used by a couple depends on a choice that they make for themselves. This must be based on good advice from doctors or trained social workers who can suggest the full range of methods available for them to choose from. Informing the public about the various contraceptive measures that are available is of primary importance. This must be done actively by Government

Agencies such as Health and Family Welfare, as well as Education and Extension workers. It is of great importance for policy makers and elected representatives of the people – Ministers, MPs, MLAs at Central and State levels – to understand the great and urgent need to support Family Welfare. The media must keep people informed about the need to limit family size and the ill effects of a growing population on the worlds resources.

The decision to limit family size depends on a couple's background and education. This is related to Government Policy, the effectiveness of Family Welfare Programs, the educational level, and information levels in mass communication. Free access to Family Welfare information provided through the Health Care System, is in some cases unfortunately counteracted by cultural attitudes. Frequently misinformation and inadequate information are reasons why a family does not go in for limiting its size. The greatest challenge the world now faces is how to supply its exploding human population with the resources it needs. It is evident that without controlling human numbers, the Earth's resources will be rapidly exhausted. In addition economically advanced countries and rich people in poorer countries use up more resources than they need.

As population expands further, water shortages will become acute. Soil will become unproductive. Rivers, lakes and coastal waters will be increasingly polluted. Water related diseases already kill 12 million people every year in the developing world. By 2025, there will be 48 countries that are starved for water. Air will become increasingly polluted. Air pollution already kills 3 million people every year. The first 'green revolution' in the '60s produce a large amount of food but has led to several environmental problems. Now, a new green revolution is needed, to provide enough food for our growing population, that will not damage land, kill rivers by building large dams, or spread at the cost of critically important forests, grasslands and wetlands.

The world's most populous regions are in coastal areas. These are critical ecosystems and are being rapidly destroyed. Global climate change is now a threat that can affect the very survival of high population density coastal communities. In the sea, fish populations are suffering from excessive fishing. Once considered an inexhaustible resource, over fishing has depleted stocks extremely rapidly. It will be impossible to support further growth in coastal populations on existing fish reserves.

Human populations will inevitably expand from farm lands into the remaining adjacent forests. Many such encroachments in India have been regularised over the last few decades. But forest loss has long-term negative effects on water and air quality and the loss of biodiversity is still not generally seen as a major deterrent to human well-being. The extinction of plant and animal species resulting from shrinking habitats threatens to destroy the Earth's living web of life.

Energy use is growing, both due to an increasing population, and a more energy hungry lifestyle that increasingly uses consumer goods that require large amounts of energy for their production, packaging, and transport. Our growing population also adds to the enormous amount of waste. With all these linkages between population growth and the environment, Family Welfare Programs have become critical to human existence.

Planning for the future

How Governments and people from every community meet challenges such as limiting population size, protecting the natural environment, change their consumer oriented attitudes, reduce habits that create excessive waste, elevates poverty and creates an effective balance between conservation and development will determine the worlds future.

The Urban Challenge

Population increases will continue in urban centers in the near future. The UN has shown that by 2025 there will be 21 "megacities" most of which will be situated in developing countries. Urban centers are already unable to provide adequate housing, services such as water and drainage systems, growing energy needs, or better opportunities for income generation.

Methods of sterilization

India's Family Welfare Program has been fairly successful but much still needs to be achieved to stabilize our population. The most effective measure is the one most suited to the couple once they have been offered all the various options that are available.
The Family Welfare Program advocates a variety of measures to control population. Permanent methods or sterilisation are done by a minor surgery. Tubectomy in females is done by tying the tubes that carry the ovum to the uterus. Male sterilization or vasectomy, is done by tying the tubes that carry the sperm. Both are very simple procedures, done under local anesthesia, are painless and patients have no post operative problems. Vasectomy does not cause any loss in the male's sexual ability but only arrests the discharge of sperm.

There are several methods of temporary birth control. Condoms are used by males to prevent sperms from fertilizing the ovum during intercourse.
Intrauterine devices (Copper Ts) are small objects which can be placed by a doctor in the uterus so that the ovum cannot be implanted, even if fertilized. They do not disturb any functions in the woman's life or work. Oral contraceptive tablets (pills) and injectable drugs are available that prevent sperms from fertilizing the ovum.

There are also traditional but less reliable methods of contraception such as abstinence of the sexual act during the fertile period of the women's cycle and withdrawal during the sexual act.

Urbanization:
In 1975 only 27% of the people in the developing world lived in urban areas. By 2000 this had grown to 40% and by 2030 well informed estimates state that this will grow to 56%. The developed world is already highly urbanized with 75% of its population living in the urban sector.r

ENVIRONMENT AND HUMAN HEALTH

Environment related issues that affect our health have been one of the most important triggers that have led to creating an increasing awareness of the need for better environmental management.
Changes in our environment induced by human activities in nearly every sphere of life have had an influence on the pattern of our health. The assumption that human progress is through economic growth is not necessarily true. We expect urbanization and industrialization to bring in prosperity, but on the down side, it leads to diseases related to overcrowding and an inadequate quality of drinking water, resulting in an increase in waterborne diseases such as infective diarrhoea and air borne bacterial diseases such as tuberculosis. High-density city traffic leads to an increase in respiratory diseases like asthma. Agricultural pesticides that enhanced food supplies during the green revolution have affected both the farm worker and all of us who consume the produce. Modern medicine promised to solve many health problems, especially associated with infectious diseases through antibiotics, but bacteria found ways to develop resistant strains, frequently even changing their behaviour in the process, making it necessary to keep on creating newer antibiotics. Many drugs have been found to have serious side effects. At times the cure is as damaging as the disease process itself.

Thus development has created several long-term health problems. While better health care has led to longer life spans, coupled with a lowered infant mortality, it has also led to an unprecedented growth in our population which has negative implications on environmental quality. A better health status of society will bring about a better way of life only if it is coupled with stabilising population.

7.3.1 Environmental health, as defined by WHO, comprises those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social, and psychosocial factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling, and preventing those factors in the environment that adversely affect the health of present and future generations. Our environment affects health in a variety of ways. Climate and weather affect human health. Public health depends on sufficient amounts of good quality food, safe drinking water, and adequate shelter. Natural disasters such as storms, hurricanes, and floods still kill many people every year. Unprecedented rainfall trigger epidemics of malaria and water borne diseases. Global climate change has serious health implications. Many countries will have to adapt to uncertain climatic conditions due to global warming. As our climate is changing, we may no longer know what to expect. There are increasing storms in some countries, drought in others, and a temperature rise throughout the world. The El Niño winds affect weather worldwide. The El Niño event of 1997/98 had serious impacts on health and well-being of millions of people in many countries. It created serious drought, floods, and triggered epidemics. New strategies must be evolved to reduce vulnerability to climate variability and changes. Economic inequality and environmental changes are closely connected to each other. Poor countries are unable to meet required emission standards to slow down climate change. The depletion of ozone in the stratosphere (middle atmosphere) also has an important impact on global climate and in turn human health, increasing the amount of harmful ultraviolet radiation that reaches the Earth's surface. This results in diseases such as skin cancer.

CASE STUDY

Bhopal Gas Tragedy

The siting of industry and relatively poor regulatory controls leads to ill health in the urban centers. Accidents such as the Bhopal gas tragedy in 1984 where Union Carbide's plant accidentally released 30 tones of methyl isocyanate, used in the manufacture of pesticides, led to 3,330 deaths and 1.5 lakh injuries to people living in the area.

HIV/AIDS

The Human Immunodeficiency Virus (HIV) causes Acquired Immunodeficiency Syndrome (AIDS) through contact with tissue fluids of infected individuals, especially through sexual contact. As it reduces an individual's resistance to disease, it causes infected individuals to suffer from a large number of environment related diseases and reduces the ability of infected individuals to go about their normal lives. It affects their income generation and/or their ability to utilize natural resources. As more and more people are affected, this disease will also have impacts on our natural resource base, as utilisation patterns change to unsustainable levels. The inability of these patients to have the strength to access natural resources also affects the outcome of the disease process, as their overall health and well being is likely to worsen the course of the disease when their nutritional status suffers. In sub Saharan Africa where the infection has become highly prevalent, it is leading to great suffering and worsening poverty. The capacity of these patients to work for their usual sources of income generation is lost. An increasing proportion of the poor are affected. It is evident that it is going to be increasingly difficult to manage environments sustainably, as natural resources on which the poor debilitated patients depend continue to be degraded. Incomes lost due to the stigma of HIV/AIDS must be met by the sufferers by overexploiting their resource

base. People affected by the disease inevitably try to get whatever they can from their natural resource base as they are not in any position to think of the long-term future. In Africa, this has led to degradation of the ecosystem and an increase of pressures from other impacts such as overuse of medicinal plants and poaching for wildlife. In South Africa, for example, people have a mistaken belief that turtle eggs can cure HIV/ AIDS, thus leading to the eggs being over harvested. As males die of the disease, work on agricultural land has to be taken over by already overworked women and their children, affecting land management and productivity. Providing balanced diets and nutritional support for these poverty stricken patients can be partially addressed by better natural resource management such as afforestation, access to clean water and wholesome food.

HIV/AIDS seriously affects the patient's working environment. It creates an incorrect fear in the minds of co-workers. It must be clearly understood that AIDS is not spread by casual contact during work. Patients have a right to continue to work as before along with unaffected individuals. As patients are unable to continue their original hard labour related work, it is essential that alternative sources of work must be created for them. Educators and extention information, in the formal and non-formal educational sectors, must address the issues related to the linkages between natural resource management and this disease, as well as the need to remove the social stigma attached to it.

HIV/ AIDS has a serious impact on the socioeconomic fabric of society. By 2002, India had an estimated 3.97 million infected individuals. There is a great need to organise AIDS education on prevention and management of the disease. This needs to be done through the formal educational sector and by using non-formal methods. Education is also important to reduce the stigma and discrimination against these patients.

In India, women who are not socially empowered are at a great disadvantage as they are powerless to demand safe sex from their partners. Women also have an added burden of caring for HIV infected husbands. This produces enormous economic stresses on their family.
HIV in India is rapidly moving from a primarily urban sector disease to rural communities. Research in Nepal has shown a linkage between rural poverty, deforestation and a shift of population to urban areas resulting in a rising number of AIDS patients. Prior to 1992, it was mainly seen in males who migrated to urban centers.

In more recent times, a growing number of women are moving to Indian cities as sex workers. Women engaged in prostitution find it difficult to make partners take protective measures, such as the use of condoms that provide safe sex. A large proportion became victims of the disease.

Blood transfusion from an infected person can also lead to HIV/AIDS in the recipient, as well as drug abuse by sharing needles with an infected person. In sexually transmitted AIDS, the use of condoms during intercourse is a key to preventing the disease. Behavioural change, where the number of individuals who have multiple partners, towards strictly single partners, reduces the risk of HIV/AIDS and thus reduces incidence of the disease in society. However, the most important measure to prevent AIDS is the proper use of condoms that form a barrier to the spread of the virus during intercourse.

WOMAN AND CHILD WELFARE

There are several environmental factors that are closely linked to the welfare of women and children. Each year, close to eleven million children worldwide are estimated to have died from the effects of disease and inadequate nutrition. Most of these deaths are in the developing world. In some countries, more than one in five children die before they are 5 years old. Seven out of 10 of childhood deaths in developing countries can be attributed to five main causes, or a combination of them. These are

pneumonia, diarrhoea, measles, malaria and malnutrition. Around the world, three out of every four children suffer from at least one of these conditions.

The diagnosis of common childhood disease Conditions Presenting complaint Possible cause or associated condition

Cough and/or Pneumonia fast breathing Severe anaemia P. falciparum malaria Lethargy or Cerebral malaria unconsciousness Meningitis Severe dehydration Very severe pneumonia Measles rash Pneumonia Diarrhoea Ear infection "Very sick" young infant Pneumonia
Meningitis Sepsis

Respiratory conditions: Most respiratory diseases are caused by or are worsened by polluted air. Crowded ill-ventilated homes and living in smokey households with open fires can trigger respiratory conditions especially in children. Pneumonia: Acute respiratory infections (ARI), most frequently pneumonia, is a major cause of death in children under five, killing over two million children annually. Upto 40% of children seen in health centers suffer from respiratory conditions and many deaths attributed to other causes are, in fact, "hidden" ARI deaths. Children may die very quickly from the infection and thus need treatment urgently. Most patients of pneumonia can be treated with oral antibiotics. Correct management could save over 1 million lives per year globally.

Gastro intestinal conditions: Contaminated water and food causes widespread ill health especially in children.

Diarrhoea: Diarrhoea is caused by a wide variety of infections. Urgent diagnosis and treatment of diarrhoea is a priority for saving a child's life. Treating malnutrition that often accompanies diarrhoea can further reduce mortality. Increasing vigilance to detect other diseases that can occur concurrently with diarrhoea, such as measles or malaria, is an important measure. Two million children die each year in developing countries from diarrhoeal diseases, the second most serious killer of children under five worldwide. In most cases diarrhoea is preventable and children can be saved by early treatment.

Correct management of diarrhoea could save the lives of up to 90% of children who currently die by promoting rapid and effective treatment through standardised management, including antibiotics and simple measures such as oral rehydration using clean boiled water with salt and sugar. In severe cases intravenous fluids must be started. Improved hygiene and management of the home and surroundings is the most important preventative measure, as well as improved nutrition. Increased breastfeeding and measles vaccination have also been observed to have reduced the number of cases of diarrhoea.
Measles: Measles is a rash that appears with fever and bodyache in children and is caused by a virus. It infects over 40 million children and kills over 800,000 children under the age of five.

Prevention includes wider immunization coverage, rapid referral of serious cases, prompt recognition of conditions that occur in association with measles, and improved nutrition, including breastfeeding, and vitamin A supplementation. Measles is prevented by a vaccine. Young children with measles often develop other diseases such as acute respiratory infections, diarrhea and malnutrition that are all linked to poor environmental conditions in their surroundings. Children who survive an attack of measles are more vulnerable to other dangerous infections for several months. Effective prevention and treatment could save 700,000 lives per year.

Malaria: This condition is closely linked to pooling and stagnation of water in tropical environments.
Malaria is a widespread tropical disease which is caused by a parasite transmitted to humans by mosquitoes. It has proved difficult to control because mosquitoes have become resistant to insecticides

used against them and because the parasite has developed resistance in some areas to the cheap and effective drugs that used to provide good protection in the past.

However, alternative newer drug therapies have been developed for use in areas where resistant parasites are found. In India the disease was nearly wiped out a few decades ago but has now re-emerged in many parts of the country. Correct management could save 500,000 lives per year. Approximately 700,000 children die of malaria globally each year, most of them in sub-Saharan Africa. Young children are particularly vulnerable because they have not developed the partial immunity that results from surviving repeated infections.

Deaths from malaria can be reduced by several measures, including encouraging parents to seek prompt care, accurate assessment of the condition of the child, prompt treatment with appropriate anti-malarial drugs, recognition and treatment of other co-existing conditions, such as malnutrition and anaemia, and prevention by using mosquito-proof bednets. Because fever may be the only sign of malaria, it can be difficult to distinguish it from other potentially lifethreatening conditions.

Poverty-environment-malnutrition: There is a close association between poverty, a degraded environment, and malnutrition. This is further aggravated by a lack of awareness on how children become malnourished.

Malnutrition: Although malnutrition is rarely listed as the direct cause of death, it contributes to about half of all childhood deaths. Lack of access to food, poor feeding practices and infection, or a combination of the two, are major factors in mortality. Infection, particularly frequent or persistent diarrhoea, pneumonia, measles and malaria, undermines nutritional status. Poor feeding practices - inadequate breastfeeding, providing the wrong foods, giving food in insufficient quantities, contribute to malnutrition. Malnourished children are more vulnerable to disease. Promoting breastfeeding, improving feeding practices, and providing micronutrient supplements routinely for children who need them are measures that reduce mortality.

The nutritional status and feeding practices of every child under two years of age, and those with a low weight for their age must be intensively managed. Counseling of parents on the correct foods for each age group and helping them to overcome various feeding problems is an essential health care measure.

Children between 6 months and 2 years of age are at increased risk of malnutrition when there is a transition between breastfeeding and sharing fully in the family diet. Changing family habits and the kinds of food offered to children is an important measure. Talking to mothers individually about home care and their child's feeding, with relatively simple changes to better feeding practices, such as helping them to eat rather than leaving them to fend for themselves, can ensure that a child gets enough to eat.

A minor increase in breastfeeding could prevent up to 10% of all deaths of children under five: When mothers breastfeed exclusively during at least the first four months and, if possible, six months of life, there is a decrease in episodes of diarrhoea and, to a lesser extent, respiratory infections. Even small amounts of water-based drinks decreases breastmilk intake and lead to lowered weight gain. This increases the risk of diarrhoea. Continuing to breastfeed up to two years of age, in addition to giving complementary foods, maintains good nutritional status and helps prevent diarrhoea.

Encouraging maximum support to mothers to establish optimal breastfeeding from birth, equipping health workers with counseling skills, and providing individual counseling and support for breastfeeding mothers are measures that reduce malnutrition. Mothers often give their babies other food and fluids before six

months because they doubt their breastmilk supply is adequate. A one-on-one counseling with mothers on breastfeeding techniques and its benefits helps reduce incidence of malnutrition.

There are strong connections between the status of the environment and the welfare of women and children in India. Women, especially in lower income group families, both in the rural and urban sector, work longer hours than men. Their work pattern differs and is more prone to health hazards. The daily collection of water, fuelwood and fodder is an arduous task for rural women. In urban areas, where lower economic group women live in crowded smoke filled shantys in unhygenic slums, they spend long hours indoors, which is a cause of respiratory diseases. In urban centers, a number of women eke out a living by garbage picking. They separate plastics, metal and other recyclable material from the waste produced by the more affluent groups of society. During this process, they can get several infections. Thus they are providing an environmental service of great value, but earn a pittance from this work.

Women are often the last to get enough nutrition as their role in traditional society is to cook the family meal and feed their husband and children. This leads to malnutrition and anemia due to inadequate nutrition.
The sorry plight of women includes the fact that the girl child is given less attention and educational facilities as compared to boys in India.

CASE STUDY
Karnataka's GIS scheme, Bhoomi, has revolutionized the way farmers access their land records. Farmers can now get a copy of the records of rights, tenancy and crops from a computerized information kiosk without harassment and bribes. Karnataka has computerized 20 million records of land ownership of 6.7 million farmers in the State. they are unable to compete with men in later life. This social-environmental divide is a major concern that needs to be corrected throughout the country.

ROLE OF INFORMATION TECHNOLOGY IN ENVIRONMENT AND HUMAN HEALTH

The understanding of environmental concerns and issues related to human health has exploded during the last few years due to the sudden growth of Information Technology. The computer age has turned the world around due to the incredible rapidity with which IT spreads knowledge. IT can do several tasks extremely rapidly, accurately and spread the information through the world's networks of millions of computer systems. A few examples of the use of computer technology that aid environmental studies include software such as using Geographical Information Systems (GIS). GIS is a tool to map landuse patterns and document change by studying digitized toposheets and/or satellite imagery. Once this is done, an expert can ask a variety of questions which the software can answer by producing maps which helps in landuse planning.

The Internet with its thousands of websites has made it extremely simple to get the appropriate environmental information for any study or environmental management planning. This not only assists scientists and students but is a powerful tool to help increase public awareness about environmental issues. Specialised software can analyse data for epidemiological studies, population dynamics and a variety of key environmental concerns.

The relationship between the environment and health has been established due to the growing utilisation of computer technology. This looks at infection rates, morbidity or mortality and the etiology (causative factors) of a disease. As knowledge expands, computers will become increasingly efficient. They will be faster, have greater memories and even perhaps begin to think for themselves.

VALUE EDUCATION

Value education in the context of our environment is expected to bring about a new sustainable way of life. Education both through formal and non-formal processes must thus address understanding environmental values, valuing nature and cultures, social justice, human heritage, equitable use of resources, managing common property resources and appreciating the cause of ecological degradation.

Essentially, environmental values cannot be taught. They are inculcated through a complex process of appreciating our environmental assets and experiencing the problems caused due to our destruction of our environment. The problems that are created by technology and economic growth are a result of our improper thinking on what 'development' means. Since we still put a high value only on economic growth, we have no concern for aspects such as sustainability or equitable use of resources.

This mindset must change before concepts such as sustainable development can be acted upon. Unsustainable development is a part of economic growth of the powerful while it makes the poor poorer. Consumerism is one aspect of this process favoured by the rich. As consumption of resources has till recently been an index of development, consumerism has thrived. It is only recently that the world has come to realize that there are other more important environmental values that are essential to bring about a better way of life.

Values in environment education must bring in several new concepts. Why and how can we use less resources and energy? Why do we need to keep our surroundings clean? Why should we use less fertilisers and pesticides in farms?

Why is it important for us to save water and keep our water sources clean? Or separate our garbage into degradable and non-degradable types before disposal? All these issues are linked to the quality of human life and go beyond simple economic growth. They deal with a love and respect for nature. These are the values that will bring about a better humanity, one in which we can live healthy, productive and happy lives in harmony with nature.

What are values?
Values deal with ones own principles and standards from which we judge what is right and wrong behaviour.

Environmental Values:
Every human being has a great variety of feelings for different aspects of his or her surroundings. The Western, modern approach values the resources of Nature for their utilitarian importance alone. However true environmental values go beyond valuing a river for its water, a forest for its timber and non-wood forest products, or the sea for its fish. Environmental values are inherent in feelings that bring about a sensitivity for preserving nature as a whole. This is a more spiritual, Eastern traditional value.
There are several writings and sayings in Indian thought that support the concept of the oneness of all creation, of respecting and valuing all the different components of Nature. Our environmental values must translate to pro conservation actions in all our day to day activities. Most of our actions have adverse environmental impacts unless we consciously avoid them.

The sentiment that attempts to reverse these trends is enshrined in our environmental values. Values lead to a process of decision making which leads to action. For value education in relation to the environment, this process is learned through an understanding and appreciation of Nature's oneness and the importance of its conservation. Humans have an inborn desire to explore Nature.

Wanting to unravel its mysteries is a part of human nature. However, modern society and educational processes have invariably suppressed these innate sentiments. Once exposed to the wonders of the wilderness, people tend to bond closely to Nature. They begin to appreciate its complexity and fragility and this awakens a new desire to want to protect our natural heritage. This feeling for Nature is a part of our Constitution, which strongly emphasises this value.

Concepts of what constitutes right and wrong behaviour changes with time. Values are not constant. It was once considered 'sport' to shoot animals. It was considered a royal, brave and much desirable activity to kill a tiger. In today's context, with wildlife reduced to a tiny fraction of what there was in the past, it is now looked down upon as a crime against biodiversty conservation.

Thus the value system has been altered with time. Similarly with the large tracts of forest that existed in the past, cutting a few trees was not a significant criminal act. Today this constitutes a major concern. We need a strong new environmental value system in which felling trees is considered unwise behaviour. With the small human numbers in the past, throwing away a little household degradable garbage could not have been considered wrong.

But with enormous numbers of people throwing away large quantities of non-degradable waste, it is indeed extremely damaging to the environment and our value system must prevent this through a strong environmental value education system.

Appreciating the negative effects of our actions on the environment must become a part of our day to day thinking. Our current value system extols economic and technical progress as being what we need in our developing country.

Environmental values based on the Constitution of India

Article 48A:
"The state shall endeavour to protect and improve the environment and to safeguard the forests and wildlife in the country." Article 51A (g)

The constitution expects that each citizen of the country must "protect and improve the natural environment, including forests, lakes, rivers and wildlife, and to have compassion for all living creatures." While we do need economic development, our value system must change to one that makes people everywhere support a sustainable form of development so that we do not have to bear the cost of environmental degradation.

Environmental problems created by development are due neither to the need for economic development, nor to the technology that produces pollution, but rather to a lack of awareness of the consequences of unlimited and unrestrained anti-environmental behaviour. Looked at in this way, it deals with concepts of what is appropriate behaviour in relation to our surroundings and to other species on Earth. How we live our lives in fact shapes our environment. This is what environmental values are about.

Each action by an individual must be linked to its environmental consequences in his/her mind so that a value is created that leads to strengthening pro-environmental behaviour and preventing anti-environmental actions. This cannot happen unless new educational processes are created that provide a meaning to what is taught at school and college level. Every small child while growing up asks questions like 'What does this mean?'. They want an explanation for things happening around them that can help them make decisions and through this process develop values. It is this innate curiosity that leads to a personalized set of values in later life. Providing appropriate 'meanings' for such questions related to our

own environment brings in a set of values that most people in society begin to accept as a norm. Thus pro environmental actions begin to move from the domain of individuals to that of a community.

At the community level, this occurs only when a critical number of people become environmentally conscious so that they constitute a pro environment lobby force that makes governments and other people accept good environmental behaviour as an important part of development.

What professions require making value judgements that greatly influence our environment?

Evidentally nearly every profession can and does influence our environment, but some do so more than others. Policy makers, administrators, landuse planners, media, architects, medical personnel, health care workers, agriculturalists, agricultural experts, irrigation planners, mining experts, foresters, forest planners, industrialists and, most importantly, teachers at school and college level, are all closely related to pro environmental outcomes.

Environmental values have linkages to varied environmental concerns. While we value resources that we use as food, water and other products, there are also environmental services that we must appreciate. These include Nature's mechanisms in cleaning up air by removing carbon dioxide and adding oxygen by plant life, recycling water through the water cycle of nature, maintaining climate regimes, etc. But there are other aesthetic, ethical values that are equally important aspects of our environment that we do not appreciate consciously.

While every species is of importance in the web of life, there are some which man has come to admire for their beauty alone. The tiger's magnificence, the whale and elephant's giant size, the intelligence of our cousins the primates, the graceful flight of a flock of cranes, are parts of nature that we cannot help but admire. The lush splendor of an evergreen forest, the great power of the ocean's waves, and the tranquility of the Himalayan mountains are things that each of us values even if we do not experience it ourselves. We value its being there on Earth for us.

This is called its 'existance value'. The list of wondrous aspects of Nature's intricate connections is indeed awe-inspiring. This is also a part of our environment that we must value for its own sake. This is the oneness of Nature.

We must equally look at our environment beyond the wild sphere. There is incredible beauty in some man-modified landscapes, the coloured patterns of farmland or the greens of a tea or coffee plantation in the hills.

Urban gardens and open space are also valuable and thus must be of prime concern to urban planners. These green spaces act as not only the lungs of a city, but also provide much needed psychological support. The mental peace and relaxation provided by such areas needs to be valued, although it is difficult to put a price tag on these values. Nevertheless, these centers of peace and tranquility give urban dwellers an opportunity to balance their highly man-modified environments with the splash of green of a garden space.

Environmental values must also stress on the importance of preserving ancient structures. The characteristic architecture, sculpture, artworks and crafts of ancient cultures is an invaluable environmental asset. It tells us where we have come from, where we are now, and perhaps where we should go. Architectural heritage goes beyond preserving old buildings, to conserving whole traditional landscapes in rural areas and streetscapes in urban settings. Unless we learn to value these landscapes, they will disappear and our heritage will be lost. As environmentally conscious individuals we need to

develop a sense of values that are linked with a better and more sustainable way of life for all people. There are several positive as well as negative aspects of behavior that are linked to our environment. The positive feelings that support environment include a value for Nature, cultures, heritage, and equity. We also need to become more sensitive to aspects that have negative impacts on the environment. These include our attitude towards degradation of the environment, loss of species, pollution, poverty, corruption in environmental management, the rights of future generations and animal rights. Several great philosophers have thoughts that have been based on, or embedded, in pro environmental behavior. Mahatma Gandhi and Rabindranath Tagore are among the many internationally well-known scholars whose thought have included values that are related to environmental consciousness. We need to appreciate these values to bring about a better way of life on earth for all people and all living creatures.

7.5.2 Valuing Nature:

The most fundamental environmental sentiment is to value Nature herself. Appreciating Her magnificence and treasuring life itself leads to positive feelings that are a manifestation of pro environmental consciousness. The one-ness of our lives with the rest of nature and a feeling that we are only a miniscule part of nature's complex web of life becomes apparent, when we begin to appreciate the wonders of nature's diversity. We must appreciate that we belong to a global community that includes another 1.8 million known living forms. Nothing makes us more conscious of this wonderous aspect of our earth's diversity than a walk through the wilderness, feeling and exploring its beauty and experiencing its infinite variety. The tiny creatures that live complex lives and the towering trees are all a part of this phenomenon we call 'life'. Today, man does not even know if other complex forms of life exist outside our own solar system in distant space. We may be alone in space or may be accompanied by other, completely different, living forms. But for now we only know for sure that the Earth's life forms are unique. We thus have a great responsibility to protect life in all its glorious forms and must therefore respect the wilderness with all its living creatures, where man's own hand has not created changes that have led to perturbing natural habitats. We need to develop a sense of values that lead us to protect what is left of the wilderness by creating effective National Parks and Wildlife Sanctuaries. However this cannot be done to the detriment of the millions of tribal or indigenous people who live in wilderness ecosystems. There are thus conflicting values that need to be balanced carefully. On the one hand we need to protect natural ecosystems, while on the other, we must protect the rights of local people.

Yet apart from valuing the diversity of life itself, we must also learn to value and respect diverse human cultures. Many of the tribal cultures of our country are vanishing because those with more dominant and economically advanced ways of life do not respect their lifestyles, that are in fact closer to nature and frequently more sustainable. We believe that our modern technology- based lifestyles are the sole way for society to progress. Yet this is only a single dimension of life that is based on economic growth.

While currently the environmental movement focuses on issues that are concerned with the management of the natural environment for the 'benefit' of man, Deep Ecology promotes an approach that is expected to bring about a more appropriate ecological balance on Earth and is akin to a spiritual approach to Nature. This has great long-term implications not only for humans but for the whole of Nature.

For example some environmentalists emphasise the need to preserve wilderness for its aesthetic and utilitarian functions. Wilderness is being preserved today in PAs because it is scenic and serves the purpose of tourism for nature lovers, and has recreational and economic value. Other environmentalists stress that the goal is for protecting the useful ecological functions of the wilderness, its services and goods that we use.

Deep Ecologists on the other hand stress that wilderness preservation is a means to achieve the conservation and protection of biological diversity. Thus it is not enough to protect bits of what is left of

the wilderness but to make attempts to restore degraded areas to their former natural ecological state. In a country such as India, with its enormous population coupled with poverty on the one hand and the need for economic industrial growth on the other, this will be extremely difficult to achieve. Another new approach is that of 'Gaia', the hypothesis that the Earth is itself like one giant form of throbbing life consisting of all the unquantifiable numbers of individuals of its millions of known and unknown species.

Valuing cultures

Every culture has a right to exist. Tribal people are frequently most closely linked with Nature and we have no right to foist on them our own modern way of life. The dilemma is how to provide them with modern health care and education that gives them an opportunity to achieve a better economic status without disrupting their culture and way of life. This will happen only if we value their culture and respect their way of life.

Social justice

As the divide widens between those people who have access to resources and wealth, and those who live near or below the poverty line, it is the duty of those who are better off to protect the rights of the poor who do not have the means to fight for their rights. If this is not respected the poor will eventually rebel, anarchy and terrorism will spread and the people who are impoverished will eventually form a desperate seething revolution to better their own lot. The developing world would face a crisis earlier than the developed countries unless the rights of poor people that are fundamental to life are protected.

Modern civilization is a homogenous culture, based until recently on a belief that modern science holds the answer to everything. We are now beginning to appreciate that many ancient and even present day sequestrated cultures have a wisdom and knowledge of their own environments that is based on a deep sense of respect for nature. Tribal cultures have over many generations used indigenous medicines which are proving to be effective against diseases. They have produced unique art forms such as painting, sculpture, and crafts that are beautiful and can enrich living experiences for everyone. They have their own poetry, songs, dance and drama -all art forms that are unfortunately being rapidly lost as we introduce a different set of modern values to them through television and other mass media. The world will be culturally impoverished if we allow these indigenous people to loose their traditional knowledge which includes sustainable use of water, land and resources with a low impact on biodiversity. They will soon lose the beauty within their homes that is based on the things they make from Nature. The art of the potter will be lost forever to the indestructible plastic pot. The bamboo basket weaver who makes a thing of beauty that is so user friendly and aesthetically appealing, will give place to yet another plastic box. Much that is beautiful and hand-crafted will disappear if we do not value these diverse aspects of human cultures.

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.

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 addressed 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 controled 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 landuse patterns changed, these mechanisms were lost and unsustainable practices evolved, frequently as a result of an inadequately planned development strategy.

Equity – Disparity in the Northern and Southern countries

Environmental ethics are concerned with, whoowns 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.

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.

The need for Gender Equity

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

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

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.

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 college 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 atschool and college level are being reoriented to bring this about. 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 inabject 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'.

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 godess. 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 ones 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 on 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.

Text Books:

1. Verma, Sneh Lata Environmental Problems: Awareness and Attitude; 2007; Academic, Excellence Publishers & Distributors; Delhi

References:

1. Saxena, Karunesh and Nityesh Bhatt (ed.) Environment Management Practices: An Indian
Outlook; 2007; Himanshu Publications, Delhi
2. Rosencranz, Armin and Shyam Divan Environmental Law and Policy in India:Cases, Materials
and Statutes 2001; Oxford University Press, new Delhi
3. Uberoi, N.K. Environmental Management; 2004; Excel Books, Delhi

4. Kumar, Mukul, Mitra Prasenjit Sarkar et al (eds.) Environmental Change and its Impact ; 2006;
Classique Books, Kolkata
5. Chatterjee, Sanjoy Encyclopaedia of Ecology; 2006; Anmol Publications, New Delhi
6. Bhatt, S. International Environmental Law; 2007; A.P.H Publishing Corporation, New Delhi