Environmental Science

Introduction to Environmental studies and Natural Resources

Lecture 7

Non- renewable resources

We have **Oil and Natural Gas**. India accompanies about 0.04% of the world's proven reserves of Hydrocarbons. The prognosticated geological resources of hydrocarbons in the country are 21.31 billion tones of which 61% are off shore and 39% on land. Crude oil is made of many different compounds, each with its specific boiling point. Using distillation we are able to separate out these compounds and turn them into commercial products, ranging from gas to asphalt. The petroleum gas obtained during cracking and fractional distillation can be easily converted into liquefied under high pressure as LPG. Natural gas is found above the oil in oil wells. It is actually a mixture of about 50-90% methane and small amounts of other hydrocarbons. If the natural gas contains lower hydrocarbons like methane and ethane, it is called dry gas. If the natural gas contains higher hydrocarbons, like propane and butane, it is called wet gas.

Petroleum or crude oil is naturally occurring flammable liquid, consisting of a complex mixture of hydro carbons, with small amounts of sulphur, oxygen, nitrogen of various molecular weights and other organic compounds that is found in geological formations beneath the earth's surface.

How is oil and gas made?:- Now we are looking at the ocean floor **about 300-400 million years ago. Tiny sea plants and animals died and were buried on the ocean floor. Over time they were covered by layers of silt and sand. Then 50-100 million years ago,** you have **plant and animal remains**. Then you have **sand and silt,** and again currently you have on the ocean floor you have **other aquatic creatures. Over the millions of years the remains were buried under deeper and deeper. The enormous heat and pressure turned them into oil and gas.** Today we drill through **these layers of sand, silt , rock to reach the rocky formations that contain the deposits of oil and gas**. That's why you see these drilling platforms.

Natural gas – Advantages: – **ample supplies 125 years, high net energy yield, low cost with huge subsidies, less air pollution compared to other fossil fuels. Lower carbon di oxide emission compared to other fossil fuels, moderate environmental impact easily transported by underground pipelines. Consumption of land is obviously low, good fuel for fuel cells and gas turbines**.

Disadvantages;- **Releases carbon di oxide when burnt, methane** which is a green house gas **can leak from the pipelines. Shipped to cross the ocean has high explosive LNG. Sometimes burned off and wasted at wells because of low price.** So this is the usual way LNG goes or natural gas is transferred from one place to another. Finally we get it in the form of **LPG** to our homes. **It is available in highly concentrated forms. It is easy to store. There Is relatively a reliable supply .Lower cost per unit of energy produced as the technology is matured. Disadvantages- it is highly polluting, available only in a few places, high running costs, limited supply and will one day get exhausted.**

As example we have the **HVJ pipeline or the Hasira- Vijaypur- Jagadishpur gas pipeline**. This is 1700 km long across the country gas pipeline that links Mumbai High and Bassein with the fertilizer Power and Industrial complexes in Western and Northern India. This artery has provided an impetus to India's gas production. The Power and fertilizers industries are the key users of natural gas. **The use of compressed natural gas or CNG for vehicles to replace liquid fuel is gaining wide popularity in the country. This is where the pipeline goes. You can see how long it is. And like we discussed there are certain disadvantages with the pipeline, it has to be regularly checked and maintained because when it is in the form of CNG it is highly inflammable and can cause disastrous accidents.** Then we finally get it as LPG, now you even use it as hybrid in cars.

Electricity:-Electricity has a wide range of applications in today's world. Its percapita consumption is considered as an index of development. Electricity is generated mainly in two ways-number 1 **by running water which drives hydro turbines to generate hydroelectricity. By burning other fuels such as coal, petroleum and natural gas to drive turbines to produce thermal power.**

Hydroelectricity is generated **by fast flowing water** which is a renewable resource. India has a number of multipurpose projects like Bhakra Nangal, Damodar Valley Corporation, the Kopili Hydel project etc. These are some hydro turbines in our country, which are usually linked with dams. **The generation of hydro electric power, you have the dam, the turbine, the continuous flow of water which runs the turbine that generates the electricity, which is then transferred to many industries and nearby power plants.**

Thermal electricity is generated by using **coal, petroleum, and natural gas**. The thermal power stations use non-renewable fossil fuels for generating electricity. There are around 310 thermal power plants in our country. Obviously as a result of this you have a lot of emissions, and pollution factors.

Nuclear or atomic energy:- Nuclear energy is obtained by altering the structure of atoms. When such an alteration is made, much energy is released in the form of heat and then this is used to generate electric power. Uranium and Thorium from Jharkhand and Aravalli ranges of Rajasthan are used to generate atomic or nuclear power. The monazite sands of Kerala is also rich In thorium.

These are the **Nuclear Power Stations**:- We have Kaiga in Karnataka, Kalpakkam in Tamilnadu, Kakrapara in Gujarat, Rawatbhata in Rajasthan, Tarapur in Maharashtra, and Narora in Uttar Pradesh.

Now moving on to next form of energy**, Tidal Energy**.- **Oceanic Tides can be used to generate electricity. Flood gate dams are built across these inlets. During high tide, water flows into these inlets and gets trapped when the gate is closed. And then when the tide falls outside the flood gate, the water retained by the floodgate, flows back to the sea via a pipe that carries it through a power generating turbine.** In India the Gulf of Kutch, provides ideal conditions for utilizing tidal energy. A 900 MW tidal energy plant is set up here by the national Hydro power Corporation. So this is how tidal energy is trapped or encrypted used.

Geothermal energy:-Geothermal energy refers to the **heat and electricity produced by using the heat from the interior of the earth**. Geothermal energy

exists because **the earth grows progressively hotter** with increasing depth. Where the geothermal gradient is high, high temperatures are found at shallow depths. Ground water in such areas absorb the heat from the rocks and becomes so hot that when it rises to the earth's surface, it actually turns into steam. This steam that is derived is then used to drive the turbines and generate different forms of electricity. You have several hundred hot springs in India, and this can be actually used to generate electricity. Two experimental projects have been set up in India to harness geothermal energy. One is located in Parvati Valley near Manikaran in Himachal Pradesh, and the other is Puga Valley in Ladakh.

Advantages of Geothermal Energy:-It is an **inexhaustible energy resource**. It is **cheap**. It is more **regular energy production source than non-conventional sources like wind and solar**. It is **good for the hilly, remote areas, w**here no other source of energy is usually available.

The **Disadvantages**:- These hot springs are generally away from the areas having potentials of industrial development, and if at all, there is some kind of development happening there, it might affect the springs. The stream energy is to be used, as it cannot be carried out for a longer distance, due to loss of energy, and due to the cost factor also.

Hydrogen energy;- is a **combustible kind of energy based on gas hydrogen**. Hydrogen is a combustible gas. In this process it **combines with oxygen to form water** and releases a large amount of energy. The amount of energy released per gram is nearly 29,860 calories as compared to 11,500 calories. Hydrogen is considered **a very clean fuel**, a **major problem** is of **fire and explosion hazard**, because it is very **difficult to store and transport**. It can be stored in the form of fuel cells. The **raw material** for fuel cell is **water ,** which is available in abundance. Thus hydrogen as a energy source is a **environmentally compatible fuel .**

Looking at the **Advantages** of it:- When it is burnt , it produces only water vapour which is obviously **pollution free**. There are **no green house gases**, there is **no fear of global warming**. It has a lot of applications like **home appliances, transport vehicles and industrial units**.

Disadvantages:- Still the large scale production for commercial use has not been introduced. Its **production costs can be quite high**. It needs **huge external energy to release hydrogen from water** or coal that is from hydrocarbons.

Conservation of Energy Resources:- Energy is a **basic requirement for economic development** every sector of the national economy that is agriculture, industry , transport, commercial, domestic needs. All of this needs inputs of energy. Consumption of energy in all forms has been already rising all over the country. There is urgent need to develop a sustainable path of energy development. **Promotion of energy conservation and increased use of renewable energy sources** are the twin planks of sustainable energy. India is presently one of the least energy efficient countries in the world. We have to adopt a cautious approach for the judicious use of our limited energy sources. As concerned citizens we can do our bit by using **public transport systems instead of individual vehicles, switch of electricity when not in use, use power saving devices and non conventional sources of energy.**

Conservation of Energy Resources;- Causes of shortage of energy in India. **Unplanned use of existing energy resources . There is a high loss of electricity at the production point and also at the distribution** point. **Use of obsolete technologies** have also **reduced the production and increased the losses**. The **theft of power** that is the illegal use of electricity has increased the cost of production**. Over irrigation, over utilization of the underground water** are the basic causes for the over use of electricity. So effect of shortage of energy in India. Due to the **short supply of electricity for the last few years, the industrial as well as agricultural production has been reduced. Lesser industrial production** has created the problem **of industrial unemployment**. The urban life totally is dependable on supply of electricity, the shortage of electricity has caused a total social unrest.

How do we go about conservation of energy;- Some of the measures of domestic level can definitely help the nation to save energy at a larger scale. After all it is only drop by drop that an ocean is created. The conventional electronic tubes or bulbs should be replaced either by CFL or the current trend the LED bulbs which

actually consume less power but produce more energy or more light. While going out of the house even for a few hours, we have to ensure that all appliances are shut off. Use of air conditioners should be made only if required. Power factor improving devices should be used for commercial as well as domestic purposes also.

Land Resources

Now moving onto **Land Resources**:- Land as a resource- many of us don't even look at land as a resource, we take land for granted. At least the awareness that is there for electricity, for water, all of that Is definitely not there for land. Land is the major constituent of the lithosphere, as an important resource for mankind and other organisms. The living organisms and vegetation are supported by land. It is rich in resources like minerals, organic as well as inorganic matter and to some extent air and water. It plays a pivotal role in some complex processes such as production of food, as well as decomposition of dead organic matter by microbes.

Various uses of land:- Agriculture or Food Production; Houses the living species of nature; Industrial and commercial purpose; Residential purpose; Waste disposal ; energy purpose. Actually for any kind of work that needs to be done on earth, land is pretty much required. If you look at the different land use patterns across the world, you have majority of it, you have here, which is in **the forest areas**, then you have **cultivable lands**, which is **a very small area, urban areas is just 3%, crop lands is 12% and forests takes about 28%.**

Land as a resource:- **Non- Renewable resource**- obviously we have only this much amount of land. Even though now currently landfills are being created and that is being utilized. It **is essential for functioning. Supports all living beings, but it is depleting day by day.**

Soil:- How do you go about defining soil? The weathered surface of the earth's crust which is associated with living organisms and products of their decomposition. Pedogenisis- process of soil formation; the main constituent of land.

Weathering:- The **process of breaking up of rocks into smaller particles** is called weathering. You have **three types- Physical; climate and biological**.

Layers of soil:- These are the layers of soil. If you start from the very first layer , you have the **solid rock**, **weathered or decomposed rock**, then you have the **sub soil,** which hosts some parts of the roots system. **Top soil which** is very important again for the root system as well as the plants. Then you have the **organic materials** which is a loose structure over the top soil.

Different types of soils in India:- You have the **Red soil**. This is the **largest soil group** in the country. This is rich in **iron , magnesium**, and is found in maximum parts of our country.

Then you have **Black soil or regular soil**, **large clay factor without gravel, contains high moisture, extremely sticky,** and mostly seen in central India.

Laterite soil or lateretic soil ;- It **lacks in fertility** and has **low value for production**, it contains, **potash nitrogen and phosphates**.

Alkaline soil- is found in drier areas. Mostly **not suitable for cultivation**, imperious that is **very slow drainage.** It is impervious to any kind of water on it or liquid on it.

Mountain or Forests soils of the Himalayan region:- Found in depressions of valleys and slopes, **provides heavy growth to plants**.

Moving onto to **the Phenomenon of Land Degradation**:- Land degradation refers to the **decline in overall quality of soil, water or vegetation condition,** commonly caused by human activities.

The **Main Causes of Degradation** are;- **Deforestation by fire clearance; Wind Erosion; Water Erosion; Pollution including industrial wastes; Poor farming practices; Live stocks including overgrazing.**

Anthropogenic Causes;- **mining; urbanization; Deforestation; overgrazing; Dams and canals; fertilizers**.

The **Effects**;- **Loss of quality of soil and decline in vegetation; increase in salinity or brackishness of the land; Drought; Soil Erosion; Shortage of fuel wood and building materials in many areas.**

Landslides;- A land slide is the next phenomenon that occurs after degradation of soil or land. A **Landslide or a land slip** is a geological phenomenon which includes a **wide range of ground movement, such as downward sliding,falling or flowing of masses of soil, rock and debris.**

Causes of land slides are;- **Loss or absence of soil nutrients** . This could be after a wild fire for example. **Erosion of the toe of a slope by rivers or ocean waves**; **Weakening of a slope through saturation by snowmelt, glaciers melting or heavy rains; earthquakes; volcanic eruptions.** Even though all of these factors seem like natural factors, erosion, weakening of the slope, loss of absence of nutrients, all of this is in a way man-made. To a certain extent even earthquakes are considered man-made, because of our disrupted use of earth, boring of earth movement, all of this are interconnected to a certain extent.

Causes of landslides by Human beings directly ;-**Vibrations of machinery or traffic**. For example it could be a dam construction, a pile foundation that is being drilled in, all of that could be a cause of a landslide**. Blasts**- like a dynamite blasts which we spoke about for clearing out land. **Construction and Forestry Activities.** Like complete deforestation of a hilly slope could also lead to landslides.

Types of landslide; you have **Falls** that is **soil or rock masses free fall from air**. This generally results from undercutting by erosion. Then you have the **Slides.** This is failure among one or more narrow planes**. Types of slides- slumps, glides and rock slide**. **Flow-** this is caused by **internal displacement in soil .** You either have **earth flow or rockslide**.

Next **Soil Erosion**:- The process by which rock fragments and soil are detached from the original site, transported and then eventually deposited at some new locality is termed as soil erosion.

The **different kinds of soil erosion** are;- **Normal and geological soil erosion** that is erosion done naturally. **Accelerated soil erosion –** loss of soil by man's activity.

Agents of soil erosion:- **Water erosion** you have 3 different **types- sheet, rill and gully**. **Wind erosion** again you have three **types, saltation, suspension, surface creep**. **Landslides or slip erosion, Biotic agencies causes soil erosion Like overgrazing and deforestation.**

Desertification is the next geographical phenomenon; What exactly Is desertification?- the **transformation of aerable or habitable land to a desert** as by a change either in **climate or destructive land use**. This is viewed as both as a process as well as a resulting condition. This is a **global problem**. It **leads to abandon desert like landscapes**.

The **Causes of Desertification** are:-**Overgrazing, Deforestation, Over cultivation**. So the land becomes infertile eventually. **Inappropriate irrigation** because of overflooding or lack of irrigation; **drought, climate change.**

The **Consequences:**- **Reduced biological productivity, biodiversity loss, loss of food security, increase in soil erosion, decreasing water availability and loss of biodiversity.**

How do we go about countering desertification?:- First step is **Afforestation**- Planting new forests or new trees in wastes lands. **Water conservation**. **Livestock management** to ensure overgrazing does not take place which lead to soil erosion and **wise agricultural methods** so that irrigation does not become a cause. Desertification occurs in about $1/3^{rd}$ of the worlds land. It has both a lot of economic losses a lot of other reasons of why it comes about into place. A Worsening drought could be a consequence, a famine, economic losses, it lowers the living standards of the people and finally causes a lot of environmental refugees.

Salinization:- Where irrigation water contains small amounts of dissolved salts. Evaporation and transpiration leaves these salts behind. And these deposition builds up on the soil. You can see the level of soil deposition here. And because of this , this piece of land actually becomes infertile.

So how do you go about preventing it?;- you need to reduce irrigation or check the quality of water that is used for irrigation. You need to ensure that you have a

cleaner set up. So your planting of trees whatever forests crops, whatever that is getting done it has to make sure that it is changed every few years and the salinity of the soil is kept in check. You can see how over salinised this part of the soil is . It is coming up to a level of forming a layer on the trees. You can see plants transpire water. Water evaporates and these salts remain behind. The water and the salts move upward from a higher water table. So we have to ensure that we have everything tested out so we can be prepared for different the consequences.

Reducing and cleaning up Salinisation:- **Reduce irrigation; Switch to salt-tolerant crops** if that area has very high saline content water. **Flush soils; Not grow crops for about 2-5 years**; and **Install an underground drainage,** so excessive salts can be drained out.

Soil Degradation on irrigated land;- **Salinisaton; Water logging**; like we discussed, over irrigating anything will actually even make your crops die as well as it will flood out the land and remove the important nutrients. **Precipitation and irrigation water percolate downwards**, **water table rises** and that is **very bad for the roots** of the vegetables or any crop that you're talking about , it will start rotting.

What controls soil productivity?;- You have nutrients, toxins, gas exchange, strength rooting volume, waste disposal, and nurseries.

Soil conservation:- this involves many ways of reducing soil erosion and restoring the fertility of the soil. The usual way which is done by most farmers is **tillage or ploughing or just changing the layers of the soil.** Farmers plough the land and then break up and smooth the soil to make a planting surface. This leaves the soil vulnerable to erosion**. Midwest tillage often down in fall** which makes the soil bare in the winter. **Disturbing the soil as little as possible while planting the crop**, that is make sure you don't till over winter. **Planting without disturbing the soil. Special equipment inject soil with seeds and fertilizers**. In 2003 , 45% of the US farms had a problem because of tillage.

So **conservation tillage** has both **advantages and disadvantages**:- it **reduces erosion**; it **saves fuel**; it **cuts costs**; it allows **for different several crops per**

season; it **does not reduce the yield of the crop** and it mainly **reduces carbon di oxide releasing from the soil**. But what are the main **disadvantages** is ;- it **leaves stalks that can harbor crop pests and fungal diseases**, and **increase the pesticide use**. It requires **an investment in expensive equipment** and it can **increase the herbicide use** for some crops.

How can soil be restored?:-You can do it by number of methods. The main methods used for restoration of soil are **organic fertilizer, animal manure, composting, crop rotation and sometimes using commercial inorganic fertilizers.**

Is land actually a renewable resource?:- Yes. We can consider it a renewable resource if utilized carefully. The roots of the trees and grass bind the soil. But if the forests are completely depleted and grasslands are overgrazed, soil erosion, loss of productive top soil occurs and the land becomes unproductive. Intense irrigation leads to water logging, and salinised soil on which crops cannot grow. Land is also converted into a non renewable resource when highly toxic material and nuclear wastes is dumped into it. Thus if managed efficiently , this natural resource indeed can be considered a renewable resource.