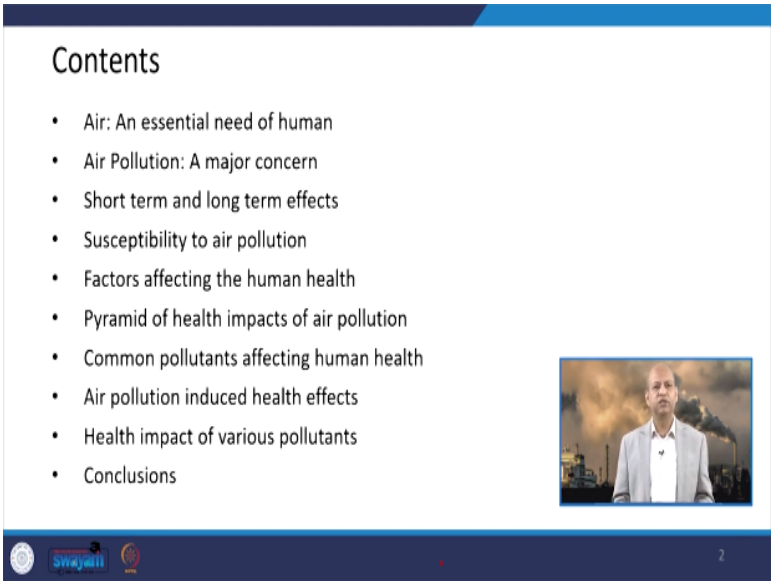
Air Pollution and Control
Professor Bhola Ram Gurjar
Department of Civil Engineering
Indian Institute of Technology, Roorkee
Lecture 3
Impact of Air Pollution on Human Health

Hello friends, so we have completed a brief introduction about air pollution, so with that background now we proceed for looking at different important aspects of air pollution, like impact of air pollution on human health, so that we can appreciate why it is important to study air pollution and why it is necessary to control the air pollution. So today, we will discuss about human health impacts of the air pollution.

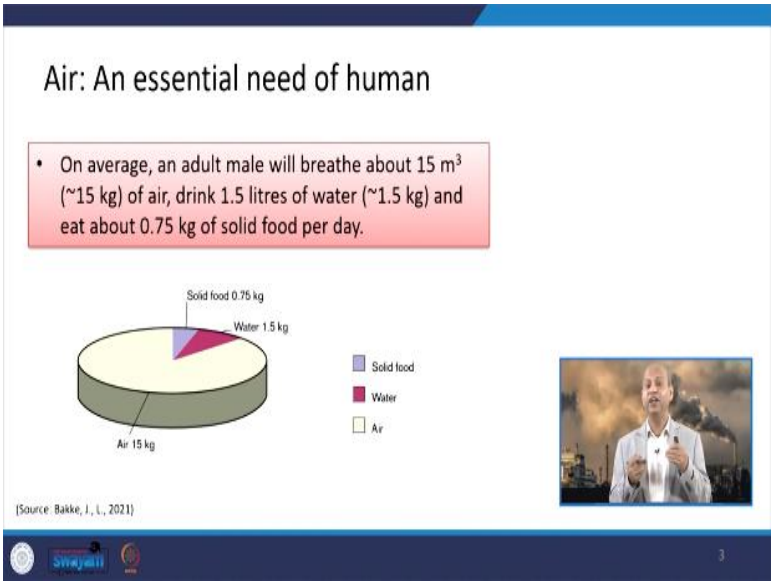
(Refer Slide Time: 0:59)



First of all like in this content list it is shown that we will see why this air is so important for well-being of human life and then the major concerns, plus short-term and long-term effects of air pollution, plus we will see that which population groups are susceptible to the ill effects of the air pollution and then factors which affect the human health and the human health impacts kind of pyramid like certain diseases are there in large number of the population and then severity of disease increases but the population number decreases, then the common pollutants affecting human health we will look at their properties and the health effects of specific air pollutants like SO_2 or particulate matter

what are their specific health impacts we will see that and then we will conclude accordingly.

(Refer Slide Time: 2:14)

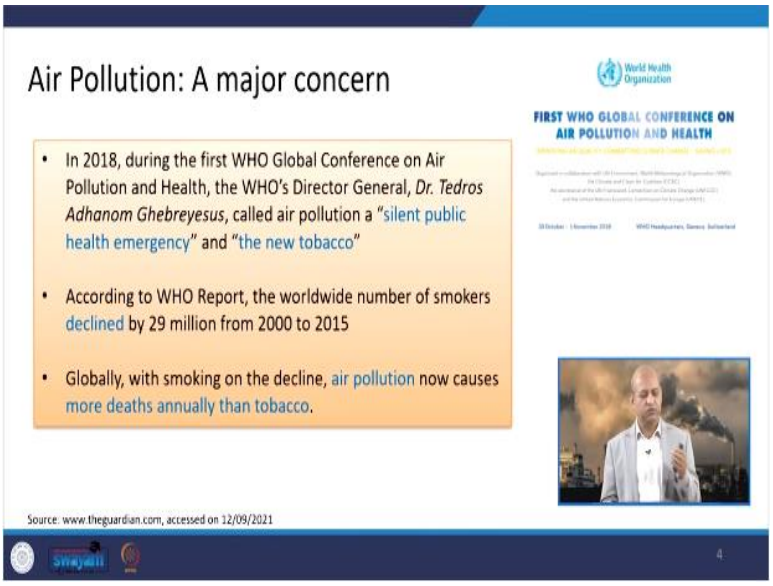


So now we see why this air is so important for comfortable survival of human life, to support the human life, so you see from this particular chart 15 kg of air is needed every day for an adult person and around 1.5 kg of water is required and 0.75 kg of solid food is required. So you can see like twice of the solid food, the water is needed but 10 times of that water quantity or 20 times of the food quantity we breathe air every day.

So, that means the exposure, if there is any pollutant present in the air, so the exposure chances or chances of that exposure or probability of getting exposed to pollutants will be very high if the pollutants are present in the air because of the huge quantity of here we breathe, we inhale and exhale so the contact, the total duration and then the quantity or concentration that makes the dose as there is a saying that in this world nothing is poisonous but it is dose which makes the poison fatal.

So, this dose or duration because of huge quantity of air which we breathe makes it very important and it is also you can see intuitively that without food we can survive even a week, without water may be 2-3 days but without air within few minutes we will be unconscious, so air is most important part of human life.

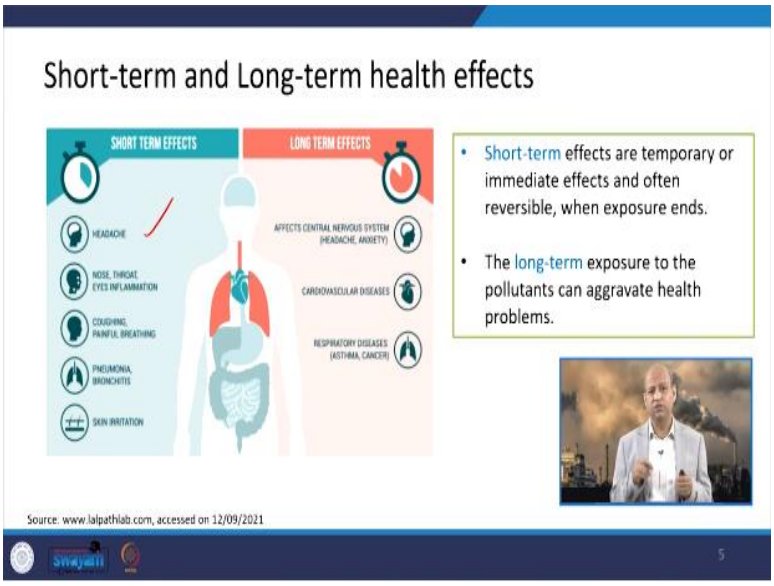
(Refer Slide Time: 3:32)



Well the concerns of air pollution related aspects when this at the world level started so WHO organized one conference and the Director General of WHO World Health Organization called air pollution as a silent public health emergency and the new tobacco because over the years because of awareness, health awareness, public awareness people have started to decline or in number those smokers population.

But at the same time because of this urban air pollution, because of industrial clusters air pollution in ambient air or even in indoor environment there are several sources of air pollution, so this passive smoking kind of thing has happened and even if people are not smoking cigarettes or tobacco but they are inhaling the pollution from the polluted air, polluted environment, so this is you know as bad as smoking.

(Refer Slide Time: 4:37)



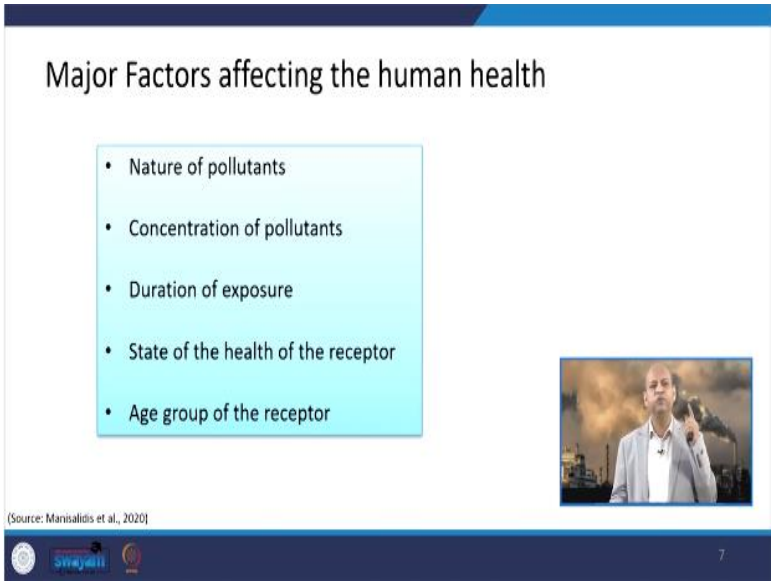
Well when we talk about short-term and long-term health effects, so you can see any air pollutant has some sort of health effects. So maybe exposure to certain air pollutant can cause headache, it can also irritate our eyes or nose and then we can have dripping nose, those people have some allergic to certain pollens or air pollutants so they have this kind of problem.

Then coughing is there like throat infection happens much more when air pollution is there and pneumonia, bronchitis, skin irritation all these kind of things may happen in short-term but in long-term even like carcinogenic elements can cause cancer, some heart diseases may happen or asthma or respiratory related diseases may be there, so those kind of things are there even reproductive organs are affected by air pollution, there are literature about this, so these are the short-term and long-term effects of health effects of air pollution.

(Refer Slide Time: 5:37)

And when we talk about the susceptible population because of air pollution, so the children means that means those who have less immune system, the immunities is not so strong like children or old people or those who have certain diseases or even like females who are exposed with the huge quantity of indoor air pollution because of cooking in not good ventilated environment, so those kind of population are the more susceptible to air pollution exposure.

(Refer Slide Time: 6:12)



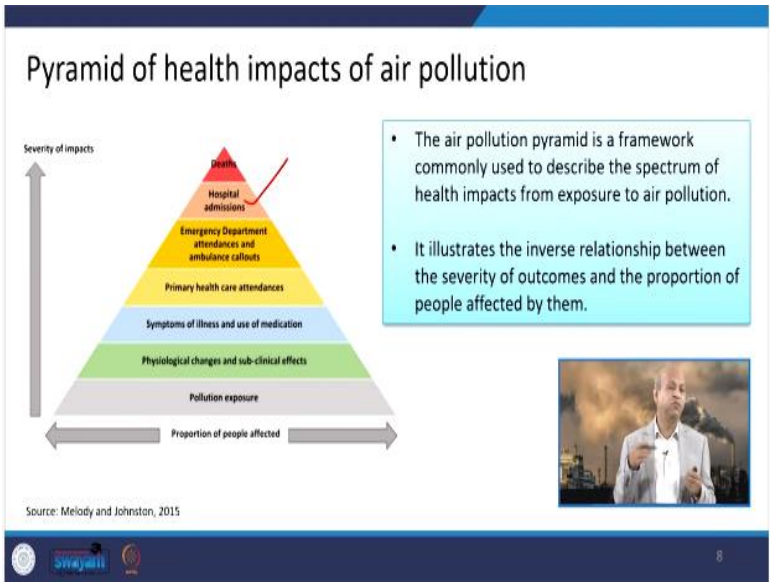
Well when we talk about major factors which affect the human health, then in terms of air pollution. So we have to see the nature of pollutant because the same concentration of particulate matter or sulfur dioxide or NO_X they will have different effects, so the nature of pollutant is important.

Then the concentration of pollutant, there may be concentration very low so it may be bearable, our system has been designed like that, that certain pollutants below the threshold quantity they may not have very severe effect on our health, it is reversible kind of thing.

Then the duration of exposure as I said the concentration and duration of exposure when we multiply it, it is a dose, so low concentration duration is very high, again very high dose total or very high concentration for low duration also very high dose may be there.

So, like acute exposure happens when some accidents happen, like Bhopal gas tragedy we discussed, so that pollutant very high dose was there for short duration even public got exposed but they got affected severely, then the state of health of the receptor, healthy people may survive even if there are high concentrations of pollutants because they have good health, they have good immunity but those people who are already ill, already diseased so their immunity may not be so good and they may fall prey to the air pollution very severely. Then the age groups of the receptor like old people, children they are more susceptible as we have seen.

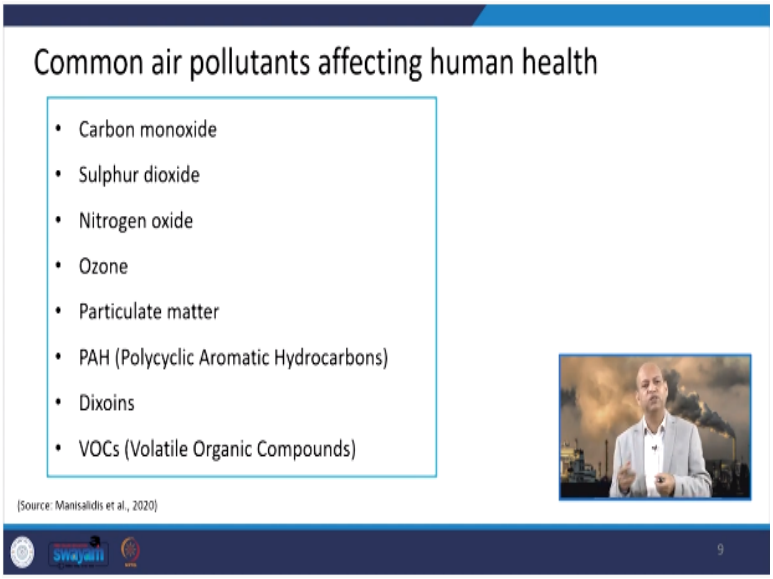
(Refer Slide Time: 7:47)



Then we see like pyramid of health impacts of the air pollution, so at the bottom you can see pollution exposure, so most of the people get exposed, the whole, the large population get exposed by air pollution. Then the physiological changes or sub clinical effects happen to some people, not the complete as I said some people are allergic to certain pollens but other people are not allergic so they will not have those symptoms but some people will have.

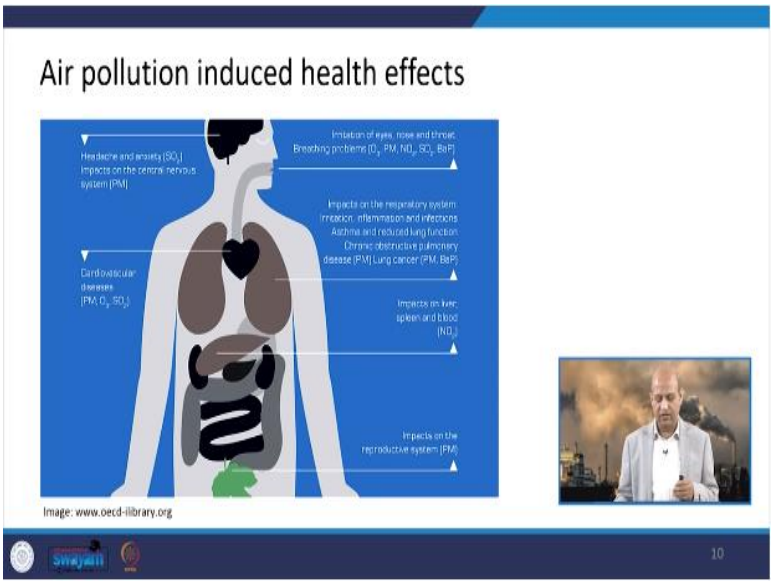
Then the symptoms of illness and the use of medication will be done by the group of that population, so that number will further reduce, then the primary health care attendance will be done by lesser number, so that way far lesser number will be admitted to hospitals if the problem is severe and a few people may also die. Again depending upon what is their health how much they are exposed to air pollution, so this is a kind of pyramid of health impacts of air pollution which is quite popular.

(Refer Slide Time: 8:47)



When we talk about the common air pollutants that generally influence the human health, so they are like carbon monoxide, sulphur dioxide or nitrogen oxides, ozone, particulate matter, then polycyclic aromatic hydrocarbons PAH, we call it PAH and dioxins they are very toxic pollutants, then VOCs Volatile Organic Compounds they are themselves have damaging effects plus they also contribute to formation of like ozone and other kind of things.

(Refer Slide Time: 9:24)

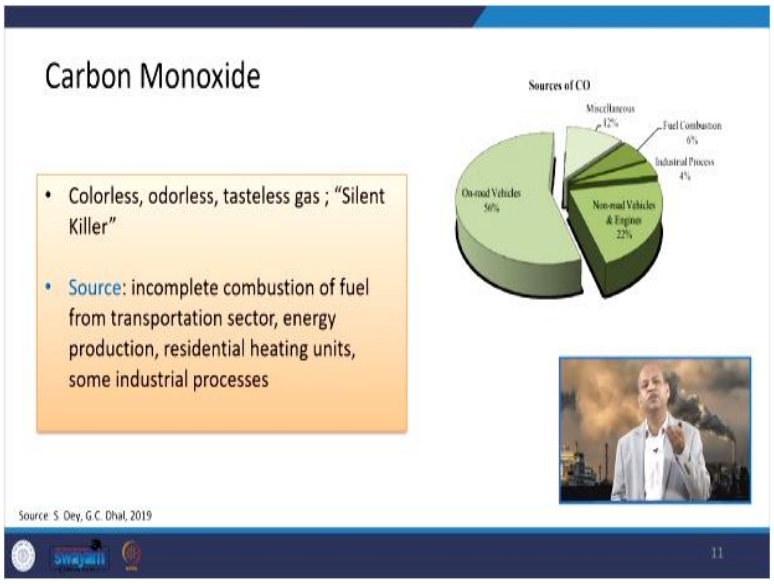


So when we see about this air pollution induced health effects, so we can see like particulate matter, sulfur dioxide they can cause headache or the central nervous system can be affected by very fine particle matter, very fine very like nano particles can go up to the blood stream and they can travel up to our brain, that is very important to visualize.

Then ozone particulate matter, nitrogen dioxide, sulphur dioxide those kind of pollutants they can cause irritation to eyes or to the nose and that throat and the complete breathing system can be affected. Lungs can be affected by particulate matter depending upon the size of the particulate matter, ozone, sulphur dioxide or those kind of pollutants.

And these can cause heart effects also, cardiovascular diseases may be because of these small particulate matter they can change those heart related issues, then lungs can be affected by again similar pollutants like particulate matters and others then NO_2 can even cause liver effects and in the blood plus the reproduction system can be affected by a small particulate matter so new research says like that.

(Refer Slide Time: 10:40)

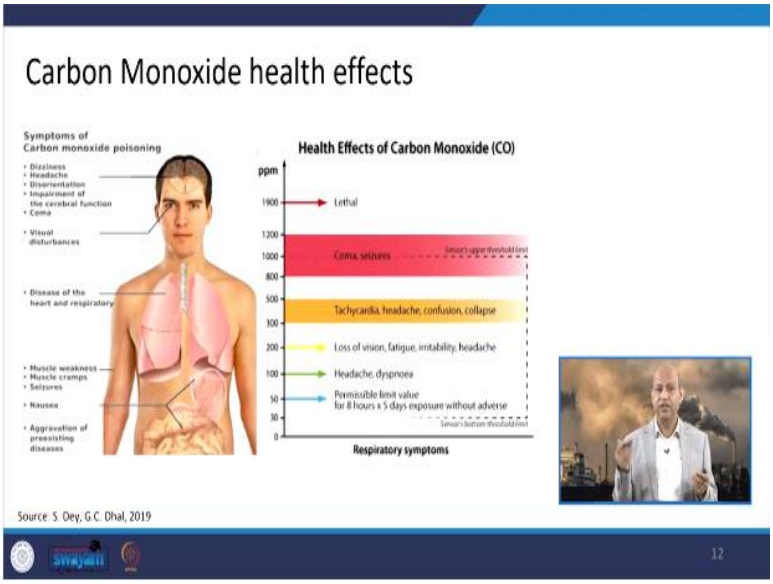


When we talk in detail like carbon monoxide, so it is as you know the colorless, odorless, tasteless gas and that is why it is known as a silent killer because in our system if we have foul smell then we feel irritated and we will do something to remove that but carbon monoxide does not warn anything, you just inhale it and it will dissolve, it will get

dissolved into your blood and the carrying capacity of oxygen of the blood will be reduced and you will be unconscious and you will not know what is happening, so this is very dangerous thing in that sense and it is emitted by several sources especially by like transportation sector, vehicular emissions, exhaust emissions are a major source of carbon monoxide, then fuel combustion, industrial processes may also be there but major portion of CO comes from on road vehicles.

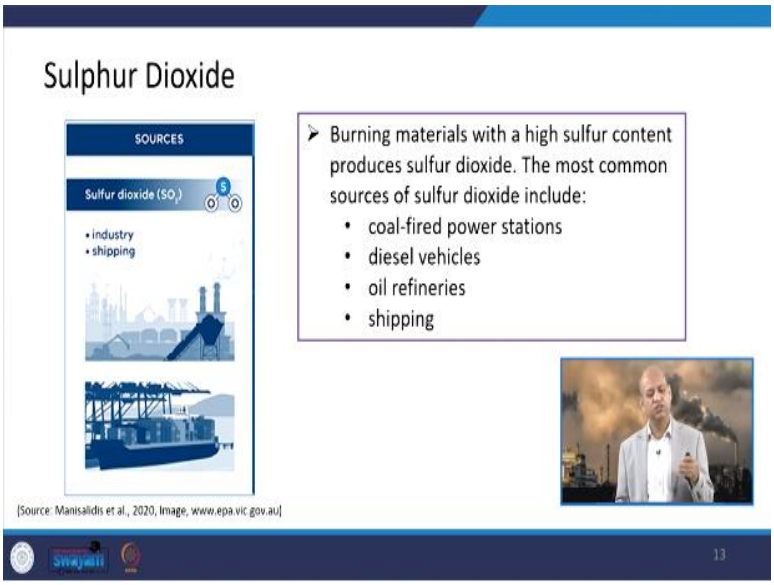
So if we can you know make the on road vehicles efficient in burning of the fuel then carbon monoxide can be reduced and it will be completely reduced if we go for electric vehicles, battery vehicles, so those kind of things you can visualize.

(Refer Slide Time: 11:46)



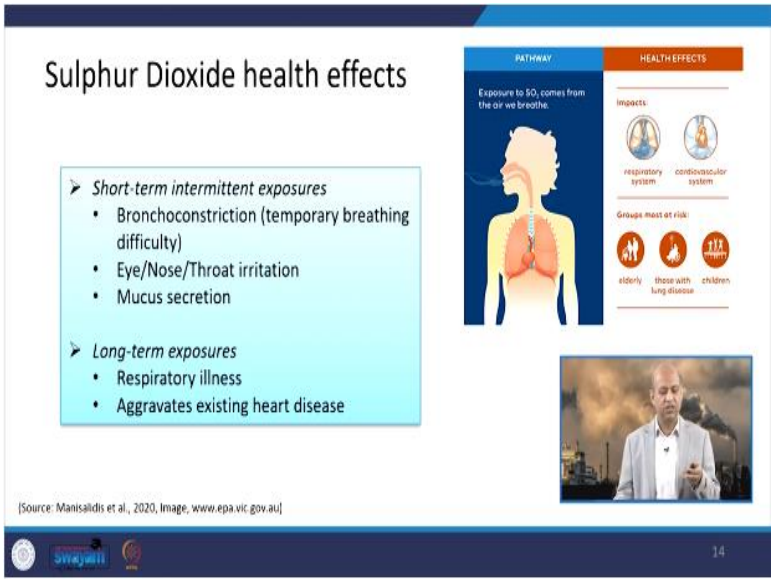
When we talk about the health effects the particularly dependent on carbon monoxide, so you can see the dizziness or headache depending upon its concentration, this shows the concentration and its health effects. So even it can cause death very high concentration, so it is very important to look from that perspective.

(Refer Slide Time: 12:07)



When we talk about sulphur dioxide so it comes from industries or shippings wherever diesel, fossil fuel like coal etc. are burnt, so sulphur dioxide is emitted in huge quantity like power plants etc., and that is very important to see that how can we control them.

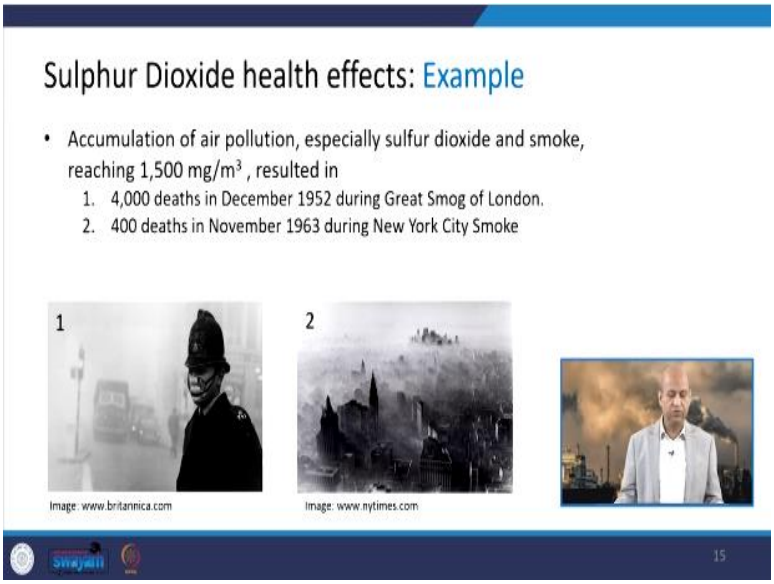
(Refer Slide Time: 12:28)



Because sulfur dioxide has several ill effects like mucous secretion, it causes eye, nose, throat irritation and then breathing difficulty those kind of things, in long-term you can have the respiratory illnesses and then it can aggravate the heart disease also, so those are

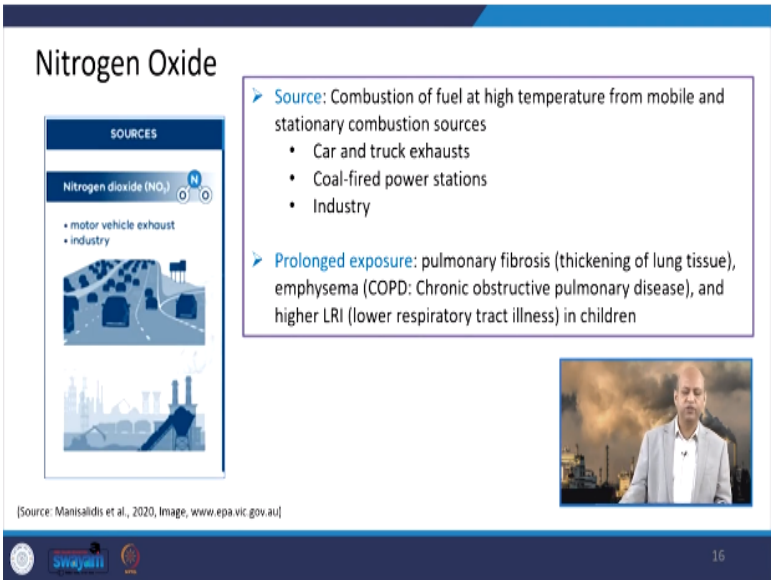
the things which we have to see. So, if we are living in the environment where sulphur dioxide is in large quantity then these kind of illnesses one can expect or should be at risk.

(Refer Slide Time: 12:59)



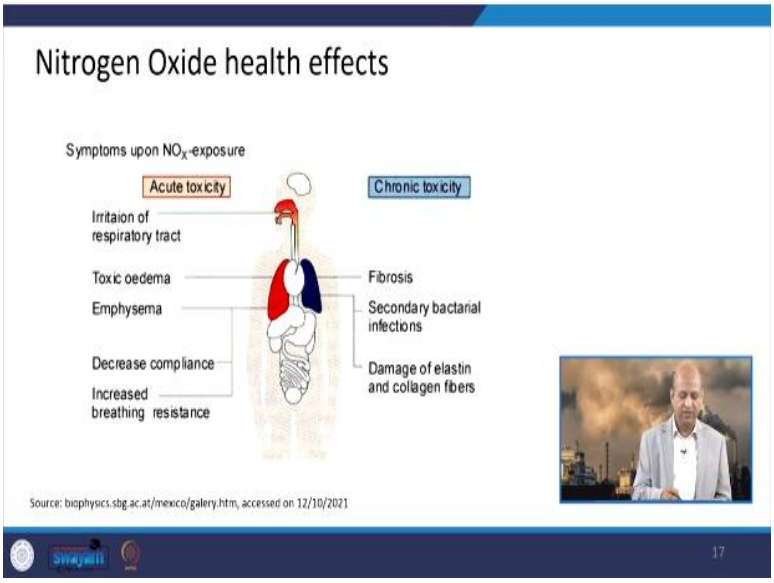
Well there are issues which we have seen in the earlier lecture also like in London Smog, London Smog as you have seen in 1952, so 4000 people died and the responsible factors was sulphur dioxide and particulate matter and 400 deaths occurred in 1963 in New York City so that was also because of sulphur dioxide high concentration.

(Refer Slide Time: 13:27)



When we talk about nitrogen oxide then the sources are like these vehicle, on road vehicles car, trucks, etc. So exhaust emissions, carbon monoxide and NO_X emissions are in huge quantity comes from on road vehicles, please remember it, but other sources are also there like coal fired power stations, industries etc..

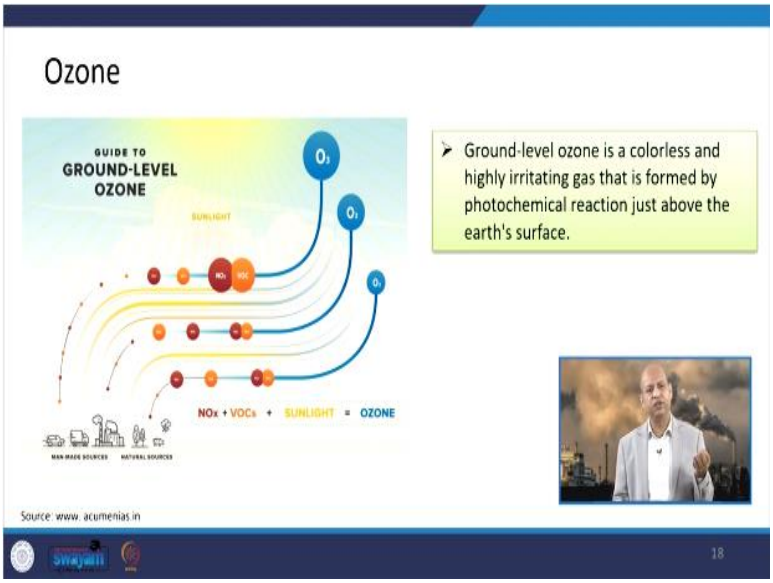
(Refer Slide Time: 13:51)



And they have their own health effects like irritation to respiratory tract or it can cause some increased breathing related resistance kind of thing, maybe their suffocation those

kind of, chronic toxicity may also be there, it can damage these fibers of the lungs, so those kind of things. So the exchange of the oxygen to the blood may be affected very negatively.

(Refer Slide Time: 14:20)



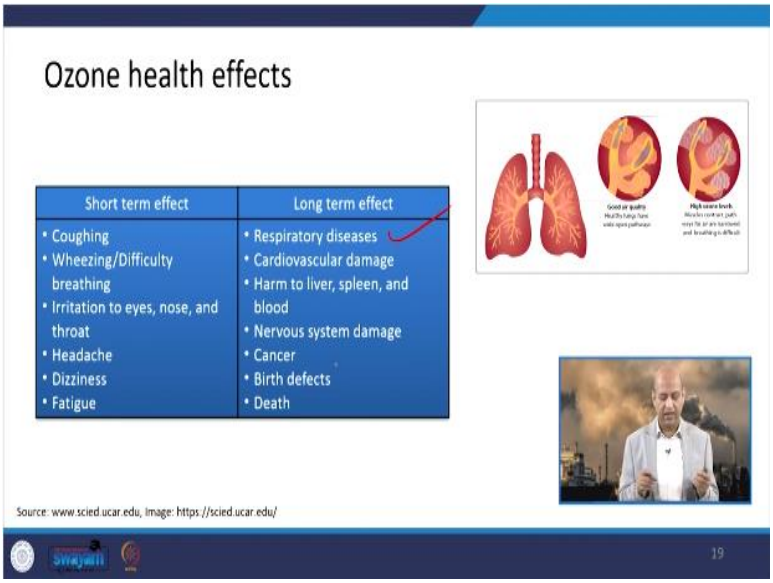
When we talk about ozone, ozone is not a primary pollutant, it is not emitted by any source, it is produced rather in the environment because of photochemical reactions but there are certain precursors which produce the ozone in the presence of sunlight like NO_X emissions, VOCs Volatile Organic Compounds or hydrocarbons.

And ozone production is dependent upon certain other factors, so sometimes we call that it is VOC driven or it is NO_X driven, so we have to see which precursor is responsible for ozone production in a particular location, if you are not dealing with that particular precursor you are reducing other precursor, may be ozone problem will not be solved, so those kind of things we will see in detail later on you can also find the literature source for this.

So, this is also again in troposphere it is very dangerous for us, it is having health effects as well as it damages the property, but in stratosphere it is very good, it is said that ozone is our friend in the stratosphere but in troposphere it is our enemy kind of thing, so that is

we do not need in troposphere but we very much need it in stratosphere because it protects us from ultraviolet rays.

(Refer Slide Time: 15:36)

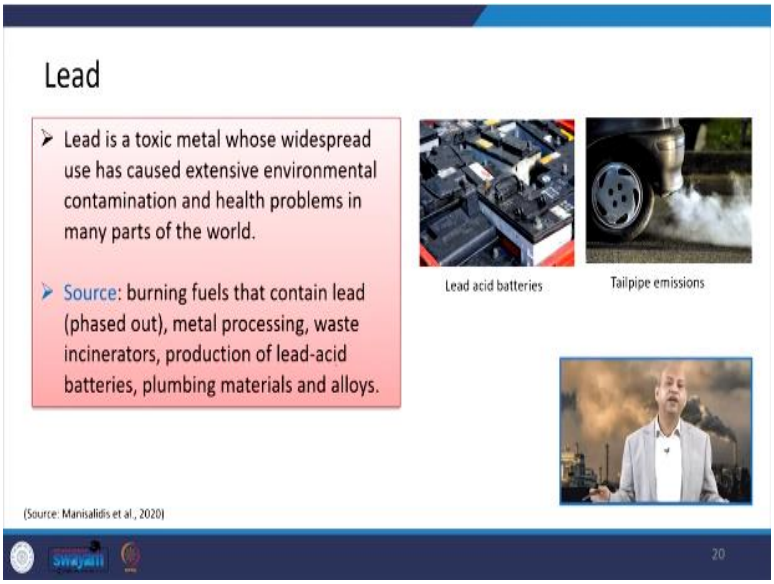


Well when we talk about the health effects of the ozone then short-term effects like coughing or wheezing kind of things when its difficult to take inhaling or exhaling so when you are exhaling then kind of sound occurs like whistling kind of things or irritation to eyes and the nose, headache or dizziness, fatigue you are tired, means sometimes people feel that I am tired, why I am so much tired even if I have not worked so hard.

But people do not know that it may be reason because of pollution, if you are living in the polluted environment continuously and like sick building syndrome that is also there if you are living inside a building which is polluted, you can have headache, you can have sickness those kind of things, so we should be careful about air quality also.

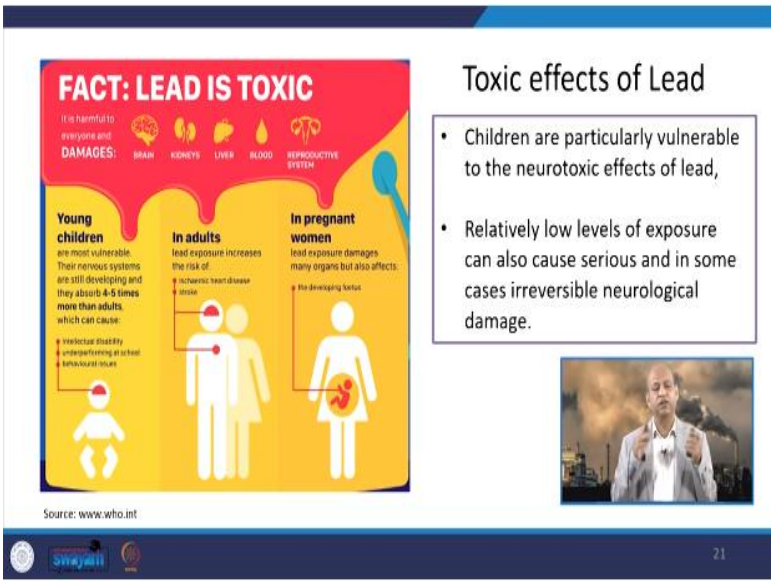
So ozone can have these short-term effects, it can also have long-term effects like respiratory diseases, cardiovascular heart related diseases, it can harm the liver or it can also harm the blood related things, the nervous system damage can be occurred by ozone, cancer or birth defects, death all these are because of ozone, it is possible depending upon how much concentration is we are exposed to.

(Refer Slide Time: 16:55)



Then like lead poisonous is there, you might have heard about unleaded petrol, what is that unleaded gasoline or unleaded petrol, why it came into existence or why government had this policy, because the lead is very toxic and it has been studied that small kids if they are exposed to high lead concentration in air their memory will be affected and their learning ability will be very slow, so those kind of things may be there, so that is why we have gone for this unleaded petrol etc..

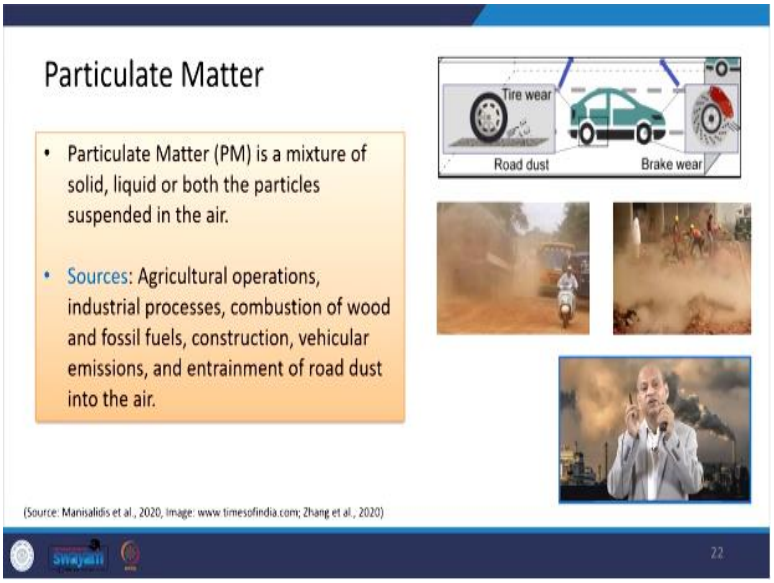
(Refer Slide Time: 17:27)



So you can see the toxicity of this lead, you can see the intellectual disability can occur because of lead concentration or under performing in the schools and you might be wondering why my child is not performing very well and you do not know that maybe it is exposed to lead and that is why in paints also nowadays there are several advertisements of paint companies they say our paint is not having VOCs, our paint is not having lead those kind of things because of this awareness, because even if in the indoor environment you are having very good shining paint on the walls but if it is having lead contamination, then you will be exposed to the lead, your children will be exposed to the lead, so be very careful about those things.

In adults also it can cause like strokes, heart diseases, in pregnancy it can develop problems to the fetus, so those are the issues which are related to lead, so we should be very careful that the environment in the air lead should not be there and we should do whatever is needed to have the air cleaner in that sense.

(Refer Slide Time: 18:39)



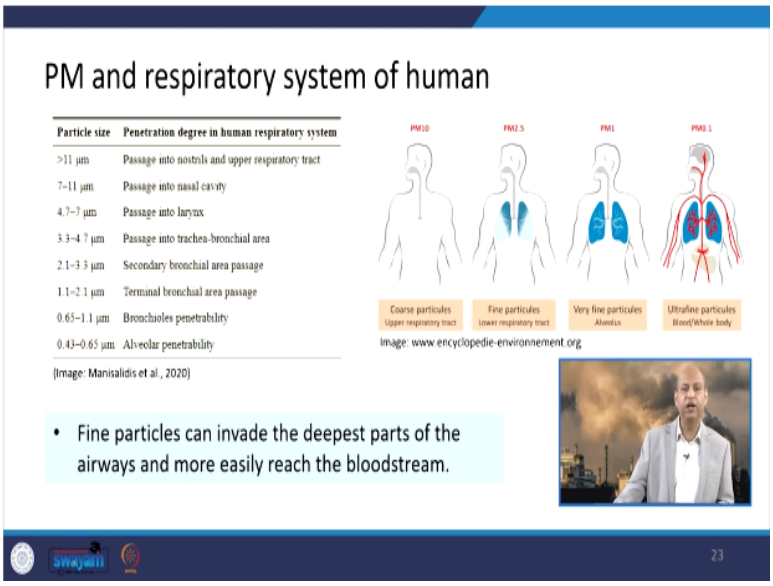
Well when we talk about particulate matter, so basically it is a mixture of solid, liquid both particles, so liquid droplets may be there, solid particles may be there of all size, very micro size which cannot be seen by eyes also, very fine particles, very nano particles may be there, they can go inside our body system and they can go into blood as I repeatedly say, so we should not take it very lightly, particulate matter is very dangerous

and suspended particulate matters our nostril can exhale it, it can trap this is a filter system nature has provided to us but the small particles are very problematic and we should be careful like tire wear, resuspension of the dust and the brake wear those metals may be there in the particulate matter also.

And then the sources can be of any kind of activity which is causing emission of particulate matter through burning of wood or fossil fuels or construction activities, vehicular exhausts, etc. you name it even natural dust like Andhi or storms, dusty storms they also are responsible for particulate matter, only the difference is that their size may be higher and because of gravity they settles down but even then there may be very small particles also in that also and that can go inside our body.

And one scientist one day in a conference we were discussing he said that in pre-industrial era our population were exposed to these sandstorms etc. and there were no very high problem related to health but now because of industries the pollutants like metal pollutants or toxic pollutants, chemical pollutants they can get coated on surface of the particulate matter, that may be very dangerous.

(Refer Slide Time: 20:41)

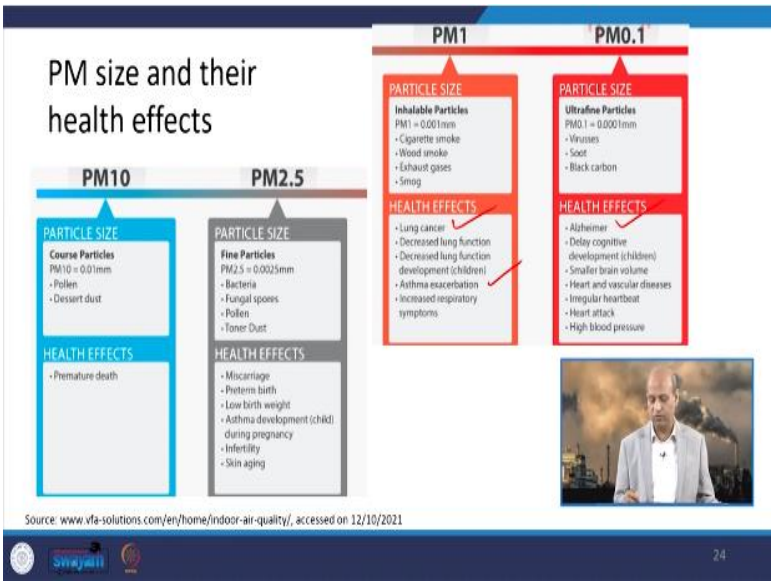


So, the particulate matter and respiratory system of human is very much related to each other, so you can see like PM_{10} can go up to this, that may not be so health hazard but

$PM_{2.5}$ can go up to the lungs and PM_1 more of more parts of the lungs can be affected, $PM_{0.1}$ can go into blood cells also, it can go up to the brain and if those small particles are carrying some carcinogenic element, some very toxic element that will be part of the body and when it will trigger the cancer you do not know.

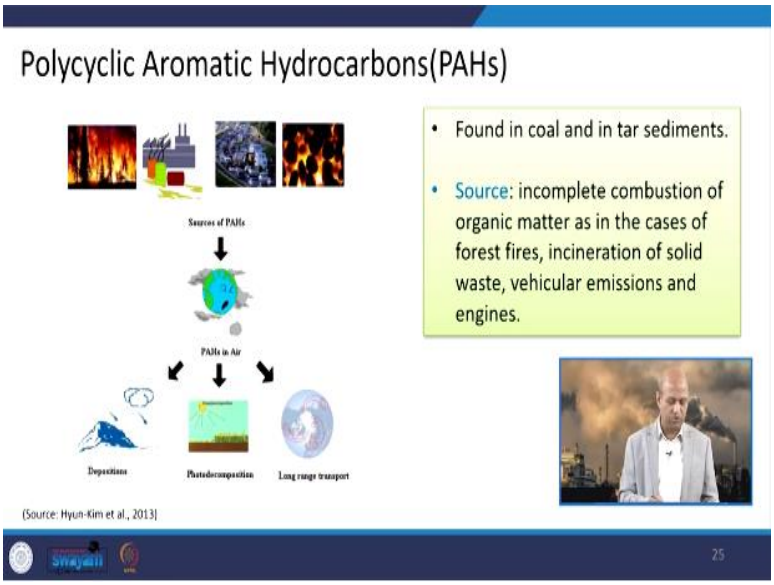
So, that is why nowadays so many patients of cancer etc., its because of pollution we are exposed from different pathways of course like food is also not so good sometimes, we are taking vegetables which were grown in dirty places. Similarly, water or milk or many ways you can get exposed to toxic material, so you can see the size of the particles and the health effects of in the respiratory system you can see in this table.

(Refer Slide Time: 21:44)



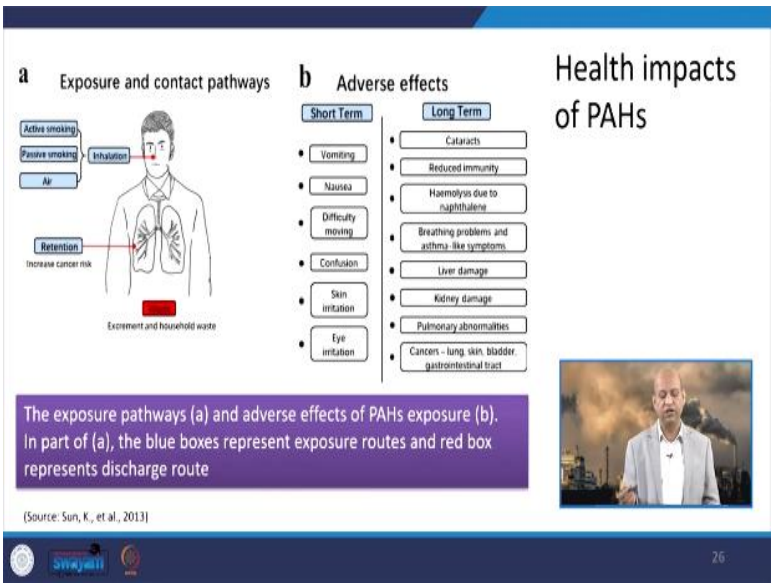
Also this is a good example of different size of the particulate matter and related health effects you can go like PM_1 it can cause lung cancer, it can cause asthma exacerbation and $PM_{0.1}$ it can cause even Alzheimer, you know Alzheimer when people start to forget things and they cannot remember even if they have taken food or not that kind of things happens in very old age, so Alzheimer's may be caused by this $PM_{0.1}$ also, although these are age related diseases they are known as, cognitive delays means your thinking ability, analytical ability will be affected, all those health effects are given here.

(Refer Slide Time: 22:27)



Well when we talk about PAHs Polycyclic Aromatic Hydrocarbons, so they are emitted from several sources like these long range transport from industries etc., and burning of different fuel etc., you can have from coal, from tar sediments.

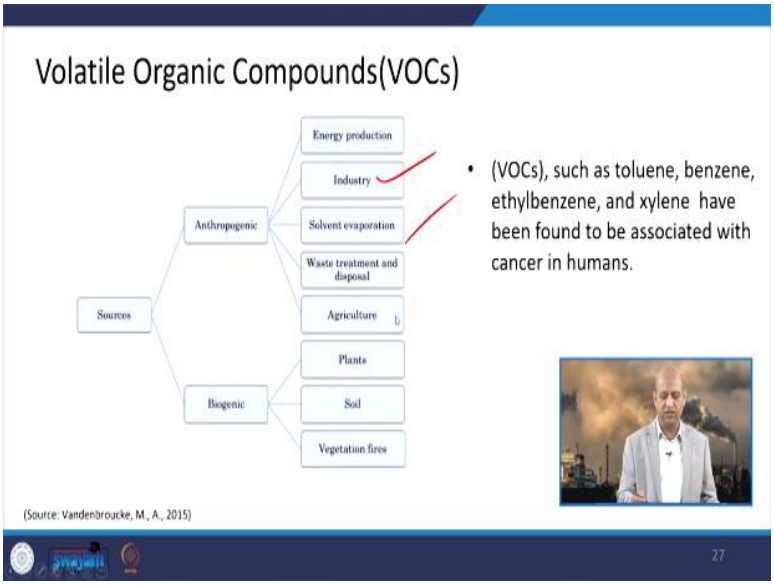
(Refer Slide Time: 22:45)



Well it has also several health effects, short-term may be like vomiting, nausea kind of thing, you are not feeling well, eye irritation, skin irritation those kind of things, in long-terms it can cause these cataracts in the eyes and liver damage or kidney damage that may

be because of PAH also, so polluted environment is not good to live they can cause several diseases.

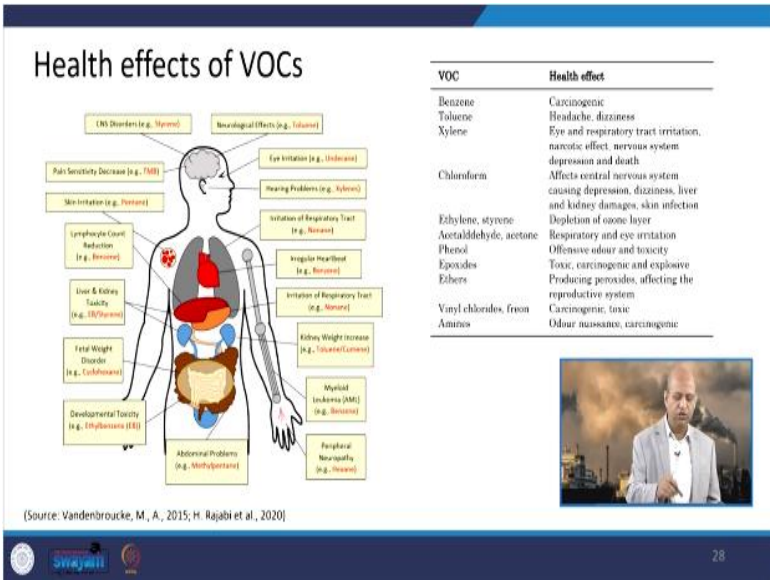
(Refer Slide Time: 23:10)



When we talk about Volatile Organic Compounds VOCs or even hydrocarbons they are known as, so sources may be natural as well as anthropogenic, as I said earlier that any plant which is giving some smell is basically emitting some VOC Volatile Organic Compound you name it, it may be you like even the spray which you use for room that is not good for health it gives you good smell but it is chemical, it is VOC it can damage our respiratory system and many people have allergy to that.

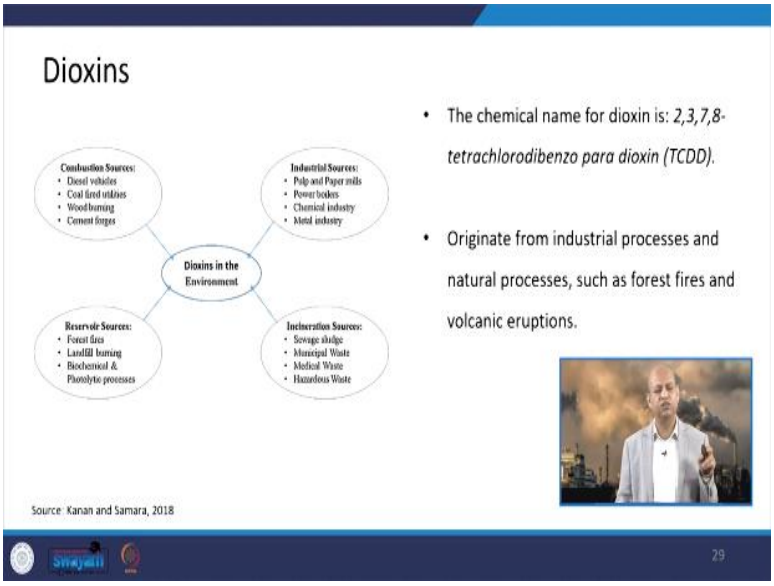
Anthropogenic there may be industries, solvent evaporation, agriculture etc. and biogenic emissions are from plants, soil, vegetation all those so VOCs may be emitted from those sources.

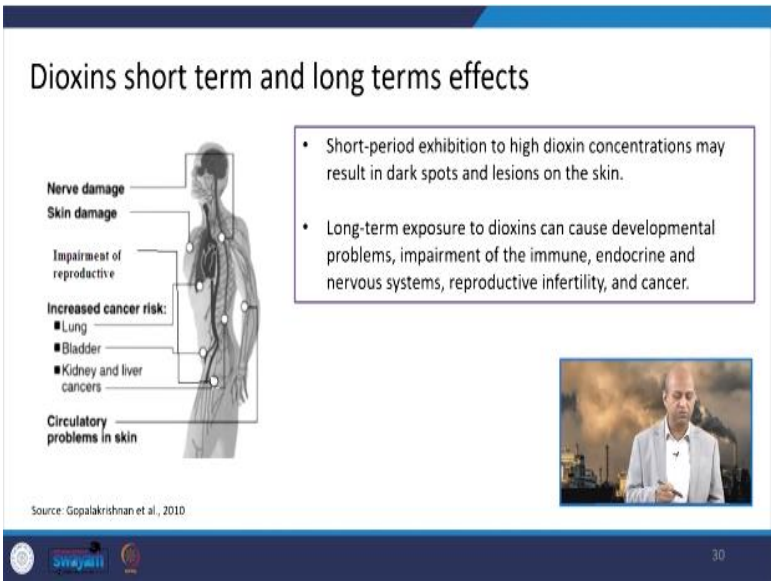
(Refer Slide Time 23:56)



When we talk about health effects of VOCs again it is you name it even including brain, heart, lungs, etc. everything is you know affected by VOCs, so VOCs are dangerous, we should not have VOCs in our air. Benzene, toluene all these are VOCs basically and they are carcinogenic, they can cause cancer, so that is very toxic and very problematic.

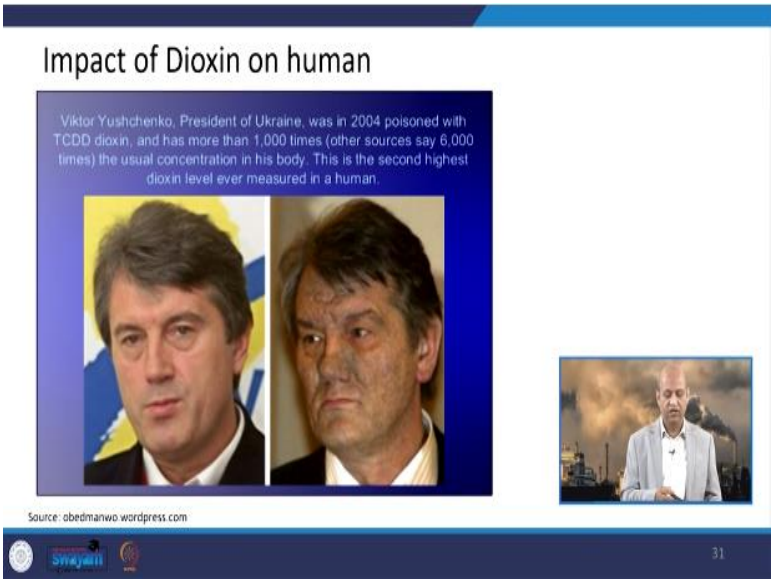
(Refer Slide Time: 24:18)





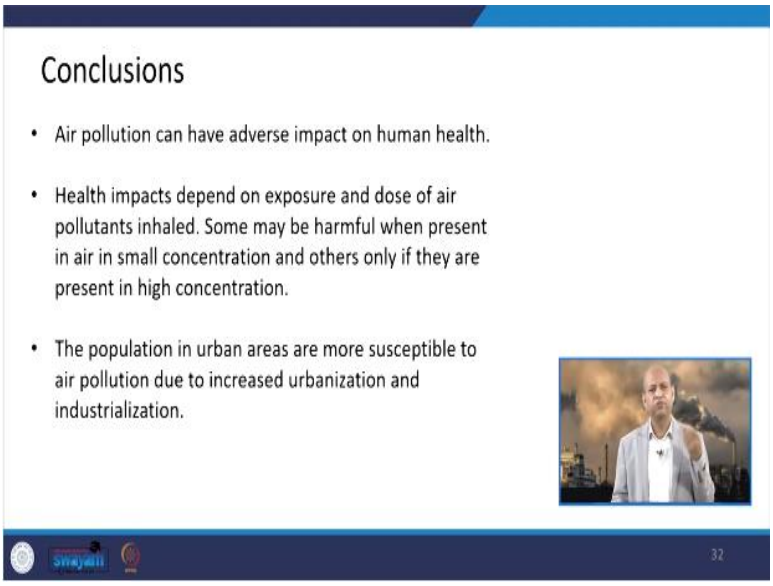
When we talk about dioxins they are also very toxic elements and they can be originated by industrial processes etc., so we can get exposed to them through air and other and it can damage the nerve system, it can cause skin related diseases.

(Refer Slide Time: 24:34)



Like you can see here it is known that this President of Ukraine by opponents he was given it is said that poisoned by some dioxin and it was later measured that around 1000 times more this dioxin concentration was found in his body, so you can see the skin was damaged because of that high concentration of dioxin.

(Refer Slide Time: 25:05)



So, in conclusion we can say that air pollution can have adverse health effects, as several health effects may be from different kind of air pollutants and it depend upon the exposure, time, duration and the concentration, so some may have less harmful effect, some way very high impacts and the population in urban areas may be susceptible because more pollutants are there and we have to be very careful that the air where we are breathing should be clean otherwise it can cause several kind of health effects depending upon the pollutants.

(Refer Slide Time: 25:40)

So, thank you for your kind attention, references are there for having additional information, you might be very curious about several health effects, you can go through them, you can know about so thanks for your kind attention, see you again in the next lecture, we will carry on impacts of the air pollution like on building materials or environment, ecosystems, etc. so today we completed health effects, now we will go for other impacts, thanks again.