

LECTURE NOTE

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MECHANICAL ENGINEERING DEPARTMENT

DESIGNATION: GUEST FACULTY

SUBJECT: ENVIRONMENTAL STUDIES

SEMESTER: 3RD

1.1 DEFINITION, SCOPE AND IMPORTANCE

1.1.1 Definition

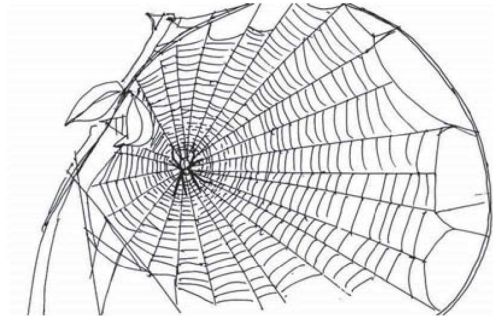
Environmental studies deal with every issue that affects an organism. It is essentially a multidisciplinary approach that brings about an appreciation of our natural world and human impacts on its integrity. It is an applied science as it seeks practical answers to making human civilization sustainable on the earth's finite resources.

Its components include biology, geology, chemistry, physics, engineering, sociology, health, anthropology, economics, statistics, computers and philosophy.

1.1.2 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.

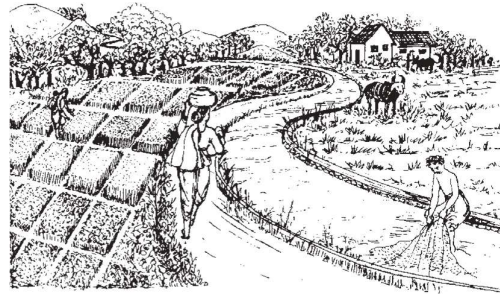
Such multiple effects on the environment resulting from routine human activities must be appreciated by each one of us, if it is to provide us with the resources we need in the long-term.

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**.

Activity 1:

Take any article that you use in daily life – a bucket full of water, or an item of food, a table, or a book. Trace its components journey backwards from your home to their origins as natural resources in our environment. How many of these components are renewable resources and how many non-renewable?

Understanding and making ourselves more aware of our environmental assets and problems is not enough. We, each one of us, must become increasingly concerned about our envi-

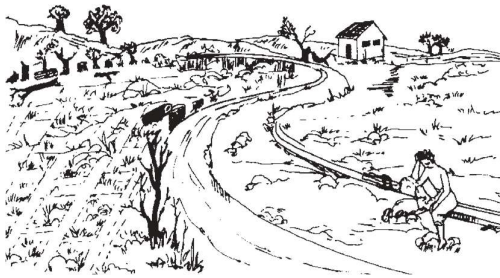


ronment and change the way in which we use every resource. Unsustainable utilization can result from overuse of resources, because of population increase, and because many of us are using more resources than we really need. Most of us indulge in wasteful behaviour patterns without ever thinking about their environmental impacts. Thus, for all our actions to be environmentally positive we need to look from a new perspective at how we use resources. For every resource we use we must ask ourselves the following questions:

- What is the rarity of the resource and where does it originate?
- Who uses it most intensively and how?
- How is it being overused or misused?
- Who is responsible for its improper use – the resource collector, the middleman, the end user?
- How can we help to conserve it and prevent its unsustainable use?

Activity 2:

Try to answer the questions above for one of the components in the article you chose in Activity 1. Then answer the following questions:



- **Are you using that resource unsustainably?**
- **In what ways could you reduce, reuse and recycle that resource?**
- **Is there an unequal distribution of this resource so that you are more fortunate than many others who have less access to it?**

Once we begin to ask these questions of ourselves, we will begin to live lifestyles that are more sustainable and will support our environment.

1.1.3 Importance

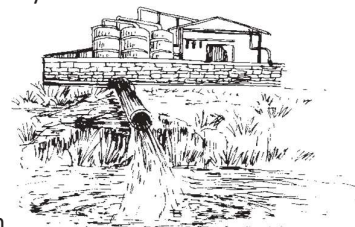
Environment is not a single subject. It is an integration of several subjects that include both Science and Social Studies. To understand all the different aspects of our environment we need to understand biology, chemistry, physics, geography, resource management, economics and population issues. Thus 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 gastrointestinal 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.

Activity 3:

- **Think of all the things that you do in a day. List these activities and identify the main resources used during these activities. What can you do to prevent waste, reuse articles that you normally throw away, what recycled materials can you use?**
- **Think of the various energy sources you use everyday. How could you reduce their use?**

Activity 4: Exercises in self learning about the environment

Attempt to assess the level of damage to the environment due to your actions that have occurred during your last working day, the last week, the last year. Then estimate the damage you are likely to do in your lifetime if you continue in your present ways.

Use the following examples for the above exercise:

Example – Plastic: Plastic bags, plastic ball pens

Think about all the articles you use daily that are made from plastic. Plastic plays an important part in our modern lives.

Make a list of the plastic articles you usually use.

How can you reduce the amount of plastic you use?

What effects does plastic have on our environment?

Where did the plastic come from/ how is it

made? 6

What happens to it when you throw it away/ where does it go?

Example – Fossil fuels:

How much do you use? Can you reduce your consumption?

What effect does it have on the air we breathe?

When we leave a motorbike or car running during a traffic stop, we do not usually remember that the fuel we are wasting is a part of a nonrenewable resource that the earth cannot reform. Once all the fossil fuels are burnt off, it will mean the end of oil as a source of energy. Only if each of us contributes our part in conserving fossil based energy can we make it last longer on earth.

Example – Water:

How much do you really need to use, as against how much you waste when you:

(a) Brush your teeth? (b) Have a bath? (c) Wash clothes? (d) Wash the scooter or car?

Where did the water come from? What is its actual source? How has it reached you?

Where will the waste water go?

Do you feel you should change the way you use water? How can you change this so that it is more sustainable?

Example – Food:

Where has it come from? How is it grown? What chemicals are used in its production? How does it reach you?

How is it cooked?

How much is wasted? How is the waste disposed off?

Example – Paper:

What is it made from?

Where does it come from and what happens during manufacture?

How much do you use and how much do you waste? How can you prevent it from being wasted?

Example – Electrical Energy:

How much do you use everyday? Where does it come from?

How do you waste it? How can you conserve energy?

Productive value of nature: As scientists make new advances in fields such as biotechnology we begin to understand that the world's species contain an incredible and uncountable number of complex chemicals. These are the raw materials that are used for developing new medicines and industrial products and are a storehouse from which to develop thousands of new products in the future. The flowering plants and insects that form the most speciesrich groups of living organisms are thus vital for the future development of man. If we degrade their habitat these species will become extinct. If one sees being sold or used, a product that comes from an illegally killed wild species, if we do not inform the authorities, we become party to its extinction. Once they are lost, man cannot bring them back. When we permit the destruction of a forest, wetland or other natural area and do not protest about it, future generations are being denied the use of these valuable resources and

will blame us for these rash and negligent actions towards the environment.

Thus the urgent need to protect all living species is a concept that we need to understand and act upon. While individually, we perhaps cannot directly prevent the extinction of a species, creating a strong public opinion to protect the National Parks and Wildlife Sanctuaries in which wild species live is an importance aspect of sustainable living. There is a close link between agriculture and the forest, which illustrates its productive value. For crops to be successful, the flowers of fruit trees and vegetables must be pollinated by insects, bats and birds. Their life cycles however frequently require intact forests.

Aesthetic/Recreational value of nature: The aesthetic and recreational values that nature possesses enlivens our existence on earth. This is created by developing National Parks and Wildlife Sanctuaries in relatively undisturbed areas. A true wilderness experience has not only recreational value but is an incredible learning experience. It brings about an understanding of the oneness of nature and the fact that we are entirely dependent upon the intricate functioning of ecosystems.

The beauty of nature encompasses every aspect of the living and non-living part of our earth. One can appreciate the magnificence of a mountain, the power of the sea, the beauty of a forest, and the vast expanse of the desert. It is these natural vistas and their incredible diversity of plant and animal life that has led to the development of several philosophies of life. It has also inspired artists to develop visual arts and writers and poets to create their works that vitalize our lives.

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A wilderness experience has exceptional recreational value. This has been described as nature tourism, or wildlife tourism, and is also one aspect of adventure tourism. These

recreational facilities not only provide a pleasurable experience but are intended to create a deep respect and love for nature. They are also key tools in educating people about the fragility of the environment and the need for sustainable lifestyles.

In an urban setting, green spaces and gardens are vital to the psychological and physical health of city dwellers. It provides not only an aesthetic and visual appeal but the ability to ensure that each individual is able to access a certain amount of peace and tranquility. Thus urban environmental planners must ensure that these facilities are created in growing urban complexes. Another important conservation education facility in urban settings includes the need to set up well designed and properly managed zoological parks and aquariums. These have got great value in sensitizing school students to wildlife. Many young people who frequented zoos as young children grow up to love wildlife and become conservationists.

In the absence of access to a Protected Area, a botanical garden or a zoo, one concept that can be developed is to create small nature awareness areas with interpretation facilities at district and taluka levels. These areas can be developed to mimic natural ecosystems even though they



could be relatively small in size. Such nature trails are invaluable assets for creating conservation education and awareness. They can

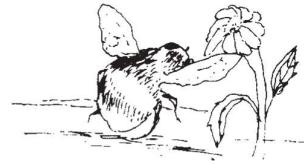
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be developed in a small woodlot, a patch of grassland, a pond ecosystem, or be situated

along an undisturbed river or coastal area. This would bring home to the visitor the importance of protecting our dwindling wilderness areas.

The option values of nature: While we utilise several goods and services of nature and enjoy its benefits, we

must recognize that every activity that we do in our daily lives has an adverse impact on nature's integrity. Thus if we use up all our resources, kill off and let species of plants and animals become extinct on earth, pollute our air and water, degrade land, and create enormous quantities of waste, we as a generation will leave nothing for future generations. Our present generation has developed its economies and lifestyles on unsustainable patterns of life. However, nature provides us with various options on how we utilize its goods and services. This is its option value. We can use up goods and services greedily and destroy its integrity and long term values, or we can use its resources sustainably and reduce our impacts on the environment. The option value allows us to use its resources sustainably and preserve its goods and services for the future.



1.2 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.

1.2.1 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 organisations 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

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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 Sci-

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ence 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

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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 organising 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-visuials 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 organisation 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.

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Zoological Survey of India (ZSI): The ZSI was established in 1916. 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.

1.2.2 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's forests. In the 1890s he formed the Sierra club, which is a major conservation NGO in the USA. **Aldo Leopald** was a forest official

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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 wellknown 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 wellknown 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 wellknown ecologist in India. His interests range from broad ecological issues such as developing Community Biodiversity Registers and conserving sacred groves to studies on the behaviour 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 wellknown 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.

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UNIT 2:

2.1 INTRODUCTION

2.2 RENEWABLE AND NON-RENEWABLE RESOURCES

2.2.1 Natural resources and associated problems

2.2.2 Non-renewable resources

2.2.3 Renewable resources

- a. **Forest Resources:** Use and over-exploitation, deforestation, case studies.
Timber extraction, mining, dams and their effects on forests and tribal people
- b. **Water Resources:** Use and over-utilisation of surface and ground water, floods, drought, conflicts over water, dams – benefits and problems.
- c. **Mineral Resources:** Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
- d. **Food Resources:** World food problems, Changes in landuse by agriculture and grazing, Effects of modern agriculture, Fertilizer/ pesticide problems, Water logging and salinity
- e. **Energy Resources:** Increasing energy needs, Renewable/ non renewable, Use of Alternate energy sources, Case studies
- f. **Land resources:** Land as a resource, land degradation, man-induced land-slides, soil erosion and desertification.

2.3 ROLE OF AN INDIVIDUAL IN CONSERVATION OF NATURAL RESOURCES

2.4 EQUITABLE USE OF RESOURCES FOR SUSTAINABLE LIFESTYLES

Natural Resources

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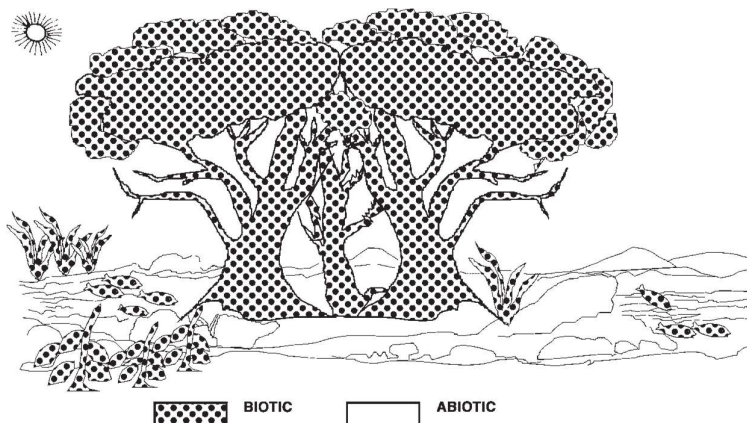
2.1 INTRODUCTION

Our environment provides us with a variety of goods and services necessary for our day to day lives. These **natural resources** include, air, water, soil, minerals, along with the climate and solar energy, which form the non-living or '**abiotic**' part of nature. The '**biotic**' or living parts of nature consists of plants and animals, including microbes. Plants and animals can only survive as communities of different organisms, all closely linked to each in their own **habitat**, and requiring specific abiotic conditions. Thus, forests, grasslands, deserts, mountains, rivers, lakes and

the marine environment all form habitats for specialised communities of plants and animals to live in. Interactions between the abiotic aspects of nature and specific living organisms together form **ecosystems** of various types. Many of these living organisms are used as our food resources. Others are linked to our food less directly, such as pollinators and dispersers of plants, soil animals like worms, which recycle nutrients for plant growth, and fungi and termites that break up dead plant material so that micro-organisms can act on the detritus to reform soil nutrients.

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History of our global environment: About ten thousand years ago, when mankind changed from a hunter-gatherer, living in wilderness areas such as forests and grasslands, into an agriculturalist and pastoralist, we began to change the environment to suit our own requirements. As our ability to grow food and use domestic animals grew, these 'natural' ecosystems were developed into agricultural land. Most traditional agriculturists depended extensively on rain, streams and rivers for water. Later they began to use wells to tap underground water sources and to impound water and created irrigated land by building dams. Recently we began to use fertilizers and pesticides to further boost the production of food from the same amount of land. However we now realize that all this has led to several undesirable changes in our environment. Mankind has been overusing and depleting natural resources. The over-intensive use of land has been found to exhaust the capability of the ecosystem to support the growing demands of more and more people, all requiring more intensive use of resources. Industrial growth, urbanisation, population growth and the enormous increase in the use of consumer goods, have all put further stresses on the environment. They create great quantities of solid waste. Pollution of air, water and soil have



begun to seriously affect human health.

Changes in land and resource use:

During the last 100 years, a better health care delivery system and an improved nutritional status has led to rapid population growth, especially in the developing countries. This phenomenal rise in human numbers has, in the recent past, placed great demands on the earth's natural resources. Large stretches of land such as forests, grasslands and wetlands have been converted into intensive agriculture. Land has been taken for industry and the urban sectors. These changes have brought about dramatic alterations in land-use patterns and rapid disappearance of valuable natural ecosystems. The need for more water, more food, more energy, more consumer goods, is not only the result of a greater population, but also the result of over-utilization of resources by people from the more affluent societies, and the affluent sections of our own.

Industrial development is aimed at meeting growing demands for all consumer items. However, these consumer goods also generate waste in ever larger quantities. The growth of industrial complexes has led to a shift of people from their traditional, sustainable, rural way of life to urban centers that developed around industry. During the last few decades, several small urban centers have become large cities, some have even become giant mega-cities. This has increased the disparity between what the surrounding land can produce and what the large number of increasingly consumer-oriented people in these areas of high population density consume. Urban centers cannot exist without resources such as water from rivers and lakes, food from agricultural areas, domestic animals from

pasture lands and timber, fuel wood, construction material and other resources from forests. Rural agricultural systems are dependent on forests, wetlands, grasslands, rivers and lakes. The result is a movement of natural resources from the wilderness ecosystems and agricultural sector to the urban user. The magnitude of the shift of resources has been increasing in parallel with the growth of industry and urbanisation, and has changed natural landscapes all over the world. In many cases, this has led to the rapid development of the urban economy, but to a far slower economic development for rural people and serious impoverishment of the lives of wilderness dwellers. The result is a serious inequality in the distribution of resources among human beings, which is both unfair and unsustainable.

Earth's Resources and Man: The resources on which mankind is dependent are provided by various sources or 'spheres'.

1) Atmosphere

- Oxygen for human respiration (metabolic requirements).
- Oxygen for wild fauna in natural ecosystems and domestic animals used by man as food.
- Oxygen as a part of carbon dioxide, used for the growth of plants (in turn are used by man).

The atmosphere forms a protective shell over the earth. The lowest layer, the troposphere, the only part warm enough for us to survive in, is only 12 kilometers thick. The stratosphere is 50 kilometers thick and contains a layer of sulphates which is important for the formation of rain. It also contains a layer of ozone, which absorbs ultra-violet light known to cause cancer and without which, no life could exist on earth. The atmosphere is not uniformly warmed by the sun. This leads to air flows and variations in climate, temperature and rainfall in different parts of the earth. It is a complex dynamic system. If its

nature is disrupted it affects all mankind. Most air pollutants have both global and regional effects.

Living creatures cannot survive without air even for a span of a few minutes. To continue to support life, air must be kept clean. Major pollutants of air are created by industrial units that release various gases such as carbon dioxide, carbon monoxide and toxic fumes into the air. Air is also polluted by burning fossil fuels. The buildup of carbon dioxide which is known as 'greenhouse effect' in the atmosphere is leading to current global warming. The growing number of scooters, motorcycles, cars, buses and trucks which run on fossil fuel (petrol and diesel) is a major cause of air pollution in cities and along highways.

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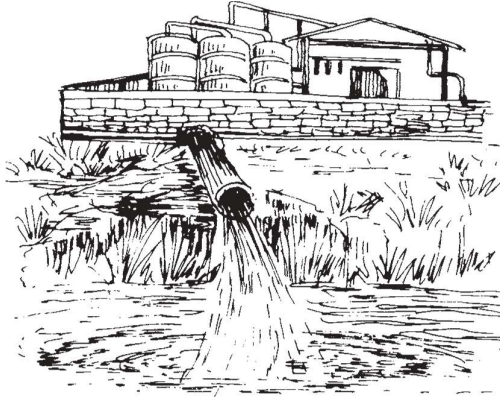
Air pollution leads to acute and chronic respiratory diseases such as various lung infections, asthma and even cancer.

2) Hydrosphere

- Clean water for drinking (a metabolic requirement for living processes).
- Water for washing and cooking.
- Water used in agriculture and industry.
- Food resources from the sea, including fish, crustacea, sea weed, etc.
- Food from fresh water sources, including fish, crustacea and aquatic plants.
- Water flowing down from mountain ranges harnessed to generate electricity in hydroelectric projects.

The hydrosphere covers three quarters of the earth's surface. A major part of the hydrosphere is the marine ecosystem in the ocean, while only a small part occurs in fresh water. Fresh water in rivers, lakes and glaciers, is perpetually being renewed by a process of evaporation and rainfall. Some of this fresh water lies in underground

aquifers. Human activities such as deforestation create serious changes in the hydrosphere. Once land is denuded of vegetation, the rain erodes the soil which is washed into the sea.



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Chemicals from industry and sewage find their way into rivers and into the sea. Water pollution thus threatens the health of communities as all our lives depend on the availability of clean water. This once plentiful resource is now becoming rare and expensive due to pollution.

3) Lithosphere

- Soil, the basis for agriculture to provide us with food.
- Stone, sand and gravel, used for construction.
- Micronutrients in soil, essential for plant growth.
- Microscopic flora, small soil fauna and fungi in soil, important living organisms of the lithosphere, which break down plant litter as well as animal wastes to provide nutrients for plants.
- A large number of minerals on which our industries are based.

- Oil, coal and gas, extracted from underground sources. It provides power for vehicles, agricultural machinery, industry, and for our homes.

The lithosphere began as a hot ball of matter which formed the earth about 4.6 billion years ago. About 3.2 billion years ago, the earth cooled down considerably and a very special event took place - life began on our planet. The crust of the earth is 6 or 7 kilometers thick and lies under the continents. Of the 92 elements in the lithosphere only eight are common constituents of crustal rocks. Of these constituents, 47% is oxygen, 28% is silicon, 8% is aluminium, 5% is iron, while sodium, magnesium, potassium and calcium constitute 4% each. Together, these elements form about 200 common mineral compounds. Rocks, when broken down, form soil on which man is dependent for his agriculture. Their minerals are also the raw material used in various industries.

4) Biosphere

- Food, from crops and domestic animals, providing human metabolic requirements.
- Food, for all forms of life which live as interdependent species in a community and form food chains in nature on which man is dependent.
- Energy needs: Biomass fuel wood collected from forests and plantations, along with other forms of organic matter, used as a source of energy.
- Timber and other construction materials.

This is the relatively thin layer on the earth in which life can exist. Within it the air, water, rocks and soil and the living creatures, form structural and functional ecological units, which together can be considered as one giant global living system, that of our Earth itself. Within this framework, those characterised by broadly similar geography and climate, as well as communities of plant and animal life can be

divided for convenience into different biogeographical realms. These occur on different continents. Within these, smaller biogeographical units can be identified on the basis of structural differences and functional aspects into distinctive recognizable ecosystems, which give a distinctive character to a landscape or waterscape. Their easily visible and identifiable characteristics can be described at different scales such as those of a country, a state, a district or even an individual valley, hill range, river or lake.

The simplest of these ecosystems to understand is a pond. It can be used as a model to understand the nature of any other ecosystem and to appreciate the changes over time that are seen in any ecosystem. The structural features of a pond include its size, depth and the quality of its water. The periphery, the shallow part and the deep part of the pond, each provide specific conditions for different plant and animal communities. Functionally, a variety of cycles such as the amount of water within the pond at different times of the year, the quantity of nutrients flowing into the pond from the surrounding terrestrial ecosystem, all affect the 'nature' of the pond.

Natural cycles between the spheres: All four spheres are closely inter-linked systems and are dependent on the integrity of each other. Disturbing one of these spheres in our environment affects all the others.

The linkages between them are mainly in the form of cycles. For instance, the atmosphere, hydrosphere and lithosphere are all connected through the **hydrological cycle**. Water evaporated from the hydrosphere (the seas and freshwater ecosystems), forms clouds in the atmosphere. This becomes rain, which provides moisture for the lithosphere, on which life depends. The rain also acts on rocks as an agent of erosion and over millions of years has created soil, on which plant life grows. Atmospheric movements in the form of wind, break down

rocks into soil. The most sensitive and complex linkages are those between the atmosphere, the hydrosphere and the lithosphere on the one hand, with the millions of living organisms in the biosphere on the other. All living organisms which exist on earth live only in the relatively thin layer of the lithosphere and hydrosphere that is present on the surface of land and in the water. The biosphere which they form has countless associations with different parts of the three other 'spheres'.

It is therefore essential to understand the interrelationships of the separate entities soil, water, air and living organisms, and to appreciate the value of preserving intact ecosystems as a whole.

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Activity 1:

Observe a nearby pond in different seasons and document the seasonal changes in it. One can also observe changes in a river or the seasonal changes in a forest or grassland.

Activity 2:

Take a simple object in daily use and track its components back to each of its spheres.

**Eg: this textbook: paper from wood – biosphere
Water for pulping – hydrosphere
Bleach to whiten paper – a mineral from lithosphere**

2.2 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

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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.

2.2.1 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 longterm 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 land use 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**'.

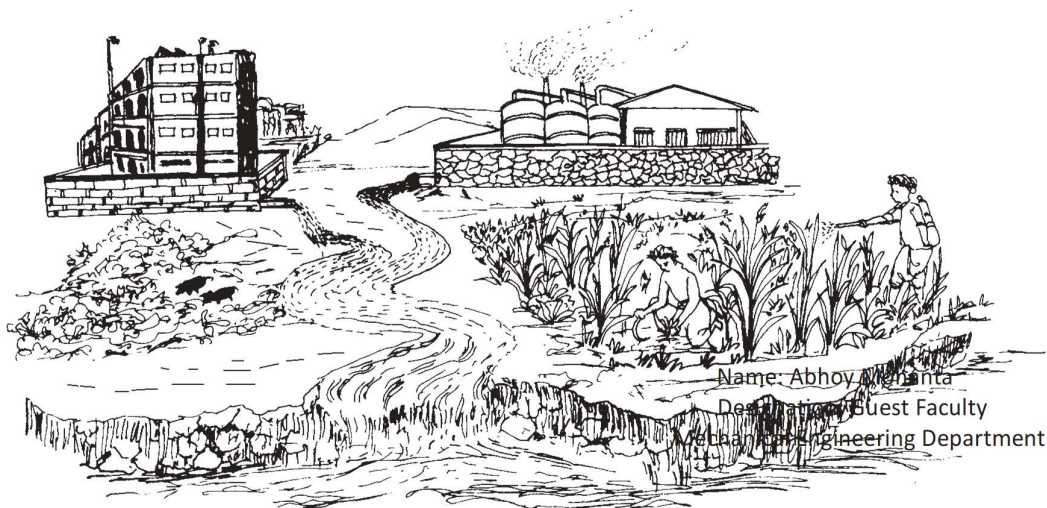
The quality of the ecosystems have indicators that are more difficult to assess.

- 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.

2.2.2 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. 22

2.2.3 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.

The Dodo of Madagascar and the Cheetah in India are well known examples of extinct species. What is however not generally recognized is that thousands of extinctions of small plants and animals are occurring every year due to loss of their habitat. Over harvesting and poaching threaten the existence of many others.

Activity 3: Utilisation of resources

The use of a resource begins with its collection, its processing into a useable product, and transport through a delivery system, to the consumer who uses it. It also involves disposal of the waste products produced at each step. Each step in resource use can affect the environment for better or worse. The control of these steps is known as environmental management.

Think of a resource you use and track it through these steps.

Eg. The cotton in the clothes you are wearing. At each step note:

- **What other resources are needed at this step to move the resource you chose to the next?**
- **What waste products are generated at that step?**
- **How are they likely to be disposed off?**
- **What pollutants are generated in the process?**

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

FOREST FUNCTIONS

Watershed protection:

- Reduce the rate of surface run-off of water.
- Prevent flash floods and soil erosion.
- Produces prolonged gradual run-off and thus prevent effects of drought.

Atmospheric regulation:

- Absorption of solar heat during evapo-transpiration.
- Maintaining carbon dioxide levels for plant growth.
- Maintaining the local climatic conditions.

Erosion control:

- Holding soil (by preventing rain from directly washing soil away).

Land bank:

- Maintenance of soil nutrients and structure.

Local use - Consumption of forest produce by local people who collect it for subsistence – (Consumptive use)

- Food - gathering plants, fishing, hunting from the forest.
(In the past when wildlife was plentiful, people could hunt and kill animals for food. Now that populations of most wildlife species have diminished, continued hunting would lead to extinction.)
- Fodder - for cattle.
- Fuel wood and charcoal for cooking, heating.
- Poles - building homes especially in rural and wilderness areas.
- Timber – household articles and construction.
- Fiber - weaving of baskets, ropes, nets, string, etc.
- Sericulture – for silk.
- Apiculture - bees for honey, forest bees also pollinate crops.
- Medicinal plants - traditionally used medicines, investigating them as potential source for new modern drugs.

Market use - (Productive use)

- Most of the above products used for consumptive purposes are also sold as a source of income for supporting the livelihoods of forest dwelling people.
- Minor forest produce - (non-wood products): Fuelwood, fruit, gum, fiber, etc. which are collected and sold in local markets as a source of income for forest dwellers.
- Major timber extraction - construction, industrial uses, paper pulp, etc. Timber extraction is done in India by the Forest Department, but illegal logging continues in many of the forests of India and the world.

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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

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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 through 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

CASE STUDY

Joint Forest Management

The need to include local communities in Forest Management has become a growing concern. Local people will only support greening an area if they can see some economic benefit from conservation. An informal arrangement between local communities and the Forest Department began in 1972, in Midnapore District of West Bengal. JFM has now evolved into a formal agreement which identifies and respects the local community's rights and benefits that they need from forest resources. Under JFM schemes, Forest Protection Committees from local community members are formed. They

participate in restoring green cover and protect the area from being over exploited.

ranges from 25 per cent in Kerala to 100 per cent 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 be-

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tween 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

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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 Ethiopia, 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.

CASE STUDY

Water pollution - Nepal

The Narayani River of Nepal has been polluted by factories located on its bank. This has endangered fish, dolphins, crocodiles and other flora and fauna of the region.

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 Brahmaputra. 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.

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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

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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.
- 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.

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.

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

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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.

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.

In India, a national assessment of dam projects cleared in the 1980s and 90s shows that in 90% of cases the project authorities have not fulfilled the environmental conditions under which environmental clearance was given by the GOI under the EPA of 1986.

CASE STUDY

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Sardar Sarovar Project

The World Bank's withdrawal from the Sardar Sarovar Project in India in 1993 was a result of the demands of local people threatened with the loss of their livelihoods and homes in the submergence area.

This dam in Gujarat on the Narmada has displaced thousands of tribal folk, whose lives and livelihoods were linked to the river, the forests and their agricultural lands. While they and the fishermen at the estuary, have lost their homeland, rich farmers downstream will get water for agriculture. The question is why should the local tribals be made homeless, displaced and relocated to benefit other people? Why should the less fortunate be made to bear the costs of development for better off farmers? It is a question of social and economic equity as well as the enormous environmental losses, including loss of the biological diversity of the inundated forests in the Narmada valley.

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Activity 4:

How much water is needed by one person? Several international agencies and experts have proposed that 50 liters per person per day covers basic human water requirements for drinking, sanitation, bathing and food preparation. Estimate your average daily consumption.

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.

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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 inad

Sariska Tiger Reserve, Rajasthan

The Forest Department has leased land for mining in the Sariska Tiger Reserve area by denotifying forest areas. The local people have fought against the mining lobby, and have filed a Public Interest Litigation in the Supreme Court in 1991. Rajendra Singh, secretary of TBS, points out that as many as 70 mines operate in close proximity to the forest.

equated ventilation are the greatest hazards. Large explosions have occurred 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

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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

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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.

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This creates a risk to our food security, as farmers can lose 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

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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.

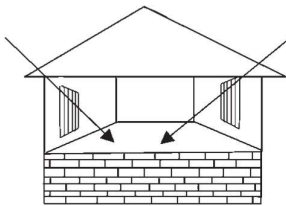
Several foods can be popularized from yet unused seafood products such as seaweed as long as this is done at sustainable levels. Educating women about nutrition, who are more closely involved with feeding the family, is an important aspect of supporting the food needs of many developing countries.

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.

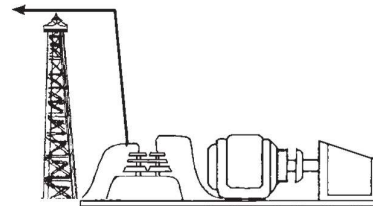
The sun is the primary energy source in our lives. We use it directly for its warmth and through various natural processes that provide us with food, water, fuel and shelter. The sun's rays power the growth of plants, which form our food material, give off oxygen which we breathe in and take up carbon 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 power 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.

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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.

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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.

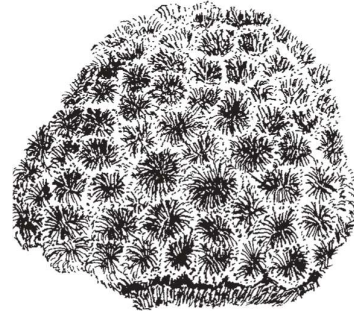
Non-Renewable Energy Sources: These consist of the mineral based hydrocarbon fuels coal, oil and natural gas, that were formed from ancient prehistoric forests. These are called 'fossil fuels' because they are formed after plant life is fossilized. At the present rate of extraction there is enough coal 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

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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-benefits of thermal power.

CASE STUDY

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

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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.

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.

CASE STUDY

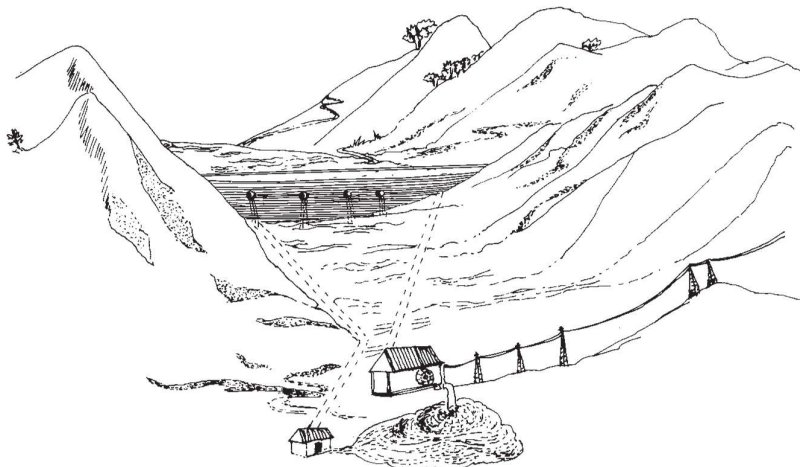
Nearly 50% of the world's population is dependent on fuel wood as a source of energy. This is obvious in our own country, which has lost a large proportion of its forest cover as our population expands and burns enormous amounts of wood. Rural women, and even women from the lower economic strata in towns, still have to spend a large part of their lives collecting fuel wood. To overcome this, various types of fuel-efficient stoves ('chulas') can burn wood extremely slowly and do not waste the heat, and also produce less smoke and ash than normal 'chulas'. There have also been several efforts to grow fuelwood by involving local people in these efforts. Examples include Social Forestry, Farm Forestry and Joint Forestry Management.

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

CASE STUDY

In 1882, the first Hydroelectric power dam was built in Appleton, Wisconsin. In India the first hydroelectric power dams were built in the late 1800s and early 1900s by the Tatas in the Western Ghats of Maharashtra. Jamshedjee Tata, a great visionary who developed industry in India in the 1800s, wished to have a clean source of energy to run cotton and textile mills in Bombay as he found people were getting respiratory infections due to coal driven mills. He thus asked the British Government to permit him to develop dams in the Western Ghats to generate electricity. The four dams are the Andhra, Shirowata, Valvan and Mulshi hydel dams. An important feature of the Tata power projects is that they use the high rainfall in the hills as storage areas. While the rivers flowing eastwards from the Western Ghats are dammed in the foothills near the Deccan plateau, the water is tunneled through the crest of the Ghats to drop several hundred meters to the coastal belt. Large turbines in the power plants generate electricity for Mumbai and its giant industrial belt.



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.

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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.

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.

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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.

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.

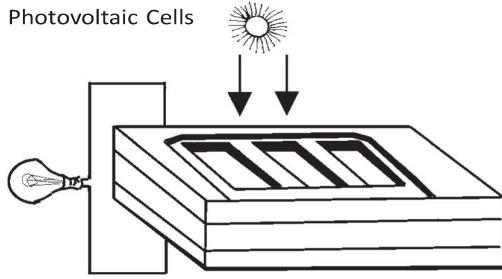
India has the world's largest solar cooker program and an estimated 2 lakh families that use solar cookers. Although solar cookers reduce the need for fuel wood and pollution from smoky wood fires, they have not caught on well in rural areas as they are not suitable to traditional cooking practices. 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.

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Photovoltaic 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.