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%.

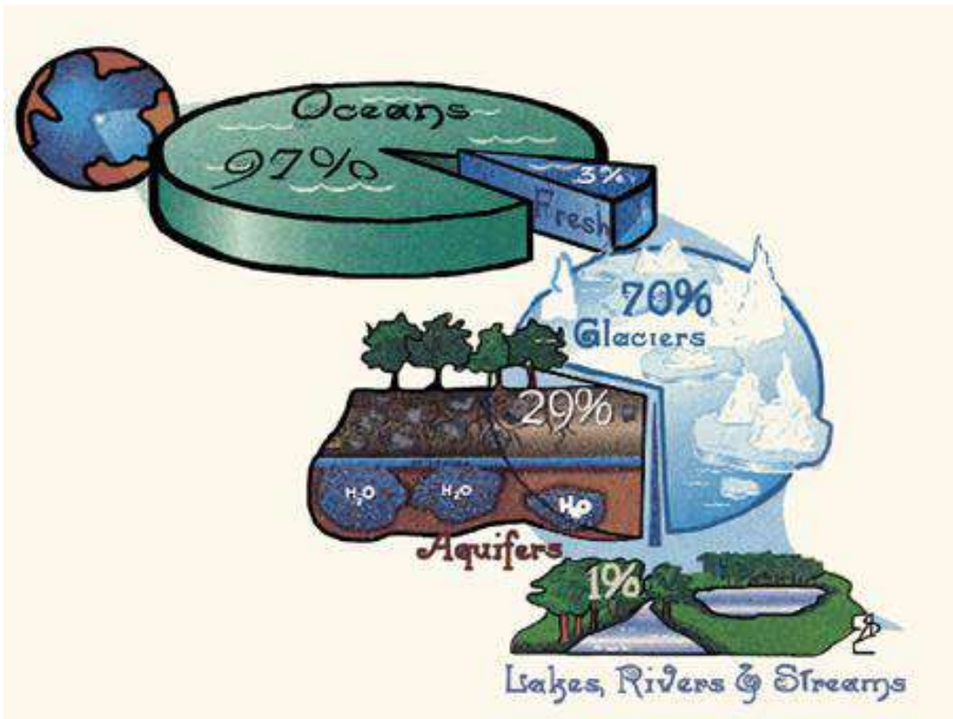
Consumption Patterns

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.

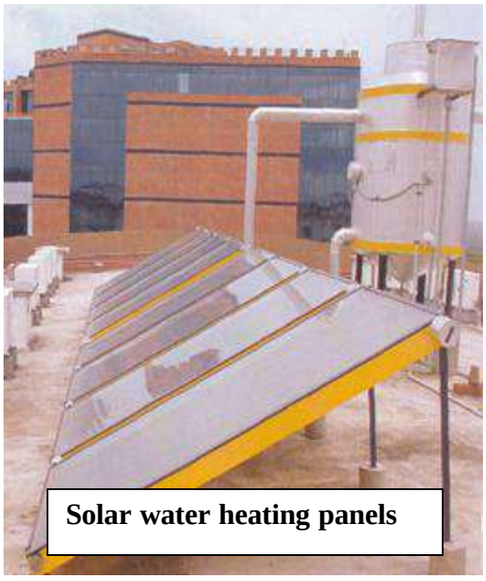
Biomass Energy:

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).

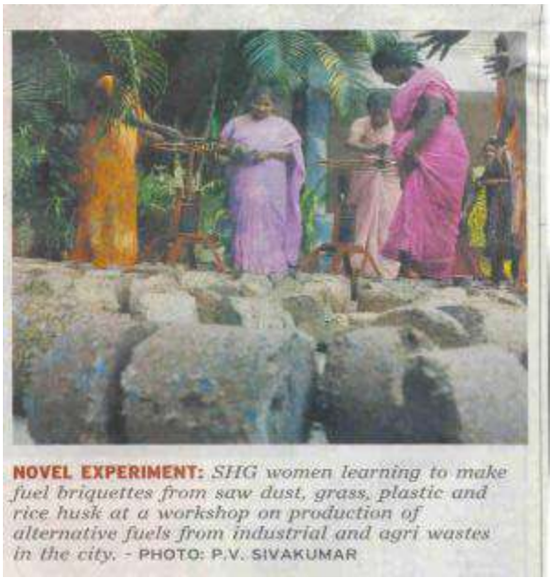
Biogas is produced from plant material and animal waste, garbage, waste from households and some types of industrial wastes, such as fish processing, dairies, and

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: