Environmental Science

Lecture 14

ENVIRONMENTAL POLLUTION

Pollution is the effect of undesirable changes in our surroundings that have harmful effects on plants, animals as well as human beings

Pollutant: Anything that is solid, liquid or gas that causes pollution is called a pollutant. So example of pollutants are lead, sulphuric acid, carbon monoxide.

Types of Pollution

Degradable: Those that can be readily broken down by natural processes, example : discarded vegetables

Non-degradable: Those cannot be degraded by natural processes, example : plastics

Types of Pollution

- AIR
- WATER
- LAND OR SOIL
- NOISE
- THERMAL
- NUCLEAR

Types of Sources

Now you have point source and non-point source.

Point source is single, identifiable source like drainpipe, smokestack we can identify to one particular point of origin.

Non-point source is dispersed source, so you cannot trace to a one particular part or factor run of from pesticides, fertilizers. This could be from hectors of land and it cannot be said that this source of point of origin.

Non-point sources like I just said could have happened anywhere, it could be run off from the industry, it could be from soil fertilizer, it could be from reverse that it carrying from upper levels of the mountains and any of these test this water now it could be polluted but to point and say this water polluted and because of this factor is not going to be possible.

Point source: This is the point source where you can actually see the point of origin to say that this and this industry is causing so much of pollution and its discarding so much of effluence. The effluence can also be measured either in gaseous or in liquid state

What are the key environmental problems?

- Population growth
- Resources use without preventing pollution and reducing waste
- Degrading habitats and reduction of biodiversity
- Poverty
- Failure of govt to encourage earth sustaining economic development

The Paul Ehrlich Formula or Equation

This is Impact = Population x Affluence x Technology where I actually is the impact on the environment resulting from consumption of human kind, P is nothing but the growing population and the A is the consumption per capita that is affluence and T is the factor of technology. So all of this is multiply and that gives as the final impact. Now if we look at the atmosphere gases that envelope the earth or healthier by gravity and that is what regulates the temperature at different parts of the earth. So the major gases that you have are 78% of nitrogen and 21% oxygen, 0.9% of argon and 0.03% of carbon dioxide, there are trace amounts of water vapor that re close to the surface, 0.01% by volume near poles to about the 5% near equator and many others like hydrogen, neon, helium, krypton, ozone and methane.

If you look at the composition of air, if we like discuss majority junk of it is nitrogen taking a whapping 78% and next we have oxygen taking nearly 21 and the others which is encompasses Argon, water vapor, carbon dioxide, methane, krypton, hydrogen, ozone everything is at 1.4%. Oxygen is what we need the most because human consume oxygen and at the same time, oxygen is required for compassion and the gas that is released as a result of compassion is carbon dioxide.

So these are the different layers of atmosphere, you have the Troposphere, the tropopause, stratosphere, the stratopause, Mesosphere, the mesopause, Thermosphere, the thermo pause which leads to outer space. So ranges from about 7 to 10 kilometers to whapping 500 kilometers. So Exosphere is right above towards space and this is the most important component ozone that is the one that protects earth and the people of earth in different animals and plants of earth from harmful radiation of the sun and the ozone occurs between stratopause and tropopause that is significantly the stratosphere encompasses the layer of ozone. So that's average around 80 km from the surface of the earth.

Layers of atmosphere

Troposphere is about 75% of mass of air, 17km thick, A turbulent layer of rising and falling air currents

Stratosphere extends up to 50km above the Earth's Surface. It's obviously less dense, contains nearly 99% of remaining atmosphere, similar composition that is ozone has a higher volume here, water vapor has a lower volume, calm air, Very little vertical mixing.

Mesosphere is about 50 – 90 km and Thermosphere is 90 – 100 km

The Stratospheric ozone layer, this is formed by natural processes, produced by O2 interacting with lightening and UV radiation absorbs most of the shorter wavelength that is UV radiation which is damaging to living things causing cancer, sunburn, cataracts, etc. And this is the one that allow life to permit on earth and ozone depletion is nothing but the reduction of the ozone layer and it's a result of pollution of different kinds we shall see though future.

What are the major sources and the types of air pollution?

The presence of one or more chemicals in the atmosphere in sufficient quantities and duration to cause harm to humans, animals or plants. Because of pollution you can see this trees and plants which are planted across the highway and the median will be drooping and brown because of the constant exposure to exhaust, true that plants due consume carbon dioxide for photosynthesis. But the percentage of exhaust comes out from the constant flow of vehicles surpasses the consumption of carbon dioxide by the plants and the secondary factor is the exhaust contains much more harmful chemicals then just carbon dioxide.

Air Pollution results from human activities such as burning fossil fuels that is oil, coal and gasoline to create electricity and power automobiles and manufacturing industrial products such as chemicals and plastics. So the typical air pollutants are particulates Hydro carbons, carbon dioxide, carbon monoxide, nitro oxide, nitro dioxide and sulphur trioxide and these are sources could be automobiles, industries etc.

The increased carbon dioxide contributes to the warming of the global climate so called the greenhouse effect, the increased chlorofluoro carbon that is CFC in the atmosphere has been depleting the stratospheric ozone. CFC is used to occur in refrigerator, coolants and even though aerosol products that come under pressure, it could be anything from shaving form to deodorants used to have CFC's. CFC's were major components to have things under compressive pressure it is only with advent of technology and we have realized that CFC's of quite harmful that is has been replaced.

Sources of Air Pollution

- Typical Natural sources of Volcanoes, fumaroles and hot springs
- Decay from marshes and bogs
- Increase ozone due to thunderstorms and fires

Made made (which are consider most severe for human health)

- Stationary sources those that are fixed in one particular location.
- That is point sources like we saw smoke stacks from industries, 14% of air pollution is from plants generating electricity
- Fugitive sources that is construction sites, exposed areas
- Area sources that is dense urban community or agricultural area

- Many of us might think how does an agricultural area actually contribute to pollution but with new methods of agriculture that is tractors and everything that is mechanized and all of this machines used diesel, the level of pollutant is far more severe in this areas
- Mobile sources those that move while polluting, so these are basically automobile industries. 60% of air pollution comes from motor vehicles and 80 – 88% in just major cities.
- So you can see whapping 60% from jets industries and commercial uses and 40% from automobiles.

Major sources of Pollutants

38%-40% of cars and trucks, 21% of Household and other products, 23% from non-road engines that could be a jet fuels it could be both and could be anything and 18% from manufacturing industries

What are the main categories from air pollutants?

Primary: Those emitted directly into the air like sulfur dioxide, carbon monoxide, nitric oxide, nitrogen dioxide.

Secondary: Those that form as a result of a chemical reaction of the primary pollutant with a natural component of the environment examples some ozone, sulfuric and nitric acids.

Types of Pollutants

Primary Pollutants and Secondary Pollutants

Primary pollutants: Those are emitted directly from identifiable sources produced by both natural events and human activities thus storm emission from vehicles are typical examples. When certain chemical reactions take place among primary pollutants so that is sulphuric acid is an example.

Moving onto typically primary pollutants we see

- Carbon oxides that is carbon dioxide and carbon monoxide
- Nitrogen oxides
- Sulphur oxides
- Volatile organic compounds that are hydro carbons
- Suspended particulate matter

Auto Exhaust

- Hydrocarbons, methane, butane, propane and others.
- Hydrogen sulfide, H2S gas which is extremely toxic
- Particulates, visible that is dust, smoke, soot, very fine which is lesser than 2.5 micron meter
- Lead, batteries, additive to gasoline. Becomes airborne, spreads to the land is well.

Primary air pollutants

- Sulfur dioxide (SO2) its colorless, odorless gas. Particulates of SO2 which combines with water to form acid rain. It's toxic to plants and animals and its cause's severe damage.
- Carbon monoxide is colorless, odorless gas, readily combines with hemoglobin in blood extremely toxic again.
- Nitrogen oxides, NO, nitric oxide and nitrogen dioxide NO2, this is the yellow brown to reddish gas. Converted to nitrates in the atmospheric causing acid rain.
- Photochemical smog this is nothing but brown air smog, smog is smoke +fog in the presence of moisture.

This is usually seen in urban areas where because of pollution and the whether at the point of time it lay as an entire layer blocking and creating a lot of respiratory issues as well as visibility issues.

Photochemical Smog

This is the kind of air pollution, originally named for the mixture of smoke and fog in the air.

Hydrocarbon and Nitric Oxide reacts in the presence of sunlight to produce ozone and PAN which is Peroxy acetyl nitrate

Nitrogen oxides+ hydrocarbons + Ultraviolet radiation leads to Peroxyacetyl nitrate PAN+O3 ozone

The effects of Photochemical Smog

- Breathing ozone results in respiratory distress and severe headaches
- It damages Plants
- And Photo hydro carbons causes polynuclear aromatic hydrocarbons or extremely carcinogenic and cancer causing.

This is the typical Photochemical smog like we discuss its usually happens only in urban areas where there is a sever pollution crisis especially cause due to vehicle of pollution.

What are the effects of air pollution?

- The effects of air pollution ranges from reduction and visual range and atmospheric clarity, less contrast and less visibility. This not only pertains to road transport but also to air travel which can cause a lot of disastrous consequences
- Damage to vegetation including leaves, needles, fruit, growth rate, reproductiveness and hardiness
- Decline in net primary productivity or NPP
- Crop losses could have happened anywhere between 1.9-5.4 billion/ year
- Degradation of human health, from mild problems like eye irritation to severely respiratory disease like asthma, bronchitis, cancer and emphysema
- Carbon monoxide, 90% natural, 10% from incomplete combustion, cigarettes this can be easily combines with hemoglobin and it reduces the ability to blood to carry oxygen. Nearly 150,000 – 350,000 deaths per year is cause due to carbon monoxide poisoning

- Degradation of vertebrate health, aquatic life, with impacts on respiration, bones, teeth, reproduction; increase lake acidity, decline in Net Productivity
- Degradation of soil and water, when air pollutants settle, toxic metals in soil and soils leached.
- Deterioration of man-made structures, break down of car paint, roofing; acid rain chemically dissolves marble statues and other building materials.

One of the examples of our own country was the acid rain that was happening in Agra causing the damage to the Taj Mahal severe yellowness was notice, it was only then it was realize the rain occurring in that area is harmful and certain activities had to be done, now flights are not allowed to flight across above Agra it has to take a circuit as root and certain of the changes also been accompany to reduce the influx of this acid rain.

Effects of Air Pollution

- Air Pollutants can overload or break down the natural defenses such as hair in our nose, sticky mucus in the lining of the upper respiratory tract causing diseases like lung cancer, asthma, chronic bronchitis etc.
- Cigarette smoking is responsible for the greatest exposure to carbon monoxide. Exposure to air containing even 0.001% of carbon monoxide for several hours can cause collapse, coma and even death and that is why later discovered with the number of experiments that air condition rooms should not allow smoking and even if the filter system must be regularly change for the same practice, because if the filter is not clean than any carbon monoxide is leak that is could cause drastic consequences
- Carbon monoxide is attached to blood hemoglobin reduces the oxygen carrying capacity of blood. This then impairs perception and thinking, slows reflexes causes headaches, drowsiness, dizziness and nausea and blurred vision.
- Nitrogen oxides and suspended particles both can irritate lungs, aggravate asthma or chronic bronchitis and increase respiratory infections.
- Many volatile organic compounds such as benzene and formaldehyde and toxic particulates such as lead and cadmium can cause mutation, reproductive problems and cancer, breathlessness and irritation of the eye, nose and throat.
- Sulphur dioxide irritates respiratory tissues and chronic exposure causes bronchitis
- Sulphur dioxide also reacts with water oxygen and other materials to form sulphur containing acids – The acids can become attached to particles which when inhaled are very very corrosive to the lung.
- Chronic exposure of the leaves to air pollutants can break down the waxy coating that helps prevent excessive water loss and leads to damage from diseases, pests, drought and frost.
- It also affects photosynthesis, respiration and other metabolic activities

Doubling Carbon dioxide

- In 1850, atmospheric carbon dioxide was about 280 parts per million (ppm)

- Today it is about 350 ppm and this itself was in 2000, so now early 16 years later it could be much more
- This increase is due to largely to burning of fossil fuels and clearing of forests for human needs.
- Oceans and also photosynthetic organisms currently absorb half of the carbon dioxide emitted

So you can see there has been the study increase in carbon dioxide inside levels from 1960 to 1990 from 320 it has reached 360 ppm.

Concentration of Carbon dioxide

That is parts from million and versus the concentration in 1990, it has steadily increase and in spite of as knowing that steadily increasing we are unable to do anything, because carbon dioxide is byproduct of most of human activities versus the only solution for its going more plants and the main problem for that is deforestation because man needs more and more land for the growing to accommodate for growing population and at the same time we needs more vegetation to satisfy the needs of this growing population. So it kind of become the vicious circle, this is to discuss the carbon dioxide cycle, you have carbon dioxide in the atmosphere through diffusion it becomes carbon dioxide in the oceans then you have the calcareous sediments like Limestone and Dolomite, Aquatic biomass that is taken and then you have plants again on the top soil which consume the CO_2 in biomass and then through photosynthesis the release out and the process of respiration, it is released out and that again it observed by the oceans and other water bodies and another source of carbon dioxide is fossil fuel burning. So even though the sources of carbon dioxide is many the only way it is observed is by plants and by the aquatic biomass, so you should realize that the process by which carbon dioxide generated is much more than the absorption rate.

Impact of increasing CO_2 levels in the atmosphere

- Increased photosynthesis and productivity by the earth's vegetation
- Increased plant production also means increased respiration
- Elevated atmospheric CO2 is global warming
- Elevated CO2 means an increase in global temperature- the greenhouse effect
- Global temperatures may increase by 2oC-4oC by the end of the next century

Elevated CO2 means an increase in global temperature which actually leads to greenhouse effect, global temperature actually increase from 3 degree Celsius to 4 degree Celsius by the end of the next century.

Greenhouse effect, greenhouse gases or (GHGs)

- Some greenhouse gases occur naturally in the atmosphere, while others result from human activities
- Naturally occurring greenhouse include water vapor, carbon dioxide, methane, nitrous oxide and ozone
- Carbon dioxide is a product of burning fossil fuel and as well as wood

- Nitrous Oxide or (NO2), produced by fertilizer use and released from decomposition of animal wastes.
- Methane (CH4) is produces by bacteria from sediments, swamps, and in flooded rice paddies.
- Chlorofluorocarbons (CFCs), Freon (a refrigerant) deplete the ozone layer in the upper atmosphere
- Halons, such as halocarbons are released from fire extinguishers
- Water vapor in clouds reradiates heat back into the Earth.

So when all of this our contribution of greenhouse gases right from water vapor which is naturally occurring and then carbon dioxide which is because of burning of fossil fuels and consumption of other such fuels

If you look at the increase in Greenhouse gases, there is the study increase, everything is steadily been increasing the parts per million is carbon dioxide it is reach 360 and here we have a methane, CFC even though it started knowingly post 1900 it's because basically only in aerosol and refrigerants and it has still steep increase in a century and nitrogen oxide even though steady in the past few years as steadily increased.

Green house effect

- Carbon dioxide and other gases allow light to pass, but trap heat in the atmosphere much like glass in a greenhouse traps heat.
- This greenhouse effect is thought to be responsible for global warming
- Carbon dioxide contributes only 50% - 56% of the greenhouse effect is heating
- The average surface temperature of the earth is around 15 degree c, global warming is increasing the average temperature of the atmosphere, oceans and landmasses of Earth.

This is the typical greenhouse effect where you have solar radiation is reflected by the earth and the atmosphere. Earth surface absorbs some radiation is absorbed and then it uses it warming it up and some is reradiated back because of this presence of water and water vapor then what happens in the atmospheric level, Infrared radiation is emitted by Earth's surface that is from absorbed by the solar energy and some of the infrared radiation passes through the atmosphere, some is absorbed by the greenhouse gases and re-emitted in all this direction by the atmosphere. The effect of this is to warm the earth's surface and lower the atmospheric temperature as well.

IMPACT OF FLOBAL WARMING

- Temperature extremes
- Rise in sea level, and change in precipitation
- Injuries from storms, coastal flooding
- Interruption of power supply, contamination of drinking water
- Drought

- Food shortages due to shift in agricultural food production
- Air pollution (made worse by warming)
- Asthma, bronchitis, emphysema complications
- Strain on public health systems
- Increased need due to population migrations
- Unable to contain spread of infectious diseases because of uncontrollable migrations as well as air borne diseases.

How do we know that we're causing global warming?

- Less heat escaping to space
- Rising temperature
- More heat is returning to earth
- There is a pattern where ocean temperature is increasing
- More fossil fuel carbon in ocean
- More fossil fuel is being noticed in corals
- More fossil fuel carbon in trees
- Nights warming faster than days
- Winters are warmer than the summers
- Is leading to the melting of the ice cap
- Upper atmosphere is reducing and cooling
- Shrinking of the upper atmosphere

So all of these factors tell as that global warming is happening.