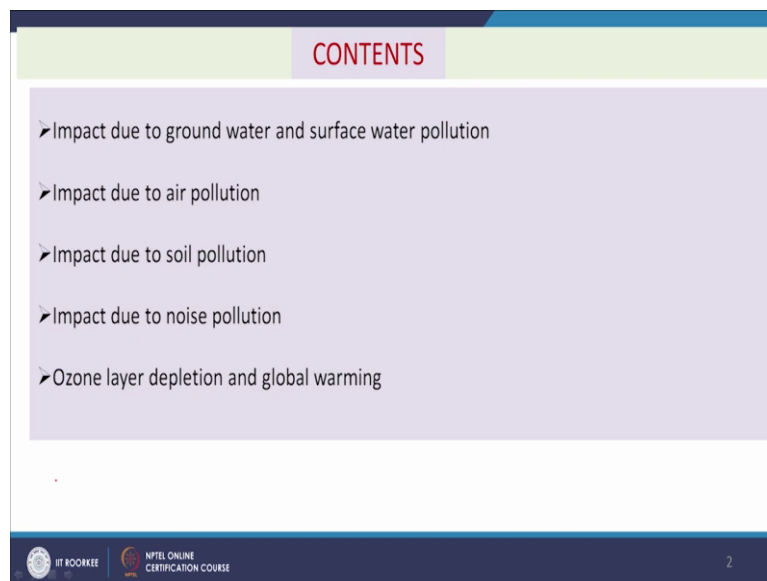


**Basic Environmental Engineering and Pollution Abatement**  
**Professor Prasenjit Mondal**  
**Department of Chemical Engineering**  
**Indian Institute of Technology, Roorkee**  
**Lecture 07**  
**Pollution: Impacts / Consequences**

Hello everyone. Now, we will discuss on the topic pollution impacts or consequences. In the last class, we have seen that due to the ever-increasing population growth, large number of pollution or pollutants are getting entry into environment in air, in soil and in water and those are entering into the human body through different sources and also different living organisms are being affected.

Not only that overall environment or the global environment are also being affected due to the pollution. And in this class, we will see how these pollutants are creating different consequences on the human health and on the environment.

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And the topic or sub topic for today's discussion are impact due to groundwater and surface water pollution, impact due to air pollution, impact due to soil pollution and impact due to noise pollution and also the ozone layer depletion and global warming. So, these will be the sub topic for today's discussion. And first we will see how the water pollutants impact on the human body as well as on the environment.

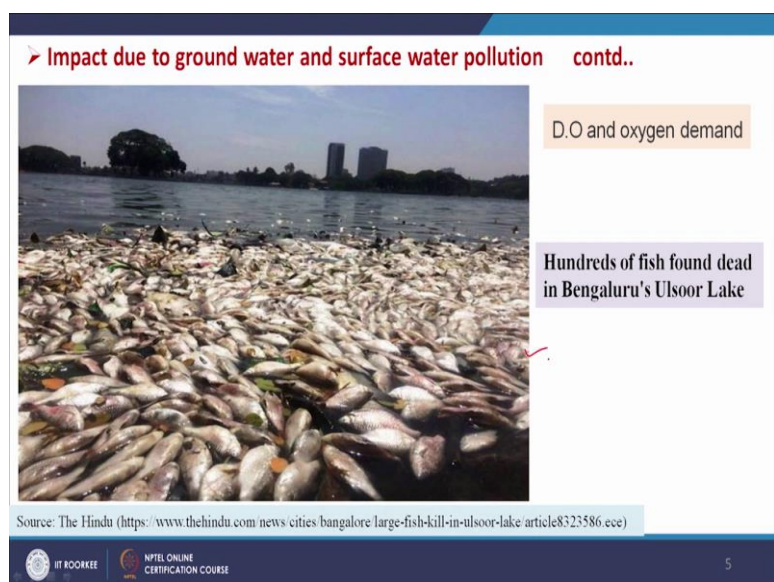
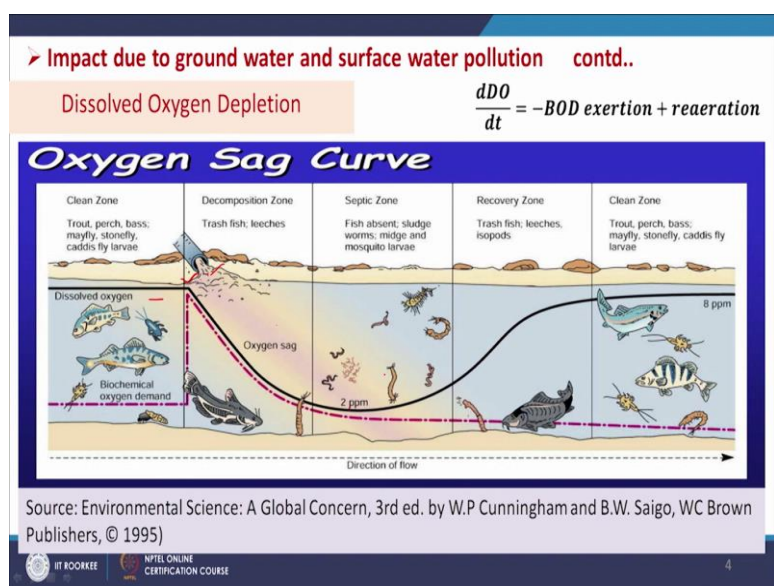
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Impact due to ground water and surface water pollution		Common wastewater pollutants	
<b>Physical</b>	<ul style="list-style-type: none"><li>• Suspended solids (TSS, Turbidity (NTU))</li><li>• TDS</li><li>• Conductivity</li><li>• APHA color</li><li>• Temperature</li><li>• Taste and odour</li></ul>	<b>Chemical</b>	<ul style="list-style-type: none"><li>• Anions (<math>\text{SO}_4^{2-}</math>, Cl<sup>-</sup>, F<sup>-</sup>, <math>\text{PO}_4^{3-}</math>, <math>\text{NO}_3^-</math>, <math>\text{NO}_2^-</math>)</li><li>• Cations (K, Fe, Mn)</li><li>• Hardness</li><li>• Salinity (Sodium Adsorption Ratio; Residual Sodium Carbonate)</li><li>• Heavy Metals (Hg, Pb, Cd, Cr)</li><li>• As (metalloid), F (non-metal)</li></ul>
<b>Biochemical</b>	<ul style="list-style-type: none"><li>• BOD, COD</li><li>• Natural Organic Matter</li><li>• Total Organic Carbon</li></ul>	<b>Microbiological</b>	<ul style="list-style-type: none"><li>• Pathogens</li><li>• Viral particles</li><li>• Prions</li><li>• Biomass, Volatile suspended solids</li></ul>

So, in the previous class, we have seen that water has different quality parameters like the Physical, Chemical, Biochemical and Microbiological parameters, and these are listed here already in the previous class we have discussed about these and all these parameters are very important and we need to maintain the quality or the values of these parameters within certain limits as per the CPCB guideline that is the central pollution control boards guideline for different types of water like say drinking water or say industrial wastewater after treatment, it will be discharged on the surface water or sewage water or irrigation like this. So, we have seen that.

So, at first we will discuss impact due to groundwater and surface water pollution and out of different parameters these biological parameter, BOD is very very important BOD and COD particularly for surface water, river water, cannal water, etc.

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Because, you see here in this graph, if the wastewater that is the sewage from the domestic sector gets entry into the river stream see here in this point. So, then immediately it will be having some impact how the impact on the water quality. How? because it will be having more BOD, COD than the upstream water and then when it is entering here it is mixed and then its BOD concentration increases and dissolve oxygen concentration is say if it is saturated, then we can say it is 8 to 9 ppm.

So, these DO will start to decrease immediately because microbes are present in the water they will try to consume the organic compounds and gradually organic compounds will be consumed and DO requirement will increase dissolved oxygen requirement will increase and availability of dissolved oxygen will be decreasing.

So, that way oxygen sag curve this is called oxygen concentration will reduce and organic concentration is maximum here. So, that will also be reduced here with time. So, as a result, what is happening with time as we go downstream of this location, then the DO concentration will be gradually decreasing.

And here two phenomena is there one is oxygen dissolved in water is consumed by the microorganisms for the oxidation of the organic compounds, so DO is reduced other way there is some equilibrium with here that is always there is some diffusion of oxygen from air to water phase.

So, oxygen concentration is increasing gradually with time, so, as you go downstream gradually the oxygen is entering into the water with the same rate, but, oxygen requirement for the degradation is initially increasing, but, gradually it is decreasing, because the all the organics will be consumed at a certain time and then the oxygen requirement will be reduced however oxygen diffusion from air to water will increase and ultimately again it will lead to the saturated value of DO.

Now, this is called oxygen sag curve and this is a natural phenomenon which happens in the river stream. Now, within any position here, if these pollutants are higher in concentration and within short distance number of wastes are entering into the river stream.

So, river will not get certain time for its revival, as a result along the length we will be having some locations where the dissolved oxygen will be very, very less and if it is lesser than say 2 ppm, the living organisms cannot survive. So, this is an impact.

So, to all the living organisms, because of these pollutions, the living organisms may not be able to survive in aquatic environment. Depending upon the concentration as well as the toxicity of the pollutants present in the stream. So, the severity will be different.

Now, you see, this figure shows the dead fishes are floating. So, maybe one possible reason is that dissolved oxygen is reached such a level that the fishes are not able to survive, that may be one reason maybe other reasons also, so this is one impact due to the depletion of dissolved oxygen concentration in the water due to the entry of contaminated water stream into the river stream.

Now, this is for surface water one example, we will give some examples for contamination in groundwater. So, groundwater contamination particularly with arsenic and fluoride, these are very, very important topic today, not only arsenic and fluoride, many other pollutants are available in the groundwater and those are also creating many negative impact on human health. So, we will be discussing those gradually. So, this we are discussing here, the impact of arsenic.

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➤ Impact due to ground water and surface water pollution contd.. Arsenic contamination

**Arsenic poisoning**

- ✓ Nerve damage
- ✓ Skin damage:
  - Hyperkeratosis (scaling skin)
  - Pigment changes
- ✓ Increased cancer risk:
  - Lung
  - Bladder
  - Kidney and liver cancers
- ✓ Circulatory problems in skin

Effects of long-term consumption of arsenic contaminated ground water

Source: *The Denver Post*  
(Alliance to End Childhood Lead Poisoning & news wires)



The diagram shows a human silhouette with lines pointing to various parts of the body. Lines from the 'Nerve damage' label point to the head and neck. Lines from 'Skin damage' point to the skin on the neck and arm. Lines from 'Increased cancer risk' point to the lung, bladder, and kidney/liver areas. Lines from 'Circulatory problems in skin' point to the skin on the arm.


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So, arsenic poisoning or arsenic have different effect, like say, nerve damage, and then skin damage and then increased cancer risk lung cancer, bladder cancer, kidney and liver cancers and circulatory problems in skin. So, these are the major impacts due to long term conjunction of arsenic contaminated groundwater.

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➤ Impact due to ground water and surface water pollution contd.. Fluoride contamination

Excess exposure (long-term consumption of fluoride contaminated ground water) to fluoride can lead to a bone disease known as skeletal fluorosis and dental fluorosis



Source- Kondala Rao et. al., Water supply 2009 9(5) 485-492, Water science & technology, IWA publishing.

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So, now, we are going to see the impact of fluoride contamination as well. In the previous class we have seen that large part of the world are having the fluoride contaminated groundwater and different types of health impacts are there. So, these two important health impacts are like skeletal fluorosis and dental fluorosis so, this is because of again, the excessive exposure to fluoride contaminated water that means long term consumption of fluoride contaminated groundwater. So, these are the bone diseases you see how severe these are. So, this is for some impacts due to contaminated groundwater.

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➤ Impact due to ground water and surface water pollution contd.. Heavy metals

- Heavy metal toxicity can have several health effects in the body. Heavy metals can damage and alter the functioning of organs such as the brain, kidney, lungs, liver, and blood
- Heavy metal toxicity can either be acute or chronic effects
- Long-term exposure of the body to heavy metal can progressively lead to muscular, physical and neurological degenerative processes that are similar to diseases such as Parkinson's disease, multiple sclerosis, muscular dystrophy and Alzheimer's disease
- Also, chronic long-term exposure of some heavy metals may cause cancer
- It has been observed that "Itai-itai" disease, an epidemic of bone fractures in Japan is due to cadmium contamination
- The symptoms of manganism are very similar to that of Parkinson disease

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Then heavy metals may be present in the groundwater. So, if it enters into our body, when we use it as a drinking purpose without any treatment, so then it can also create different types of health problems like heavy metal toxicity can have several health effects in the body. Heavy metals can damage and alter the functioning of organs such as brain, kidney, lungs, liver, and blood.

So, heavy metal toxicity can either be acute or chronic effects, they may be even higher concentration, they may show immediate impact, and if lower concentration but for long term consumption, they can give acute impact.

So, now, long term exposure of the body to heavy metal can progressively lead to muscular, physical and neurological degenerative processes that are similar to diseases such as Parkinson's disease, multiple sclerosis, muscular dystrophy and Alzheimer's disease.

So, these are some example of diseases caused due to the heavy metal contamination. Also, chronic long-term exposure of some heavy metals may cause cancer. It has been observed that Itai-Itai disease an epidemic of bone fractures in Japan was due to cadmium contamination. And the symptoms of manganism are very similar to that Parkinson disease because of manganese.

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➤ **Impact due to ground water and surface water pollution contd..** Nitrates

- High nitrate/nitrite levels may cause a potentially fatal blood disorder in infants under six months of age called methemoglobinemia or "blue-baby" syndrome.
- With this disorder there is a reduction in the oxygen carrying capacity of blood, which can cause shortness of breath and a blueness of the skin of infants or even lead to the infant's death.
- The most common cause of blue baby syndrome is **water contaminated with nitrates**. After a baby drinks formula made with nitrate-rich water, the body converts the nitrates into nitrites. These nitrites bind to the hemoglobin in the body, forming methemoglobin, which is unable to carry oxygen

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Now we will see the impacts of Nitrates. The Nitrate is also present in groundwater. And if we use the Nitrate contaminated groundwater, if the concentration is above certain limit, then

also we will be facing some consequences like say, Blue-Baby syndrome, which we see from this.

What is this? So, high nitrate and nitrate levels may cause a potentially fatal blood disorder in infants under 6 months of age called Methemoglobinemia and this is Blue-Baby Syndrome. And with this disorder, there is a reduction in the oxygen carrying capacity of blood, which can cause shortness of breath and blueness of the skin of infants or even lead to the infants death. So, this is one serious consequence.

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➤ Impact due to ground water and surface water pollution contd..

BACTERIAL PATHOGENS		HELMINTHS	
Bacteria (unicellular, <10 micrometer)	Associated Disease	Protozoa (10-50 micrometer, unicellular)	Associated Disease
<i>Salmonella typhi</i> ✓	Typhoid fever ✓	<i>Entamoeba histolytica</i> ✓	Amoebic dysentery ✓
<i>Shigella</i> ✓	Bacillary dysentery ✓	<i>Giardia lamblia</i> ✓	Diarrhoea ✓
<i>Vibrio cholerae</i> ✓	Cholera ✓	<i>Cryptosporidium</i>	Diarrhoea ✓
<i>Yersinia enterocolitica</i>	Gastroenteritis ✓		

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Next is your other contaminants which is available in the groundwater like bacteriological contaminants like say, bacteria, virus, protozoa, helminthic, etc. So, different types of organisms are present in water that can create different diseases. For example, here, say this is water associated diseases, water associated diseases are classified into water borne disease, water washed disease, water based and water related. So, water borne means, oral ingestion of pathogens in water contaminated by urine or feces. So, that is say cholera, typhoid, bacillary, trachoma. So, these are some example.

And water washed diseases. So, this disease spread enhanced by scarcity of water making cleanliness difficult, and then trachoma and dysentery are two example that is water washed, and then water-based water provides habitat for intermediate organism, transmission to human through water contact.



So, this is your schistosomiasis and then water related diseases are caused because of insect vectors, like say mosquitoes that rely on water for habitate human water contact not needed. Mosquito can carry this one. So, water is needed for the growth of the mosquito so that is the malaria, yellow fever, dengue, etcetera.

So, different types of diseases can take place because of this water contamination. And then bacterial pathogens present and they will also create different types of diseases like say, Salmonella Typhi, that is typhoid fever, like say Shigella, so bacillary dysentery and Vibrio cholera, cholera, and then Yersinia enterocolitica, gastroenteritis and different Helminths are also may present in water so, like say Entamoeba histolytica, so Amoebic dysentery or may Giardia lamblia so, diarrhoea and Cryptosporidium. So, that can also cause diarrhoea.

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➤ Impact due to ground water and surface water pollution contd..

VIRAL PATHOGENS		PROTOZOAN PATHOGENS	
Virus (less than 1 micrometer, smallest creature)	Associated Disease	Helminthes	Associated Disease
Poliovirus	Poliomyelitis ✓	Hookworm	Infection of the intestines/ iron deficiency anemia ✓
Hepatitis-A Virus ✓	Infectious Hepatitis ✓	Roundworm ✓	Ascariasis
Adenovirus ✓	Respiratory, eye infections ✓	Whipworm ✓	Trichuriasis
Others	Gastroenteritis, diarrhoea ✓		

Water Associated Diseases

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These are the water associated disease. Some other water associated disease may take place through Viral pathogens, like say Poliovirus, Polymycetis, Hepatitis-Avirus, Infectious hepatitis and Adenovirus, Respiratory, eye infections and others. Your gastroenteritis and diarrhoea. So, those can also happen because of these pollutants.

Protozoan pathogens like say Hookworm that which causes infections of the intestines, an iron deficiency or anemia, and then Roundworm, so Ascariasis and then Whipworm that is Trichuriasis.

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➤ **Impact due to air pollution**

**Air pollution** may be defined as the presence in the air (outdoor atmosphere) of one or more contaminants or combinations thereof in such quantities and of such durations as may be or tend to be injurious to human, animal or plant life, or property, or which unreasonably interferes with the comfortable enjoyment of life or property or conduct of business.

**Health effects of particulate matters**

- Impact depends on particle size, shape and composition
- Large particles trapped in nose
- Particles  $>10\ \mu\text{m}$  removed in tracheobronchial system
- Particles  $<0.5\ \mu\text{m}$  reach lungs but are exhaled with air
- Particles  $2 - 4\ \mu\text{m}$  most effectively get deposited in lungs

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So, these are the waterborne diseases. Now, we will see some air pollution and its impact, so like water, air also have some pollutants and then they will be having some impacts as well. So, you see the air pollution may be defined as the presence in the air that is outdoor atmosphere of one or more contaminants or combinations they are up in such quantities and of such duration, as may be or tends to be injurious to human, animal or plant life or property, or which unreasonably interferes with the comfortable enjoyment of life or property or conduct of business.

So, this is the impact which the air pollutants can have. And different air pollutants which you have discussed in the previous class was particulate matter, then  $\text{SO}_x$ ,  $\text{NO}_x$ , carbon monoxide, lead, etc, ozone, all those things we have discussed in the previous class.

So, all those having some impacts like say particulate matter, particulate matter initially it was suspended particulate matter SPM, now, it is defined, redefined and  $\text{PM}_{2.5}$ ,  $\text{PM}_{10}$  like this definition was given depending on the severity of the particulate matters.

Variations in the severity of the particulate matters, like as example, here, the impact depends on the particle size, shape and composition of the particulate matter like large particles trapped in nose, if particular is greater than  $10\ \mu\text{m}$ .

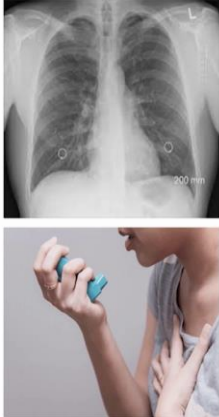
So, it will not be able to pass through our nose, nasal systems, well that is your tracheobronchial system, they will arrest it and if particles less than  $0.5\ \mu\text{m}$ , then also it will

reach to the lungs. So, particle 2 to 4 is very dangerous, 2 to 4  $\mu\text{m}$ , that is most effectively get deposited in lungs. So, that is what 2.5, PM 2.5 has been introduced. So, what is the concentration of that, that is a major concern now.

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➤ **Impact due to air pollution contd..** Health effects of particulate matters

- aggravated asthma
- increase in respiratory symptoms like coughing and difficult or painful breathing
- chronic bronchitis
- decreased lung function
- premature death



Source-Convenientmd.com


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And because of this particulate matter different health impacts we can have like say, aggravated asthma, increase in respiratory symptoms like coughing and difficult or painful breathing and then chronic bronchitis, decreased lung functions and premature death even.

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➤ **Impact due to air pollution contd..** Other Effects of PM

- Visibility Impairment
  - PM is the major cause of reduced visibility (haze).
- Aesthetic Damage
  - Soot, a type of PM, stains and damages stone and other materials, including objects such as monuments and statues.
- Plant Damage
  - PM can form a film on plant leaves interfering with photosynthesis and plant growth



- The deposition of PM on the shimmering white marble of the Taj Mahal imparts yellow tinge to the marble surface

Source-TheHindustanTimes  
Source- swachhindia.ndtv.com  
Source- Ontario, Ministry Of Agriculture, Food And Rural Affairs

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Then PM also have particulate matter have some other impacts as well on vegetation on visibility, it has like say visibility impairment. So, particulate matter is the major cause of

reduced visibility and then Aesthetic damage, soot a type of PM, stains and damages stone and other materials including objects such as monuments and statues. And then you will see the deposition of particulate matter on the shimmering white marble of the Taj Mahal imparts yellow tinge to the marble surface.


So, this is you, how white it was and now it has converted to the yellowish tinge is that so, these are the impact of the particulate matter and plant damage can also be possible particulate matter can form a film on plant leaves in interfering with photosynthesis and plant growth. So, these are the impact of particulate matter.

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➤ Impact due to air pollution contd..

Carbon Monoxide

- Most abundant air pollutant
- Produced by incomplete combustion ✓
  - insufficient  $O_2$  ✓
  - low temperature ✓
  - short residence time ✓
  - poor mixing ✓
- Major source (~ 77%) is motor vehicle exhaust ✓



Source-Infocusmagazine.org

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And then we will see the impact of carbon monoxide. So, if carbon monoxide, that it is generated basically, because of the incomplete combustion of carbonaceous fuels, so, mostly it comes out from the vehicles at least 77% it comes from the motor vehicles and this is produced by incomplete combustion and insufficient oxygen, low temperature, short residence time and poor mixings are responsible for it.

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➤ Impact due to air pollution contd..

Carbon Monoxide

- Colorless and odorless
- When inhaled, binds to hemoglobin in blood to form carboxyhemoglobin, reducing the oxygen carrying capacity ✓
- Brain function reduced, heart rate increased at lower levels ✓
- Asphyxiation occurs at higher levels ✓
- $\% \text{COHb} = \beta(1 - e^{-\gamma t}) (\text{CO})$  ✓
- $\% \text{COHb} = \text{Carboxyhemoglobin as \% saturation}$  ✓
- $\text{CO} = \text{Carbon monoxide conc. in ppm}$  ✓
- $\gamma = 0.402 \text{ h}^{-1}$  ✓
- $\beta = 0.15 \% / \text{ppm CO}$  ✓
- $t = \text{exposure time in hours}$  ✓

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And you see carbon monoxide can be a danger and how it can be let us see. So, you know that due to the presence of carbon monoxide our hemoglobin function is affected carboxyhemoglobin is formed. So, that how much carbon dioxide is getting entry into this, into our human body or how long we are exposed, what is the concentration of the carbon dioxide in the environment that will influence the severity or its impacts.

So, it is a colorless and odorless and when inhaled, binds to hemoglobin in blood to form carboxyhemoglobin reducing the oxygen carrying capacity just I have discussed and brain function reduced heart rate increased at lower levels and asphyxiation occurs at higher levels, so if concentration is very high that can be asphyxiation or swasavrodh.

So, now, we can calculate the carboxyhemoglobin concentration in our blood, if we know the concentration of the carbon monoxide in the environment and our exposure to this environment.

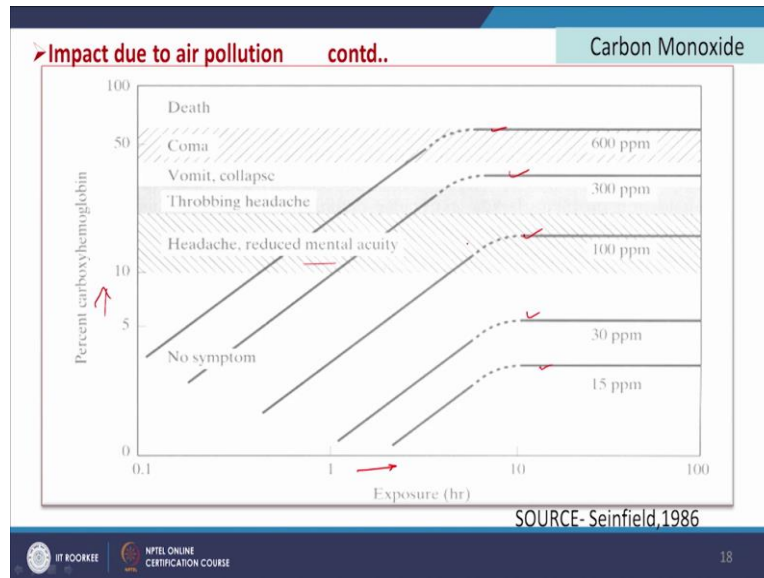
$$\% \text{COHb} = \beta (1 - e^{-\gamma t}) (\text{CO})$$

COHb that is equal to your carboxyhemoglobin as % saturation and then CO is the concent carbon monoxide concentration in ppm. And this Gamma ( $\gamma$ ) and t,  $\gamma$  is equal to  $0.402 \text{ h}^{-1}$

So, this is a constant and we Beta ( $\beta$ ) 0.1 percent per ppm of CO and t is the exposure time in hours. So, these  $\gamma$  and  $\beta$  are constants and t is the exposure time and CO is the concentration of carbon monoxide. So, this is empirical relationship people have worked on it and they

have found that this relationship can be applied to find out the concentration of carboxyhemoglobin in the human blood, if someone is exposed in the CO environment.

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Now, you see this is the different impact due to the CO concentration. So, this is 15 PPM, graph, this is 30 ppm, 100 ppm, 300, and 600 ppm, this is your exposure and this is your percentage carboxyhemoglobin. So, if exposure is less than no symptoms up to this, so, 100 ppm, so, exposure is less no, but, if exposure is more than also the lower PPM also can give us some impact up to, so, upto 50 or 30 there is no impact as shown here.

So, upto 50 there is nothing but percentage carboxyhemoglobin is 10 it is shown here, so, no symptom. But above this if it is more than that 50 and then your duration exposure time will give the severity of the impact, somewhere even we can have death even, we can have coma, we can have Vomit, collapse or you may have throbbing headache, reduced mental acuity. So, these are the symptoms we can have at different concentration and exposure time.



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➤ Impact due to air pollution contd..

SOx and NOx

- High concentrations of SO<sub>2</sub> can result in temporary breathing impairment.
- Longer-term exposures to high concentrations of SO<sub>2</sub>, in conjunction with high levels of PM, include respiratory illness, alterations in the lungs' defenses, and aggravation of existing cardiovascular disease
- NO has few health effects, but is oxidized to NO<sub>2</sub>
- NO<sub>2</sub> irritates lungs and promotes respiratory infections
- NO<sub>2</sub> reacts with hydrocarbons in presence of sunlight to produce smog

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Now, we will see the impact of SO<sub>x</sub> and NO<sub>x</sub>, so SO<sub>x</sub> we know that sulfur is present in many fossil fuels and when it is combusted, the SO<sub>x</sub> are generated and it has some impact, what are those.

Say high concentration of SO<sub>2</sub> can result in temporary breathing impairment and long term exposures to high concentration of SO<sub>2</sub> in conjunction with high levels of particulate matter include respiratory illness, alterations in the lungs, defenses and aggravations of existing cardiovascular disease. So, these are the impact and NO<sub>x</sub> particularly NO, has few health impacts but is oxidized to NO<sub>2</sub> and NO<sub>2</sub> irritates lungs and promotes respiratory infections. And NO<sub>2</sub> reacts with hydrocarbons in presence of sunlight to produce smog.

So, those are the impact of SO<sub>x</sub> and NO<sub>x</sub>. You see here, these hydrocarbons NO<sub>x</sub> and sunlight, it gives us the photochemical smog or oxidants so, that hazy environment will be generated. Accident may take place.


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➤ Impact due to air pollution contd..

Source- National Geographic

$\text{hydrocarbons} + \text{NO}_x + \text{sunlight} \rightarrow$   
*photochemical smog (oxidants)*

- primary oxidants produced:
  - ozone (O<sub>3</sub>) ✓
  - formaldehyde ✓
  - peroxyacetyl nitrate (PAN) ✓



Smog in Shanghai, China

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So, primary oxidants produce that ozone, formaldehyde and your peroxyacetyl nitrate or PAN. So, these are some impacts of NO<sub>x</sub> that is called the photochemical smog.

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➤ Impact due to air pollution contd..

Ozone

- Increased incidents of respiratory distress. ✓
- Repeated exposures to ozone:
  - Increased susceptibility to respiratory infection
  - Lung inflammation ✓ ✓
  - Aggravation of pre-existing respiratory diseases such as asthma. ✓
  - Decrease in lung function and increased respiratory symptoms such as chest pain and cough. ✓
- Ozone also affects vegetation and ecosystems ✓
  - reductions in agricultural and commercial forest yields (\$0.5 billion/yr in US alone)
  - reduced growth and survivability of tree seedlings
  - increased plant susceptibility to disease, pests, and other environmental stresses (e.g., harsh weather).

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➤ Impact due to air pollution contd.. Pb - Lead

- Accumulates in the blood, bones, and soft tissues ✓
- Adversely affects the kidneys, liver, nervous system, and other organs ✓
- Excessive exposure to Pb may cause neurological impairments, such as seizures, mental retardation, and behavioral disorders
- May be a factor in high blood pressure and subsequent heart disease

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Ozone can have some impacts as well. So, increased incidence of respiratory distress due to the presence of higher concentration of ozone and repeated exposure to ozone increased susceptibility to respiratory infection and lung inflammation and then aggravation of pre existing respiratory diseases such as asthma and decrease in lung function and increased respiratory symptoms such as chest pain and cough.

And ozone also affects vegetations and ecosystems and reductions in agricultural and commercial forest yield this one 0.5 billion/yr in US alone and reduced growth and survivability of trees or seedlings. So, this is also a problem for the plants and then increased plant susceptibility to disease, pests and other environmental stresses. So, these are the impact of the Ozone on living organism.

And lead has some impact also. So, this accumulates in the blood, bones and soft tissues and adversely affects the kidneys, liver, nervous systems and other organs and excessive exposure to lead may cause neurological impairments such as seizures, mental retraditions, and behavioral disorders. May be a factor in high blood pressure and subsequent heart disease.

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➤ **Impact due to soil pollution**

Soil pollution refers to the contamination of soil with anomalous concentrations of toxic substances. It is a serious environmental concern since it harbours many health hazards. For example, exposure to soil containing high concentrations of benzene increases the risk of contracting leukaemia.

The root cause of soil pollution is often one of the following:

- Agriculture (excessive/improper use of pesticides)
- Excessive industrial activity
- Poor management or inefficient disposal of waste

Examples

- Arsenic in rice ✓
- Heavy metals, pesticides in vegetables

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Next, we see the impact due to soil pollution. Soil pollution refers to the contamination of soil with anomalous concentrations of toxic substances. It is a serious environmental concern, since it harbours many health hazards. For example, exposure to soil containing high concentrations of Benzene increases the risk of contracting leukemia.

The root cause of soil pollution is often one of the following. There may be many reasons out of those some maybe agriculture, the excessive or improper use of pesticides, so, pesticides if we use so, that will come into the soil and it will be passing through the food, because it is conservative pollutants and then it will be accumulated in the plants and plants to food and it will be coming to the food chain.

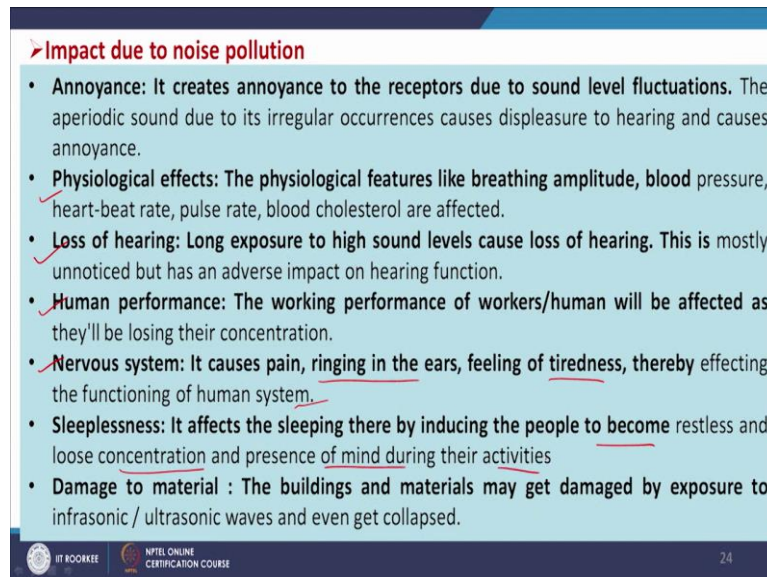
And then excessive industrial activity industrial pollution will also come into the soil and it can contaminate and poor management or inefficient disposal of waste that is also another reason for the pollution of the soil and because of the soil pollution, our food is polluted, water groundwater is polluted. So, as a result our health will be affected.

And for examples of soil contaminations, direct impact like say, arsenic in rice. So, recent report says that arsenic is not only available in groundwater, it is also coming into the rice as well.

So, because of the contamination of the soil and groundwater, both and heavy metals, pesticides in vegetables say in many vegetables, we are getting heavy metals and pesticides, this is because of the soil contamination, water contamination, etc.

Now, due to noise pollution, what are the impacts of noise we will discuss here. So, due to the noise we may be annoyed, it may be sometimes it may be unbearable, we may be irritated.

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➤ **Impact due to noise pollution**

- **Annoyance:** It creates annoyance to the receptors due to sound level fluctuations. The aperiodic sound due to its irregular occurrences causes displeasure to hearing and causes annoyance.
- **Physiological effects:** The physiological features like breathing amplitude, blood pressure, heart-beat rate, pulse rate, blood cholesterol are affected.
- **Loss of hearing:** Long exposure to high sound levels cause loss of hearing. This is mostly unnoticed but has an adverse impact on hearing function.
- **Human performance:** The working performance of workers/human will be affected as they'll be losing their concentration.
- **Nervous system:** It causes pain, ringing in the ears, feeling of tiredness, thereby effecting the functioning of human system.
- **Sleeplessness:** It affects the sleeping there by inducing the people to become restless and loose concentration and presence of mind during their activities
- **Damage to material :** The buildings and materials may get damaged by exposure to infrasonic / ultrasonic waves and even get collapsed.

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So, there will be some physiological effects as well, loss of hearing can also be and human performance can also be decreased because of the high noise level and nervous systems it causes pain, ringing in the ears, feeling of tiredness thereby affecting the functioning of human system, even sleeplessness, it affects the sleeping thereby inducing the people to become restless and lose concentration and presence of mind during their activities.

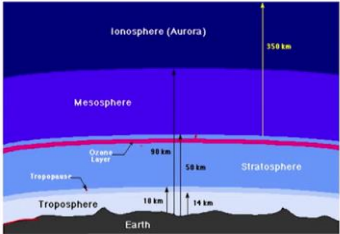
Sleeping is very, very important for good health, if you have 6 hours of sound sleep, so, almost most of that disease, we can expect that will not be in the health maybe. So, damage due to material, the buildings and materials may get damaged by exposure to infrasonic or ultrasonic waves and even get collapsed. So, that can also be some impact of the noise.

Now, these are the impact due to air pollution, water pollution, soil pollution, noise pollution, etc. But now we will be discussing the impacts of pollution in global scale that is global warming.

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**Ozone layer depletion and global warming**

- Ozone sits in the upper atmosphere and absorbs ultraviolet radiation, another type of solar energy that's harmful to humans, animals and plants.
- CFCs and halons cause chemical reactions that break down ozone molecules, reducing ozone's ultraviolet radiation-absorbing capacity.
- Carbon dioxide spreads around the planet like a blanket, and is one of the main gases responsible for the absorption of infrared radiation (felt as heat).
- This blanket warms the surface of the Earth and protects it from the cold air above it.



Global warming gases

- Water Vapor ✓
- Carbon Dioxide (CO<sub>2</sub>) ✓
- Methane (CH<sub>4</sub>) ✓
- Nitrous oxide (N<sub>2</sub>O) ✓
- Fluorinated Gases (HFCs, PFCs, SF<sub>6</sub>) ✓

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As you know, the atmosphere has different layers. So, troposphere, which is associated with the earth surface up to say 10 to 14 Km, then we are having stratosphere then we are having mesosphere then it is ionosphere.

So, Troposphere, stratosphere, mesosphere, ionosphere and we have one tropopause here and we have stratosphere when it starts then at this case we have a ozone layer.

The stratosphere ends and mesosphere starts we have one ozone layer. So, this ozone prevents the passage of UV lights from the sun and this UV light has good potential to be absorbed by the different gases like say carbon dioxide etc. And as a result, the gas will be heated up. So, atmosphere will be heated up and global warming will take place.

So, this is a mechanism through which global warming takes place. And this is because of the presence of the different pollutants in the atmosphere. So, above certain limit. If these are present, then certainly the global warming is obvious.

So, that is what we are going to discuss. So, ozone sits in the upper atmosphere and absorbs ultraviolet radiations and other types of solar energy that is harmful to humans, animals and plants that just were talking about here ozone is there and CFC and halons cause chemical reactions that break down ozone molecules reducing ozone's ultraviolet radiations-absorbing capacity.



So, now UV rays are coming at the troposphere, where Carbon dioxides are generated and concentration of carbon dioxide, water vapor, methane, nitrous, nitrous oxides, all those things are getting more and more concentration, so some of these gases most of almost all of these gases have capacity to capture that ultraviolet rays, and then to increase the temperature of the atmosphere.

So, carbon dioxide spreads around the planet like a blanket, and it is one of the main gases responsible for the absorptions of infrared radiation. Felt as heat and this blanket warms the surface of the earth and protects it from the cold air above it.

So, global warming takes place. So, these are the different impacts due to the pollution on human health, on other animals and on the overall environment. Thank you very much for your patience.