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ENVIRONMENTAL SCIENCE

BIRM 301 Study Material

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Multidisciplinary nature of Environmental Studies

The word environment is derived from the French verb ‘environner’ which means to ‘encircle or surround’. Thus our environment can be defined as the physical, chemical and biological world that surround us as well as the complex of social and cultural conditions affecting an individual or community. This broad definition includes the natural world and the technological environment as well as the cultural and social contexts that shape human lives. It includes all factors living and nonliving that affect an individual organism or population at any point in the life cycle; set of circumstances surrounding a particular occurrence and all the things that surrounds us.

Objective of this course is to develop concern for our own environment which will lead us to act at our own level to protect the environment we all live in. There are three reasons for studying the state of the environment. The first, is the need for information that clarifies modern environmental concepts like equitable use of natural

resources, more sustainable life styles *etc.* Second, there is a need to change the way in which we view our own environment, using practical approach based on observation and self learning. Third, there is a need to create a concern for our environment that will trigger pro-environmental action, including simple activities we can do in our daily life to protect it.

Environmental science is essentially the application of scientific methods and principles to the study of environmental issues, so it has probably been around in some forms as long as science itself. Environmental science is often confused with other fields of related interest, especially ecology, environmental studies, environmental education and environmental engineering. Environmental science is not constrained with any one discipline and it is a comprehensive field.

Environmental science is not ecology though that discipline may be included. Ecologists are interested in the interactions between some kind of organisms and its surroundings. Most ecological research and training does not focus on environmental problems except as those problems impact the organism of interest. Environmental scientists may or may not include organisms on their field of view. They mostly focus on the environmental problem which may be purely physical in nature. For *eg*. Acid deposition can be studied as a problem of emissions and characteristic of the atmosphere without necessarily examining its impact on organisms.

There are two types of environments:

1. Natural environment
2. Man made environment

Natural: The environment in its original form without the interference of human beings is known as natural environment. It operates through self regulating mechanism called homeostasis *i.e*, any change in the natural ecosystem brought about by natural processes is counter balanced by changes in other components of environment.

Man made or Anthropogenic Environment: The environment changed or modified by the interference of human beings is called man made environment. Man is the most evolved creature on this earth. He is modifying the environment according to his requirements without bothering for its consequences. Increased technologies and population explosion are deteriorating the environment more and more.

Scope of environmental studies:

Because, the environment is complex and actually made up of many different environments, including natural, constructed and cultural environments, environmental studies is the inter disciplinary examination of how biology, geology, politics policy studies, law, geology, religion engineering, chemistry and economics combine to inform the consideration of humanity's effects on the natural world. This subject educates the students to appreciate the complexity of environmental issues and citizens and experts in many fields. By studying environmental science, students may develop a breadth of the interdisciplinary and methodological knowledge in the environmental fields that enables them to facilitate the definition and solution of environmental problems.

The scope of environmental studies is that, the current trend of environmental degradation can be reversed if people of educated communities are organized and empowered; experts are involved in sustainable development. Environmental factors greatly influence every organism and their activities. The major areas in which the role of environmental scientists are of vital importance are natural resources, ecosystems, biodiversity and its conservation, environmental pollution, social issues and environment human population and environment.

It is essentially a multidisciplinary approach and its components include Biology, Geology, Chemistry, Physics, Engineering, Sociology, Health Sciences, Anthropology, Economics, Statistics and Philosophy It is essentially a multidisciplinary approach. An Understanding of the working of the environment requires the knowledge from wide ranging fields. The table below shows a list of topics dealt commonly in air pollution and the related traditional fields of knowledge illustrating the interdisciplinary nature of the subject.

Table: Interdisciplinary Nature of Environmental Science Ex:Air Pollution

Environmental issue/topics	Major subject/Topic knowledge required
Nature and reaction of air pollutants	Chemistry and Chemical engineering
Effects of air pollutants on human beings, animals and plants	Zoology and botany and various branches of life science. Physics and Chemistry
Effect of air pollutants on materials	Meteorology, Thermodynamics, Geography
Effect of climate on air pollution	Mathematical modeling, *etc.*
Air pollution control devices	Physics, chemistry and various branches of Engineering
History of air pollution and air pollution episodes	History
Economic impacts of air pollution	Economics, Demography
Sociological impacts of air pollution	Sociology
Alternative fuels	Various branches of physical sciences
Conservation of resources and pollution control	Various branches of physical and political sciences
Ozone hole and global warming	Almost all fields under the sun has got something to contribute to the understanding and prevention of these phenomenon.

Importance of environmental education:

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, resources management, economics, and population issues. Thus, the scope of environmental studies extremely wide and covers some aspects of nearly every major discipline.

We live in a world where natural resources are limited. Water, air, soil, minerals, oils, the products we get from forests, grasslands, oceans and from agriculture and live stock, are all a part of our life support systems. Without them, life itself would be

impossible. If we use them more and more, the earth's resources must inevitably shrink. The earth cannot be expected to sustain indefinitely due to over utilization of resources, misuse of resources. We waste or pollute large amount of clean water. We discard plastic, solid wastes and liquid wastes from industries which cannot be managed by natural processes. These accumulate in our environment, leading to a variety of diseases and other adverse environmental impacts, now seriously affecting all our lives. Air pollution leads to respiratory diseases, water pollution to gastro – intestinal diseases and many pollutants are known to cause cancer.

This situation will only improve if each of us begins to take action in our daily lives that will help to preserve our environmental resources. We cannot expect Government alone to manage the safeguarding of the environment, nor we can 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 one's own.

Environmental Issues of Global Concern

The main environmental issues today are wide ranging and all-encompassing are deforestation, biodiversity, soil erosion, climate change, pesticide build-up, industrial and municipal pollution. All these problems can be categorized into three main issues:

1. Population explosion
2. Land degradation
3. Environmental pollution: Industrialization, agriculture/fertilizer/pesticide/green house gases, air pollution, acid rain, ozone depletion, green house effect, water pollution and deforestation.

Environmental problems in India can be put into three classes: Poverty, problems arising as negative effects of the very process of development and problems arising from improper implementation of the directives and laws of environmental protection

Values of Nature: This can be discussed under three categories *i.e.* i) Productive value, ii) Aesthetic value or recreational value and iii) Option value

Productive value of nature: Worlds' species contain an incredible and unaccountable number of complex chemicals. These are raw materials used for developing new medicines and industrial products. When we permit the destruction of a forest, wet land or other natural area and do not protest about it, future generations are being denied the use of these valuable resources. Thus the urgent need to protect all living species is a concept that we need to understand and act upon. There is 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 and birds. Their life cycle frequently require intact forests.

Aesthetic/ recreational value of nature: Nature encompasses every aspect of living (biodiversity: flora and fauna) and non-living (sea, desert) part of the earth and it enlivens our existence on earth. This is created by developing national parks and wildlife sanctuaries in relatively undisturbed areas. In an Urban setting, there will be green spaces and gardens – psychological and physical health of city dwellers and provides aesthetic

value and visual appeal. It also gives access to certain amount of peace. Nature tourism or wildlife tourism or eco tourism is a pleasurable experience and also creates a deep respect and love for nature.

The option value of nature:

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 impact on environment. The option value allows us to use its resources sustainable and preserve its goods and services for the future. "The earth provides enough to satisfiy every persons need but not every persons greed" is the vision of Mahatma Gandhiji.

Need for public awareness:

As the earth's natural resources are rapidly dwindling and our environment is being increasingly degraded by human activities, it is evident that some thing needs to be done.

The following measures may help for the environmental awareness.

1. Join a group to study nature, such as WWF-1 or BNHS or another environmental group
2. Begin reading news paper articles and periodicals like Down to Earth, WWF-1 News letter, BNHS, Hornbill, Sanctuary magazine etc which will tell you more about our current environmental issues. There are also several environmental websites.
3. 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 plastic, practicing the 3Rs principle of reduce, reuse, recycle and proper waste disposal.
4. Join local movements that support activities like saving trees in your area, go on nature treks, recycle waste, buy environmentally friendly products.
5. Practice and promote good civic sense and hygiene such as enforcing no spitting or tobacco chewing, no throwing garbage on the road, no smoking in public places, no urinating or defecating in public places.
6. Take part in events organized on World Environment Day, Wildlife Week etc.
7. Visit a National Park or Sanctuary or spend time in whatever natural habitat you have near your home.

Institutions in environment

Managing natural resources require efficient institutions at all levels i.e. local, national, regional and global. Institutions, as defined by Young (1999), are systems of rules, decision-making procedures, and programs that give rise to social practices, assign roles to participants in these practices, and guide interactions among theoccupants of the relevant roles. Institutions often figure prominently in efforts to solve or manage environmental problems. Several Government and Non- Government Organizations (NGO'S) are working towards environmental protection in our country. They play a role both in causing and in addressing problems arising from human-environment interactions. They

have led to a growing interest in environmental protection and conservation of nature and natural resources. Among the large number of institutions that deal with environmental protection and conservation, a few well-known organization include government organizations like the BSI and ZSI, and NGOs like the BNHS, WWF-1, *etc.*

The Bombay Natural History Society (BNHS), Mumbai: It was founded on 15 September 1883, is one of the largest non-governmental organizations in India engaged in conservation and biodiversity research. It supports many research efforts through grants, and publishes a popular magazine called the Hornbill and also an internationally well-known the Journal of the Bombay Natural History Society. Its other publications include salim Ali's Handbook on Birds, JC Daniel Book of Indian reptiles. SH Prater's book of Indian mammals and PV Bole's book of Indian trees. Many prominent naturalists, including the ornithologists Sálim Ali and S. Dillon Ripley have been associated with it. The BNHS has over the years helped the government to frame wildlife-related laws and has taken up battles such as the 'save the silent valley' campaign.

World Wide fund for nature - India (WWF-1), New Delhi: The WWF-1 was initiated in 1969 in Mumbai, after which the headquaters were shifted to Delhi with several State, Divisional and Project offices spread across India. In the early years it 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 environmental and development issues.

Centre or science and environment (CSE), New Delhi: is a public interest research and advocacy organisation based in New Delhi. CSE researches into, lobbies for and communicates the urgency of development that is both sustainable and equitable. It has 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. It also publishes a popular magazine, Down to Earth which is a science and environment fortnightly. It is involved in the publication of material in the form of books posters, video films and also conducts workshops and seminars on biodiversity- related issues. The Centre's efforts are built around five broad programmes: Communication for Awareness, Research and Advocacy, Education and Training, Knowledge Portal and Pollution Monitoring.

C.P.R Environmental Education Centre, Madras: the CPR-EEC was set up in 1988 CPREEC) is a Centre of Excellence of the Ministry of Environment and Forests (MoEF), Government of India, established jointly by the Ministry and the C.P. Ramaswami Aiyar Foundation. It conducts a variety of programs to increase awareness and knowledge of public i.e., school children, local communities, woman as main key target groups about the various aspects of environment Its programs include components on wildlife and biodiversity issues. CPR-EEC also publishes large number of text books for school children and video-on wheels for rural public. The C. P. R. Environmental Education Centre received the Indira Gandhi *Paryavaran Puraskar* for the year 1996.

The **Centre for Environment Education** (CEE) in India was established in August 1984 as a Centre of Excellence supported by the Ministry of Environment and Forests. The organisation works towards developing programmes and materials to increase awareness about the environment and sustainable development. The head office is located in Ahmedabad. The Centre has 41 offices including regionalcells and several field offices, across India.. It has international offices in Australia, Bangladesh and Sri Lanka. CEE's primary objective is to improve public awareness and understanding of the environment with a view to promoting the conservation and sustainable useof nature and natural resources, leading to a better environment and a better quality of life. To this end, It undertakes demonstration projects in education, communication and development that endorse attitudes, strategies and technologies which are environmentally sustainable. CEE is committed to ensuring that due recognition is given to the role of education in the promotion of sustainable development.

Bharati Vidyapeeth University, Institute of Environment Education & Research, Pune was established in 1993.This is part of the Bharati Vidyapeeth deemed University. Its major focus is to spread the message of the need for pro-environmental action in society at large through a dual strategy of formal and non –formal integrated activities. BVIEER is a one of a kind institution that caters to the need of Environment Education at all levels - PhD, M.Sc and Diploma. The distinctive characteristics of BVIEER are its wide mandate of teaching, research and extension. It implements a large outreach program that has covered over 435 schools in which it trains teachers and conduct fortnightly environment education programs. Biodiversity conservation in a major focus of its research initiatives. It develops low-cost interpretation centers 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. It has developed a teachers handbook linked to school curriculum and a textbook for UGC for the compulsory undergraduate course on environment. Its director has developed a CD-ROM on India's biodiversity.

The Salim Ali Center for Ornithology and Natural History (SACON): - It is an autonomous organization with headquarters at Coimbattore. It is a national centre for information, education and research in ornithology and natural history in India. This institution was Dr. Salim ali's dream, which became a reality only after his demise and was named in honor of Salim Ali, the leading pioneer of ornithology in India. Its mission is *"To help conserve India's biodiversity and its sustainable use through research, education and peoples' participation, with birds at the centre stage"*.

Wild life Institute of India (WII), Dehradhun: Is an autonomous institution of MoEF, GOI, established in 1982. It is an internationally acclaimed Institution, which offers training program, academic courses and advisory in wildlife research and management. The Institute is actively engaged in research across the breadth of the country on biodiversity related issues. Its most significant publication has been 'Planning wild life and protected area network for India (Rodgers and Panwar,1988).It has environment

impact assessment cell. It trains personnel in ecodevelopment, wildlife biology, habitat management and nature interpretation.

Zoological survey of India (ZSI): is a premier organisation in zoological research and studies. The activities of the ZSI are coordinated by the Conservation and Survey Division in the MoEF, GOI. This is the only taxonomic organization in the country involved in the study of all kinds of animals from Protozoa to Mammalia, occurring in all possible habitats from deepest depth of the ocean to the peaks of Himalaya, was established on 1st July, 1916 to promote survey, exploration and research leading to the advancement in our knowledge of the various aspects of the exceptionally rich animal life. It has over the years collected type specimens on the basis of which our animal's life has been studied over the years. Its origins were collections based at the Indian museum at Calcutta, which was established in 1875. The older collections of the Asiatic society of Bengal and of the Indian museum were also transferred to the ZSI. Today, it has over a million specimens. This makes it one of the largest collections in Asia. It currently operated from 16 regional centers.

The madras Crocodile Bank Trust (MCBT): MCBT, the first crocodile conservation breeding in Asia, was founded in 1976 to conserve Indian crocodilians and establish program for the conservation and propagation of other species of endangered reptiles Head quarters are at Madras. Over years, over 1500 crocodiles and several hundred eggs have been supplied to various state forest departments for restocking programmes in the wild, and for setting up breeding facilities in other state in India and neighboring countries. It is the one which started the first sea turtle surveys and conservation program in India, including a sea turtle hatchery. It is involved in environmental education programs for the villages and schools that include nature camps, training workshop for teachers and youth from fishing villages.

The Andaman and nicobar islands Environmental team (ANET) a division of the MCBT was constituted in 1992. A base was set up by Harry Andrews in south Andaman for herpetological and other ecological studies in these islands. The Crocodile bank is the site of the *irula* Snake catchers' cooperative society, which is an adivasi self-help project and supplies all of India's snake and scorpion venom needed for the production of anti-venom and for medical use. MCBT personal also initiated the Irula Tribual Women's welfare society, which is primarily a society for reforestation of wastelands and income-generation projects for irula women.

Uttarkhand seva nidhi (USKN), Almora: It is a public charitable trust founded in 1967. This organization was appointed as a nodal agency in 1987 by the Department of Education, Ministry of Human Resources Development, Government of India to undertake locale-specific environmental education programmes both in rural schools and villages in the hill districts of Uttar Pradesh, now Uttaranchal. Subsequently, a research and resource centre, the Uttarakhand Environmental Education Centre (UEEC), was set up in 1993, also with support from the Department of Education. As activities continued to increase, a separate organisation, the Uttarakhand Seva Nidhi Paryavaran Shiksha Sansthan (USNPSS), a registered society, was set up in 1999 to handle all the

environmental activities of the Nidhi. As Uttaranchal is a fragile ecological zone where human activities can cause extensive land degradation (deforestation and soil erosion) if not carried out in an environmentally-sound manner. The organization conducts education, training and on the spot problem solving programmes with the aim of helping people to understand their surroundings from a broad ecological point of view and encourage them to organise themselves to deal with environmental problems that affect their daily lives, and to provide training in technical know-how and practical skills. Its main target is sustainable resource use at the village level through training school children. Its environment education program covers about 500 schools.

Kalpavriksh: This NGO, initially Delhi-based, is now working from pune and is active in several other parts of India. Kalpavriksh worked on a variety of fronts: education and awareness; investigation and research; direct action and lobbying, and litigation with regard to environment and development issues. Its activities include talks and audio-visuals in schools and colleges, nature walks and outstation camp, organizing student participation in ongoing campaigns including street demonstrations, pushing form consumer awareness regarding organic food, press statements, handling green alerts, and meeting with city administrators. Kalpavriksh was among those responsible for developing India's National Biodiversity Strategy and action plan in 2003.

The **Botanical Survey of India (BSI)** is an institution set up by the Government of India in 1887 to survey the plant resources of the Indian empire. The Botanical Survey was formally instituted on 13 February 1890 under the direction of Sir George King, who had been superintendent of Royal Botanic Garden, Calcutta since 1871. King became the first ex-officio Director of BSI. Presently, it has nine regional centres. It carries out surveys of plant resources in different regions. It monitors botanical resources by analyzing their occurrence, distribution, ecology, economic utility, conservation, environment impact, *etc.*

People in environment

There are several internationally known environmental thinkers. Among those who have made landmark contributions include Charles Darwin, Ralph Emerson, Henry Thoreau, John Muir, Aldo Leopold, 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 way of thinking about man's relationship with other species that was based on evolution.

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 had lived in the wilderness for a year. Thoreau had many theories and beliefs, which he poured out in his journals and books. Among these was the concept of human ecology: of the relationship between humans and nature. He saw unity and community as important aspects of nature, and he saw all disturbances in these links as caused by

human beings. “Thank God men cannot fly, and lay waste the sky as well as the earth” is his famous quotation.

John Muir: He was a Scottish-born American naturalist, author, and early advocate of preservation of wilderness in the United States. His letters, essays, and books telling of his adventures in nature, especially in the Sierra Nevada mountains of California, have been read by millions. His activism helped to save the Yosemite Valley, Sequoia National Park and other wilderness areas. He is remembered as having saved the great ancient sequoia trees in California’s forests. In the 1890s he formed the ‘Sierra club’, which is major conservation NGO in the USA.

Aldo Leopold: was a forest official in the US in the 1920s. He designed the early policies on wilderness conservation and wildlife management. He was considered the father of wildlife ecology and a true Wisconsin hero. His book, *‘A Sand County Almanac’* is acclaimed as the century's literary landmark in conservation, which guided many to ‘live in harmony with the land and with one another’.

Rachel Carson : was an American marine biologist and conservationist whose writings are credited with advancing the global environmental movement. She was nature writer, and some of the books like *‘The Sea Around Us’ and ‘The Edge of the Sea’* are to her credit. In the late 1950s, Carson turned her attention to conservation and the environmental problems caused by synthetic pesticides. Then in 1962, she wrote *‘Silent Spring’* , which was met with fierce denial from chemical companies, spurred a reversal in national pesticide policy—leading to a nationwide ban on DDT and other pesticides—and the grassroots environmental movement the book inspired led to the creation of the Environmental Protection Agency. Carson was posthumously awarded the Presidential Medal of Freedom by Jimmy Carter.

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. He emphasised 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 are several individuals who have been instrumental in shaping the environmental history of our country. To name a few with their significant contributions goes as follows:

Salim Ali*:* was an Indian ornithologist and naturalist, Known as the "birdman of India", Salim Ali was among the first Indians to conduct systematic bird surveys across India. He was instrumental in creating the Bharatpur bird sanctuary (Keoladeo National Park) and prevent the destruction of what is now the Silent Valley National Park. He was awarded India's second highest civilian honour, the Padma Vibhushan in 1976. 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.

Smt. Indira Gandhi: as PM played a very significant role in the preservation of India’s wildlife. It was during her period as PM, that the network of protected areas (PAs) grew

from 65 to 298 and the wildlife protection act was formulated. The Indian Board of wildlife was extremely active as she personally chaired all its meetings.

S P Godrej was one of Inida's greatest supports of wildlife conservation and nature awareness programs. Between 1975 and 1999 SP Godrej received 10 awards for his conservation led to his playing a major advocacy role for wildlife in India.

M. S. Swaminathan: He has founded the MS Swaminathan Research Foundation in Chennai, which does work on the conservation of biological diversity.

Madhav Gadgil is a well-known ecologist in India. His interests range from board ecological issues such as developing community Biodiversity Registers and conserving sacred groves to studies on the behavior of mammals, birds and insects. His research interests include population biology, conservation biology, human ecology and ecological history and he has published over 215 research papers and 6 books and and the editor for the series '*lifescapes of peninsular India'*..

M. C. Mehta: Environmental lawyer. Initiated the Government to implement Environmental education in schools and colleges, struggles for protection of Taj Mahal and cleaning of Ganga water.

Anil Agarwal : a journalist who wrote the first report on the state of India's Environment in 1982. He was the founder of CES, an active NGO that supports various environmental issues.

Medha Patkar: known as one of rural India's champions, has supported the cause of the downtrodden tribal people whose environment is being affected by the dams on the Narmada river.

Sunderlal Bahuguna's chipko movement has become an internationally well-known example of a highly successful conservation action program through the efforts of local people for guarding their forest resources. His fight to prevent the construction of the Tehri Dam in a fragile earthquake-prone setting is a battle that he continues to wage. The Garhwal hills will always remember his dedication to the cause for which he has walked over 20 thousand kilometers.


Medha Patkar

sunderlal bahuguna

NATURAL RESOURCES

The main problem associated with natural resources is unequal consumption. A major part of natural resources are consumed in the 'developed' world. The 'developing nations' 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 upto 50 times greater than in most developing countries. Advanced countries produce over 75% of global industrial waste and greenhouse gases. Energy from fossil fuels consumed in relatively much greater quantities in developed countries. Their per capita consumption of food too is much greater as well as their waste. 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.

Our natural resources can be compared with money in 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 utilization or development. 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. These are : Increased longevity, an increase in knowledge and an enhancement of income. These three together are known as the '**human development index**'. It means a source of supply/support *i.e,* generally held in reserve natural means, an ecosystem not influenced by man. It means that reserve stock of supply which living things can take from nature for sustenance of life. The natural reserve stock/ supply which man utilizes for sustenance and welfare.

Natural resources can be defined as 'variety of goods and services provided by nature which are necessary for our day-to-day lives'. Eg: Plants, animals and microbes (living or biotic part), Air, water, soil, minerals, climate and solar energy (non-living or abiotic part). They are essential for the fulfillment of physiological, social, economical and cultural needs at the individual and community levels. They are of two types namely **Renewable and Non-Renewable Resources.**

Renewable resources: Natural resources which can be used but can be regenerated by natural processes provided if there is no intervention in natural regeneration cycle.Ex: water, wood

Non Renewable Resources: Those which will be exhausted in the future if we continue to extract these without a thought for subsequent generations. Example: minerals, fossil fuels.

Different types of resources *viz.*, forest, water, food, energy and land resources are detailed below.

FOREST RESOURCES

A forest can be defined as a biotic community predominant of trees, shrubs or any other woody vegetation usually in a closed canopy. It is derived from latin word *'foris'* means *'outside'*.

India's Forest Cover is 6,76,000 sq.km (20.55% of geographic area). Scientists estimate that India should ideally have 33% of its land under forests. Today we only have about 12% thus we need not only to protect our existing forests but also to increase our forest cover.

Forest Functions :

I. Protective and ameliorative functions.

II. Productive functions

III. Recreational and educational functions

IV. Development functions

I. Protective and ameliorative functions

A. Watershed protection

Reducing the rate of surface run-off of water

Preventing flash floods and soil erosion

Producing prolonged gradual run-off and thus safeguarding against drought.

B. Erosion control

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

C. Land bank

Maintaining soil nutrients and structure.

D. Atmospheric regulation

Absorption of solar heat during evapotranspiration

Maintaining carbon dioxide levels for plant growth

Maintaining the local climatic conditions

II. Productive Functions

Local use – Consumption of forest produce by local people who collect it for sustenance

Food: (comsumptive use) gathering plants, fishing, hunting from the forest.

Fodder for cattle

Fuel wood and charcoal for cooking and heating

Poles for building homes in rural and wilderness areas

Timber for house hold articles and construction

Fiber for weaving baskets, ropes, nets, strings, etc.,

Sericulture for silk

Apiculture for rearing bees for honey (bees as pollinators)

Medicinal plants for traditional medicines, investigating them as potential source for new modern drugs

Market use (productive use) Most of the products used for consumptive purposes and good source of income for supporting their livelihood of forest dwelling people.

Minor forest products (NTFPs): Fuel wood, fruits, gum, fiber, etc which are collected and solid in local markets as a source of income for forest dwellers

Major timber extraction for 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.

III. ***Recreational And Educational Functions***: Eco tourism

IV. ***Developmental Functions***

Employment functions

Revenue

Ecological significance of forests:

1. Balances CO_2 and O_2 levels in atmosphere.
2. Regulates earth temperature and hydrological cycle
3. Encourage seepage and reduces runoff losses, prevents drought
4. Reduces soil erosion (roots binding), prevents siltation and landslides thereby floods
5. Litter helps in maintaining soil fertility
6. Safe habitat for birds, wild animals and organisms against wind, solar radiation and rain

Deforestation:

Deforestation refers to the loss of forest cover; land that is permanently converted from forest to agricultural land, golf courses, cattle pasture, home, lakes or desert. The FAO (Food and Agriculture Organization of the UN) defines tropical deforestation as " change of forest with depletion of tree crown cover more than 90%" depletion of forest tree crown cover less than 90% is considered forest degradation

.**Causes for Deforestation**:

1. Agriculture: Conversion of forests to agricultural land to feed growing numbers of people
2. Commercial logging: (which supplies the world market with woods such as meranti, teak, mahogany and ebony) destroys trees as well as opening up forest for agriculture. Cutting of trees for fire wood and building material, the heavy lopping of foliage for fodder and heavy grazing of saplings by domestic animals like goals.
3. The cash crop economy: Raising cash crops for increased economy.
4. Mining
5. Increase in population: The needs also increase and utilize forests resources.
6. Urbanization & industrialization
7. Mineral exploration
8. Construction of dam reservoirs
9. Infrastructure development
10. Forest fires
11. Human encroachment & exploitation
12. Pollution due to acid rain

Environmental effects /Consequences of deforestation

1. Food problems
2. Ecological imbalance

3. Increasing CO_2
4. Floods leading to soil erosion
5. Destruction of resources
6. Heavy siltation of dams
7. Changes in the microclimate
8. Loss of biodiversity
9. Dessication of previously moist forest soil
10. Heavy rainfall and high sunlight quickly damage the topsoil in clearings of the tropical rainforests. In such circumstance, the forest will take much longer to regenerate and the land will not be suitable for agricultural use for quite some time.
11. Where forests are replanted, their replacement can mean a loss of quality
12. Loss of future markets for ecotourism. The value of a forest is often higher when it is left standing than it could be worth when it is harvested.
13. Some indigenous peoples' way of life and survival are threatened by the loss of forests. Fewer trees results an insecure future for forest workers
14. Deforestation can cause the climate to become extreme in nature. The occurrence and strength of floods and droughts affecting the economy.
15. The stress of environmental change may make some species more susceptible to the effect of insects, pollution, disease and fire
16. Most humid regions changes to desert
17. Environmental pollution
18. Global warming

Conservation Conservation derived from two Latin words, *con* – together,- *servare* – to keep or guard measures, *i.e.* an act of preservation or to keep together **.**

Concepts in conservation

1. Restraining cutting of trees and submerging the forests
2. Reforestation
3. Afforestation
4. Control forest diseases and forest fire
5. Recycling forest products
6. Replacing forest products
7. Avoids diversion of forest lands for other activities through acts like Forest Conservation Act and Wild life (protection) Act
8. Bringing awareness among people ex**:** Chipko movement, Appiko , Narmada Bachao Andolan
9. Implementing people's participatory programmes. Ex: Joint Forestry Manangement (JFM)

Deforestation

Afforestration –Planting of saplings

Department of Environmental Science & Technology,College of Agriculture

Joint Forest Management (JFM)

The need to include local communities in forest managenet has become a growing concern. Local people will only support greening an area if they can see some economic benefits from conservation. An informal arranagement between local communities and the forest department began in 1972, in the Midnapore district of West Bengal. JFM has now evolved into a formal agreement which identifies and respects the local community's right and benefits that they need from forest resources. Under JFM schemes, forest protection communities (FPCs) from local community members are formed. They participate in restoring the green cover and protect the area from being over – exploited.

Realising this, the MoEF formulated the National Forest Policy of 1988 to give added importance to joint forest management (JFM), which co-opts the local village communities and the forest department to work together to sustainable manage our forests. Another resolution in 1990 provided a formal structure for community participation though the formation of village forest communities (VFS). Based on this experience, new JFM guidelines were issued in 2000 which stipulated that at least 25% of the income from the area must go to community. From the initiation of the program. Until 2002, there were 63,618 JFM communities managing over 140,953 sq km of forest under JFM in 27 states in India.

The various states have tried a variety of approaches to JSM. The share of profits for the VFCs ranges from 25% in Kerala to at 100% in Andhra Pradesh, 50% in Gujrat, Maharastra, Orrisa and Tripura. In many states, 25% of the revenue is used for village development. In many states, non-timber forest products (NTFPS) are available to the people free of cost.

Some states have stopped grazing completely. While others have rotational grazing schemes that have helped in forest regeneration. (from Barucha)

Case Study: Chipko Movement ***From Barucha***

About 300 years ago, a ruler in Rajasthan decided to fell the 'khejri' trees in his state to create lime. Local women led by a Bishnoi woman, Amrita Devi, clung to the trees to prevent the felling of the trees that formed the basis of the scarce resources on which they were dependent. The women were ruthlessly massacred. It is said that the ruler later realised his mistake. The story, however, has been remembered and was revived in the 1970s when severe tree-felling for timber in the Himalayas prompted local women, supported by people such as Sundertat Bahuguna and Chandi Prasad Bhat, ted a people's movement to prevent deforestation by timber contractors. They catted their movement the 'Chipko' movement in memory of the event during which women had clung to their trees and given up their lives. The movement followed the path the 300 Bishnoi women had taken three centuries ago in Rajasthan. Chipko is a movement primarily begun and supported by local women in the hills of Uttarakhand and Garhwal, where the women (the traditional fuel collectors) have had to bear the brunt of deforestation. They have not only realized that their fuelwood and fodder resources have receded away from their 'resource use areas' around their settlements due to commercial timber extraction, but that this has led to serious floods and the toss of precious soil. Chipko activists have made long padyatras across the Himalayas protesting against deforestation. The movement has been highly successful and has been primarily supported by empowering local women's groups, who are the most seriously affected segment. The movement has proved to the world that the forests of the hills are the life-support systems of local communities and of immense value in terms of local produce, and that the forest has less quantifiable but even more important ecological services such as soil conservation and the maintenance of the natural water regime of the whole region. The ability of local women to band together in the foothills of the Himalayas goes back to the pre-independence days when women such as Miraben, a disciple of Gandhiji, moved to this region and understood that it was the deforestation that led to floods and devastation of villages in the valleys and in the Gangetic plains below. They also appreciated that substitution of oak and other broad-Leaved forests of the Himalayas with the planting of fast-growing pine for timber and resin was an ecological and social disaster which reduced the forest resources used by traditional hill communities.

MANGROVES

The word "Mangrove" is considered to be a combination of the Portuguese word "Mangue" and the English word "grove". Mangroves are salt-tolerant plants of tropical and subtropical intertidal regions of the world. The specific regions where these plants occur are termed as 'mangrove ecosystem'. These are classified as salt-tolerant evergreen forests, found along coastlines, lagoons, rivers or deltas in 124 tropical and subtropical countries and areas, protecting coastal areas against erosion, cyclones and wind. These are highly productive (wood, food, fodder, medicine and honey) but extremely sensitive

and fragile. Besides mangroves, the ecosystem also harbours other plant and animal species. They are habitats for many animals like crocodiles and snakes, tigers, deer, otters, dolphins and birds. A wide range of fish and shellfish also depends on these coastal forests and mangroves help to protect coral reefs against siltation from upland erosion. Indonesia, Australia, Brazil, Nigeria and Mexico together account for around 50 percent of the total global mangrove area. The total mangrove area has declined from 18.8 million ha in 1980 to 15.2 million ha in 2005. The world has lost around 3.6 million hectares (from 18.8) of mangroves since 1980, equivalent to an alarming 20 percent loss of total mangrove area according to FAO's recent mangrove assessment study, entitled 'The world's mangroves 1980-2005'. The rate of mangrove loss is significantly higher than the loss of any other types of forests. If deforestation of mangroves continues, it can lead to severe losses of biodiversity and livelihoods, in addition to salt intrusion in coastal areas and siltation of coral reefs, ports and shipping lanes. Tourism would also suffer. Asia suffered the largest net loss of mangroves since 1980, with more than 1.9 million ha destroyed, mainly due to changes in land use. FAO cited high population pressure, the large-scale conversion of mangrove areas for shrimp and fish farming, agriculture, infrastructure and tourism, as well as pollution and natural disasters as the major causes for the destruction of mangroves. As the experiences have proved that the presence of mangrove ecosystems on coastline save lives and property during natural hazards such as cyclones, storm surges and erosion, the conservation efforts are given importance.

The distribution of mangrove ecosystem on Indian coastlines indicates that the Sundarban mangroves occupy very large area followed by Andaman-Nicobar Islands and Gulf of Kachch in Gujarat. Rest of the mangrove ecosystems are comparatively smaller. Over 1600 plant and 3700 animal species have been identified from these areas. A Senior Forestry Officer reported that part of the largest mangrove area in the world, the Sundarbans Reserved Forest in Bangladesh, is well protected and no major changes in the extent of the area have occurred during the last few decades, although some damage to the mangroves was reported after the cyclone in 2007. In Ecuador, the abandoning of ponds and structures for shrimp and salt production led to a rebuilding of various mangrove sites.

WATER RESOURCES

The United Nations has recognized access to water as a basic human right, stating that water is a social and cultural good, not merely an economic commodity. Since ancient times, water has been recognized universally as an invaluable resource. Water has been harvested in India since the dawn of civilization. The Ramayana, Mahabharata and various other Vedic, Buddhist and Jain texts contain several references to water harvesting structures in existence and water being revered as a life giving and sustaining force. Water covers 70% -75% of earth's surface of which 97.2% is locked in sea or oceans (1332 million cu.km, considering total availability as 1400 million cu km), 3% is fresh water 2.15% in polar ice caps (29.20 cu.km), < 1% available as surface and sub surface water (rivers, streams, lakes) with which we have to manage ourselves. Water is renewable resource. It may change it's form but quantity of water on earth has remained same for millions of years. Out of 1400 million cu.km. of water available on earth, only 14 million cu.km. is fresh water. As per the National Commission on Agriculture, considering an average rainfall of 1200mm,the water wealth of India is about 400 million hectare meters.

Main sources of water for our use are:

Rainfall: India can be broadly divided into 15 ecological regions. The vast ecological diversity of this country is reflected in the diversity in available water resources. With an average annual rainfall of 1170 mm, India is one of the wettest countries in the world. However, there are large variations in the seasonal and geographical distribution of rainfall over the country. At one extreme are areas like Cherrapunji, in the northeast, which is drenched each year with 11,000 mm of rainfall,

and at the other extreme are places like Jaisalmer, in the west, which receives barely 200 mm of annual rainfall. Though the average rainfall is adequate, nearly three-quarters of the rain pours down in less than 120 days, from June to September.

Groundwater: India's groundwater resources are almost ten times its annual rainfall. According to the Central Groundwater Board of the Government of India, the country has an annual exploitable groundwater potential of 26.5 million hectare-meters. Nearly 85% of currently exploited groundwater is used only for irrigation. Groundwater accounts for as much as 70-80% of the value of farm produce attributable to irrigation. Besides, groundwater is now the source of four-fifths of the domestic water supply in rural areas, and around half that of urban and industrial areas. However, according to the International Irrigation Management Institute (IIMI), the water table almost everywhere in India is falling at between one to three meters every year. Furthermore, the IIMI estimates that India is using its underground water resources atleast twice as fast they are being replenished. Already, excessive ground water mining has caused land subsidence in several regions of Central Uttar Pradesh.

Surface water: There are 14 major, 44 medium and 55 minor river basins in the country. The major river basins constitute about 83-84% of the total drainage area. This, along with the medium river basins, accounts for 91% of the country's total drainage. India has the largest irrigation infrastructure in the world, but the irrigation efficiencies are low, at around 35%.

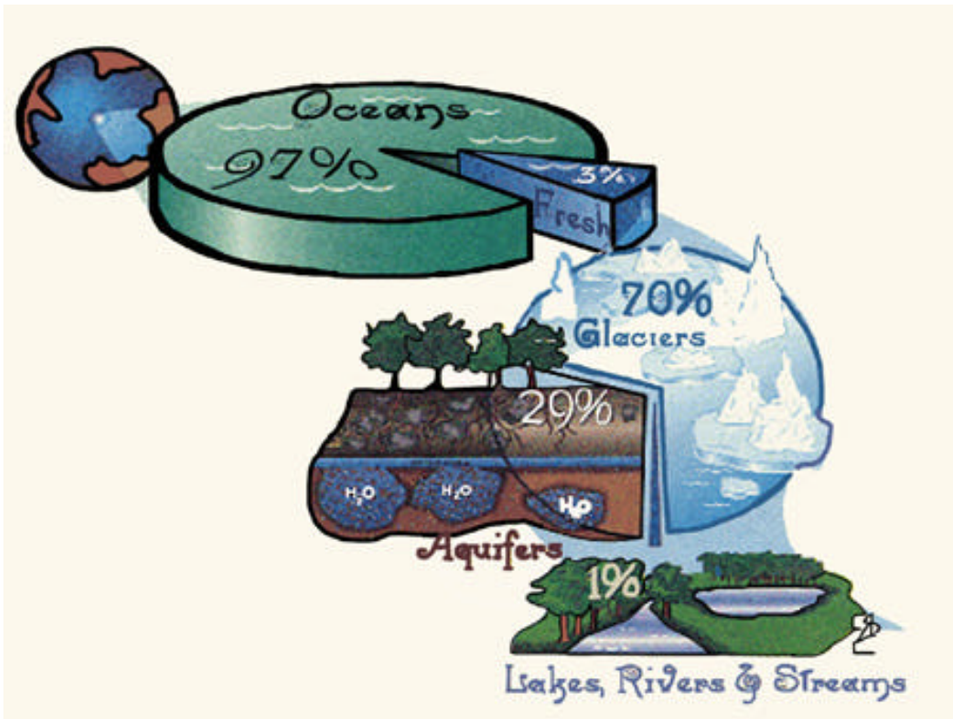
Consumption Patterns

Today, due to increasing consumption patterns, water is becoming scarce and this scarcity is an emerging threat to the global population, rendering the adages of the Bible and Koran irrelevant. Global consumption of water is doubling every 20 years, more than twice the rate of human population growth. At present more than one billion people on earth lack access to fresh drinking water. By the year 2025 the demand for freshwater is expected to rise to 56% above what currently available water can deliver, if current trends persist (Maude Barlow, 2003).

If per capita water availability is any indication, ‘water stress’ is just beginning to show in India. This index is based on the minimum per capita level of water required to maintain an adequate quality of life in a moderately developed arid zone country. A region where renewable fresh water availability is below 1700 cubic meters/capita/annum is a 'water stress' region, and one where availability falls below 1000 cubic meters/capita/annum experiences chronic 'water scarcity'. The annual per capita availability of renewable freshwater in the country has fallen from around 5,277 cubic meters in 1955 to 2,464 cubic meters in 1990. Given the projected increase in population by the year 2025, the per capita availability is likely to drop to below 1,000 cubic meters *i.e.,* to levels of water scarcity (Sudhirendar Sharma, 2003). If it falls below 500 cu.m. it is the state of “Absolute Scarcity”. 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 United Nations 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.

USES: Is essential for all forms of life. Many uses of water include agricultural, industrial, household, recreational and environmental activities. Virtually, all of these human uses, require fresh water. No plant or animal species can survive without water. If water in our body drops by 1% we feel thirst, if it drops by 10% we face death.



Reasons for decline of ground water

Population continues to rise at an unprecedented and unsustainable rate; many more areas are expected to experience this imbalance in the near future.

i) **Population explosion**: World population is > 6 billion and will continue to increase significantly during the next few decades - 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).

ii) **Overutilization of Surface and Groundwater:** occurs at various levels. Use of more water than really needed by human beings. Many agriculturists use more water than necessary to grow crops. Industries in order to maximize short-term economic gains does not

bother its liquid waste and releases it into streams, rivers and the sea.

iii) 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. This soil and water management and afforestation are long-term measures that reduce the impact of droughts. The destruction of forests influence the regulation of natural water cycle. The removal of dense and uniform cover over the hilly zones leads to occurrence of floods in drainage basins. Nations situated in tropical climates including India experience disastrous floods caused by the indiscriminate deforestation of the slopes above the valleys.

iv) Hydropower generation: Large amount of water is used for generating power which other

wise used for human needs.

v) **Dams -** for Agriculture and Power Generation

vi).**Rain fall**: The erratic and inadequate rainfall results in reduction in storage in subsurface reservoirs. The building construction activities are sealing the permeable zone, reducing the area for per collation of rainwater into subsurface and increase in surface runoff.

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. Dams support 30 to 40% of this area.

DAMS: It can be unequivocally stated that dams have made significant contributions to human development and the benefits derived from them have been considerable. Large dams are designed to control floods and to help the drought prone areas, with supply of water. But large dams have proved to cause catastrophic environmental damage. Hence an attempt has been made to construct small dams. Multiple small dams have less impact on the environment.

Benefits: Dams ensure a year round supply of water for domestic use and provide extra water for agriculture, industries and hydropower generation.

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, particularly is the case with mega dams. Some of the problems are mentioned below.

- Dam construction and submersion leads to significant loss of areable farmland and forest and land submergence

- Siltation of reservoirs, water logging and salination in surrounding lands reduces agricultural productivity
- Serious impacts on ecosystems - significant and irreversible loss of species and ecosystems, deforestation and loss of biodiversity, affects aquaculture
- Socio economic problems for example, displacement, rehabilitation and resettlement of tribal people.
- Fragmentation and physical transformation of rivers
- Displacement of people - People living in the catchment area, lose property and livelihood
- Impacts on lives, livelihoods, cultures and spiritual existence of indigenous and tribal people
- Dislodging animal populations
- Disruption of fish movement and navigational activities
- Emission of green house gases due to rotting of vegetation
- Large landholders on the canals get the lion's share of water, while poor and small farmers get less and are seriously affected leading to conflicts. Irrigation to support cash crops like sugarcane produces an unequal distribution of water.
- Natural disasters – reservoirs induced seismicity, flash floods etc and biological hazards due to large-scale impounding of water – increase exposure to vector-brone diseases, such as malaria, schistosomiasis, filariasis

LONG WAIT: *The Sangameswara temple in Srisailam reservoir near Kurnool, which got submerged in 1981 after construction of Srisailam dam, surfaced in 2003 for the first time.*

Case Study : Narmada River Dams *- For over a decade, villagers have waged an intense battle to stop dams on India's Narmada River. The Narmada Valley Development Project include 30 major dams and 3,000 smaller dams. The Sardar Sarovar Project (SSP) has gained international notoriety due to intense opposition by villagers. Led by the Narmada Bachao Andolan (Save the Narmada movement), activists and villagers forced the World Bank to withdraw from the project in the early '90s. A case filed with the Indian Supreme Court stopped construction for nearly six years. However, on October 18, 2000, the Indian Supreme Court issued a controversial final ruling allowing construction to proceed. About 200 000 people would be displaced for the reservoir; hundreds of thousands more will lose land or livelihood due to related developments. Thousands of people who have been resettled are*

struggling to survive on cramped plots with no arabIe land or source of livelihood. Faced with these future prospects, villagers have vowed to remain on their lands and face submergence behind the partly-built dam rather than face a life of certain destitution. People affected by the extensive canal system are not considered as project-affected people and are not entitled to the same resettlement and compensation packages as those living in the reservoir area. There are no credible environmental studies or rehabilitation plans. Although the legal framework requires that affected people be given land-for-land compensation, there is no land available for resettlement. The project is expected to generate only 50MW (of 1450 MW planned) after seasonal water flow and power consumption for pumping water is accounted for. The project is supposed to irrigate 1.9 million hectares and provide drinking water to over 20 million people. However, these benefits are based on overestimates of annual flow in the river and assume extremely high irrigation efficiency. The arid Kutch region will not receive any water supply benefits until 2025.

Sustainable Water Management

1. Building several small reservoirs instead of few mega projects
2. Developing small catchment dams and protecting wetlands
3. Soil management, micro-catchment development and afforestation permits recharging of underground aquifer, thus reducing the need for large dams
4. Treating and recycling municipal waste water for agricultural use.
5. Preventing leakages form dams and canals and loss in municipal pipes
6. Effective rainwater harvesting in urban environments
7. Water conservation measures in agriculture, such as using drip irrigation, control of growing water intensive cash crops ; control of waterlogging.
8. Pricing water at its real value makes people use it more responsibility and efficiently and reduces wastage
9. In deforested areas where land has been degraded, appropriate soil management practices, making bunds along the hill-slopes and making *nalla* plugs can help retain moisture and make it possible to revegetate degraded areas
10. Domestically use water by VED principle- use for Vital activities, control for Essential activities, cut down for Desirable activities.
11. Use waste water for activities that does not need fresh water – Recycling
12. Adopt mini water harvesting models for domestic usage.
13. Protect existing tanks
14. Develop systematic water management and adopt strict water auditing
15. “Save water Campaigns” for public awareness on water scarcity
16. Through rainwater harvesting, community based participatory initiatives and holistic watershed management.
17. Responsible water usage can only be achieved by empowering local communities and creating local accountability.

18. The government should develop policies that protect water resources, promote sustainable watershed management and invest in technologies that will increase efficiency in irrigation, industrial usage and improve water harvesting techniques.

World Water Day- March 22nd

FOOD RESOURCES

Our food comes almost entirely from agriculture, animal husbandry and fishing *i.e.*, - 76% from crop lands, 17% from range lands *i.e.*, meat from grazing livestock and 7% - marine and fresh water *i.e.*, fisheries. The FAO (Food & Agricultural Organization of UN) defines sustainable agriculture as the one which conserves land, water and plant and animal genetic resources, does not degrade the environment and is economically viable and socially acceptable. *The report, "The Food Gap –the Impacts of Climate Change on Food Production: A 2020 Perspective", produced after a year-long assessment by America's Universal Ecological Fund (FEU-US), revealed that :*

- *Global food production would not meet the food requirements of the world's estimated 7.8 billion people by 2020.*
- *Food prices are expected to jump by 20% in the next ten years as prolonged droughts and floods take their toll on food production.*
- *The report, which looked at the impact of climate change on four cereals - wheat, rice, maize and soybean - pointed out that*
    - *global wheat production will experience a 14 percent deficit between production and demand*
    - *Rice production will experience 11 percent deficit, and*
    - *9 percent deficit in maize production.*
    - *Soybean is the only crop showing an increase in global production, with an estimated five percent surplus.*
- *Current wheat production is estimated to decline to 663 million tons by 2020 yet 772.3 million tons is the estimated need at that time, creating a gap of 109 million tons.*
- *Rice is estimated to grow to 692.1 million tons by 2020 yet demand at that time is estimated at 775.1 million –creating a shortage of 82.9 million tons.*

- *Maize production stands at 826.2 million tons and is estimated to grow to 849.1 million tons by 2020 yet demand at that time is estimated at 933.7 million tons, creating a shortage of 85 million tons.*

World Food Problems and Environmental Concerns:

1) Population growth: Food production in 64 of the 105 developing countries is lagging behind their population growth levels.
2) Poor agricultural practices: Poor environmental agricultural practices such as slash and burn, shifting cultivation, or 'rab' (wood ash) cultivation degrade forests.
3) Degradation of agricultural lands: 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.
4) Our fertile soils are being exploited faster than they can recuperate.
5) Forests, grasslands and wetlands have been converted to agricultural use, which has led to serious ecological questions.
6) Use of genetically modified seed variety, without minding the conducive environment for such experimentation, will seriously affect the land ecosystem.
7) Our fish resources, both marine and inland, show evidence of exhaustion.
8) 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.
9) Loss of Genetic Diversity: Modern agricultural practices have resulted in a serious loss of genetic variability of crops. India's distinctive traditional varieties of rice alone are said to have numbered between 30 and 50 thousand. Most of these have been lost to the farmer during the last few decades as multinational seed companies push a few commercial types. This creates a risk to our food security, as farmers can loose all their produce due to a rapidly spreading disease. A cereal that has multiple varieties growing in different locations does not permit the rapid spread of a disease.

Food security: It is the ability of all people at all times to access enough food for an active and healthy life. 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.

The following 3 conditions must be fulfilled to ensure food security

- Food must be available
- Each person must have access to it.
- The food utilized must fulfill nutritional requirements

Options To Achieve Food Security

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.

1) Institutional support for small farmers: 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.
2) Trade related issues: 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 under priced foodstuffs produced in the developed world, onto markets in undeveloped countries undermines prices and forces farmers there to adopt unsustainable practices to compete.
3) Protecting genetic diversity: The most economical way to prevent loss of genetic diversity 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. 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.
4) 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. 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 in-situ preservation of wild relatives of crop plants.
5) Environmental friendly farming methods: Shift from chemical agriculture to organic farming, practicing integrated nutrient management (INM), integrated pest management (IPM).
6) Several crops can be grown in urban settings, including vegetables and fruit which can be grown on waste household water and fertilizers from vermi-composting pits.
7) Prevention of water and land degradation: Pollution of water sources, land degradation and desertification must be rapidly reversed. Adopting soil conservation measures, using appropriate farming techniques, especially on hill slopes, enhancing the soil with organic matter, rotating crops and managing watersheds at the micro level are a key to agricultural production to meet future needs.
8) Population control: Most importantly food supply is closely linked to the effectiveness of population control programs worldwide.

9) Education: Educating women about nutrition, who are more closely involved with feeding the family, is an important aspect of supporting the food needs/security of many developing countries.

10) Changing food habits : 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.

11) 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.

12) Alternate Food Source: 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 such as fruit, mushrooms, sap, etc. which can be used for food if harvested sustainably. Of course, this takes time, as people must develop a taste for these new foods.

- 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. (snake gourd in Italy)

- Several foods can be popularized from yet unused seafood products such as seaweed as long as this is done at sustainable levels.

We 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.

World Food Day – October 16th

Case study - The Aral Sea Tragedy

The Aral sea, covering an area the size of Lithuania, started receding in the 1960s after Soviet state planners diverted its water sources, the Amu Dar ya and the Syr Dar' ya rivers, to irrigate cotton on other crop. From 1960 to 1990, the area of irrigated land in central Asia increased from 3.5 million hectares to 7.5 millino ha. Cotton production soared, making the region the world's fourth largest producer. But by 1980s the annual flow of fresh water into the Aral was barely one-tenth of the 1950 supply. The salinity level increased, destroying the sea's flora and fauna. The change in water chemistry wiped out huge populations of fish. The decline of the fish populations in turn, wiped out the commercial fishing industry on the lake. Today, fishing boats sit in the desert many kilometers from the water's edge. The lakebed sediments that are now exposed on the desert floor become airborne quite easily, contributing to large dust storms in the region. In 1989, Aral sea was divided into a smaller northern sea and a large southern one. Drinking water in the region contains four times more salt per liter than the recommended by the world health organization. This has caused increases in kidney disease, diarrhea and other serious ailments. Tuberculosis has reached epidemic proportions. Cancers, lung diseases and infant mortality are 30 times higher than they used to be because the drinking water is heavily polluted with salt, cotton fertilizers and pesticides.

When the former sovient Union diverted the Ama Dariya and the Syr Dariya (the rivers which fed the Aral Sea) to grow cotton in the desert, they created an ecological and human disaster. What was the fourth biggest inland sea is now mostly desert. All of this was done in the name of cotton (grow where it would not grow naturally).

The worsening health and environmental problems of people living the Aral Sea basin, which consists of part of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, are the direct consequences of man-made environmental disaster in the region. The children of Muynak have made a playground out of the wrecks of ships, which might have provided food and a future for them.

Experts say the disaster has left behind a 36 000 km^2 area of seabed covered with accumulated salts, which the wind carries away and deposits over thousand of squares kilometers of cultivated land. Pesticides and fertilizers have also found their way into water and irrigation channels, poisoning food and drinking water affecting the lives of about five million people.

After the collapse of the Soviet Union in 1991, international donor agencies rushed to the central Asian region to asses the environmental impact of the shrinking of the Aral Sea and to find ways of restoring it to its original level. Now, almost a decade later, after countless studies and reports have been written, experts say that restoration is impossible and efforts should now focus on avoiding a humanitarian catastrophe.

The Aral Sea is not an example of a success in water resource management. In fact, it is a classic example of what can happen if we don't start to take action before a crisis begins. Still, the Aral Sea is very instructive sustainability case study, as it demonstrates how few environmental problems are not international in scope. The world is getting increasingly smaller and the problems require multinational solutions.(Benny Joseph, 2006)

ENERGY RESOURCES

Energy is defined as 'the capacity to do work'. Sun is the primary source of energy. Joule is the standard unit of energy in SI units. Energy utilization is an index of economic development, which does not take into account of ill effects/damage on to environment.

From 1900 to 2000 population increased by 3 times while energy consumption by 14 times!

Energy Resources

All energy sources ultimately come from the sun, the moon or the earth.

Sources of Energy

Solar energy drives the following:

- The global climate system which give as wind power.
- Wave power
- Hydroelectric power
- Solar heating and Solar lighting
- The global ecosystems which give as biomass power such as wood or muscle.
- The ancient ecosystem whose energy is now stored as fossil fuels.

The moon's gravitational energy is responsible for the ideal effect, which give rise to tidal power.

The earth itself is the key source of energy such as the following:

- Gravitational energy for hydroelectric power
- Chemical energy for nuclear power, electro- chemical reaction and hydrogen fuel cells.
- Geothermal power from the heat of lower crust.

Other exciting energy sources are currently untapped, such as energy in the earth's magnetic field, the energy potential caused by temperature differences in different layers of the ocean and the energy contained in combustible deposits of methyl hydrates in the sediments of the continental shelves. There are undoubtedly energy types we have not yet discovered. The relatively recent discovery of radiation remains us that novel discoveries will continue to happen. There are also energy types that are not new but are simply untapped. The average human beings give of f 60 watts of heat by simply standing in a room. With effective insulation and ventilation it is possible to heat many building types by the heat energy of their occupants alone.

Types of Energy Energy resources can be described as renewable, non renewable and sustainable.

Renewable energy sources include

- Wind power
- Wave power
- Ocean Thermal Exchange Capacity (OTEC) - based on temperature differences in ocean layers.
- Solar Power
- Hydro power
- Fuel cells
- Bio- fuels- also known as biomass fuels-such as alcohol form, sugar, methane from organic waste or charcoal from trees and biodiesel.

The key characteristics of renewable energies is that the energy sources are continually available, still some cases such as with hydro power and biomass, continuing availability requires good management – for example tree planting or river management. Other renewable like solar and wind power are available for the foreseeable future without any human intervention.

Non- renewable types of energy include all the fossil fuels – coal, oil, gas and their derivatives such as petrol and diesel. The non- renewable are finite in supply because their rate of formation is so low that they are, in reality, finite sources.

Sustainable energy is a term sometimes applied to nuclear power. The supplies are not exactly renewable but they will lost for a very long time because a great of electricity is produced from a small amount of radioactive material.

In general, the three types of energy have very different characteristics. This means there is no 'ideal' energy source. The future will most likely to be a mix of sources with increase in emphasis on the renewable.

Advantages and Disadvantages of various Energy Types

Energy type	Advantages	Disadvantages
Renewable	• Wide availability • Lower running cost • Decentralized power production • Low Pollution • Available for the foreseeable future	• Unreasonable supply • Usually produced in small quantities • Often very difficult to store • Currently per unit cost of energy is more compared to other types.
Non renewable	• Available in highly concentrated form • Easy to store • Reliable supply • Lower cost per unit of energy produced as the technology is matured.	• Highly polluting • Available only in few places • High running cost • Limited supply and will one day get exhausted
Sustanible (Nuclear Power)	• Highly reliable • Produces large amounts of energy with very little CO_2emissions • Uses small amount of raw material per unit energy production.	• Risk of radioactivity • High waste disposal costs • High capital investment and maintenance cost

Non Renewable Energy Sources:

Environmental Impacts of fossil fuels in general

Fossil fuels- (coal, oil, gas, peat, lignite, etc.)

Extraction of fuel by mining, drilling, quarrying and/ or excavation leads to significant impacts on the surrounding environment and landscape (habitat modification and destruction, pollution etc.)

- Spoil and solid wastes from mining and extraction have both visual and environmental impacts.
- Wastewater and leachates from mining, drilling and excavation, and gas leaks from pipelines can pollute surrounding waters, air and land.
- Purification or modification of raw products for use as fuels requires energy, and may lead to secondary sources of pollution.
- Transportation of fuels to energy production sites uses fuel (causes air pollution) and possibly a pollution risk, *eg*.oil tankers are at risk from accidents and may lead to oil spills at sea.
- Combustion of fuels to produce energy leads to air pollution (carbon, nitrogen and sulphur oxides) and in some cases, the production of solid wastes (in the form of ash).

Oil and Its Environmental Impacts:

India's oil reserves which are being used at present lie off the coast of Mumbai and in Assam. 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, during refining oil, solid waste such as salts and grease are produced which also damage the environment. Accidental fires that may go on burning for days or weeks before the fire can be controlled. Oil slicks are caused at sea from offshore oil wells, cleaning of oil tankers and due to shipwrecks. 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. Running petrol vehicles with unleaded fuel has been achieved by adding catalytic converters on all the new cars, but unleaded fuel contains benzene and butadiene which are known to be carcinogenic compounds. Delhi, which used to have serious smog problems due to traffic, has been able to reduce this health hazard by changing a large number of its vehicles to CNG, which contains methane. Dependence on dwindling fossil fuel resources, especially oil, results in political tension, instability and war. At present 65 percent of the world's oil reserves are located in the Middle East.

Coal and Its Environmental Impacts:

Coal is the world's single largest contributor of green house gases and is one of the most important causes of global warming. At the current rates of use the world's coal reserves lasts for another 200 years. 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/cement ingredient. Among the fossil fuels coal is most harmful to the environment.

Natural gas: Is a mixture of methane, butane, ethane and propane found above oil reserves. Propane and butane are liquified and removed as LPG and Methane is cleaned and pumped in to pipelines. Natural gas is in abundance, low production cost and low pollution. It is an ideal fuel transition from fossil fuels to renewable sources. Most of our natural gas is linked to oil and, because there is no distribution system, it is just burnt off.

Sustainable energy

Nuclear Power and it's Environmental Impacts:

Energy that is trapped inside each atom is nuclear energy. In 1938 two German scientists Otto Hahn and Fritz Strassman demonstrated nuclear fission. They found that they could split the nucleus of a uranium atom by bombarding it with neutrons. As the nucleus split, some mass was converted to energy. The nuclear power industry however was born in the late 1950s. The first large-scale nuclear power plant in the world became operational in 1957 in Pennsylvania, USA. Dr. Homi Bhabha was the father of Nuclear Power development in India. India has uranium mines in Bihar. There are deposits of thorium in Kerala and Tamilnadu. The nuclear reactors use Uranium 235 to produce electricity. Energy released from 1kg of Uranium 235 is equivalent to that produced by burning 3,000 tons of coal. Uranium 235 (U_{235}) is made into rods which are fitted into a nuclear reactor. The control rods absorb neutrons and thus adjust the fission which releases energy due to the chain reaction in a reactor unit. The heat energy produced in the reaction is used to heat water and produce steam, which drives turbines that produce electricity.

Impacts on the environment The rods need to be changed periodically. This has impacts on the environment due to disposal of nuclear waste. The reaction releases very hot waste water that damages aquatic ecosystems, even though it is cooled by a water system before it is released. The disposal of nuclear waste is becoming an increasingly serious issue. Uranium (fuel used in nuclear power stations) mining can cause high levels of pollution in the surrounding environment, as well as posing health risks for mine workers. Transport of uranium and nuclear fuels carries potential pollution and environmental contamination risks. The radioactive waste produced in nuclear power plants remains highly toxic for centuries. There are currently no safe ways to either store this waste or dispose of it permanently. Waste (such as cooling water) from nuclear power and fuel reprocessing plants can cause radioactive pollution in the surrounding environment. The cost of Nuclear Power generation must include the high cost of disposal of its waste and the decommissioning of old plants. These have high economic as well as ecological costs that are not taken into account when developing new nuclear installations.

Although, the conventional environmental impacts from nuclear power are negligible, what overshadows all the other types of energy sources is that an accident can

be devastating and the effects last for long periods of time. While it does not pollute air or water routinely like oil or biomass, a single accident can kill thousands of people, make many others seriously ill, and destroy an area for decades by its radioactivity which leads to death, cancer and genetic deformities for generations. Land, water, vegetation are destroyed for long periods of time. There have been nuclear accidents at Chernobyl in USSR and at the Three Mile Island in USA. Management, storage and disposal of radioactive wastes resulting from nuclear power generation are the biggest expenses of the nuclear power industry. Low level waste can be stored safely for 100 – 500 years while the high level wastes remains radioactive for 240,000 years! Decommissioning an old plant costs more than the original construction cost!

Renewable Energy:

Renewable energy systems use resources that are constantly replaced and are usually less polluting. Ex: 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. Renewable energy technologies will improve the efficiency and cost of energy systems. We may reach the point when we may no longer rely mostly on fossil fuel energy.

Hydroelectric Power:

This uses water flowing down a natural gradient to turn turbines to generate electricity known as 'hydroelectric power' by constructing dams across rivers. Between 1950 and 1970, Hydropower generation worldwide increased seven times.

Advantages:

- 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

Environmental impact / 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.
- The reservoir drown large areas of farm land, wild life habitats and places of historical & cultural importance
- 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.

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. The development of small hydroelectric power units could become a very important resource in India, which has steeply falling rivers and the economic capability and technical resources to exploit them.

***Solar Energy**:*

Sun is the primary source of energy. Sun's energy each day is 600 times greater than produced from all other sources (1/5 of known reserves of fossil fuels). If it was possible to harness this colossal quantum of energy, humanity would need no other source of energy. Several methods were developed for collecting this energy for heating water and generating electricity. Readily available source of energy and is free. Non conventional source of energy and non polluting. The major problem with solar energy is its intermittent nature, during day less in cloudy weather. Hence, supplementary source of energy is essential. It needs people's initiatives and high initial expenses. After dramatic rise in oil prices during 1970's several countries started research and developmental programmes to exploit the solar energy.

Is PV cells are environment friendly? PV cells are environmentally benign, *i.e*. they do not release pollutants or toxic material to the air or water, there is no radioactive substance, and no catastrophic accidents. Some PV cells, however, do contain small quantities of toxic substances such as cadmium and these can be released to the environment in the event of a fire. Solar cells are made of silicon which, although the second most abundant element in the earth's crust, has to be mined. Mining creates environmental problems. PV systems also of course only work when the sun is shining, and thus need batteries to store the electricity.

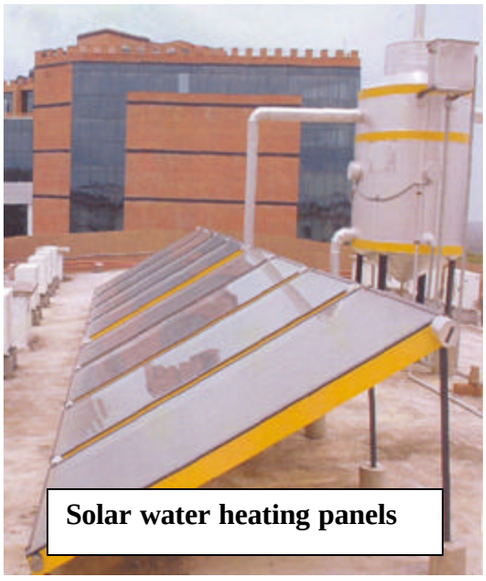
Biomass Energy:

Biomass is organic material which has stored sun light in the form of chemical energy. Because plants and trees depend on sunlight to grow, biomass energy is a form of stored solar energy. Although wood is the largest source of biomass energy, we also use agricultural waste, sugarcane wastes, and other farm byproducts to make energy. Half a kilo of dry plant tissue – produce as much as 1890 Kcal of heat – equivalent to quarter kilo of coal A typical biogas sample contains 68% methane, 31% CO_2, 1% Nitrogen and calorific value is 5871 Kcal/m^3 (*i.e*. 80% natural gas).

Biogas is produced from plant material and animal waste, garbage, waste from households and some types of industrial wastes, such as fish processing, dairies, and

sewage treatment plants. It is a mixture of gases which includes methane, carbon dioxide, hydrogen sulphide and water vapour. In this mixture, methane burns easily.

With a ton of food waste, one can produce 85 Cu. M of biogas. Once used, the residue is used as an agricultural fertilizer. Denmark produces a large quantity of biogas from waste and produces 15,000 megawatts of electricity from 15 farmers' cooperatives. London has a plant which makes 30 megawatts of electricity a year from 420,000 tons of municipal waste which gives power to 50,000 families. In Germany, 25% of landfills for garbage produce power from biogas. Japan uses 85% of its waste and France about 50%. Biogas plants have become increasingly popular in India in the rural sector. These biogas plants use cow dung (Gobar gas), which is converted into a gas which is used as a fuel – for lighting/cooking. It is also used for running dual fuel engines.



Solar water heating panels

NOVEL EXPERIMENT: *SHG women learning to make fuel briquettes from saw dust, grass, plastic and rice husk at a workshop on production of alternative fuels from industrial and agri wastes in the city.* - PHOTO: P.V. SIVAKUMAR

Wind Power:

Wind was the earliest energy source used for transportation by sailing ships.Wind energy produces electricity at low cost, capital costs are moderate and there are no emission. Some 2000 years ago, windmills were developed in China, Afghanistan and Persia to draw water for irrigation and grinding grain. Most of the early work on generating electricity from wind was carried out in Denmark, at the end of the last century. Five nations Germany, USA, Denmark, Spain and India 80% of world's wind energy capacity. Today, Denmark and California have large wind turbine cooperatives which sell electricity to the government grid. Wind Farms – cluster of wind turbines (aero generators) to charge large batteries. The power in wind is a function of the wind speed and therefore the average wind speed of an area is an important determinant of economically feasible power. Wind speed increases with height.

Environmental Impacts: Wind power has few environmental impacts, as there are virtually no air or water emissions, or radiation, or solid waste production. The principal problems are bird kills, noise, effect on TV reception *etc.* Although large areas of land are required for setting up wind farms, the amount used by the turbine bases, the foundations and the access roads is less than 1% of the total area covered by the wind farm. The rest of the area can also be used for agricultural purposes or for grazing. Setting windmills offshore reduces their demand for land and visual impact. Wind is an intermittent source

and the intermittency of wind depends on the geographic distribution of wind. Wind therefore cannot be used as the sole resource for electricity, and requires some other backup or stand-by source (as in solar system).

Tidal and Wave Power:

The energy of waves in the sea that crash on the land of all the continents is estimated at 2 to 3 million megawatts of energy. From the 1970s, several countries have been experimenting with technology to harness the kinetic energy of the ocean to generate electricity. Water flows from a higher level to lower level, greater the difference between high and low tides more energy can be extracted. Tidal power is tapped by placing a barrage across an estuary and forcing the tidal flow to pass through turbines. In a one-way system the incoming tide is allowed to fill the basin through a sluice, and the water so collected is used to produce electricity during the low tide. In a two way system power is generated from both the incoming as well as the outgoing tide.

Environmental impact: Tidal power stations bring about major ecological changes in the sensitive ecosystem of coastal regions and can destroy the habitats and nesting places of water birds and interfere with fisheries. A tidal power station at the mouth of a river blocks the flow of polluted water into the sea, thereby creating health and pollution hazards in the estuary. Other drawbacks include offshore energy devices posing navigational hazards. Residual drift current could affect spawning of some fish, whose larvae would be carried away from spawning grounds. They may also affect the migration patterns of surface swimming fish.

Thermal Energy:

Ocean collects and store huge quantities of solar radiations in the form of heat. This is another developing concept to harnesses energy due to the differences in temperature between the warm upper layers of the ocean and the cold deep sea water.

Geothermal Energy: It is the energy stored within the earth ("geo" for earth and "thermal" for heat). Core of the earth is very hot – as high as 6000^0C , temperature rises with depth @ 30^0C per Km. Geothermal energy starts with hot, molten rock (called magma) deep inside the earth which surfaces at some parts of the earth's crust (volcanoes). With modern technology, wells are drilled deep below the surface of the earth to tap into geothermal reservoirs. This is called direct use of geothermal energy, and it provides a steady stream of hot water that is pumped to the earth's surface. Geothermal energy is nearly as cheap as hydropower and will thus be increasingly utilised in future.

Environmental impact:Water from geothermal reservoirs often contains minerals that are corrosive and polluting and they may be toxic to fishes.Steam contains H_2S gas which gives rotten egg smell and cause air pollution. Geothermal fluids are a problem which must be treated before disposal.

Methods to solve energy crisis

- Avoid fossil fuels
- Smokeless stoves
- Use solar energy extensively

- Biogas – (500kg litter gives $50m^3$/day)
- Trees should be planted.

LAND RESOURCES

Land is a major resource for, food production, animal husbandry, industry our growing human settlements, Forests, wild life and biodiversity. Land on earth is as finite as any of our other natural resources. Scientists today believe that at least 10 percent of land and water bodies of each ecosystem must be kept as wilderness for the long term needs of protecting nature and natural resources.

Soil types are red soil, black cotton soil, literate soil, alluvial soil, desert soil etc. In nature India is moving North East @5cm/yr (fastest continent) so the Eurasian plate deforms and India compresses by 4mm/year

Land degradation: It is the decline in land quality or reduction in its productivity or production potential caused by human activities. World wide 5 -7 m ha farm land is being degraded annually.

Mechanisms that initiate land degradation include

Physical processes: decline in soil structure leading to crusting, compaction, erosion, decertification, Ana vision, environmental pollution and unsustainable use of natural resources.

Chemical processes: Acidification, leaching, decrease in caitions retention capacity and loss of nutrients.

Biological processes: Reduction in total and biomass carbon and decline in land biodiversity.

Causes for land degradation:

i. Intensive irrigation leads to water logging and salinisation, on which crops cannot grow.

ii. The use of more and more chemical fertilizers poisons the soil so that eventually the land becomes unproductive.

iii. The roots of trees and grasses bind the soil. If forests are depleted, or grasslands overgrazed, the land becomes unproductive and wasteland is formed.

iv. Land is also converted into a non-renewable resource when highly toxic industrial and nuclear wastes are dumped on it.

v. As urban centers grow and industrial expansion occurs, the agricultural land and forests shrink. This is a serious loss and has long term ill effects on human civilization.

vi. Land degradation/soil erosion due to deforestation is more evident on steep hill slopes in the Himalayas and in the Western Ghats. These areas are called '**ecologically sensitive areas' or ESAs**. To prevent the loss of millions of tons of valuable soil every year, it is essential to preserve what remains of our natural forest cover. It is equally important to reforest denuded areas. The linkage between the existence of forests and the presence of soil is greater than the forest's physical soil binding function alone. The soil is enriched by the leaf litter of the forest. It is

broken down by soil micro-organisms, fungi, worms and insects, which help to recycle nutrients in the system. Further losses of our soil wealth will impoverish our country and reduce its capacity to grow enough food in future.

vii. The rate of mangrove loss is significantly higher than the loss of any other types of forests. If deforestation of mangroves continues, it can lead to severe losses of biodiversity and livelihoods, in addition to salt intrusion in coastal areas and siltation of coral reefs, ports and shipping lanes.

Land use planning:

Land use planning is an iterative process based on the dialogue amongst all state holders aiming at the negotiation and decision for a sustainable form of land use. Land use planning creates the prerequisite required to achieve a type of land use, which is sustainable, socially and environmentally compatible, socially desirable and economically sound. Planning approaches often fail because global models and implementation strategies are applied and taken over automatically and uncritically. Land use planning is not a standardized procedure which is uniform in its application world wide its content is based on an initial regional or local situation analysis. Land use planning should consider following principles.

1. It should take into account traditional strategies and local environmental knowledge.
2. Differentiation of state holders and the gender approach are core principles in land use planning.
3. The ecological, economic technical financial, social and cultural dimension of land use makes it necessary to work with inter disciplinary approach.
4. It should aim at finding solutions for present problems (soil erosion, low yield, and low income in rural house holds) with the planning towards long conservations and sustainable use of land resources.

Desertification: It is land degradation occurring in arid, semiarid and dry subhumid areas of the world. It is a process where in fertile lands become arid through land mismanagement or climate changes. Many deserts in the world are man-made. Desertification is taking place much faster worldwide than historically and usually arises from the demands of increased populations that settle on the land in order to grow crops and graze animals. These susceptible dry lands cover 40 percent of the earth's surface and puts at risk more than 1 billion people who are dependent on these lands for survival. Around 80 % of the productive land in the arid and semi-arid regions of the world is estimated to be converting into deserts and around 600 million people are threatened by desertification (according to UNEP). Globally around 2 billion acres of land have become deserts in the past 50 years. The current rate of desertification is around 15 million acres per year, the worst being in sub-saharan Africa. Thar desert in Rajasthan covers about 12,000 hectares of land.

Causes of desertification:

1) Overgrazing: By pounding the soil with their hooves, livestock compact the substrate, increase the proportion of fine material, and reduce the percolation rate of the soil, thus

encouraging erosion by wind and water. Grazing and the collection of firewood reduce or eliminate plants that help to bind the soil.

2)*Increased population*: Livestock pressure on marginal lands accelerates desertification.

3) *Deforestation practices*: Loss of vegetation results in surface run off as there are no plants to bind the soil and resulting in soil erosion and depletion of nutrients.

4) Increased food production from marginal lands in arid or semi- arid areas.

5) Irrigation projects in areas with no drainage facility.

6) Shifting of sand dunes by wind storms

Effects: A major impact of desertification is biodiversity loss, and loss of productive capacity, such as the transition from grassland dominated by perennial grasses to one dominated by perennial shrubs. In extreme cases, it leads to the destruction of lands' ability to support life.

Control of desertification

1. Afforestation and planting of soil binding grasses can check soil erosion, floods and water logging.

2. Crop rotation and mixed cropping improve the fertility of the soil. It would increase production which can sustain large population.

3. Desertification can be checked by artificial bunds or covering the area with proper type of vegetation.

4. Shifting of sand can be controlled by mulching (use of artificial protective covering.)

5. Salinity of the soil can be checked by improved drainage. Saline soil can be recovered by leaching with more water, particularly where water table of the ground is not very high.

ROLE OF AN INDIVIDUAL IN CONSERVATION OF NATURAL RESOURCES

Until fairly recently mankind acted as if he could go on for ever exploiting the ecosystems and natural resources such as soil, water, forests and grasslands on the earth's surface and extracting minerals and fossil fuels from underground. But, in the last few decades, it has become increasingly evident that the global ecosystem has the capacity to sustain only a limited level of utilization. Biological systems cannot go on replenishing resources if they are overused or misused. At a critical point, increasing pressure destabilizes their natural balance. Even biological resources traditionally classified as 'renewable' - such as those from our oceans, forests, grasslands and wetlands, are being degraded by overuse and may be permanently destroyed. And no natural resource is limitless. 'Non-renewable' resources will be rapidly exhausted if we continue to use them as intensively as at present.

The two most damaging factors leading to the current rapid depletion of all forms of natural resources are increasing 'consumerism' on the part of the affluent sections of society, and 'rapid population growth'. Both factors are the results of choices we make as individuals.

Energy conservation

- Turn off lights and fans as soon as you leave the room.
- Use tube lights and energy efficient bulbs that save energy rather than bulbs. A 40- watt tube light gives as much light as a 100 watt bulb.
- Keep the bulbs and tubes clean. Dust on tubes and bulbs decreases lighting levels by 20 to 30 percent.
- Switch off the television or radio as soon as the program of interest is over.
- A pressure cooker can save up to 75 percent of energy required for cooking. It is also faster.
- Keeping the vessel covered with a lid during cooking, helps to cook faster, thus saving energy.

Water conservation:

- Keep taps closed when brushing teeth and taking a bath
- Use drip and sprinkler type of irrigation in agricultural fields
- Practice rain water harvesting techniques
- Reuse the waste water from kitchens and bath for garden use

Soil conservation:

- Do not cut trees and induce soil erosion
- Practice contour farming, agro forestry and strip cropping
- Practice no till farming for less soil disturbance
- Avoid over use of fertilizers, pesticides and water logged conditions
- Use organic fertilizers and vermicompost
- Practice integrated pest management practices

World Earth day- April 22nd

Biodiversity

The word biodiversity refers to the variety of living organisms (flora and fauna). Biodiversity or Biological diversity is defined as the variability among all living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and ecological complexes of which they are part. Wilson, 1988 defined 'Biological diversity' or 'biodiversity' as that part of nature which includes the differences in genes among the individuals of a species, the variety and richness of all the plant and animal species at different scales in space i.e. local, regional, country wise and global, and various types of ecosystems- both terrestrial and aquatic-within a defined area.

Types of Biodiversity:

Biological diversity deals with the degree of nature's variety in the biosphere. This variety can be observed at three levels *i.e.*, genetic, species and ecosystem.

Genetic diversity: Genetic diversity refers to the variation at the level of individual genes. Tremendous amount of genetic diversity exists within individual species. This genetic variability is responsible for the different characters in species. Genetic diversity is the raw material from which new species arise through evolution. Today, the genetic diversity is made use to breed new crop varieties, disease resistant crops.

Species diversity The number of species of plants and animals that are present in a region constitutes its species diversity. This diversity is seen both in natural ecosystem and in agricultural ecosystem. Some areas are richer in species than others. For example, natural undisturbed tropical forests have much greater species richness than mono culture plantations developed by the forest department for timber products. A natural forest ecosystem provides large number of non-timber forest products that local people depend on such as fruits, fuel, wood, fodder, fiber, gum, resin and medicines. Timber plantations do not provide the large variety of goods that are essential for local consumption. Modern intensive agro ecosystem have a relatively lower density of crops than traditional agro-pastoral farming systems, where multiple crops were planted.

Areas that are rich in species diversity are called 'hotspots' of diversity and the countries with highest species richness or have a relatively large proportion of these hot spots of diversity are referred to as 'megadiversity nations'. India is among the world's 15 nations that are exceptionally rich in species diversity. The earth's biodiversity is distributed in specific ecological regions. There are over a thousand major eco-regions in the world. Of these, 200 are said to be the richest, rarest and most distinctive natural areas. These areas are referred to as the Global 200. It has been estimated that 50,000 endemic plants which comprise 20% of global plant life, probably occur in only 25 *'hot spots'* in the world. These hotspots harbor many rare and endangered species. Two criteria help in defining hotspots namely rich endemism and the degree of threat. To qualify as hotspots an area must contain at least 0.5 per cent or 1500 of the worlds 3, 00,000 plants species as endemics (Myers *et al.*, 2000).

Ecosystem diversity:

There are a large variety of different ecosystem on earth, each having their own complement of distinctive inter linked species based on differences in the habitat. Ecosystem diversity can be described for a specific geographical region or a political entity such as a country, a state or a taluk. Distinctive ecosystems include landscapes like forests, grasslands, deserts, mountains *etc* as well as aquatic ecosystems like rivers, lakes and seas. Each region also has man-modified areas such as farmland or grazing pastures. It refers to the variation in the structure and functions of the ecosystem. It describes the number of niches, trophic levels and various ecological processes that sustain energy flow, flood webs and the recycling of nutrients. It has focus on various biotic interactions

and the role and functions of **keystone species** (species determining the ability of large number of other species to persist in the community).

Methods of measuring Biodiversity:

There are three perspectives measuring of diversity at the level of community. These are (i) Alpha diversity, (ii) beta diversity and (iii) gamma diversity. Community diversity refers to the variations in the biological communities in which species live.

(i) **Alpha diversity** indicates diversity within the community. It refers to the diversity of organisms sharing the same community or habitat. A combination of species richness and equitability / evenness is used to represent diversity within a community or habitat.

(ii) **Beta diversity** indicates diversity between communities. Species frequently change when habitat or community changes. There are differences in species composition of communities along environmental gradients, *e.g*, altitudinal gradient, moisture gradient, etc. the higher heterogeneity in the habitats ina region or greater dissimilarity between communities exhibit higher beta diversity.

(iii) **Gamma diversity** refers to the diversity of the habitats over the total land scope or geographical area. The sum of alpha and beta diversities of the ecosystems is an expression of the biodiversity of landscape, which is considered as Gamma Diversity.

Higher diversity at community level provides stability and higher productivity. In temperate grasslands, it has been observed that diverse communities are functionally more productive and stable, even under environmental stresses such as prolonged dry conditions.

Biogeographic Classification of India

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

India's Biogeographic Zones:

1. The cold mountainous snow covered Trans-Himalayan region of ladakh
2. The Himalayan ranges and valleys of Kashmir, Himachal Pradesh, Uttatkhand, Assam and other North eastern States.
3. The *Terai,* the low land where the Himalayan rivers flow into the plains
4. The Gangetic and Brahmaputra plains.
5. The Thar Desert of Rajastan
6. The semi-arid grassland region of the Deccan plateau, Gujarat, Maharashtra, Andhra Pradesh, Karnataka and Tamilnadu
7. The North eastern States of India

8. The Western Ghats in Maharastra, Karnataka and Kerala
9. The Andaman and Nicobar Islands
10. The long western and eastern coastal belt with sandy beaches, forests and mangroves.

Threats to Biodiversity: *Habitat loss is mainly due to human population growth, industrialization and changes in the land use patterns, poaching of wild life and man wildlife conflicts.* Man has begin to overuse or misuse most of these natural ecosystems. Due to unsustainable resource-use, once productive forests and grasslands have been turned into deserts and wastelands have increased all over world. Scientists have estimated that human activities are likely to eliminate approximately 10 million species by the year 2050.

1) Human population growth, industrialization and changes in the land use patterns: Around 1.8 million species of plants and animals are known to science. The actual number of species have been existing is >10x1.8millions. Though new species have been continually identified, the rate of extinction is very high (10-20,000 species per year *i.e.,* 1000 to 10,000 times faster rate). Human actions are expected to exterminate 25% of world's species in next 20-30 years. The mega extinction spasm is related to human population growth, industrialization and changes in the land use patterns in India. The reasons are:

i Forests and grasslands are changed to agricultural land. Encroachments are being repeatedly legalized.

ii Natural wetlands are drained to establish crop lands leading to loss of aquatic species.

iii Mangroves have been cleared for fuel wood and prawn farming, which has led to decrease in the habitat essential for breeding of marine fish.

iv Grasslands are changed to other forms, degraded by overgrazing. Loss to cattle, goat and sheep.

v Natural forests are being deforested for timber and replanted for teak, sal *etc.* Such monoculture does not support biodiversity as in forests which has closed canopy and rich undergrowth. Excess collection of fire wood by lopping of branches of trees canopy is opened up altering the local biodiversity.

vi Foraging cattle retard regeneration of forest as young seedlings are trampled.

vii Ever increasing population gradually decrease buffer zones and forested areas. A prime example is Gir national park, the last bastion of Asiatic lion with a meter gauge railway line, state expressway and 3 temples.

viii Repeated fires by local grazers to increase growth of grass ultimately reduce regeneration of grasses.

ix Introductions of exotic weeds *eg*. lantana bushes, *Eupatorium* shrubs and 'congress' grass are invading at the expense of indigenous undergrowth species. Following traditional farming techniques like slash and burn in Himalayas, and *rab*, lopping of tree branches for making wood ash fertilizer in Western ghats are now leading to loss of biodiversity.

x Over harvesting of fish by large trawling boats is leading to depletion of fish stocks. Marine turtles caught in the net are massacred of the coast of Orissa. The rare whale shark, a highly endangered species, is being killed off the coast of Gujarat.

2) *Poaching*: Specific threats to certain animals are related to large economic benefits. The skin and bones from tigers, ivory from elephants, horns from rhinos and perfume from the musk deer are extensively used abroad. Bears are killed for their gall bladders. Corals and shells are also collected for export or sold on the beaches of Chennai, Kanyakumari and the Andaman and Nicobar islands. Tortoises, exotic birds and other small animals are packed into tiny containers and smuggled abroad for the pet trade. A variety of wild plants with real or sometimes, dubious medicinal values are being over-harvested. The commonly collected plants include Rauwolfia, *Nux vomica*, Datura, *etc.* The garden plants collected for illegal trade include orchids, ferns and mosses.

3) Man wild life conflicts: Conflicting situations with wild life starts causing immense damage and danger to man. *Ex:* In Sambalpur, Orissa 195 humans are killed in last 5 years by elephants and in retaliation villagers killed 98 elephants and badly injured more than 30 elephants. Similarly incidents with tigers, leopards *etc.* are in news.Shrinking forest cover, human encroachment, ill and weak animals, lack of food (one adult elephant needs 200 kg green fodder and 150 kg of clean water) for animals, protecting villagers by putting electric fence are the main reasons for such happenings. As the compensation by government. is not enough, conflicts occur between forest department and villagers.

Man- wild life conflicts

Man-wild life harmony

Endangered & endemic species in India

Several species of plants and animals have been endangered due to human activities. The Species whose existence is in danger by human activities are called

endangered species. These endangered species have been categorized into four *viz*, 1) Vulnerable 2) Rare 3) Intermediate 4) Threatened. Endangered species which are on verge of extinction are called *threatened species*. Most of the endangered species are found today only in protected areas (PAs). Some *eg* of the species being Tiger, rhino, elephant; bird species include Siberian crane, great Indian bustard, Florican, vultures; reptiles and amphibians. Habitat loss caused by human activity is causing threat to plants species like orchids. Over harvesting as ingredients in medical products or cosmotics is also threatening species. To protect endangered species India has created a wildlife protection act. Under this plants and animals are characterized according to thereat to their survival.

The species which are unique to a locality/region are called ***endemic species.*** Some species are found only in India and are thus endemic (restricted to our country). Some have very localized distribution and are considered highly endemic. Some species of this category being Indian wild ass, angular kashmiri stag, golden langur, pigmyhog.

Conservation of biodiversity: is of two types *i.e., In situ* and *Ex situ*

***In situ* conservation**: Conserving a species in its own environment by creating national parks and wildlife sanctuaries. Habit is protected with all the other spp that in it in nature Biodiversity at all levels can be best preserved *in situ* by setting aside wildness as protected areas (in national parks and wildlife sanctuaries) with distinctive ecosystem included in the network. Such net work preserve the total diversity of life of the region. Biologists view point is to deal with areas which are 1) Species rich 2) Rare /threatened/endangered species / endemic species are found should be given imp as there spp would easily become extinct due to human activity. For *eg*. Elephants utilize open grasslands after the rains (when it is nutritious) but move into forest to feed on foliage in dry season. Hence a PA for elephant must be large to include a diverse habitat that supports a complete complement of interlinked species.

India has 589 PAs of which 89 are national parks and 500 are wildlife sanctuaries. Over 100 PAs are created in Andaman and Nicobar to preserve the special island ecosystem. The great Himalayan national park is the largest sanctuaries in the ecosystem and is the home of snow leopard. Dachigam sanctuary for hangul or kashmiri stag; Kaziranga national park for animals like elephant, guar, wild boar and swamp deer, and birds like ducks geese, pelicans and storks; Manas sanctuary forGolden langur, pigmy hog and wild boar are some of the examples worth mentioning under *in situ* conservation.

***Ex situ* conservation:** Conserving the species outside the natural habitat in a carefully controlled situation, such as botanical garden for plants or zoological parks for animals, expertise exists to multiply species under artificially managed condition. Gemplasm is preserved in a gene bank for future need, this is taken up for expensive endangered /extinct species. Care is taken to avoid inbreeding such that weak offspring would not develop. Breeding programmes in zoos provide animal needs including enclosures that

simulate their wild habitat. Modern zoo's function is to breed endangered species as a conservation. Successful examples are

1. Madras crocodile trust bank has successfully bred the 3 crocodiles. Here crocodiles lay two clutches of eggs in one year year instead of one in wild .
2. Guchali zoo has bred pigmy hog
3. Delhi zoo has bred the rare Manipur brow antlered deer.

The successful breeding programme also to aims at reintroduction of the species into wild habitat, with simultaneous removal of problems like poaching disturbances and man made influences.

Conservation of cultivars and livestock breeds:

Fifty years ago nearly 30,000 rice var. were grown in India now only a few of these are cultivated. The new varieties being developed use the germplasm of these original types. But if all these traditional types vanish, it would be difficult to develop new disease resistant varieties for future. Use of varieties from gene banks have been expensive and risky. Farmers need to be encouraged to grow traditional varieties. This is a concern for future of mankind. Gene banks have at present 34,000 creeds and 2200 pulses). Traditional breeds/ varieties have to be encouraged for genetic variability. In contrast men interested in cash returns in short time wouldn't appreciate the benefits of growing indigenous varieties.

Biological Diversity act 2002:

Biological diversity is a national asset of a country, hence the conservation of biodiversity assumes greater significance. The first attempt to bring the biodiversity into the legal frame work was made by way of the biodiversity bill 2000 which was passed by the Lok sabha on 2nd December 2002 and by Rajya Sabha on the December 2002.

Objectives of the act:

1. To conserve the Biological Diversity
2. Sustainable use of the components of biodiversity
3. Fair and equitable sharing of benefits arising out of the use of the B.D

A national biodiversity authority has been established by the Biodiversity Act 2002 to regulate act implementing rules 2004 has been operationalised since coming in to force.

Act: Regulating access well as pushing the officially sponsored documentation of biological resources and traditional practices through people's diversity registers at the local and data bases at the national levels, respectively. It further probes the extent to which the principles of conservation have realized.

Provisions of Act.

1. Prohibition on transfer of Indian genetic material outside the country without specific approval of the Indian Government

2. Prohibition of anyone claiming an (IPR) such as a patent over biodiversity or related knowledge without permission of Indian Government.

3. Regulation of collection and use of biodiversity by Indian national while exempting local communities from such restrictions

4. Measures from sharing of benefits from use of biodiversity including transfer of technology, monitory returns, joint research and development, joint IPR ownership etc.

5. Measuring to conserve sustainable use of biological resources including habitat and species protection (EIP) of projects, integration of biodiversity into the plans and policies of various Departments and Sectors.

6. Provisions for local communities to have a say in the use of their resources and knowledge and to charge fees for this

7. Protection of indigenous or tradition laws such as registration of such knowledge

8. Regulation of the use of the genetically modified organisms

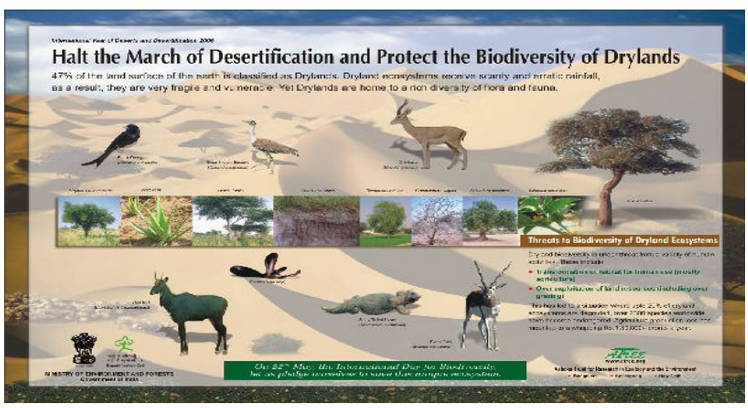
9. Setting up of National, state and local Biodiversity funds to be used to support conservation and benefit sharing

10. Setting up of Biodiversity Management committees (BMC) at local village levels, State Biodiversity Boards at state level and National Biodiversity Authority.

Functions of Authority:

1. Advise the central Government on any matter concerning conservation of biodiversity sustainable use of its components and fair and equitable sharing of benefits arising out of the use of biological resource and knowledge
2. Coordinate the activities of state biodiversity
3. Provide the technical assistance and guidance to the state biodiversity boards
4. Sponsor investigation and research
5. Engage consultants for a specific period not exceeding 3 years for providing technical assistance to the Authority in the effective discharges of its functions.
6. Collect, compile and publish technical and statistical data, manuals, codes or guides relating to conservation of biodiversity, sustainable use of its components and fair and equitable sharing of benefits arising out of the use of biological resource and knowledge's
7. Organize through mass media a comprehensive programme regarding conservation of biodiversity, sustainable use of components and fair and equitable sharing of benefits arising out of the use of biological resources and knowledge.
8. Plan and organize training of personal engaged or likely to be engaged in programmes for the conservation of biodiversity and sustainable use of its components

9. Prepare the annual budget of the authority including its own receipts as also the devaluation from the central Government provided that the allocation by the central government shall be operated in accordance with budget provisions approved by the central govt.
10. Recommend creation of posts to the central Government for effective discharge of the functions by the authority.
11. Approve the method of recruitment to the officers and servants of the authority.
12. Take steps to build up data base and to create information and documentation system for biological resources and associated traditional knowledge through biodiversity register and electronic data bases to ensure effective management, promotion and sustainable uses.
13. Give directions to state Biodiversity Boards and the Biodiversity Management Committees in writing for effective implementation of the act.
14. Report to the central Government about the functioning of the Authority and implementation of the Act
15. Sanction grants to the State Biodiversity Board and Biodiversity Management committees for specific purposes.
16. Take necessary measures including appointment of legal experts to oppose grant of intellectual property right in any country outside india on any biological outside India on any biological resource and associated knowledge obtained from India and in an illegal manner.
17. Do such other functions as may be assigned to directed by the central government from time to time
18. Regulates the commercial utilization or biosurvey and bio-utilization of any biological resource by Indians.



International day for Biological Diversity - 22nd May

POLLUTION

Pollution is derived from Latin word ‘polluere’ which means ‘to contaminate’ any feature of environment. Pollution is the effect of undesirable changes in our surroundings

that have harmful effects on plants, animals and human beings. This occurs only when short term economic gains are made at the cost of long term ecological benefits of humanity. *Environmental pollution* is defined as an undesirable change in the physical, chemical and biological characteristics of any component of the environment (water, soil, air) that can cause harmful effect on various forms of life and property. Pollution can be primary (effects immediately on release to the environment) or secondary (product of interaction after release with moisture, sunlight, other pollutants etc.) pollution may be local, regional, trans boundary or global. The agent which cause pollution is called pollutant.

Pollutants can be classified as:

1. Degradable or non persistent pollutants: These can be rapidly broken by natural processes. *Eg.* Domestic sewage, discarded vegetables *etc.*
2. Slowly degradable or persistent pollutants: These remain in the environment for many years in an unchanged condition and take decades or longer to degrade. *Eg*: DDT
3. Non degradable pollutants: These cannot be degraded by natural processes. *Eg:* Toxic elements like lead or mercury and nuclear wastes

Various types of pollutions namely air, water, soil, marine, thermal and noise pollution are presented here under

AIR POLLUTION

Air pollution occurs due to the presence of undesirable solid or gaseous particles in the air in quantities that are harmful to human health and environment. It can be defined as presence of foreign matter either gaseous or particulate or combination of both in the air which is detrimental to the health and welfare of human beings.

Pollutants that are emitted directly from identifiable sources are produced by natural events can be in the form of particulate matter or gaseous form. These are called primary pollutants *Ex*: Dust storms and volcanic eruptions and through human activities like emission from vehicles, industries *etc.* There are five primary pollutants that contribute to 90% of global air pollution. These are carbon oxides (CO & CO_2), N oxides, sulphur oxides, volatile organic compounds and suspended particulate matter.

The pollutants that are produced in the atmosphere, when certain chemical reactions take place among the primary pollutants and with others in the atmosphere are called secondary air pollutants. Eg: Sulphuric acid nitric acid, carbonic acid and acid rain.

Particulates are small pieces of solid material. Particulate matter can be 1) Natural such as dust, seeds, spores, pollen grains, algae fungi, bacteria and viruses 2) Anthropogenic such as mineral dust, cement, asbestos dust, fibers, metal dust, fly ash smoke particles form fires etc.

Causes of Air pollution:

Air pollution may originate form one or more variety of sources. The natural pollution include sources such as oceanic aerosol, volcanic emissions, biogenic sources, wind blown terrestrial dust and lightening. The artificial pollution generates from human activities and includes sources such as fuel burning, refuge burning, transportation, construction of buildings, chemical factories, metallurgical factories and, vehicles.

The third category includes solvent usage and sources include spray painting and solvent extraction. Automobiles are the first rate of polluters. Industries occupy second position.

Effects of Air Pollution:

i. **Effects on human health:** Particulates cause carcinogenic effects, accumulate in lungs and interfere with ability of lungs to exchange gases. Prolongeal exposure causes lung cancer and asthma. Cigarette smoking is responsible for greatest exposure to carbon monoxide (CO). Exposure to air containing even 0.001% of CO for several hours can cause collapse, coma and even death. As CO remains attached to heamoglobin in the blood for a long time, it accumulates and reduces the oxygen carrying capacity of blood. This impairs thinking, causes headaches, drowsiness and nausea. SO_2 irritates the respiratory tissues. NO_2 can irritate lungs, aggravate asthma and susceptibility to influenza and common colds. Many volatile organic compounds (benzene and formaldehyde) and toxic particulates can cause mutations and cancer.

ii. **Effects on plants**: Gaseous pollutants enter the leaf pores and damage the leaves of crop plants, interfere with photosynthesis and plants growth and reduces nutrient uptake and causes the leaves to turn yellow, brown or drop off altogether.

iii. **On materials**: Air pollutants break down the exterior paint on cars and houses.

iv. **Effect on stratosphere**: The upper stratosphere consists of considerable amounts of ozone, which works as an effective screen for UV light. This region is called ozone layer, which extends up to 60km above the surface of the earth. Ozone is a form of oxygen with 3 atoms instead of 2. It is produced naturally in the atmosphere. Presence of certain pollutants can accelerate the break down of ozone. Depletion of ozone effects human health, food productivity and climate as given below.

   a. **Effects on human health**: - Sun burn, cataract, aging of skin and skin cancer are caused by increased UV radiation. It weakens the immune system by

supporting the body's resistance to certain infections like measles, chickenpox & other viral diseases.

b. Effect on Food Production: UV radiation affects the ability of plants to capture light energy during the process of photosynthesis. This reduces the nutrient content and growth of plants mostly in legumes and cabbage. Plants and animals are damaged by UV radiations

c. Effects on climate: Contribute to global warming, a phenomenon which is caused due to the increase in concentration of certain gases like CO_2, NO_2 methane and chloroflorocarbons (CFCs).

Control measures: Two approaches

1. Preventive technique
2. Effective control

Effective means of controlling air pollution is to have proper equipments in place. This includes devices for removal of pollutants form fuel gases through scrubbers, closed fuel collection recovery systems. The use of dry and wet collectors, filters, electrostatic precipitators etc.

Using unleaded petrol for vehicles is another way of control. The substitution of raw materials that cause more pollution with those that cause less pollution. Building higher smoke –stacks facilitate the discharge of pollutants as far away from the ground as possible. Industries should be carefully located so as to minimize the effect of pollution after considering topography and wind directions.

Ambient air quality standards in India by the central pollution control board

Area Category	**SPM µg/m^3**	**SO_2 µg/m^3**	**CO µg/m^3**	**NO_X µg/m^3**
Industrial & mixed use	500	120	5000	120
Residential and rural	200	80	2000	80
Sensitive	100	3	1000	30

Case study on environmental impact of Iceland volcanic eruption

The air traffic disruption caused by the Iceland volcano eruption in 2010 highlighted the environmental impacts of atmospheric dust from volcanic eruption.The volcanic ash, in effect pulverized rock, was spewed between 20,000 to 40,000 feet into the atmosphere right where modern aircraft ply their trade. This atmospheric dust not only hinders visibility but can also damage aircraft engines, forcing them to shut down completely. The fact that this disruption is not only affecting the countries of Europe, but has a knock on effect on all worldwide flights that have a European destination. Volcanoes can spew atmospheric dust and gases tens of kilometers into the earth's atmosphere where prevailing winds can very quickly transport them thousands of kilometers from the original eruption. Volcanic ash can lower visibility in the upper atmosphere and knock out aircraft engines. Widespread ash from volcanic eruptions increase the Earth's "Albedo Effect", cooling the temperature of the lower troposphere while increasing the temperature of the stratosphere. Volcanic activity is estimated to be

responsible for the release of 130 million tonnes of carbon dioxide into the atmosphere annually. Sulfur dioxide, a major ingredient of volcanic activity, is the primary cause of environmentally damaging acid rain. It also forms sulfuric acid mists which causes pulmonary damage to both people and animals. Hydrogen sulfide, a colorless gas with an offensive odor, causes irritation of the upper respiratory tract and pulmonary edema. Atmospheric dust from volcanoes can act as a magnet for other pollutants and water vapor, giving rise to atmospheric hazes and heavy fogs.

SOIL POLLUTION

Soil is a natural resource for which there is no substitute. Environmental historian Donald Worster reminds us that fertilizers are not a substitute for fertile soil. Soil can not be manufactured with a tank of chemicals. Soil is formed from the parent material by physical and chemical weathering of rocks. Climate and time are also important in the development of soils. Extremely dry or cold climates develop soils very slowly while humid and warm climates develop them more rapidly. It is a thin covering over the land consisting of a mixture of minerals, organic material, living organisms, air and water that together support the growth of plant life. The organic portion, which is derived from the decayed remains of plants and animals, is concentrated in the dark uppermost "top soil". The inorganic portion, which is made up of rock fragments, is formed over thousands of years by physical and chemical weathering of bedrock. We may enhance the soil by helping its processes along, but we can never recreate what we destroy. Soil pollution is the introduction of substances, biological organisms, or energy into the soil, resulting in a change of the soil quality, which is likely to affect the normal use of the soil or endangering public health and the living environment.

Causes of Soil Pollution

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

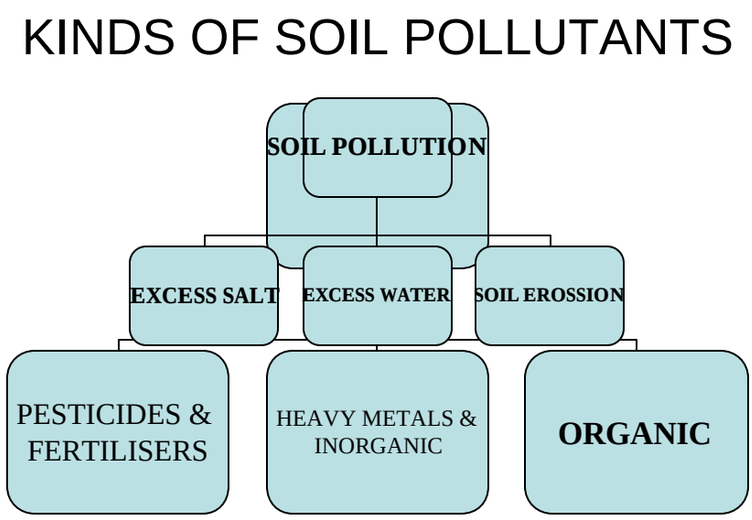
b. Soil contaminants are spilled onto the surface though many different activities. Most of these are the result of accidents involving the vehicles that are transporting waste material from the site at which it originated to the site at which it is to be deposited. Others involve accidents involving vehicles (automobiles, trucks and airplanes) not transporting wastes, but carrying materials, including fuel, that when spilled contaminate the soil. When any liquid pollutant is on or just below the ground the surface for any period of time, one of these could happen to it, if it is not cleaned up first.

c. Pollutant might be washed away by precipitation, causing little or no harm to the ground on which it is found (however, pollutants will simply accumulate somewhere else).The pollutant, if volatile, could evaporate, again causing little harm to the soil

(however, not a solution to the bigger pollution problem, as it might become a source of air pollution)

d. Excess use of fertilizers and pesticides: Pollutant could infiltrate through the unsaturated soil, same way has ground water. Agricultural practices including the use of agriculture chemicals is primary sources of pollution on or near the ground surface. Most agricultural chemicals are water soluble, nitrates and phosphates that are applied to fields, lawn and gardens to stimulate the growth of crops, gross and flowers. Farmers are generally use fertilizers to correct soil deficiency. Mixed fertilizers often contain ammonium nitrate, phosphorus and potassium.

e. Excess use of irrigation water



Effects of Soil Pollution

a) *Food shortage:* The foremost effect of loosing top soil is causing water pollution and reduced food production leading to food shortage. With population growth, it becomes more critical.

b) *Desertification:* Continuous exposure of eroded soil to sun for longer periods may transform the land into sandy and rocky in nature. These are symptoms of desertification rendering the soil unsuitable for cultivation.

c) Decrease in the extent of agricultural land

d) Top soil which is washed away also contributes water pollution by clogging of lakes, and increasing turbidity of water, ultimately leading to loss of aquatic life.

e) Excess use of irrigation leads to waterlogging and soil salinisation.

f) Fertilizer run off leads to the eutrophication of waterways.

Control measures

a) Proper soil conservation measures to minimize the loss of top soil

b) INM, IPM, using bio pesticides and integrated environment friendly agriculture to reduce pesticides or fertilizers**.**

c) Appropriate water management practices in agriculture

d) Keeping the soil surface covered with crop residues or crop cover

e) Planting trees as a part of afforestation/ shelter belts/wind breakers

f) ***Cleaning up of polluted soil***

Soil pollution information needed to clean up materials added to soil include the following:

1) Kind of material—organic or inorganic—is the material biodegradable, is the material dangerous to animals and humans.

2) C: N ratio of the pollutant material.

3) Nature of soil

4) Growing conditions for the soil organisms

5) How long as the material been on the site

6) Immediate danger to people and the environment.

One of the techniques for cleaning polluted soils is bioremediation

Bioremediation can be defined as any process that uses microorganisms, fungi, green plants or their enzymes to return the natural environment altered by contaminants to its original condition. Bioremediation may be employed to attack specific soil contaminants, such as degradation of chlorinated hydrocarbons by bacteria. Generally requires a mechanism for stimulating and maintaining the activity of the microorganisms, e.g., addition of an electron acceptor (oxygen, nitrate); nutrients (nitrogen, phosphorus); and an energy source (carbon). An example of a more general approach is the cleanup of oil spills by the addition of nitrate and/or sulfate fertilisers to facilitate the decomposition of crude oil by indigenous or exogenous bacteria.

Naturally occurring bioremediation and phytoremediation have been used for centuries. For example, desalination of agricultural land by phytoextraction has a long tradition. Bioremediation technologies can be generally classified as *in situ* or *ex situ. In situ* bioremediation involves treating the contaminated material at the site. *Ex situ* involves the removal of the contaminated material to be treated elsewhere.

Conditions that favor Bioremediation include the following:

• Temperature favorable for organisms

• Availability of water

• Availability of nutrients(N,P, K)

• C:N ratio of the contaminant material

• Availability of oxygen in sufficient quantity in the soil

Some examples of bioremediation technologies are bioventing (injection of air/nutrients into unsaturated zone), land farming, bioreactor, composting, bioaugmentation (inoculation of soil with microbes), rhizofiltration, and biostimulation (stimulation of biological activity) and biosparging (injection of air/nutrients into unsaturated and saturated zone).

Not all contaminants, however, are easily treated by bioremediation using microorganisms. For example, heavy metals such as cadmium and lead are not readily absorbed or captured by organisms. The assimilation of metals such as mercury into the food chain may worsen matters. Phytoremediation is useful in these circumstances, because natural plants or transgenic plants are able to bioaccumulate these toxins in their

above-ground parts, which are then harvested for removal. The heavy metals in the harvested biomass may be further concentrated by incineration or even recycled for industrial use.

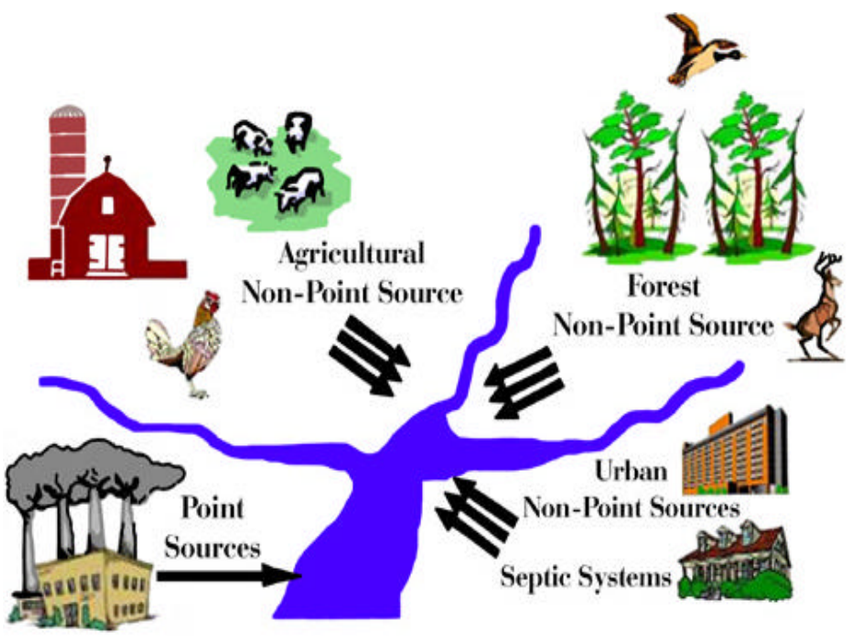
WATER POLLUTION

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

Two types of pollutions:

Point source of pollution: This source of pollution can be readily identified because it has a definite source and place, where it enters the water. Eg: Municipal industrial discharges pipes.

Non point source of pollution: when a source of pollution cannot be readily identified such as agricultural run off, acid rain etc, it is called as non point source of pollution.



Causes of water pollution: (surface water)

- **Disease causing agents** parasitic worms, bacteria, viruses, protozoa that enter water from domestic sewage and untreated human and animal wastes.
- **Oxygen depleting wastes**: These are organic wastes that can be decomposed by aerobic bacteria. The amount of oxygen required to break down a certain amount of organic matter is called BOD. It is an indicator of level of pollution.
- **Inorganic plant nutrients**: There are water soluble nitrates and phosphates

- **Excess pesticides:** For control of pest pesticides are used in discriminately. These fall on ground and leach with rain water to canals and rivers.
- **Water soluble organic chemicals**: These are acids, salts and compounds of toxic metals such as mercury & lead**.**
- **Variety of organic chemicals**: includes oil, gasoline, plastics, pesticides, detergents & many other chemicals.
- **The sediments of suspended matter**: Occur when soil is eroded.
- **Water soluble radio active isotopes**: Enter the water courses along with rain water.
- **Hot water** released by power plants & industries that use large volume of water to cool the plant results in a rise in temp of local water bodies.
- Acid drainage into rivers.

ACID MINE DRAINAGE INTO THE RIO TINTO RIVER

Ground water pollution: A greater threat to human life comes from ground water which is used for drinking and irrigation being polluted.

Causes of ground water pollution:

1. Urban runoff of untreated or poorly treated waste water storage and garbage
2. Industrial waste storage located above or near aquifer
3. Agricultural practices such as application of large amounts of fertilizers and pesticides, animal feeding operations etc in rural sector
4. Leaks from under ground storage tanks containing gasoline and other hazardous substances
5. Leachate from land fills
6. Poorly designed and inadequately maintained septic tanks
7. Mining waters

Case study:Cashew in Kasargod, Kerala poisonous nuts

Endosulfan, a pesticide banned by many countries in the world including India was extensively sprayed aerially in the cashew plantations of Plantation Corporation of Kerala (PCK) spread over 2209 hectares in various divisions of Kasargod district, Kerala. Endosulfan is slated to be phased out globally under the Stockholm Convention 2001, to which India is a signatory. The pesticide is classified as an organochlorine compound and its breakdown products are persistent in the environment, with an estimated half-life of nine months to six years. It is known to

potentially bioaccumulate in humans and other animals, in the liver, kidneys and fatty tissue. PCK started using this pesticide in 1979 and unusual health disorders were reported from places like Vaninagar, Adur, Mulleria, Padre etc. The people were unaware that this was a lethal poison. A study conducted by the Centre for Science and Environment (CSE) confirmed the presence of high quantities of endosulfan in the samples of water, soil, fruits, mother's milk and blood in Kasargode. Further disorders of the central nervous system, cerebral palsy, mental and physical retardation, epilepsy and congenital anomalies like stag horns, liver cancer, blood cancer, infertility, miscarriages, hormonal imbalances, skin diseases and asthma have been reported. All these disorders were traced to endosulfan effects. After mass agitations and several reports by various agencies, the use of endosulfan was banned in Kerala in August 2001. Though, the state government has paid compensations, the rehabilitation of the living victims is really tough and challenging. Reports reveal that approximately, 224 people were critically affected and 226 have a 60 per cent disability. This tragedy was spread over 20 villages in the state. (Ref: Sushmitha Baskar and .R.Baskar)

Effects of Water pollution:

1. Large amount of human waste in water increase the number of bacteria such as *Escherichia coli* and *streptococcus* sps which cause gastro intestinal diseases. Water borne diseases diarrhea, typhoid *etc.*
2. If more organic matter is added to water the O_2 is used up. This causes fish and other forms of O_2 dependent aquatic life dies.
3. Eutrophication due to inorganic pollutants.
4. Excess pesticides cause Biomagnification.
5. High levels of organic chemicals (acids, salts& toxic metals) can make the water unfit to drink, harm fish and other aquatic life, reduce crop yields
6. Variety of organic chemicals / oil gasoline, plastics detergents) are harmful to aquatic life and human life
7. Sediments (erosion) fish, clog the lakes and artificial reservoirs
8. Radioisotopes cause birth defects, cancer and genetic damage. Hot water cause thermal pollution not only decrease the solubility of O2 but also changes the breeding cycles of various aquatic organisms
9. Hot water because of thermal pollution not only decrease the solubility of O_2 but also changes the breeding cycles of various aquatic organisms.
10. Accidental oil spills cause environmental damage.
11. Minamata disease is caused due to mercury poisoning of water.
12. Fluorine contamination in drinking water causes Fluorosis, NO_3 contamination causes Blue baby disease (Methaemoglobinaceae) and PO_4 contamination causes bone marrow disease.

13. Arsenic poisioning is the major effect mostly in West Bengal. Arsenicosis or arsenic toxicity develops after 2-5 years exposure to arsenic contaminated drinking water.

Eutrophication The term “eutrophic” means well-nourished; thus, “eutrophication” refers to natural or artificial addition of nutrients to bodies of water and to the effects of the added nutrients. When the effects are undesirable, eutrophication may be considered a form of pollution (National Academy of Sciences, 1969). Nixon (1995) defined it as an increase in the rate of supply of organic matter in an ecosystem. It is the process by which a body of water acquires a high concentration of nutrients, especially phosphates and nitrates. These typically promote excessive growth of algae. As the algae die and decompose, high levels of organic matter and the decomposing organisms deplete the water of available oxygen, causing the death of other organisms, such as fish. Similarities include subsequent negative environmental effects such as anoxia, and severe reductions in water quality, fish and other animal populations may occur. Other species may experience an increase in population that negatively affects other species in the direct ecosystem. In simpler terms it is the bloom of phytoplankton in a water body. It is often the result of anthropogenic pollution with nutrients, particularly the release of sewage effluent and agricultural run-off carrying fertilizers into natural waters. However, it also occurs naturally in situations where nutrients accumulate (e.g. depositional environments) or where they flow into systems on an ephemeral basis. Eutrophication generally promotes excessive plant growth and decay, favours simple algae and plankton over other more complicated plants, and causes a severe reduction in water quality. In aquatic environments, enhanced growth of choking aquatic vegetation or phytoplankton (*eg:* algal blooms) disrupts normal functioning of the ecosystem, causing a variety of problems such as a lack of oxygen in the water, needed for fish and shellfish to survive. The water then becomes cloudy, coloured a shade of green, yellow, brown, or red. Human society is impacted as well: eutrophication decreases the resource value of rivers, lakes, and estuaries such that recreation, fishing, hunting, and aesthetic enjoyment are hindered. Health-related problems can occur where eutrophic conditions interfere with drinking water treatment.

Biomagnification, also known as **bioamplification** or **biological magnification**, is the increase in concentration of a substance, such as the pesticide DDT, that occurs in a food chain as a consequence of:

- Persistence (can't be broken down by environmental processes)
- Food chain energetics

Low (or nonexistent) rate of internal degradation/excretion of the substance (often due to water-insolubility). Biological Magnification often refers to the process whereby certain substances such as pesticides or heavy metals move up the food chain, work their way into rivers or lakes, and are eaten by aquatic organisms such as fish, which in turn are eaten by large birds, animals or humans. The substances become concentrated in tissues

or internal organs as they move up the chain. Bioaccumulants are substances that increase in concentration in living organisms as they take in contaminated air, water, or food because the substances are very slowly metabolized or excreted. For example, though mercury is only present in small amounts in sea water, it is absorbed by algae (generally as methyl mercury. Bioaccumulation and bioconcentration result in buildup in the adipose tissue of successive trophic levels: zooplankton, small nekton, larger fish etc. Anything which eats these fish also consumes the higher level of mercury the fish have accumulated. This process explains why predatory fish such as swordfish and sharks or birds like osprey and eagles have higher concentrations of mercury in their tissue than could be accounted for by direct exposure alone. For example, herring contains mercury at approximately 0.01 ppm and shark contains mercury at greater than 1 ppm (EPA 1997).

Case study of groundwater pollution in India - *An example of groundwater pollution caused by excessive extraction is that fluoride contamination. It has spread across 19 states and across a variety of ecological regions ranging from the Thar desert, the Gangetic plains and the Deccan plateau. Source: When the bedrock weathers the fluoride leaches into water and the soil. surfaced during the last three decades - extraction of groundwater which has resulted in the tapping of aquifers with high fluoride concentrations was noticed during 1970s and the 1980s when there was massive state investment in rural water development for irrigation as well as for drinking. Encouraged by state subsidies on diesel and electricity, people invested in diesel and submersible pumps in a bid to extract groundwater through borewells. This policy aggravated the fluoride problem. Effects: combines with the bones as it has an affinity for calcium phosphate in the bones. Excess intake of fluoride can lead to dental fluorosis, skeletal fluorosis or non-skeletal fluorosis. Correction: - Deflouridation plants and household water treatment kits are stop-gap solutions. (Ref: Sushmitha Baskar & R.Baskar)*

Control measures of water pollution*:*

- Setting up of effluent treatment plants to treat waste water can reduce the pollution load in the recipient water. The treated effluent can be reused either for gardening or cooling purposes or wherever possible.
- Root zone process has been developed by Thermax. by running contaminated water through the root zone of specially designed reed beds. These have the capacity to absorb from the surrounding air through their stomata openings. It creates O_2 rich conditions where bacteria and fungi oxidize the wastes.
- Providing sanitation and waste water treatment facility.
- Integrated nutrient management (INM) and integrated pest management (IPM) practices will reduce the effects caused due to excess pesticides.

Root zone treatment Technology for sewage

The process in a root zone system to treat the sewage is very simple to explain yet complex in nature. Raw effluent (after removing grit or floating material is passed horizontally or vertically through a bed of soil having impervious bottom. The effluent percolates through the bed that has all the roots of the wetland plants spread very thickly . Nearly 2,500 types of bacteria and 10,000 types of Fungi, which harbor around roots get oxygen form the weak membranes of the roots and aerobically oxidize the organic matter of the effluent. The characteristics of plants of absorbing oxygen through their leaves and passing it down to roots through their stems which are hollow, is utilized as a bio-pump. Away from the roots, anaerobic digestion also takes place. The filtering action of the soil bed, the action with fungi etc. and chemical action with certain existing or added inorganic chemicals help in finally obtaining a very clear and clean water. The system of plants regenerates itself as the old plants die and form useful humus. Hence the system becomes maintenance free and can run upto 50 to 60 years without any loss of efficiency as has been described.

Reed bed is one of the natural and attractive methods of treating domestic, industrial and agricultural wastes. A reed bed is an engineered method of purifying polluted water as it passes through artificially constructed wetland area, usually containing common reeds. Reed bed is considered as an effective and reliable secondary and tertiary treatment method where land area is not a major constraint. Generally reed bed is made in shallow pits, installed with a drain pipe in a bed of pieces of lime stones and filled up with pebbles, iron filings and graded sand. In this sandy body, reed plants (with hollow root which bring oxygen into the filter bed) are planted

It is advantageous to treat the sewage by root zone system. It achieves the standard for tertiary level treatment standard with no operating cost. There is no chemical used for pH adjustment or for flocculation. Low electricity is consumed for pumping treated water from the collection tank to the reed bed. From the reed bed the treated water is collected and used for irrigation by gradient flow.

The root zone system has low maintenance cost since it involves no machinery and its associated maintenance. It requires negligible attendance for operation and monitoring. It has no sludge handling problem such as scraping of slurry from the sludge drying beds and its disposal twice in a week.

The sludge gets mineralized in the vertical zone of the reed bed .The sludge mineralizing beds needs to be disposed once in 10 or 15 years.

- *It enhances the landscape and gives the site a green appeal.*
- *It provides natural habitat for birds and after a few years gives an appearance of a Bird´s sanctuary.*
- *It is though an effluent treatment plant, it does not have odour problem and though it is a green zone, it does not have mosquitoes problem.*

- *The reeds are not grazed by ruminants.*
- *Salinity may not be a problem for a survival or operations of reed beds.*
- *It is recommended to combine vertical flow and then horizontal flow of sewage with a soil having impervious bottom.*
- *In the horizontal flow system, the sewage percolates through bed and that has all roots of the wetland plants spread very thickly nearly with 2500 types of bacteria and 10,000 types of fungi and aerobically oxidized organic matter of the effluent.*
- *Root zone system gives a very good performance of removing 90% BOD and 63% Nitrogen.*
- *Phragmites australis has been found more efficient in nitrogen removal compared to Typha latifolia.*

However, compared to the conventional treatment processes such as activated sludge, aerated lagoons, waste stabilization pond etc the performance of the root zone treatment system is good with regard to the removal or reduction of BOD, COD, TOC and Total coliforms

(http://wasterecycleinfo.com/sewage.html)

THERMAL POLLUTION

Thermal pollution is the degradation of water quality by any process that increases the ambient water temperature. The increase in temperature (a) decreases the dissolved oxygen/oxygen supply, and (b) affects ecosystem composition.

Sources:

1) Industries: A common cause of thermal pollution is the use of water as a coolant by power plants and industrial manufacturers.

i) Hydro-electric power plants

ii) Coal fired power plants

iii) Nuclear power plants

iv) Industrial effluents from power, textiles, paper and pulp industries

2)Urban runoff : storm water discharged to surface waters from roads and parking lots can also be a source of elevated water temperatures.

3) *Domestic sewage:* municipal sewage normally has a higher temperature.

Effects: The warmer temperature decreases the solubility of oxygen and increases the metabolism of fish. Tropical marine animals are generally unable to withstand a temperature increase of 2 to 3^0C and most sponges, mollusks and crustaceans are eliminated at temperatures above 37^0C. When a power plant first opens or shuts down for

repair or other causes, fish and other organisms adapted to particular temperature range can be killed by the abrupt rise in water temperature known as 'thermal shock'.

- Elevated temperature typically decreases the level of dissolved oxygen (DO) in water. The decrease in levels of DO can harm aquatic animals such as fish and amphibians.
- Thermal pollution may also increase the metabolic rate of aquatic animals, as enzyme activity, resulting in these organisms consuming more food in a shorter time than if their environment were not changed. In Australia, where many rivers have warmer temperature regimes, native fish species have been eliminated, and macro invertebrate fauna have been drastically altered and impoverished.
- An increased metabolic rate may result to fewer resources; the more adapted organisms moving in, may have an advantage over organisms that are not used to the warmer temperature. As a result one has the problem of compromising food chains of the old and new environments. As a result Biodiversity can be decreased.
- Releases of unnaturally cold water from reservoirs can dramatically change the fish and macro invertebrate fauna of rivers, and reduce river productivity.
- **Increase in toxicity**: The rising temperature changes the physical and chemical properties of water. A 10^0 C rise in temperature doubles the toxic effect of potassium cyanide.
- **Interference with reproduction**: In fishes, several activities like nest building, spawning, hatching, migration and reproduction etc. depend on some optimum temperature. For instance, the maximum temperature at which lake trout will spawn successfully is 8.9^0 C. the warm water not only disturbs spawning, but also destroys the laid eggs.
- **Increased vulnerability to disease**: Activities of several pathogenic micro-organisms are accelerated by higher temperature. Hot water causes bacterial disease in salmon fish.
- **Invasion of destructive organisms** : Thermal pollutants may permit the invasion of organisms that are tolerant to warm water and highly destructive. Invasion of shipworms into New jersey's Oyster Creek constitute the best example.
- **M**any of the planktons, small fish and insect larvae that re sucked into the condenser along with the cooling water are killed by the thermal shock, increased pressure and water viscosity.

Control measures:

- Thermal pollution can be controlled by passing the heated water through a cooling pond or a cooling tower after it leaves the condenser. One method is to construct a large shallow pond. Hot water is pumped into one end of pond and cooler water is removed from the other end. Another method is using a cooling tower.
- During warm weather, urban runoff can have significant thermal impacts on small streams, as storm water passes over hot parking lots, roads and sidewalks. Storm water management facilities that absorb runoff or direct it into groundwater, such as bioretention systems and infiltration basins, can reduce these thermal effects.

Retention basins tend to be less effective at reducing temperature, as the water may be heated by the sun before being discharged to a receiving stream.

MARINE POLLUTION

Marine pollution is defined as the introduction of substances to the marine environment directly or indirectly by man resulting in adverse effects such as hazardous to human health, obstruction of marine activities and lowering the quality of sea water

Sources

1. Municipal waste & sewage from residences and hotels in coastal towns are directly discharged into sea
2. Pesticides and fertilizers from agriculture which are washed off by rain enter water courses & finally to sea. India is estimated to use 55,000 tons of pesticides annually and about 25 percent of it is carried to ocean.
3. Petroleum & oil washed of from roads normally enter sewage system & finally into seas
4. Ship accidents & accidental spillage at sea can therefore be very damaging to the marine environment.
5. Off shore oil exploration also pollute the sea water to a large extent.
6. Dry docking: All ships periodic dry docking servicing; cleaning the hulls etc. during this period when cargo compartments are emptied, residual oil goes into sea.
7. Pollution due to organic wastes**:** When O_2 concentration falls 1.5 mg/l, the rate of aerobic oxidants reduced and replaced by the anaerobic bacteria that can oxidize the organic molecules without the use of oxygen.
8. Pollution due to oil: Crude oil is transported by sea after a tanker has unloaded its cargo of oil; it has to take on sea water ballast for return journey. This ballast water is stored in cargo compartments that previously contained oil. During unloading of cargo certain amount of oil remains clinging to the walls of container & this may amount to 800t in a 200,000t tankers. The ballast water thus contaminated with oil. When fresh crag of oil is to be loaded these compartments are clean with water which discharges the dirty ballast along with oil into sea.
9. Tanker accidents: In the natural process, a large no of oil tanker accidents happen every year. Sometimes this can results in major disasters.
10. Volcanic eruptions in the sea.
11. *Deep sea mining* is a relatively new mineral retrieval process that takes place on the ocean floor. Ocean mining sites are usually done at about 1,400 - 3,700 meters below the ocean's surface. The vents create sulfide deposits, which contain precious metals such as silver, gold, copper, manganese, cobalt, and zinc. These raises questions about environment damage to surrounding areas. Removal of parts of the sea floor will result in disturbances to the benthic layer, and habitat of

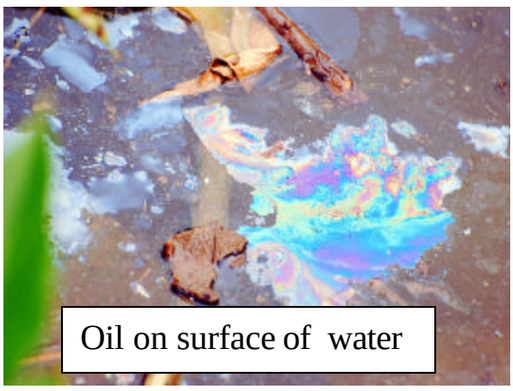
benthic organisms. Beside from direct impact of mining the area, leakage, spills and corrosion would alter the mining area's chemical makeup.

Case study**: **Marine Pollution in Tamil Nadu: Oceans not spared

Industrial pollution has threatened the natural habitats of pearls in the pearl banks of Tuticorin coast in the Gulf of Mannar. It has affected fish and other organisms as far as 30 kms south of Tuticorin due to effluents released from chemical industries. Tannery wastes have caused the pollution of coastal waters from Chennai to Vedaranyam. The effect of diversity of phytoplankton ecology of mangrove estuaries of Tuticorin is greatly affected by industrial effluents. The Chennai coastal waters showed high levels of pesticides like DDT, lindane, endosulphan and heptachlor. The bioaccumulation of these pesticides in marine organisms could pose major health hazards.(Ref:.Sushmitha Baskar and R.Baskar)

Effects of marine pollution:

- Apart from causing Eutrophication, a large amount of organic wastes can also result in the development of 'red tides'. These are phytoplankton blooms because of which the whole area is discolored.
- Commercially important marine species are also killed due to clogging of gills and other structures.
- When oil is spilled on the sea, it spreads over the surface of the water to form a thin film called as oil slick. This damages marine life to a large extent. Commercial damage to fish by tainting which gives unpleasant flavor to fish and sea food reduces market values of sea food and causes death of birds through its effect on feathers. Birds often clean their plumage by pruning and in the process consume oil which can lead to intestinal, renal and liver failure.
- For salt marshy plants oil slick can affect the flowering, fruiting and germination.



Oil on surface of water

Bird effected by Oil slick

- Organic waste addition results in end products such as hydrogen sulphide, ammonia and methane which are toxic to many organisms. This process results in the formation of an anoxic zone which is low in its oxygen content; from which most life disappears except for anaerobic microorganisms and renders the water foul smelling.
- The coral reefs are the productive ecosystems offer many benefits to people. These coral reefs are threatened by a) the sediments from deforestation carried by the runoffs. b) the agricultural and industrial chemicals reaching through river discharges.To mention an example, River Ganga is estimated to carry 1.5 billion tons of sediments due to deforestation and intensive farming in India, Bangladesh and Nepal through which it flows to Bay of Bengal.
- Drill cuttings dumped on the seabed result in the production of toxic sulphides in the bottom sediment thus eliminating the benthic fauna.

Control measures of marine pollution:

1) Introduction of *sewage treatment* plants to reduce BOD of final product before discharging into sea.
2) Cleaning oil from surface waters and contaminated beaches can be accelerated through the use of chemical dispersants which can be sprayed on the oil.
3) Load on top system reduce oil pollution cleaned with high pressures jets of water.
4) Crude oil washing: The clingage is removed by jets of crude oil while the cargo is being unloaded.

NOISE POLLUTION

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

noise. It may be considered as music to one person and may be noise to another. Noise is defined as ‘unwanted or offensive sound that unreasonably intrude into our daily activities’. Sound is measured in a unit called the decibel (dB). The permitted noise level is 125 decibels as per the Environment Protection Rules 1999.

Sources:

There are numerous sources but may be broadly classified into two classes such as indoor and outdoor.

1) Outdoor - Industries/factories, vehicular movements such as car, motor, truck, train, tempo, motor cycle, aircrafts, trains, Construction work, defence equipments, explosions, playing of loudspeakers during various festivals etc. The higher the speed of an air crafts the greater the noise pollution. The invention of supersonic air crafts has added more noise for the persons who live near aerodromes. Another source of noise pollution connected with aeroplanes has been scaring away of birds. Satellites are projected into space with the help of high explosive rockets also contributes to noise pollution.
2) Indoor - Loudly played radio or music systems, and other electronic gadgets etc.

Source of Noise pollution

Effects of noise pollution:

- Emotional or psychological effects - irritability, anxiety and stress. Lack of concentration and mental fatigue are significant health effects of noise.
- It has been observed that the performance of school children is poor in comprehension tasks when schools are situated in busy areas of a city and suffer from noise pollution - disturbance.
- Interferes with normal auditory communication, it may mask auditory warning signals and hence increases the rate of accidents especially in industries.
- The effects can range in severity from being extremely annoying to being extremely painful and hazardous Lowers workers efficiency and productivity and higher accident rates on the job.
- *Effects of Noise Pollution on Physical Health:*
  - Physical damage to the ear and the temporary hearing loss often called a temporary threshold shift (TTS). People suffering from this condition will be unable to detect weak sounds. However, hearing ability is usually recovered within a month of exposure. Permanent loss, usually called Noise Induced Permanent Threshold Shift (NIPTS) represents a loss of hearing ability from which there is no recovery. Below a sound level of 80 dB. hearing loss does not occur at all. However temporary effects are noticed at sound levels between 80 and 130 dB. About 50 percent of the people

exposed to 95 dB sound levels at work will develop NIPTS and most people exposed to more than 105 dB will experience permanent hearing loss. A sound level of 150 dB or more can physically rupture the human eardrum and >180dB can kill a person.

- In additions to hearing losses, excessive sound levels can cause harmful effect on the circulatory system by raising blood pressure and altering pulse rates.

Noise control techniques: There are 4 fundamental ways in which noise can be controlled. 1) Reduce noise at the source 2) block the path of noise 3) increase the path length and 4) protect the recipient.

Reduce noise at the source

1. Make sure that all openings are acoustically sealed. Noise, lake water rushes out through any cracks or openings. Muffling vehicles and machinery to reduce the noise.
2. In industries, different types of absorptive material can be used to control interior noise. Noise reduction can be done by using rigid sealed enclosures around machinery lined with acoustic absorbing material. Isolating machines and their enclosures from the floor using special spring mounts or absorbent mounts and pads and using flexible couplings for interior pipelines also contribute to reducing noise pollution at the source
3. Regular and thorough maintenance of operating machinery. We should reduce mechanical run out of shafts. By reducing this source of vibration excitation many components like bearing gears and cans may generate less noise and have generate life. We must improve lubrications. We should install bearings correctly. Improper installation sometimes is the reason for bearing noise problems
4. Traffic volume and speed also have significant effects on the overall sound. Ex: doubling the speed increases the sound levels by about 9 dB and doubling the traffic volume (number of vehicles per hour) increases sound levels by about 3 dB. A smooth flow of traffic causes less noise than a stop-and-go traffic pattern. Thus proper highway planning and design are essential for controlling traffic noise.
5. Establishing lower speed limits for highways that pass through residential areas, limiting traffic volume and providing alternative routes for truck traffic are effective noise control measures.
6. Using efficient flow techniques: for reducing noise associated with high fluid velocities and turbulence.
7. Reducing fluid jet velocities: As jet noise is proportional to the eight power of jet velocity

Block the path of noise: through construction of temporary/permanent barriers

1. Planting of trees around houses can also act as effective noise barriers.
2. Highly absorptive interior finish material for walls, ceilings and floors can decrease indoor noise levels significantly.

***Increasing the path length*:** Increasing distance from the noise source and the recipient offers a passive means of control.

1. Municipal land-use ordinances pertaining to the location of airports make use of the attenuating effect of distance on sound levels.

Protect the recipient

1.Use of earplugs and earmuffs. Specially designed earmuffs can reduce the sound level reaching the eardrum by as much as 40 dB.

Besides these in general making Legislation, Educating and bringing awareness in the people is common for control of any pollution Ex: Ban on loud speakers from 10pm to 6pm.

***Case study**: **Noise Hits Whales in Hong Kong** Studies have shown that shipping traffic in Hong Kong, which is one of the busiest ports in the world with approximately half a million oceanic vessels traveling through its waters every year (including over 10,000 transits by high speed ferries) has caused changes in the dolphin and whale behavior especially in response to fast moving vessels. A special sanctuary was established by the Hong Kong government in 1995, surrounding the islands of Sha Chau and Lung Kwu Chau, an important place occupied by the humpback dolphins. At any given time approximately 200 vessels surrounds this sanctuary. The sanctuary was a measure to mitigate boat traffic and tremendous noise produced. Adjacent to the sanctuary is an airport, where 700 planes descend and take off everyday, directly over the sanctuary. All the above activities have caused high noise input into the natural whale habitat. Noise, a major anthropogenic stress factor has caused a general decline in the whale populations. (Ref: .Sushmitha Baskar and Baskar)*

NUCLEAR HAZARDS

Radionuclides are elements (uranium 235, uranium 283, thorium 232, potassium 40, radium 226, carbon 14 etc) with unstable atomic nuclei and on decomposition release ionizing radiations in the form of alpha, beta and gamma rays. Out of the known 45O radioisotopes only some are of environmental concern like strontium 90, tritium, plutonium 239, argon 41, cobalt 60, cesium 137, iodine 131, krypton 85 *etc.* These can be both beneficial and harmful, depending on the way in which they are used. We routinely use X-rays to examine bones for fractures, treat cancer with radiation and diagnose diseases with the help of radioactive isotopes. About 17% of the electrical energy generated in the world comes from nuclear power plants.

Radioactive substances when released into the environment are either dispersed or become concentrated in living organisms through the food chain. Other than naturally occurring radioisotopes, significant amounts are generated by human activity, including the operation of nuclear power plants, the manufacture of nuclear weapons, and atomic bomb testing.

For example, strontium 90 behaves like calcium and is easily deposited and replaces calcium in the bone tissues. It could be passed to human beings through ingestion of strontium-contaminated milk. Again another example is tritium, which is radioactive hydrogen. The amount of tritium released from nuclear power plants to the atmosphere have reached as high as tens of thousands of curies in one year, and releases to bodies of water have measured as high as tens of millions of picocuries per litre. The

U.S. Environmental Protection Agency standard for permissible levels of tritium in drinking water is 20,000 picocuries per litre. Nuclear power plants routinely and accidentally release tritium into the air and water. Tritium has a half-life of 12.3 years and emits radioactive beta particles. Once tritium is inhaled or swallowed, its beta particles can bombard cells causing a mutation.

. A few occupations that involve radioactive exposures are uranium mineworkers, radium watch dial painters, technical staff at nuclear power plants, *etc.* Exposure to radioactive and nuclear hazards has been clinically proven to cause cancer, mutations and teratogenesis (Teratogenesis is a prenatal toxicity characterized by structural or functional defects in the developing embryo or fetus).

Nuclear hazard effects can be either initial or residual. Initial effects occur in the immediate area of explosion and are hazardous immediately after the explosion where as the residual effects can last for days or years and cause death. The principal initial effects are blast and radiation. Blast causes damage to lungs, ruptures eardrums, collapses structures and causes immediate death or injury. Thermal Radiation is the heat and light radiation, which a nuclear explosion's fireball emits producing extensive fires, skin burns, and flash blindness. Nuclear radiation consists of intense gamma rays and neutrons produced during the first minute after the explosion. This radiation causes extensive damage to cells throughout the body. Radiation damage may cause headaches, nausea, vomiting, diarrhea, and even death, depending on the radiation dose received.

Sources

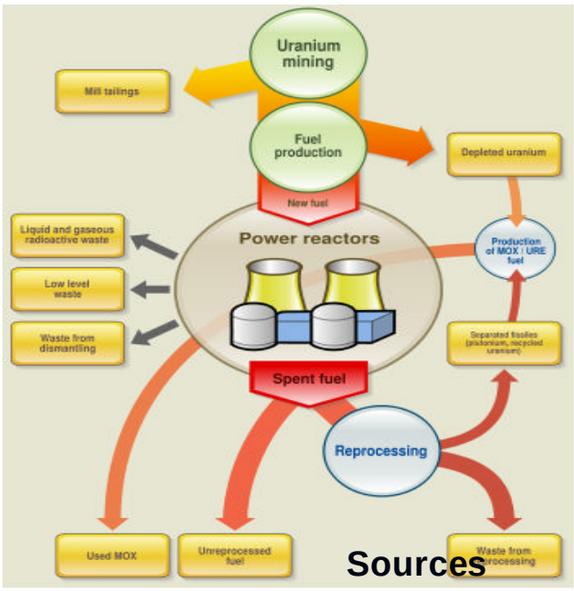
The sources of radioactivity include both natural and manmade.

Natural sources

- Cosmic rays from outer space
- Emissions from radioactive materials in the earth's crust (rocks, marine sediments etc)

Man-made sources include the nuclear wastes produced during

- Mining and processing of radioactive ores
- Use of radioactive materials in power plants
- Use of radioactive isotopes in medical technology (x-ray machines, radioisotopes used in medicine)
- Industrial applications include wastes from nuclear reactors
- Research applications: radioactive fallouts during nuclear weapons testing.
- In a nuclear power plant, any leak or accident taking place emit nuclear radiation. In either case it results in nuclear hazard.
- Nuclear tests Conducted under the ground or under oceans which also release radiation.
- Uranium mining and milling, Nuclear reactors and reprocessing of nuclear fuel cause nuclear pollution.



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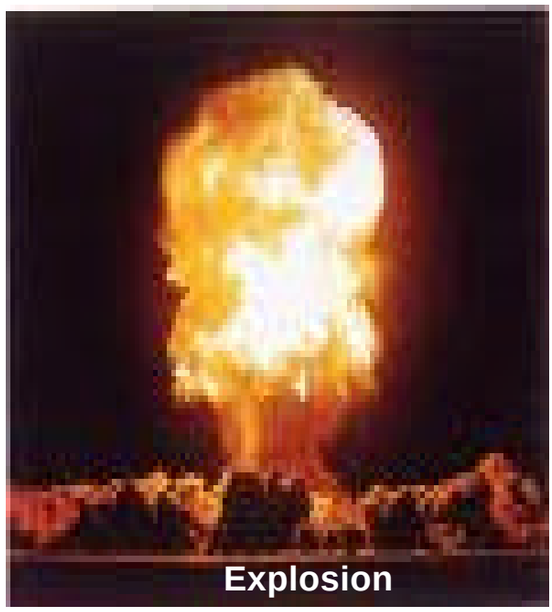

Explosion

Effects

Studies shown that the health effects due to radiation are dependent on the level of dose, kind of radiation, duration of exposure and types of cells irradiated. Radiation effects can be somatic or genetic. ***Somatic affects*** the function of cells and organs. It causes damages to cell membranes, mitochondria and cell nuclei resulting in abnormal cell functions, cell division, growth and death. ***Genetic affects*** the future generations. Radiations can cause mutations, which are changes in genetic make up of cells. These effects are mainly due to the damages to DNA molecules. People suffer from blood cancer and bone cancer if exposed to doses around 100 to 1000 roentgens. Instantaneous deaths on exposure in the event if disasters are many.

Control measures

- Laboratory generated nuclear wastes should be disposed off safely and scientifically.
- Nuclear power plants should be located in areas after careful study of the geology of the area, tectonic activity and meeting other established conditions.
- Appropriate protection against occupational exposure
- Leakage of radioactive elements from nuclear reactors, careless use of radioactive elements as fuel and careless handling of radioactive isotopes must be prevented.
- Safety measure against accidental release of radioactive elements must be ensured in nuclear plants.
- Unless absolutely necessary, one should not frequently go for diagnosis by x-rays.
- Regular monitoring of the presence of radioactive substance in high risk area should be ensured.

Among the many options for waste disposal, the scientists prefer to bury the waste in hundreds of meters deep in the earth's crust is considered to be the best safety long term option.

The Chernobyl nuclear disaster: A lesson in the technological disaster of human history *This disaster that occurred on April* 26*, 1986 in Ukraine, (i.e. former USSR) at the Chernobyl power plant reactor, designed to produce 1000 MW of electrical energy. It resulted in the release of Sr-90, Ce-134, Ce-137, I-131 etc. which polluted the whole region. The explosion occurred due to faulty shutting down of the plant. Combustion of the graphite rods inside the rector resulted in fire and the temperature of the reactor went up to 2000°C. The radioactive debris, gases and plume drifted over the entire northern hemisphere affecting mostly Sweden, Norway, Poland, and Denmark etc. More than 2000 people died in the disaster and many children were affected with congenital abnormalities. The disaster damaged agricultural crops, plants and caused cancer, lung, eye and blood disorders. Many European countries like Denmark and Sweden had banned the import of milk and milk containing products from the former USSR. This was because the milk was contaminated by I-131, which had entered the cows through grazing on pastures and plants, contaminated with the same.*

SOLID WASTE

The combined effects of population explosion and changing modern living standards have had a cumulative effect in the generation of a large amount of various types of wastes. Solid waste can be classified into different types depending on their source.

- Municipal solid waste (MSW)
- Industrial waste
- Hazardous waste
- Biomedical or hospital waste: as infectious waste.
- Agricultural waste

Solid waste management:

Muncipal Solid Waste (MSW): The term municipal solid waste (MSW) is generally used to describe most of the non-hazardous solid waste from a city, town or village that requires routine collection and transport to a processing or disposal site. Sources of MSW

include private homes, commercial establishments and institutions, as well as industrial facilities. However, MSW does not include wastes from industrial processes, construction and demolition debris, sewage sludge, mining waste or agricultural wastes. MSW is also called as trash or garbage. In general, domestic waste and MSW are used as synonyms. Municipal solid waste contains a wide variety of materials. It can contain food waste (like vegetable and meat material, leftover food, eggshells etc.), which is classified as wet garbage as well as paper, plastic, tetrapack, plastic cans, newspaper, glass bottles, carboard boxes, aluminum foil, metal items, wood pieces, etc., which is classified as dry garbage. The different types of domestic wastes generated and the time taken for them to degenerate is illustrated in the table given below.

Table: Domestic wastes and their degeneration time

Common domestic wastes	**Approximate time taken for degeneration**
Organic kitchen waste vegetables, fruits	1—2 weeks
Paper, cardboard paper	15 days—1 month
Cotton clothes	2—5 months
Woolen clothes	about a year
Metal cans, tin, aluminum	100—500 years
Plastics	1 million years

India's urban population slated to increase from the current 330 million to about 600 million by 2030, the challenge of managing municipal solid waste (MSW) in an environmentally and economically sustainable manner is bound to assume gigantic proportions. The country has over 5,000 cities and towns, which generate about 40 million tonnes of MSW per year today. Going by estimates of The Energy Research Institute (TERI), this could well touch 260 million tonnes per year by 2047.

The functional elements of MSW management

The municipal solid waste industry has four components: recycling, composting, landfilling, and waste-to-energy via incineration.

The primary steps are generation, collection, sorting and separation, transfer and disposal/utilisation. *Waste generation* encompasses activities in which materials are identified as no longer being of value and are either thrown out or gathered together for disposal. The functional element of *Collection* includes not only the gathering of solid waste and recyclable materials, but also the transport of these materials, after collection, to the location where the collection vehicle is emptied. This location may be a materials processing facility, a transfer station or a landfill disposal site. *Waste handling and separation* involves activities associated with waste management until the waste is placed in storage containers for collection. Handling also encompasses the movement of loaded containers to the point of collection. Separating different types of waste components is an important step in the handling and storage of solid waste at the source.The types of means and facilities that are now used for the recovery of waste materials that have been separated at the source include curbside collection, drop off and buy back centers. *Transfer and transport* involves two main steps. First, the waste is transferred from a

smaller collection vehicle to larger transport equipment. The waste is then transported, usually over long distances, to a processing or disposal site.Today the disposal of wastes by land filling or land spreading is the ultimate fate of all solid wastes, whether they are residential wastes collected and transported directly to a landfill site, residual materials from materials recovery facilities (MRFs), residue from the combustion of solid waste, compost or other substances from various solid waste processing facilities. A modern sanitary landfill is not a dump; it is an engineered facility used for disposing of solid wastes on land without creating nuisances or hazards to public health or safety, such as the breeding of insects and the contamination of ground water. Municipal solid waste can be used to *generate energy*. Several technologies have been developed that make the processing of MSW for energy generation cleaner and more economical than ever before, including landfill gas capture, combustion, pyrolysis, gasification, and plasma arc gasification. While older waste incineration plants emitted high levels of pollutants, recent regulatory changes and new technologies have significantly reduced this concern. In USA, EPA regulations in 1995 and 2000 under the Clean Air Act have succeeded in reducing emissions of dioxins from waste-to-energy facilities by more than 99 percent below 1990 levels, while mercury emissions have been by over 90 percent The EPA noted these improvements in 2003, citing waste-to-energy as a power source "with less environmental impact than almost any other source of electricity" (en.wikipedia.org).

Municipal solid waste management is more of an administrative and institutional mechanism failure problem rather than a technological one. Until now, MSW management has been considered to be almost the sole responsibility of urban governments, without the participation of citizens and other stakeholders. The Centre and the Supreme Court, however, have urged that this issue be addressed with multiple stakeholder participation. Cities in India spend approximately 20% of the city budget on solid waste services.

Hazardous Wastes

Hazardous wastes are those that can cause harm to human and the environment.

Characterstics of hazardous wastes:

Wastes are classified as hazardous if they exhibit any of four primary characterics based on physical or chemical properties of toxicity, reactivity ignitability and corrosivity.

Toxic wastes

Toxic wastes are those that are poisonous in small or trace amounts. Some may have acute or immediate effect on human or animals. Carcinogenic or mutagenic causing biological changes in the children of exposed people and animals. *Eg*: pesticides, heavy metals.

Reactive wastes: reactive wastes are those that have a tendency to react vigorously with air or water are unstable to shock or heat, generate toxic gases or explode during routine management. *Eg*: Gun powder, nitroglycerine.

Ignitable waste: are those that burn at relatively low temperatures (<60^{o} C) and are capable of spontaneous combustion during storage transport or disposal. *Eg:* Gasoline, paint thinners and alcohol.

Corrosive wastes: are those that destroy materials and living tissues by chemical reactions. *Eg:* acids and base

Infectious wastes: included human tissue from surgery, used bandages and hypoderm needles hospital wastes.

Sources: Chemical manufacturing companies, petroleum refineries, paper mills, smelters and other industries. Plastic industries

Thousand of chemicals are used in industries every year. When used incorrectly or inappropriately they can become health hazards. PCBs (Polychlorinated biphenyls) are resistant to fire and do not conduct electricity very well, which makes them excellent materials for several industrial purposes. Rainwater can wash PCBs out of disposal areas in dumps and landfills thus contaminating the water. PCBs do not break open very rapidly in the environment and thus retain their toxic characteristics. They cause long-term exposure problems to both human and wildlife.

Many household chemicals can be quite toxic to humans as well as wildlife. Most of the dangerous substance in our homes are found in various kinds of clearness, solvents and products used in automotive care. When these products are used incorrectly they have the potential to be harmful.

Effects: As most of the hazardous wastes are disposed off or in land, the most serious environmental effect is contaminated ground water. Once ground water is polluted with hazardous wastes, it is very often not possible to reverse the damage. Pesticides form residues in the soil that are washed into streams which then carry them forward. The residues may persist in PCBs (poly chlorinated biphenyls) are concentrated in the kidneys and liver and cause damage; they cause reproductive failure in birds and mammals .The soil or in the bottom of lakes and rivers. Exposure can occur through ingestion, inhalation and skin contact, resulting acute or chronic poisoning. Lead, mercury and arsenic are hazardous substances which can often referred to as heavy metals. Most of the lead absorbed by people is stored in the bones. Lead can effect red blood cells by reducing their ability to carry oxygen and shortening their life span. Lead may also damage nervous tissue, resulting in brain disease. Mercury is used in production of chlorine and as a catalyst in the production of some plastics.

Mercury build up in body over long period of time is known to cause brain damage. Minamata disease occur due to mercury poisoning. Vinyl chloride is a chemical that is widely used in plastic manufacture. A long continuous exposure in humans it can cause deafness, vision problem circulation disorders and bone deformities.

Control: common methods for disposing of hazardous wastes are land disposal and incineration Industries need to be encouraged to generate less hazardous waste in the manufacturing process. Although toxic wastes cannot be entirely eliminated, technologies are available for minimizing recycling and treating the wastes. Integrated pest management practices (IPM) reduce the usage of pesticides. Substitute the use of PCBs

and vinyl chloride with chemicals that are less toxic. Polyvinyl chloride use can be lowered by reducing the use of plastics.

Industrial wastes

These contain more of toxic and require special treatment.

Source: Food processing industries, metallurgical chemical and pharmaceutical unit's breweries, sugar mills, paper and pulp industries, fertilizer and pesticide industries are major ones which discharges toxic wastes. During processing, scrap materials, tailings, acids etc.

Effect: Most common observation is that the health of the people living in the neighborhood of dumping sites is severely affected. The exposure may cause disorders of nervous system, genetic defects, skin diseases and even caner. The liquid effluents discharged by the industries contain inorganic and organic pollutants and they enter into water bodies causing destruction of fish, formation of sediments, pollution of ground water and release of foul odours.

Control: Waste minimization technologies have to be developed. Source reduction recycling and reuse of materials need to be practiced on a large scale.

Hazardous waste should not mix up with general waste. Source reduction involves altering the design, manufacture or use of products & materials to reduce the amount and toxicity of materials that get thrown away. Local communities and voluntary organizations should educate the industrialists as well as the public about dangers of pollution and the need to keep the environment clean. Land filling, incineration & composting technologies to be followed. Biogas is obtained from solid waste treatment of industrial and mining waste is done for the recovery of useful products.

A classic case study of waste mismanagement: The Love Canal tragedy

In 1892, a small area near Niagara Falls, New York, USA was dug up and designed as a route for transportation and for the production of hydroelectric power connecting the lower and upper reaches of the Niagara River, called the love canal (named after William T. love). The process was left incomplete and eventually became a site for waste disposal. A Plastic manufacturing chemical company disposed off its wastes in sealed steel drums during the years 1940 to 50. More than 20,000 tons of 80 different chemicals were dumped in the area. In 1953, the company sold the land to the city of Niagara Falls. Subsequently, many residences and an elementary school were built on the land. The tragic story of the love canal incident started after twenty years due to heavy snow and rains. The sealed plastic wastes had corroded the drums and started leaking into the soil, buildings, water etc. Children in the school were shocked to see their rubber shoe soles disintegrating and they also suffered burns. This caused the officials to look into the matter and it was found that the wastes contained lot of carcinogens and a wide array of toxic organic compounds like benzene, chloroform, dichloroethylene etc. The clean up of the Love canal totally amounted to about 275 million US dollars. The schools and homes were destroyed, the families relocated, the soil was completely covered with compacted

clay, the wastes were diverted to a treatment plant, the water pipes were blocked with barriers, etc. This was a classic example of solid waste mismanagement.

Toxic materials pose significant health hazards and dwindle our precious bio-reserves. Proper and timely management of waste is very important in the good interest of our environment, and us. The above classic case study proves that management of wastes is a very serious business and if not handled with care, the cleaning up of improperly disposed wastes can cause loss/damage to human life and be extremely costly. It therefore makes sense to plan the disposal of various kinds of wastes in a scientific manner.

Agricultural Wastes

Sources: The waste generated by agriculture includes waste from crops and live stock. In developing countries, this waste does not pose a serious problem as most of it is used e.g. dung is used for manure, straw is used as fodder. Some agro-based industries produce waste e.g., rice milling, production of tea, tobacco etc. Agricultural wastes are rice husk, degasses, ground nut shell, maize cobs, straw of cereals etc.

Effects: If more C: N ratio wastes like paddy husk or straw may cause immobilization of nutrients if applied on the fields. It occupies to large land areas if not properly disposed.

Management

1. **Waste to energy**
   i) **Gasification**: It is the process in which chemical decomposition of biomass takes place in the presence of controlled amounts of oxygen, producing a gas. This gas is cleaned and used in an internal combustion engine to produce electric power. Without clean up also, the gas can be used in boilers to produce electric power. This technology is highly suited to generate electric power from agrl wastes like rice husks, groundnut shells etc.

   ii) Pyralysis: It is similar to gasification except that the chemical decomposition of biomass wastes take place in the absence or reduced presence of O_2 at high temp. Mixtures of gases result from decomposition including H_2, NH_4 Co, CO_2 depending on the organic nature of waste matter. This gas used for power generation.

2. **Biogas production**: Animal wastes, food processing wastes and other organic matter are decomposed anaerobically to produce a gas called biogas. It contains methane and CO_2. The methane can provides gas for domestic use. The byproduct of this technology is slurry, settled out the bottom of the digester. This can be used as manure.

3. Agricultural waste like corn cobs, paddy husk, bagasse of sugarcane, waste of wheat, rice and other cereals, cotton stalks, coconut wastes, jute waste etc can be used in making of paper and hard board.

Waste production can be minimized by adopting the 3 R's principle: Reduce, Reuse, Recycle

- Reduce the amount and toxicity of garbage and trash that you discard.
- Reuse containers and try to repair things that are broken.
- Recycle products wherever possible, which includes buying recycled products *i.e.* recycled paper books, paper bags etc.

These are processes that involve integrated waste management practices (IWM). They can reduce the wastes generated by approximately 50 %.

Reduce (Waste prevention): Waste prevention, or "source reduction," means consuming and discarding less, is a successful method of reducing waste generation. Backyard composting, double sided copying of papers, purchasing durable, long-lasting environmentally friendly goods; products and packaging that are free of toxics, redesigning products to use less raw material production and transport packaging reduction by industries are the normal practices used and have yielded substantial environmental benefits. Source reduction prevents emissions of many greenhouse gases, reduces pollutants the need saves energy, conserves resources, and reduces wastes for new landfills and combustors. It reduces the generation of waste and is generally preferred method of waste management that goes a long way toward saving the environment.

Re-use: Re-use is the process, which involves reusing items by repairing them, donating them to charity and community groups, or selling them. Reusing products is an alternative to recycling because the item does not need to be reprocessed for its use again. Using durable glassware, steel using cloth napkins or towels, reusing bottles, reusing boxes, purchasing refillable pens and pencils are suggested.

Recycling: The process of recycling, including composting, has diverted several million tons of material away from disposal. Recycled materials include batteries, recycled at a rate of 93%, paper and paperboard at 48%, and yard trimmings at 56%. These materials and others may be recycled through drop off centers, buy-back programs, and deposit systems. Recycling prevents the emission of many greenhouse gases that affect global climate, water pollutants, saves energy, supplies valuable raw materials to industry, creates jobs, stimulates the development of greener technologies, conserves resources for our children's future, and reduces the need for new landfills and combustors. For example, by recycling of solid waste in 1996, the United States prevented the release of 33 million tons of carbon into the air roughly the amount emitted annually by 25 million cars. Recycling can create valuable resources and it generates a host of environmental, financial, and social benefits. Materials like glass, metal, plastics, and paper are collected,

separated and sent to processing centers where they are processed into new products. The advantages of recycling are it conserves resources for future generation, prevents emissions of greenhouse gases and pollutants, saves energy, supplies valuable raw, materials to industries, stimulates the development of greener technologies, reduces the need for new landfills and incinerators.

DISASTER MANAGEMENT

Natural calamities, of different types and intensities affect nations all over the world. The Indian subcontinent is very vulnerable to droughts, floods, cyclones, earthquakes, landslides, and forest fires. While not all natural calamities can be predicted and prevented, a state of preparedness and ability to respond quickly to natural calamity can considerably mitigate loss of life and property and human suffering, and restore normalcy at the earliest.

'Post Disaster Management' and 'Disaster Mitigation':

The post disaster approach towards dealing with natural disasters, involving problems such as evacuation, warnings, communications, search and rescue, fire-fighting, medical and psychiatric assistance, provision of relief, shelter, etc, is generally referred to as 'Post Disaster Management' . It is a primarily a 'Reactive Mechanism' to the natural disasters.

'Mitigation' means lessening the negative impact of the natural hazards. It is defined as sustained action taken to reduce long term vulnerability of human life and the recovery property to natural hazards. While the preparatory, response and the recovery phases of emergency management relate to specific events. Mitigation activities have the potential to produce repetitive benefits over time. It is a 'Proactive approach' to natural disasters.

Multidisciplinary and Multi- sectoral nature of Disaster Management:

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

Guidelines for effective management of mitigation program.

1. Pre- disaster mitigation can help in ensuring foster recovery from the impacts of disasters.
2. Mitigation measures must ensure protection of the natural and cultural assests of the community
3. Hazard reduction methods must take into account the various hazards faced by the affected community & their desires and priorities
4. Any mitigation programme must also ensure an effective partnership between the Govt, Scientific, private sector, NGOs and the community

The main elements of a mitigation strategy

1. Risk assessment and Vulnerability analysis: This involves the identification of hotspot areas of prime concern, collection of information on past natural hazards, information on the population and infrastructure.
2. Applied research and technology transfer: There is a need to establish or upgrade observation equipment and networks, monitor the hazardous properly, improve the quality of forecasting and warning.
3. Public awareness and training: Training to be given to officials & staff of various Departments involved in state & district level.
4. Institutional mechanisms: There is need to emphasize on proactive and pre-disaster measures rather than post-disaster response. It is thus essential to have a permanent administrative structure which can monitor the developmental activities across departments and provides suggestions for necessary mitigation measures. The national disaster management centre (NDMC) can perform such a task. Professional like architects, structural engineers, doctors and chemical engineers who are involved with management of hazardous chemicals, can be asked to form groups that can design specific mitigation measures.
5. Incentives and resources for mitigation: Provide stable source of funding for all mitigation programs.
6. Land use planning and regulations.
7. Hazard resistant design and construction.
8. Structural and Constructional reinforcement of existing buildings: This can be done by the insertion of walls, specially on chored frames, construction of new frame systems, designing residential electrical equipment above flood level, designing water storage tanks to be able to withstand cyclonic winds, earthquakes & floods.

Some of the causes, effects and mitigation measures of the disasters commonly occurring in India are detailed below:

Floods : Floods can be caused by natural, ecological or anthropogenic factors either individually or as a combined result. Human activities such as deforestation and shifting cultivation can also contribute to floods. Heavy rainfall is the main cause of floods in the rivers. The breaches to tanks and reservoirs due to inflow of large quantities of water from excessive rainfall also result in floods. Floods occur sometimes in a flash due to intensive rains at the time of cyclones next to Bangladesh, India is the most flood – affected country in the world. The west coast of India has an advantage, it has western ghats with thick forests which act as natural buffer to floods.

Effects: floods cause heavy suffering to people living in low lying areas because the houses and the properties are inundated or washed away. Most of the victims are rural folks who are economically poor. Floods also damage standing crops and livestock.

The *mitigation measures* for floods include both structural and non structural measures.

The structural measures include

1. Reservoirs for impounding monsoon flows to be released in a regular manner after the peak flood flow passes.
2. Prevention of over –bank spilling by the construction of embarkments and flood walls
3. Improvement of flow conditions in the channel and anti erosion measures.
4. Improved drainage

The non structural measures include

1. Flood-plain management such as Flood Plain zoning and flood proofing including disaster preparedness
2. Maintaining wet lands
3. Flood forecasting and warning services
4. Disaster relief and public health measures.
5. Flood insurance

Case study

Since 2006, Mumbai faces flooding in most of the Suburban Locations Like Andheri, Dahisar, Goregaon, Malad Subway, Milan Subway, Santacruz, Chembur, Dombivali, Worli etc which are low line areas and also highly affected during Monsoon and Heavy rainfall. Because of Unstable weather, Mismanagement of Natural Resources by People, Old or No proper drainage systems and Real Estate development, Mumbai is underwater Mostly every year even if Bombay Municipal Corporation tries it level best to help the disaster.

Flood 2006 will never be forgotten by any person who was in Mumbai during the day, every thing was like stand Still, the Transportation, Private Vehicles, Mobile Services and all major communication and transport channels stopped. Still salute to mumbaikers for the Humanity shown that day by helping each others at there level best. Someone helped giving Biscuits and Few by preparing whatever fast food like Vada pav, samosas

etc. Lots of NGO's and Private organizations came up for the help. All this happened within couple of hours of very heavy rain in Mumbai. Many lost there lifes and many saved it loosing just there belongings like Mobiles and bags etc. Every person stayed where they were for next 24 hours.

Flood 2007 of Mumbai was not as hard as 2006, few of the slums and people stying in low line ground floor locations faced terrible problems. People of Mumbai are now tough enough to face such flooding disaster's and bomb blasts and Epidemics and Diseases because of flood.Mumbai Flood Pictures can speak much better than this article.

Now in 2008 and 2009 Flooding in Mumbai is comparatively low because of not so heavy rainfall. Almost opposite situation like cloud seeding experiments are undertaken to save mumbai from low rainfall.

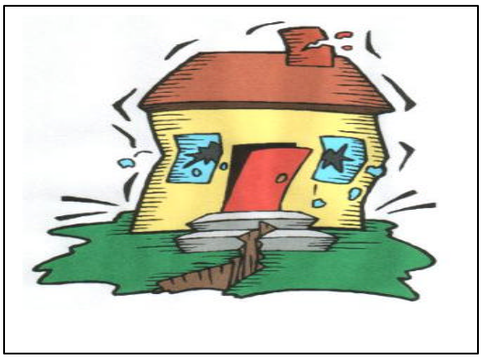
www.mumbai77.com

Earth quakes: An abrupt and tremendous release of energy stored in the rocks and the earth's crust through the action of tectonic process is described as an earth quake. Some areas on the planet earth are so located that more than one tectonic plate constantly change against one another and an earthquake can result when one or more of these plates move against the others at high speed. In certain regions of earth, earth quakes occur with regularity. In India, Assam and the Himalayan regions are more infested with earthquakes. Earthquake that occurred in 2001 in Gujarat taking a toll of 30,000 per ape was major one Hythi at present. The intensity of earth quake is measured on Richter scale. As of now there is no way of predicting an earth quake. Earthquake by themselves do not cause casualties but the houses collapse due to poor construction. The construction of quake-proof houses may reduce human loss but it may be economically difficult for poor countries. The Government of countries which are quake prone should ensure that the infrastructure could withstand earth quakes.

On 26 January 2001 an earthquake registering 7.9 on the Richter scale devastated the Indian state of Gujurat. It was the second largest recorded earthquake in India, the largest being in 1737, and was the worst natural disaster in India in more than 50 years.

The earthquake struck at approximately 8.46am local time, its epicentre located 80 kilometres north-east of the city of Bhuj .The place in the earth's crust where an earthquake occurs is known as the focus. The epicentre of an earthquake is the place directly above the focus. The shock waves or tremors from the Gujurat earthquake lasted about two minutes, followed by aftershocks for more than a month. The scale of the impact of the earthquake is almost impossible to comprehend. The shock or seismic waves spread out in a 700 kilometre circumference from the epicentre, and within this area the devastation was immense. There were more than 20,000 deaths and 167,000 people injured. Four districts of Gujurat lay in ruin and altogether, 21 districts were affected.

Around 300,000 families and at least 3 million children aged 14 and under were affected. Around 600,000 people were left homeless. In the city of Bhuj, more than 3,000 inhabitants of the city lost their lives, the main hospital was crushed and close to 90% of the buildings was destroyed. Nothing was left of the town of Bhachau. The town resembled a quarry. Few structures remained standing



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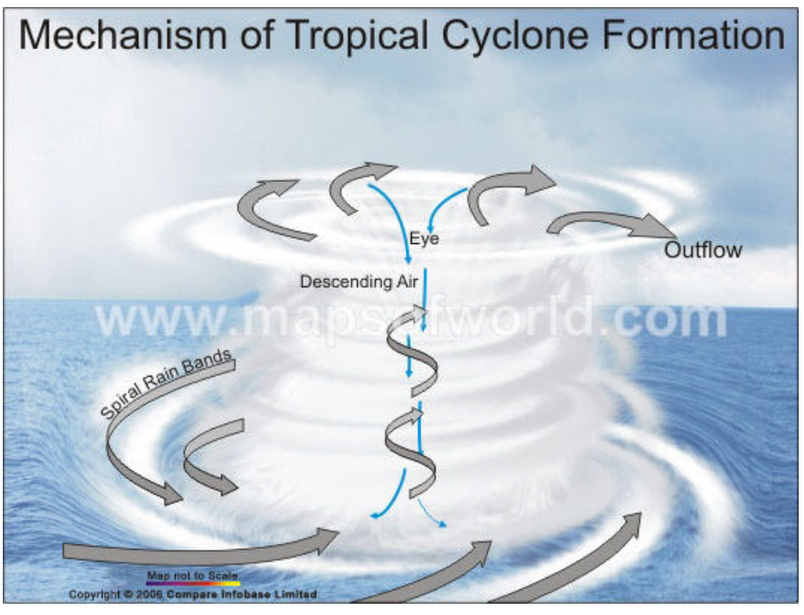
Cyclones: Cyclone is a meteorological phenomena of intense depressions forming over the open oceans and moving towards the land on the shore. In reaching the shores, it moves into the interior of the land or along the shorelines. The cyclone once formed may be active from days to weeks and affects many days to weeks and affects many areas, even countries depending on the nature and the intensity. Globally North West pacific regions are more prone to cyclones. The Indian Ocean is one of the six major cyclone prone regions of the world. India has a long coastline of 5700 kms, which is exposed to tropical cyclones arising in the Bay of Bengal and the Arabian Sea. The eastern coastline is more prone to cyclones as it is hit by about 80 percent of the total cyclones generated in the region. In India, cyclones originating from Bay of Bengal are more in number and intensity. In India, cyclones occur usually between April and May and also between October and December. The damage depends on the intensity of cyclone, the damage to human life, crops, settlements roads, communications, tanks, canals, and livestock sometimes their occurrence slow down the developmental activities of the areas.



Mitigation measures are:

- Installation of early warning systems
- Developing communication infrastructure
- Developing shelter belts
- Construction of permanent houses
- Training and education land use control and settlement planning.

Land slides: are recurring phenomena in Himalayan region. It is a geological process which includes a wide range of mass movements, such as rock falls, deep failure of slopes and shallow debris flows. Although gravity acting on an over steepened slope is the primary reason for a landslide, there are other contributing factors affecting the original slope stability erosion by rivers, glaciers, or ocean waves create over steepened slopes. In recent years, however, intensive construction activity and the destabilizing forces of nature have aggravated the problem. Landslides occur as a result of changes on the slope, sudden or gradual either in its composition, structure, hydrology or vegetation. The changes can be due to geology, climate, weathering, changing land use and earth quakes.

- Rock and soil slopes are weakened through saturation by snowmelt or heavy rains earthquakes create stresses that make weak slopes fail
- Volcanic eruptions produce loose ash deposits, heavy rain, and debris flows
- Vibrations from traffic, machinery, thunder and blasting can trigger weak slopes
- Groundwater pressure acting to destabilize the slope
- Excess weight from accumulation of rain or snow, stockpiling of rock or ore, from waste piles, or from man-made structures may stress weak slopes to failure and other structures.

Measures to prevent land slides are drainage measures, erosion control measures such as bamboo check dams, terracing, jute and coir netting and rock fall control measures such as grass plantation, vegetated dry masonry walls, preventing deforestation and improving forestation. A significant reduction in the hazards caused by land slides can be achieved by preventing the exposure of population and by physically controlling the land slides.

TSUNAMI The term Tsunami comes from the Japanese language, meaning harbor (*tsu*) and wave (*nami*). A Tsunami is generated when the sea floor abruptly deforms and vertically displaces the overlying water. It is the wave disturbance that rapidly displaces a large mass of water like an under sea earth quake, volcanic eruption or submarine land slide. Tectonic earthquakes are a particular kind of earthquakes that are associated with earth's crustal deformation; when these earthquakes occur beneath the sea, the water above the deformed area is displaced from its equilibrium position. Waves are formed as the displaced water mass, which acts under the influence of gravity attempts to regain its equilibrium. When large areas of the sea floor elevate or subside, a tsunami can be created. Tsunami wave can travel at the speed of a commercial jet plane, over 800 km/h. they can move from one side of the pacific ocean in less than a day. The waves can be extremely dangerous and damaging when they reach the shore. The wave travels across the ocean at speed of 500-1000 km/ha. As the wave approaches the land, it compresses-some times upto a highest of 30mts and the sheer weight of water is enough the crush the objects in its path, often reducing the building to their foundations and scouring exposed ground to the bed rock. When there is a tsunami warning:

1. If you are at home and there is a tsunami warning, you should make sure your entire family is aware of the tsunami. Your family should evacuate your house if you live in a tsunami evacuation zone.
2. If you are at the beach or near the ocean and you feel the earth shake, move immediately to higher ground. Do not wait for a tsunami warning to be announced.
3. If you are on a ship or boat, do not return to port if you are at sea and a tsunami warning has been issued for your area. Tsunami can cause rapid changes in water level and unpredictable dangerous current in harbours and ports.

On the morning of Sunday, 26 December 2004, there was a severe earthquake in the Indian Ocean off the coast of northern Sumatra, Indonesia. The earthquake measured 9.0 on the Richter scale and was followed by aftershocks ranging from 6.3 to 7.0 in severity in a zone 1,000 kilometres north to the Andaman Islands. The underwater earthquake also resulted in a powerful tsunami ('soo-na-mi', from the Japanese words meaning 'harbour wave'). The wave travelled quickly under the ocean, building to a wall of water up to 10 metres high when it reached the shallow coastal waters and causing massive destruction when it hit land. Without an effective warning system and disaster plan, many people did not know to move quickly to higher ground to escape the wave and its load of debris. In some places the sea receded for hundreds of metres before the wave rushed in. Curious people looking at this strange occurrence from the beaches did not recognise this as a sign of danger, and as a result were killed by the tsunami.The tsunami caused extraordinary damage. The death toll was put at roughly 187,000, with nearly 43,000 missing and many hundreds of thousands injured and suffering trauma and the grief of losing family members, their homes and their livelihoods. Countries lost people with the knowledge and skills that were needed for their ongoing development. Roads, bridges, water and electricity supplies, health centres and schools were destroyed. The landscape was altered unrecognisably, with some areas lifted high out of the water while others were washed entirely away. Debris and waste were scattered widely and salt inundated farmland and underground water supplies.

One of the most severely affected areas was that closest to the epicentre, the province of Aceh on Sumatra, Indonesia. More than 130,000 people died and 36, 786 were still missing in December 2005. The highest tolls were among the women and

children who were in the low lying coastal areas while their husbands were at sea fishing. Over 800 kilometres of coast was severely affected, often up to five kilometres inland. At least 654 villages were damaged or destroyed, more than 500,000 people lost their homes, and more than 150,000 children were left without schools. To add to the devastation an earthquake measuring 8.7 on the Richter scale struck the west coast of Sumatra near the island of Nias on 28 March 2005.

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SOCIAL ISSUES

India is the largest contributor to world population growth, adding about 17 million people every year to an already huge population of over one billion. Although more than two-thirds of India's population still lives in the rural areas, it has experienced rapid urbanization over the last two decades. India has attained food sufficiency in spite of its growing population. It has also created a large base of skilled scientific and technical human resources with a diversified industrial base. However, the benefits of this impressive growth have been substantially offset by environmental degradation. Even though India has a rich tradition of environment conservation, large scale environment degradation has resulted from population pressures, industrialization and the indiscriminate use of forest areas for fuel, power generation and irrigation purposes. The spread of input-intensive green technology has given India, of a certain measure of food security, but it has been at the cost of falling water tables, degrading soils, poor management of irrigation systems and the harmful side-effects of increasing pesticide and fertiliser use. Industrial growth and uncontrolled urbanisation pollute water, air and land. Similarly, rapid economic growth led to changing lifestyle such as increasing use of automobiles and plastics are also putting an immense stress on resources and the environment. All these circumstances raise the issue of how to achieve environmentally sustainable economic development. In this context, it is fundamental that policy-makers and the public understand how society and the economy have changed, and how they cause environmental degradation.

FROM UNSUSTAINABLE TO SUSTAINABLE DEVELOPMENT.

Sustainable development has been defined as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (The World Commission on Environment and Development, Brundtland Commission 1987). In other words, when people make decisions about how to use the Earth's resources such as forests, water, minerals, wildlife, etc. they must take into account not only how much of these resources they are using, what processes they used to get these resources, and who has access to these resources. Are enough resources going to be left for our future generations to use and will the environment be left as we know it today? Therefore, development plans have to ensure: sustainable and equitable use of

resources for meeting the needs of the present and future generations without causing damage to environment.

.The primary objective of sustainable development is to reduce the absolute poverty of the world's poor through providing lasting and secure livelihoods that minimize resource depletion, environmental degradation, cultural disruption and social instability.

It also considers the equity between countries and continents races and closes, gender and ages. It includes social and economic development. It is a process which leads to a better quality of life while reducing the impact on the environment.

To ensure sustainable development, any activity that is expected to bring about economic growth must also consider its environmental impacts for long term growth and development. Long term economic development is inter linked with environmental practices.

Practicing sustainable development poses a challenge because people must learn to live on the world's ecological interest and not on ecological capital. To accomplish sustainable development, a number of areas have to be organised. Those are

1. Improving energy efficiency
2. Saving forests
3. Safeguarding biodiversity
4. Adopting water resources management
5. Managing coastal zones and ocean fisheries
6. Arresting pollution
7. Planning cities better
8. Accomplishing a second green revolution
9. Stabilizing world population
10. Stopping environmentally destructive subsidies

WOMEN AND CHILD WELFARE

There are several environmental factors that are closely linked to the welfare of women and children. Each year, close to eleven million children worldwide are estimated to have died from the effects of disease and inadequate nutrition. Most of these deaths are in the developing world. In some countries, more than one in five children die before they are 5 years old. Seven out of ten childhood deaths in developing countries can be attributed to five main causes, or a combination of them. These are: pneumonia, diarrhea, measles, malaria and malnutrition. Around the world, three out of every four children suffer from at least one of these conditions.

Most respiratory diseases are caused by or are worsened by polluted air. living in crowded, ill-ventilated homes with smoky, open fires can trigger respiratory conditions, especially in children.

There are strong connections between the status of the environment and the welfare of women and children in India.

Women and girls are often the last to eat, as their role in traditional society is to cook the family meal and feed their husband and sons first. This leads to malnutrition and anemia due to inadequate nutrition. The girl child is given less attention and educational facilities as compared to boys in India. Thus, they are unable to compete with men in later life. This social-environmental divide is a major concern that needs to be corrected throughout the country.

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

The Department of Women and Child Development was set up in the year 1985 as a part of the Ministry of Human Resource Development to give the much needed impetus to the holistic development of women and children. As the national machinery for the advancement of women and children, the department formulates plans, policies and programmes; enacts/amends legislation, guides and coordinates the efforts of both governmental and non-governmental organizations working in the field of Women and Child Development. Besides, playing its nodal role, the Department implements certain innovative programmes for women and children. These programmes cover welfare and support services, training for employment and income generation, awareness generation and gender sensitization. These programmes play a supplementary and complementary role to the other general developmental programmes in the sectors of health, education, rural development etc. All these efforts are directed to ensure that women are empowered both economically and socially and thus become equal partners in national development along with men.

Child Development

Government of India proclaimed a National Policy on Children in August 1974 declaring children as, "supremely important assets". The policy provided the required framework for assigning priority to different needs of the child. The programme of the Integrated Child Development Services (ICDS) was launched in 1975 seeking to provide an integrated package of services in a convergent manner for the holistic development of the child.

For the holistic development of the child, the Department has been implementing the worlds largest almost unique and outreach programme of Integrated Child Development services (ICDS) providing a package of services comprising of the following:

- Supplementary nutrition,
- Immunization,
- Health check-up and referral services,
- Pre-school non-formal education.

HIV/AIDS

The Human Immuno-deficiency Virus (HIV) causes Acquired Immunodeficiency Syndrome (AIDS) through contact with the tissue fluids of infected individuals, especially through sexual contact. It is not a disease but a weakness in the body that results in the body being unable to fight off illnesses. The immune system of a person with AIDS is weakened to such a point that medical intervention is necessary to prevent or treat the deterioration in the body and the entire system. AIDS is the most serious stage of HIV infection. It results from the destruction of the infected person's immune system. As it reduces an individual's resistance to disease, it causes infected individuals to suffer from a large number of environment-related diseases and reduces the ability of infected individuals to go about their normal lives. It saps their strength, leads to skin lesions (Karposi's sarcoma) and they become increasingly vulnerable to any air- or water-borne pollutant, until they eventually die. Our immune system is our body's defense system. Cells of our immune system fight off infection and other diseases. If the immune system does not work well, we are at risk for serious and life-threatening infections and cancers. HIV attacks and destroys the disease-fighting cells of the immune system, leaving the body with a weakened defense against infection and cancer.

HIV/ AIDS has a serious impact on the socioeconomic fabric of society. By 2002, India had an estimated 3.97 million infected individuals. HIV in India is rapidly moving from being a primarily urban disease to rural communities. Research in Nepal has shown a linkage between rural poverty, deforestation and a shift of population to urban areas resulting in a rising number of AIDS patients. Prior to 1992, it was mainly seen in males who migrated to urban centers.

HIV Test

The only way to know infected person is to be tested for HIV infection. Many people who are infected with HIV do not have any symptoms at all for many years. The following may be warning signs of infection with HIV:

- Rapid weight loss, dry cough
- Recurring fever or profuse night sweats, profound and unexplained fatigue
- Swollen lymph glands in the armpits, groin, or neck, diarrhea that lasts for more than a week, white spots or unusual blemishes on the tongue, in the mouth, or in the throat
- Pneumonia, red, brown, pink, or purplish blotches on or under the skin or inside the mouth, nose, or eyelids
- Memory loss, depression, and other neurological disorders

However, no one should assume they are infected if they have any of these symptoms. Each of these symptoms can be related to other illnesses. Again, the only way to determine whether a person is infected is to be tested for HIV infection. The symptoms of AIDS are similar to the symptoms of many other illnesses. AIDS is a medical diagnosis made by a doctor based on specific criteria established.

Transmission of HIV

HIV transmission can occur when body fluids of an infected person enters the body of an uninfected person. The most common ways that HIV is transmitted from one person to another:

1. By having sexual intercourse with an HIV-infected person;
2. By sharing needles or injection equipment with an injection drug user who is infected with HIV;
3. From HIV infected women to babies before or during birth, or through breast-feeding after birth.
4. HIV can also be transmitted through transfusions of infected blood or blood clotting factors.
5. Some health care workers have become infected after being stuck with needles containing HIV infected blood or, less frequently, after infected blood contact with the worker's open cut or through splashes into the worker's eyes or inside his or her nose.

PREVENTION:

1. However, the most important measure to prevent AIDS is the proper use of condoms that form a barrier to the spread of the virus.
2. Using disposable needles
3. transfusion of uninfected blood
4. Organizing AIDS education on prevention and management of disease.

ROLE OF INFORMATION TECHNOLOGY IN ENVIRONMENT AND HUMAN HEALTH

The understanding of environmental concerns and issues related to human health has exploded during the last few years due to the sudden growth of information technology. The computer age has turned the world around due to the incredible rapidity with which IT spreads knowledge. IT can do several tasks extremely rapidly, accurately and spread the information through the world's networks of millions of computer systems. Information technology has also increased the pace of discovery. The capacity of establishing and maintaining worldwide databases has linked environmental, researches around the globe. The advancement in computer, communication, satellite and other technological developments have enabled engineers or environmentalists to gather relevant information simultaneously from many sources. The information is utilized for developing and early warning system and to forecast any eventuality much earlier. A large amount of information is easily available through Remote Sensing technology, Geographical Information System (GIS) and Global Positioning System (GPS) that is being used for various environmental studies.

Ministry of Environment, Government of India has established a Environmental Information System (ENVIS) in 1982. This has been established as a decentralized information system network whose purpose is collection, storage, retrieval and dissemination of environmental information to decision makers, policy makers, planners, scientists, engineers, environmentalists, researchers and general public all

over the country. The ENVIS network has its focal point in the Environmental ministry along with thirteen subject oriented centers, known as ENVIS Centers, set up in the various institutions, organizations of the country in the priority areas of environment like pollution control, toxic chemicals, energy and environment, environmentally sound and mangroves, corals and lagoons, media and environment etc.

New communication links are particularly vital to make use of such information sources as Geographic Information Systems (GIS), a computerbased system for gathering, manipulating, and analyzing environmental data. GIS databases are commonly established with information obtained from remote surveys via satellite and a variety of atmospheric and ground level surveys. GIS software packages and databases, which have almost unlimited applications, have a crucial relevance for national and local environmental management and learning. GIS allows for the simulation of hypothetical models of environmental management and can demonstrate how subUe changes in one element of a landscape may have a powerful effect elsewhere. GIS is a tool to map Land use patterns and document change by studying digitized top sheets and/or satellite imagery. Once this is done, an expert can ask a variety of questions which the software can answer by producing maps which helps in land use planning.

Online healthcare information about Medicare and various related web sites guide consumers to a wide variety of health information available including the full text of clinical practice guidelines, and consumer brochures developed. A number of centers for disease control & prevention are functioning and the public health service maintains their websites.

The Internet with its thousands of websites has made it very simple to get the appropriate environmental information for any study or environmental management planning. This not only assists scientists and students but is a powerful tool to help increase public awareness about environmental issues.

Specialized software can analyze data for epidemiological studies, population dynamics and a variety of key environmental concerns. The relationship between the environment and health has been established due to the growing utilization of computer technology. This looks at infection rates, morbidity or mortality and the etiology (causative factors) of a disease. As our knowledge expands, computers wilt become increasingly efficient.

ACTS

Excessive rise in population, rampant industrialization and rapid growth in industrial sectors has led to a great deterioration of Indian environment. However, Environmental management is now accepted as a major guiding factor for National Development in India. Over the last few decades there has been a progressive & strengthening of official involvement in environmental management with increased scientific technical, administrative and legislative back up at the central and state levels.

Evolution of Environmental Policy: A policy is a deliberate plan of action to guide decisions and achieve rational outcome(s). Some of the milestones of Indians environmental policy are. Year 1972 was the beginning of India's efforts in developing any environmental policy when the them prime minister of India Mrs. Indira Gandhi attended the first UN conference on Human Environment and delivered her most popular speech *"poverty the polluter."* The environmental movement in India really got started after her return when she setup a committee under the Chairmanship of Shri. Pitamber Pant to prepare a basic report on India's environmental policy which led to formation of "National Committee on Environmental Planning and coordination (NCEPC)" which was formed in Department of Science & Technology. **NCEPC** was given various tasks to perform ranging from review of policies, reviews of ecological research etc. During the VIth five year plan (1980-85) special emphasis was given on sound environmental and ecological principals in land use, agriculture, forestry, wildlife, water, air marine environment, minerals, fisheries, renewable resources, energy and human settlements.

In 1980 Govt. of India set-up a committee under the chairman ship of Shri. N.D. Tiwari. popularly know as Tiwari committee recommending legislative measures and administrative machinery to ensure environmental protection. It recommended the creation of a Department of Environment at the center to explicit recognition to the pivotal rote that environment conservation must play for sustainable National Development. In 1980 a separate Department of Environment was established. It became Ministry of Environment, Forests and wildlife in 1986. India has a unitary constitutional system. It has 25 states and union territories. Each state has a separate Department of Environment. The function of the state Department of Environment is basically to regulate industries subject to the provision of union list. CPCB and SPCB established in every state/ country are responsible for implementing these legislations as well as issuing the rules, regulations and notification there of which prescribe the standards for emissions and effluents of air and water pollutants and noise levels

The thrust areas of activities on pollution monitoring and control are addressed to the following:

• Assessment and regulatory measures for prevention and control of pollution from point sources.

• Assessment and regulatory measures for prevention and control of pollution in ambient air and water (inland and land-based coastal pollution); and

•Promotional measures through incentives, guidelines, development of cost-effective technology demonstration projects.

ENVIRONMENTAL LAWS

Following is a list of major Environmental Acts and Rules applicable in India.

• The Water (Prevention & Control of Pollution) Act 1974 (as amended upto 1998).

• The Water (Prevention &control of Pollution) cess Act, 1977 (as amended by Amendment Act 1991).

• The Air (Prevention & Control of Pollution) Act 1981 as amended by Amendment Act 1986

• Environment (Protection) Act 1986.

• Hazardous Waste (Management & Handling) Rules 1989.

• The Public Liability Insurance Act 1991.

• Environment Protection Amendment Rule 1983.

• Manufacture, Storage and Import of Hazardous Chemicals (Amendment) Rules 1984.

• The Factories Act 1984.

• The Forest Conservation Act 1980.

• The Notification on Environment Impact Assessment 1994.

Besides this there are a large number of RULES and AMENDEMENTS and a plethora of STATE LAWS. Only Major acts are briefly discussed here.

THE ENVIRONMENT (PROTECTION) ACT (EPA)

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

Although there were several existing laws that dealt directly or indirectly with environmental issues it was necessary to have a general legislation for environmental protection because the existing laws focused on very specific types of pollution, or specific categories of hazardous substances, or were indirectly related to the environment through laws that control land use, protect our national parks and sanctuaries and our wildlife. However, there was no overarching legislation and certain areas of environmental hazards were not covered. There were also gaps in areas that were potential environmental hazards and there were essentially related to the multiplicity of regulatory agencies. Thus, there was a need for an authority to study, plan and implement the long-term requirements of environmental safety, and direct and coordinate a system of appropriate response to emergencies threatening the environment,

This Act was thus passed to protect the environment, as there was a growing concern over the deteriorating state of the environment. As impacts grew considerably environmental protection became a national priority in the 1970s. While the wider general legislation to protect our environment is now in place, it has become increasingly evident that our environmental situation continues to deteriorate. We need to implement this Act much more aggressively if our environment is to be protected. The presence of excessive concentrations of harmful chemicals in the atmosphere and aquatic ecosystems leads to the disruption of food chains and a loss of species.

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

THE AIR (PREVENTION & CONTROL OF POLLUTION) ACT:

It is also a comprehensive legislation with more than fifty sections. It makes provisions, *inter alia*, for Central and State Boards, power to declare pollution control areas, restrictions on certain industrial units, authority of the Boards to limit emission of air pollutants, power of entry, inspection, taking samples and analysis, penalties, offences by companies and Government and cognizance of offences etc. The Act specifically empowers State Government to designate air pollution areas and to prescribe the type of fuel to be used in these designated areas. According to this Act, no person can operate certain types of industries including the asbestos, cement, fertilizer and petroleum industries without consent of the State Board. The Board can predicate its consent upon the fulfillment of certain conditions. The Air Act apparently adopts an industry wide "best available technology" requirement. As in the Water Act, courts may hear complaints under the Act only at the instigation of, or with the sanction of, the State Board.

The Government passed this Act in 1981 to clean up our air by controlling pollution. It states that sources of air pollution such as industry, vehicles, power plants, etc., are not permitted to release particulate matter, lead, carbon monoxide, sulfur dioxide, nitrogen oxide, volatile organic compounds (VOCs) or other toxic substances beyond a prescribed level. To ensure this, Pollution Control Boards (PCBs) have been set up by Government to measure pollution levels in the atmosphere and at certain sources by testing the air. This is measured in parts per million or in milligrams or micrograms per cubic meter. The particulate matter and gases that are released by industry and by cars, buses and two wheelers is measured by using air-sampling equipment. However, the most important aspect is for people themselves to appreciate the dangers of air pollution and reduce their own potential as polluters by seeing that their own vehicles or the industry they work in reduces levels of emissions. This Act is created to take appropriate steps for the preservation of the natural resources of the Earth which among other things includes the preservation of high quality air and ensures controlling the level of air pollution. The main objectives of the Act are as follows:

(a) To provide for the prevention, control and abatement of air pollution.

(b) To provide for the establishment of central and State Boards with a view to implement the Act.

(C) To confer on the Boards the powers to implement the provisions of the Act and assign to the Boards functions relating to pollution

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

Powers and Functions of the Boards

Central Pollution Board: The main function of the Central Board is to implement legislation created to improve the quality of air and to prevent and control air pollution in

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

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

Penalties: The persons managing industry are to be penalized if they produce emissions of air pollutants in excess of the standards laid down by the State Board. The Board also makes applications *to* the court for restraining persons causing air pollution. Whoever contravenes any of the provision of the Act or any order or direction issued is punishable with imprisonment for a term which may extend to three months or with a fine of Rs 10,000 or with both, and in case of continuing offence with an additional fine which may extend to Rs 5,000 for every day during which such contravention continues after conviction for the first contravention.

THE WATER (PREVENTION & CONTROL OF POLLUTION) ACT:

The government formulated this act in 1974 to prevent the pollution of water by industrial, agricultural and household wastewater that can contaminate our water sources. Wastewaters with high levels of pollutants that enter wetlands, rivers, lakes, wells as well as the sea are serious health hazards. Controlling the point sources by monitoring the levels of different pollutants is one way to prevent pollution, by punishing the polluter. Individuals can also do several things to reduce water pollution such as using biodegradable chemicals for household use, reducing the use of pesticides in gardens, and identifying polluting sources at work places and in industrial units where oil are or other petroleum products and heavy metals are used. Excessive organic matter, sediments and infecting organism from hospital wastes can also pollute our water. Citizen needs to develop a watchdog force to inform authorities to appropriate actions against different types of water pollution. However, preventing pollution is better than trying to cure the problems it has created, or punishing offenders.

The main objectives of the Water Act are to provide for prevention, control and abatement of water pollution and the maintenance or restoration of the wholesomeness of

water. It is designed to assess pollution levels and punish polluters. The Central Government and State Government have set up PCBs to monitor water pollution.

The Water Act 1974 with certain amendments in 1978 is an extensive legislation with more than sixty sections for the prevention and control of water pollution. Among other things, the Act provides for constitution of central and State Boards for preventing water pollution, power to take water samples and their analysis, discharge of sewage or trade effluents, appeals, revision, minimum and maximum penalties, publication of names of offenders, offences by companies and Government departments, cognizance of offences, water laboratories, analysis etc. Prevention and control of water pollution is achieved through a permit or 'consent administration' procedure. Discharge of effluents is permitted by obtaining the consent of the State Water Board, subject to any condition they specify. Any person who fails to comply with a directive of the State cannot, however, entertain in suit under this Act unless the suit is brought by, or with the sanction of the State Board.

WATER POLLUTION CESS ACT 1977 According to this Act, anyone consuming water has to pay certain amount of cess depending on 1. Whether the industry is using water for industrial cooling, spraying in mine pits or boilers feed, 2. For domestic purposes, 3. in processing, whereby water gets polluted and pollutants are easily biodegradable, and 4. in processing whereby water gets polluted and the pollutants are not easily bio-degradable and are toxic. Those industries that had installed a suitab'e treatment plant for the treatment of industrial effluents can get a rebate of 70 per cent on the cess payable.

FOREST CONSERVATION ACT

The Indian Forest Act of 1927 consolidated all the previous laws regarding forests that were passed before the 1920s. The Act gave the Government and Forest Department the power to create Reserved Forests, and the right to use Reserved Forests for Government use alone. It also created Protected Forests, in which the use of resources by local people was controlled. Some forests were to be controlled by the village community, and these were called village Forests. The Act remained in force till the 1980s when it was realized that protecting forests for timber production alone was not acceptable. The other values of protecting the services that forests provide and its valuable assets such as biodiversity began to overshadow the importance of their revenue earnings from timber. This led to the Forest Conservation Act of 1980 and its amendment 1988. India's first Forest Policy was enunciated in 1952. Between 1952 and 1988, the extent of deforestation was so great that it became essential to formulate a new policy on forests and their utilization. The earlier forest policies had focused only on revenue generation. In the 1980's it became clear that forests must be protected for their other functions such as the maintenance of soil and water regimes centered around ecological concerns. It also provided for the use of goods and services of the forest for its local inhabitants,

The new policy framework made conversion of forests into other uses much less possible. Conservation of the forests as a natural heritage finds a place in the new policy, which includes the preservation of its biological diversity and genetic resources. It also values meeting the needs of local people for food, fuel wood, fodder and Non Timber Forest Produce or NTFPs. It gives priority to maintaining environmental stability and ecological balances. It expressly states that the network of Protected Areas should be strengthened and extended.

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

Penalties for offences in Reserved Forests:

- No person is allowed to make clearing or ser fire to a reserved forest. Cattle are not permitted to trespass into the reserved forest, cutting, collecting of timber, bark or leaves, quarrying or collecting any forest products is punishable with imprisonment for a term of six months or with a fine which may extended to Rs 500 or both.

Penalties for offences in protected Forests:

- A person who commits any of the following offences like cutting of trees, stripping the bark or leaves of trees, set fire to such forests or permits cattle to damage any tree, shall be punishable with imprisonment for a term which may extended to six months or with a fine which any extended to Rs 500 or both.
- Any forest officer even without an order from the magistrate or a warrant can arrest any person against whom a reasonable suspicion exists.

WILD LIFE (PROTECTION) ACT, 1972, amended in 1983, 1986 and 1991:

The act is aimed to protect and preserve wild life. Wild life refers to all animals and plants that are not domesticated. India has rich wild life heritage; it has 350 species of mammals, 1200 species of birds and about 20,000 known species of insects. Some of them are listed as 'endangered species' in the Wild life (Protection) Act.

The Act envisages national parks and wild life sanctuaries as protected areas to conserve wild life. Wild life populations are regularly monitored and management strategies formulated to protect them.

The Act covers the rights and non-rights of forest dwellers too,- it provides restricted grazing in sanctuaries but prohibits in national parks. It also prohibits the collection of non-timber forest produce which might not harm the system. The rights of forest dwellers recognized by the Forest policy of 1988 are taken away by the Amended Wild life Act of 1991.

The act, a landmark in the history of wildlife legislation in our country by which wildlife was transferred from State list to concurrent list in 1976, thus giving power to the Central Government to enact the legislation. In India, nearly 134 animal species have been regarded as threatened. A National Wildlife action plan has been prepared whose objective is to establish a network of scientifically managed areas such as national parks, sanctuaries and biosphere reserves, to cover representative and viable samples of all significant bio-geographic subdivisions within the country.

The major activities and provisions in the act can be summed up as follows:

1. It defines the wildlife related terminology.

2. It provides for the appointment of wildlife advisory board, wildlife warden, their powers, duties etc

3. Under the Act, comprehensive listing of endangered wildlife species was done for the first time and prohibition of hunting of the endangered species was mentioned

. 4. Protection to some endangered plants like Beddome cycad, Blue Vanda, Ladies Sliper Orchid, Pitcher plant etc. is also provided under the Act.

5. The act provides for setting up of National Parks, Wild life Sanctuaries etc.

6. The Act provides for the constitution of Central Zoo Authority.

7. There is provision for trade and commerce in some wildlife species with license for sale, possession, transfer etc.

8. The Act imposes a ban on the trade or commerce in scheduled animals.

9. It provides for legal powers to officers and punishment of offenders.

10. It provides for captive breeding programme for endangered species.

Several conservation projects for individual endangered species like lion (1972), tiger (1973), crocodile (1974), and brown antlered deer (1981) were started under this Act. The Act is adopted by all states in India except J&K, which has its own Act!

ISSUES INVOLVED IN THE ENFORCEMENT OF ENVIRONMENTAL LEGISLATION

Legislation evolves in response to problems, so there is often delay between need and the establishment of satisfactory law. Without effective legislation—resource use, pollution control, conservation, and most fields of human activity are likely to fall into chaos and conflict. It must, therefore, be made clear that there is little point in passing laws or making international agreements if there cannot be adequate enforcement. Various forms of legislation/regulation principles, standards, guidelines, *etc.*, which are not firm laws, but help lawmakers. Environmental legislation is evolved to protect our environment as whole our health and the Earth's resources. For successful implementation, there has to be an effective agency to collect relevant data, process it and pass it on to a law enforcement agency. If the law rule is broken by an individual or institution, this has to be punished through the legal process.

Three issues/things that are especially important for environmental legislation are:

1. The precautionary principle This principle has evolved to deal with risks and uncertainties faced by environmental management. The principle implies that an ounce of prevention is worth a pound of cure— it does not prevent problems but may reduce their

occurrence and helps ensure contingency plans are made. The application of this principle requires either cautious progress until a development can be judged 'innocent', or avoiding development until research indicates exactly what the risks are, and then proceeding to minimize them. Once a threat is identified, action should be taken to prevent or control damage even if there is uncertainly about whether the threat is real. Some environmental problems become impossible or costly to solve if there is delay, therefore waiting for research and legal proof is not costless.

2. ***The polluter-pays principle*** In addition to-the obvious—the polluter pays for the damaged caused by a development—this principle also implies that a polluter pays for monitoring and policing. A problem with this approach is that fines may bankrupt small businesses, yet be low enough for a large company to write them off as an occasional overhead, which does little for pollution control. There is, thus, debate as to whether the principle should be retrospective. If the polluter pays, how long back does liability stretch? Developing nations are seeking to have developed countries pay more for carbon dioxide and other emissions controls, arguing that they polluted the global environment during the Industrial Revolution, yet enjoy the fruits of invention from the era. This principle, in fact, is more a way of allocating costs to the polluter than a legal principle. This principle was adopted by OECD member countries in 1972, at least in theory.

3. *Freedom of information:* Environmental planning and management is hindered if the public, NGOs or even official bodies are unable to get information. Many countries have now begun to release more information—the USA has a Freedom of Information Act, and the European Union is moving in this direction. But still many governors and multinational corporations fear that industrial secrets will leak to competitors if there is too much disclosure, and there are situations where authorities declare strategic' needs and suspend disclosure.

PUBLIC AWARENESS

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

Using an environmental calendar of activities:

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

Feb 2nd: World Wetland Day is celebrated to create awareness about wetland and their value to mankind.

March 21st: World Forest Day can be used to initiate a public awareness campaign about the extremely rapid disappreance on forests.

March 22nd: World Water Day

April 7th : World Health Day (WHO) come into existence on this day in 1948

April 18th : World Heritage Day; to arrange a visit to a local museum

April 22nd: Earth Day; to draw attention to increasing environmental problems caused by humans

on earth

June 5th : World Environment Day

June 11th: World Population Day

Aug 6th : Hiroshima Day

Sept 16th: World Ozone Day

Sept 28th : Green Consumer Day

October 16th: World Food Day