Dr. Subin K Jose Christ College

INTRODUCTION

A natural resource may be defined as any material given to us by nature which can be transformed in a way that it becomes more valuable and useful. For an example wood is used for making furniture. Yarn obtained from cotton is used for weaving cloth. Likewise, various machine, tools and household goods are made of metals. Now furniture, clothes, machine, tools are more valuable than their raw form i.e. raw formed. wood, cotton and metal, respectively. The wood, metal resources. It is impossible to obtain valuable items from any resources. Thus, water, minerals, forests, wildlife as well as human beings are resources. Any material may be called, as a resource provided, and appropriate technology is available to transform that into more valuable goods.

Renewable and Non-renewable Resources

On the basis of continuity, the resources are classified as under:

(1) Renewable Resources

(2) Non-renewable Resources.

1. *Renewable Resources*

Resources, which can be renewed along with their exploitation, are always available for use. Hence, they are called renewable resources. For instance, forests are renewable. If trees are felled for wood, original forest covers may be maintained through planning new trees i.e. a forestation. Likewise, solar energy and wind energy are examples of renewable resources.

2. *Non-renewable Resources*

The formation of some resources like iron ore, coal, mineral oil etc. has taken several thousand years. Once they are used in unlimited way, they cannot be easily replaced. Thus, their exploitation at large scale will result in their fast depletion. Some such resources are called non-renewable resources or exhaustible.

3. *Cyclic Resources*

For resources there is no final use as they can be used continuously. For example, water used in industry and domestic ways can be cleaned and used again for similar or other purpose. Such resources are given the name of Cyclic Resources.

Land resources:

Land as a resource: Landforms such as hills, valleys, plains, river basins and wetlands include different resource generating areas that the people living in them depend on. Many traditional farming societies had ways of preserving areas from which they used resources. E.g. In the 'sacred groves' of the Western Ghats, requests to the spirit of the Grove for permission to cut a tree, or extract a resource, were accompanied by simple rituals. The outcome of a chance fall on one side or the other of a stone balanced on a rock gave or withheld permission. The request could not be repeated for a specific period. If land is utilized carefully it can be considered a renewable resource. The roots of trees and grasses bind the soil. If forests are depleted, or grasslands overgrazed, the land becomes unproductive and wasteland is formed. Intensive irrigation leads to water logging and salination, on which crops cannot grow. Land is also con-

verted into a non-renewable resource when highly toxic industrial and nuclear wastes are dumped on it. Land on earth is as finite as any of our other natural resources. While mankind has learnt to adapt his lifestyle to various ecosystems world over, he cannot live comfortably for instance on polar ice caps, on under the sea, or in space in the foreseeable future. Man needs land for building homes, cultivating food, maintaining pastures for domestic animals, developing industries to provide goods, and supporting the industry by creating towns and cities. Equally importantly, man needs to protect wilderness area in forests, grasslands, wetlands, mountains, coasts, etc. to protect our vitally valuable biodiversity. Thus, a rational use of land needs careful planning. One can develop most of these different types of land uses almost anywhere, but Protected Areas (National Park's and Wildlife Sanctuaries) can only be situated where some of the natural ecosystems are still undisturbed. The Protected Areas are important aspects of Goodland use planning.

Land Degradation:

Farmland is under threat due to more and more intense utilisation. Every year, between 5 to 7 million hectares of land worldwide is added to the existing degraded farmland. When soil is used more intensively by farming, it is eroded more rapidly by wind and rain. Over irrigating farmland leads to salinization, as evaporation of water brings the salts to the surface of the soil on which crops cannot grow. Over irrigation also creates waterlogging of the topsoil so that crop roots are affected, and the crop deteriorates. The use of more and more chemical fertilizers poisons the soil so that eventually the land becomes unproductive.

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

Soil erosion:

The characteristics of natural eco-systems such as forests and grasslands depend on the type of soil. Soils of various types support a wide variety of crops. The misuse of an ecosystem leads to loss of valuable soil through erosion by the monsoon rains and, to a smaller extent, by wind. The roots of the trees in the forest hold the soil. Deforestation thus leads torpid soil erosion. Soil is washed into streams and is transported into rivers and finally lost to the sea. The process is more evident in areas where deforestation has led to erosion on steep hill slopes as in the Himalayas and in the Western Ghats. These areas are called 'ecologically sensitive areas' or ESAs. To prevent the loss of millions of tons of valuable soil every year, it is essential to preserve what remains of our natural forest cover. It is equally important to reforest denuded areas. The linkage between the existence of forests and the presence of soil is greater than the forest's physical soil binding

DEFORESTATION: MEANING AND RESULTS

Meaning of Deforestation

Deforestation is the process of felling trees indiscriminately resulting in nude or semi-nude surface of the hill hitherto covered by thick forests.

Main causes responsible for deforestation are as under:

(a) Felling of trees to meet the ever-increasing demand of the cities.

(b) Grazing by the local cattle, goats, sheep etc. They not only destroy the vegetation but also pull out the roots of plants. After denudation of our Himalayas, the process of deforestation started in the Shivalik range. Shivalik range forests were over-exploited for industry use, i.e. railway sleepers etc. Consequently, the foothills of the Shivalik are in semi desert conditions.

(c) Meeting out the growing hunger for land. It has hit the ecology of the country badly very soon India is likely to have more of wasteland than productive land. Largescale deforestation has badly affected the weather facing almost each year more of bleak than the normal weather.

(d) The increase in shifting (jhum) cultivation in North east and Orissa has also laid large in forest tracts bare. As the jhum cycle is shortened to six years only (in some districts, even 2-3 years only), too short period does not provide enough time for natural repair of damaged ecosystem.

(e) A major cause of deforestation has been the construction of hill roads. About a decade back, they were about 30, 000 km long. Most of these roads are in state and most fragile belt of Himalayas. Road construction damaged the protective vegetation cover both above and below roads. It blocked natural and pollution streams.

Evil Consequences of Deforestation

With deforestation ecological balance maintain by nature breaks away. Floods or drought tore the terrible consequences. The trees increase rainfall of an area, as well as conserve the water which falls on the ground rain. Consequent to deforestation, the plant reduces evaporation allowing water to remain in solid for a long time. In our country unabated deforestation over grazing and the growing hunger for land has hit the ecology of India badly. If it goes on, we may soon have more of wasteland than productive land. Large-scale deforestation has badly affected the weather. Evil consequences of deforestation can be summed up as under:

1. Adverse Effect on Productivity

It is noticed that the devasting effects of deforestation in India include soil, water and wind erosions, estimated to cost over 16,400 crores every year. Deforestation affectsproductivity of our croplands in two ways as under:

(i) The deforestation increases the soil erosion increase manifold. The soil so washed leads to an accentuated cycle of floods and drought.

(ii) Deforestation creates to use cow dung and crop wastes as fuel mainly for cooking. As a result, no part of the plant goes back to loss in soil fertility.

2. Land/Erosion and Landslides

Deforestation has been causing tremendous land erosion and landslides. Data reflect that about 6,000 million ton of topsoil is lost annually due to water erosion in the absence of trees. The loss worked out from the topsoil erosion in 1973 was Rs. 700 crores. The figures for the years 1976, 1977 and 1978 are Rs. 889 crores, Rs. 1,200 crore and Rs. 1,091 crores respectively.

3. *Low Per Capita Forestland*

As far as per capita forestland is concerned, India today is the poorest in the world. Theper capita forestland in India is 0.10 hectare compared to the world average of 1 hectare.

TIMBER EXTRACTION: MINING, DAMS AND THEIR EFFECTS ON FORESTS AND TRIBAL PEOPLE

Timber Extraction

It is estimated that India is losing 15 million hectares of forests cover year. If this trend continuous unchecked, it could take only a period 9 of 20 years hence to reach to zero forest value in our country. During a period of 25 years (1951-1976) India has lost 4.1 million hectares of forests area. Trees have been felled in large number of fuels, fodder, valley projects, Industrial uses, road construction etc. India consumes nearly, 170 million tonnes of firewood annually, and 10-15 million hectares of forests cover is being stripped every year to meet fuel requirements. The rise in fuelwood consumption can be noticed from the comparative study of the fuel consumption in earlier years. It was 86.3 million ton in 1953.It reached about 135 million ton in 1980. During a period of 20 years (1951 to 1971) forests have been cut for various purposes as under:

(1) For Agriculture (24-32 lack hectares)

(2) River valley projects (4.01 lakh hectares)

(3) Industrial uses (1.24 lakh hectares)

(4) Road construction (0.55 lakh hectares)

(5) Miscellaneous uses (3.88 lakh hectares)

In this way, a total of 3.4 million hectares of forests were lost during this period. The disastrous of the heavy deforestation are visible. Nearly 1 percent of the land surface of India is turning barren every year due to deforestation. In the Himalayan range, the rainfallas declined from 3 to 4 percent.

Mining

It is often remarked that in our country most mining work has been unscientific. Consequently, no heed is paid to environment protection. The consequences have been disastrous. For example:

(1) They have developed large tracts that lost productivity.

(2) There have been water and air pollution, despoliation of land and deforestation, noise and ground vibration problems etc. As such, to ameliorate the situation, the mined areas to be reclaimed for agriculture, forestry, fisheries and recreation. During last 20-30 years, a number of mining operations have been started in the country. These operations affected forest and cultivated land areas. Such operations have been taken mainly in U.P., Bihar, M.P., Orissa and Andhra Pradesh.

The results are as under:

(1) The use of land scale for townships, communication, excavation and transport affected the socioeconomic and ecology of these areas.

(2) Ecological problems developed in coal mine areas in Ranchi, Hazaribagh (Bihar), Bina Project (U.P.) and Singular complex at Gorbi (U.P.) and Jayant (M.P.).

Some illustrations are as under:

(1) Ranchi

In Ranchi several hundred sq. km. of land has been converted to badlands.

(2) Singrauli

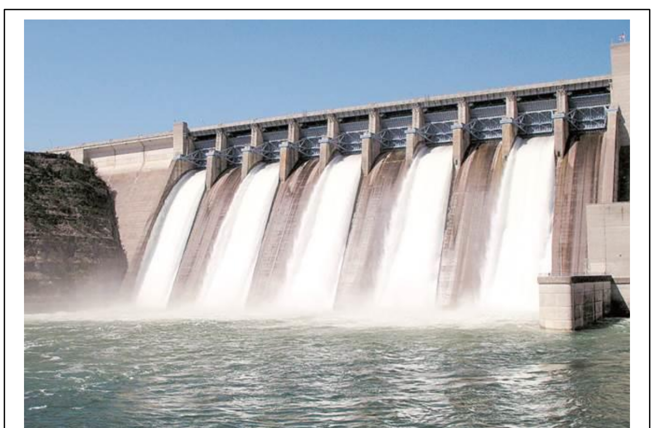
In Singrauli complex forests and hillocks have been erased due to construction of high-power transmission lines, roads and rail tracks. Establishment of other factories as cement and super thermal power stations around coal mines have resulted into environment degradation.

Reclamation of Mined Areas: There are two successful cases of reclamation of mined areas in India. These are asunder:

(1) Neyveli Lignite Corporation Ltd. in Tamil Nadu.

(2) Stone Quarries of Sayaji Iron Works in Gujarat.

Dams



We can classify the environment side effects of river valley and hydel projects into three categories as under:

(i) Impacts within and around the area covered by the dam and reservoir.

(ii) Downstream effects caused by alternation in hydraulic regime, and

(iii) Regional effects in terms of overall aspects including resources use and socio-economic aspects.

The impacts caused by construction of dams and reservoir in including the following effects and consequences:

(1) The various change in the microclimate.

(2) The loss of vegetal cover.

(3) Soil erosion.

(4) Variation in water table.

(5) Enhanced seismic activities due to pressure of water.

It should be kept in mind that the nature and magnitude of the impacts vary with the project locations and the conditions therein. It can be elucidated with the help of illustration:

(1) In hilly tracts, blasting operations for road construction can cause considerable

damage to the environment through the following activities:

(a) Loosening of hill sides and resultant landslides,

(b) Sedimentation of reservoirs

(c) Drying up of spring and flash floods.

(2) The creation of new settlements for the workmen and rehabilitation of project out sees in the watershed areas may result in the aggravation of the seriousness of advance impacts. In our country a number of big, medium and minor dams are undertaken mainly for three purposes-irrigation, power generation and water supply. The country's first Prime Minister, Jawharlal Nehru, hailed these dams as the Temples of Modern India. They have increased agricultural production, power generation and reduced dependence in imports. However, on the contrary to the advantages enumerated above, some experts opine that the social, environmental and even economic cost of these dams, far outweighs their benefits. They hold that the most important social consequences of big dams has been the displacement of millions of tribal from their homeland and their eventual influx into urban areas, almost as refugees. This is the reason why the scientists, environmentalists, journalists, social activists, lawyers and bureaucrats have now raised their voice against big dams.

Direct solar energy

The sun produces a tremendous amount of energy, most of which dissipates into space. Only a small portion is radiated to Earth. Solar energy is different from fossil and nuclear fuels because it is perpetually available; we will run out of solar energy only when the sun's nuclear fire burns out. Solar energy is dispersed over Earth's entire surface rather than concentrated in highly localized areas, as are coal, oil, and uranium deposits. Consequently, to make solar energy useful, we must collect it. Solar radiation varies in intensity depending on the latitude, season of the year, time of day, and cloud cover. Areas at lower latitudes closer to the equator receive more solar radiation annually than do latitudes closer to the North and South Poles. More solar radiation is received during summer than during winter because the sun is directly overhead in the summer and lower on the horizon in the winter. Solar radiation is more intense when the sun is high in the sky (noon) than when it is low in the sky (dawn or dusk). Clouds both scatter incident light and absorb some of the sun's energy, thereby reducing its intensity. The south western United States, with its lack of cloud cover and lower latitude, receives the greatest amount of solar radiation annually, whereas the Northeast receives the least.

un with its windows rolled up becomes much hotter than the surrounding air. Similarly, the air inside a greenhouse remains warmer than the outside air during cold months. (Greenhouses usually require additional heating in cold climates, but far less than you might expect.) This kind of warming occurs partly because the material such as glass that envelops the air inside the enclosure is transparent to visible light but impenetrable to heat. Visible light from the sun penetrates the glass and warms the surfaces of objects inside, which in turn give off infrared radiation invisible waves of heat. Heat does not escape because infrared radiation cannot penetrate glass, and the air within the glass grows continuously warmer.

In passive solar heating, solar energy heats buildings without the need for pumps or fans to distribute the heat. Certain design features are incorporated into a passive solar heating system to warm buildings in winter and help them remain cool in summer. In the Northern Hemisphere, large south-facing windows receive more total sunlight during the day than windows facing in other directions. The sunlight entering through the windows provides heat that is then stored in floors and walls made of concrete or stone, or in containers of water. This stored heat is transmitted throughout the building naturally by convection, the circulation that occurs because warm air rises and cooler air sinks. Buildings with passive solar heating systems must be well insulated so that accumulated heat does not escape. Depending on the building's design and location, passive heating saves as much as 50% of heating costs.

In active solar heating, a series of collection devices mounted on a roof or in a field is used to gather solar energy. The most common collection device is a panel or plate of black metal, which absorbs the sun's energy. Active solar heating is used primarily for heating water, either for household use or for swimming pools. The heat absorbed by the solar collector is transferred to a liquid inside the panel, which is then pumped to the heat exchanger, where the heat is transferred to water that will be stored in the hot water tank. Because approximately 8% of the energy consumed in the United States goes toward heating water, active solar heating has the potential to supply a significant amount of the nation's energy demand.

Solar thermal electric generation

Systems that concentrate solar energy to heat fluids have long been used for buildings and industrial processes. In solar thermal electric generation electricity is produced by several different systems. One approach is to collect incident sunlight and concentrate it, using mirrors or lenses, to heat a working fluid to high temperatures. In one such system, trough shaped mirrors, guided by computers, track the sun for optimum efficiency, focus sunlight on oil-filled pipes, and heat the oil to 390°C (735°F). The hot oil is circulated to a water storage system and used to change water into superheated steam, which turns a turbine to generate electricity. Alternatively, the heat is used to power a Stirling engine. A fluid in a cylinder expands, driving a piston that turns a shaft, providing mechanical energy or producing electricity. Most electricity in the United States is fed into a grid, a network of cables that carry electricity where it is needed. Since demand is highest during the day, particularly when the need for air conditioning is high, the fact that solar systems work only during the day is not a serious disadvantage. The world's largest solar thermal system is currently operating in the Mojave Desert in southern California. The solar power tower is a solar thermal system with a tall tower surrounded by hundreds of mirrors.

The computer controlled mirrors move to follow the sun, focusing solar radiation on a central receiver at the top of the tower. There the concentrated sunlight heats a circulating liquid (molten salt), and the heat is used to produce steam for generating electricity. Molten salt retains heat, and some of the heat is stored for electricity generation during the night, when solar energy is unavailable. Solar power towers have been tested in the United States, several European countries, and Japan; the United States is no longer working on this technology.

Photovoltaic solar cells

Photovoltaic (PV) solar cells currently provide more than 13,000 MW of electricity worldwide. This is about the same as 13 large nuclear power plants but accounts for only about 0.65% of global electricity. PV cells convert sunlight directly into electricity; they are usually arranged on large panels that absorb sunlight, even on cloudy or rainy days. PVs generate electricity with no pollution and minimal maintenance. They are used on any scale, from small, portable modules to large, multimegawatt power plants. Our current PV solar cell technology, though used to power satellites, uncrewed airplanes, highway signals, watches, and calculators, has a few limitations that prevent the cells' widespread use to generate electricity. Photovoltaic solar cells are only about 15% to 18% efficient at converting solar energy to electricity (although experimental cells reach 40%), and the number of solar panels needed for large scale use would require a great deal of land. At current efficiencies, several thousand acres of solar panels would be required to absorb enough solar energy to produce the electricity generated by a single large conventional power plant. One benefit of PV devices is that utility companies can purchase them as small modular units that become operational in a short period. A utility company can purchase PV elements to increase its generating capacity in small increments, rather than committing a billion dollars or more and a decade or more of construction for a massive conventional power plant. Used in this supplementary way, the PV units could provide the additional energy needed, for example, to power irrigation pumps on hot, sunny days.

In remote areas that are not served by electric power plants, such as rural areas of developing countries, it is more economical to use PV solar cells for electricity than to extend power lines. Photovoltaics are the energy choice to pump water, refrigerate vaccines, grind grain, charge batteries, and supply rural homes with lighting. According to the Institute for Sustainable Power, more than 1 million households in the developing countries of Asia, Latin America, and Africa have installed PV solar cells on the roofs of their homes. A PV panel the size of two pizza boxes can supply a rural house- hold with enough electricity for five lights, a radio, and a television.

Biomass energy

Biomass, one of the oldest fuels known to humans, consists of such materials as fast growing plant and algal crops, crop wastes, sawdust and wood chips, animal wastes, and wood. Biomass contains chemical energy that comes from the sun's radiant energy, which photosynthetic organisms use to form organic molecules. Biomass is a renewable form of energy when used no faster than it is produced; deforestation and desertification can result when biomass is overused. Biomass cannot replace fossil fuels. The entire photosynthesis production of the continental United States amounts to only half of our current energy use and that would mean devoting it to no other uses, including food, paper, and construction materials.

Biomass fuel, which can be a solid, liquid, or gas, is burned to release its energy. Solid biomass such as wood is burned directly to obtain energy. Biomass particularly firewood, charcoal (wood that is heated in an oxygen free environment to concentrate its energy and drive off water), animal dung (primarily undigested plant fiber), and peat (partly decayed plant matter found in bogs and swamps) supplies a substantial portion of the world's energy. At least half of the human population relies on biomass as their main source of energy. In developing countries, wood is the primary fuel for cooking. Biomass accounts for about 4% of total U.S. energy production.

Biomass in the form of low-cost residues from sawmills, paper mills, and agricultural industries is burned in power plants to generate about 7.6 gigawatts (GW) of electricity. It is possible to convert biomass, particularly animal wastes, into biogas. Biogas, which is usually composed of a mixture of gases (mostly methane), is stored and transported like natural gas. It is a clean fuel its combustion produces fewer pollutants than either coal or biomass. In India and China, several million familysized biogas digesters use microbial decomposition of household and agricultural wastes to produce biogas for cooking and lighting.

When biogas conversion is complete, the solid remains are removed from the digester and used as fertilizer. Although the technology for biogas digesters is relatively simple, the conditions inside the digester, such as the moisture level and pH, must be carefully monitored if the bacteria are to produce biogas at an optimum level. Biomass can be converted to liquid fuels, especially methanol (methyl alcohol) and ethanol (ethyl alcohol), which can be used in internal combustion engines. In many parts of the world, automotive fuels must contain 10% or more ethanol, and many high-performance race cars run entirely on ethanol. Biodiesel, made from plant or animal oils, is becoming more popular as an alternative fuel for diesel engines in trucks, farm equipment, and boats. The oil is often refined from waste oil produced at restaurants (for example, the oil used to make french fries); biodiesel burns much cleaner than diesel fuel.

Wind energy

Wind energy capacity worldwide has increased by 20% to 45% in each of the last ten years it is the world's fastest-growing source of energy. Wind, caused by heating of Earth's surface, is an indirect form of solar energy. Radiant energy from the sun is trans- formed into mechanical energy the movement of air molecules. Wind is sporadic over much of Earth's surface, varying in direction and magnitude. Like direct solar energy, wind power is a highly dispersed form of energy. Harnessing wind energy to generate electricity has great potential, and wind is increasingly important in supplying our energy needs. New wind turbines can be huge 100 m tall and have long blades designed to harness wind energy efficiently. As turbines have become larger and more efficient, costs for wind power have declined rapidly from $0.40 per kilowatt hour in 1980 to $0.04 to $0.07 per kilowatt hour in 2006. Wind power is cost-competitive with many forms of conventional energy. Advances, such as turbines that use variable speed operation, may make wind energy an important global source of electricity during the first half of the 21st century. Harnessing wind energy is most profitable in rural areas that receive fairly continual winds, such as islands, coastal areas, mountain passes, and grasslands. Germany and the United States are the world's top producers of wind energy; each has about 23 GW of installed capacity. However, this represents about 30% of Germany's total electricity use but only about 4% of U.S. electricity use.

Hydropower

Hydropower is the world's main renewable source of electrical generation, producing about the same amount of electricity as do the world's nuclear power plants. The sun's energy drives the hydrologic cycle, which encompasses precipitation, evaporation from land and water, transpiration from plants, and drainage and runoff . As water flows from higher elevations back to sea level, we can harness its energy. Unlike the sun's energy, which is highly dispersed, hydropower is a more concentrated energy. The potential energy of water held back by a dam is converted to kinetic energy as the water falls down a penstock, where it turns turbines to generate electricity.

Hydropower is more efficient than any other energy source in producing electricity about 90% of available hydropower energy is converted into electricity. Hydropower generates approximately 19% of the world's electricity, making it the most widely used form of solar energy. The 10 countries with the greatest hydroelectric production are, in decreasing order, Canada, the United States, Brazil, China, Russia, Norway, Japan, India, Sweden, and France. In the United States, approximately 2200 hydropower plants produce between 8% and 12% of its electricity, making it the country's leading renewable energy source. Highly developed countries have already built dams at most of their potential sites, but this is not the case in many developing nations. Particularly in undeveloped, unexploited parts of Africa and South America, hydropower represents a great potential source of electricity.

Geothermal energy

Geothermal energy, the natural heat within Earth, arises from the ancient heat within Earth's core, from friction where continental plates slide over one another, and from the decay of radioactive elements. The amount of geothermal energy is enormous. Scientists estimate that just 1% of the heat contained in the uppermost 10 km of Earth's crust is equivalent to 500 times the energy contained in all of Earth's oil and natural gas resources. Nonetheless, because it is difficult to extract, geothermal is not likely to compete with wind, hydropower, or solar energy. Geothermal energy is typically associated with volcanism. Areas of geologically recent volcanism contain large underground heat reservoirs. As groundwater in these areas travels downward and is heated, it becomes buoyant and rises until it is trapped by an impermeable layer in Earth's crust, forming a hydrothermal reservoir. Hydrothermal reservoirs contain hot water and possibly steam, depending on the temperature and pressure of the fluid. Some of the hot water or steam may escape to the surface, creating hot springs or geysers. Hot springs have been used for thousands of years for bathing, cooking, and heating buildings. Hydrothermal reservoirs are tapped by drilling wells similar to those used for extracting oil and natural gas. One option is to heat water, which can then be used to heat buildings. Alternatively, the heated fluid can be brought to the surface, and the resulting steam is expanded through a turbine to spin a generator, creating electricity.

Geothermal Power and Water Use

The water used to transfer heat from geothermal wells to the surface is not inexhaustible. Some geothermal applications recirculate all the water back into the underground reservoir, ensuring decades of heat extraction from a given reservoir. Others consume a portion of the water, eventually depleting water in the underground reservoir. A good example is The Geysers geothermal field, where after nearly 40 years of production, about half the water is depleted but about 95% of the heat remains in the rock. Geothermal Energy from Hot, Dry Rock Conventional use of geothermal energy relies on hydrothermal reservoirs that is, on groundwater to bring the heat to the surface. These geothermal resources are limited geographically and represent only a small fraction of total geothermal energy. An alternative is to access the vast amount of geothermal energy stored in hot, dry rock. Researchers at the Los Alamos National Laboratory in New Mexico demonstrated the feasibility of drilling into hot, dry rock; fracturing rock with hydraulic pressure; then circulating water into the fracture to make an artificial underground reservoir. The pressurized water returned to the surface in a second well, where it turned to steam and drove an electricity-generating turbine. Technology to create such systems is expensive, but in time it could greatly expand the extent and use of geothermal resources. Heating and Cooling Buildings with Geothermal Energy Increasingly, geothermal energy is employed to heat and cool commercial and residential buildings. Geothermal heat pumps (GHPs) take advantage of the difference in temperature between Earth's surface and subsurface (at depths from 1 m to about 100 m).

Underground temperatures fluctuate only slightly and are much cooler in summer and warmer in winter than air temperatures. GHPs have an underground arrangement of pipes containing circulating fluids to extract natural heat in winter, when Earth acts as a heat source, and to transfer excess heat underground in summer, when Earth acts as a heat sink . The hundreds of feet of pipe form a ground loop that feeds into a heat pump, which directs the flow of heated or cooled air. Geothermal heating systems can be modified to provide supplemental hot water.

Tidal energy

Tides, the alternate rising and falling of the surface waters of the ocean and seas that generally occur twice each day, are the result of the gravitational pull of the moon and the sun. Normally, the difference in water level between high and low tides is about 0.5 m (1–2 ft). Certain coastal regions with narrow bays have extremely large differences in water level between high and low tides. The

Bay of Fundy in Nova Scotia has the largest tides in the world, with a difference of up to 16 m (53 ft) between high and low tides. Water at high tide contains enormous amounts of potential energy as compared to low tide. This energy can be captured (with a dam across a bay or a turbine that works much like a wind turbine) and converted into electricity. Tidal power plants currently operate in France, Russia, China, India,and Canada. However, total global production is only a few MW and is not expected to increase much in the near future.

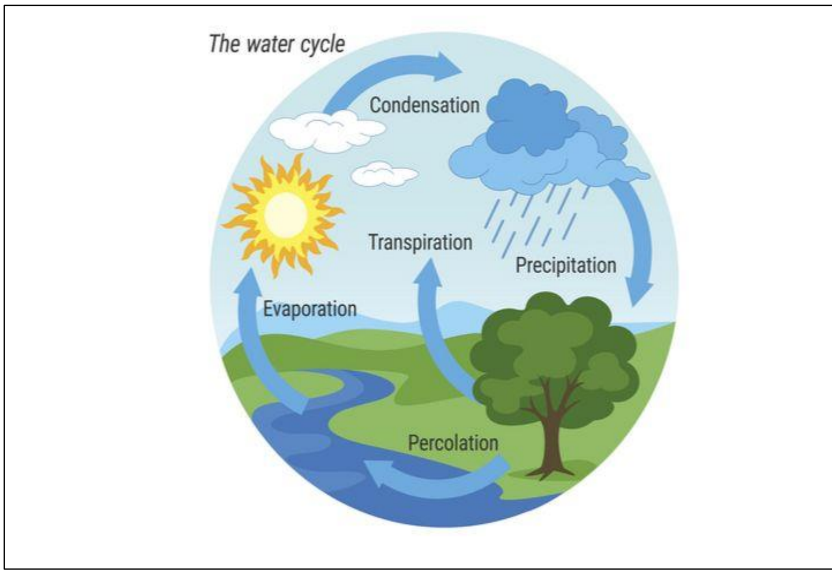
Hydrogen and fuel cells

Hydrogen and electricity are versatile secondary forms of energy; that is, they are not found in nature, but they can be generated from any of the energy sources discussed. Consequently, they can be as clean or dirty as the fuels used to produce them. Electricity has been in use for over a century and will probably play an increasing role in the future. Hydrogen is likely to be a major fuel for the future, although it is not likely to see widespread use for at least a decade. Hydrogen is a common element. Water molecules contain two hydrogen atoms and one oxygen atom. While water contains little available chemical energy, a hydrogen molecule with two hydrogen atoms (H_2) contains large amounts of available energy. H_2, which is a gas at room temperature, will explode when combined with the plentiful O2 in the atmosphere, releasing energy and forming water. When chilled to 253°C (423°F), H_2 becomes a liquid and thus takes up much less space than H_2 gas. Hydrogen has both advantages and disadvantages as an energy source. One advantage is that it has very high energy density, comparable to that of gasoline or liquified natural gas (LNG). Thus, unlike coal and nuclear energy, hydrogen could substitute for gasoline in automobiles and other forms of transportation. Another advantage is that hydrogen can be produced from any electrical source. Electrolysis is the process of using electricity to separate water into O_2 and H_2, which can be separately captured and stored.

Water resources

The water cycle, through evaporation and precipitation, maintains hydrological systems which form rivers and lakes and support in a variety of aquatic ecosystems. Wetlands are intermediate forms between terrestrial and aquatic ecosystems and contain species of plants and animals that are highly moisture dependent. All aquatic ecosystems are used by a large number of people for their daily needs such as drinking water, washing, cooking, watering animals, and irrigating fields. The world depends on a limited quantity of fresh water. Water covers 70% of

the earth's surface but only 3% of this is freshwater. Of this, 2% is in polar ice caps and only1% is usable water in rivers, lakes and subsoil aquifers. Only a fraction of this can be actually used. At a global level 70% of water is used for agriculture about 25% for industry and only 5%for domestic use. However, this varies in different countries and industrialized countries use a greater percentage for industry. India uses 90% for agriculture, 7% for industry and 3% for domestic use. One of the greatest challenges facing the world in this century is the need to rethink the overall management of water resources. The world population has passed the 6 billion mark. Based on the proportion of young people in developing countries, this will continue to increase significantly during the next few decades. This places enormous demands on the world's limited freshwater supply. The total annual freshwater withdrawals today are estimated at 3800cubic kilometers, twice as much as just 50 years ago (World Commission on Dams, 2000). Studies indicate that a person needs a minimum of20 to 40 liters of water per day for drinking and sanitation. More than one billion people world-wide have no access to clean water, and to many more, supplies are unreliable.



Tamil Nadu over the waters of the

India is expected to face critical levels of water stress by 2025. At the global level 31 countries are already short of water and by 2025 there will be 48 countries facing serious water shortages. The UN has estimated that by the year2050, 4 billion people will be seriously affected by water shortages. This will lead to multiple conflicts between countries over the sharing of water. Around 20 major cities in India face chronic or interrupted water shortages. There are 100 countries that share the waters of 13large rivers and lakes. The upstream countries could starve the downstream nation's leading to political unstable areas across the world. Examples are Ethiopia, which is upstream on the Nile and Egypt, which is downstream and highly dependent on the Nile. International accords that will look at a fair distribution of water in such areas will become critical to world peace. India and Bangladesh already have a negotiated agreement on the water use of the Ganges.

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

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

Industry tends to maximize short-term economic gains by not bothering about its liquid waste and releasing it into streams, rivers and the sea. In the longer term, as people become more conscious of using 'green products' made by Eco sensitive industries, the polluter's products may not be used. The polluting industry that does not care for the environment and pays off bribes to get away from the cost needed to use effluent treatment plants may eventually be caught, punished and even closed down. Public awareness may increasingly put pressures on industry to produce only eco-friendly products which are already gaining in popularity. As people begin to learn about the serious health hazards caused by pesticides in their food, public awareness can begin putting pressures on farmers to reduce the use of chemicals that are injurious to health.

Global climate change:

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

Floods:

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

that year after year kill people, damage crops and destroy homes in the Ganges and its tributaries and the Brahmaputra. Rivers change their course during floods and tons of valuable soil is lost to the sea. As the forests are degraded, rainwater no longer percolates slowly into the subsoil but runs off down the mountainside bearing large amounts of topsoil. This blocks rivers temporarily but gives way as the pressure mounts allowing enormous quantities of water

to wash suddenly down into the plains below. There, rivers swell, burst their banks and floodwaters spread to engulf peoples' farms and homes.

Drought:

In most arid regions of the world therians are unpredictable. This leads to periods when there is a serious scarcity of water to drink, use in farms, or provide for urban and industrial use. Drought prone areas are thus faced with

irregular periods of famine. Agriculturists have no income in these bad years, and as they have no steady income, they have a constant fear of droughts. India has 'Drought Prone Areas Development Programs', which are used in such areas to buffer the effects of droughts. Under these schemes, people are given wages in bad years to build roads, minor irrigation works and plantation programs. Drought has been a major problem in our country especially in arid regions. It is an unpredictable climatic condition and occurs due to the failure of one or more monsoons. It varies in frequency in different parts of our country.

While it is not feasible to prevent the failure of the monsoon, good environmental management can reduce its ill effects. The scarcity of water during drought years affects homes, agriculture and industry. It also leads to food shortages and malnutrition which especially affects children.

Several measures can be taken to minimize the serious impacts of a drought. However, this must be done as a preventive measure so that if the monsoons fail its impact on local people's lives is minimized years when the monsoon is adequate, we use up the good supply of water without trying to conserve it and use the water judiciously. Thus during a year when the rains are poor, there is no water even for drinking in the drought area. One of the factors that worsens the effect of drought is deforestation. Once hill slopes are denuded of forest cover the rainwater rushes down the rivers and is lost. Forest cover permits

water to be held in the area permitting it to seep into the ground. This charge the underground stores of water in natural aquifers. This can be used in drought years if the stores have been filled during a good monsoon. If water from the underground stores is overused, the water table drops, and vegetation suffers. This soil and water management and afforestation are long-term measures that reduce the impact of droughts.

Principles of Water Harvesting and Conservation

In deciding which techniques to use to make more efficient use of the available water, it is important to consider how crops receive or lose water. Crops receive water through rainfall, irrigation and stored soil water. They lose it through run off, evaporation and drainage. Some key principles on effective water management are:

Use rainwater effectively.

In many climates, rainfall is distributed unevenly in intense downpours that cannot be readily used by a crop. Storage techniques (such as external catchments or roof top collection) increase the availability of water in the drier seasons. They also harvest water from a wider area making more water available to the crop. Measures can also be taken to avoid the rainwater running off the surface during intense rainfall (explained below).

Make effective use of soil water reserves.

The soil stores water from rainfall providing a reserve that is available to the crop. How much water is available depends on the soil type and the rooting system of the crop. Sandy soils hold much less water than clay or silt soils, so crops will require watering more often. Deeper rooting crops, such as grasses or cereals will exploit soil water reserves more effectively than shallower rooting crops such as vegetable crops and therefore can be grown in drier periods. Good cultivation practices (e.g. not ploughing too deep or when the soil is wet) that result in a soft, friable soil will also help in making effective use of soil water reserves.

Take measures to avoid run off

Run off is where water is not absorbed by the soil but runs across the surface away from where the crop can use it. Structures such as contour schemes, terracing, pits and bunds can reduce run-off. Run off is more likely to occur on silty or clay soils where the surface has been subjected to intense rainfall then baked in the sun to form a crust or cap. Adding mulch to break up the intensity of rainfall, or adding manure, compost or incorporating green manure residues will reduce the tendency of the soil to form a crust.

Avoid wasting water through evaporation

Water that evaporates directly from bare soil is wasteful as it is not being used for productive plant growth. It is desirable to maintain full ground cover for as much of the time as practically possible. Applying mulch to the soil will also reduce evaporation considerably. Use of drip irrigation and irrigating in the evening will also reduce the amount of water lost through evaporation.

Reduce water losses through drainage

When water drains out of the soil, not only is it wasted but essential mobile nutrients such as nitrogen are also washed out. This is more of a problem on light sandy soils. Adding organic matter in the form of compost, manures or plant residues will eventually increase the amount of water a soil can retain, but this will only have an effect if it is added over a longer period of years. Most drainage occurs during the heavy rains, especially if the soil is left bare. Growing a cash or cover crop during this period reduces these losses, as the roots lift water and nutrients back from deeper to shallower soil profiles

Plan your irrigation Irrigation

is one way of supplementing water from rainfall and soil reserves, but can waste large amounts of water if not used carefully. A key way of making the most of the water supply is to only irrigate when necessary. Many people irrigate on a regular basis whether the crop needs it or not. If water is scarce, irrigation should be restricted to the most critical periods such as germination and fruit set. Drip irrigation makes much better use of water than overhead systems as it is targeted to the roots rather than sprayed up into the air rooting and efficient use of soil water reserves.

Watershed management

Watershed management is the study of the relevant characteristics of a watershed aimed at the sustainable distribution of its resources and the process of creating and implementing plans, programs, and projects to sustain and enhance watershed functions that affect the plant, animal, and human communities within the watershed boundary. Features of watershed that agencies seek to manage include water supply, water quality, drainage, stormwater runoff, water rights, and the overall planning and utilization of watersheds. Landowners, land use agencies, stormwater management experts, environmental specialists, water use surveyors and communities all play an integral part in watershed management.

Forest Resources

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

People who live in or near forests know the value of forest resources first hand because their lives and livelihoods depend directly on these resources. However, the rest of us also derive great benefits from the forests which we are rarely aware of. The water we use depends on the existence of forests on the watersheds around river valleys. Our homes, furniture and paper are made from wood from the forest. We use many medicines that are based on forest produce. And we depend on the oxygen that plants give out and the removal of carbon dioxide we breathe out from the air.

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

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

FOREST FUNCTIONS

Watershed protection:

• Reduce the rate of surface run-off of water.

• Prevent flash floods and soil erosion.

• Produces prolonged gradual run-off and thus prevent effects of drought.

Atmospheric regulation:

• Absorption of solar heat during evapo-transpiration.

• Maintaining carbon dioxide levels for plant growth.

• Maintaining the local climatic conditions.

Erosion control:

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

Land bank:

• Maintenance of soil nutrients and structure.

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

• Food - gathering plants, fishing, hunting from the forest. (In the past when wildlife was plentiful, people could hunt and kill animals for food. Now that populations of most wildlife species have diminished, continued hunting would lead to extinction.)

• Fodder - for cattle.

• Fuel wood and charcoal for cooking, heating. • Poles - building homes especially in rural and wilderness areas.

• Timber – household articles and construction. • Fiber - weaving of baskets, ropes, nets, string, etc.

• Sericulture – for silk.

• Apiculture - bees for honey, forest bees also pollinate crops.

• Medicinal plants - traditionally used medicines, investigating them as potential source for new modern drugs.

Market use - (Productive use)

• Most of the above products used for consumptive purposes are also sold as a source of income for supporting the livelihoods of forest dwelling people.

• Minor forest produce - (non-wood products): Fuelwood, fruit, gum, fiber, etc. which are collected and sold in local markets as a source of income for forest dwellers.

• Major timber extraction - construction, industrial uses, paper pulp, etc. Timber extraction is done in India by the Forest Department, but illegal logging continues in many of the forests of India and the world.

Deforestation:

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

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

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

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

CASE STUDY

Joint Forest Management

The need to include local communities in Forest Management has become a growing concern. Local people will only support greening an area if they can see some economic benefit from conservation. An informal arrangement between local communities and the Forest Department began in 1972, in

Midnapore District of West Bengal. JFM has now evolved into a formal agreement which identifies and respects the local community's rights and benefits that they need from forest resources. Under JFM schemes, Forest Protection Committees from local community members are formed. They participate in restoring green cover and protect the area from being over exploited

Mineral Resources

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

Minerals are formed over a period of millions of years in the earth's crust. Iron, aluminum, zinc, manganese and copper are important raw materials for industrial use. Important non-metal resources include coal, salt, clay, cement and silica. Stone used for building material, such as granite, marble, limestone, constitute another category of minerals. Minerals with special properties that humans' value for their aesthetic and ornamental value are gems such as diamonds, emeralds, rubies. The luster of gold, silver and platinum is used for ornaments. Minerals in the form of oil, gas and coal were formed when ancient plants and animals were converted into underground fossil fuels.

Minerals and their ores need to be extracted from the earth's interior so that they can be used. This process is known as mining. Mining operations generally progress through four stages:

1) Prospecting: Searching for minerals.

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

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

(4) Exploitation: Extracting the minerals from the mines.

CASE STUDY

Sariska Tiger Reserve, Rajasthan

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

Environmental problems:

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

Food resources

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

The FAO defines sustainable agriculture as that which conserves land, water and plant and animal genetic resources, does not degrade the environment and is economically viable and socially acceptable. Most of our large farms grow single crops (monoculture). If this crop is hit by a pest, the entire crop can be devastated, leaving the farmer with no income during the year. On the other hand, if the farmer uses traditional varieties and grows several different crops, the chance of complete failure is lowered considerably. Many studies have shown that one can use alternatives to inorganic fertilizers and pesticides. This is known as Integrated Crop Management.

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

• Our fertile soils are being exploited faster than they can recuperate.

• Forests, grasslands and wetlands have been converted to agricultural use, which has led to serious ecological questions.

• Our fish resources, both marine and inland, show evidence of exhaustion.

• There are great disparities in the availability of nutritious food. Some communities such as tribal people still face serious food problems leading to malnutrition especially among women and children.

Ecological Footprint

Environmental scientists Mathis Wackernagel and William Rees developed the concept of ecological footprint to help people visualize what they use from the environment. Each person has an ecological footprint, an amount of productive land, fresh water, and ocean required on a continuous basis to supply that person with food, wood, energy, water, housing, clothing, transportation, and waste disposal. The Living Planet Report 2008, produced by scientists at the Global Footprint Network, World Wildlife Fund, and Zoological Society of London, calculated that Earth has about 11.4 billion hectares (28.2 billion acres) of productive land and water. If we divide this area by the global human population, we see that each person is allotted about 1.8 hectares (4.4 acres). However, the average global ecological footprint is currently about 2.7 hectares (6.7 acres) per person, which means we humans have an ecological overshoot we have depleted our allotment. We can see the short-term results around us forest destruction, degradation of croplands, loss of biological diversity, declining ocean fisheries, local water shortages, and increasing pollution. The long-term outlook, if we do not seriously address our consumption of natural resources, is potentially disastrous.

Carbon footprint

A **carbon footprint** is historically defined as the total emissions caused by an individual, event, organization, or product, expressed as carbon dioxide equivalent. Greenhouse gases (GHGs), including carbon dioxide, can be emitted through land clearance and the production and consumption of food, fuels, manufactured goods, materials, wood, roads, buildings, transportation and other services.

In most cases, the total carbon footprint cannot be exactly calculated because of inadequate knowledge of and data about the complex interactions between contributing processes, including the influence of natural processes that store or release carbon dioxide. For this reason, Wright, Kemp, and Williams, have suggested to define the carbon footprint as A measure of the total amount of carbon dioxide (CO_2) and methane (CH_4) emissions of a defined population, system or activity, considering all relevant sources, sinks and storage within the spatial and temporal boundary of the population, system or activity of interest. Calculated as carbon dioxide equivalent using the relevant 100-year global warming potential (GWP100).