Air Pollution and Control
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Lecture 4
Impact of Air Pollution on Vegetation and Animals

Hello friends you may recall last time we discussed impacts of air pollution on human health, so in continuation now we would like to discuss today the impacts of air pollution on vegetation and animals.

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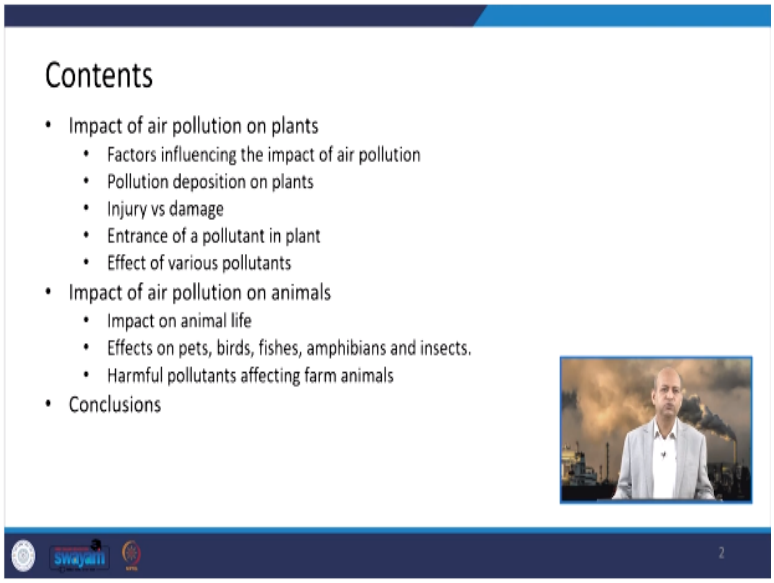

So, this is the contents list of this lecture like we will go through about impacts of air pollution on plants, for example, what are the factors that influence the process of influence of air pollution on the plant growth process or their photosynthesis process, those kind of things and then pollution deposition on plants that also causes several kinds of problems.

Injury versus damage, sometimes injury happens to plant leaves but it may also cause some damages which can result into some economic costs. Entrance of a pollutant in a plant, so what are the pathways the plant get exposed to air pollutants, so then negative implications happen.

Effect of various pollutants, means every pollutant has a different kind of effect as you have seen like SO_2, ozone, particulate matter they have different health impacts on human beings, similarly on plants also different pollutants have different kind of effects or impacts.

Then we will see the impacts on animals of the air pollution, so like animal life again they are also living beings, so similar to human health effects animals also have certain health effects due to air pollution, but this impact can vary from animal to animal, from there at the evolutionary stages, pets, birds, fishes different kind of environment is affected differently by air pollutants. So all those things we will see, what are the total harmful impacts of the pollutants on different kind of animals like pets or farm animals or wildlife or insects etc, and thereafter we will conclude it.

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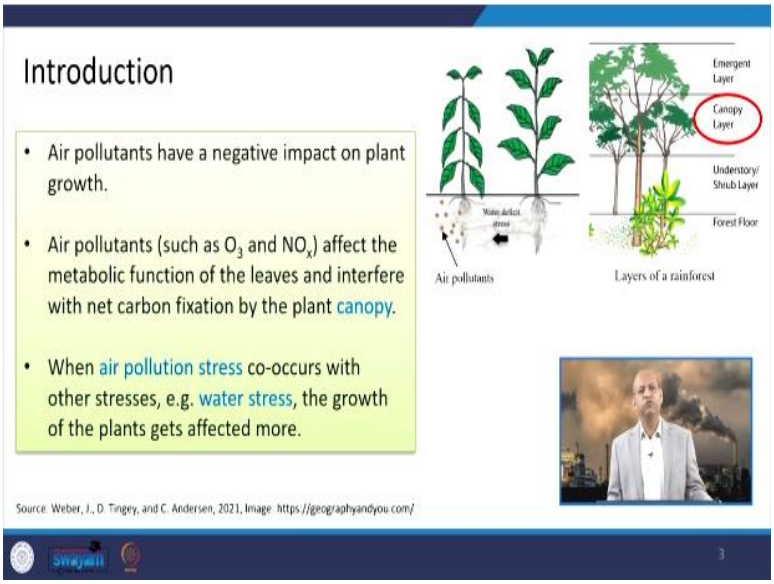

So, as an introduction if you want to see the impact of air pollution, the negative impact of the air pollution on plant growth. So, you can see, these are shown this picture of the plants or trees, so the air pollutants can affect basically the metabolic function of the leaves and they can interfere in the net carbon fixation by the plant canopy.

So, plant canopy means these leaves etc, are there but in total process whether stem or the roots, so different ways impact can be through different ways and then the air pollution

causes some stress and when other stresses are there like water related stresses are there for the plant or trees, so these combined effect may be little bit severe.

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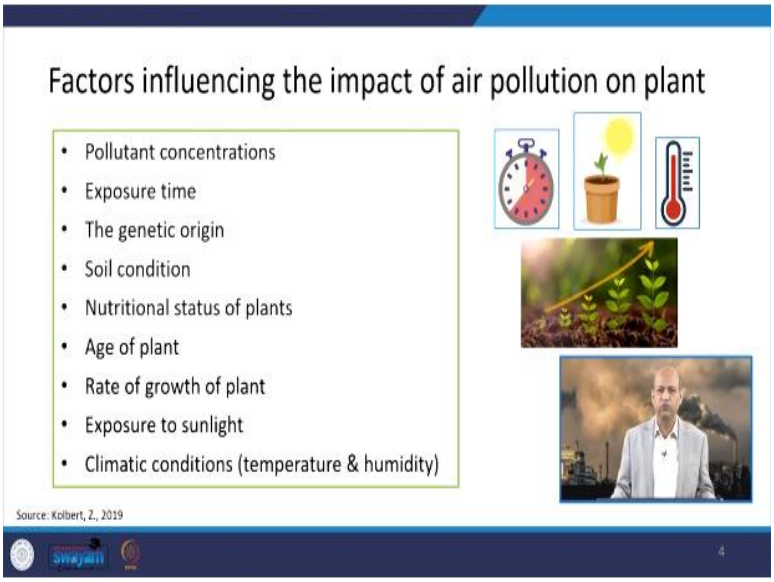

When we talk about different factors which influence the impact of air pollution on plant then basically we talk about exposure time and then what is the concentration of the pollutant with like we have seen in human beings also, a small concentration you can get exposed to for longer period even then there may be little disturbance about the system but the high concentrations, the acute exposure can cause more damage.

Similarly, the temperature, like heat stress may be caused by temperature those kind of things then what is the condition of the soil, that soil condition can be affected by air pollutants because of dry deposition, because of wet deposition, then the nutritional status of plants because metabolic system can be affected by air pollutants, so what is the status if it is healthy plant and good nutrients are being pumped into the system of the plant, so it can maybe it can be kind of resilient or it can be sturdy, it can face or get exposed to air pollutants but damage may not be very severe.

Then the age of the plant, as we have seen there are vulnerable population in human beings also like children or old people or those having some allergy or some other diseases like diabetes etc, they get exposed to air pollution and effect may be severe or

more. So, similarly, like a plant is more old or plant is very tender when it is just growing so at that time maybe the effect can be severe or more damaging.

Then the rates of the growth of the plant that also affect the pollution effect. Exposure to sunlight as we have seen because the in the presence of sunlight they make the food, so again if it is lot of particulate pollution is there and good amount of sunlight is not absorbed by plants, so then again the growth can be affected. Then there are climate conditions like temperature, humidity they also contribute into negative or positive effect of the plant growth.

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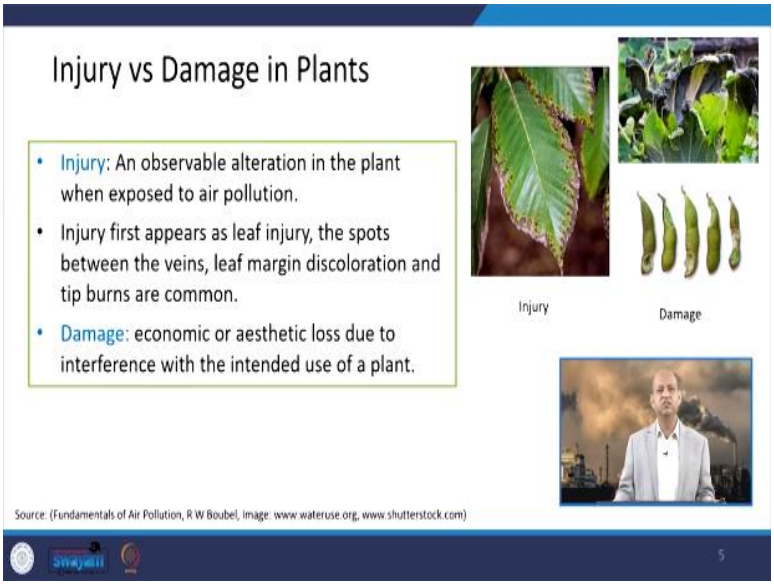

Well when we talk about injury versus damage, so basically we see like whatever observable alterations are there in the plant growth or plant leaves, some color changes etc those kind of things are known as injuries.

So, in continuation to injury the damage is there, damage means loss of aesthetic value of the plant as well as some economic loss can be there because of those kind of injuries which could be the degree or extent of the injury which can result into losses, economic or aesthetic losses then we call that it is damage kind of thing. Well so degree of injury against the air pollution can depend upon the exposure, the dose, the concentration etc.

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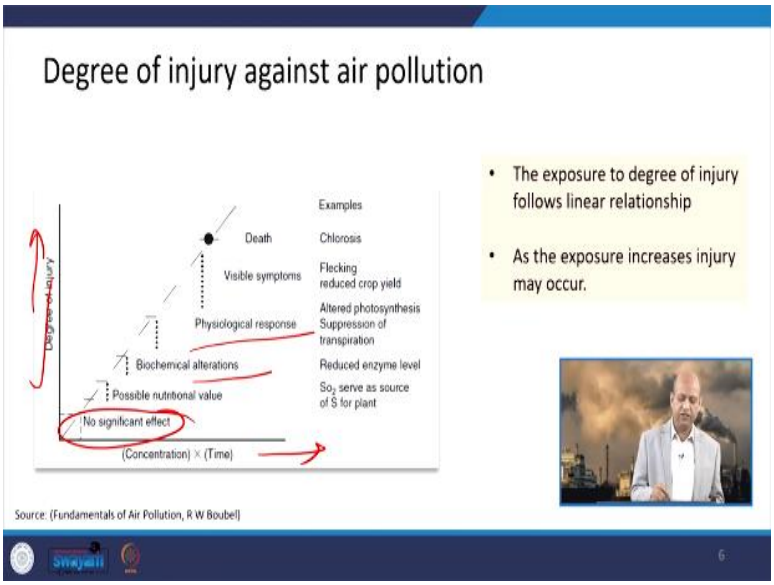

So, you can see here the degree of injury and on this is concentration into time that is basically the dose. You may recall that last time also I said there is a saying that everything is toxic or non-toxic, everything it depends on basically the dose, so very low dose even poisonous things your system can digest or it can not react in that negative way which it will be when dose is very high.

So, very small dose may not affect the health very severely but again it depends upon the toxicity of the pollutant also, like cyanide, even very small quantity of the cyanide if we are get exposed to it is dangerous to the life, so the concentration into time, the dose, as dose increases the degree of injury also increases, so that kind of things are there, small doses, small exposure it may just bear it or tolerate it so no significant effect may be there at the small level of the doses, when dose is increased then this possible nutritional value, means the food taking process may be affected, then biochemical alterations can be there after certain level of the dose.

Then physiological responses can be there when dose is very high and it can also result into some visible negative symptoms and after that even it can cause the death of the plant, where does very high and it is for longer duration then maybe plant do not recover and it dies, so the exposure of the degree and injury follows the linear relationship, as dose increases this injury level also increases and the exposure increases injury may occur and even it can convert it into damage.

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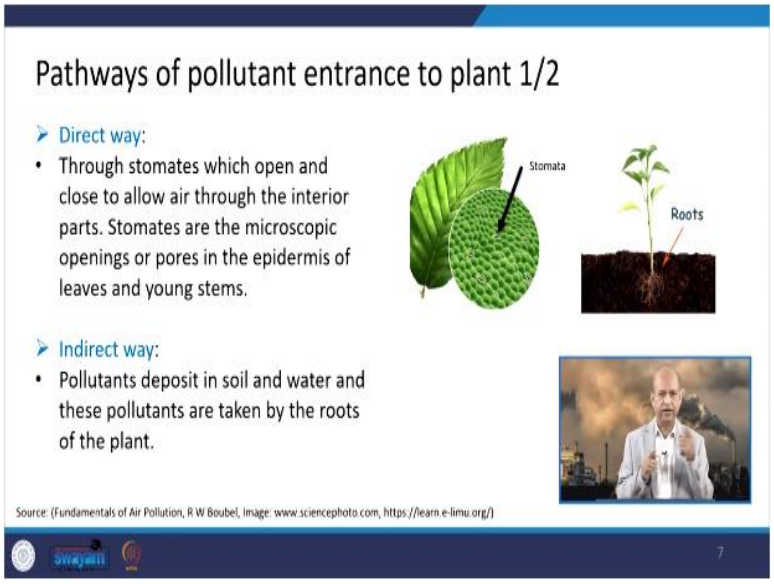

When we talk about in a pathways of the pollutant entrance to the plants, so it can be direct or indirect. So, direct means through stomates, stomates are very small pores are there you can see, these are basically the microscopic openings or pores in this epidermis of leaves and young stems. So, through that pollutant can enter into the system of the plant.

Or indirect can be there because the pollutants can deposit in on to the soil or it may be on to some water body where from water is being fetched and the plant is watered by that particular water body, so it can come through soil or water also, so that is the indirect way and it can go through the roots also, so maybe it can come to the leaves like particulate matter, it can deposited, even gases can get injected into the pores or it can come through the roots also, so both direct and indirect.

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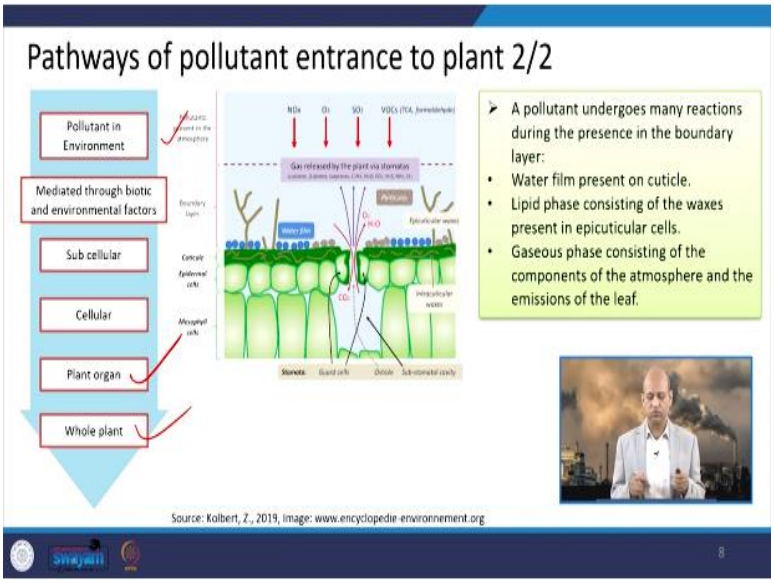

So, a pollutant undergoes many reactions during the presence in the boundary layer, it can go through the roots, it can go through the stem, it can go through the leaves etc, gaseous phase transformation is there, several kind of phase transformation may be there.

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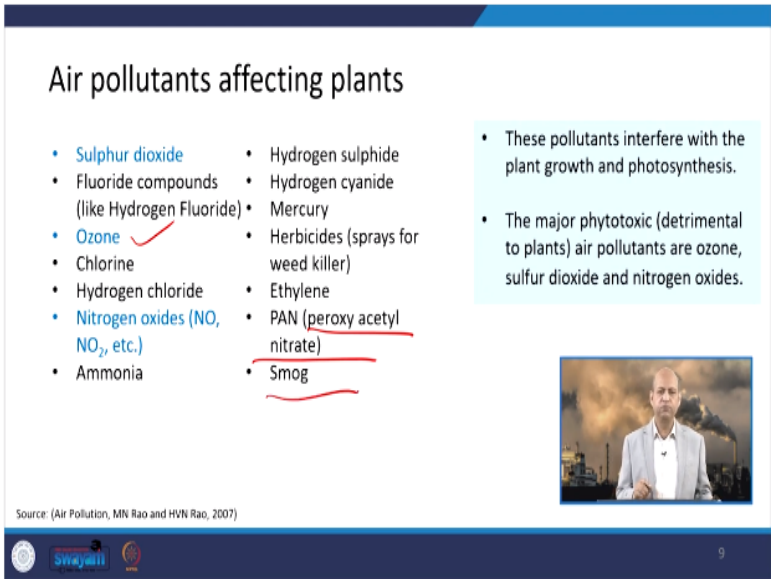

Then when we talk about air pollutants affecting plants different kind of air pollutants because the air is composed of nitrogen, oxygen, etc but pollutants enter from different sources and the presence of pollutant can be in terms of sulphur dioxide or it can be

fluoride compounds like hydrogen fluoride, it can be in terms of ozone, as you know ozone is secondary pollutant, it is produced in the presence of sunlight because of certain precursors like NO_X etc, then chlorine may be there, hydrogen chloride can be there.

Then oxides of nitrogen can also be there, nitric oxide or nitrous oxide or nitrogen dioxide those kind of oxide, ammonia can also be there, hydrogen sulfide and then hydrogen cyanide or mercury or heavy metals or herbicides can be there because when we are doing sprays to kill the weeds, so that those small particles in terms of aerosols they may be in the air.

There can be like peroxy acetyl nitrate or PAN in short we call, then smoke can also be there, so different air pollutants can be present in air and they can cause individual effect on the plants as well as collective impact, so both impact may be there.

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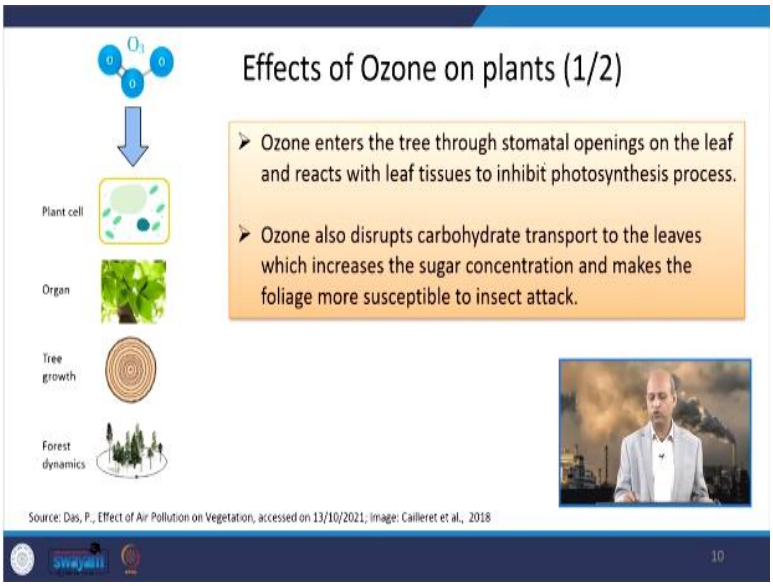

When we see the effect of the ozone on the plants, then basically it enters the tree through this stomatal openings as we have just discussed, on the leaf and it reacts with the leaf tissues to inhibit the photosynthesis process. Basically it can remove that greenery portion, so that food process, this photosynthesis process, food producing process affected, it can discolor it, so solar absorption, solar light absorption may be completely disrupted.

Then ozone also disrupts the carbohydrate transport to the leaves and which increases the sugar concentration at certain places in the plant at several places and it makes all these leaves etc susceptible to insect attack because sugary things they attract the insects etc, so those kind of disturbances may be there in the plant growth process.

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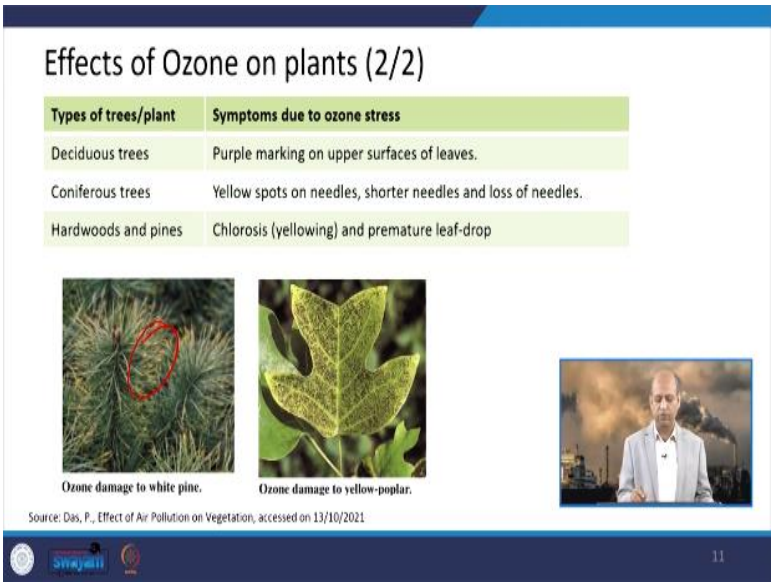

When we see the symptoms like what kind of symptoms may be there because of exposure to the ozone, so you can see yellow spots on the needles can be there, here like you can see, then it can also yellowing of the complete leave and the premature leaf drop can be there because it is damaged and it cannot survive for longer period.

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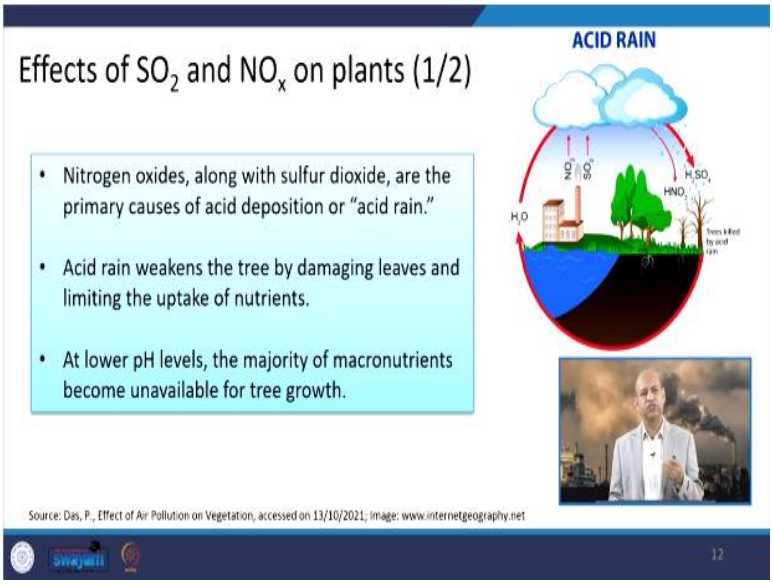

Then the sulphur dioxide or NO_X, oxides of nitrogen their effect can be seen in different way because they produce as the acid rain, in the presence of moisture so to get converted into sulphuric acid and nitric acid and when it comes down with the precipitation, with the rain or acid rain it can be depending upon how much concentration of sulphur dioxide is present in the air, so that acid rain can affect the plant growth because of disturbances into nutrient uptake etc.

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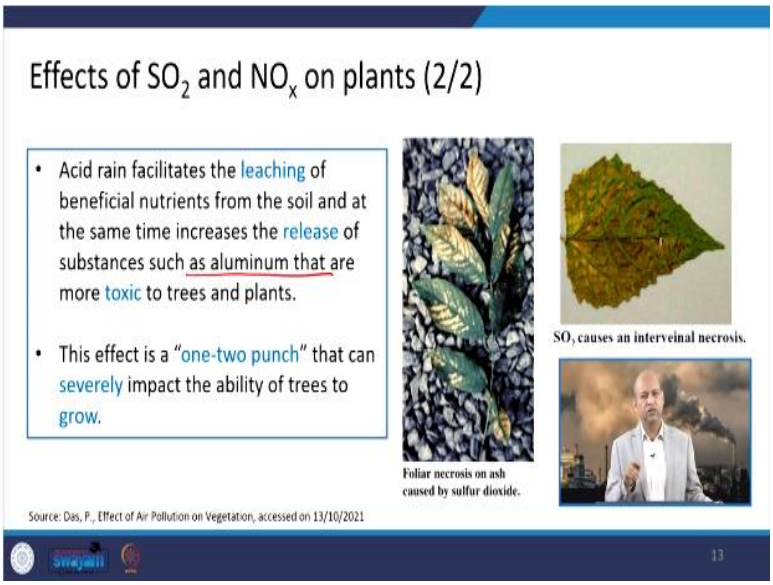

So, when we see the effect, it can leach because the rain, this acid rain can leach the beneficial nutrients and then those nutrients are not available to the plant, so the growth is affected and the toxic, this aluminum etc, they are taken by the trees because its concentration increases and other nutrients goes away, so that can be kind of double effect, negative effect on the plant growth and like SO_2 causes this kind of necrosis effect on these leaves.

So, this is again because of different pollutants but sulphur dioxide pollutant effect can be seen in that way, it can also fold the leaves, so unhealthy leaves are there because of sulphur dioxide exposure.

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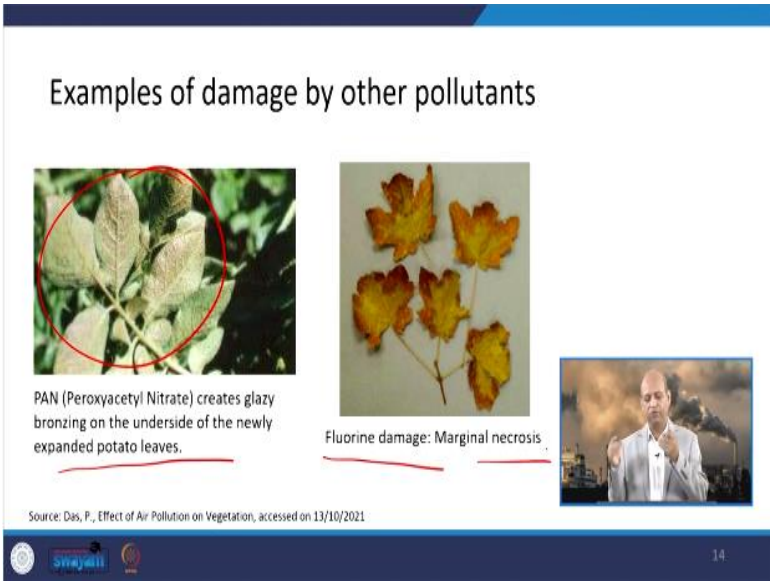

Similarly, like this fluorine you can see, the PAN related peroxy acetyl nitrate it creates the glazy bronzing kind of effect on and this potato leaves picture is there, so this is not the healthy leave and this color becomes the part of the growth, similarly the fluorine damage can be like again some low level of necrosis, so that way this damage is there to the leaves.

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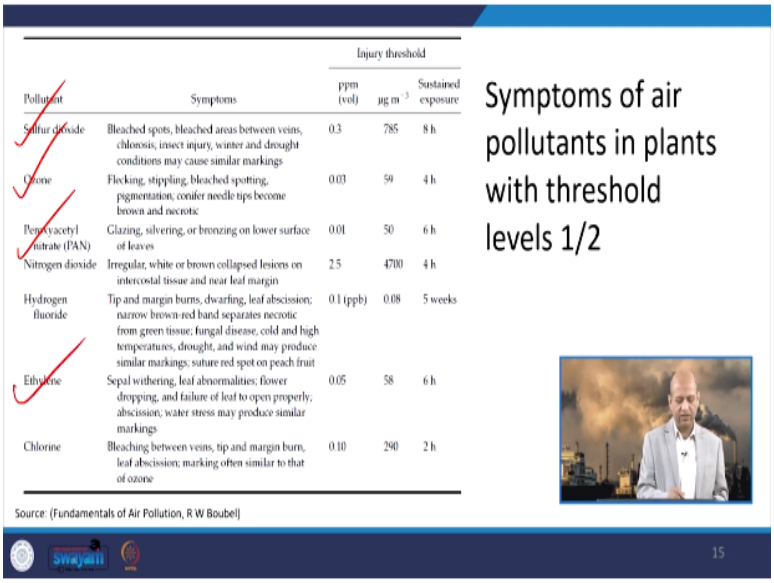

When we talk about different pollutants and their effects depending upon how much threshold limit is there, so beyond the threshold limit concentration is there, so that it can affect very negatively, we have seen the effect of sulphur dioxide, ozone, PAN etc, so similarly ethylene can also have negative impacts like leaf abnormalities can be there, flower droppings can be there because the presence of that, if chlorine is there, chlorine can bleach the leaves so again photosynthesis process will be affected.

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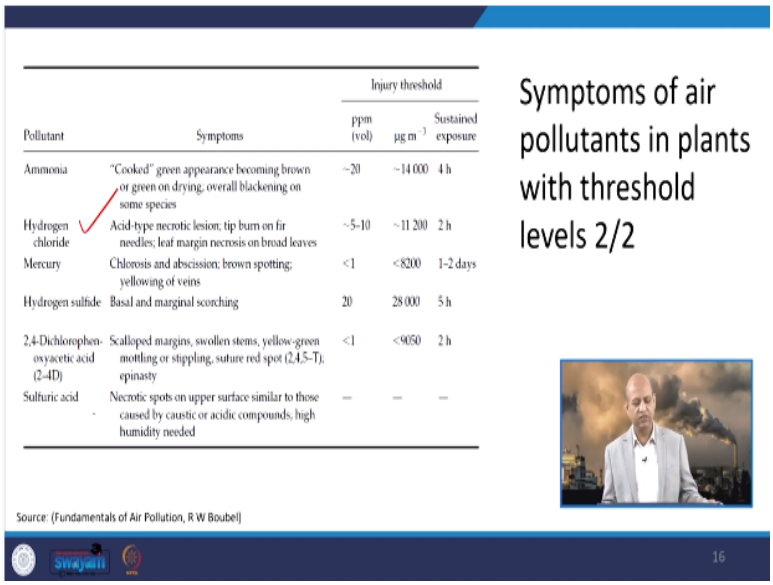

Similarly, if you see the ammonia, this cooked green appearance becoming brown or green on drying, so these are the effect of ammonia. Hydrogen chloride can have you know this necrotic kind of effect and mercury it is like chlorosis and then it can also result in brown spotting. Hydrogen sulphide can have similarly sulfuric acid because of this acidic nature it can affect the plants in a very negative way.

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Now, we talk about animals, how animals are affected by the air pollution. So, because its similar to the process like they also inhale air, so polluted air is inhaled then their respiratory system as well as other organs can get affected.

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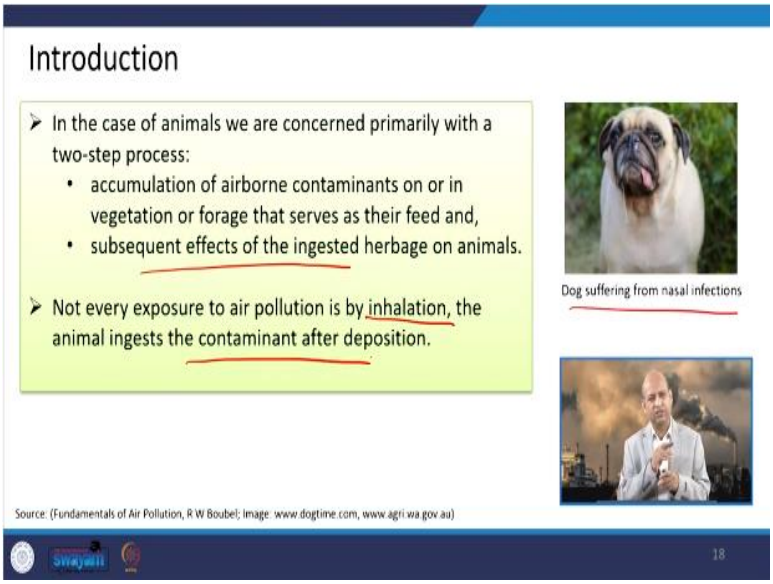

For example, if you see like this dog is suffering from nasal infections and that can be because of polluted air. Accumulation of airborne contaminants, pollutants or in vegetation or forage that serve their feed, so through that also they consume these pollutants and these subsequent effects ingested those on animals, so they get affected negatively, but not every exposure to air pollution is by inhalation, it can go through injection, through skin, through other pathways also.

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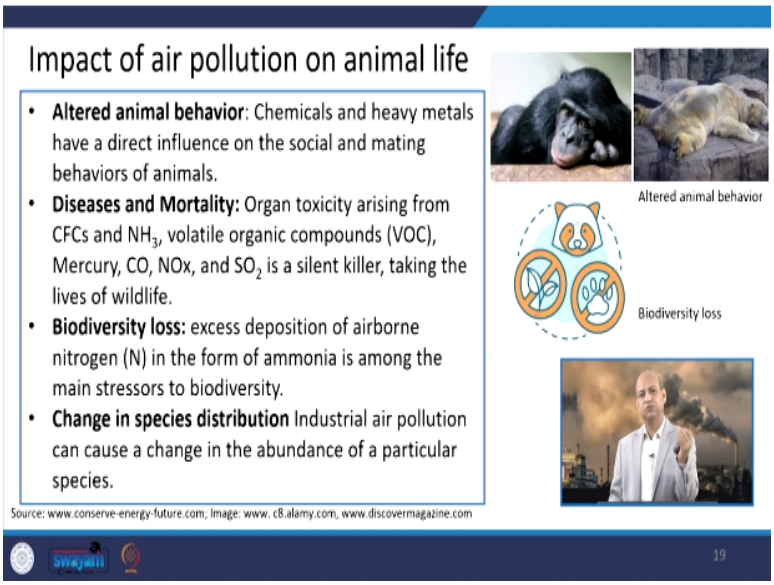

Well it can also make unhealthy living like their moods can be affected, they can be depressed, their behavior can be altered, so the chemicals and heavy metals and they have direct influence on the social and mating behavior of animals. So if that is kind of pollution is there their whole cycle can be affected, then there can be several diseases and that can result into mortality or death and that can come through like NO or SO_2 they are kind of silent killers for these wildlife animals because even small concentration they get accumulated into their body and their system get affected very negatively.

Biodiversity loss is there because if certain species getting affected by a particular pollutant in a severe way and if they are reducing in number, so the whole chain get affected in this ecosystem, then their population and their food chain all those things get affected.

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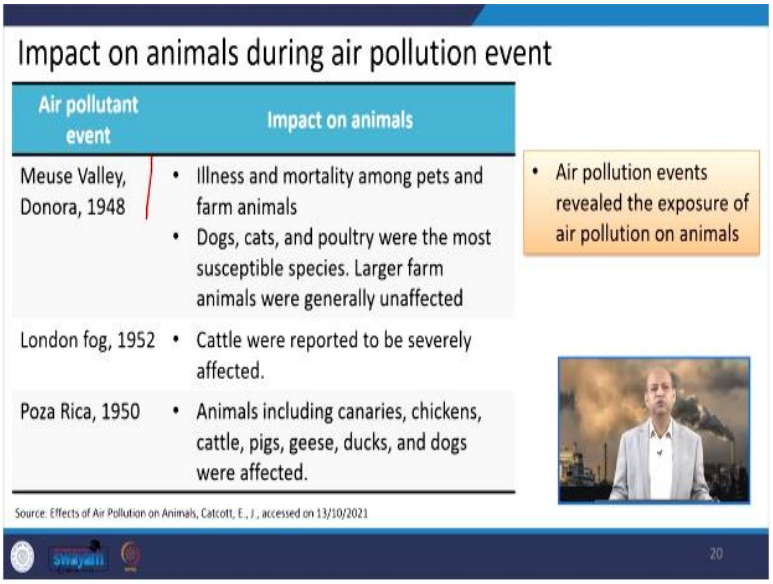

When we talk about these examples where animals got exposed to air pollutants and the negative impacts were observed, so like these examples we have discussed in case of human health impact also but they were also responsible for negative impacts on animals, like this Meuse Valley incident in 1948, so it caused illness and mortality among pets and farm animals. Dogs, cats and poultry were the most susceptible species in that sense and the larger farm animals were generally unaffected because of their sturdy nature.

Then in London Smog the cattle were reported to be severely affected because of that London Smog that we know about and this Poza Rica 1950 incident or episode you can see these animals including canaries or chickens, cattle, pigs, all geese or ducks, dogs all over affected, means across all these population.

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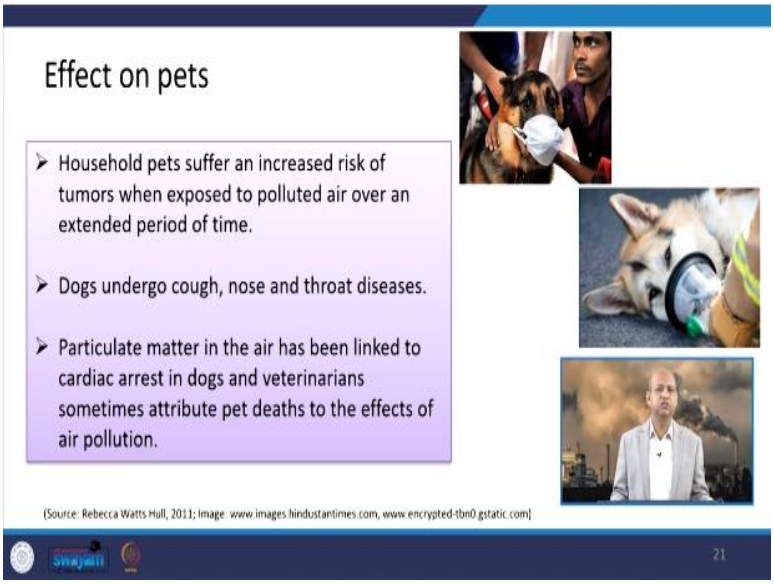

When we see the effects on the pets, household pets suffer an increased risk of tumors when exposed to polluted air over an extended period of time, so those kind of things may happen, then they can go coughing and nose and throat disease infections etc in polluted environment and then particulate matter in the air this has been linked to cardiac arrest, like heart attack as it happens in human beings also and many veteran doctors they say that these pet deaths are related to air pollution, high air pollution levels.

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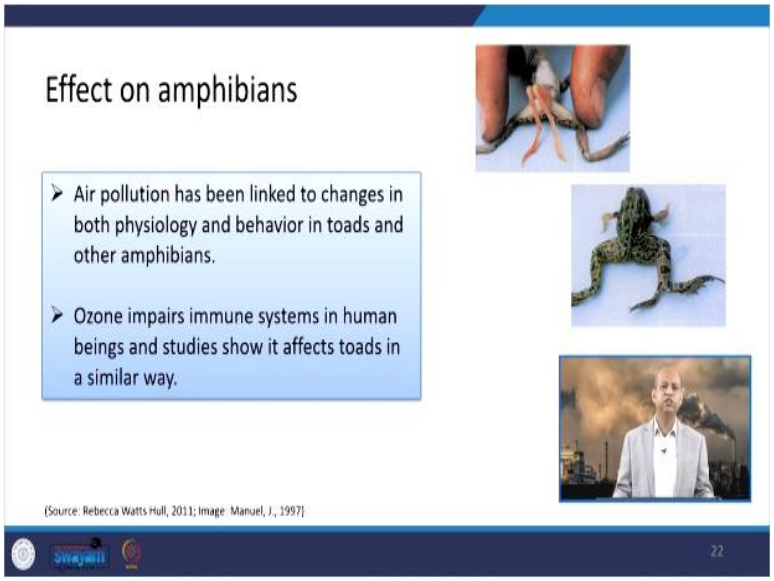

When we talk about these amphibians, so they have again similar effects or changes in physiology as it does in case of human beings and ozone basically impairs this immune system in human beings as well as in these like toads etc.

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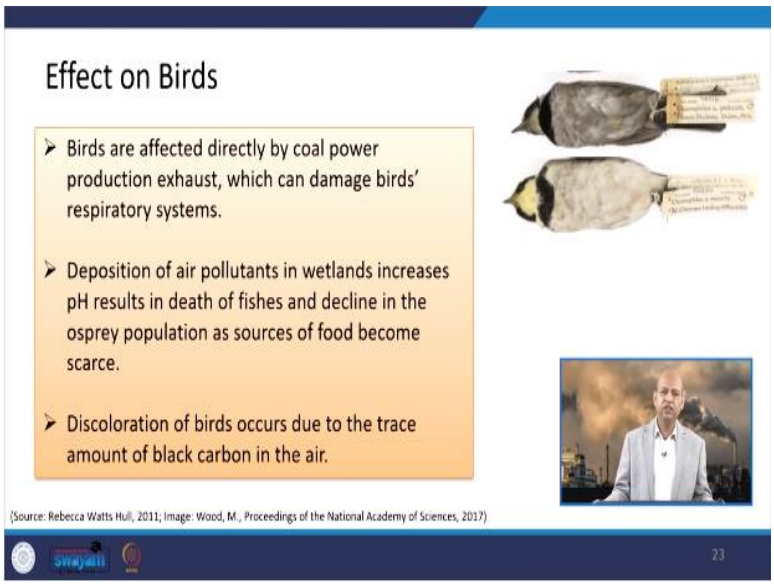

Well when we talk about the birds, so birds are affected directly by coal power plant emissions, those if they are not controlled, if high concentration of sulphur dioxide is

coming out or particulate matter is coming out, so they can damage the birds respiratory systems.

So the whole system get affected and their reproductivity also get affected, their behavior get affected from morning to evening those kind of things, the deposition of air pollutants in wetlands, this can increase the acidity, it can reduce the pH and it can cause the death of the fish and that can result into a reduction of population of those preys which are dependent on these eating the fish. Then discoloration of birds occur because of black carbon in the air and other pollutants this can happen.

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When we talk about the fish, so acid rain falling in rivers and streams they can cause the pH levels to decrease and very low level of pH is not fit for aquatic life, so they can kill the fish and if they are dependent on the, its general range of the pH so fluctuation of pH they cannot really bear or tolerate those kind of things, acidic rivers and streams that can cause respiratory distress in fish, so that is also a problem.

Similarly, the acidic water is generally clear or cleaner, so the sunlight goes deep into that so it increases the temperature and there are certain fish population which are very sensitive to the temperature, if temperature increases beyond certain limits, so again they

are not happy there and they get into stress and maybe their behavior will change or they will migrate.

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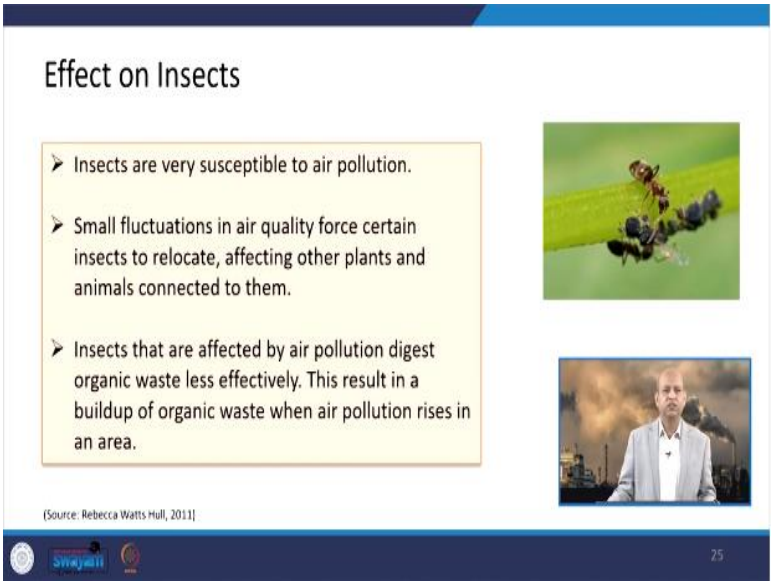

So, then we can see the insects behavior or impact on the insects as you know like people say that the best biological indicator to find whether the environment is clean or not, air is clean or not see the small insects, if you find lot of this bio diversity, small insects and all those kind of things there, so that means the environment is healthy, air is healthy, so small fluctuations in air quality that can force certain insects to relocate, they cannot tolerate the changes in that particular air pollution level and they can affect the plants also because the life of plants and insects are very much integrated kind of symbiotic life you can say, so then the plants affected.

Then animals also affected because they are dependent on the plant diet, so insects which are affected by air pollution they digest organic waste less effectively and then that can result into build up of organic waste when air pollution rises in the area, so butterfly or small insects if you do not find somewhere you should be worry, it is a very some condition because that may be an indicator that air pollution or other pollution may be high in that particular region.

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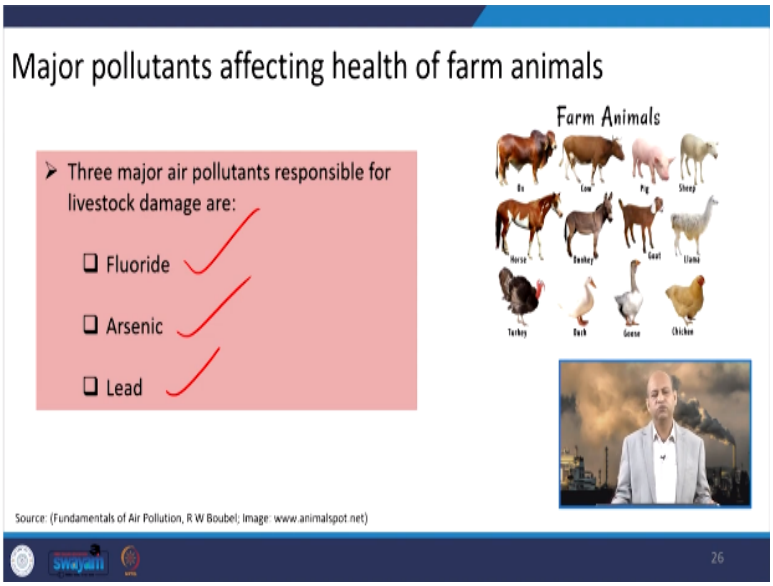

When we talk about major pollutants which affect the health of animals, so basically like three major air pollutants are responsible for livestock damage because they are quite big in size and their interaction with air pollutant is different than the like fish or insects or those small animals. So the fluoride, arsenic and lead these are the three very toxic pollutants which can affect this farm life or farm animals.

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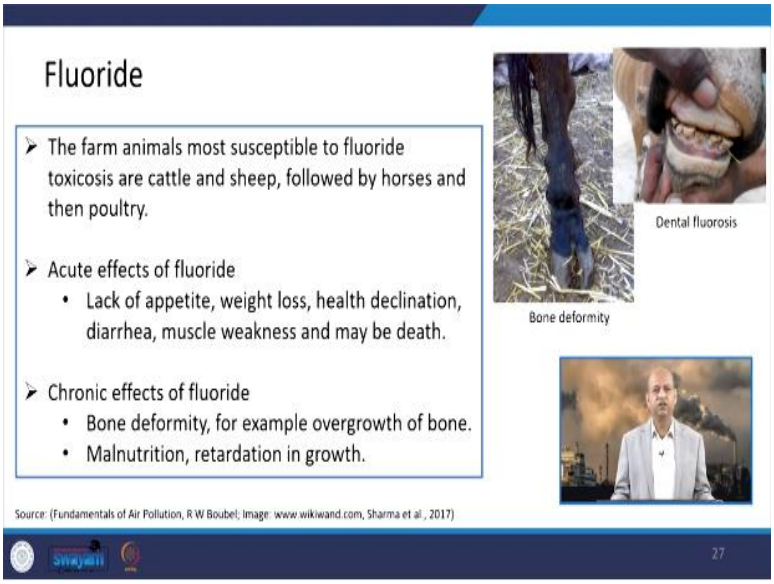

Like fluoride the farm animals they are most susceptible to fluoride because it is very toxic and particularly cattle and sheep and even horses and this poultry they can affected by fluoride, and the acute effects of fluoride result in lack of appetite, weight loss because they do not eat properly and then health declination, diarrhea or muscle weakness or ultimately they can die.

Similarly, chronic effect means longer duration of exposure that kind of even small concentration but for longer period, if chronic effect is there that can result into deformity of the bones and overgrowth of the bones also can be there in certain animals and malnutrition or retardation in the growth, all those symptoms are there because of these fluoride.

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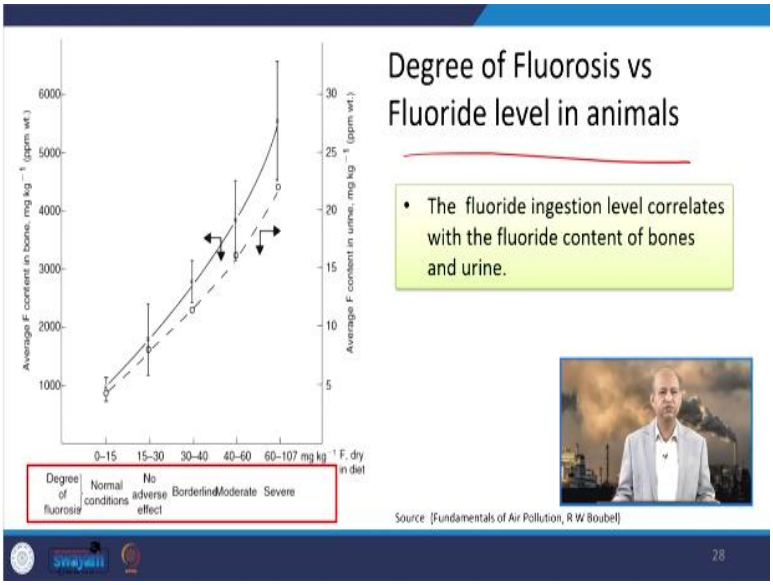

Then when we see the average, this fluoride content in bones and this degree of fluoresces and fluoride level in animals, so this kind of relationship occurs, so this is based on certain study, so you can see the fluoride ingestion level correlates with the fluoride content of bones and urine, so it directly affects, it directly affects their complete body structure.

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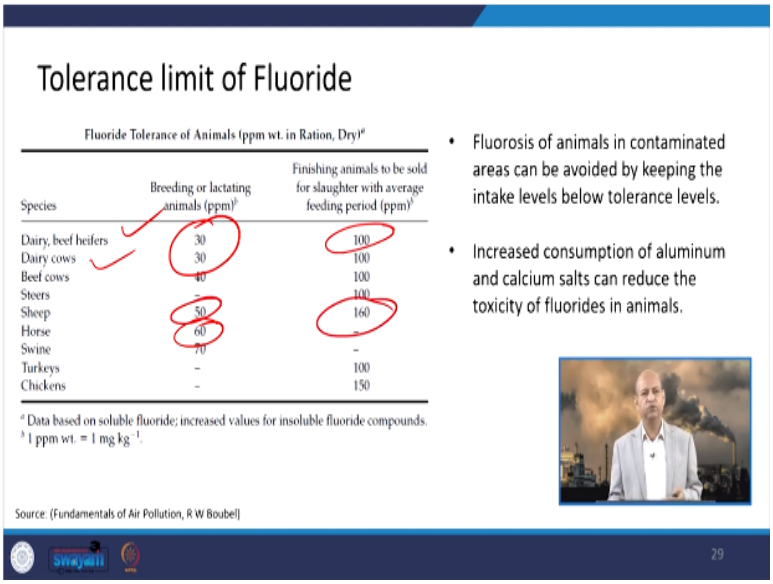

When we talk about tolerance limit of fluoride, so different animals have different tolerance limit and it is also defined as per their status like breeding or this breeding animals they are allowed only very small 30 ppm for dairy cows and beef cows and horses they can tolerate up to 60 ppm, means breeding, breeding kind of but when they are ready to be sold after certain age, so their concentration may be higher like 100 ppm or so in case of sheep for breeding it is 50 ppm and when it is to be sold it can be 160 ppm, so that depends upon the age of the animal and the state of the animal.

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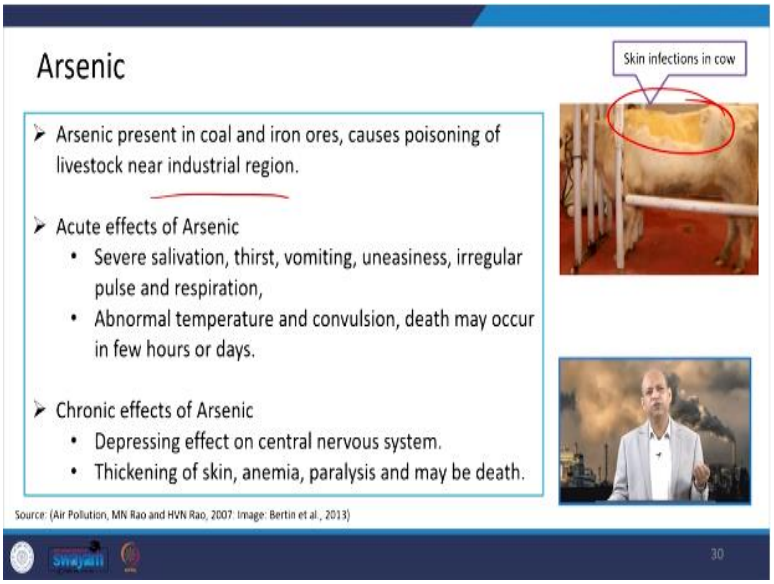

Well when we talk about arsenic this can cause skin diseases, skin infections and it is present in coal and iron ores, so it can cause poisoning of livestock near industrial region because it can get exposed to that pollutant. Acute effects of the arsenic may result in severe thirst and vomiting kind of thing, irregular pulse and respiration those kind of problems, abnormal temperature and it can cause even death after certain hours or days.

When chronic effect is seen of the arsenic then the depressing effect is there, central nervous system get affected and you find that animals are not behaving properly, they are depressed, they are lazy and the thickening of skin, anemia, paralysis and even the mortality occurs because of chronic effect of arsenic.

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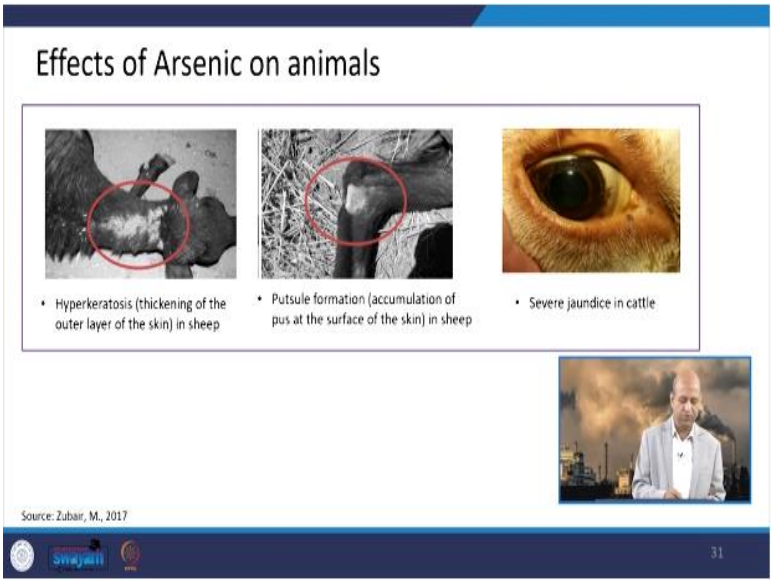

When we see the effects of arsenic on animals the visual effects you can see thickening of this outer layer of the skin can be there, similarly accumulation of pus may be there at surface of the skin and severe jaundice can also be caused because of arsenic exposure.

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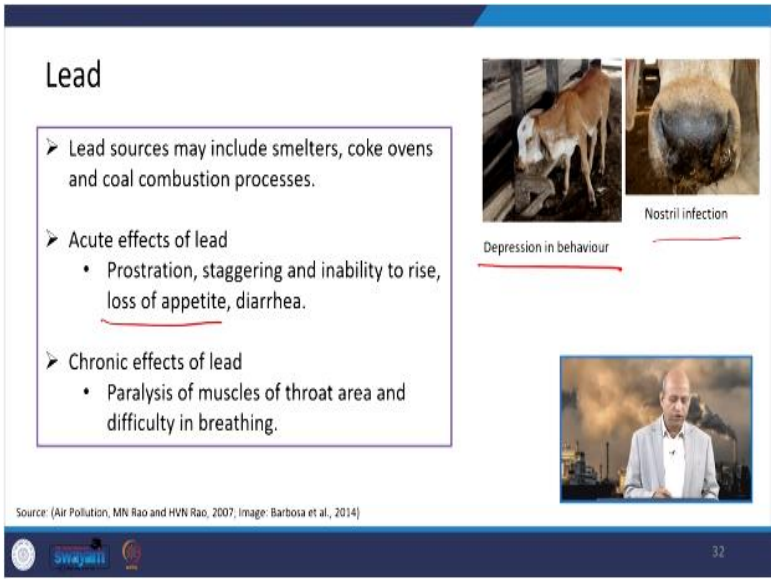

When we talk about the lead, lead is very important in that sense because it is very harmful, it can cause depression behavior and this nostril infection can also be there because of lead exposure and the sources of lead can be like smelters, coke ovens and

coal combustion processes, so in nearby areas the possibility may be the lead present in the air.

Acute effects can be there, means it can be present in particulate matter coating or those heavy metals may be present there, this prostration can be caused because of acute exposure then staggering or inability to rise, they are not able to rise, loss of appetite, diarrhea those kind of effect can be because of acute effects of the lead concentration.

Chronic effects of the lead can result into paralysis of muscles, of the throat area, so difficulty in breathing, difficulty in eating, so again these are life threatening kind of problems arise from the lead.

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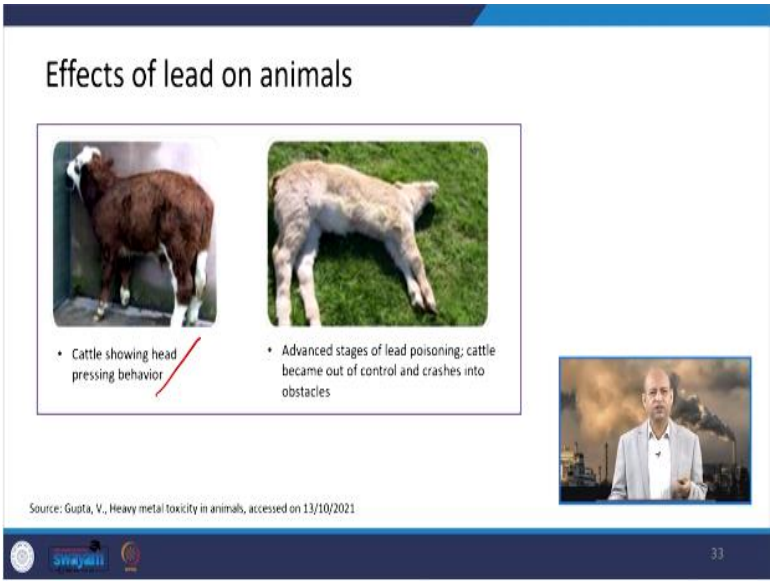

And the effects of the lead you can see like cattle showing head pressing behavior, so if you are finding some cattle they are going towards the wall and hitting the wall those kind of things and then you can think that maybe lead position may be there in the body and advanced stages lead poisoning can result into out of control behavior and it can crashes into obstacles, means they cannot focus, they cannot control their movements and they can fall down or they can try to some other things.

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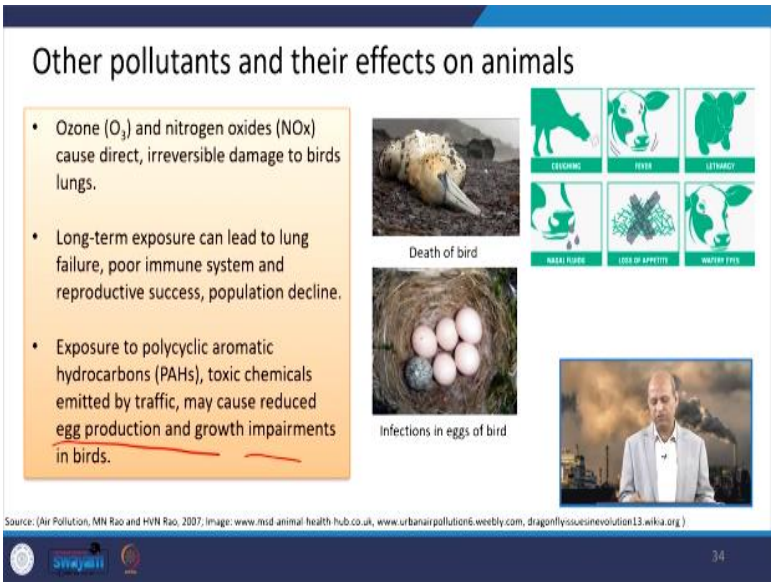

Other pollutants and their effects on animals can be seen in this particular table, ozone, nitrogen oxides they can cause direct or irreversible damage to birds and their lungs. Long term exposure can lead to lung failure or poor immune system and this reproductive success or population decline, all those negative impact can be there, then exposure to PAH polycyclic aromatic hydrocarbons and the toxic chemicals they can enter through different pathways and they can reduce the egg production or the growth impairments, you can see the infection also they can be there.

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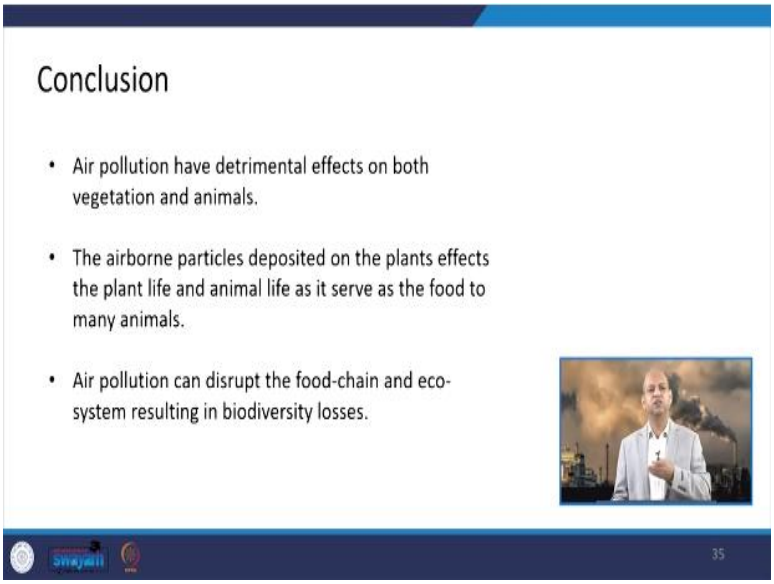

So different kind of effects can be there from different air pollutants, so in conclusion we can say that the air pollution has very detrimental effects on both vegetation as well as animals and the airborne particles deposited on the plants they affect the photosynthesis process and they can affect plant life and then in subsequently animal life can also be get affected because they are dependent on plants for food, so the food chain get affected.

Air pollution can also disrupt ecosystem in larger scale, they can cause the biodiversity losses etc. So thank you for your attention, for this lecture on impact of air pollution on vegetation and animals.

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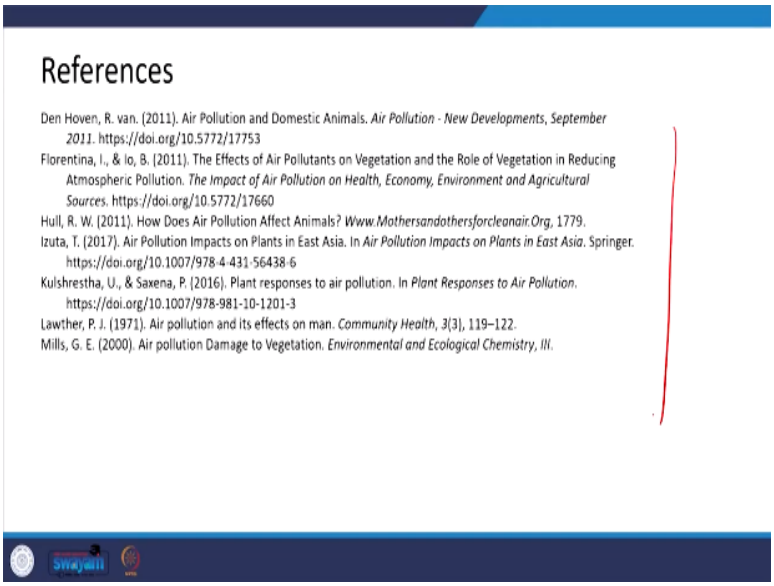

So, these are the references you can go through to get additional information, thanks a lot, see you in next lecture, thanks.