Major Plant Communities (Biomes) of the World

Based on Habitat & Envtal Conditions

Biomes are of 2 Types

1. Aquatic Communities
2. Terrestial Communities

Aquatic Envts : occupy major part of earth with diff. kind of plt communities,

Aquatic Plant Communities are:

1. Freshwater Communities : fresh H_2O habitat.
   - Lentic (Standing H_2O) Lake, Ponds, Swamps, Bog.
   - Lotic (running H_2O) : River, Spring, Stream.

Cover 1% of earth's surface

Phytoplanktons (floating green plts) include diatoms, desmid, BGA, GA, protozoans & green flagellates.

2. Marine Communities : Oceans continuous Land one another 3/4 earth's surface is ocean.

Bromalgae + Phytoplanktons. Sea weeds Red Algae

designing a highly immunogenic DNA vaccine using IL-12 as adjuvant. Microb Pathog 51:77-87

27. Slathia P, Sharma P (2012) Predicting conserved epitopes in the variants of amastin protein of *Leishmania major* and designing an epitope based immunogenic DNA vaccine. Int J Infect Dis 16:e314
28. Lu YJ, Chen DSH, Hao WT, Xu HW, Zhang YW, Sun FF, Pan W (2017) In silico characterization of *Echinococcus granulosus* paramyosin nucleotide sequence for the development of epitope vaccine against cystic echinococcosis. Helminthologia 54:275-283
29. Andreatta M, Nielsen M (2016) Gapped sequence alignment using artificial neural networks: application to the MHC class I system. Bioinformatics 32:511-517
30. Nielsen M, Lundegaard C, Worning P, Laumoller SL, Lamberth K., Buus S, Brunak S, Lund O (2003) Reliable prediction of T-cell epitopes using neural networks with novel sequence representations. Protein Sci 12:1007-1017
31. Nielsen M, Lund O (2009) NN-align. An artificial neural network-based alignment algorithm for MHC class II peptide binding prediction. BMC Bioinformatics 10:296
32. Nielsen M, Lundegaard C, Lund O (2007) Prediction of MHC class II binding affinity using SMM-align, a novel stabilization matrix alignment method. BMC Bioinformatics 8:238
33. Larsen MV, Lundegaard C, Lamberth K, Buus S, Lund O, Nielsen M (2007) NetCTL-1.2: Large-scale validation of methods for cytotoxic T-lymphocyte epitope prediction. BMC Bioinformatics 8:424
34. Chen J, Liu H, Yang J, Chou K (2007) Prediction of linear B-cell epitopes using amino acid pair antigenicity scale. Amino Acids 33:423-428
35. EL-Manzalawy Y, Dobbs D, Honavar V (2008) Predicting linear B-cell epitopes using string kernels. J Mol Recognit 21:243-255.
36. Saha S, Raghava GPS (2006) Prediction of Continuous B-cell Epitopes in an Antigen Using Recurrent Neural Network. Proteins 65:40-48
37. Gupta S, Kapoor P, Chaudhary K, Gautam A, Kumar R, Raghava GPS (2013) In Silico Approach for Predicting Toxicity of Peptides and Proteins. PLoS ONE 8:e73957
38. Saha S, Raghava GPS (2006) AlgPred: prediction of allergenic proteins and mapping of IgE epitopes. Nucleic Acids Res 34:W202-W209
39. Shen Y, Maupetit J, Derreumaux P, Tufféry P (2014) Improved PEP-FOLD approach for peptide and miniprotein structure prediction. J Chem Theor Comput 10:4745-4758
40. Thévenet P, Shen Y, Maupetit J, Guyon F, Derreumaux P, Tuffery P (2012) PEP-FOLD: an updated de novo structure prediction server for both linear and disulfide bonded cyclic peptides. Nucleic Acids Res 40:W288-293
41. Nielsen M, Lundegaard C, Lund O, Kesmir C (2005) The role of the proteasome in generating cytotoxic T cell epitopes: Insights obtained from improved predictions of proteasomal cleavage. Immunogenetics 57:33-41
42. Pierce BG, Wiehe K, Hwang H, Kim BH, Vreven T, Weng, Z (2014) ZDOCK Server: Interactive docking prediction of protein-protein complexes and symmetric multimers. Bioinformatics 30:1771-1773
43. Rammensee H, Bachmann J, Emmerich NP, Bachor OA, Stevanovic S (1999) SYFPEITHI: database for MHC ligands and peptide motifs. Immunogenetics 50:213-219
44. Reche PA, Glutting JP, Reinherz EL (2002) Prediction of MHC class I binding peptides using profile motifs. Human Immunol 63:701-709

7. WHO. West Nile virus. Fact sheet No. 354. July 2011 (http://www.who.int/mediacentre/factsheets/fs354/en/)
8. CDC: West Nile Virus (2016) https://www.cdc.gov/westnile/statsmaps/index.html
9. Petersen LR, Brault AC, Nasci RS (2013) West Nile virus: review of the literature. JAMA 310:308–315
10. Filette MD, Ulbert S, Diamond MS, Sanders NN (2012) Recent progress in West Nile virus diagnosis and vaccination. Vet Res 43:16
11. Scherwitzl I, Mongkolsapaja J, Screaton G (2017) Recent advances in human flavivirus vaccines. Curr Opin Virol 23:95–101
12. Khan MA, Hossain MU, Rakib-Uz-Zaman SM, Morshed MN (2015) Epitope-based peptide vaccine design and target site depiction against Ebola viruses: an immunoinformatics study. Scand J Immunol 82:25–34
13. Arnon R (2006) A novel approach to vaccine design - Epitope-based vaccines. Biotech International 18:10-13
14. Kanai R, Kar K, Anthony K, Gould LH, Ledizet M, Fikrig E, Marasco WA, Koski RA, Modis Y (2006) Crystal Structure of the West Nile Virus Envelope glycoprotein reveals viral surface epitopes. J Virol 80:11000-11008
15. Luca VC, Mansour JA, Nelson CA, Fremont DH (2012) Crystal Structure of the Japanese Encephalitis Virus Envelope Protein. J Virol 86:2337-2346
16. Taeg KW, Lee WS, Park PJ, Park TK, Kang H (2012) Protective Immunity of *Pichia pastoris*-Expressed Recombinant Envelope Protein of Japanese Encephalitis Virus. J Microbiol Biotechnol 22:1580–1587
17. Ledizet M, Kar K, Foellmer HG, Wang T, Bushmich SL, Anderson JF, Fikrig E, Koski RA (2005) A recombinant envelope protein vaccine against West Nile virus. Vaccine 23:3915-24
18. Schneeweiss A, Chabierski S, Salomo M, Delaroque N, Al-Robaiy S, Grunwald T, Burki K, Liebert UG, Ulbet S (2011) A DNA vaccine encoding the E protein of West Nile virus is protective and can be boosted by recombinant domain DIII. Vaccine 29:6352–6357
19. Chu JHJ, Chiang CCS, Ng ML (2007) Immunization of flavivirus West Nile recombinant envelope domain III protein induced specific immune response and protection against West Nile virus infection. J Immunol 178:2699–2705
20. Friedrich BM, Beasley DWC, Rudra JS (2016) Supramolecular peptide hydrogel adjuvanted subunit vaccine elicits protective antibody responses against West Nile virus. Vaccine 34:5479-5482
21. Liu SA, Haque M, Stanfield B, Andrews FM, Roy AA, Kousoulas KG (2017) A recombinant fusion protein consisting of West Nile virus envelope domain III fused in-frame with equine CD40 ligand induces antiviral immune responses in horses. Vet Microbiol 198: 51–58
22. Patronov A, Dotchinova I (2013) T- cell epitope vaccine design by immunoinformatics. Open Biol 3:120139
23. Alam A, Ali S, Ahamad S, Malik MZ, Ishrat R (2016) From ZikV genome to vaccine: in silico approach for the epitope-based peptide vaccine against Zika virus envelope glycoprotein. Immunol 149:386–399
24. Slathia PS, Sharma P (2016) Epitiope based DNA vaccine design using epitopes predicted from Zika virus polyprotein. Int J Infect Dis 53:149
25. Jahangiri A, Rasooli I, Gargari SL, Owlia P, Rahbar MR, Amani J, Khalili S (2011) An in silico DNA vaccine against *Listeria monocytogenes*. Vaccine 29:6948-6958
26. Akhoon BA, Slathia PS, Sharma P, Gupta SK, Verma V (2011) In silico identification of novel protective VSG antigens expressed by *Trypanosoma brucei* and an effort for

Estuarine Communities : Transition zone b/w

Fresh H2O & Marine habitats under strong influence of tidal actions.

Plt communities are : Macrophyte.
Sea grasses,
Sea weeds.
Marsh Grass.

Benthic microphytes. + Some Phytoplankton

Terrestial Communities (Biomes) in which

Biome (Major life Zone) the life form of climatic climax vegetation is uniform.

1- Tundra Biome (large area of arctic zone.) Forest Palearctic Nearctic Regions

2. Northern Conifeous Biome (Pine trees) Fir trees.
North America & Eurasia. Chief Biome evergreen trees.

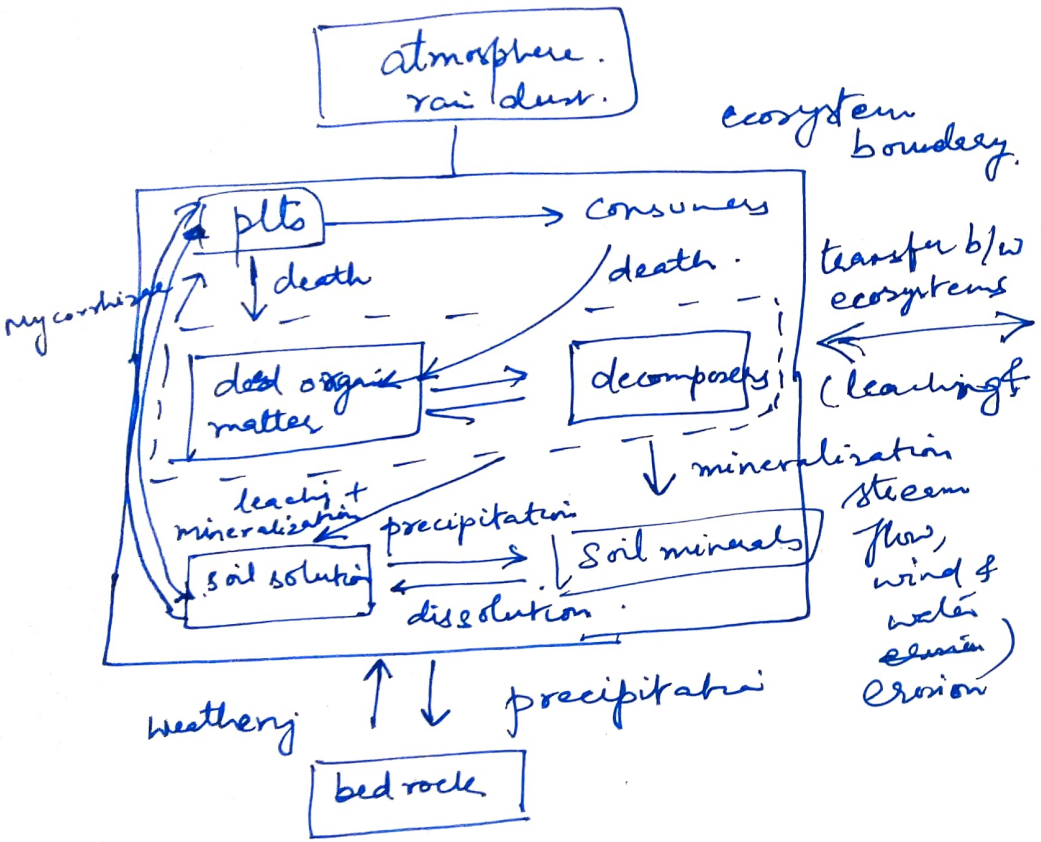
3. Moist temperate Conifeous forest Biomes (OR Temperate Rain forest)
West Coast of North America (central California to Alaska)
Sequoia in South Picea in north are dominant.
Thuja, Epiphytic mosses
sub-climax Pines

4. Temperate Deciduous forest Biomes.
Eastern North America, all of Europe part of Japan.
Beech, oak tree, chestnut, Maple.

Broad leaved evergreen subtropical forest
Varies 5 epiphytes less temperature diff. b/w summer & winter
warm Temperate Biomes Marine climate Central & South Japan.

6. Temperate Grassland Biomes.
Rainfall higher than in deserts. Large areas of world.

Generalized scheme of edaphic cycles



1. Uptake & accumulation in vegetation:

Fungi (Symbiotic fungi)

Ecto (temperate forest) Basidiomycetes

Endo (tropical rain forest)

2. Herbivore food web:

Herbivore consume small portion of pr. production in most ecosystems. In rain forest 10% of pr. production was eaten by herbivores. total herbivore & carnivore biomass contained only 0.1% of total minerals in the biota.

3 - Litter decomposition & soil nutrients

Hypothetical steady state ecosystem, nutrients taken up by plts are balanced by that returned to soil in dead plt parts & washed from the plts by rain H_2O. Through

Decomposition → insoluble organic compds broken down.
releasing soluble inorganic ions

rate vary in diff ~~ecosystem~~ events at
different elements released at
different rates to one another.
K is rapidly leached out of litter.

Many feature of leaf quality affect rate of decomposition.

Fire is an imp decomposer

& mineralised in many savanna. Some proportion of elements enter the atmosphere as gases (N, S, P) or small particles Ca, Mg, K although these are ppted down by gravity or rainfall

4. Rate of Nutrient Cycling

Turn over rate of nutrients in vegetation can be measured as uptake relative to the quantity contained in living biomass. Elements found are more quickly in tropical humid forest than in temperate deciduous, second forest

Ca is least mobile followed by Mg.

Food chain: Transfer of food energy from producers through a series of organisms (herbivores to carnivores to decomposers) with repeated eating and being eaten is k/a food chain. In any food chain green plts occupy the first trophic level ie the producer level and are clss primary producers.

Detritus food chain is a sub-component of another ecosystem. The two ~~chains~~ types of food chains are indeed linked together belongig to the same ecosystem.

Food chains: is a simple chain of eating and being eaten away. Food chain in grassland ecosystem starts with grasses & forbs. through grasshoppers, frogs, snakes, hawks a sequential arrangement based on food habits.

In pond ecosystem food chains starts with phytoplanktons, going through water fleas, smaller fish, bigger fish, birds & large animals & so on.

Grazing food chain: Ecosystem ~~is~~ such type of food chains is directly dependent on an influx of solar radiation.

Detritus food chain: This type of food chain goes from dead organic matter into micro-organisms & then to organisms feeding on detritus and their predators. These depend chiefly on the influx of organic matter produced in another system. Such types of chain are found in temperate forest. eg mangrove leaves. - Jelly in warm, shallow waters. Found in estuarie areas.

Food-web: Food chains never operate as isolated sequences, but are interconnected with each other forming some sort of interlocking pattern which is referred to as food web.

Food-web in grassland. may be seen as 5 linear food chains.

(1) Grass - Grasshopper - hawk.

(2) Grass - " → lizard → Hawk.

(3) Grass - Rabbit → Hawk.

(4) Grass - Mouse → Hawk

(5) Grass → Mouse → Snake → Hawk

Complexity of food-web depends on 2 pts:

(1) Length of food chain. Diversity in the org based upon their food habits, more longer would be food chain.

(2) Alternatives at different points of consumers in the chain. More the alternatives, more would be the interlocking pattern.

Structure of an Ecosystem: Abiotic (non-living) — eg soil, H_2O, Light, inorganic nutrients.
Biotic (living) → eg producers + Consumers

Biotic Components of an ecosystem.
- Producers
- Consumers
- Decomposers.

Function of an ecosystem: Components of an ecosystem are seen to function as a unit. while considering following aspects:
- Productivity
- Decomposition
- Energy flow
- Nutrient cycling.

Productivity: Rate of Biomass production :- g^2/yr or $kcal/m^2/yr$

GPP = total energy fixed.] Primary productivity (production of organic matter during photosynthesis)
NPP = GPP - respiration]

Secondary Productivity: (it is always heterotrophs)
or
Assimilation: Rate of formation of new organic matter by consumers eg secondary productivity

Net Productivity: NPP — Consumption by heterotrophs during the unit period. ie season or yr.
(Cg/m^2/day)

Decomposition: - Breakdown of complex organic matter into inorganic substances like CO_2, H_2O, nutrients.

Steps → fragmentation.
→ leaching.
→ Catabolism.
→ Humification.
→ Mineralization.

Energy Flow (unidirectional)

Producers → Consumers → ends in Decomposition.

Second law of Thermodynamics: Part of energy is lost as heat.

First:- Due to one way flow of energy, the system would collapse if primary source, sun were cut off.

Second: There occurs a progressive decrease in energy level at each trophic level.

Shorter the food chain greater would be the available food energy. as with an increase in the length of food chain there is corresponding more loss of energy.

There is no correlation b/w biomass & energy. Energy represents rate functions say productivity rates. Relationship b/w ~~energy &~~ biomass & energy content differs acc. to the situation eg.

1 gm of algae may be equal to many gm of forest tree leaves, due to the fact that rate of production of algae is higher than that of tree leaves. Thus standing biomass (structure) should not be confused with productivity (rate function). Organisms with higher biomass does not necessarily mean it would be productive too.

The autoclave of M/s Kirloskar Make procured in 20 needs to be written off as it is beyond repair, other autoclaves are either in working condition or are under the process of repair.

Sawej Singh Bhatti's

Ecological energetics we study.

(1) Quantity of solar energy reaching an ecosystem.

(2) Quantity of energy used by green plts for photosynthesis

(3) Quantity & path of energy flow from producers to consumers

Y – shape energy flow models.

two food chains – Grazing food chain + Detritus food chains not separated. ~~It is more~~

Y shaped energy flow model is more realistic + practical

1. It confirms to the basic stratified structure of ecosystem.
2. It separates Grazing & Detritus food chains (direct consumption of living plts & utilization of dead organic matter) in both time & space.
3. Microconsumers (~~absorbtive~~ absorptive bacteria / fungi) and the Macroconsumers (phagotrophic animals) differ greatly in size – metabolism relations.

Universal model of energy flow. applicable to any living component, whether a plt, animal, mos or individual sp population or a trophic gp. It can be used in 2 ways: ① It can represent a species population in which case the appropriate energy inputs & links with other species would be shown a conventional species oriented food web - diagram.

The model can represent a discrete energy level in which case the biomass & energy channels represent all or parts of many populations supported by same energy source. eg Foxes obtain their food from plts and by eating herbivores.

A single box could represent the whole population of foxes if our objective is to stress intrapopulation energetics.

On the other hand 2 or more boxes would be employed if we wish to separate the metabolism of a population into 2 or more trophic levels in accordance c̄ proportion of plt & animal consumed.

These models depict the basic pattern of energy flow in an ecosystem.

Several food chains interlocked form food web. Complexity of food webs depends on length of food chains. Thus in nature there operate multi-channels energy flows, but in these the channels belong to

either of the two basic food chains
ie Grazing food chain
or
Detritus food chain.

Minerals + Energy move through biotic + abiotic components of this ecological, self-sufficient system.

Nutrient cycles closely parallel the routes of energy flow in the biotic components of ecosystem. but an imp distinction b/w the 2 processes is the relationship in the abiotic components.

Energy flow driven by solar energy nutrient cycle is conservation; with chemical elements being drawn from finite pools & being largely retained in ecosystem.

Macro nutrients - C, H, O → cycles with an atmospheric system
obtained from soil ← P & K

Micro nutrients
Cu, Fe, Co. - Edaphic cycles or soil based cycle.

the chain : interlocking

as in the past. Popularising this crop could add to food availability from marginal lands. Several crops can be grown in urban settings, including vegetables and fruit, which can be grown on waste household water and fertilisers from vermicomposting pits.

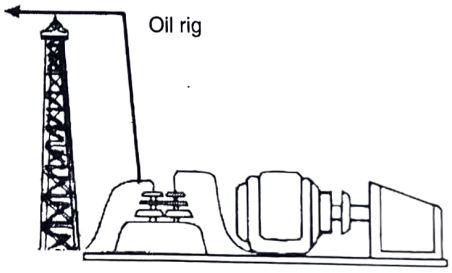
Several foods can be popularised from yet unused seafood products like seaweed, as long as this is done at sustainable levels. Educating women, who are more closely involved with feeding the family, about nutrition is an important aspect of supporting the food needs of many developing countries.

Integrated Pest Management which includes preserving pest predators, using pest-resistant seed varieties and reducing the use of chemical fertilisers, should also be adopted for sustainable food production.

(v) Energy Resources

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

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



The chemical energy present in chemical compounds is released when they are broken down by animals in the presence of oxygen. In India, manual labour is still extensively used to get work done in agricultural systems, and domestic animals used to pull carts and ploughs. Electrical energy is produced in several ways—power transport, artificial lighting, agriculture and industry. This comes from hydel power based on the water cycle that is powered by the sun's energy that supports evaporation, or from thermal power stations powered by fossil fuels. Nuclear energy is held in the nucleus of an atom and is now harnessed to develop electrical energy.

We use energy for household purposes, agriculture, production of industrial goods and for transportation. Modern agriculture uses chemical fertilisers, which require large amounts of energy for their manufacture. Industry uses energy to power manufacturing units and the urban complexes that support it. Energy-demanding roads and railway lines are built to transport products from place to place and to reach raw materials in mines and forests.

No energy-related technology is completely 'risk free' and unlimited demands on energy increase this risk factor many-fold. All energy use creates heat and contributes to atmospheric temperature. In addition, many forms of energy release carbon dioxide and lead to global warming.

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

Thus, when we use energy wastefully, we are contributing to the environmental deterior of our planet. We all need to become responsible energy users. Remember that even a s electrical light that is burning unnecessarily is a contributor to environmental degradation

Growing energy needs: Energy has always been closely linked to man's economic gr and development. The present strategies for development, focussed on rapid econ growth, have used energy utilisation as an index of economic development. This index, how does not take into account the adverse long-term effects of excessive energy utilisatio society.

Between 1950 and 1990, the world's energy needs increased four-fold. The world's den for electricity has doubled over the last 22 years! The world's total primary energy consump in 2000 was 9096 million tons of oil; a global average per capita that works out to be 1.5 of oil. Electricity is at present the fastest growing form of end-use energy worldwide 2005, the Asia–Pacific region is expected to surpass North America in energy consumpt and by 2020 is expected to consume some 40% more energy than North America.

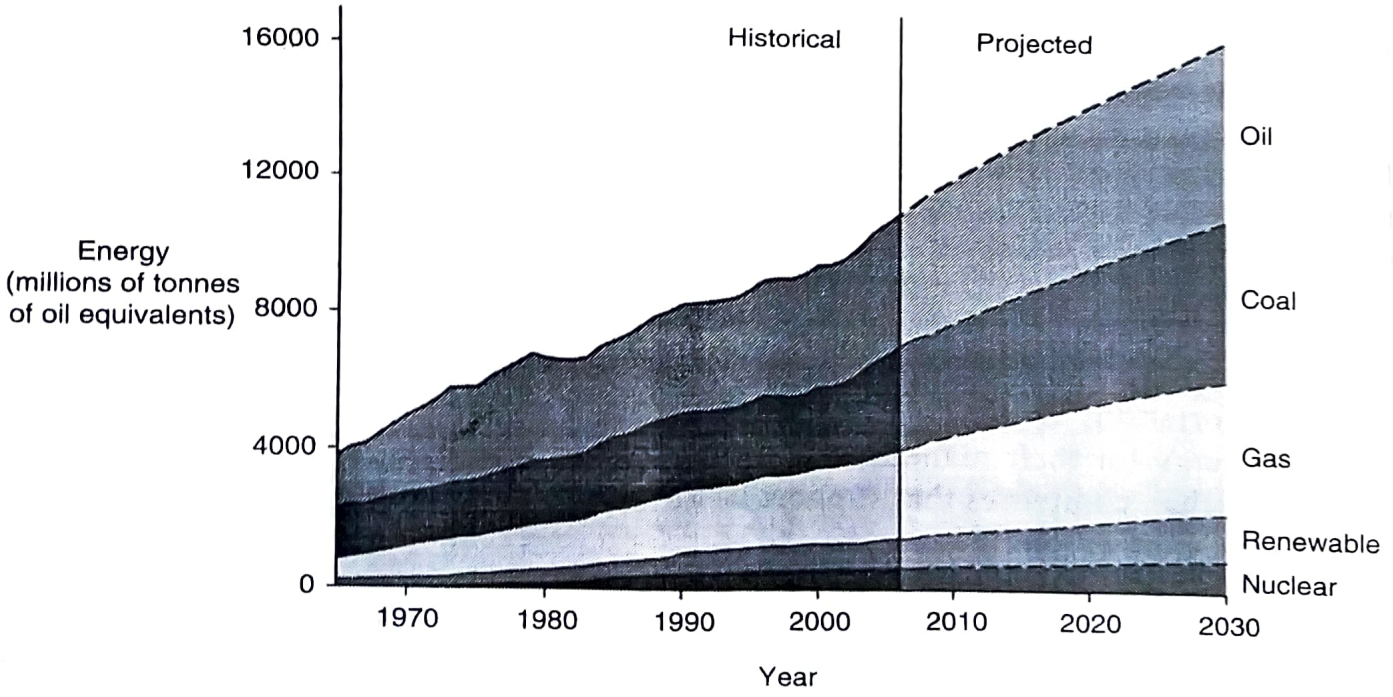


Fig 2.4 Energy demand by fuel type

urce International Energy Agency (Power generation from coal) 2011

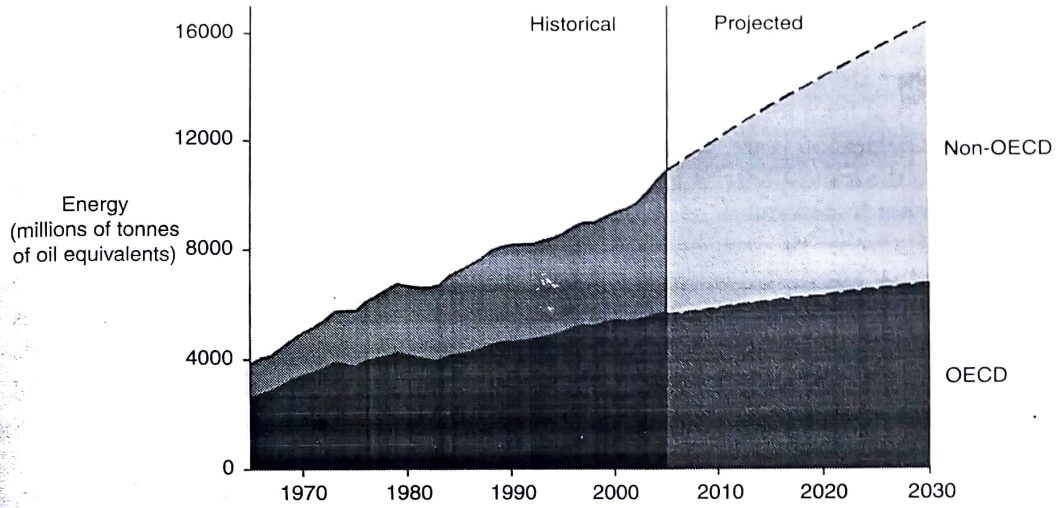


Fig. 2.5 World energy consumption: OECD vs. non-OECD

Source: International Energy Agency (Power generation from coal) 2011

OECD: Organisation for Economic Co-operation and Development is an international organisation of 34 countries to help economic progress and world trade. Some of the OECD countries include Australia, New Zealand, Belgium, Austria, Germany, South Korea, Japan, United Kingdom, United States of America. Some of the non-OECD countries include Brazil, China, Colombia, India, South Africa.

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

Among the commercial energy sources used in India, coal is a predominant source, accounting for 55% of energy consumption estimated in 2001, followed by oil (31%), natural gas (8%), hydro (5%) and nuclear power (1%). In India, biomass (mainly wood and dung) accounts for almost 40% of the primary energy supply. While coal continues to remain the dominant fuel for electricity generation, nuclear power has been used increasingly since the 1970s and 1980s, and the use of natural gas increased rapidly in the '80s and '90s.

Types of energy: There are three main types of energy: those classified as non-renewable; those that are said to be renewable; and nuclear energy, which uses such small quantities of raw material (uranium) that supplies are, to all effect, limitless. However, this classification is inaccurate because several of the renewable sources, if not used 'sustainably', can be depleted more quickly than they can be renewed.

Non-renewable energy

To produce electricity from non-renewable resources, the material must first be ignited. The fuel is placed in a secured area and set on fire. The heat thus generated turns water to steam, which moves through pipes to turn the blades of a turbine. This converts magnetism into electricity, which we use in various ~~applications~~ appliances.

Non-renewable energy sources: These consist of the mineral-based hydrocarbon fuels – coal, oil and natural gas – that were formed from ancient prehistoric forests. These are called 'fossil fuels', because they are formed after plant life is fossilised. At the present rate of extraction, there is enough coal for a long time to come. Oil and gas resources, however, are likely to be used up within the next 50 years. When these fuels are burnt, they produce waste products that are released into the atmosphere as gases such as carbon dioxide, oxides of sulphur, nitrogen, and carbon monoxide—all causes of air pollution. These have led to respiratory tract problems in an enormous number of people all over the world, have also affected historic monuments like the Taj Mahal and destroyed many forests and lakes due to acid rain. Many of these gases contribute to the greenhouse effect, letting sunlight in and trapping the heat inside. This leads to global warming, a rise in global temperature, increased drought in some areas, floods in other regions, the melting of icecaps and a rise in sea levels, which is slowly submerging coastal belts all over the world. The warming of the seas also leads to the death of sensitive organisms like coral.

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

Oil-powered vehicles emit carbon dioxide, sulphur dioxide, nitrous oxide, carbon monoxide and particulate matter that are a major cause of air pollution, especially in cities with heavy traffic density. Leaded petrol leads to neurological damage and reduces attention span. Petrol vehicles can be run with unleaded fuel by attaching catalytic converters to all new cars, but unleaded fuel contains benzene and butadiene which are known to be carcinogenic compounds. Delhi, which used to have a serious smog problem due to traffic, has been able to reduce this health hazard by changing a large number of its vehicles to CNG, which contains methane.

This high dependence on dwindling fossil fuel resources, especially oil, results in political tension, instability and war. At present, 65% of the world's oil reserves are located in the Middle East.

Coal and its impact on the environment: Coal is the world's largest single contributor of greenhouse gases and is one of the most important causes of global warming. Many coal-based power generation plants are not fitted with devices such as electrostatic precipitators to reduce emissions of suspended particulate matter (SPM), which is a major air polluter. Burning coal also produces oxides of sulphur and nitrogen which, combined with water vapour, lead to 'acid rain'. This destroys forest vegetation, 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 of this waste material; some efforts have been made to use it for making bricks. The transport of large quantities of fly-ash and its eventual dumping are costs that have to be included in calculating the cost benefits of thermal power.

Renewable energy

Renewable energy systems use resources that are constantly replaced and are usually less polluting. Some examples are: hydropower, solar, wind and geothermal (energy from the heat inside the earth). We also get renewable energy from burning trees and even garbage as fuel and processing other plants into biofuels.

One day, all our homes may get their energy from the sun or the wind. Your car's fuel tank will probably use biofuel, and your garbage might contribute to your city's energy supply. Renewable energy technologies will improve the efficiency and cost of energy systems. We may reach the point when we may no longer rely mostly on fossil fuel energy.

CASE STUDY 5

Oil-related disasters

The Deepwater Horizon oil spill, also known as the Gulf of Mexico oil spill or the BP oil spill, is considered amongst the largest oil spills in history. On 10 April 2010, an oil well blowout occurred about 5,000 feet below the ocean surface causing a catastrophic explosion on the Deepwater Horizon offshore oil drilling platform. Hundreds of millions of litres of oil have been spilled to date. Work to drill relief wells to permanently close the oil well continues. The best estimate of the spill so far is approximately 12,000 to 19,000 barrels of oil per day. Petroleum toxicity is expected to affect the habitats of thousands of marine and bird species. This ongoing environmental disaster has already impacted the Gulf of Mexico fishing industry and tourism industry.

Hydroelectric power

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

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

- To produce hydroelectric power, large areas of forest and agricultural lands are submerged. These lands traditionally provided a livelihood for local tribal people and farmers. Conflicts over land use are inevitable.
- The silting of the reservoirs (especially as a result of deforestation) reduces the life of the hydroelectric power installations.

CASE STUDY 6

Hydel power in the Western Ghats

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

- Water is required for many purposes besides power generation. These include domestic, agricultural and industrial requirements. This also gives rise to conflicts over the equitable allocation of water.
- The use of rivers for navigation and fisheries becomes difficult once the water is dammed to generate electricity.
- The resettlement of displaced persons is a problem for which there is no ready solution. The opposition to large hydroelectric schemes is growing, as most dam projects have been unable to resettle or adequately compensate the affected people.
- In certain seismically sensitive regions, large dams can induce increased seismic activity, resulting in earthquakes and the consequent loss of lives and property. There is a great possibility of this occurring around the Tehri Dam in the Himalayan foothills. Shri Sunderlal Bahuguna, the initiator of the Chipko Movement, has fought against the Tehri Dam for several years.

With large dams causing so many social problems, an attempt has made to develop small hydroelectric generation units. Multiple small dams have less impact on the environment. China has the largest number of these—60,000, generating 13,250 megawatts, that is 30% of China's electricity. Sweden, the US, Italy and France have also developed small dams for electrical power generation. The development of small hydroelectric power units could become a very important source in India, which has rivers, traversing steep gradients as well as the economic capability and technical resources to exploit them.

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

Solar heating for homes: Modern houses that use air conditioning and/or heating are extremely energy dependent. A passive solar home or building is designed to collect the sun's heat through large, south-facing glass windows. In solar-heated buildings, *sunspaces* are built on the south side of the structure and act as large heat absorbers. The floors of sunspaces are usually made of tiles or bricks that absorb heat throughout the day and then release heat at night when it is cooler.

In energy-efficient architecture, the sun, water and wind are used to heat a building when the weather is cold and to cool it in summer. This is mostly based on design and building material. Thick walls of stone or mud were used in traditional architecture as insulators. Small doors and windows kept direct sunlight and heat out. Deeply-set glass windows in colonial homes, on which direct sunlight could not reach, permitted the use of glass without creating a greenhouse effect; verandahs also served a similar purpose. Traditional bungalows also had high roofs and ventilators that permitted the hot air to rise and leave the room. Cross-ventilation where wind can drive the air in and out of a room keeps it cool. Large overhangs or eaves over windows prevent the glass from heating the room inside. Double walls are used to prevent heating, and shady trees around the house help reduce the temperature.

Solar water heating: Most solar water-heating systems have two main parts—the solar 'collector' and the 'storage tank'. The solar energy collector heats the water, which then flows to a well-insulated storage tank. A common type of collector is the 'flat-plate collector', a rectangular box with a transparent cover that faces the sun, usually mounted on a flat roof. Small tubes run through the box, carrying the water or any other fluid such as antifreeze, to be heated. The tubes are mounted on a metal 'absorber plate', which is painted black to absorb the sun's heat. The back and sides of the box are insulated to hold in the heat. Heat builds up in the collector and as the fluid passes through the tubes, it too heats up.

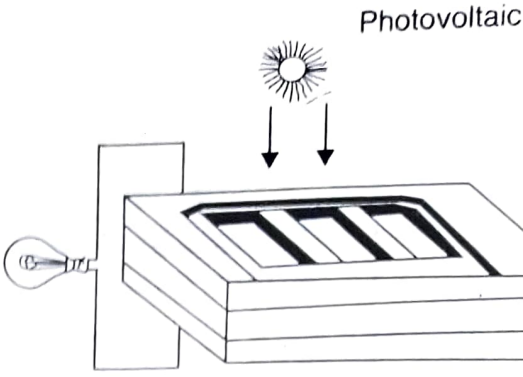
Solar water-heating systems cannot heat water when the sun is not shining. Thus, homes must also have a conventional backup system. About 80% of homes in Israel have solar water heaters.

Solar cookers: The heat produced by the sun can be harnessed directly for cooking using solar cookers. A solar cooker is a metal box, which is black on the inside to absorb and retain heat. The lid has a reflective surface to reflect the heat from the sun into the box. The box contains black vessels in which the food to be cooked is placed.

India has the world's largest solar cooker programme and an estimated 2 lakh families that use solar cookers. Although solar cookers reduce the need for fuelwood and pollution from smoky wood fires, they have not yet become popular in rural areas as it is felt that they are not suitable for traditional cooking practices. However, they have great potential if marketed well.

Other solar-powered devices: Solar desalination systems (for converting saline or brackish water into pure distilled water) have been developed. In future, they should become important alternatives for our future economic growth in areas where freshwater is not available.

Photovoltaic energy: The solar technology that has the greatest potential for use throughout the world is that of solar photovoltaic cells, which directly produce electricity from sunlight using photovoltaic (PV) also solar cells or solar panels). PV cells use the suns light,



not its heat, to make electricity. PV cells require little maintenance, have no moving parts and essentially no environmental impact. They work cleanly, safely and silently. They can be installed quickly in small modules, in any place where there is sunlight. Solar cells are made up of two separate layers of silicon, each of which contains an electric charge. When light hits the cells, the charges begin to move between the two layers and electricity is produced. PV cells are wired together to form a module. A module of about 40 cells is enough to power a light bulb. For more pow PV modules are wired together into an array. PV arrays can produce enough power to meet t electrical needs of a home. Over the past few years, extensive work has been done in decreasi PV technology costs, increasing efficiency and extending cell lifetimes. Many new materia such as amorphous silicon, are being tested to reduce costs and automate manufacturing.

PV cells are commonly used today in calculators and watches. They also provide power satellites, electric lights, small electrical appliances such as radios, for water pumping, highw lighting, weather stations and other electrical systems located away from power lines. Son electric utility companies are building PV systems into their power supply networks.

PV cells are environmentally benign; that is, they do not release pollutants or toxic materi into the air or water, there is no radioactive substance and no possible catastrophic accident Some PV cells, however, do contain small quantities of toxic substances such as cadmium, an these can be released into the environment in the event of a fire. PV cells are made of silico which, although the second most abundant element in the earth's crust, has to be mined. Mining creates environmental problems. PV systems, of course, only work when the sun is shining and thus need batteries to store the electricity.

CASE STUDY 7

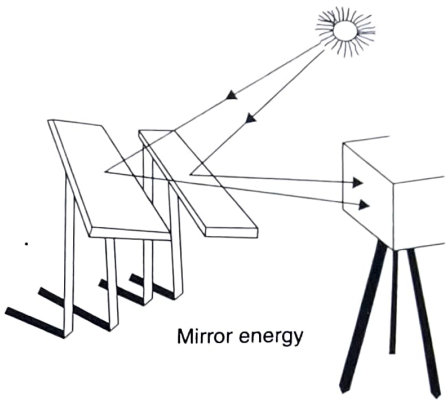
Solar power

- In 1981, a plane called 'The Solar Challenger' flew from Paris to England in 5 hours, 20 minutes. It had 16,000 solar cells glued to its wings and tail, and they produced enough power to drive a small electric motor and propeller. Since 1987, every three years there is a World Solar Challenge for solar-operated vehicles in Australia, where the vehicles cover 3000 km!
- The world's first solar-powered hospital is in Mali in Africa. Situated at the edge of the Sahara desert, Mali receives a large amount of sunlight. Panels of solar cells supply the power needed to run vital equipment and keep medical supplies cool in refrigerators.
- Space technology requires solar energy and the space race spurred the development of solar cells. Only sunlight can provide power for long periods of time for a space station or long-distance spaceship.
- Japanese farmers are substituting PV-operated insect killers for toxic pesticides.
- In recent years, the popularity of Building Integrated Photovoltaics (BIPVs) has grown

In this application, PV devices are designed as part of the building (i.e., roofs & siding) both to produce electricity and reduce costs by the costs of normal construction materials. There are more than PV systems in Germany & Japan has a programme for 70,000 BIPV buildings

Solar thermal electric power (STE): Solar radiation can produce high temperatures, which can generate electricity. Areas with low cloud cover with little scattered radiation, as in the desert, are considered the most suitable sites. According to a UNDP assessment, STE is about 20 years behind the wind energy market exploitation, but is expected to grow rapidly in the near future.

Mirror energy: During the 1980s, a major solar thermal electrical generation unit was built in California, containing 700 parabolic mirrors, each with 24 reflectors, 1.5 m in diameter, which focussed the sun's energy to produce steam to generate electricity.



Biomass energy: When a log of wood is burned, we are using biomass energy. Because plants and trees depend on sunlight to grow, biomass energy is a form of stored solar energy. Although wood is the largest source of biomass energy, we also use agricultural waste, sugarcane waste and other farm byproducts to make energy.

There are three ways to use biomass. It can be burned to produce heat and electricity, changed to a gas-like fuel such as methane or changed to a liquid fuel. Liquid fuels, also called *biofuels,* include two forms of alcohol—*ethanol* and *methanol.* Because biomass can be changed directly into liquid fuel, it could someday supply much of our transportation fuel needs for cars, trucks, buses, airplanes and trains with diesel fuel replaced by *biodiesel* made from vegetable oils. In the US, this fuel is now being produced from soybean oil. Researchers are also developing algae that produce oils, which can be converted to biodiesel, and new ways have been found to produce ethanol from grasses, trees, bark, sawdust, paper and farming wastes.

Organic municipal solid waste includes paper, food waste and other organic non–fossil fuel-derived materials such as textiles, natural rubber and leather, that are found in the waste of urban areas. Currently, in the US, approximately 31% of organic waste is recovered from municipal solid waste via recycling and composting programmes, 62% is deposited in landfills and 7% is incinerated. Waste material can be converted into electricity by combustion boilers or steam turbines.

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

Biogas: Biogas is produced from plant material, animal waste, garbage, waste from households and some types of industrial waste 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. From 1 ton of food waste, one can produce 85 cu m of biogas. Once used, the residue is used as an agricultural fertiliser. Denmark produces a large quantity of biogas from waste and 15,000 mW of electricity from 15 farmers' cooperatives. London has a plant which makes 30 mW of electricity a year from

420,000 t of municipal waste, which supplies power to 50,000 families. In Germany, 2 landfills for garbage produce power from biogas; Japan uses 85% of its waste in a simila and France about 50%.

Biogas plants have become increasingly popular in India in the rural sector. The biogas use cowdung that is converted into a gas which is used as a fuel. It is also used for runnin fuel engines. The reduction in kitchen smoke by using biogas has reduced lung proble thousands of homes.

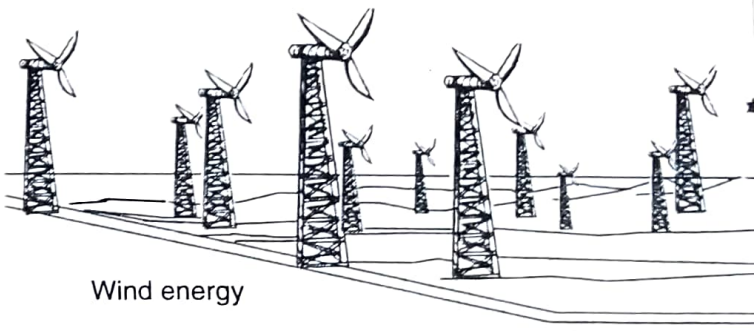
The fibrous waste of the sugar industry is the world's largest potential source of bi energy. Ethanol produced from sugarcane molasses is a good automobile fuel and is nov in a third of the vehicles in Brazil. The National Project on Biogas Development (NPBI Community/Institutional Biogas Plant Programme promote various biogas projects. In there were already 2.18 million families in India that used biogas. However, China has 20 n households using biogas!

Let's do it!

What you throw out in your garbage today could be used as fuel for someone els Municipal solid waste has the potential to be a large energy source. Garbage is inexpensive energy resource. Unlike most other energy resources, someone will colle garbage, deliver it to the power plant and even pay to get rid of it. This helps cover t cost of turning garbage into energy. Garbage is also a unique resource because we contribute to it.

Keep a record of all the garbage that you and our family produce in a day. Wh proportion of it is in the form of biomass? Weigh this. How long would it take you gather enough waste biomass to make a tank-full (0.85 cu m) of biogas? (Remember of biomass produces 85 cu m of biogas.)

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



Wind energy

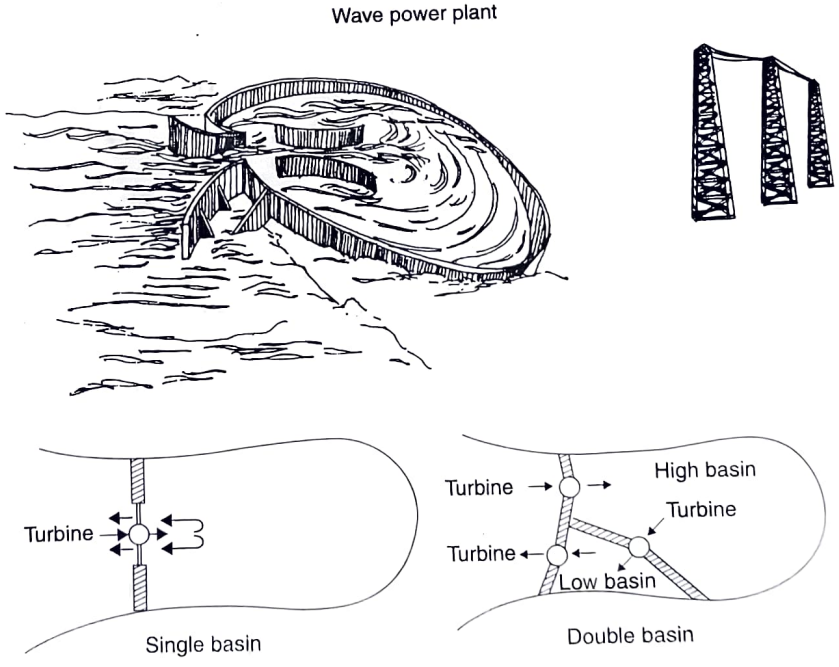
Wind power is a function of the wind speed and therefore the average wind spee important determinant of economically feasible power. increases with height. At a given turbine site, the 30 m above ground is typically 60% greater than the past 2yrs a great deal of technical progress made

in the design, siting, installation, operation and maintenance of power-producing windmills (turbines). These improvements have led to higher wind conversion efficiency and lower electricity production costs.

Environmental impact: Wind power has little environmental impact, as there are virtually no air or water emissions, radiation or solid waste production. The principal problems are bird kills, noise, effect on TV reception and aesthetic objections to the sheer number of wind turbines that are required to meet electricity needs. Although large areas of land are required for setting up wind farms, the amount used by the turbine bases, the foundations and the access roads is less than 1% of the total area covered by the wind farm. The rest of the area can also be used for agricultural purposes or for grazing. Siting windmills offshore reduces their demand for land and visual impact.

Wind is an intermittent source and the intermittency of wind depends on the geographic distribution of wind. Wind, therefore, cannot be used as the sole resource for electricity and requires some other backup or standby electricity source.

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



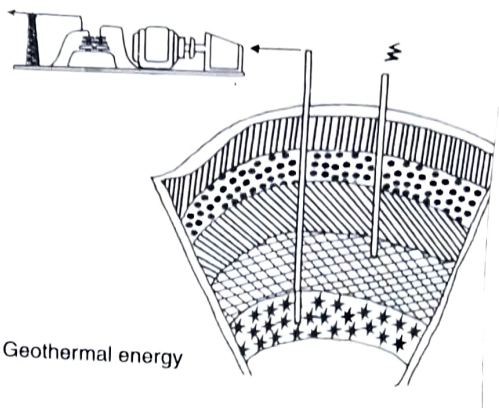
However, tidal power stations bring about major ecological changes in the sensitive ecosystem of coastal regions and can destroy the habitats & nesting places of water birds.

and interfere with fisheries. A tidal power station at the mouth of a river blocks the flo of polluted water into the sea, thereby creating health and pollution hazards in the estuar Other drawbacks include offshore energy devices posing navigational hazards. The residu drift current could affect the spawning of some fish, whose larvae would be carried away fro the spawning grounds. They may also affect the migratory patterns of surface swimming fish

Wave power converts the motion of waves into electrical or mechanical energy. For this, a energy extraction device is used to drive turbo-generators. Electricity can be generated at se and transmitted by cable to land. This energy source has yet to be fully explored. The larges concentration of potential wave energy on earth is located between 40 and 60 degrees latitud in both the northern and southern hemispheres, where the winds blow most strongly.

Another developing concept that harnesses energy due to the differences in temperatur between the warm upper layers of the ocean and the cold deep-sea water is called Ocea Thermal Energy Conversion (OTEC). This is a high-tech installation, which may prove to b highly valuable in the future. At present, the Department of Ocean Development (DOD) ha one plant in Tiruchendur in Tamil Nadu, producing 1 mW a day.

Geothermal energy: This is the energy stored within the earth ('geo' for earth and 'thermal' for heat). Geothermal energy starts with hot, molten rock (called *magma*) deep inside the earth, which surfaces at some parts of the earth's crust. The heat rising from the magma warms underground pools of water known as *geothermal reservoirs*. If there is an opening, hot underground water comes to the surface and forms hot springs or it may boil to form geysers. With modern technology, wells are drilled deep below the surface of the earth to tap into geothermal reservoirs. This is called 'direct' use of geothermal energy, and it provides a steac stream of hot water that is pumped to the earth's surface.



Geothermal energy

In the 20th century, geothermal energy has been harnessed on a large scale for space-heatin industrial use and electricity production, especially in Iceland, Japan and New Zealan Geothermal energy is nearly as cheap as hydropower; there are, however, very few good exampl of this. Furthermore, water from geothermal reservoirs often contains minerals that a corrosive and polluting. In addition, geothermal fluids contain contaminants which must treated before disposal.

Nuclear power

In 1938, two German scientists, Otto Hahn and Fritz Strassman, demonstrated nuclear fissio They found they could split the nucleus of a uranium atom by bombarding it with neutro As the nucleus split, some mass was converted to energy. The nuclear power industry, howev

born in the late 1950s. The first large scale nuclear power plant in the world becam the world became operational in 1957, in Pennsylvania, USA.
As of 2008, India and the US have an agreement facilitating nuclear cooperation in energy & satellite technology between the two countries. The US's three-decade suspension of nuclear trade with India has been lifted.

Homi Bhabha is considered the father of nuclear power development in India. The Bhabha Atomic Research Centre (BARC) in Mumbai studies and develops modern nuclear technology. India has ten nuclear reactors at five nuclear power stations that produce 2% of India's electricity. These are located in Maharashtra (Tarapur), Rajasthan, Tamil Nadu, Uttar Pradesh and Gujarat. India has uranium from mines in Bihar. There are also thorium deposits in Kerala and Tamil Nadu.

The nuclear reactors use uranium-235 to produce electricity. The energy released from 1 kg of uranium-235 is equivalent to that produced by burning 3,000 t of coal. U-235 is made into rods that 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. The drawback is that the rods need to be changed periodically. This has an adverse impact on the environment due to the disposal of nuclear waste. Additionally, the reaction releases very hot waste water that potentially damages aquatic ecosystems, even though it is cooled by a water system before it is released.

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. For environmental reasons, Sweden has decided to become a nuclear-free country by 2010.

Although the conventional environmental impact from nuclear power is 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. Land, water, vegetation are destroyed for long periods of time. The management, storage and disposal of radioactive waste resulting from nuclear power generation are the biggest expenses of the nuclear power industry. There have been horrifying nuclear accidents at Chernobyl in USSR and at the Three-Mile Island in the USA. The radioactivity unleashed by such accidents can affect humans for generations.

Energy conservation

Conventional energy sources affect nature and human society in different ways. India needs to rapidly move towards a policy to reduce energy needs and use cleaner energy production technologies. Here are some approaches towards energy conservation in India:

- A shift to alternative energy use and renewable energy sources that are used judiciously and equitably would bring about environmentally friendly and sustainable lifestyles. This would also reduce India's dependency on imported oil.
- Electricity losses in India during transmission and distribution are significantly high—approximately 30–45%. And this is before we even turn on our bulbs at home! Minimising these losses is critical to effective energy conservation in India.
- Small hydrogeneration units are environment-friendly. They do not displace people, destroy forests or wildlife habitats or kill aquatic and terrestrial biodiversity. They can be placed on

several hill-streams, canals & rivers. The generation depends on flowing water due to gravity. However this fails if the flow is seasonal. An estimated potential of about 15,000 MW of small hydrogeneration projects exist in India. Andhra Pradesh, Arunachal Pradesh & Assam are example of some states where small hydroprojects have been implemented.

- Enhancing fuelwood plantations and managing them through JFM.
- Using energy-efficient cooking stoves or *chulhas* which help the movement of air throu them, making the wood burn more efficiently. Additionally, these stoves have a chimney minimise air pollution and thus reduce respiratory problems.
- Biomass generated from firewood, cattle dung, crop residue such as rice husk, coconut she or straw can be converted into biogas or liquid fuels; that is, ethanol and methanol. This c provide a low-cost fuel option for heating purposes such as cooking. Alternatively, biog can be compressed and used to power motor vehicles.
- Unplanned and inefficient public transport systems, especially in cities, also waste a lar amount of energy. Providing for bicycle paths during the town planning stage wou encourage more people to conserve energy by using bicycles.
- In the agricultural sector, irrigation pumps to lift water are the most energy intensive; the are either electrical or run on fossil fuels. Alternative energy sources such as solar-powere irrigation pumps should be used instead.
- Large-energy consumers include chemical industries, especially petrochemical units, iro and steel, textiles and paper. Efforts must be made by these industries to be more energ efficient.

It is easy to waste energy but cheaper to save it than generate it. We can conserve energ by preventing or reducing energy waste and by using resources more efficiently. People ofte waste energy because the government subsidises it. If the real cost was levied, people would n be able to afford to waste it carelessly.

(vi) Land Resources

Land as a resource: Landforms like hills, valleys, plains, river basins and wetlands inclu different resource-generating areas that the people living in them depend on. Many tradition farming societies had ways of preserving areas from which they used resources. For example, the 'sacred groves' of the Western Ghats, requests to the spirit of the grove for permission to c a tree or extract a resource were accompanied by simple rituals. The outcome of a chance f on one side or the other of a stone balanced on a rock gave or withheld permission. The requ could not be repeated for a specified period.

If land is utilised carefully, it can be considered a renewable resource. The roots of tre and grasses bind the soil. If forests are depleted or grasslands overgrazed, the land becom unproductive and wasteland is formed. Intensive irrigation leads to water-logged and salinis soil, on which crops cannot grow. Land is also converted into a non-renewable resource wh highly toxic industrial and nuclear waste is dumped on it.

Land on earth is as finite as any other natural resource. While humans have learnt to ad our lifestyle to various ecosystems, we cannot live comfortably for instance on polar ice ca under the sea or in space in the foreseeable future. We need land for building homes, cultivat food, maintaining pastures for domestic animals, developing industries to provide goods a supporting the industries by creating towns and cities. Equally importantly, humans need

to protect wildemess areas in forests, grasslands, wetlands, mountains & coasts to protect our critically valuable biodiversity. Thus, the rational use of land demands carefull planning. One can develop most of these different types of land uses almost anywhere, but protected areas (national parks and wildlife sanctuaries) can only be situated where some of the natural ecosystems are still undisturbed.

6.3 Water Conservation, Rainwater Harvesting, Watershed Management

6.3.1 Water Conservation

Conserving water has become a prime environmental concern. Clean water is bec
increasingly scarce globally. With deforestation, surface run-off increases and the sub-soi
table drops as water has no time to seep slowly into the ground once the vegetation is cle

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

When we waste water, we do not realise that it affects all of us in so many differen
Water has to be equitably and fairly distributed so that household use, agriculture and in
all get a share of the water. The overuse and misuse of water due to various activiti
the resulting pollution has led to a serious shortage of potable drinking water. Thus,
conservation is linked closely with overall human well being.

CASE STUDY 2

Pani Panchayat, Pune district, Maharashtra

Mahur village, in the Pune District of Maharashtra, is situated in a drought prone ar
The people were not able to grow a good crop in most years; clean drinking wa
was also scarce. At such a time, Vilasrao Salunkhe initiated a movement known
Pani Panchayat, to conserve water in this drought prone area. Watershed developm
was initiated on a barren and uncultivated piece of land belonging to a temp
Soil conservation and water harvesting, brought about through a comprehens
micro-watershed management program, gradually led to a surplus of water. Ou
the 16 ha of land in the village, 9.6 ha were brought under irrigation, 2.4 ha w
afforested and 4 ha were converted into percolation tanks. Wells and field bunds w
built. While 200 quintals of grains were produced on 24 acres of Salunkhe's la
40 acres of land in the same area yielded only 10 quintals. This made other villag
follow suit and the area rapidly turned green and productive.

Traditional systems of collecting water and using it optimally have been used in In
many generations. These have been forgotten in the recent past. Conserving water in m
small percolation tanks and *jheels* was an important feature of traditional forms of agric
Villages all over the country had one or more common *talabs* or tanks from which people co
or used water carefully.

As carrying water to their homes over long distances was a time-consuming and lab
activity, the water was not be wasted. Many homes had a kitchen garden that was wate
by the waste water. Conservation of water was done in a traditional homes through a
conscious effort. During the British periods many dams were built across the country
to supply water especially to growing urban areas. After independence, India's
policy on water changed towards building

large dams for expanding agriculture to support the green revolution. While this reduced the need to import food material and mitigated food shortages in the country, the country began to see the effects of serious water shortages and problems related to its distribution. The newer forms of irrigated agriculture, such as sugarcane and other water-hungry cash crops, required enormous quantities of water. Finally, however, such irrigated areas become waterlogged and unproductive. Thus, the ill effects of the poorly-conceived management of water at the national and local level have made it mandatory to consider a new water policy for the country.

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

Saving water in urban settings: Urban people waste large amounts of water. Leaking taps and pipes are a major source of water loss. Canals and pipes carrying water from dams to the consumer contribute nearly 50% to water loss during transfer. Implementing water distribution infrastructure that reduces such distribution losses as well as reducing the demand for water by saving it, is more appropriate than trying to meet growing demands.

6.3.2 Rainwater Harvesting

As our world faces serious water shortages, every drop of water we can use efficiently becomes great in value. One method is to manage rainwater in such a way that it is used at the source. If as much water as possible is collected and stored, this can be used after the rainy season is over. In many parts of the world, especially in very dry areas, this has been the traditional practice. However, the stored water has to be kept pollution-free and clean so that it can be used as drinking water. Stored water can grow algae and zooplankton (microscopic animals) which can be pathogenic and cause infections. Thus, keeping the water uncontaminated is of great importance.

Current technologies of rainwater harvesting require that all roof and terrace water passes down into a covered tank (below or above ground) where it can be stored for use after the monsoon (Fig. 6.1). This practice is most advantageous in arid areas where clean water is very scarce. However, there are practical difficulties such as constructing large storage tanks which can be expensive.

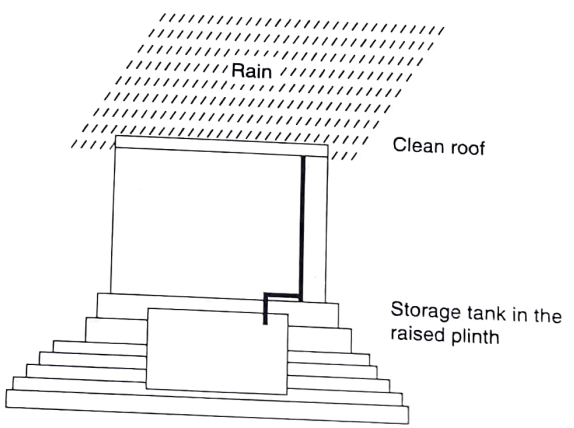


Fig. 6.1 Rainwater harvesting: Storage tank below the ground

Another way of using rooftop rainwater harvesting is to collect the rainwater so that it percolates into the ground to

recharge wells instead of flowing over the ground into rivers (Fig 6.2). Thus, the by recharging the groundwater by water harvested from rooftops the water table rises and the surrounding wells retain water throughout the year.

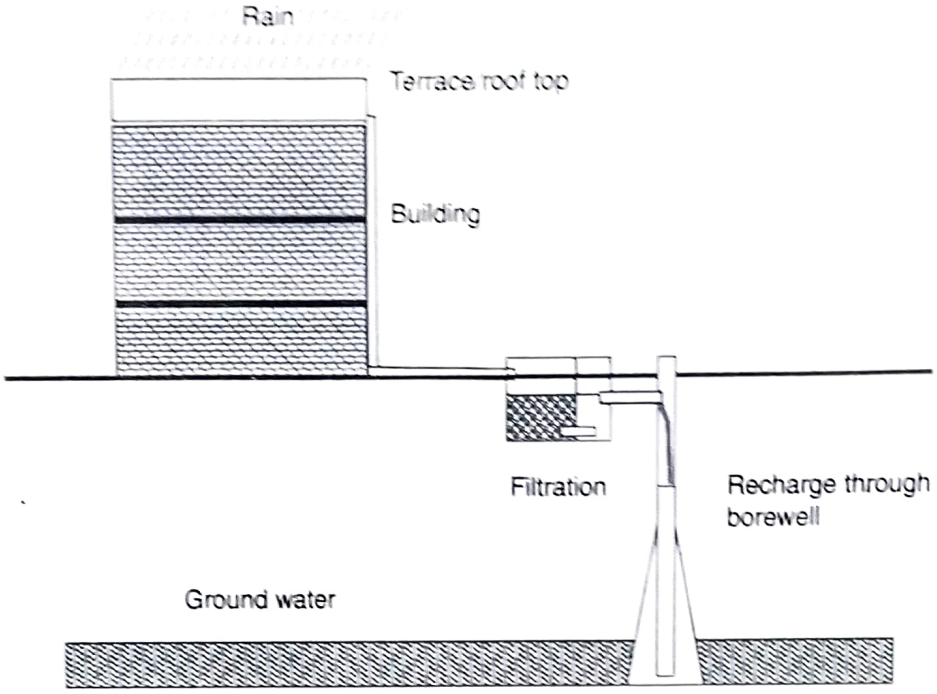


Fig. 6.2 Rainwater harvesting: Recharge of groundwater through borewell

CASE STUDY 3

Mewar, Rajasthan

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

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

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

Hembar: These are small temporary dams constructed with stones, twigs and mud over a seasonal stream, when the water in it is reduced to a point that it cannot be taken directly to the fields for irrigation.

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

Talab: The Mewar region is well-known for its built reservoirs (*talabs*). Udaipur city is famous for its large number of *talabs*, and is called the lake city. A small reservoir of

than five bighas is called talai a medium size lake is bandh or talab and a bigger lake is called sagar samand

(continued)

(Continued)

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

6.3.3 Watershed Management

Rivers originate in streams that flow down mountains and hill-slopes. A group of small streams flow down hillsides to meet larger streams in the valley, which form the tributaries of major rivers. The management of a single unit of land with its water drainage system is called watershed management. This is a technique that has several components including soil and water management, and developing a vegetation cover. The natural drainage pattern of a watershed unit, if managed properly, can bring about local prosperity by providing year-round supply of water, thereby improving the quality of life in the area.

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

Watershed management begins by taking control of a degraded site through local participation. People must appreciate the need to improve the availability of water both in quantity and quality for their own area. Once they are adequately educated and sensitised, the community begins to understand the project and people begin to work together to promote good watershed management.

Technical steps to take appropriate soil conservation measures for a sound watershed management setup:

Construct a series of long trenches and mounds along the contours of hills to hold the rainwater and allow it to percolate into the ground. This ensures that underground stores of water are fully recharged. This cab be enhanced by growing grasses and shrubs, and planting trees (mainly local species) which hold the soil and prevent it from being washed away in the monsoon.

Note: Local grass cover can only increase if free grazing of domestic animals is regulated or replaced by stall feeding.

Make *nala* plugs in the streams, so that the water is held in the stream and does not rush down the hillside. In selected sites, several small check-dams should be built, which together can hold back larger amounts of water.

6.4 Resettlement and Rehabilitation of People: Its Problems and Concerns

Any major project such as a dam, mine, expressway or the notification of a National Park, disrupts the lives of the people who live in that area and often requires relocating them to an

it hard to adapt to a new way of life in a new place. Thus, no major project that is lik
displace people can be carried out without the consent of the local people. In India, la
people have been arbitrarily displaced by the thousands of dams built since independe
drive the green revolution. The dams have been built virtually at the cost of these poor
people who have been powerless to resist the Government's will. The Government is exp
to find 'good' arable land to resettle these displaced persons and provide them wi
adequate rehabilitation package to recover from the disruption. This has rarely occurred
satisfaction of the individuals affected by the project. In many cases across the country
has not been implemented satisfactorily for decades.

CASE STUDY 4

Indigenous tribes

It is not just our flora and fauna alone that is under the threat of extinction. Amon
the many tribes across the globe, the Jarawas of the Andaman islands in the India
Ocean are dwindling. Dispossession of their customary rights over land has put the
survival at risk. They have been compelled to give up their traditional lifestyles, resultin
in a rapidly diminishing indigenous population.

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

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

6.5 Environmental Ethics: Issues and Possible Solutions

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

6.5.1 Resource Consumption Patterns and the Need for Equitable Utilisation

Can individuals justifiably use resources so differently that one individual uses resources ma
times more lavishly than other individuals who have barely enough to survive? In a just wor
there has to be a more equitable sharing of resources than what exists at present. There are r
and poor nations, there are rich and poor communities in every country, and there are rich a
poor families. In this era of modern economic development, the disparity between the hav
and have-nots is widening. Our human environments in the urban, rural and wilderness secto
use natural resources that shift from the wilderness (forests, grasslands, wetlands) to the ru
sector and from there to the urban sector. Wealth also shifts in the same direction. This uneq
distribution of wealth and access to land and its resources is a serious
environmental concern.

An equitable sharing of resources forms the basis of sustainable development for urban, rural and wilderness-dwelling communities. As the political power base is in the urban centers, this leads to inequalities and a subsequent loss of sustainability in resource management in the rural and forest sectors.

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

(i) Environmental destruction is largely caused by the consumption of the rich.
(ii) The worst sufferers of environmental destruction are the poor.
(iii) Even where nature is being 'recreated', as in afforestation, it is being transformed away from the needs of the poor and towards those of the rich.
(iv) Even among the poor, the worst sufferers are the marginalised cultures and occupations and, most of all, women.
(v) There cannot be proper economic and social development without a holistic understanding of society and nature.
(vi) If we care for the poor, we cannot allow the Gross Nature Product to be destroyed any further. Conserving and recreating nature has become our highest priority.
(vii) The Gross Nature Product will be enhanced only if we can arrest and reverse the growing alienation between the people and the common property resources. Towards this end, we will have to learn a lot from our traditional cultures.
(viii) It is totally inadequate to talk only of sustainable rural development as the World Conservation Strategy does. We cannot save the rural environment or rural people dependent on it, unless we can bring about sustainable urban development.

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

Who pays for the cost of environmental degradation? Most sections of society do not feel the direct effects of degradation of the environment till it is too late. Several marginalised sectors of society are most affected by deforestation, or the loss of grassland tracts, or the deterioration of perennial water sources. All these effects can be linked to increasing unsustainable pressures on land & natural resources. Traditional fishermen who are dependent on streams & rivers, and coastal people who fish and catch crustaceans are seriously affected by the degradation of our aquatic ecosystems.

A Task Group set up by WHO has warned that climate change may have a serious impact on human health. Climate change will increase existing health problems and may also bring new and unexpected ones. Strategies aimed at reducing potential health impacts of anticipated climate changes should include the monitoring of infectious diseases and disease vectors to detect early changes in the incidence of diseases and the geographical distribution of vectors; environmental management measures to reduce risk; disaster preparedness for floods or droughts and their health-related consequences. It will be necessary to educate and create early warning systems for epidemic preparedness. Improved water and air pollution control will become increasingly essential for human health. Public education will have to be directed at changes in personal behaviour. The training of researchers and health professionals is essential towards the world becoming more responsible for the expected outcome of Global Climate Change (GCC).

6.6.2 Global Warming

About 75% of the solar energy reaching the earth is absorbed by the earth's surface, which leads to an increase in its temperature. The rest of the heat radiates back to the atmosphere. Some of the heat is trapped by greenhouse gases (GHGs), mostly carbon dioxide. As carbon dioxide is released by various human activities, the amounts are rapidly increasing. This is causing global warming.

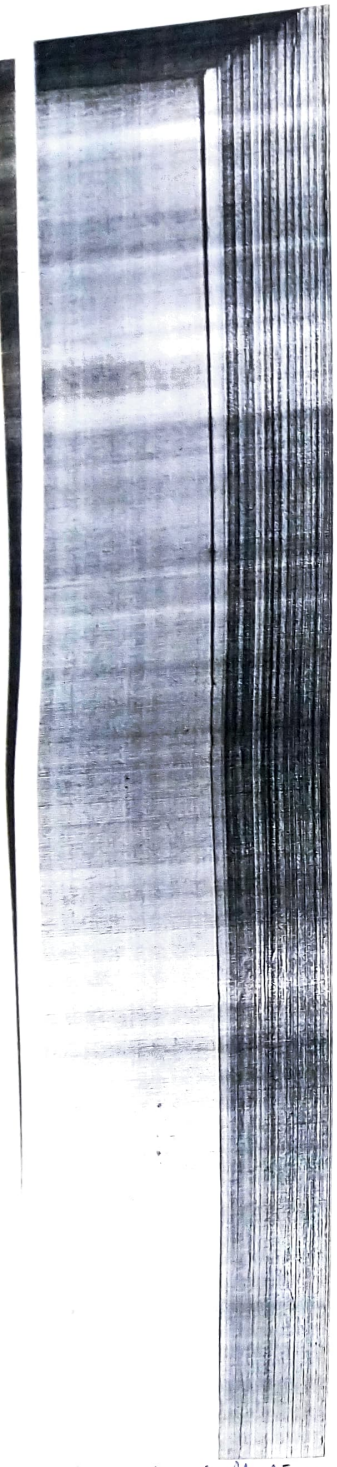
The average surface temperature is about 15°C. This is about 33°C higher than it would be in the absence of the greenhouse effect. Without such gases, most of the earth's surface would be frozen with a mean air temperature of –18°C.

Human activities during the last few decades of industrialisation and population growth have polluted the atmosphere to the extent that it has begun to seriously affect the climate. The carbon dioxide in the atmosphere has increased by 31% since pre-industrial times, causing more heat to be trapped in the lower atmosphere. There is evidence to show that carbon dioxide levels are still increasing. Many countries have signed a convention to reduce GHGs under the United Nations Framework Convention on Climate Change (UNFCC). However, the current international agreements are not still effective enough to prevent significant changes in climate and a rise in sea levels.

Global warming is accelerating faster than that calculated by climatologists a few years ago. In 1995, the IPCC predicted that global warming would raise temperatures by 3.5–10°C during the 21st century, if the present trends continue. It is now believed that the raise could be much greater. This would lead to not only to changes in temperature but also the amount of rainfall. India may see great annual fluctuations in rainfall leading to floods and droughts.

6.6.3 Acid Rain

When fossil fuels such as coal, oil & natural gas are burned, chemicals like sulphur dioxide and nitrogen oxides are produced. These chemicals react with H_2O & other chemicals in the air to form sulphuric acid, nitric acid and other harmful pollutants like sulphates & nitrates.



These acid pollutants spread upwards into the atmosphere and are carried by finally return to the ground in the form of acid rain, fog or snow. The corrosive nature of acid rain causes many forms of environmental damage. Acid pollutants also occur as dry particles and gases, which when washed from the ground by rain, add to the acids in the rain to form an even more corrosive solution. This is called acid deposition.

Damage from acid rain is widespread in North America, Europe, Japan, China and South-east Asia. In the US, coal-burning power plants contribute to about 70% of sulphur dioxide. In Canada, oil refining, metal smelting and other industrial activities account for 61% of the sulphur dioxide pollution. Motor vehicle exhaust fumes are the main source of nitrogen oxides. The acids in acid rain chemically react with any object they come into contact with.

Effects

- Acid rain dissolves and washes away nutrients in the soil, which are needed by plants. It can also dissolve naturally occurring toxic substances like aluminum and mercury, freeing them to pollute water or poison plants.
- Acid rain indirectly affects plants by removing nutrients from the soil in which they grow. It affects trees more directly by creating holes in the waxy coating of leaves, causing brown dead spots which affect the plant's photosynthesis. Such trees are also more vulnerable to insect infestations, drought and cold. Spruce and fir forests at higher elevations seem to be most at risk. Farm crops are less affected by acid rain than forests.
- Acid rain that falls or flows as ground water to reach rivers, lakes and wetlands, causes the water in them to become acidic. This affects plant and animal life in aquatic ecosystems.
- Acid rain also has far reaching effects on wildlife. By adversely affecting one species, the entire food chain is disrupted, ultimately endangering the entire ecosystem. Different aquatic species can tolerate different levels of acidity. For instance clams and mayflies have a high mortality when water has a pH of 6.0. Frogs can tolerate more acidic water, although with the decline in supply of mayflies, frog populations may also decline. Land animals that are dependent on aquatic organisms are also affected.
- Acid rain and dry acid deposition damages buildings, automobiles and other structures made of stone or metal. The acid corrodes the materials causing extensive damage and ruins historic buildings. For instance the Parthenon in Greece and the Taj Mahal in India have been affected by acid rain.
- Although surface water polluted by acid rain does not directly harm people, the toxic substances leached from soil can pollute the water supply. Fish caught in these waters may be harmful for human consumption. Acid, along with other chemicals in the air, produces urban smog, which causes respiratory problems.

The best way to stop the formation of acid rain is to reduce the emissions of sulphur dioxide and nitrogen oxides into the atmosphere. This can be achieved by using less energy from fossil fuels in power plants, vehicles and industries. Switching to cleaner burning fuels is also a way out. For example, using natural gas which is cleaner than coal or using coal with lower sulphur content. Developing more efficient vehicles will reduce pollutants from being released into the air. If pollutants have already been formed by burning fossil fuel, they can be prevented from entering the atmosphere by using scrubbers in the smoke stacks of factories. These spray a mixture of H_2O & limestone into the polluting gases, recapturing the sulphur.

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

6.6.4 Ozone Layer Depletion

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

In the 1970s, scientists discovered that chemicals called chlorofluorocarbons or CFCs, which are used as refrigerants and aerosol spray propellants, pose a threat to the ozone layer. The CFC molecules are virtually indestructible until they reach the stratosphere, where UV radiation breaks them down to release chlorine atoms. These chlorine atoms react with ozone molecules to break them down into oxygen molecules. These oxygen molecules do not absorb UV radiation. Since the early 1980s, scientists have detected a thinning of the ozone layer in the atmosphere above Antarctica. This phenomenon is now being detected in other places as well, including Australia.

The destruction of the ozone layer causes increased incidence of skin cancer and cataracts. It also causes damage to certain crops and plankton, thus affecting natural food chains and food webs. This decrease in vegetation leads to an increase in carbon dioxide.

With the signing of the Montreal Protocol in 1987, a treaty for the protection of the ozone layer, the use of CFCs was to be banned by the year 2000, after which the ozone layer is expected to slowly recover over a period of about 50 years. Although the use of CFCs has been reduced and is now banned in most countries, other chemicals and industrial compounds such as bromine, halocarbons and nitrous oxides from fertilisers continue to attack the ozone layer.

6.6.5 Nuclear Accidents and Nuclear Holocaust

Nuclear energy was researched and developed by man as an alternate source of clean and cheap energy compared to fossil fuels. Although this did happen, along with the benefits of nuclear energy came its downfalls. In the short history of nuclear energy, there have been a number of accidents that have surpassed any natural calamities or other energy source extractions in their impact. A single nuclear accident causes loss of life, long-term illnesses and destruction of property on a large scale and for a long period of time. Radioactivity and its fallout lead to cancer, genetic disorders and death in the affected area for decades after the accident, thus affecting all forms of life for several generations.

The use of nuclear energy in war has had devastating effects on humans and on the earth. In the only use of nuclear power in war the United States dropped two atomic bombs over the

CASE STUDY 8

Nuclear disasters and leakages

In 1986, the Nuclear Power Station at Chernobyl in the erstwhile USSR develo a problem that led to a fire and a number of explosions in its nuclear reactor. radioactive dust spread over many kilometers and covered not only Europe but N America as well. Three people died in the explosion and 28 shortly after due to radiat exposure. Around 259 sick people were hospitalised. As the area had to be evacuat 1,35,000 people had to be moved immediately and another 1.5 lakh by 19 As radioactive fall-out continued, even more people had to be moved. An estimat 6.5 lakh people may have been seriously affected. They could get cancer, thyr tumours, cataracts and suffer from a lowered immune mechanism. Sheep in Scotla and reindeer in Lapland were affected and were unfit for human consumption sin radioactivity passed from grass to these herbivores. Vegetables, fruit and milk we contaminated in Europe.

Japanese towns of Hiroshima and Nagasaki in 1945. These two atomic bombs killed thou of people, left many more thousands injured and destroyed everything for miles around effects of the radiation from these nuclear bombs can still be seen today in the form of c and genetic mutations in the affected children and survivors of the incident.

6.7 Wasteland Reclamation

Loss of vegetation cover leads to loss of soil through erosion, which ultimately creates wastel This is one of the pressing problems of our country as loss of soil has already ruined amounts of cultivable lands. If it remains unchecked, it will affect the remaining lands. Unle adequately safeguard our 'good' lands, we may eventually face a serious shortage of foodgr vegetables, fruit, fodder and fuelwood. Hence, conservation of soil, protecting the exi cultivable lands and reclaiming the already depleted wastelands figure prominently amon priority tasks of planning for the future. Unfortunately, some wasteland reclamation prog have been unsuccessful as reclaimed lands have reverted to their original poor condition to mismanaged and unscientific methods of reclamation.

In choosing wasteland reclamation methods, attention must be paid to the cost factor. A pr study of environmental aspects and human impact which are responsible for the developme wastelands must also be made.

Wastelands can be classified into: (i) easily reclaimable, (ii) reclaimable with some diffic and (iii) reclaimable with extreme difficulty.

Easily reclaimable wastelands can be used for agriculture. Those which can be reclai with some difficulty can be utilised for agro-forestry. Wastelands that are reclaimed with extr difficulty can be used for forestry or to recreate natural ecosystems.

Wastelands can be reclaimed for agriculture by reducing the salt content in the soil w can be done by leaching and flushing. Gypsum. urea potash and compost are added to n such areas. Agro-forestry involves putting land to multiple the integration of trees with agricultural crops or livestock manely. The main purpose is to have trees

and crops interspersed to form an integrated system of biological production within a certain area. Attempts to grow trees in highly alkaline saline soils have been largely unsuccessful. Field experiments have shown that species like eucalyptus, *Prosopis* and *Acacia nilotica* cannot be grown in highly alkaline soil. Studies have shown that if tree seedlings are planted with a mixture of original soil, gypsum and manure, better growth can be achieved. It is, however, preferable to use indigenous species of trees so that the program recreates the local ecosystem with all its constituent species.

Need for Wasteland Development

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

Process of Wasteland Reclamation

The problem needs to be identifed at the micro-level. For this, district, village and plot-level surveys of the wasteland are necessary. A profile of the maps indicating the detailed distribution and information on the wasteland is essential. With the help of local government institutions such as the village *panchayats*, along with Block Development officers and Revenue Department functionaries, a plan based on the community's needs must be produced. This must be a participatory exercise, involving all the different stakeholders in the community. A think-tank of administrators, ecologists and local NGOs must also be involved in the process. Next, the factors that are responsible for the formation of wastelands should be identified. Based on these factors the wasteland is classified into marginally, partially or severely deteriorated lands. Once this is done, the steps to be followed are:

- Locale-specific strategies for reclaiming the wasteland must be worked out. Government officials along with the local NGOs must assist the farmers by demonstrating improved methods of cultivation, arranging for loans for the small, marginal and landless farmers and the people from the weaker sections of society.
- Involving the local women will prove to be of great value.
- Publicity campaigns integrated with training farmers and frontline government and Forest Department staff on the various aspects of wasteland utilisation should be organised.
- Environmental scientists can help by suggesting necessary changes in cropping patterns particularly for drought prone areas.
- Selection of appropriate crops for fodder and trees that provide local people with NTFPs according to the nature of the wasteland should be done.
- Soil must be tested in laboratories to provide guidance to the farmers on the proper land management techniques to be employed.

• Newer technological advances in irrigation and allied expertise for improving productivity without creating unsustainable patterns of development should be provided to the local people, especially the weaker sections and landless farmers.

Unit 7

Human Population and the Environment

Let's understand

- About population growth and how it varies among nations
- What population explosion is and how to control it
- How human health depends on the environment
- About human rights
- What is value education and why it is necessary
- About HIV/AIDS
- About woman and child welfare
- What the role of information technology in environment and human health is

7.1 Population Growth, Variation Among Nations

Human history dates back to at least 3 million years. Our ancestors lived as hunters and gatherers, thus maintaining small numbers, probably less than 10 million. With the development of agriculture, food subsistence was achieved, thus supporting a larger population. By ADE 1, the population grew to 300 million and continued to grow at a moderate rate. The 18th century marked the start of the Industrial Revolution. Human population expanded as the standard of living rose and famines and epidemics decreased in several regions. From 760 million in 1750, the population reached 1 billion by 1800. After World War II, the growth of world population accelerated mainly in the less developed countries. A billion people were added between 1960 and 1970 and then another billion between 1975 and 1987. The 20th century started off with 1.6 billion people and ended with 6.1 billion! It is not the census figures alone that need to be stressed, but an appreciation of this impact on our natural resources. The extent of this depletion is further increased by affluent societies that consume more energy and resources per capita, than less fortunate people.

Figure 7.1 shows the explosive population growth in the last 50 years. From 2.5 billion people in 1950 to 6.5 billion in 2005. By 2050, this number could rise to more than 9 billion. This explosive growth in the last 200 years has had it impact on (i) the disparity in living standards between the nations & within nations, (ii) resource use, and (iii) the environment.

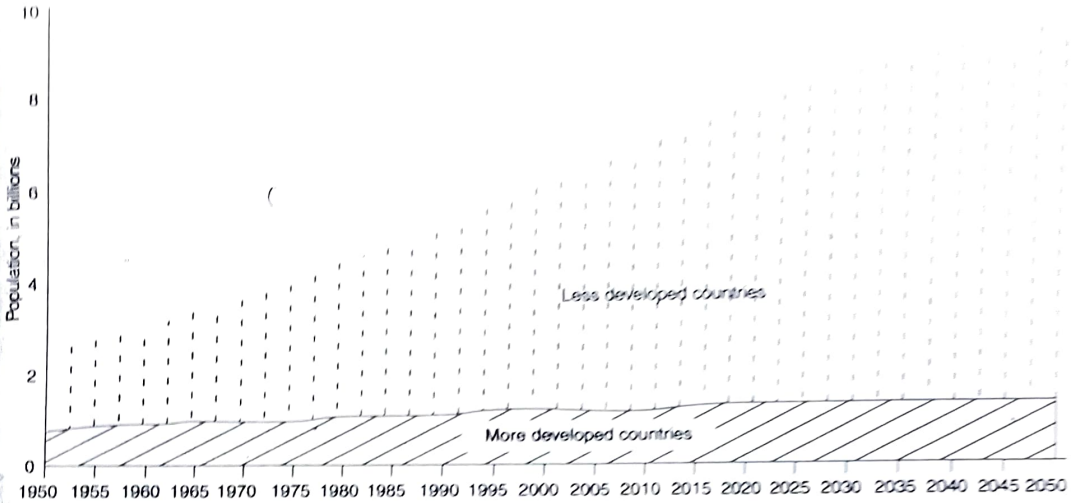


Fig. 7.1 World population growth, 1950–2050
Source: United Nation Population Division, *World Population Prospects*, 2008.

Our landscapes have changed drastically and will continue to change with human population growth. The increasing pressures on resources place great demands on the in-built buffering action of nature that has a certain ability to maintain a balance in our environment. However, current development strategies have led to a breakdown of the earth's ability to replenish the resources on which we all depend.

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

7.1.1 Global Population Growth

While the rate at which the world's population is increasing has slowed, the population continues to grow. The rate of the world's annual population change can be expressed as a percentage:

$$\text{Annual rate of natural population change (\%)} = \frac{\text{Birth rate} - \text{Death rate}}{1{,}000 \text{ persons}} \times 100$$

Birth rates and death rates are decreasing worldwide. However, better access to medical care, more widespread immunisation and improved sanitation have meant that death rates have fallen more steeply than birth rates—adding more babies to the world's population. So while the exponential growth rate has declined to a slower rate – from 2.2% to 1.2% – between 1963 and 2005, the same period has seen the population base being almost doubled – from 3.2 billion to 6.5 billion (Miller 2006). Furthermore, the exponential growth rate has been drastically

different in developed countries (0.1% annually) compared with developing nations (1.5% annually). This means that the population in developed countries, which is currently 1.2 billion, is expected to change very little in the next 50 years. On the other hand, developing countries will see a steady rise in their population—from 5.3 billion in 2005 to over 8 billion in 2050.

Another measure of population growth is *doubling time*. This is the time taken for a population to double in size. The method to calculate this is by dividing the natural logarithm of 2 by the exponent of growth, or approximated by dividing by 70 by the percentage growth rate. For example, in 2008, the world's population grew by 1.2%. This means that if this rate continues, the world's population will be doubled in approximately 58 years (70/1.2).

Let's do it!

If the population in India is increasing by 1.3% per year, how long will it take for its population to double?

Lets find out

How governments and people from every community meet challenges such as, limiting population size, protecting the natural environment, changing consumer-oriented attitudes, reducing habits that create excessive waste, alleviating poverty and creating an effective balance between conservation and development will determine the world's future.

7.2 Population Explosion: Family Welfare Programme

In response to our phenomenal population growth, India seriously took up an effective Family Welfare Programme (FWP) in 1951. This programme's objective is to 'reduce birth rates to the extent necessary to stabilise the population at a level which is consistent with the requirement of the national economy'. Slogans such as *Hum do hamare do* indicated that each family should not have more than two children. The best decision for the method to be used by a couple must be based on good advice from doctors or trained social workers who can suggest the full range of methods available for them to choose from.

Informing the public about the various contraceptive measures that are available is of primary importance. This must be done actively by government agencies such as Health and Family Welfare, as well as education and extension workers. It is of great importance for policy makers and elected representatives of the people – ministers, MPs, MLAs at the central and state levels – to understand the great and urgent need to support the FWP. The media must keep people informed about the need to limit family size and the ill effects of a growing population

on the world's resources

The decision to limit family size depends on a couple's background and education. This is related to government policy, the effectiveness of FWPs, the educational level and information levels in mass communication. The free access to family welfare information provided through the health care system is, in some cases, unfortunately counteracted by cultural attitudes. Frequently, misinformation and inadequate information are reasons why a family does not go in for limiting its size.

The importance of an effective FWP is crucial for India's growing population. The first green revolution in the 1960s produced a large amount of food, but has led to several environmental problems. Now, a new green revolution is needed, to provide enough food for our growing population that will not damage land, change river courses by building large dams or spread at the cost of critically important forests, grasslands and wetlands. Growing human populations will inevitably expand from farm lands into the remaining adjacent forests. Many such encroachments in India have been regularised over the last few decades. But forest loss has long term negative effects on water and air quality. Unfortunately, the loss of biodiversity is still not generally seen as a major deterrent to human well being. Energy use is growing, both due to an increasing population, and a lifestyle that increasingly uses consumer goods which require large amounts of energy for their production, packaging and transport. Our growing population also adds to the enormous amount of waste.

With all these links between population growth and the environment, FWPs have become critical to human existence.

Urban centers are already unable to provide for adequate housing, services such as water and drainage systems, growing energy needs or better opportunities for income generation.

7.2.1 Methods of Sterilisation

India's FWP advocates a variety of measures to control the population. Permanent methods or sterilisation are done by a minor surgery. Tubectomy in females is done by tying the fallopian tubes that carry the ovum to the uterus. Male sterilisation or vasectomy is done by tying the tubes that carry the sperm. Both are very simple procedures, done under local anesthesia, are painless and patients have no post-operative problems. Vasectomy does not cause any loss in the male's sexual ability but only arrests the discharge of sperm.

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

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

At the global level, in the year 2000, 600 million (or 57%) of women in the reproductive age group were using some method of contraception. However, the use of contraceptive measures is higher in developed countries and lower in developing countries—68% and 55% respectively. Female sterilisation is the most popular method of contraception used in developing countries at present. This is followed by the use of oral contraceptive pills and intrauterine devices (IUDs) for women, and the use of condoms for men. India and China have been using permanent sterilisation more effectively than many other countries in the developing world.

7.2.2 Urbanisation

In 1975, only 27% of the people in the developing world lived in urban areas. By 2000, this had grown to 40% and by 2030, well informed estimates state that this will grow to 56%. The developed world is already highly urbanised with 75% of its population living in urban areas. The urban population growth is both due to migration of people to towns and cities from the rural areas in search of better job opportunities as well as population growth within cities.

As a town grows into a city, it not only spreads outwards into the surrounding agricultural lands or natural areas such as forests, grasslands and wetlands, but also grows skywards with high-rise buildings. The town often loses its open spaces and green cover unless consciously preserved leading to the destruction of the quality of life in urban areas.

Good urban planning is essential for rational landuse, for upgrading slum areas, improving water supply and drainage systems, providing adequate sanitation, developing effective waste water treatment plants and an efficient public transport system.

While all these issues appear to be under the purview of local Municipal Corporations, better living conditions can become a reality only if every citizen plays an active role in managing the environment. This includes a variety of 'Dos and Don'ts' that should become an integral part of our personal lives. Unplanned and haphazard growth of urban complexes has serious environmental impacts. Increasing solid waste, improper garbage disposal and air and water pollution are frequent side effects of urban expansions.

Apart from undertaking actions that support the environment, every urban individual has the ability to influence a city's management. He/she must see that the city's natural green spaces, parks and gardens are maintained, river and water fronts are managed appropriately, roadside tree cover is maintained, hill slopes are afforested, and architectural and heritage sites are protected. Failure to do this leads to increasing urban problems which eventually destroy a city's ability to maintain a healthy and happy lifestyle for its dwellers. All these aspects are closely linked to the population growth in the urban sector. In many cities, population growth often outstrips the planner's ability to respond in time.

A megacity is one which has over 10 million inhabitants. In 1950, there was only one — New York. In 1985, there were five, in 2001 there were fifteen (with Mumbai, Kolkata and Delhi being added to the list from India); as of 2010, there are 25 megacities 19 of which are in developing countries. By 2015 there will be 36 megacities.

Table 7.1 Megacities in India

Name	Population (in millions) in 2001	Projection (in millions) for 2015
Mumbai	16.5	22.6
Kolkata	13.3	16.7
Delhi	13.0	20.9

Pull and Push Factors

Small urban centers too will grow rapidly during the next decade and several rural areas will require reclassification as urban centers. India's urban areas will grow by a projected 297 million residents. In India, people move to cities from rural areas in the hope of earning better incomes. This is the 'pull' factor. Poor opportunities in the rural sector thus stimulate migration to cities. The loss of agricultural land to urbanisation and industry, the inability of governments to sustainably develop the rural sector and a lack of supporting infrastructure in rural areas—all these factors 'push' people from the agricultural and natural wilderness ecosystems into the urban sector.

As populations in urban centers grow, they draw on resources from more and more distant areas. The *ecological footprint* corresponds to the land area necessary to supply natural resources to a community and disposal of its waste. At present the average ecological footprint of an individual at the global level is said to be 2.3 ha of land per capita. It is estimated though, that the world has only 1.7 ha of land per individual to manage these needs thus leading to an unsustainable use of land.

The pull factor of the urban centers is not only due to better job opportunities, but also better education, health care and relatively higher living standards. During the last few decades in India, improvements in the supply of clean water, sanitation, waste management, education and health care have all been urban centric, even though the stated policy has been to support rural development. In reality, development has lagged behind in the rural sector that is rapidly expanding in numbers. For people living in wilderness areas in our forests and mountain regions, development has been most neglected. It is not appropriate to use the development methods used for other rural communities for tribal people who are dependent on collecting natural resources from the forests. A different pattern of development that is based on the sustainable extraction of resources from their own surroundings would be ideal. In general though, the growing human populations in the rural sector will opt to live where they are only if they are given an equally satisfying lifestyle as they would get in an urban sector.

The wilderness–rural–urban link

Urban centers occupy 2% of the world's land but use 75% of the wood available. About 60% of the world's water is used by urban areas of which half irrigates food crops for urban dwellers, one third goes towards industrial use and the rest for household use and drinking water.

The impact of urban dwellers on the environment is not obvious to them as it affects distant places which support the urban economy using resources from agricultural & even more remote wilderness ecosystems

Urban Poverty and the Environment

The number of poor people living in urban areas is rapidly increasing; a third of all poor people in the world live in urban centers. These people live in urban slums and suffer from water shortages and unsanitary conditions. In most cases, while a slum invariably has unhygienic surroundings, the dwellings themselves are kept relatively clean. It is the common areas used by the community that lacks the infrastructure to maintain a hygienic environment.

One billion urban people in the world live in inadequate housing, mostly in slums, the majority of buildings being temporary structures. However, low income groups that live in high rise buildings can also have high densities and live in poor unhygienic conditions in certain areas of cities. Illegal slums often develop on government land, along railway tracks, on hill-slopes, riverbanks and marshes that are unsuitable for formal urban development. On the riverbanks, floods can render these poor people homeless. Adequate legal housing for the urban poor remains a serious environmental concern.

Urban poverty is even more serious than rural poverty, as unlike in the rural sector, the urban poor have no direct access to natural resources such as relatively clean river water, fuelwood and NTFPs. The urban poor can only depend on cash to buy the goods they need, while in the rural sector they can grow a substantial part of their own food. Living conditions for the urban poor are frequently worse than for rural poor. Both outdoor and indoor air pollution due to high levels of particulate matter and sulphur dioxide from industrial and vehicle emissions leads to high death rates from respiratory diseases. Most environmental efforts are targeted at reducing outdoor air pollution whereas indoor air pollution, due to the use of fuelwood, waste material and coal in *chulhas*, is an equally major health issue. This can be addressed by using better designed 'smokeless' *chulhas*, hoods and chimneys to remove indoor smoke.

With the growing urban population, a new crisis of unimaginable proportions will develop in the next few years. Crime rates, terrorism, unemployment and serious environmental health-related issues can be expected to escalate. This course of things can only be altered by stabilising population growth on a war footing.

7.3 Environment and Human Health

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

Thus, development has created several long term health problems. A better health status of society will bring about a better way of life only if it is coupled with a stabilising population growth.

7.3.1 Environmental Health

Environmental health, as defined by WHO, comprises those aspects of human health, including the quality of life, that are determined by physical, chemical, biological, social and psychosocial factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling and preventing those factors in the environment that adversely affect the health of present and future generations.

Our environment affects health in a variety of ways. Climate and weather affect human health. Public health depends on sufficient amounts of good quality food, safe drinking water and adequate shelter. Natural disasters such as storms, hurricanes and floods still kill many people every year. Unprecedented rainfall triggers epidemics of malaria and water-borne diseases.

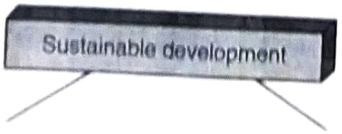
Global climate change has serious health implications. Many countries will have to adapt to uncertain climatic conditions due to global warming. As our climate is changing, we may no longer know what to expect. There are increasing storms in some countries, drought in others and a temperature rise throughout the world.

CASE STUDY 1

The El Nino/La Nina–Southern Oscillation (ENSO)

ENSO is a climate pattern that occurs across the Pacific ocean roughly every five years. The changes associated with the El Nino persist for about a year. The atmospheric variations associated with the El Nino and La Nina events are called the Southern Oscillation. Due to global climate change, the number of El Nino events have increased, causing an increase in extreme weather (floods and droughts) in many regions of the world. This also has a strong correlation to the incidence of epidemic diseases. Cycles of malaria in India, Venezuela and Colombia have now been linked to El Nino. Outbreaks of Australian encephalitis (a mosquito-transmitted disease) occur in South-east Australia after heavy rainfall and are associated with La Nina events.

Development strategies that do not incorporate ecological safeguards often lead to ill health, while strategies that can promote health invariably also protect the environment (Fig. 7.2). Thus, environmental health and human health are closely interlinked. An improvement in health is central to sound environmental management. However this is rarely given sufficient importance in planning development strategies.



Healthy environment → Healthy people

7.2 Importance of sustainable development

Examples of the links

- Millions of children die every year due to diarrhea from contaminated water or food. An estimated 2000 million people are affected by these diseases and more than 3 million children die each year from water-borne diseases across the world. In India, it is estimated that every fifth child under the age of 5 dies due to diarrhea (UNICEF—Water, Sanitation and Hygiene 2006). This is a result of inadequate environmental management and is mainly due to inadequate purification of drinking water. Wastewater and/or sewage entering water sources without being treated leads to continuous gastrointestinal diseases in the community and even sporadic large epidemics.
- Millions of people, mainly children, have poor health due to parasitic infections such as amebiasis and worms. This occurs from eating infected food or using poor quality water for cooking food. It is estimated that 36% of children in low-income countries and 12% in middle-income countries are malnourished. In India, about half the children under the age of four are malnourished and 30% of newborns are significantly underweight (World Bank, 2009).
- Hundreds of millions of people suffer serious respiratory diseases, including lung cancer and tuberculosis, from ill-ventilated homes and public places. Motor vehicle exhaust fumes, industrial fumes, tobacco smoke and cooking food on improper *chulhas*, contribute to respiratory diseases.
- Millions of people are exposed to hazardous chemicals in their workplace or homes that lead to poor health due to industrial products where controls are not adhered to.
- Tens of thousands of people in the world die due to traffic accidents owing to inadequate management of traffic conditions. Ineffective first aid at the accident site and the frequent inability to reach a hospital within an hour causes a large number of deaths, especially from head injuries.

Important Strategic Concerns

- Strategies to provide clean potable water and nutrition to all people are an important part of a healthy living environment.
- Providing clean energy sources that do not affect health is a key to reducing respiratory diseases.
- Reducing the environmental consequences of industrial and other pollutants such as transport emissions, can improve public health.
- Changing agricultural patterns to move away from harmful pesticides, herbicides and insecticides which are injurious to the health of farmers and consumers and using alternatives, such as IPM and non-toxic biopesticides, can improve the health of agricultural communities as well as food consumers.
- Changing industrial systems into those that do not use or release toxic chemicals that affect the health of workers and people living in the vicinity of industries can improve health and the environment.
- There is a need to change from using conventional energy to cleaner and safer sources like

Solar, wind and ocean power that dont affect human health
Providing clean energy will lead to better health.
• Poverty is closely related to health & is itself a consequence of improper environmental nangemt. An inequitable sharing of natural resources & environmental goods & services is linked to poor health.

Definition of health impact assessment (HIA): The WHO defines HIA as a combination of procedures, methods and tools by which a policy, program or project may be judged on the basis of its potential effects on the health of a population and the distribution of those effects within the population. HIA helps decision makers in making choices that promote health by preventing disease/injuries. For example, transport is a major contributor to traffic-related injuries, noise and air pollution. An effective HIA can promote a healthy transport policy/plan that reduces such risks and encourages the use of walking/cycle tracks.

7.3.2 Climate and Health

Centuries of human civilisation have helped mankind to adapt to living in a wide variety of climates—from the hot tropics to the cold arctic, in deserts, marshlands and in the high mountains. Both climate and weather have a powerful impact on human life and health issues.

Natural disasters (heavy rains, floods, hurricanes) can severely affect the health of a community. Poor people are more vulnerable to the health impacts of climate variability than the rich. Of approximately 80,000 deaths which occur world-wide each year as a result of natural disasters, about 95% are in poor countries. In weather-triggered disasters, hundreds of people and animals die, homes are destroyed, crops and other resources are lost. Public health infrastructure, like sewage disposal systems, waste management, hospitals and roads, are damaged. The cyclone in Orissa in 1999 caused 10,000 deaths. The total number of people affected was estimated at 10 to 15 million!

Human physiology can adapt to changes in weather, within certain limits. However, marked short-term fluctuations in weather lead to serious health issues. Heat waves cause heat-related illness and death (heat stroke). The elderly and persons with existing heart or respiratory diseases are more vulnerable. The heat wave in India in 1998 was associated with many deaths.

CASE STUDY 2

European heat wave

The 2003 European heat wave was one of the hottest summers on record, killing more than 35,000 people. France in particular had more than 14,000 heat-related deaths (mostly among elderly) when 7 days of more than 40°C temperatures were recorded between July and August 2003.

Climate plays an important role in vector-borne diseases transmitted by insects like mosquitoes. These disease transmitters are sensitive to the direct effects of climate such as temperature, rainfall patterns and wind. Climate affects their distribution and abundance through its effects on host plants and animals.

7.3.3 Infectious Diseases

Many infectious diseases have re-emerged with a vengeance. The loss of effective control over diseases such as malaria and tuberculosis, have led to a return of these diseases decades after being kept under stringent control. Other diseases which were not known to science earlier, seem to have suddenly hit our health and our lives during the last few decades. Two examples of new diseases include AIDS due to the HIV caused though sexual transmission and Severe

Acute Respiratory Syndrome (SARS). While these cannot be directly related to environment change, they affect the environment in which we live by forcing a change in lifestyles an behaviour patterns. For example, the SARS outbreak prevented people in several countri from travelling to other countries for months, severely affecting national economies, airlin companies and the tourism industry.

Why have infectious diseases that were related to our environment that were under contr suddenly make a comeback? Diseases like tuberculosis have been effectively treated wit anti-tubercular drugs for decades. These antibiotics are used to kill off the bacteria that caus the disease. However, nature's evolutionary processes permitted the bacteria to mutate b creating new genetically modified strains. These mutated strains, which are not affected by th routinely-used antibiotics, begin to spread rapidly. This leads to a re-emergence of the disease In the case of tuberculosis, this has led to multi-drug resistant tuberculosis. This is frequentl related to HIV, which reduces an individual's immunity to bacteria, such as *mycobacterium tuberculosis* that causes tuberculosis.

The newer broad-spectrum antibiotics, antiseptics, disinfectants and vaccines once though of as the complete answer to infectious diseases have thus failed to eradicate infectious diseases In fact, experts now feel that these diseases will be the greatest killers in the future and no diseases such as cancer or heart disease.

While antibiotic resistance is a well-known phenomenon, there are other reasons for the re-emergence of diseases:

- Overcrowding due to the formation of slums in the urban areas leads to several health hazards, including easier spread of respiratory diseases.
- Inadequate drinking water quality, poor disposal of human waste due to the absence of a closed sewage system and poor garbage management are all urban health issues. This has led to the reappearance of diseases such as cholera and an increased incidence of diarrhea and dysentery as well as infectious hepatitis (jaundice).
- Impacts of climate change mean a change in disease patterns and their distribution. For example, warmer climate will change the distribution of dengue, malaria and yellow fever to spread further away from the equator. Warmer, wetter climates could cause serious epidemics of diseases such as cholera. The *El Niño,* which causes periodic warming, is likely to affect rodent populations; this could bring back diseases like the plague.

Globalisation and Infectious Diseases

Globalisation is a world-wide process which includes the internationalisation of communication, trade and economic organisation. It involves parallel changes such as rapid social, economic and political adjustments. Whilst globalisation has the potential to enhance the lives and living standards of certain population groups, for the poor and marginalised populations in both the non-formal as well as formal economic sectors of developing countries, globalisation enhances economic inequalities.

Tuberculosis (TB) kills approximately 2 million people each year (including persons infected with HIV). In India, the disease ~~has re-emerged and is now~~ has re-emerged and is now more difficult to treat. TB is Contagious & airborne. It is a disease that affects mostly young adults in their most productive years. Only people who are sick with pulmonary TB can infection. When infectious people cough, sneeze, talk or spit, they emit the tubercle bacilli into air. When a healthy person inhale,

these, she/he gets infected by the disease. The symptoms include prolonged fever, coughing spells and weight loss.

It is estimated that left untreated, each patient of active tuberculosis will infect, on an average, between 10–15 people every year. But people infected with TB will not necessarily get sick with the disease. The immune system can cause the TB bacilli, which is protected by a thick waxy coat, to remain dormant for years. When an individual's immune system is weakened, the chances of getting active TB are greater.

HIV is accelerating the spread of TB. The link between HIV and TB affects a large number of people, each disease speeding the other's progress. HIV weakens the immune system. Someone who is HIV-positive and infected with TB is much more likely to become seriously ill with TB, rather than someone infected with TB who is HIV-negative.

Poorly-managed TB programs are threatening to make TB incurable

Until 50 years ago, there were no drugs to cure tuberculosis. Now, strains that are resistant to one or more anti-TB drugs have emerged. Drug-resistant tuberculosis is caused by inconsistent or partial treatment—when patients do not take all their drugs regularly for the required period, when doctors or health workers prescribe inadequate treatment regimens, or where the drug supply is unreliable. From a public-health perspective, poorly-supervised or incomplete treatment of TB is worse than no treatment at all. When people fail to complete standard treatment regimens, or are given the wrong treatment, they may remain infectious. The bacilli in their lungs may develop resistance to anti-TB drugs. The people that they infect will have the same drug-resistant strain. While drug-resistant TB is treatable, it requires extensive chemotherapy that is often very expensive and is also more toxic to patients.

Malaria

Malaria is a life-threatening parasitic disease transmitted by mosquitoes. The cause of malaria, a single-celled parasite called plasmodium, was discovered in 1880. Later, it was found that the parasite is transmitted from person to person through the bite of the female *Anopheles* mosquito, which requires blood for the growth of her eggs.

At present, approximately 40% of the world's population, mostly those living in the world's poorest countries, risk getting malaria. The disease was once more widespread but it was successfully eliminated from many countries with temperate climates during the mid-20th century. Today, malaria has returned and is found throughout the tropical and sub-tropical regions of the world and causes more than 200 million acute illnesses and at least one million deaths annually (WHO, 2009).

There are several types of human malaria. *Falciparum* malaria is the most dangerous type of infection and is most common in Africa south of the Sahara, where it accounts for extremely high mortality rates. There are indications of the spread of P. falciparum malaria in India and it has reappeared in areas where it had been eliminated.

the sexual stage where it can again infect a human host when the mosquito takes her next blood meal, 10 or more days later.

Malarial symptoms appear about 9–14 days after the mosquito bite, although this varies with different plasmodium species. Malaria produces high fever, headache, vomiting and body ache. If drugs are not available for treatment or the parasites are resistant to them, the infection can progress rapidly to become life-threatening. Malaria can kill by infecting and destroying red blood cells (anemia) and by clogging the capillaries that carry blood to the brain (cerebral malaria) or other vital organs.

Malarial parasites are developing unacceptable levels of resistance to drugs. Besides this, many insecticides are no longer useful against the mosquitoes transmitting the disease.

Measures to prevent malaria:

- Clear pools of stagnant water during the monsoons.
- Use mosquito nets treated with insecticide.
- Prompt access to treatment with effective up-to-date medicines, like artemisinin-based combination therapies (ACTs), saves lives.

7.3.4 Water-Related Diseases

Water supply, sanitation and hygiene development

Globally, about 2.4 billion people live under highly unsanitary conditions. Poor hygiene increases the exposure to risk of incidence and spread of infectious diseases. Water improperly stored in homes is frequently contaminated by inadequate management at the household level. This can be easily reduced through education and awareness about how water-borne diseases are transmitted.

Providing access to sufficient quantities of safe water, facilities for the sanitary disposal of excreta, and introducing sound hygiene-related behaviour can reduce the morbidity and mortality caused by these risks.

Health and water resources development

An important aspect of water-related diseases (in particular, water-related vector-borne diseases) is the way water resources are developed and managed. In many parts of the world, the adverse health impacts of dam construction, irrigation development and flood control is related to increased incidence of malaria, Japanese encephalitis, schistosomiasis, lymphatic filariasis and other conditions. Other health issues indirectly associated with water resources development include nutritional status, exposure to agricultural pesticides and their residues.

Water-borne diseases

Arid areas with rapidly expanding populations are already facing a crisis over water. Conservation of water and better management of existing resources is an urgent need. The demand and

major source of environmental problems that require policy change, administrative capacity building and increased financial support.

There are 4 major types of water-related diseases:

Water-borne diseases: They are caused by dirty water contaminated by human and animal wastes, especially from urban sewage or by chemical wastes from industry and agriculture. Some of these diseases, such as cholera and typhoid, cause serious epidemics. Diarrhea, dysentery, polio, meningitis and hepatitis A and E, are caused due to improper drinking water. Excessive levels of nitrates cause blood disorders when they pollute water sources. Pesticides entering drinking water in rural areas cause cancer, neurological diseases and infertility. Improving sanitation and providing treated drinking water reduces the incidence of these diseases.

Water-based diseases: They are caused by aquatic organisms that live a part of their life cycle in water and another part as a parasite in man, lead to several diseases. In India, guinea worm affects the feet. Round worms live in the small intestine, especially of children.

Water-related vector diseases: They are caused by insects like mosquitoes that breed in stagnant water spread diseases such as malaria and filariasis. Furthermore, changes in climate are leading to the formation of new breeding sites. Other vector-borne diseases in India include dengue fever and filariasis. Dengue fever carries a high mortality; filariasis leads to fever and chronic swelling of the legs. Eliminating mosquito-breeding sites when pooling of water occurs in the monsoon and using fish to control mosquito larval populations, are two ways to reduce these diseases without using toxic insecticides that have ill-effects on human health.

Water-scarcity diseases: In areas where water and sanitation is poor, there is a high incidence of diseases, such as tuberculosis, leprosy and tetanus which occur when one's hands are not properly washed. In other words, the lack of water leads to poor hygiene.

Diarrhea

There are several types of diarrhea, which give rise to loose motions and dehydration. About 4,500 children die *each day* from unsafe water and lack of basic sanitation facilities, mostly in developing countries (UNICEF, 2006).

Effects on health: Diarrhea is the frequent passage of loose or liquid stools and is a symptom of various gastrointestinal infections. Depending on the type of infection, the diarrhea may be watery (as in cholera caused by *Vibrio cholerae*) or passed with blood and mucus (in dysentery caused by an amoeba, *E. histolitica*).

Depending on the type of infection, it may last a few days or several weeks. Severe diarrhea can become life threatening due to the acute loss of fluids and electrolytes such as sodium and potassium, in watery diarrhea. This is particularly fatal in infants and young children. It is also dangerous in malnourished individuals and people with poor immunity.

The impact of repeated diarrhea on nutritional status is linked in a vicious cycle in children; chemical or non-infectious intestinal conditions can also result in diarrhea. There are several causes for the onset of diarrhea.

It is caused by several bacterial, viral and parasitic organisms.

- The feces of domestic animals also contain microorganisms that can cause diarrhea through water.
- Food is a major cause of diarrhea when prepared in unhygienic conditions.
- Fish and seafood from polluted water can cause severe diarrhea.
- Polluted water can also contaminate vegetables during irrigation.

Interventions: Key measures to reduce the number of cases of diarrhea include:

- access to safe drinking water,
- improved sanitation,
- good personal and food hygiene, and
- health education about how these infections spread.

Key measures to treat diarrhea include:

- giving more fluids than usual (oral rehydration) with salt and sugar, to prevent dehydration,
- continued feeding, and
- consulting a health worker if there are signs of dehydration or other problems.

In rural India, during the last decade, public education through posters and other types of communication strategies has decreased infant mortality due to diarrhea in several states. Posters depicting a child with diarrhea being given a salt and sugar solution to reduce death from dehydration has gone a long way in reducing both—a serious condition requiring hospitalisation and intravenous fluids, as well as mortality.

7.3.5 Risks Due to Chemicals in Food

Food contaminated by chemicals is an important public health concern. This contamination may occur through environmental pollution of the air, water and soil. Toxic metals, PCBs and dioxins, or the intentional use of various chemicals, such as pesticides, animal drugs and other agrochemicals have serious consequences on human health. Food additives and contaminants used during food manufacture and processing also adversely affect human health.

Diseases spread by food: Some food-borne diseases, though well recognised, have recently become more common. For example, outbreaks of salmonellosis which have been reported for decades, has increased within the last 25 years. In the Western hemisphere and in Europe, Salmonella serotype Enteritidis (SE) has become a predominant strain. Investigations of SE outbreaks indicate that its emergence is largely related to the consumption of poultry or eggs.

While cholera has devastated much of Asia and Africa for years, its reintroduction for the first time in almost a century on the South American continent in 1991 is an example of a well-recognised infectious disease re-emerging in a region after decades. While cholera is often water-borne, many foods also transmit the infection. In Latin America, ice and raw or under-processed seafood are important causes for cholera transmission.

Infection with a specific type of *Escherichia coli* (*E. coli*) was first described in 1982. Subsequently, it has emerged rapidly as a major cause of bloody diarrhoea and acute renal failure.

in southern Africa. Outbreaks have also implicated alfalfa sprouts, unpasteurised fruit juice, lettuce, game meat (meat of wild animals) and cheese curd.

In 1996, an outbreak of *E. coli* in Japan affected over 6,300 school children and resulted in 2 deaths.

Listeria monocytogenes (Lm): The role of food in the transmission of this condition has been recognised recently. In pregnant women, infections with Lm cause abortion and stillbirth. In infants and persons with a poor immune system, it may lead to septicemia (blood poisoning) and meningitis. The disease is most often associated with consumption of foods like soft cheeses and processed meat products that are kept refrigerated for a long time, because Lm can grow at low temperatures. Outbreaks of listeriosis have been reported from many countries, including Australia, Switzerland, France and the US. Two recent outbreaks of Listeria monocytogenes in France in 2000 and in the USA in 1999 were caused by contaminated pork tongue and hot dogs, respectively.

Food-borne trematodes (worms) are increasing in Southeast Asia and Latin America. This is related to a combination of intensive aquaculture production in unsanitary conditions, and the consumption of raw or underprocessed freshwater fish and fishery products. Food-borne trematodes can cause acute liver disease, and may lead to liver cancer. It is estimated that 40 million people are affected worldwide.

7.3.6 Cancer and the Environment

Cancer is caused by the uncontrolled growth and spread of abnormal cells that may affect almost any tissue of the body. Lung, colon, rectal and stomach cancer are among the five most common cancers in the world for both men and women. Among men, lung and stomach cancer are the most common cancers worldwide. For women, the most common cancers are breast and cervical cancer. In India, oral and pharyngeal cancers form the most common type of cancers, which are related to tobacco chewing.

More than 10 million people are diagnosed with cancer in the world every year. It is estimated that there will be 15 million new cases every year by 2020. Cancer causes 6 million deaths every year or 12% of the deaths worldwide.

The causes of several cancers are known. Thus, the prevention of at least one-third of all cancers is possible. Cancer is preventable by stopping smoking, providing healthy food and avoiding exposure to cancer-causing agents (carcinogens). Early detection and effective treatment is possible for a further one-third of cases. Most of the common cancers are curable by a combination of surgery, chemotherapy (drugs) or radiotherapy (X-ray technology). The chance of the cure increases if the cancer is detected at an early stage.

Cancer control is based on the prevention and control of cancer by:

- promoting and strengthening comprehensive national cancer-control programs,
- building international networks and partnerships for cancer control,
- promoting organised, evidence-based interventions for the early detection of cervical and breast cancer,
- developing guidelines on disease and programme management,

Prevention of Cancer

Tobacco smoking is the single-largest preventable cause of cancer in the world. It causes 80% to 90% of all lung cancer deaths. Another 30% of all cancer deaths, especially in developing countries, include deaths from cancer of the oral cavity, larynx, esophagus and stomach, which are related to tobacco chewing. Preventive measures include bans on tobacco advertising and sponsorship, increased tax on tobacco products and educational programs to reduce tobacco consumption.

Dietary modification is an important approach to cancer control. Overweight individuals and obesity are known to be associated with cancer of the esophagus, colon, rectum, breast, uterus and kidney. Fruits and vegetables may have a protective effect against many cancers. The excessive consumption of red and preserved meat may be associated with an increased risk of colorectal cancer. Infectious agents are linked with 22% of cancer deaths in developing countries and 6% in industrialised countries.

More on cancers

- Viral hepatitis B and C cause cancer of the liver. Human papilloma virus infection causes cancer of the cervix.
- The bacterium *Helicobacter pylori* (*H. pylori*) increases the risk of stomach cancer.
- In some countries, the parasitic infection schistosomiasis increases the risk of bladder cancer.
- Liver fluke increases the risk of cancer of the bile ducts. Preventive measures include vaccination and prevention of infection.
- Excessive solar UV radiation increases the risk of all types of cancer of the skin. Avoiding prolonged exposure to the sun, as well as the use of sunscreens and protective clothing, are effective preventive measures.
- Asbestos is known to cause lung cancer.
- Aniline dyes have been linked to bladder cancer.
- Benzene can lead to leukemia (blood cancer).
- The prevention of certain occupational and environmental exposure to several chemicals such as benzene, asbestos and aniline dyes is an important element in preventing cancer.

7.4 Human Rights

Several environmental issues are closely linked to human rights. These include the equitable distribution of environmental resources, the utilisation of resources and Intellectual Property Rights (IPRs), conflicts between people and wildlife especially around PAs, resettlement issues around development projects such as dams and mines, and access to health to prevent environment-related diseases. All of these aspects have been discussed in Chapter 6.

7.5 Value Education

Value education in the context of our environment is expected to bring about a new sustainable way of life. Education, both through formal and non-formal

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

What are values?

Values deal with ones own principles and standards from which we judge what kind of behaviour is right or wrong.

Values in environment education must bring in several new concepts. Why and how can we use less resources and energy? Why do we need to keep our surroundings clean? Why should we use less fertilisers and pesticides in farms? Why is it important for us to save water and keep our water sources clean? Or segregate our garbage into degradable and non-degradable types before disposal? All these issues are linked to the quality of human life and go beyond simple economic growth. They deal with a love and respect for nature. These are the values that will bring about a better humanity, one in which we can live healthy, productive and happy lives in harmony with nature.

7.5.1 Environmental Values

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

Values lead to a process of decision making which leads to action. For value education in relation to the environment, this process is learned through an understanding and appreciation of nature's oneness and the importance of its conservation.

Humans have an inborn desire to explore nature and to unravel its mysteries. However, modern society and educational processes have invariably suppressed these innate sentiments.

protect our natural heritage. This feeling for nature is a part of our constitution, which stro emphasises this value.

Concepts of what constitutes 'right' and 'wrong' behaviour change with time; values are constant. It was once considered 'sport' to shoot animals. It was considered a royal, brave desirable activity to kill a tiger. In today's context, with wildlife reduced to a tiny fractio what there was in the past, it is now looked down upon as a crime against biodiversity conservati Thus, the value system has been altered with time and circumstances. Similarly, with the la tracts of forest that existed in the past, cutting a few trees was not a significant crimi act. Today, this constitutes a major concern. With the small human numbers in the past, throw away a little household degradable garbage could not have been considered wrong. with enormous numbers of people throwing away large quantities of non-degradable waste is indeed extremely damaging to the environment and our value system must prevent all through a strong environmental value education system.

Appreciating the negative effects of our actions on the environment must becom part of our day-to-day thinking. Our current value system extols economic and techni progress as being what we need in our developing country. While we do need econom development, our value system must change to one that makes people everywhere supp a sustainable form of development so that we do not have to bear the cost of environmen degradation.

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

Each action by an individual must be linked to its environmental consequences in his/he mind, so that a value is created that strengthens pro-environmental behaviour and preven anti-environmental actions. This cannot happen unless new educational processes are create that provide a meaning to what is taught at school and college level. Every child asks question like 'What does this mean?' They want an explanation for things happening around ther that can help them make decisions and through this process develop values. It is this innat curiosity that leads to a personalised set of values in later life. Providing appropriate 'meaning for such questions related to our own environment develops a set of values that most peopl in society begin to accept as a norm. Thus, pro-environmental actions begin to move from th domain of individuals to that of a community.

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

What professions require making value judgments that greatly influence our environment? Evidently nearly every profession can and does influence our environment, but some do so more than others. Policy-makers, administrators, landuse planners, media, architects, medical personnel, health-care workers, agriculturalists, agricultural

Environmental values are linked to varied environmental concerns. While we value resources that we use as food, water and other products, there are also environmental services that we must appreciate. These include nature's mechanisms in cleaning up air by removal of carbon dioxide and addition of oxygen by plant life, recycling water through the water cycle of nature and maintaining climate regimes.

Let's take a pledge

- I will work towards the protection of our environment and the preservation of our wild species.
- I will work towards this with other like-minded individuals.
- I will consciously avoid committing acts that damage our environment and will publicly assert my dislikes for acts against the environment.
- I will not permit others to cause harm to the wilderness and our wild species without protest.
- I will use resources carefully by reducing, reusing and recycling whatever I use, such as water, paper, plastic, metal and glass articles.
- I will not carelessly throw away items that are made of our precious natural resources.
- I will use energy carefully and switch off electrical appliances when not in use.
- I will not waste energy by using a fuel-based vehicle when I can walk or cycle.
- I will visit our wondrous wild places with clean air, water, soil and all their plants and animals, and become a party to their conservation.
- I will not permit any individual or government action to spoil our environment or damage wilderness without protest.
- I will always care for Mother Earth.
- I will try not to damage her, knowingly or unknowingly.

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

We must also look at our environment beyond the wild sphere. There is incredible beauty in

Urban gardens and open spaces are also valuable and must be of prime concern to urban planners. These green spaces act as not only the 'lungs' of a city, but also provide much-needed psychological support. The mental peace and relaxation provided by such areas needs to be valued, although it is difficult to put a price tag on these values. Nevertheless, these centres of peace and tranquility give urban dwellers an opportunity to balance their highly modified environments with the splash of green of a garden space. Dr Ernest Wilson believed, as many do today, that these green spaces are vital to our mental and physical well-being; he coined the term *biophilia* to describe this.

Environmental values must also stress on the importance of preserving ancient structures. The characteristic architecture, sculpture, artworks and crafts of ancient cultures are invaluable environmental assets. They tell us where we have come from, where we are now, and perhaps (if we are willing to learn from them) where we should go. Architectural heritage goes beyond preserving old buildings, to conserving whole traditional landscapes in rural areas and streetscapes in urban settings. Unless we learn to value these landscapes, they will disappear and our heritage will be irrevocably lost.

As environmentally conscious individuals we need to develop a set of values that are linked with a better and more sustainable way of life for all people. There are several positive as well as negative aspects of behaviour that are linked to our environment. The positive feelings that support environment include a value for nature, cultures, heritage and equity. We also need to become more sensitive to aspects that have a negative impact on the environment. These include our attitude towards the degradation of the environment, loss of species, pollution, poverty, corruption in environmental management, the rights of future generations and animal rights.

7.5.2 Valuing Nature

The most fundamental environmental sentiment is to value nature herself. The oneness of our lives with the rest of nature and a feeling that we are only a miniscule part of nature's complex web of life becomes apparent, when we begin to appreciate the wonders of nature's diversity. We must appreciate that we belong to a global community that includes another 1.8 million known living forms. We know for sure that the earth's life-forms are unique. We have a great responsibility to protect life in all its glorious forms and must therefore respect the wilderness with all its living creatures, where human beings have not created changes that have led to perturbing natural habitats. We need to develop a sense of value that leads us to protect what is left of the wilderness. On the one hand, we need to protect natural ecosystems, while on the other we must protect the rights of local people.

Apart from valuing the diversity of life itself, we must also learn to value and respect diverse human cultures. Many of the tribal cultures of our country are vanishing because those with

CASE STUDY 3

Deep ecology

In the 1970s, a new thinking on environmental concerns began to emerge, protecting nature and the wilderness for its own sake, which is now referred to as 'Deep Ecology'. It was fostered by the thinking of Arne Naess, a Norwegian professor of Philosophy and a great believer in Gandhian thinking and Buddhism. It recognises the intrinsic value of all living beings and looks upon mankind as a small segment of a great living community of life-forms. It teaches that the well-being and flourishing of human and non-human life on earth have value in themselves and that these values are independent of the usefulness of the non-human world for human purposes.

Another new approach is that of *Gaia*, the hypothesis that the earth is itself like one giant form of throbbing life consisting of all the unquantifiable numbers of individuals of its millions of known and unknown species.

7.5.3 Valuing Cultures

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

7.5.4 Social Justice

As the gulf widens between the haves and the have-nots, it is the duty of the former to protect the rights of the latter. If this is not respected, the poor will eventually rebel, anarchy and terrorism will spread and the people who are impoverished will eventually form a desperate seething revolution to better their own lot. The developing world will face a crisis earlier than the developed countries, unless we protect the rights of poor people.

CASE STUDY 4

Darfur murders

An example of consequences of social injustice can be found in the genocidal murders in the Darfur region of Africa. Darfur is in the part of Africa that includes southern Sudan to the east of Lake Chad where such murders have become commonplace. Niger, which is just west of Lake Chad has regionwide drought leading to famine conditions, affecting millions. While there are many complex political causes of the famine and genocide, one of the major contributing factors is the disappearance Lake Chad—the sixth largest lake in the world! This lake has shrunk to one-twentieth

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

7.5.5 Human Heritage

The earth itself is a heritage left to us by our ancestors, not only for our own use but also for the generations to come. There is much that is beautiful on our earth—the undisturbed wilderness, a traditional rural landscape, the architecture of a traditional village or town and the value of a historical monument or place of worship. These are all part of our human heritage.

Heritage preservation is now a growing environmental concern, because we have undervalued much of this heritage during the last several decades and it is vanishing at an astonishing pace. While we admire and value the Ajanta and Ellora Caves, the temples of the 10^{th} to 15^{th} centuries that led to different and diverse styles of architecture and sculpture, the Moghul styles that led to structures such as the Taj Mahal, or the unique environmentally-friendly colonial buildings, we have done little to actively preserve them. As environmentally conscious individuals, we need to lobby for the protection of the wilderness and our glorious architectural heritage.

7.5.6 Equitable Use of Resources

An unfair distribution of wealth and resources, based on a world that is essentially only for the rich, will bring about a disaster of unprecedented proportions. The equitable use of resources is now seen as an essential aspect of human well-being and must become a shared point of view among all socially and environmentally conscious individuals. In spite of the great number of people in the more populous developing countries, the smaller number of people in the developed countries use more resources and energy than those in the developing world. This is equally true of the small number of rich people in poor countries whose per capita use of energy and resources, and the generation of waste based on the one-time use of disposable products, leads to great pressures on the environment. As we begin to appreciate that we need more sustainable lifestyles, we also begin to realise that this cannot be brought about without a more equitable use of resources.

recycles, the air that we all breathe, the forests and grasslands which maintain our climate and soil, are all common property resources. When the government took over the control of community forests in British times, the local people who until then had controlled their use through a set of norms that were based on equitable use, began to overexploit the resources in which they now had no personal stake. Bringing back such traditional management systems is extremely difficult. However, in the recent past managing local forests through village-level FPC's has shown that if people know that they can benefit from the forests, they will begin to protect them. This essentially means sharing the power to control forests between the Forest Department and the local people.

7.5.8 Ecological Degradation

In many situations, valuable ecological assets are turned into serious environmental problems. This is because we, as a society, do not strongly resist forces that bring about ecological degradation. These consist of sectors of society that use a get-rich-quick approach to development. While ecological degradation has frequently been blamed on the needs of fuelwood and fodder of growing numbers of rural people, the rich, urbanised, industrial sector is responsible for greater ecological damage. The changes in landuse from natural ecosystems to more intensive utilisation (such as turning forests into monoculture forestry plantations, tea and coffee estates) or marginal lands into intensive agricultural patterns (such as sugarcane fields) or changes into urban or industrial land carry an ecological price. For example, wetlands provide usable resources and a variety of services not easily valued in economic terms; when destroyed to provide additional farmland, in many cases they produce lower returns. A natural forest provides valuable NTFPs, whose economic returns far outweigh that provided by felling the forest for timber. These values must form a part of a new conservation ethic. We cannot permit unsustainable development to run onwards at a pace in which our lives will be overtaken by a development strategy that must eventually fail as earth's resources are consumed and ecosystems rendered irreparable.

7.6 HIV/AIDS

The Human Immuno-deficiency Virus (HIV) causes Acquired Immunodeficiency Syndrome (AIDS) through contact with the tissue fluids of infected individuals, particularly through sexual contact. As it reduces an individual's resistance to disease, it causes infected individuals to suffer from a large number of environment-related diseases and reduces the ability of infected individuals to go about their normal lives. It saps their strength, leads to skin lesions (Karposi's sarcoma) and they become increasingly vulnerable to any air or water borne pollutants, until they eventually die.

In sub-Saharan Africa, where the infection has become highly prevalent, it is leading to great suffering and worsening poverty. These patients become unable to work and their usual sources of income generation are lost. An increasing proportion of the poor are affected.

people have a mistaken belief that turtle eggs can cure HIV/AIDS, thus leading to the eggs being over-harvested. When males die of the disease, agricultural work has to be taken over by already overburdened women and children, affecting land management and productivity. Providing balanced diets and nutritional support for these poverty-stricken patients can be partially addressed by better natural resource management like afforestation, access to clean water and wholesome food.

HIV/AIDS has a serious impact on the socioeconomic fabric of society. In 2007, India had an estimated 2.5 million infected individuals. There is a great need to organise AIDS education on prevention and management of the disease. This needs to be done through the formal educational sector and by using non-formal methods. Education is also important to reduce the stigma and discrimination against these patients. In India and sub-Saharan Africa, women who are not socially empowered are at a great disadvantage as they are powerless to demand safe sex from their partners. Women also have an added burden of caring for HIV-infected husbands. This produces enormous economic stresses on their family. HIV in India is rapidly moving from being a primarily urban disease to rural communities.

Blood transfusion from an infected person can also lead to HIV/AIDS in the recipient, as well as drug abuse by sharing needles with an infected person. However, the most important measure to prevent AIDS is the proper use of condoms that form a barrier to the spread of the virus during intercourse.

7.7 Woman and Child Welfare

There are several environmental factors that are closely linked to the welfare of women and children. Each year, close to eleven million children worldwide have been 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.

Respiratory 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.

CASE STUDY 5

The *chulha* issue

According to a study conducted in 2005 by the World Health Organisation, it was estimated that 1.6 billion early deaths occur annually from cooking stove pollution. Between 400,000 to 550,000 children less than five years and women die each year in India due to indoor smoke. *Chulha* smoke is the third-highest cause of disease and death, after dirty water and lack of sanitation. Hence, by providing access to clean

Pneumonia: Acute respiratory infections (ARI), most frequently pneumonia, is a major cause of death in children under five years, killing over two million children annually (WHO, 2009). Up to 40% of children seen in health centers suffer from respiratory conditions and many deaths attributed to other causes are, in fact, hidden ARI deaths. Children may die very quickly from the infection and thus need treatment urgently. Most patients of pneumonia can be treated with oral antibiotics. Correct management could save over 1 million lives every year globally.

Measles: Measles is a rash that appears with fever and body ache in children and is caused by a virus. It infects over 200,000 children and kills over 150,000 children under the age of five (WHO, 2009). Its prevention includes wider immunisation coverage, rapid referral of serious cases, prompt recognition of conditions that occur in association with measles and improved nutrition, including breastfeeding, and vitamin A supplements. Measles can be prevented by a vaccine. Young children with measles often develop other diseases like acute respiratory infections, diarrhea and malnutrition that are all linked to poor environmental conditions in their surroundings. Children who survive an attack of measles are more vulnerable to other dangerous infections for several months. Effective prevention and treatment could save at least 150,000 lives per year.

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

Malnutrition: Although malnutrition is rarely listed as the direct cause of death, it contributes to about half of all childhood deaths. Lack of access to food, poor feeding practices (inadequate breastfeeding, providing the wrong type of food or insufficient food) and infection, or a combination of the two, are the major causes of mortality.

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

There are strong connections between the status of the environment and the welfare of women and children in India. Women, especially in lower-income groups, both in the rural and urban sectors, work longer hours than men. Their work pattern differs and is more prone to health hazards. The daily collection of water, fuelwood and fodder is an arduous task for rural women. In urban areas, where lower economic group women live in crowded smoke-filled

social–environmental divide is a major concern that needs to be corrected throughout th country.

7.8 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. With the help of computer technologies, we can do several tasks extremely rapidly, accurately and spread the information through the world's networks of millions of computer systems.

A few examples of the use of computer technology that aid environmental studies include software such as using Geographical Information Systems (GIS). GIS is a tool to map landuse patterns and document change by studying digitised toposheets and/or satellite imagery. Once this is done, an expert can ask a variety of questions which the software can answer by producing maps which help in landuse planning. The internet, with its thousands of websites, has made it very simple to get 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.

Table 7.2 Symptoms for common conditions

Complaint/symptom	Possible cause or associated condition
Cough and/or fast breathing	Pneumonia Severe anemia *P. falciparum* malaria
Lethargy or unconsciousness	Cerebral malaria Meningitis Severe dehydration Very severe pneumonia
Measles rash	Pneumonia Diarrhea Ear infection
'Very sick' young infant	Pneumonia Meningitis Sepsis

CASE STUDY 6

Karnataka's GIS scheme, *Bhoomi*, has revolutionised the way farmers access their land records. Farmers can now get a copy of the records of rights, tenancy and crops from a computerised information kiosk without harassment and bribes. Karnataka has computerised 20 million records of land ownership of 6.7 million farmers in the state.

Specialised software can analyse data for epidemiological studies, population dynamics and