BLOCK 4

CHAPTER 1 ORIGIN AND EVOLUTION OF EARTH

Earth is an active place. Earthquakes rip along plate boundaries, volcanoes spew fountains of molten lava, and mountain ranges and seabed are constantly created and destroyed. Earth scientists have long been concerned with deciphering the history—and predicting the future—of this active planet. Over the past four decades, Earth scientists have made great strides in understanding Earth's workings. Scientists have ever-improving tools to understand how Earth's internal processes shape the planet's surface, how life can be sustained over billions of years, and how geological, biological, atmospheric, and oceanic processes interact to produce climate—and climatic change.

The origin of the Earth

The age of the Earth was once, and still is, a matter great debate. In 1650 Archbishop Ussher used the Bible to calculate that the Earth was created in 4004BC. Later on in the mid-nineteenth century Charles Darwin believed that the Earth must be extremely old because he recognised that natural selection and evolution required vast amounts of time.

It wasn't until the discovery of radioactivity that scientists began to put a timescale on the history of the Earth. Rocks often contain heavy radioactive elements which decay over long periods of time, the decay is unaffected by the physical and chemical conditions and different elements decay at different rates (These rates are slow and half-lives of several hundred million years are not uncommon)

Throughout this century the race has been on to discover the oldest rocks in the world. The oldest volcanic rock found so far has been dated at 3.75 billion years old, but this is not the whole story. Meteorites created at the same time as the Earth hit us all the time, radioactive dating shows that they are about 4.55 billion years old.

How did Earth and other planets form?

The Solar System is composed of a set of radically different types of planets and moons—from the gas giants Jupiter, Saturn, Uranus, and Neptune to the rocky inner planets. Centuries of Studying Earth, its neighbouring planets, and meteorites have enabled the development of models of the birth of the Solar System. Astronomical observations from increasingly powerful telescopes have added a new dimension to these models, as have studies of asteroids, comets, and other planets via spacecraft, as well as geochemical studies of stardust and meteorites.

While it is generally agreed that the Sun and planets all coalesced out of the same nebular cloud, little is known about how Earth obtained its particular chemical composition, or why the other planets ended up so different from Earth and from each other. For example, why has Earth, unlike every other planet, retained the unique properties—such as the presence of water—that allow it to support life? New measurements of Solar System bodies and extrasolar planets and objects, will further advance understanding of the origin of Earth and the Solar System.

The first billion years

The Earth's surface was originally molten, as it cooled the volcanoes belched out massive amounts of carbon di oxide, steam, ammonia and methane. There was no oxygen. The steam condensed to form water which then produced shallow seas.

Evidence points to bacteria flourishing 3.8 billion years ago so this means that life got under way about 700 million years after the Earth was created. Such early forms of life existed in the shallow oceans close to thermal vents; these vents were a source of heat and minerals.

The next billion years

These primitive life forms then took the next evolutionary step and started to photosynthesise (using sunlight to convert carbon dioxide and water to food energy and oxygen). This was an important turning point in Earth history because the carbon dioxide in the atmosphere was being converted to oxygen. These green plants went on producing oxygen and removing the CO_2).

Most of the carbon from the carbon- oxide in the air became locked up in sedimentary rocks as carbonates and fossil fuels. Carbon dioxide also dissolved into the oceans. The ammonia and methane in the atmosphere reacted with the oxygen.

Nitrogen gas was released, partly from the reaction between ammonia and oxygen, but mainly from living organisms such as denitrifying bacteria. (Nitrogen is a very unreactive gas and it has built up slowly)

The last 2½ billion years or so

As soon as the oxygen was produced by photosynthesis it was taken out again by reacting with other elements (such as iron).This continued until about 2.1 billion years ago when the concentration of oxygen increased markedly. As oxygen levels built up and then the ozone layer

was formed which started to filter out harmful ultraviolet rays. This allowed the evolution of new living organisms in the shallow seas.

Earth's climate and Habitability

It is widely recognized that Earth's mean global surface temperature has risen since the beginning of the industrial age, and that emissions of CO2 and other greenhouse gases are at least partly responsible. The potentially serious consequences of global warming underscore the need to determine how much of the warming is caused by human activities and what can be done about it. Earth science has an important role in answering both the questions.

The geological record has revealed the history of the planet's climate to be a peculiar combination of both variability and stability. Global climate conditions have been favourable for life and relatively stable for the past 10,000 years and suitable for life for over 3 billion years.
But geological evidence also shows that momentous changes in climate can occur in periods as short as decades or centuries. How does Earth's climate remain relatively stable in the long term, even though it can change so abruptly? Understanding periods in which the planet was extremely cold, extremely hot, or changed especially quickly are leading to new insight about Earth's climate. Observations of ancient rocks could eventually improve prediction of the magnitude and consequences of climate changes.

How has life shaped Earth and how has Earth shaped life?

Scientists know that the composition of Earth's atmosphere, especially its high concentration of oxygen, is a consequence of the presence of life. At the microscopic scale, life is an invisible but powerful chemical force: organisms catalyse reactions that would not happen in their absence, and they accelerate or slow down other reactions. These reactions, compounded over immense stretches of time by a large biomass, can generate changes of global consequence.

Likewise, Earth's geologic evolution, as well as catastrophic events like meteorite impacts, has clearly affected the evolution of life. But even when extinctions and major evolutionary changes can be documented, the causes still remain a mystery. To what extent were they caused by geological as opposed to biological processes?

Exactly how geological events have affected evolution, and how much control life has had on climate, are still topics of debate. Understanding the interrelationships between life and the processes that shape the land presents a critical challenge.

COMPONENTS OF EARTH

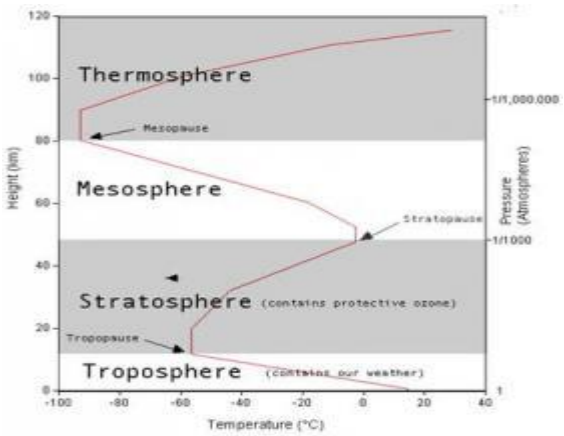
Earth has four different spheres or domains that are affected by climate:

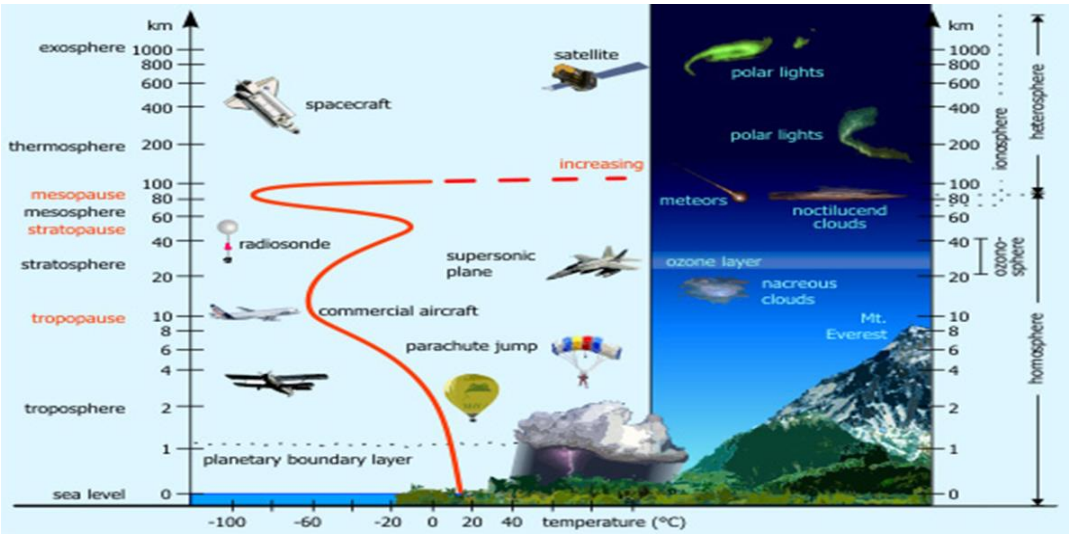
1. Atmosphere
2. Hydrosphere
3. Lithosphere
4. Biosphere

1. Atmosphere

- The atmosphere can be divided into four layers based on its temperature, as shown in the figure below. These layers are the troposphere, the stratosphere, the mesosphere and the thermosphere. The thermosphere is divided into two divisions. The lower part of thermosphere is called as ionosphere. And further region, beginning about 500 km above the earth's surface, is called the exosphere. The thermosphere is the fourth layer of the Earth's atmosphere and is located above the mesosphere.

The red line on the figure below shows how temperature varies with height (the temperature scale is given along the bottom of the diagram). The scale on the right shows the pressure. For example, at a height of 50 km, the pressure is only about one thousandth of the pressure at the ground.





The regions of atmosphere

(a) The Troposphere

This is the lowest part of the atmosphere - the part we live in. It contains most of our weather - clouds, rain, and snow. In this part of the atmosphere the temperature gets colder as the distance above the earth increases, by about 6.5°C per kilometre. This change of temperature with height varies from day to day, depending on the weather.

The troposphere contains about 75% of all of the air in the atmosphere, and almost all of the water vapour (which forms clouds and rain). The decrease in temperature with height is a result of the decreasing pressure. If a parcel of air moves upwards it expands (because of the lower pressure). When air expands it cools. So air higher up is cooler than air lower down.

The top of the troposphere is called the tropopause. This is lowest at the poles, where it is about 5 km above the earth's surface. It is highest (about 16 km) near the equator.

(b)The Stratosphere

This extends upwards from the tropopause to about 50 km. It contains much of the ozone in the atmosphere. The increase in temperature with height occurs because of absorption of ultraviolet (UV) radiation from the sun by this ozone. Temperatures in the stratosphere are highest over the summer pole, and lowest over the winter pole.

By absorbing dangerous UV radiation, the ozone in the stratosphere protects us from skin cancer and other health damage. However chemicals (called CFCs or Freon's) which were once used in refrigerators and spray cans have reduced the amount of ozone in the stratosphere, particularly at polar latitudes, leading to the so-called "Antarctic ozone hole".

Now humans have stopped making most of the harmful CFCs we expect the ozone hole will eventually recover, but this is a slow process.

(c)The Mesosphere

- The region above the stratosphere is called the mesosphere. Here the temperature again decreases with height, reaching a minimum of about -90°C at the "mesopause".It lies between maximum altitude for aircrafts and minimum altitude for orbital space crafts. Millions of meteors burn up daily in the sphere as a result of collisions with gas particles contained there. This creates enough heat vaporize almost all of the falling objects long before they reach the ground, resulting in a high concentration of iron and other metals atoms are there. It is a protection barrier for living beings. Without this layer we could get bombarded by meteors.

(d)The Thermosphere and Ionosphere

The thermosphere lies above the mesopause, and is a region in which temperatures again increase with height. This temperature increase is caused by the absorption of energetic ultraviolet and X-Ray radiation from the sun.

The region of the atmosphere above about 80 km is also caused the "ionosphere", since the energetic solar radiation knocks electrons off molecules and atoms, turning them

- Functions of Thermosphere: The lower part between 80 km to 550 km is called ionosphere. The upper part is called thermosphere, which is from 550 km infinite is called exosphere. The air is really thin in the thermosphere. A small change in energy can cause a large change in temperature. That's why the temperature is very sensitive to solar activity. When the sun is active, the thermosphere can heat up to 1,500° C or higher. So the temperature in this layer is 2000 degrees is centigrade. It is so because oxygen and nitrogen absorbs a lot of radiation from space and convert into heat. Nitrogen and oxygen and other particles in the atmosphere absorb radiation from the Sun and become electrically charged. Electrically charged particles are called ions. The energetic solar radiation knocks electrons off molecules and atoms, turning them into "ions" with a positive charge. The temperature of the thermosphere varies between night and day and between the seasons, as do the numbers of ions and electrons which are present. The ionosphere reflects and absorbs radio waves, allowing us to receive shortwave radio broadcasts in New Zealand from other parts of the world. The thermosphere is the fourth layer of the Earth's atmosphere and is located above the mesosphere.

(e)The Exosphere

This zone is called satellite zone. The region above about 500 km is called the exosphere. It contains mainly oxygen and hydrogen atoms, but there are so few of them that they rarely collide - they follow "ballistic" trajectories under the influence of gravity, and some of them escape right out into space.

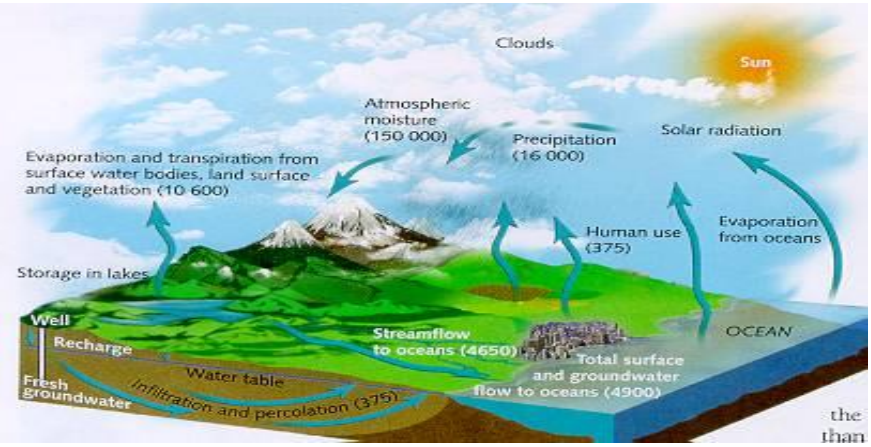
(f)The Magnetosphere

The earth behaves like a huge magnet. It traps electrons (negative charge) and protons (positive), concentrating them in two bands about 3,000 and 16,000 km above the globe - the Van Allen "radiation' belts. This outer region surrounding the earth, where charged particles spiral along the magnetic field lines, is called the magnetosphere.

All life on earth depends on the atmosphere for protection of direct radiation from the sun, for supplying water, and for providing plants with the things they need to grow. The gases in the atmosphere participate in cycles. One of the most important is the Carbon Cycle since all of the organisms on earth are carbon-based life forms.

2. Hydrosphere

- Includes all water on the surface of the earth oceans, lakes, rivers, aquifers, and ice.
- 70% of the earth's surface is covered with water.



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3.Lithosphere

- Covers the remaining 30% is between 0 and 40 km thick.
- Consists of igneous, metamorphic, and sedimentary rock that can be transformed through the rock cycle

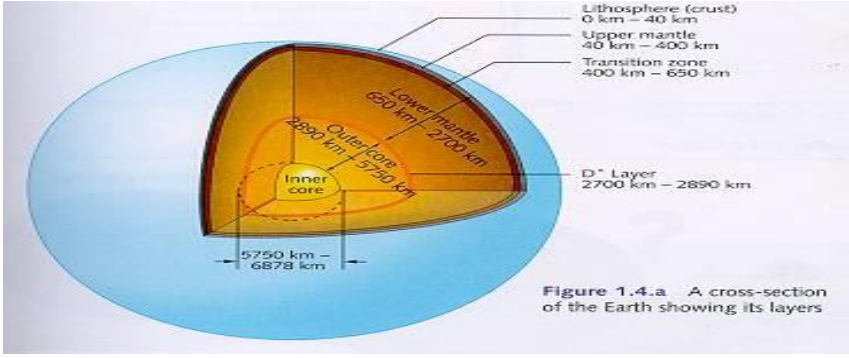
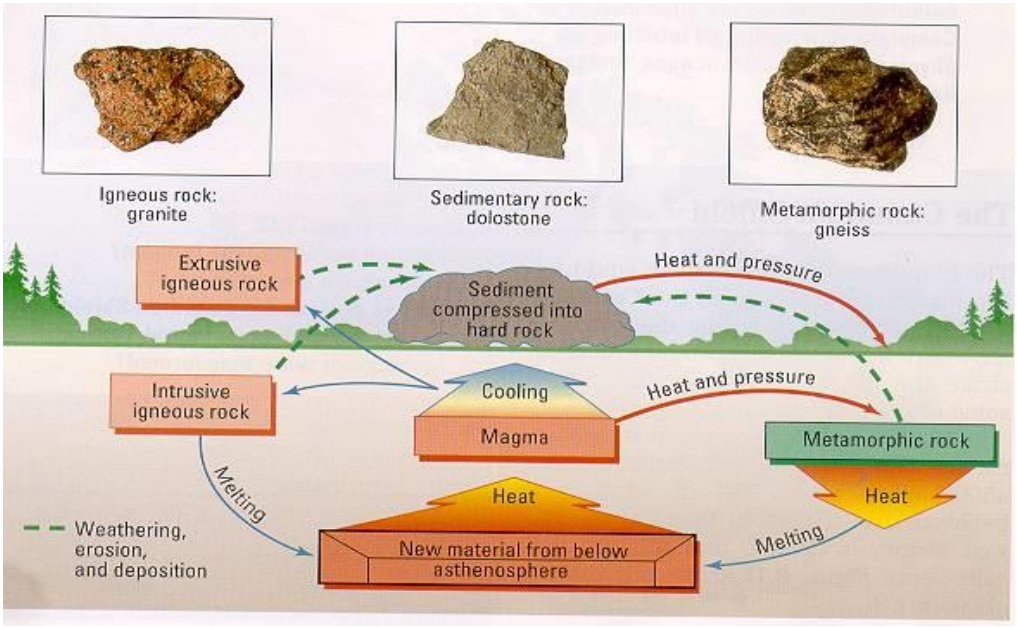


Figure 1.4.a A cross-section of the Earth showing its layers

Mountains are formed and then continually broken down by the forces of erosion wind, ice, flowing water, plant roots, temperature changes, and chemical reactions.

The processes of erosion are balanced with the processes of mountain building folding, faulting, and volcanism on the earth's surface and ocean floors. These processes are explained by the theory of plate tectonics.



4.Biosphere

- Where all life exists and includes the other three spheres the lower layer of the atmosphere, a few metres of the lithosphere, and all of the hydrosphere.
- Amount and diversity of the biomass depends on the distance from the equator. Generally, the closer to the equator, the greater the biodiversity. These plants are reservoirs for carbon, either in solid or dissolved form, as carbohydrates (sugar, cellulose), proteins, and oils.

CHAPTER 2: RENEWABLE and NON-RENEWABLE ENERGY RESOURCES

A renewable resource is defined as a natural resource that renews itself at a rate that is faster, or equal to the rate of consumption. Non Renewable resources differ from Renewable resources that once depleted never return, such as fossil fuels. Renewable resources can include perpetually sustainable resources that never run out, such as solar power, as well as renewable commodities like paper. The use and cultivation of renewable resources helps to minimize the impact humanity has on the Earth, while ensuring continued survival.

In many cases, commodities such as foods and building materials can become renewable when steps are taken to harvest them at specific rates. In other words, it is possible to regulate consumption and growth of resources to ensure a resource is not depleted before it has time to renew itself.

In some cases, renewable resources and recycling can go hand-in-hand. Paper, for example, can be a renewable resource when enough time is given for trees to reseed and replenish harvested forests. While recycling of non-renewable resources, such as metals, can simply extend their life span, recycling of paper can give the time required for a forest to renew itself, thereby making paper, wood and trees a renewable resource.

- The primary sources of energy on earth is Sun. 99% of energy comes from Sun. The life on the earth cannot survive without sun.
- The solar energy gets stored in plants as biomass. Plants use energy with carbon to produce food through photosynthesis. The food gives energy to the living organisms
- The commercial energy comes from fossil fuels. i.e. oil, coal and natural gas.
- **The table 1 shows Utilization energy resources global level.**

Purpose	Percentage of total energy consumed
Transportation	**24**
Industry	**40 from that production of electricity 10%**
Domestic	**20**
Commercial **Others**	**10** **06**

Sustainable Resources

Sustainable resources are defined as resources that are **perpetually renewable**. These resources can be used indefinitely with no care or action taken to renew them.

(a)Solar Energy

Solar energy is the most readily available source of energy. It does not belong to anybody and is, therefore, free. It is also the most important of the non-conventional sources of energy because it is non-polluting and, therefore, helps in lessening the greenhouse effect.

Today's solar photovoltaic power systems are light years ahead of those early designs and haphazard set-ups. Modern solar systems use a method of sun exposure to generate electricity via semiconductors. Simple, direct exposure to the sun and its heat generates electrons that are then captured into the solar system and transformed into usable electricity. This same basic design can be used for a variety of things as small as powering a mobile phone to as large the system needed to power our home.

- Sources of Commercial Energy
- Coal (thermal) 69 %
- Hydropower 25%
- Diesel & Gas 04%
- Nuclear Power 02%
- Less than non conventional 01%
- (Solar, Wind, Geo-thermal, Ocean, Biomass

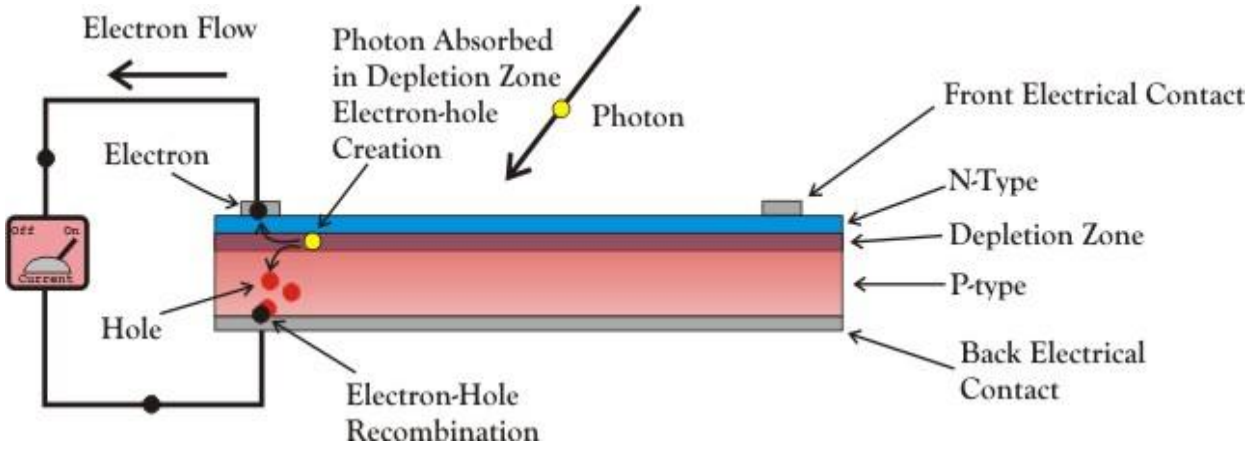
- A third world population about 2 billion people lack access to adequate energy supplies.
- At least 3 billion people depend on fuel wood, cow dung, coal, charcoal and kerosene for cooling and heating.
- 25% global population use 70% commercial energy US is the largest energy consumer in the world.
- During 1950-1990 production of world energy resources increased according to needs.
- The demand of energy is doubled over last 22 years. World’s total primary energy consumption in 2000 years was 9096 million tons from oil.
- By 2020 consumption energy from various sources is given below.
- Oil 39%, Natural gas 24%, Hydropower 06 %
- Coal 24%, Nuclear power 07%

- Solar energy can produce enough electricity and hot water to drop our utility bills to all time lows and almost eliminate them completely. When systems are designed properly they can all but eliminate the need for utility companies
- **Solar Panels**

- Photovoltaic Arrays are glass clad panels with materials called semiconductors sandwiched in between them.
- The most popular semiconductor currently used is silicon. When the energy of the sun hits the cells of silicon the cells absorb the energy and in the process knocks electrons loose.
- The electrons are compelled by the electrical fields contained in the photovoltaic panels to move in one direction and form a current.

The current is then attracted to the strips of metal in the panel that allow it to be used externally.

a. Solar Power



- **Photovoltaic energy**

The sun's energy can also be made directly into electricity using *photovoltaic (PV) cells,* sometimes called *solar cells.*

- PV cells make electricity without moving, making noise, or polluting.
- They are used in calculators and watches. And also provide power to satellites, electric lights, and small electrical appliances such as radios.

Advantages of Solar Energy

- Solar energy does not need fuel, thus saving us money as well as the possibility of polluting the environment by burning fuel. Large area requires for installing the panels.
  Solar energy is clean, sustainable and doesn't let out carbon dioxide, sulphur dioxide or other harmful gases which usually electric generation does. So, it doesn't contribute to global warming, acid rain or smog.
  Being eco-friendly, it also helps to decrease the harmful emission of the Green House gases.
- There are no incurring costs, once the initial costing is taken care of, it is virtually maintenance free. And its easily expandable as well as most solar panels can be added required for a family or any machine.

  Since solar energy can work entirely independently, it does not require any connections or anything, so it can be used effectively and easily anywhere. Systems can be set up anywhere, in remote locations as well. So, those locations can rely on solar energy even if the modern technologies don't reach out to them. So, its very pragmatic & cost-effective for a new site.
  Solar energy bolsters local jobs and wealth establishments. Thus it helps to fuel economies as well.

Disadvantages

- The initial cost is the main disadvantage of installing a solar energy system, largely because of the high cost of the semi-conducting materials used in building one.
- The cost of solar energy is also high compared to non-renewable utility-supplied electricity. As energy shortages are becoming more common, solar energy is becoming more price-competitive.
- Solar panels require quite a large area for installation to achieve a good level of efficiency.

- The efficiency of the system also relies on the location of the sun, although this problem can be overcome with the installation of certain components.
- The production of solar energy is influenced by the presence of clouds or pollution in the air.
- Similarly, no solar energy will be produced during nighttime although a battery backup system and/or net metering will solve this problem
- As far as solar powered cars go - their slower speed might not appeal to everyone caught up in today's rat race.

http://www.dsireusa.org for details on how net metering allows you to save electricity and money.

Examples:

- More than 2, 00,000 houses in the United States have been designed to use solar energy
- The floors of the sunspaces are usually made of tiles that absorb heat through the day and then release heat.

In 1982 a plane called ‘Solar Challenger flew from Paris to England in 5 hours 20 minutes. 16, 000 solar cells glued to its wings and tails, they produced enough energy to drive small electric motor and propeller.

- In 1987 solar operated vehicles developed in Australia. They cover 3, 000 Km
- The first Solar hospital is constructed at Mali in Africa at the edge of the Sahara desert.
- Japanese farmers are substituting PV operated insect killers for toxic pesticides.
- Building Integrated Photovoltaies used for roofs and sides of the building at Germany (3, 000 cells) and Japan (70, 000 cells).

During 1980s, a major solar thermal electrical generation unit was built in California, containing 700 parabolic mirrors , each mirror contains 24, reflectors and 1.5 m diameter, which focused to energy to produce steam to generate electricity.

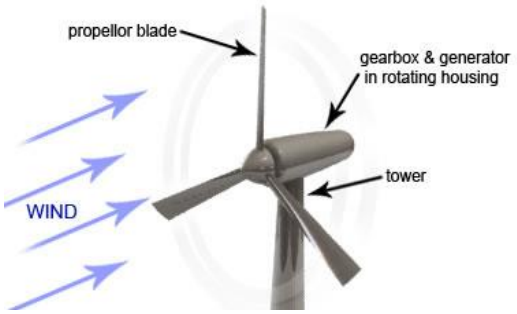
b. Wind Power

Wind power is produced by using wind generators to harness the kinetic energy of wind. It is gaining worldwide popularity as a large scale energy source, although it still only provides less than one percent of global energy consumption.

Most wind energy comes from turbines that can be as tall as a 20-story building and have three 200-foot-long (60-meter-long) blades. These contraptions look like giant airplane propellers

on a stick. The wind spins the blades, which turn a shaft connected to a generator that produces electricity. Other turbines work the same way, but the turbine is on a vertical axis and the blades look like a giant egg beater.

Wind is a clean source of renewable energy that produces no air or water pollution. And since the wind is free, operational costs are nearly zero once a turbine is erected. Mass production and technology advances are making turbines cheaper, and many governments offer tax incentives to spur wind-energy development.



- The wind mills turbines had many blades, long ago, but today's wind turbines usually have two or three blades. Each blades can be 82 feet or 25 meters long.
- i.e. Afghanistan, China, Persia, California, Denmark and China.
- Wind has been used to sail ships, grind grains and pump water.
- **Advantages**
- Wind farms have been around for years.
- They are an efficient way to generate electricity.
- However, there are drawbacks when using these efficient behemoths. Although it is a clean, nonpolluting source of electricity, producing no acid rain, oil spills, or radioactive waste, it does have it's drawbacks.
- **Disadvantages**
- Some environmentalists call them Condor Cuisinart's! The truth is these machines are detrimental to all species of bird life in the vicinity of their operation.
- However, the battle between the developers, the ever growing need for more energy and the environmentalist has come to one common denominator. Wind powered turbines are here to stay.

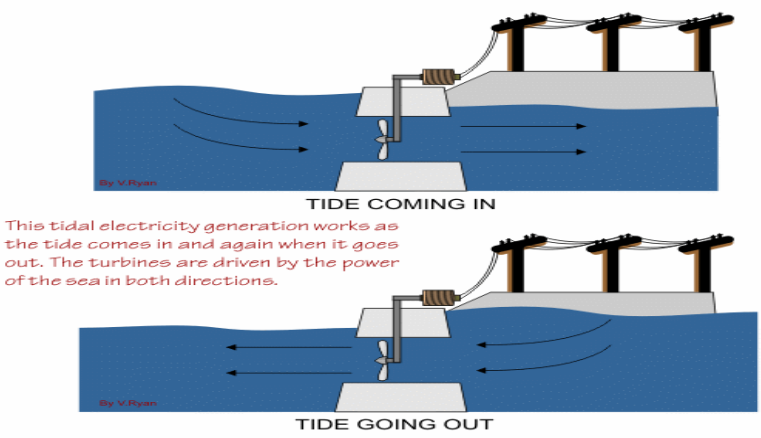
- Studies show that the impact of global warming, changing weather patterns and air pollution would be far worse for the wild animal habitat then the lethal encounter birds would sustain by the blades of a windmill. The wind turbine produce noise when it rotates.

(c)Tides

Tidal energy is produced through the use of tidal energy generators. These large underwater turbines are placed in areas with high tidal movements, and are designed to capture the kinetic motion of the ebbing and surging of ocean tides in order to produce electricity. Tidal power has great potential for future power and electricity generation because of the massive size of the oceans.

Tidal power traditionally involves erecting a dam across the opening to a tidal basin. The dam includes a sluice that is opened to allow the tide to flow into the basin; the sluice is then closed, and as the sea level drops, traditional hydropower technologies can be used to generate electricity from the elevated water in the basin. Some researchers are also trying to extract energy directly from tidal flow streams.

The energy potential of tidal basins is large — the largest facility, the La Rance station in France, generates 240 megawatts of power. Currently, France is the only country that successfully uses this power source. French engineers have noted that if the use of tidal power on a global level was brought to high enough levels, the Earth would slow its rotation by 24 hours every 2,000 years.



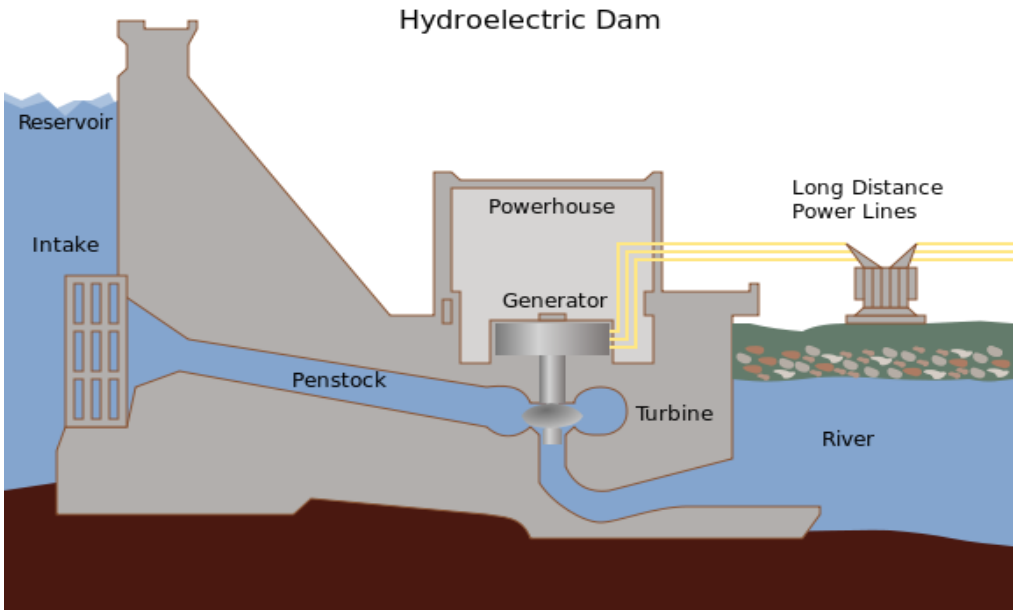
(d)Hydroelectricity

Hydropower is considered a renewable energy resource because it uses the Earth's water cycle to generate electricity. Water evaporates from the Earth's surface, forms clouds, precipitates back to earth, and flows toward the ocean.

The movement of water as it flows downstream creates kinetic energy that can be converted

into electricity. A hydroelectric power plant converts this energy into electricity by forcing water, often held at a dam, through a hydraulic turbine that is connected to a generator. The water exits the turbine and is returned to a stream or riverbed below the dam.

Hydropower is mostly dependent upon precipitation and elevation changes; high precipitation levels and large elevation changes are necessary to generate significant quantities of electricity.



- In 1882 first hydroelectric power dam was built in Appleton, Wisconsin at USA.
- Late 1800- early 1900 the first hydroelectric power dam constructed at Western Ghats of Maharastra by Jamshedgee Tata.
- This energy used for running cotton & textile mills in Bombay. Coal driven mills caused respiratory problems to the people.
- China has the largest number multiple of small dam; 60,000 dams generate 13, 250 (30%) megawatts of China's electricity.
- Sweden, US, Italy, France developed small dams for electricity.

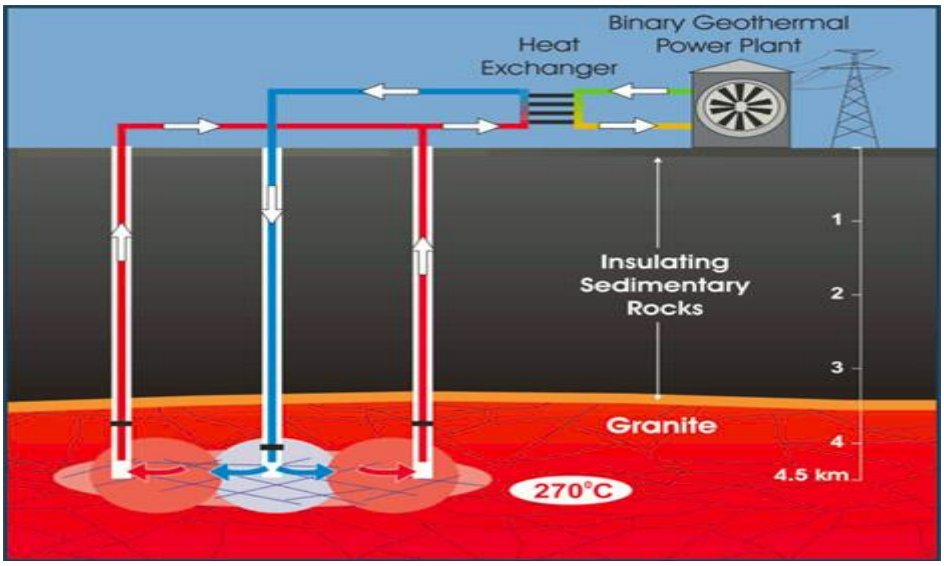
(e) Geothermal Power

Geothermal energy has been used for thousands of years in some countries for cooking and heating. It is simply power derived from the Earth's internal heat. This thermal energy is contained in the rock and fluids beneath Earth's crust. It can be found from shallow ground to several miles

below the surface, and even farther down to the extremely hot molten rock called magma.

These underground reservoirs of steam and hot water can be tapped to generate electricity or to heat and cool buildings directly. In the simplest geothermal power plant, called a dry steam plant, a well is drilled into the rock to tap a steam reservoir. The steam escapes the well under great pressure, which is used to turn a turbine and generate electricity.

Since steam deposits aren't as common as hot water and hot rock reserves, the most promising geothermal technology is called a binary-cycle power plant. In this system, hot water from a deep well circulates through a heat exchanger. There, the water transfers some of its heat to a secondary or binary liquid with a much lower boiling point. When the binary liquid vaporizes, the steam that remains is captured to power turbines.



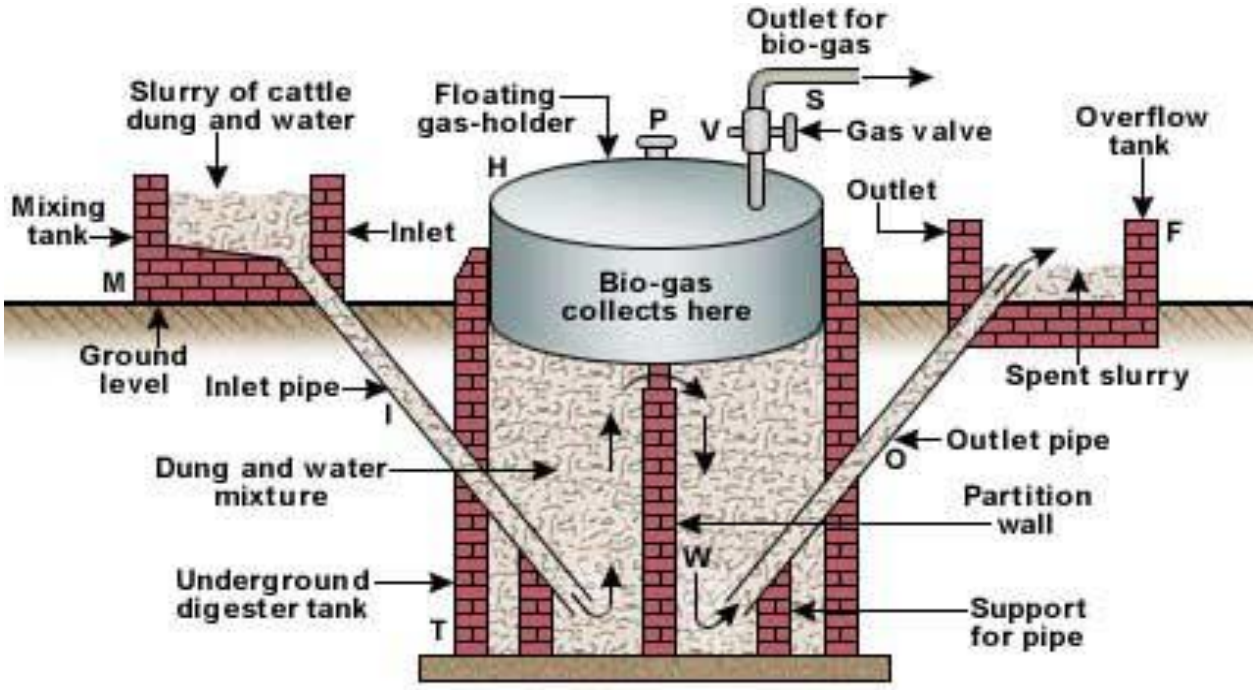
- **Advantages**
- No need to supply any energy for boiling water.
- Disadvantages
- The site specific and along with the heat from the earth.
- It can also bring up toxic chemicals when obtaining the steam. The geothermal reservoirs contain toxic minerals that are corrosive and polluting
- Drilling geothermal reservoirs and finding them can be an expensive task.
- Examples : i.e. Iceland, Japan, & New Zealand are generating geothermal energy for industrial use. Old Faithful in Yellow stone National park in northern California is generating large amount of energy from earth.

(f) Biomass

Burning plants can also generate energy. As plants grow, they use the process of photosynthesis to thrive and grow. The photosynthesis process generates energy and when burned, plants release their energy. Dead plant matter and residue can also transfer into a renewable energy source by applying heat.

Gobar gas plant:

- When we burn log of wood at fire place during festival of pongal or campfires , we are using biomass energy. Biomass energy is a form of stored solar energy.
- Biomass energy can obtain from wood, waste from animals (cow dung) and vegetable waste from vegetable market yards. Waste from corn, sugarcane waste (bag gas), paddy etc.



Floating gas-holder type bio-gas plant.

Examples:

- One tone of food waste can produce 85 cu.m of biogas.
- London produce 30 megawatts of energy from 4, 20, 000 tons of municipal waste. It supplies 50, 000 families.
- Germany 25%, Japan 85%, France 50% waste used for generating power.
- Biomass waste can use three ways to produce energy.

(g) Biofuel

The fermentation process also can generate power in the form of biofuel. By fermenting the

sugars in plants and plant matter, scientists have discovered that they can generate an alcohol called ethanol. This type of fuel is commonly generated from crops that contain a high amount of sugars and starches.

- There are two forms of liquid fuels.
- Ethanol and Methanol
- Ethanol made from corn is currently more expensive than gasoline on gallon basis. US uses ethanol for transportation.
- Ethanol can produce from grasses, bark of trees, sawdust, algal forms and farm waste.

Additionally scientists found that by combining alcohol with animal fat or vegetable oil they can generate another type of fuel called biodiesel. Researchers have found that biodiesel can be used alone, or it can be combined with petro diesel.

Renewable resources are crucial to the continued survival of life on Earth. When non-renewable resources, such as fossil fuels, have been depleted, renewable resources will be required to keep things going. While some types of renewable commodities have been cultivated for years, others are just beginning to see practical use. As recycling becomes more important, so does the harvesting of sustainable powers, such as those generated by oceans, wind and solar power.

Wind turbines, the harvesting of heat from the Earth's surface, the power generated from the ocean tides, and the energy from the sun are all ways that sustainable resources can be brought into play on a daily basis. Use of these resources not only can halt depletion of the Earth's commodities, but can also improve the quality of life on Earth.

Non-Renewable resources

Non-renewable energy is energy from fossil fuels (coal, crude oil, natural gas and uranium. Fossil fuels are mainly made up of Carbon. It is believed that fossil fuels were formed over 300 million years ago, when the earth was a lot different in its landscape. It had swampy forests and very shallow seas. This time is referred to as '*Carboniferous Period*'

The four non-renewable energy sources used most often are:

- Oil and Petroleum products — including gasoline, diesel fuel and propane
- Natural Gas
- Coal
- Uranium (Nuclear Energy)

Fossil fuels are usually found in one location as their formation is from a similar process. Let us take a look at the diagram below to see how fossil fuels are formed:

1.Millions of years ago, dead sea organisms, plants and animals settled on the ocean floor and in the porous rocks. This organic matter had stored energy in them as they used the sun's energy to prepare foods (proteins) for themselves (photosynthesis).

2. With time, sand, sediments and impermeable rock settled on the organic matter, trapping its' energy within the porous rocks. That formed pockets of coal, oil and natural gas.

3. Earth movements and rock shifts creates spaces that force to collect these energy types into well-defined areas. With the help of technology, engineers are able to drill down into the sea bed to tap the stored energy, which we commonly known as crude oil.

(3)Coal

Coal is the most plentiful non-renewable resource in the world and is used to create more than half of the electricity used in the U.S. Coal is made when plant material has been compressed in bogs for millions of years. The extraction of coal from surface and sub-surface mines creates numerous problems for humans and the environment. Sub-surface mines are dangerous for miners as tunnels can collapse and built-up gas can explode. They also create subsidence, meaning that the ground level lowers when the coal is removed. Surface mining, or strip-mining, causes erosion and water pollution and decreases biodiversity by reducing plant and animal habitats. Additionally, the combustion of coal contributes to air pollution and global climate change and creates a toxic ash as a by-product.

- Formation of Coal
- The coal deposits that exist on our planet today were formed by the remains of plants from millions of years ago. These remains have gone through the process of **carbonization**.
- The process begins when plants that are not fully decomposed are buried in areas that have little or no exposure to oxygen.
- Swamp areas and bogs fit this condition. Once the plants are buried, they become a substance called **peat**. While in the swamp or bog, the peat is partially consumed by bacteria. This causes the methane gas, CH_4 to be released, along with carbon dioxide, CO_2.
- The chemical composition of the peat changes as the gas is released.
- Eventually if the oxygen is present in the swamp or bog, then only peat will be produced.

- It is the absence of oxygen that allows the first stage of coal production, carbonization, to occur.
- There also needs to be enough time for coal to form. When there is not enough time, the peat will not transform into coal.
- The peat is harvested and burned to provide heat for homes. There are also some electric power plants that use peat as fuel. In Europe, specifically Iceland and Scotland, peat is used for fuel.
- Combusting fossil fuels with oxygen releases water, carbon dioxide, and other substances into the environment.
- In the case of coal, these substances include sulfur dioxide and nitrogen oxides, which have been shown to be responsible for acid rain.
- To control these emissions, today's coal-fired power plants are equipped with scrubbers, filters, collectors, electrostatic precipitators, and other devices.
- Natural-gas-fired power plants release virtually no sulfur dioxide, but require controls to limit their nitrogen oxide emissions.
- **Formation of Petroleum & Natural Gas**
- (1)Petroleum

Oil, or petroleum, comes from the liquefied, fossilized remains of plants and animals that lived hundreds of millions of years ago; once oil sources are depleted, they cannot be replaced. Oil is an energy source that the U.S. is very much dependent upon. It is used to create fuels, such as gasoline, diesel and jet fuel. It is also used in the manufacturing of plastics and industrial chemicals. Much of our oil is imported, creating a dependency on sources that are unpredictable and costly. The environmental impacts of mining oil include threats to waterways, plants and wildlife due to oil spills and increased infrastructure in natural areas. The impacts of oil combustion include air pollution, smog and increased greenhouse gas emissions.

- (2)Natural Gas

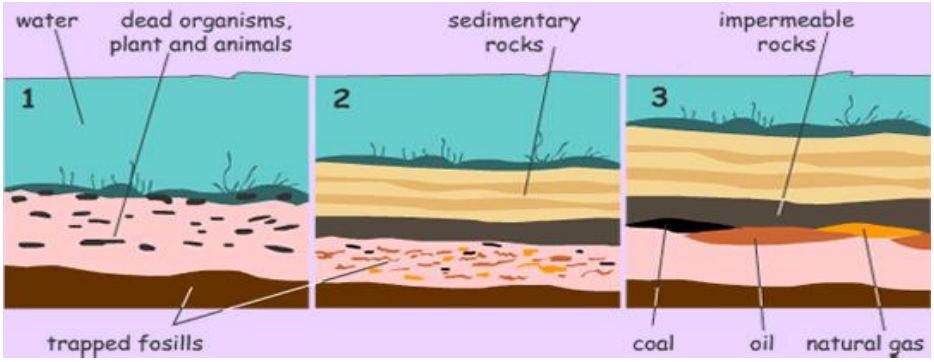
Natural gas is the result of decomposing plants and animals that were trapped beneath rock millions of years ago. This gas is drilled from the ground or extracted using dynamite and then processed and piped through thousands of miles of pipelines for cooking, heating homes and fuelling vehicles. Though natural gas is considered to be a relatively "clean" fossil fuel, the

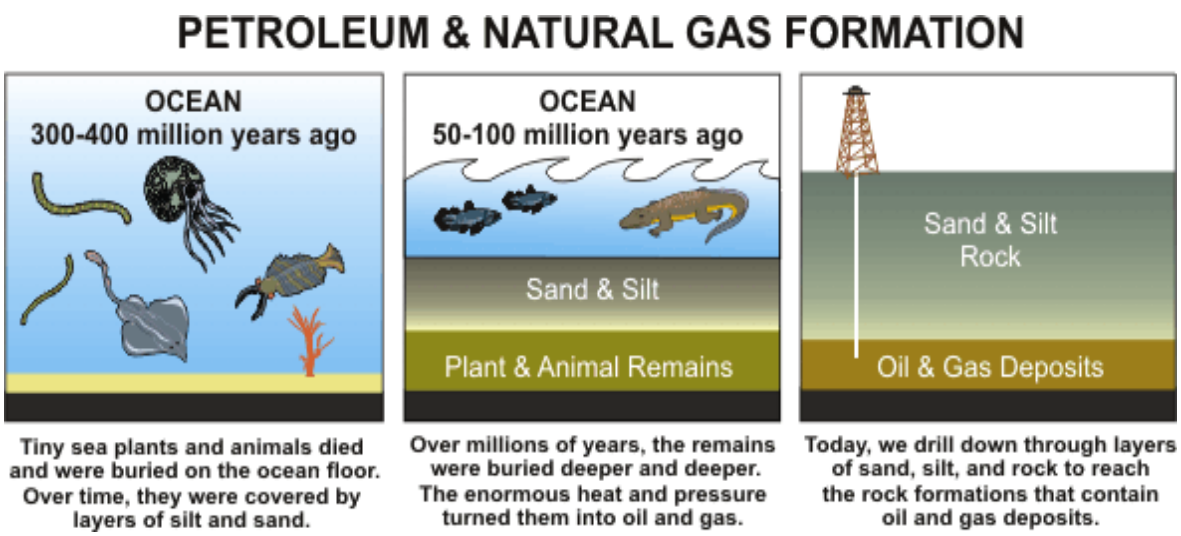
environmental impacts of extracting it and installing pipelines include severe disruption of wildlife habitat and groundwater contamination.

Formation of Oil

- It is commonly taught that oil takes millions of years to form, and bio mass was the main source for the oil deposits that currently exist.
- Geologists maintain that most of the oil they pump out of the ground was formed tens and hundreds of millions of years ago from biological debris.
- But in the Guaymas Basin, in the Gulf of California, the oil seeping out of the sediments is only 4240 years old! Actually, it could be even 500-3,000 years younger than that for two reasons:
- (1) The organic debris that was C-14-dated may have taken many years to become incorporated in the sediments; and
- (2) The dating may be skewed by older material in the sediments. By subtraction, the oil might be as young as 1240 years!
- The picture geologists draw of the Guaymas Basin is that of a spreading center covered by perhaps a half kilometer of sediments. Spewing up from the spreading center is hot water at 300-350°C, which "cracks" the organic material in the sediments, converting it into petroleum only 10-30 meters below the sea floor. (Hecht, Jeff; "Youngest Oil Deposit Found below Gulf of California," New Scientist, p. 19, April 6, 1991.) Or: Science Frontiers

Formation of Oil, coal & natural gas in earth crust





The world's top five crude oil-producing countries are:

- Saudi Arabia ,Russia , United States , Iran , China

Oil impact on Environment

- Products from oil (petroleum products) help us do many things.
- We use them as fuel our airplanes, cars, and trucks, to heat our homes, and to make products like medicines and plastics.
- Even though petroleum products make life easier - finding, producing, moving, and using them can cause problems for our environment like air and water pollution.
- Over the years, new technologies and laws have helped to reduce to petroleum related problems . The government monitors is produced, refined, storage of oil, and transport of oil to the market and also reduce the impact of oil on the environment.
- Since 1990, fuels like gasoline and diesel fuel have also been improved so that they produce less pollution when we use them.

- Exploring and drilling for oil may disturb land and ocean habitats. New technologies have greatly reduced the number and size of areas disturbed by drilling, sometimes called "footprints."
- Satellites, global positioning systems, remote sensing devices, and 3-D and 4-D seismic technologies, make it possible to discover oil reserves while drilling fewer wells.

Plus, the use of horizontal and directional drilling make it possible for a single well to produce oil from much bigger areas.

If oil is spilled into rivers or oceans it can harm wild life. When we talk about "oil spills"

people usually think about oil that leaks from ships when they crash. Although this type of spill can cause the biggest shock to wildlife because so much oil is released at one time, only 2 percent of all oil in the sea comes from ship or barge spills.

- For example, gasoline that sometimes drips onto the ground when people are filling their gas tanks, motor oil that gets thrown away after an oil change, or fuel that escapes from a leaky storage tank.
- When it rains, the spilled products get washed into the gutter and eventually go to rivers and the ocean. Another way that oil sometimes gets into water is when fuel is leaked from motorboats and jet skis.

(4)Nuclear Energy

Although nuclear energy is often held up as a viable alternative to coal and oil, it is not a renewable energy source. Nuclear power requires uranium, a radioactive metallic element that must be mined from the earth and is not quickly replenished. Nuclear energy does not create air pollution though combustion like fossil fuels. It does, however, produce radioactive waste, which must be disposed of and which can cause problems for humans and ecosystems for thousands of years. Additionally, accidents and leaks from nuclear power plants can have catastrophic effects on the entire planet.

- The nuclear power industry was born in the late 1950.
- The first large scale nuclear power plant in the become operational in 1957. in Pennsylvania, USA.
- One KG of uranium 235 equaling to 3000 tones of coal . Sweden in by 2100 it is nuclear free country.
- In1935, two German scientists OTTO Hahn & Fritz Stresemann demonstrated the nuclear fission.

Generation power from uranium 235 or 233 and plutonium

- The nucleus of uranium atom bombarding it with neutrons. As the nucleus splints and release the energy.
- Uranium-235, found in certain rock formations, is mined for use as the fissile material in slow-reaction nuclear power generation.

- Rare in its natural state, uranium-235 is a nonrenewable resource, although small quantities go a long way.
- For example, the fission of one pound of uranium releases more energy than burning three million pounds of coal.
- Nuclear fission reactors split atoms to release the energy from the nucleus of enriched uranium.
- In this process, the fuel is placed in rods in the reactor core, and a chain reaction is started by bombarding the fuel with slow neutrons. Heat from the chain reaction is absorbed by the water in the reactor.
- The water then turns into steam, which, in turn, drives a turbine and a generator to produce electricity.
- Control rods—made of cadmium or boron—are introduced to slow down or stop the chain reaction.
- In fast-reaction nuclear power generation (breeder reactors), high-velocity neutrons cause the fissions, using plutonium or uranium-233.
- Breeder reactors produce more fuel (enriched uranium and plutonium) than they consume. Thus, fast-reaction nuclear power fuel is considered renewable and sustainable.

Advantages

- Nuclear power plants do not release carbon dioxide (a contributor to global climate change) or sulfur dioxide (a contributor to acid rain).
-

Precautions at Nuclear power plants.

- One obstacle to nuclear fission power is that radioactive nuclear waste is generated.
- High-level radioactive waste—the fission products in the used fuel rods—will be dangerous for the next 100 to 1,000 years.
- There is no known way to speed the removal of radioactivity from waste. Spent fuel rods are first cooled in large tanks, then encapsulated in ceramic or glass containers.

These containers are then placed in stainless steel containers and stored. Very little high-level waste is made by a reactor in a year—enough to occupy a volume of about half a cubic yard.

- Most of the Indian industries use more energy than required.

- Conservation of resources can support the natures' wealth.

CHAPTER 3
DEFORESTATION

Deforestation is the permanent destruction of forests in order to make the land available for other uses. An estimated 18 million acres (7.3 million hectares) of forest — roughly the size of Panama — are lost each year, according to the United Nations' Food and Agriculture Organization (FAO).

Some other statistics:

- About half of the world's tropical forests have been cleared (FAO)
- Forests currently cover about 30 percent of the world's land mass National Geographic)
- Forest loss contributes between 12 percent and 17 percent of annual global greenhouse gas emissions (World Resources Institute)

Deforestation is considered to be one of the contributing factors to global climate change. Trees absorb greenhouse gases and carbon emissions. They produce oxygen and perpetuate the water cycle by releasing water vapour into the atmosphere. Without trees, forest lands can quickly become barren land.

Deforestation occurs around the world, though tropical rainforests are particularly targeted. Countries with significant deforestation currently or in the recent past include Brazil, Indonesia, Thailand, the Democratic Republic of Congo and other parts of Africa, and parts of Eastern Europe, according to GRID-Arendal, a United Nations Environment Program collaborating center.

Though deforestation has increased rapidly in the last 50 years, it has been practiced throughout history. For example, since 1600, 90 percent of continental United States' indigenous forest has been removed. The World Resources Institute estimates that most of the world's remaining indigenous forest — about 22 percent of its original amount — is located in Canada, Alaska, Russia, and the North-western Amazon basin. The Amazon is a highly targeted area of recent deforestation.

Causes of deforestation

Deforestation is typically done to make more land available for housing and urbanization, timber, large scale cash crops such as soy and palm oil, and cattle ranching. The WWF reports that much of the logging industry that contributes to deforestation is done illegally (about half of it used for firewood).

Common methods of deforestation are burning trees and clear cutting, which is the controversial practice of complete removal of a given tract of forest. A forestry expert quoted by the

Natural Resources Defence Council describes clear cutting as "an ecological trauma that has no precedent in nature except for a major volcanic eruption."

Burning can be done quickly, in vast swaths of land for plantation use, or more slowly with the slash-and-burn technique. This destructive practice entails cutting down a patch of trees, burning them, and growing crops on the land until the soil becomes too degraded from overgrazing and sun exposure for new growth. Then, the farmers move on to a new patch of land.

Major Causes of Deforestation in India

(1) Expansion of Agriculture:

With increase in the demands for agricultural products, more and more land is brought under cultivation for which forests are destroyed, grasslands ploughed, uneven grounds, levelled, marshes drained and even land water is reclaimed. Such an expansion is marked with more ecological destruction. In tropical regions of the world, as much of the mineral material is lodged in the plant biomass, its removal takes away large part of nutrients. The soil becomes poorest thus is unable to support farming for long duration.

(2) Shifting Cultivation:

Shifting cultivation is considered to be another cause for deforestation. In fact shifting cultivation has occurred due to poor fertility of the soil. In this cultivation a small patch of tropical forests is cleared, vegetation, destroyed and burned. Crops are grown as long as the soil is productive, after which the cultivation is abandoned, and a cultivations move on to fresh patch of land.

The abandoned land is allowed to lay as such for long periods during which regret of vegetation took place and natural ecosystem was restored, shifting cultivations thus worked in harmony with nature. The soil is unable to regain its fertility before it is put to use again. This causes degradation of soil and failure of crops after crops. As crops fail more and more land is cleared of forests to be put to similar over exploitation. The overall result is that green forests are being gradually replaced by barren waste land.

(3) Fire Wood Collection:

Majority of rural populations as well as larger number of people living in small towns and cities of developing countries, the only fuel is wood, which's burned to cook food and provide heat in chilly winters. Fire wood collection contributes much to the depletion of tree cover. Denser forests usually produced a lot of combustible material in the form of dead twigs, leaves etc.

There is hardly any need of cutting down live trees in densely wooded localities. However in

case of lightly wooded forests, where the pressure demands is usually higher, a slow thinning of wood lands occurs due to regular foraging of villagers. However, the dead woods is actually manufactured, trees are axed their barks girdled and live trees became personal head loads to find their way to local markets.

(4) Timber Harvesting:

in national as well as international markets. According to natural forests are being exploited logging or felling of forest trees for obtaining timber is an important cause of deforestation.

Live trees with thick and straight trunks are filled and transported to commercial establishments elsewhere to consumers. In this process large stretches of forests are damaged. The profits from timber trade are more enjoyed by Governments, large companies or affluent contractors, local people get a tiny share in the benefits while axing their own resource base.

(5) Extension of Cultivation on Hill Slopes:

Though agriculture has always been concentrated on planes and floors of valleys farming on narrow flat steps cut one after another across the slope or terrace farming is an age old practice. The ever rushing human numbers and their necessities have forced many to go up the mountains slopes for cultivation. More and more slopes are cleared of plants, steps carved out and against many ads cultivation is attempted. After a few crops the productivity declines.

Effects of deforestation

Forests are complex ecosystems that are important to the carbon and water cycles that sustain life on earth. When they are degraded, it can set off a devastating chain of events both locally and around the world.

(1)Loss of Species: Seventy percent of the world's plants and animals live in forests and are losing their habitats to deforestation. Loss of habitat can lead to species extinction. This is not only a biodiversity tragedy but also has negative consequences for medicinal research and local populations who rely on the animals and plants in the forests for hunting and medicine.

(2)Carbon Emissions: Healthy forests help absorb greenhouse gasses and carbon emissions that are caused by human civilization and contribute to global climate change. Without trees, more carbon and greenhouse gasses enter the atmosphere. To make matters worse, trees actually become carbon sources when they are cut, burned, or otherwise removed. "Tropical forests hold more than 210 gigatons of carbon, and deforestation represents around 15 percent of greenhouse gas

emissions," according to the WWF.

(3)Water Cycle: Trees play an important part in the water cycle, grounding the water in their roots and releasing it into the atmosphere. In the Amazon, more than half the water in the ecosystem is held within the plants. Without the plants, the climate may become dryer.

(4)Soil Erosion: Without tree roots to anchor the soil and with increased exposure to sun, the soil can dry out, leading to problems like increased flooding and inability to farm. The WWF states that scientists estimate that a third of the world's arable land has been lost to deforestation since 1960. Cash crops planted after clear cutting or burning — like soy, coffee, and palm oil — can actually exacerbate soil erosion because their roots cannot hold onto the soil the way trees' can.

(5)Life Quality: Soil erosion can also lead to silt entering the lakes, streams, and other water sources. This can decrease local water quality, contributing to poor health in the local population.

All of these factors can have adverse effects on local economies. Increased flooding, lack of quality water, and inability to produce their own food causes many locals migrate to cities that lack infrastructure for them. Or, they work on plantations, worsening the deforestation problem and at times being subjected to inhumane working conditions.

ROLE OF INDUVIDUAL IN CONSERVATION OF NATURAL RESOURCES

At the back of the demand for each and every commodity there are isolated choices made by consumers. Each individual as a consumer has every right to choose what s/he prefers within the income level. Although consumer as an entity is free to choose whatever his/her prefers but careless choice for resource use can lead to a situation where we eventually use up all our resources such as water, mineral, land etc at a rate which is not sustainable. So, rational consumer has the responsibility to make his/her choice prudent and far-sighted. This also includes being careful about the wastage and creating demand for newer forms of goods and services that ensure a sustainable lifestyle for higher number of people on earth. At each stage of daily life the consumer gets chance to choose between different forms of appliance having different implications for conservation.

Conservation of soil:

To maintain the essential ecological processes i.e. food chain, recycling of mineral resources etc , conservation of soil is necessary. The following methods can be adopted for the same:

- Growing different types of plants, herbs, trees and grass in garden and open areas which bind the soil prevent erosion.

- Not using excess fertilisers and pesticides.
- Using natural manure for the crops
- Using mixed cropping , so that some specific soil nutrients will not get depleted.

Conservation at home:

- checking for water leaks in pipes and toilets and repairing them promptly saves the scarce resources being wasted in gallons
- Rain water harvesting in individual buildings
- An alternative choice of appliances such as CFL instead of tube lights, use of CFC free refrigerators etc.

Conservation in Transport:

- Use of public transport which not only reduces the per capita energy use, but also lowers the emission level
- Use of pollution free vehicle such as bicycle, electric cars etc.
- Car pooling while commuting to office.

Conservation at work place

Centralised cooling/heating requires lot of energy and the amount of cooling required may not be the same at all places. So local cooling/heating can be opted.

CHAPTER 4
EQUITABLE USE OF RESOURCES FOR SUSTAINABLE LIFESTYLES

"Sustainable lifestyles are patterns of action and consumption, used by people to affiliate and differentiate themselves from others, which: meet basic needs, provide a better quality of life, minimise the use of natural resources and emissions of waste and pollutants over the lifecycle, and do not jeopardise the needs of future generations".

'Sustainable livelihoods' and 'sustainable ways of living' are other commonly used terms, usually with the same meaning as sustainable lifestyles.

Scarcity of resources is the burning problem of modern technology. The twenty-first century will see growing human needs for resources since many parts of the world are using natural resources at a rate faster than the natural processes can replenish it.

Natural resources are limited. For example, the existing water sources are being subjected to heavy pollution. Global climatic changes are altering the quality of fresh water sources as a consequence of unknown effects on the hydrological cycle.

Sustainable development is currently being discussed as a focal theme in the field of development, planning and other associated aspects. In the light of self-defeating current mode of development and recurrent natural calamities, people are urged to ponder over the faults, shortcomings, lacunae, discrepancies and limitations of the ongoing developmental process and production system.

It is essential to sustain the natural resources. We should conserve natural resources so that it may yield sustainable benefit to the present generation while maintaining its potential to meet the needs of the future generation

Resources

The natural resources can be broadly defined to include the atmosphere and the oceans as well as forests, water and minerals. These resources give access to food, water and energy. The planet's resources are being consumed at a much higher rate than they can be replenished, resulting in increasing scarcities, widespread pollution, species extinction and precarious feedback loops .Especially loops caused by climate change, such as the melting of glaciers and ice caps, may have unpredictable and irreversible consequences if the escalation of their effects proves to be nonlinear and certain tipping points are surpassed.

Current and future global challenges:

Human civilization has witnessed many positive developments in science, technology and industry. But, its strong reliance on individualism and short-term interests may not be the best guide for coping with current and emerging challenges.

Against the background of dwindling resources, population increases, and growing middle classes, well-off people around the world are adopting the Western model of consumption that has held since the Industrial Revolution. Driven by product promotion and placement, and espousing using a quantitative definition of wellbeing, these new world players are creating their own consumerist Arcadias of "Americas", including hundreds of millions of people globally. Despite rhetoric to the opposite, wealthy nations continue down the same path. Meanwhile billions of people are still living in poverty, without access to sufficient food, adequate drinking water, and basic sanitation.

The resulting competition for limited resources-from water to food, fuel, and minerals-is due to escalate, as foreseen by strategic planners in the U.S. defense and intelligence communities and as already witnessed in intensifying disputes over resource-rich areas, such as the South China Sea and the Falklands/Malvinas. Natural disaster, intensified by climate change, is expected to aggravate the situation and mong other consequences, increase migration, which can lead to further conflict. But justice (or the lack thereof) regarding natural resources is not only reflected in the divide between rich and poor, but also in the respect,(or the lack thereof) shown towards other forms of life and life supporting ecosystems, and towards future generations, as the world overuses the capacity of the planet by more than 50% each year.

The way Forward

There is need for urgent action, beyond promises of ever-increasing efficiency and eventual decoupling of resource use and prosperity, which are most probably unrealistic. Concrete steps should include the adoption of more sustainable lifestyles, while still [emitting growth and progress especially for those least developed today, as well as providing leadership, improving more planning and rebalancing the role of state and non-state actors within a rule-of-law frame work. To move toward a more sustainable and equitable world, actions would be needed at different levels, in many directions, by various actors individually and collectively.

More sustainable lifestyles, while still permitting growth and progress especially for those least developed today

Instead of putting a focus only on adaptation measures that aim to address the consequences of undesirable actions, or mitigation that tackles the proximate causes, more upstream measure need

to be prioritized to tackle the root causes of today's challenges. We need a civilization shift- a new, less consumption-based definition of well-being. With new metrics that go beyond GDP to account for natural capital and ecosystem service. Bhutan's gross national happiness index, based on Buddhist principles, and other such initiatives are interesting points of departure. A civilization shift would involve setting aside the mainstream Western belief in continuous, linear progress and learning from more holistic approaches, non-Western traditions. And indigenous people's practices. This is not to indict the West of the Industrial Revolution which have led to some wonderful technological and human rights achievements, but rather to acknowledge the need for a change, of course after two hundred years of increasing exploitation of nature, coupled with conflicts, power grabs, and imposition other. It should also be an acknowledgement of a trend toward major transfers of wealth from the poor to the rich that has lead to unsustainable and unethical situations; the richest three hundred people in the world today possess a s much wealth as bottom three billion people.

The essence of the required major shift, however, is a change in human behaviour across the board, which would be equally or even more difficult to effect among those who have only recently started to taste the fruits of affluence and consumption. They and those still waiting to achieve such affluence can argue quite validly for why they should be exempt from any constraints. But these arguments cannot change the actual planetary limits that are being reached, and increasingly breached. Developed countries and their populations should lead the way in introducing and implementing measures toward sustainability, changing production and consumption patterns, effecting a transition to sustainable energy, sharing technologies, and accepting responsibility for decades of excess. This will be immensely challenging- especially as the economic crisis across Europe and North America has pushed sustainability lower down developed countries' policy agendas. Despite the currently low per capita consumption in emerging economies such as China and India, they may also create a path for themselves, achieving a better life without following the same route as the West.

CHAPTER 5
CASE STUDY-NARMADA VALLEY DAM PROJECT

A dam is a barrier (wall) of earth, concrete or rock. A dam is built across a river to restrict the flow of water. Dams are usually built in gorges or across narrow parts of rivers. An artificial (man-made) lake or reservoir is formed behind the dam.

The Narmada Valley Project (NVP) is made up of plans for 30 major, 136 medium and 3,000 minor dams in India. In Sardar Sarovar Project (SSP) in the state of Gujarat and the Narmada Sagar Project (NSP) in the state of Madhya Pradesh are, at present, the NVP's major constituents. Estimates show that the cost of the whole project would be around US $19 billion over the next 25 years. The present estimate for the NSP and the SSP is US $3 billion and $9 billion, respectively.

The state governments of Gujarat and Madhya Pradesh claim that the SSP and the NSP would irrigate 1.9 million ha and 0.14 million ha of land and generate 1,450 megawatts (mw) and 1,000 mw of power, respectively. The hydroelectric power of the SSP would be shared by the states of Gujarat, Maharashtra and Madhya Pradesh; the irrigation benefits would accrue to the states of Gujarat and Rajasthan. All irrigation and power benefits of the NSP would go only to Madhya Pradesh. Without the NSP, the SSP would not be able to achieve its full irrigation and power potential - it needs regulated water supply from upstream.

These projects had been treading water for many years for want of environmental clearance from the Ministry of Environment and Forests. Recently, the Indian government gave clearance for the construction of the SSP in Gujarat and the NSP in Madhya Pradesh. But very few dispute the fact that the ecological impacts of these projects have not been properly studied.

Both environmentalists and social activists have raised serious questions about the projects. The studies done thus far have been found to be inadequate, or the follow-up actions to rectify the damages not up to the mark. The government of Gujarat commissioned a study of the projects carried out by the department of botany, M.S. University, Baroda, in just six months. The study did not take into consideration the seasonal temporal variations in the climate and many other important parameters. This study was commissioned only after the work on the project had begun. Moreover, much of the information in this study derives from government data, rather than from recent, independent, empirical data.

Similarly, the Environment Planning and Coordination Organization (EPCO), in Bhopal, carried out a study to assess the environmental impact of the NSP. This study is an almost worthless exercise; it is based on secondary data, which were at times found to be contradictory. Such a report

can hardly be passed off as legitimate environmental research.

Other studies, conducted by Consulting Engineering Services Pvt. Ltd., in New Delhi, and the Indian Institute of Sciences, in Bangalore, can only be considered a piecemeal approach to the whole project, because they only examine one or two dams.

Impacts of the project:

Submerging Forests and Agricultural Land

The Sardar Sarovar Project will submerge about 10,000 ha of forest land. The case of Narmada Sagar Project is even worse: it will submerge 40,332 ha of forest land.

The forests to be submerged are basically teak, with excellent strands of bamboo and other woods. The only pure stand of anjun left in India is located in the Dewas district of Madhya Pradesh. Many of these species no longer naturally regenerate.

These projects will also flood a large amount of agricultural and grazing land. Most of the agricultural land, situated close to the river Narmada, is highly fertile and produces fine yields of wheat, jowar (barley) and cotton. The official document for the NSP says, "big chunks of cultivable land are not available in Khandwa, Khargone, Dhar, Jhabua, Dewas Hoshangabad and other districts. In these circumstances the only course left is to allot the affected families small bits of government land available in the nearby districts of the submergence area." This policy would lead to serious sociocultural disruption in the life of the area's residents. A report carried out by National Institute of Urban Affairs (NIUA), in New Delhi, mentions that adequate areas in every district would be available for the residents. However, the project authorities have made no serious attempt to find cultivable land for the residents.

Loss of wildlife

The project report of the NSP states, "the impact of the project on the wildlife shall be nil. Since wildlife has got natural characteristics of shifting to nearby jungles wherever it is felt unsuitable to them." In other words, the wildlife will relocate itself. Similarly, the policy document prepared by the government of Madhya Pradesh says, "wild life in submerged forests will be guided to adjacent localities. Protection of the wildlife will be the responsibility of the forest authorities." These statements not only contradict each other but also reflect the irresponsible attitude of the project authorities toward the fate of the area's wildlife, which consists of several rare and endangered species. To date, no one has taken an inventory of the species of plants and animals found in the forests; these studies have only just been commissioned.

Displacement and Rehabilitation

Both these projects will displace nearly 200,000 people from their homes. Official sources state that, in the case of the SSP, 182 villages in Madhya Pradesh, 36 in Maharashtra and 19 in Gujarat will be under water and the NSP will submerge an additional 254 villages in Madhya Pradesh. These figures, however, are incorrect, because they only include revenue villages, with no mention of forest villages. A recent field report by Multiple Action Research Group (MARG), a nongovernmental organization in New Delhi, mentions six forest villages of Tehsil Barwani (Dhar district, Madhya Pradesh) that will go under Sardar Sarovar's waters. Similarly, no attempt has been made to list those villages that will fall victim to the backwater effect.

Water logging

Every year, a large portion of good, fertile land is rendered unproductive and barren by almost all the irrigation projects. The annual increase in soil salinity and waterlogging was as high as 50,999 ha and 27,000 in Ramganga project area in Uttar Pradesh. About 25 percent of the arable lands of Punjab and Haryana have been affected by waterlogging and soil salinity, too. The problem of waterlogging and soil salinity in the Narmada projects is expected to be serious because the command areas of the projects have largely black soils, which have very good water retention capacity. A study by Indian Institute of Science, in Bangalore, found that about 40 percent of the NSP's command area will become waterlogged unless stringent preventive measures are taken. Significantly, the cost of these measures does not figure in the original cost-benefit analysis for NSP-the analysis submitted for funding approval.

Catchment Area Treatment

There is no denying the fact that the catchment areas of the river Narmada are subject to heavy ecological degradation. If this is not properly checked, the increasing soil erosion will lead to salutation and sedimentation, thereby reducing the life span of the reservoirs. No comprehensive study has been commissioned on the existing state and future demands on the catchment forests in the Narmada Valley. However, an expert committee has looked into the matter for part of the area, and has suggested a US $38 million scheme to treat the catchment. As the Department of Environment report points out, however, this study was commissioned several years before the projects were sanctioned.

Apart from the above impact, the other negative impacts are,

- Seismicity - a hotly debated issue that seems to produce more confusion than clarity.
- Contamination by pollution, pesticides and minerals
- Saltwater ingess at mouth of river due to reduced water flow

- Spread of waterborne diseases in the command area
- Impact on aquatic ecology

Both the projects involve displacing nearly 200,000 people, many of whom make their livings from common property resources. There is no comprehensive resettlement and rehabilitation scheme for them in the directives and rules laid down thus far.