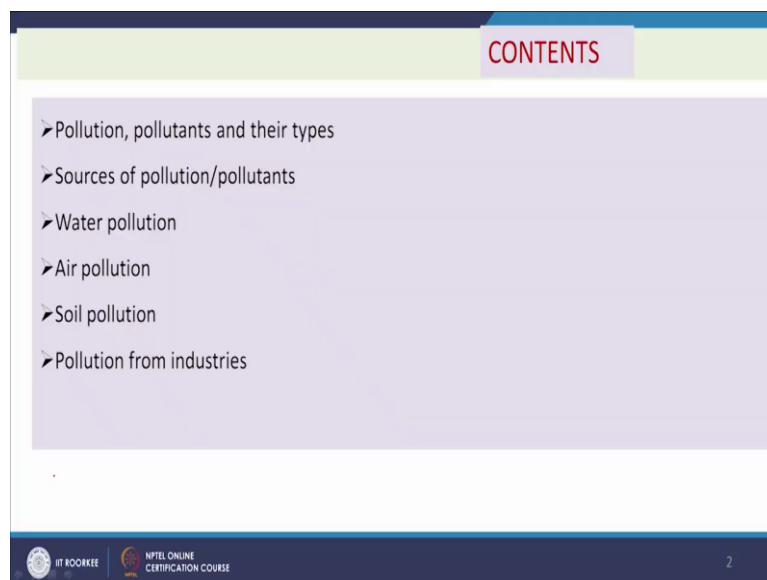


Basic Environmental Engineering and Pollution Abatement
Professor Prasenjit Mondal
Department of Chemical Engineering
Indian Institute of Technology, Roorkee
Lecture 06
Pollution Types and Sources

Hello everyone, today, now, we will discuss on the topic Pollution types and sources. In the previous classes, we have seen that nature has cyclic processes and if pollution is generated into the environment, then naturally it can heal to some extent, but due to ever increasing population growth and the increase in pollution load, the natural cycles, that processes are not able to accommodate those, as a result many places the ecosystem is being altered and different types of consequences we are facing.

So, pollution generation is very very important, we have to know how the pollutions is being generated, what are the sources and what are the types, how it is entering into the water or it is entering into the air and how it is entering into the living organisms. So, one way what is the source, where it is coming into the environment and from environment to the living organisms. So, transportation of the pollutants in the environment is also very important.

(Refer Slide Time: 02:03)



CONTENTS
➤ Pollution, pollutants and their types
➤ Sources of pollution/pollutants
➤ Water pollution
➤ Air pollution
➤ Soil pollution
➤ Pollution from industries

IIT ROORKEE NPTEL ONLINE CERTIFICATION COURSE 2

So, in this class we will see what are pollution, pollutants and their types, then sources of pollution or pollutants and we will see water pollution, air pollution, soil pollution and pollution from industries.

(Refer Slide Time: 02:19)

➤ Sources of pollution/pollutants

Natural pollution/pollutants : Produced through natural phenomena, calamities etc. ; for example, geogenic arsenic in ground water

Man made pollutants : Produced through human activities; can be classified as follows:

- ❖ Point and non point sources
- ❖ Domestic, industrial, agricultural and transport activities

Gaseous pollutants

Gaseous air pollutants are emitted from various natural sources, such as volcanoes and forest fires. However, anthropogenic emissions of some gases may be greater than the natural ones and are increasing because of population growth and industrialization.

Liquid pollutants

Liquid pollutants usually come from liquid waste, which includes human excreta (both faeces and urine), industrial wastewaters and other forms of waste from water-using activities. Factories generate liquid waste from activities related to washing in the manufacturing process, cleaning objects and chemical mixing, wastes

IT ROORKEE NPTEL ONLINE CERTIFICATION COURSE 4

So, what is pollution? Pollution is the introduction of contaminants or harmful materials into the natural environment that cause adverse change. So, this is the pollution and these harmful materials are called pollutants.

Then, pollution can take the form of chemical substances or energy such as noise, heat, etc. And as I mentioned, that entry of these pollutants to the environment is very important along with its pathway, how it is being passed from one place to others, and how it enters into the living organism that is also very important.

So, the pathway of pollution is the way the pollutant moves from source, enters into the environment and finally, how it reaches the human body or other recipients. So, these are the phenomenon which is happening in the environment and we are getting more pollutants in our body automatically.

Now, pollutants can be either naturally occurring contaminants or it may be man made. So, naturally occurring contaminants such as volcanic ash or maybe created by human activity that we are talking about that is from household, from industrial sectors, from commercial sectors, different human activities are creating the pollution.

So, one is natural and other is man made and pollutants maybe in the form of gas, liquid and solid as well as energy, it may be heat energy or it may be noise also and these damage the quality of air, water and land.

Now, natural or manmade whatever may be the source the pollutants may be generated in a point that is called point source that is we are able to identify where the pollution is being generated and maybe some nonpoint sources, so, nonpoint source is very difficult to identify where from these pollutants has entered into the environment. I will give you some example.

(Refer Slide Time: 04:34)

➤ Sources of pollution/pollutants

Natural pollution/pollutants : Produced through natural phenomena, calamities etc. ; for example, geogenic arsenic in ground water

Man made pollutants : Produced through human activities; can be classified as follows:

- ❖ Point and non point sources
- ❖ Domestic, industrial, agricultural and transport activities

Gaseous pollutants

Gaseous air pollutants are emitted from various natural sources, such as volcanoes and forest fires. However, anthropogenic emissions of some gases may be greater than the natural ones and are increasing because of population growth and industrialization.

Liquid pollutants

Liquid pollutants usually come from liquid waste, which includes human excreta (both faeces and urine), industrial wastewaters and other forms of waste from water-using activities. Factories generate liquid waste from activities related to washing in the manufacturing process, cleaning objects and chemical mixing, wastes

IT KOOKEE NPTEL ONLINE CERTIFICATION COURSE 4

And apart from these man made pollutants can be from domestic, industrial, agricultural and transport activities. So, now we have seen that pollutants can be in gaseous, liquid or solid phase. Now we will see what are the gaseous pollutants.

So, gaseous air pollutants are emitted from various natural sources such as volcanoes and forest fires. These are the two major sources for air pollution, however, anthropogenic emissions of some gases may be greater than the natural ones and are increasing because of population growth and industrialization.

So, many man made pollutions are also entering into the atmosphere and liquid pollutants you can see, then liquid pollutants usually come from liquid waste which includes human excreta, both faeces and urine. Industrial waste waters and other forms of waste from water-using activities. Factories generate liquid waste from activities related to washing in the manufacturing process, cleaning objects and chemical mixing.

(Refer Slide Time: 05:43)

➤ Sources of pollution/pollutants contd..

- **Sewage** is a mixture of human excreta from water-flushed toilets and other wastewater from houses and businesses. Sewage and human waste from overflowing septic tanks and latrines are frequent sources of pollution.
- **Urban run-off** can contain a lot of organic matter. This may come from open defecation or inappropriate handling of organic wastes produced from households and businesses.
- **Organic matter** includes anything that is derived from living organisms, such as human and animal wastes, decaying plants and food.
- **Solid waste** is any solid material that is assumed not to be useful and is therefore thrown away. Factories, businesses and households produce different kinds of solid waste such as paper, plastics, metals, chemicals in solid form, pieces of cloth or food and animal remains. Sometimes you faecal matter is discarded with solid waste, which adds to the problems.
- **Noise pollution** means unacceptable levels of noise in work, residential and recreational places.

IT KOOBEE NPTEL ONLINE CERTIFICATION COURSE 5

Sewage another liquid form of waste. This is a mixture of human excreta from water-flushed toilets and other wastewater from houses and businesses. Sewage and human waste from overflowing septic tanks and latrines are frequent sources of the pollution these are very regular.

Apart from this Urban run-off, so, when raining. So, the urban run-off can contain a lot of organic matter and this may come from open defecation or inappropriate handling of organic wastes produced from households and businesses during rainy season. So, it is very small period huge amount of water is flowing and at that time that flood like situations or huge amount of water is going to the river and taking the pollutants which is available on the land.

So, organic matter includes anything that is derived from living organisms such as human and animal waste and decaying plants and foods these are also going to the water and industry also industrial wastewater is generated we have mentioned and now we are coming to solid waste.



So, Solid waste is any solid material that is assumed not to be useful and is therefore thrown away. So, factories, businesses and households produce different kinds of solid wastes such as paper, plastics, metals, chemicals in solid form, pieces of cloth or food and animal remains sometimes faecal matter is discarded with solid waste which adds to the problems. So, those are also one way of the solid waste contamination. And the noise pollution we know that means unacceptable levels of noise in work residential and recreational places.

(Refer Slide Time: 07:47)

➤ Sources of pollution/pollutants contd..

Point sources are identifiable points or places that you can easily locate. An example is a diesel truck that produces visible black exhaust fumes from its tailpipe. Liquid waste released from a pipe into a river is another example

A **non-point source** (also known as 'diffuse pollution') is one where it is difficult to identify the exact origin of the pollution. A good example is floodwater that washes all types of waste from the land (possibly including faecal matter) into a river. In this situation it is difficult to identify the individual or household or establishment that has caused the water pollution

	Point source of industrial pollution along the Calumet River		Non point source of pollution due to runoff of soil and fertilizer during a rainstorm
---	--	--	---

Source- U.S. Environmental Protection Agency

Source- Wikipedia -Nonpoint source pollution

IT ROORKEE NPTEL ONLINE CERTIFICATION COURSE 6

Now, we will see the point source and nonpoint source. A point source as we mentioned that are identifiable points or places that we can easily locate. An example is say diesel truck or motor vehicles or say scooter. So, there engine is using fuel and it is emitting the pollution, emission. So, that why, we are able to identify but when the pollution comes say runoff. So, during flood situations or huge rainings.

So, at that time the pollutants is coming from many places and getting into the river, but here in some other cases a particular factory or say Roorkee's town, so, after the collection of the wastewater, so, that can go to the river so that we can identify like for example here for any town it is coming here.

So, this can be a point source, but here we cannot identify from where sources the water is coming in from where source what sources the pollutants are getting enter into the water stream. So, this is our nonpoint sources.

(Refer Slide Time: 08:47)

➤ Sources of pollution/pollutants contd..

<ul style="list-style-type: none">• Point Sources<ul style="list-style-type: none">➤ Municipal WW➤ Industrial WW➤ Tributaries	Well defined origin easily measured more constant	Easier to treat/regulate
<ul style="list-style-type: none">• Non-point Sources<ul style="list-style-type: none">➤ Untreated sewage➤ Agricultural runoff➤ Urban & Suburban Runoff➤ Groundwater	Diffuse origin more transient often dependent on precipitation	Difficult to treat/regulate

IT ROORKEE NPTEL ONLINE CERTIFICATION COURSE 7

Now, we will see point sources like municipal wastewater it is coming as a I have given you an example from Roorkee. So, industrial wastewater from each industry is coming and getting into each river or tributaries. So, from small tributaries to big river it is going so then also we can identify so, all are point sources.

The nonpoint sources say untreated sewage, sewage is not treated it is going and entered into this agricultural runoff, urban and suburban runoff and groundwater. So, these are the nonpoint sources we do not know where from these pollutants are coming and it is very difficult to treat and regulate for nonpoint sources but point sources are easier to regulate and treat. So, these are different types of pollutants we are getting.

(Refer Slide Time: 09:30)

➤ Sources of pollution/pollutants contd..

The pathway between source and recipient can take several different forms depending on the type of pollutant. Primary recipients for pollution are water, air, and soil. Pollutants usually reach humans through the consumption of contaminated and polluted water and food, and breathing polluted air.

Once released into the environment, the worst effects of many pollutants are reduced by one or more of the following processes:

- **Dispersion** – smoke disperses into the air and is no longer noticeable away from the source.
- **Dilution** – soluble pollutants are diluted in the water of a river or lake.
- **Deposition** – some suspended solids carried in a river settle (are deposited) on the river bed.
- **Degradation** – some substances break down (degrade) by natural processes into different, simpler substances that are not polluting.

In each case the effect is to reduce the concentration of the pollutant.

There are some **persistent pollutants** which remain intact when released into the environment because they do not break down by natural processes.

IT KOOBEE NPTEL ONLINE CERTIFICATION COURSE 8

Now we will be seeing the pathways, the how the pollutants are distributed from one place to other place, and how it is getting entry into the living organisms. So, the pathway between source and recipient can take several different forms depending on the type of pollutants, primary recipients for pollution, primary recipients for pollution are water, air and soil and pollutants usually reach human through the consumption of contaminated and polluted water and food and breathing polluted air.

So, these are the major routes through which the pollutants are getting into the human body. And once the pollutants is released into the environment, the worst effects of many pollutants are reduced by one or more of the following processes, how it is say some industry is producing some gas streams which is having some pollutants, but when it will be distributed in a local area.

So, the concentration will be gradually decreased as we go away from the point of source. So, that way dispersion. So, smoke dispersions into the air and is no longer noticeable away from the source. Another example, so, due to the dispersion of that, the concentration of pollutants gradually decreases and that its severity becomes lower.

Another is dilution, so, a river stream is going so, from any municipality some water stream is wastewater stream is coming and getting entry into it. So, with downstream if we go away, then we will see the concentration is gradually decreasing. So, that way dilution and then

deposition and sometimes some chemical reactions can take place and something can settle in that riverbed also.

So, the deposition and degradation and some compounds can be degraded, they say in a river stream some organics are available. So, those say easily biodegradable. So, what microbes will work on it and will be degraded and some pollutants are there those cannot be easily bio degraded and those are called persistent chemicals and those remains for longer period in the environment.

So, that way, there are different methods through which the concentration is reduced or can be reduced that is why if the pollution generation is less so, naturally the environment can be healed up, but if the generation of pollution is very high, so, natural process cannot work.

(Refer Slide Time: 12:19)

➤ Sources of pollution/pollutants contd..

POLLUTANT	POINT SOURCES		NON-POINT SOURCES	
	MUNICIPAL SEWAGE ✓	INDUSTRIAL WASTE ✓	AGRICULTURAL RUNOFF ✓	URBAN RUNOFF ✓
BOD	✓	✓	✓	✓
Nutrients	✓	✓	✓	✓
Pathogens	✓	✓	✓	✓
Suspended solids ✓	✓	✓	✓	✓
Salts		✓	✓	✓
Toxic metals		✓		✓
Toxic organics		✓	✓	✓
Heat		✓		✓

Major pollution sources for fresh and saline waters

IT ROORKEE NPTEL ONLINE CERTIFICATION COURSE 9

So, now, we will see here say point sources like municipal sewage and industrial waste, these are we know that point sources and non point source agricultural runoff and urban runoff and we see different pollutants which may be available in this. So, BOD, nutrients, pathogens, suspended solid, salts, toxic metals, toxic organics, heat, etc. as given in this table.

(Refer Slide Time: 12:40)

Water pollution Environmental Risk Assessment and Remediation, (2017) Volume 1, Issue 3

Major sources of water pollution

- i. Domestic sewage ✓
- ii. Industrialization ✓
- iii. Population growth ✓
- iv. Pesticides and fertilizers ✓
- v. Plastics and polythene bags ✓
- vi. Urbanization ✓
- vii. Weak management system ✓

• **Water pollution** is characterised by the presence of excess physical, chemical or biological substances that change the qualities of the water and are capable of causing harm to living organisms.

• Polluted water should not be used for drinking, washing, bathing or agriculture. If polluted water is used by humans, then it can adversely affect the body in different ways, depending on the type and concentration of pollutant.

It is reported that 75 to 80% water pollution is caused by the domestic sewage

80% of the world's population is facing threats to water security

25% pollution is caused by the industries and is more harmful

The WHO reports that 80% diseases are waterborne

• Water pollution can affect surface water such as rivers and lakes, soil moisture and groundwater in aquifers, and the oceans.

IT ROORKEE NPTEL ONLINE CERTIFICATION COURSE 10

Now, we will see what is water pollution. So, we will focusing on the contamination of water. So, we see that major sources are domestic sewage, industrialization and then population growth, pesticides and fertilizers used and plastics and polythene bags, and this is another plastics and polythene bag, that is micro plastic issue, which is being reported very recently that it is available in the human blood also.

So, although the impact is not known, but it is getting entry, the plastic is getting entry into the human body through the drinking water that has been reported and then urbanization is another source and weak management systems, if your management systems is not that strong, so, proper treatment will not be possible. So, easily the surface water will be contaminated or even the groundwater will be contaminated. So, that way, the pollution will be taking place.

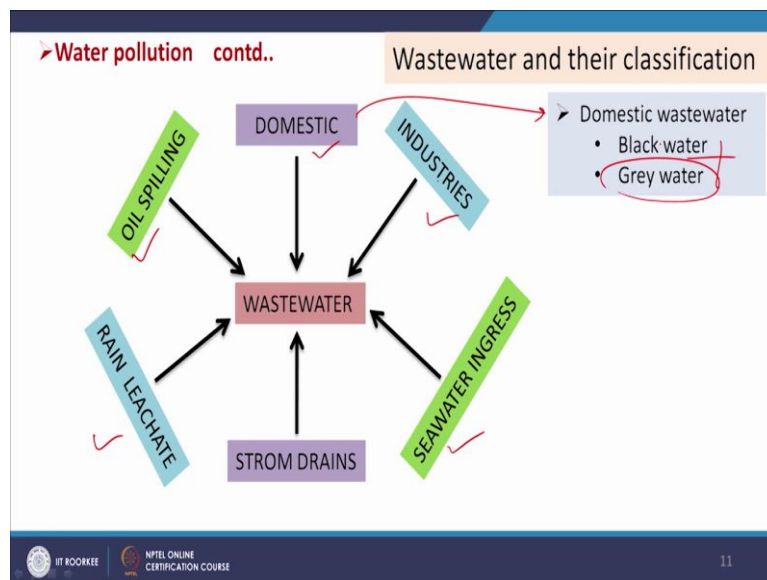
And usually, the water pollution is characterized by the presence of excess physical, chemical or biological substances that change the qualities of the water and are capable of causing harm to living organisms. And polluted waters should not be used for drinking, washing, bathing or agriculture. We will be seeing the standards in next chapters. If polluted water is used by humans, then it can adversely affect the body in different ways depending on the type and concentration of pollutants.

So, it is reported that 75 to 80% water pollution is caused by the domestic sewage. So, you were this is very good information, there is a debate or we do not know in normally that which one is producing more pollution, industry or domestic.

You see here some statistics on it. It is reported that 75 to 80% water pollution is caused by domestic sewage and 80% of the world's population is facing threats to waters security and 25% percent pollution is caused by the industries and is more harmful, although pollution is less but more severe and more are harmful in case of industrial pollution of the water.

And the WHO reports that 80% diseases are water born and water pollution can affect surface water such as rivers and lakes, soil moisture and groundwater in aquifers and as well as the oceans, like say microplastics in ocean is another current topic that people are giving more focus on it day by day.

(Refer Slide Time: 15:39)



And these are the different sources of wastewater you see from the domestic I have already discussed and industries and Seawater Ingress and Rain Leachate and oil spilling, so, out of these, these domestic, industrial and leachates these are very very important and larger in volume and regular we can get it and this domestic also we can get sewage and now, the new thought process is going on to separate the wastewater generated in the domestic sectors into two part that is black water and gray water.

So, gray water the wastewater which is generated in the kitchen, bathroom, washing machines, etc. And the black water is latrines and toilets. So, these two different types of

water that means in terms of quality. So, now efforts are on to separate these two and separate greywater from this black water and with treatment to reuse it so that is the efforts are going on.

(Refer Slide Time: 16:42)

Waste water and their classification contd..

Typical composition of untreated domestic waste water

Contaminants	Concentration		
	Low strength (mg/L)	Medium strength (mg/L)	High strength (mg/L)
Solids, total(TS)	390	720	1230
Dissolved, total (TDS)	250	500	850
Suspended solids(TSS)	120	210	400
BOD, 5 day,20°	110	220	400
TOC	75	140	290
COD	250	500	1000
Total nitrogen (as N)	20	40	70
Total Phosphorus(asP)	4	8	15
Chloride	30	50	100
Sulfate	20	30	50
Alkalinity (as CaCO ₃)	50	100	200
Grease	50	100	150
Total coliform	10 ⁶ -10 ⁷ (No/100 ml)	10 ⁷ -10 ⁸ (No/100 ml)	10 ⁷ -10 ⁹ (No/100 ml)

IT ROORKEE NPTEL ONLINE CERTIFICATION COURSE 12

Now we will see because of these different sources, different types of pollutants are also getting entry into the water stream. Say for example, if we consider a domestic wastewater, it can contain say solids, that is, total solid, dissolved solids, suspended solids, BOD, TOC, COD, total nitrogen, total phosphorus, chloride, sulphate, alkalinity, grease, total coliform.

So, these are and their concentration can also vary, so some are low strength, some are medium strength and some are high strength and the concentrations are given in this table. So, that way we know what pollutants are getting entry into the water through what type of sources.

(Refer Slide Time: 17:41)

Waste water and their classification contd.. Typical composition of landfill leachates				
Parameter	Acidogenic phase		Methanogenic phase	
	Average	Range	Average	Range
pH	5	4.5 - 5.5	8	7.5 - 9
BOD ₅ (mg/l)	13000	4000-40000	180	20 - 550
COD (mg/l)	22000	6000-60000	3000	500 - 4500
BOD ₅ /COD ✓	0.58	-	0.06	
Sulphate (mg/l) ✓	500	70-1750	80	10 - 420
Calcium (mg/l) ✓	1200	10-2500	60	20 - 600
Magnesium (mg/l) ✓	470	50 - 1150	180	40 - 350
Iron (mg/l) ✓	780	20 - 2100	1.5	3 - 280
Manganese (mg/l) ✓	25	0.3-65	0.7	0.03 - 45

Now, if we see the landfill leachates, so then the parameters are something different, some metals are there manganese, iron, magnesium, calcium, sulphate, BOD, COD is also there, pH is also there.

So, here we are getting some acidogenic phase and methanogenic phase in case of leaching or when the organics are in a landfill so, then anaerobic condition prevails. So, the organic compounds are converted into biogas through different steps. The first step is acidogenic, acidogen is hydrolysis acidogenesis, acidogenesis and the last is methanogenesis. So, methanogenesis takes place at higher pH, but other are lower pH.

So, these two if we take the leaching, or the water getting out from the solids under these two different steps, so we will be getting different pollutants. So, these are the given here in this table.

(Refer Slide Time: 18:35)

Sources of pollution/pollutants contd..		Common wastewater pollutants
Physical	<ul style="list-style-type: none">Suspended solids (TSS, Turbidity (NTU))TDSConductivityAPHA colorTemperatureTaste and odour	Chemical <ul style="list-style-type: none">Anions (SO_4^{2-}, Cl^-, F^-, PO_4^{3-}, NO_3^-, NO_2^-)Cations (K, Fe, Mn)HardnessSalinity (Sodium Adsorption Ratio; Residual Sodium Carbonate)Heavy Metals (Hg, Pb, Cd, Cr)As (metalloid), F (non-metal)
Biochemical instability	<ul style="list-style-type: none">BOD, CODNatural Organic MatterTotal Organic Carbon	Microbiological <ul style="list-style-type: none">PathogensViral particlesPrionsBiomass, Volatile suspended solids

And these are the common water pollutants available in the water. And these are the quality parameters as well. We will discuss in the next class on it. So, different types of physical, biochemical properties, and then chemical and microbiological different properties we will discuss in the next class.

(Refer Slide Time: 19:07)

Air pollution
<ul style="list-style-type: none">Air pollution is defined as the presence of abnormal amounts of chemical constituents in the air, which are capable of causing harm to living organisms.Polluted air may contain particulate matter (such as black soot) and many different gaseous chemicals such as carbon monoxide, carbon dioxide, nitrogen oxides, sulphur oxides, ozone, nitrates, sulphates, organic hydrocarbons and many others.The most common sources of air include the burning of wood, charcoal and other biomass fuel by households, small businesses such as bakeries, manufacturing industries, and vehicles.Clean air consists of nitrogen (78% by volume), oxygen (21%) and trace gases (< 1%)

And now we are coming to air pollution. So, air pollution is defined as the presence of abnormal amounts of chemical constituents in the air, which are capable of causing harm to living organisms. And then polluted air may contain particulate matter and many different

gaseous chemicals such as carbon monoxide, carbon dioxide, nitrogen oxides, SO_x, ozone, nitrates, sulphates, organic hydrocarbons, and many others.

The most common sources of air include the burning of wood, charcoal, and other biomass fuel by households, small businesses such as bakeries, manufacturing industries and vehicles. And then clean air consists we know that around 78 to 79% of Nitrogen and around 21% of oxygen and rest is your gases.

(Refer Slide Time: 19:51)

➤ Air pollution contd.. Main cause

- Dust storm and Wildfires: ✓
- Animal and Vegetation: ... ✓
- Volcanic Activity: ... ✓
- Fossil-Fuel Emissions: ... ✓
- Agriculture and Animal Husbandry: ... ✓
- Waste ✓

• **Main cause: Combustion**

Fuel (C,H,S,N,Pb,Hg,ash) + Air (N₂ + O₂)

CO₂, CO, NO_x, SO_x, Pb, Hg, SPM, PM₁₀, PM_{2.5}, VOCs

Usage/handling of Chemicals: paint, varnishes, perfumes, CFCs, petrol pumps, etc.

Cement handling, insulation on winding of motors/alternators/transformers etc.

IT KOOKEE NPTEL ONLINE CERTIFICATION COURSE 16

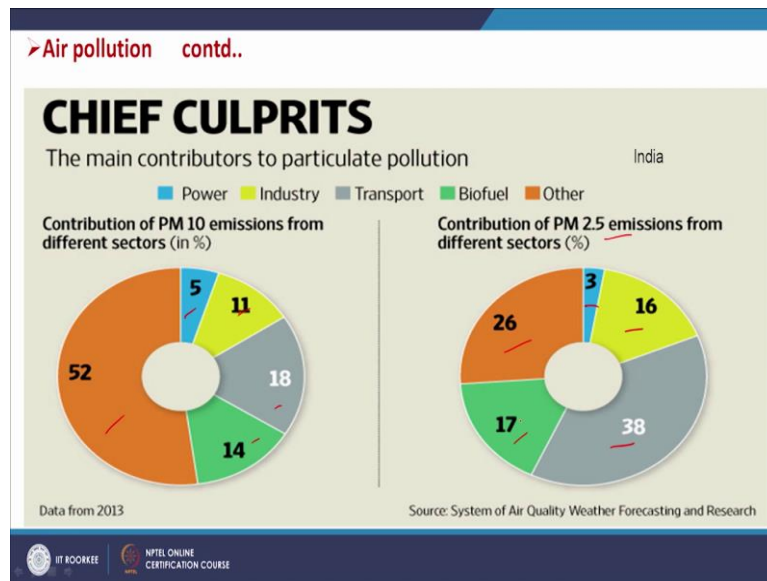
And the main cause of this air pollution we see both from your natural as well as man made sources and natural sources dust storm and wildfires and other animal and vegetations and then volcanic activity and manmade your fossil fuel emissions, agriculture and animal husbandry sectors and waste also, we can burn it or we can during managing it some pollutants can also come into the air and main cause is your combustion, this is the main cause.

So, we use the fuels, then air and then it gives these other different pollutants which are produced during the combustion of it. So, particulate matter SPM suspended particulate matter, particulate matter 10, particulate matter 2.5 are those are very important and previously SPM was used, but now, with the day by day more understanding is being developed and it is found that the particle size of the suspended particles are not same and they are having different impact on human health.

So, PM 10 that means 10 micrometer particle solid space then PM 2.5 particle size of average is 2.5 or less so, that the why so, PM 2.5 and 10 are there and VOC is your volatile organic carbons. So, these are available in the air through different sources.

Like say uses handling of chemicals, paint, varnishes, perfumes, CFCs, petrol pumps, etc. Cement handling, insulation on winding of motors, alternators and transformers, etc. Those are also the source of air pollution.

(Refer Slide Time: 21:48)



And this is the main culprit if we see here contribution of PM 10. So, here transport 18%, 14% is biofuel and then 11% percent industry, 5% power and 52% others. Similarly, for contribution of PM 2.5 emissions from different sources you see here transport is 38. So, then, industry 16 and other 26 and 3 is power and 17 is biofuel. So, that we are talking about, so, these different PM 10 and PM 2.5 has different toxicity or different impact on human health and those are generated from different sources also. So, that I wanted to highlight here.

(Refer Slide Time: 22:30)

➤ Air pollution contd..

SOx and NOx

- $\text{SO}_2, \text{SO}_3, \text{SO}_4^{2-}$ formed during combustion of fuel containing sulfur
- H_2S released is converted to SO_2
- 10 Tg/yr natural sources
- 75 Tg/yr anthropogenic sources

- Primarily NO and NO_2
- $\text{NO}_3, \text{N}_2\text{O}, \text{N}_2\text{O}_3, \text{N}_2\text{O}_4, \text{N}_2\text{O}_5$ are also known to occur
- **Thermal NO_x** created by oxidation of atmospheric N_2 when $T > 1000 \text{ K}$
- **Fuel NO_x** from oxidation of N in fuel

IT ROORKEE NPTEL ONLINE CERTIFICATION COURSE 18

And then SOx and NOx, which are also available, SOx is coming from burning combustion of fuel containing sulfur. So, that is H_2S released is converted to SO_2 . 10 Tg/yr natural sources used to production and 75 Tg/yr anthropogenic sources of SOx. And for Nitrogen we see NOx. So, primarily NO and NO_2 these two and others are maybe $\text{NO}_3, \text{N}_2\text{O}, \text{N}_2\text{O}_3, \text{N}_2\text{O}_4, \text{N}_2\text{O}_5$ are also known to occur. So, these are the different composition of NOx and thermal NOx created by oxidation such atmospheric nitrogen when temperature greater than 1000 K. So, again through the process and fuel NOx from oxidation of nitrogen in fuel.

(Refer Slide Time: 23:19)

➤ Air pollution contd..

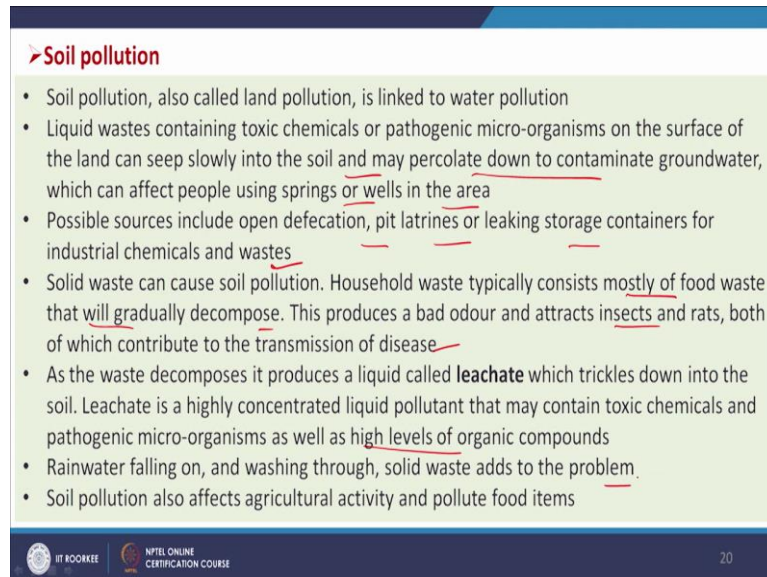
Lead

- Sources:
 - Gasoline and paints (historical)
 - metals processing
- Highest air Pb concentrations
 - in the vicinity of nonferrous and ferrous smelters, and battery manufacturers.

IT ROORKEE NPTEL ONLINE CERTIFICATION COURSE

And the lead pollutant of air that is the gasoline and paints. So, this gasoline was an history today, the unleaded petrol are used and metal processing that is another sources and highest air lead concentrations in the vicinity of nonferrous and ferrous smelters, and battery manufacturers. So, these are the source of lead in the air.

(Refer Slide Time: 23:43)



The slide is titled "Soil pollution" and contains a bulleted list of seven points. The text is as follows:

- Soil pollution, also called land pollution, is linked to water pollution
- Liquid wastes containing toxic chemicals or pathogenic micro-organisms on the surface of the land can seep slowly into the soil and may percolate down to contaminate groundwater, which can affect people using springs or wells in the area
- Possible sources include open defecation, pit latrines or leaking storage containers for industrial chemicals and wastes
- Solid waste can cause soil pollution. Household waste typically consists mostly of food waste that will gradually decompose. This produces a bad odour and attracts insects and rats, both of which contribute to the transmission of disease
- As the waste decomposes it produces a liquid called leachate which trickles down into the soil. Leachate is a highly concentrated liquid pollutant that may contain toxic chemicals and pathogenic micro-organisms as well as high levels of organic compounds
- Rainwater falling on, and washing through, solid waste adds to the problem
- Soil pollution also affects agricultural activity and pollute food items

At the bottom of the slide, there are logos for "IIT KOOKEE" and "NPTEL ONLINE CERTIFICATION COURSE", and the number "20" in the bottom right corner.

And then we see the Soil pollution. So, soil pollution, also called land pollution is linked to water pollution, liquid waste containing toxic chemicals or pathogenic microorganisms on the surface of the land can sweep slowly into the soil and may percolate down to contaminate groundwater.

So, when it is going, then this can affect people using springs or wells in the area. And possible sources include open defecation, pit latrines or leakings storage containers for industrial chemicals and wastes.

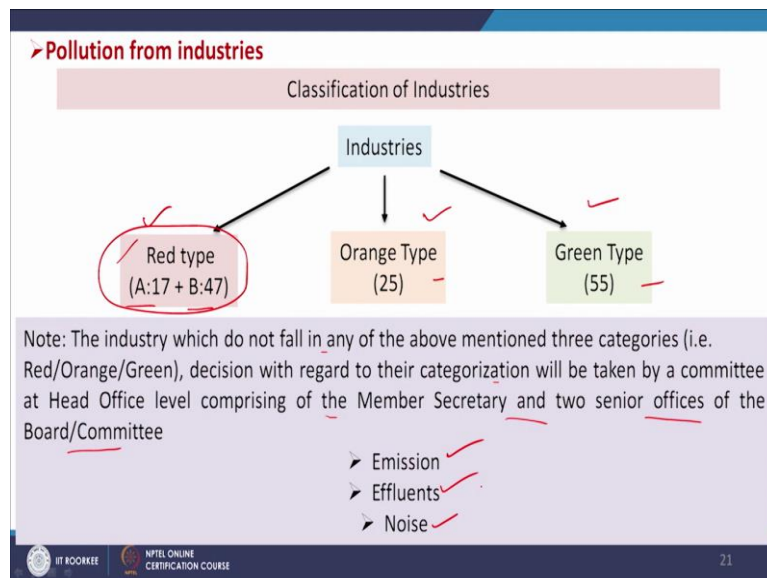
And solid waste can cause soil pollution. Household waste typically consists mostly of food waste, that will gradually decompose and it will contaminate the soil as well as the water also. So, this produces a bad odor and attracts insects and rats, both of which contribute to the transmission of disease.

And as the waste decomposes, it produces a liquid called leachate which trickles down into the soil. And leachate is a highly concentrated liquid pollutant that may contain toxic chemicals and pathogenic microorganisms as well as high levels of organic compounds. And rainwater falling on and washing through solid waste adds to the problem.

So, solid waste when it rains takes place. So, then also leaching takes place and it gets entry into the soil as well as the water and soil pollution can affect agricultural activity and pollute the foods. So, nowadays it is reported that arsenic is available in rice also, heavy metals are available in vegetables. So, those foods also are being contaminated and soil contamination is one of the reasons for that.

Now, we will see the industrial emission or from the industry we will see here. So, there are different types of industries and different types of industries have different potentials to generate pollution and according to the nature of the industry and the amount of pollution generated and that type of toxicity or severity, these industries are classified into three categories.

(Refer Slide Time: 26:05)



Basically, red category, orange category and green category. So, Red type that is, this A 17 and B 47. So, these are the red type industries, which are very hazardous type, basically, the pollutants generated by these are more toxic and has more severe impact, so these are separated from the others, but orange type is intermediate around 25, 25 types of industry types are under orange type and green type are another those industries which has very less pollution creation.

So, those are green type, so, now the industry which do not fall in any of the above mentioned three categories, then decision with regard to their categorization will be taken by committee at Head Office Level comprising of the member secretary and two senior officers of the board committee in which state the industry is there.

So, the members Secretary of the State pollution control board along with some other officers, they will decide under which category it would fall and what is the importance of this categorization of industry because their pollution generation will be more and it will be more impact on the human health. So, more strict or norms will be applicable.

So, that is the reason to categorize these industries and grossly polluting industries are basically under the red type industry those produces extensive pollution. So, their amount is also high and their type is such that the pollutants are very harmful to the human health and other animals as well. So, in industry we can get emission, we can get effluents, we can get noise also. So, all types of pollution are created by the industry.

(Refer Slide Time: 28:05)

Composition of some industrial wastewater		
Industry type	Organic load (mg/l)	Typical composition of organic compound
Pulp and paper	COD: 32000 – 40000 BOD: 12 000–16 000	Soaps: 40-45% ; lignin: 35-45% Other organics: 10-15%
Distillery	COD: 110000–190000 BOD: 50000–60000 Melanoidin for colour	Reducing sugar (g/l): 0.5; Total sugar (g/l): 0.8 Total acids (g/l): 3.34; Free amino acids (g/l): 3.18 Total nitrogen (g/l): 11.0
Sugar	COD: 385 – 978 BOD: 112 – 225	Glucose Fructose
Oil refinery	COD:1965, BOD: 685	Oil contents , total solids, phenol
Petrochemicals	COD:1500; BOD: 350,	Octanol, HCHO, phenol, organic acid, petroleum

And now some examples composition of some industrial wastewater here you see paper and pulp, distillery, sugar, oil refinery, petrochemicals. So, here BOD, COD is extreme in case of distillery you see, in case of domestic we have only COD around 1000.

So, here we have COD is equal to 110000 to 190000. So, special type of pollutants are present in it. So, certainly this will be more undesirable and it will be having more potential to create impacts on human health and some other composition of the organic compounds present in the industrial wastewater are provided here. And we see there is no similarity all are different and some are specific.

So, special treatment is also needed for the management of these waste streams, and more stricter norms are applied. So, that these will be treated in the factory premise and the treated water will only be getting entry into the water stream.

So, now, we are able to discuss the different sources of pollutions into the environment, into the water, into the air and into the soil and how these get entry into the living organisms that we have discussed. So, upto this in this class, thank you very much for your patience.