Availability and Management of Groundwater Resources
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Lecture - 55
Impact of Climate Change on Water Resources

Welcome you all in the part 1 of the model 12 impact of climate change on water resources. So, for we have discussed the different issues related with the water availability and its management. Now, we will discuss on the issues related to the climate change and its impact on water resources.

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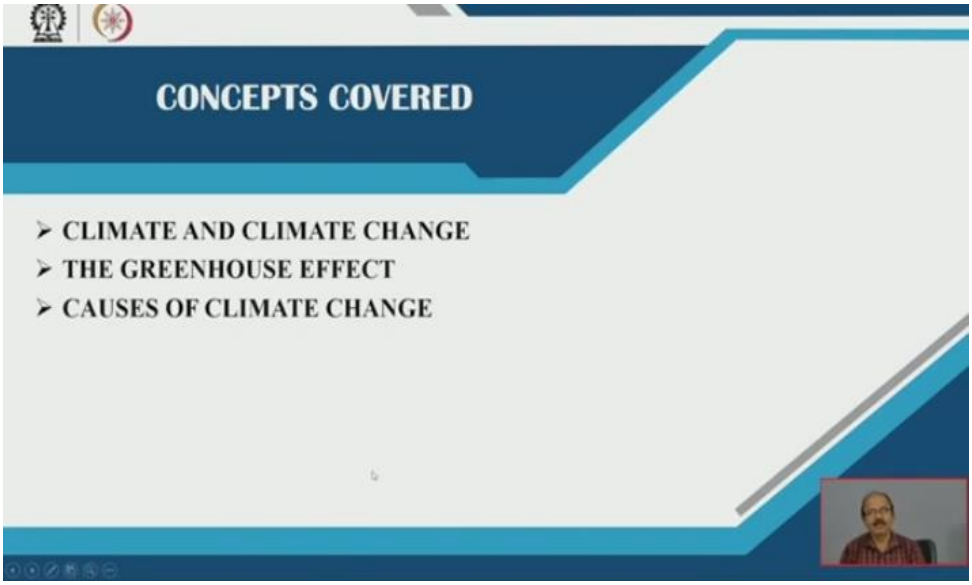

So, in this part, I will discuss the climate and climate change, the greenhouse effect and the causes of climate change.

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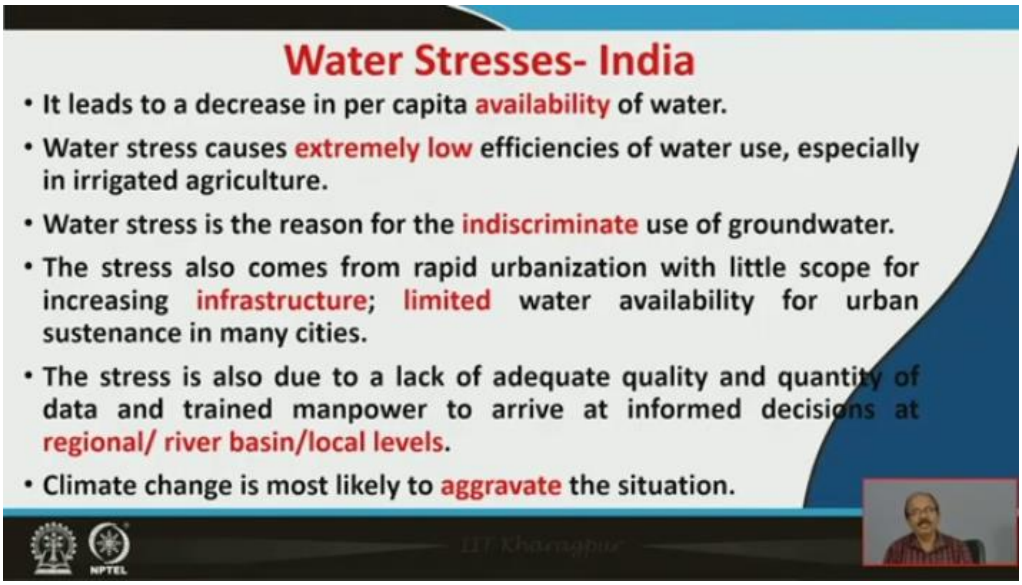

Now, we have seen in the past lectures I have discussed we have seen that the subject itself is a very important theme, that water availability and its management. We are knowing the aspects we are knowing the characteristics of the atmosphere also, we are knowing the activities of the atmosphere also that we are having the hydrological cycles and within the hydrological cycles, we are having the different parameters, different parameters are very very related to each other among each other.

And these are generally giving us the pathways for the recharge of the groundwater inside the aquifer. But, in some places, we have also seen the other side also that the water bodies generally remain ground water bodies generally remains in certain rock formations. And these rock formations are some types of rocks, which are having the characteristics of 4 spaces as well as some pathways, for the transmission of the water from one rock to another rock, which are the characteristics we have discussed as permeability.

Now, the point is that these rocks are holding the water, but it is not essential it not ensure that at every place a stable of rocks will be available in which the water will remain stored there, it is also not sure that each and every place will have the same volume of rainfall and the different periods of the years. So, for these regions or we can also see in some different ways, all the points we have discussed in the previous lectures, we can also see that the levels of the water the volume of the water in certain areas, if the rocks are having the ability to store the water.

If the rocks are having the ability to store the water, but the amount of the water stored is comparatively less than the activities for which the water are being extracted. So, in that case, what will happen there will be the water stress in the area, because demand is more but your requirement your volume of water will be less. So, in that case, we are getting we are facing the water stresses in India also and it leads to decrease the per capita availability of water, water stress leads to decrease the per capita availability of water.

Water stress causes extremely low efficiencies of water use especially in irrigated agriculture area. Water stress is the region for the indiscriminate use of groundwater. So many wars, you can see for the use of groundwater and because they are people are facing the water stress condition. The stress also comes from rapid urbanization with little scope for increasing infrastructure, limited water availability for urban sustenance in many cities.

So, the stress is also due to the lack of adequate quality and quantity of data, and trained manpower to arrive at informed decisions at regional levels, river basin levels or local levels. Climate change is most likely to aggravate the situation that will see the background because what are the causes of the water stresses the climate change is playing a very important role for just enhancing such type of stress condition all over the area in India also.

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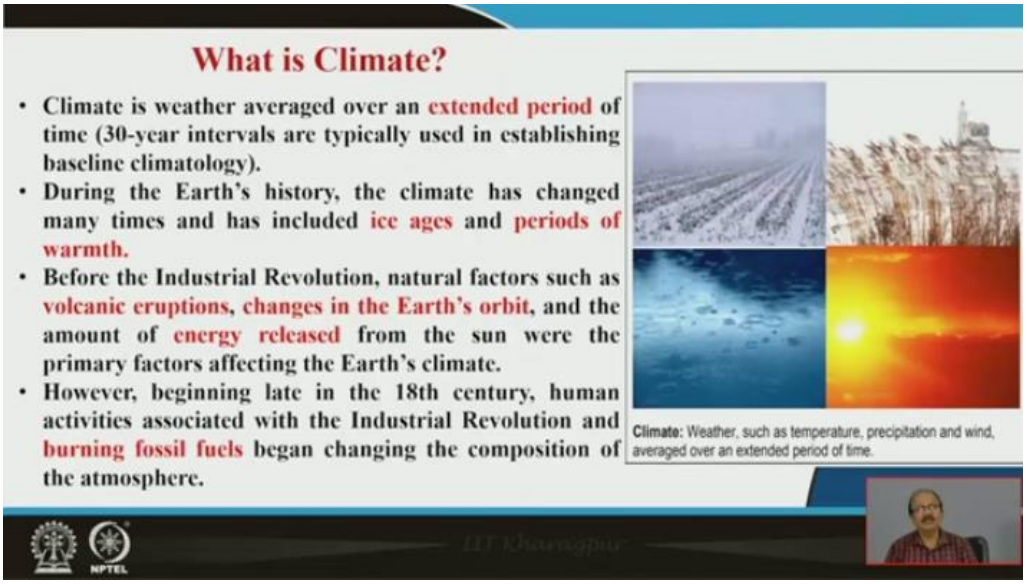

Now the point is what a climate change what is climate? Climate is whether the average over an extended period of time, say 30 year intervals are typically used in establishing baseline climatology. During the Earth's History the climate has changed many times and has included ice ages and periods of warmth. So, the Earth history reveals that periodically there was the change in the climate.

Before the Industrial Revolution, natural factors such as volcanic eruptions, changes in the Earth's orbit and the amount of energy released from the sun were the primary factors affecting the Earth's climate. So, these are the volcanic eruptions, changes in Earth orbit and amount of energy released from the sun. These are some of the factors which are natural factors these are some of the natural factors which are affecting the Earth's climate.

However, beginning late in the 18th century, human activity associated with the industrial revolution and burning fossil fuels began changing the composition of the atmosphere. So, earlier the natural factors before it was a revolution, the natural factors were the major factors for the change of the earth climate. Now, after 18 century, what the Earth had noticed that because of the anthropogenic activities, human activities, along with the natural factors are just composing the change in the Earth's climate, by burning of fossil fuels.

Or by other different activities created by the human beings also, so, this whole in totally change the climate of the local levels as well as the regional levels.

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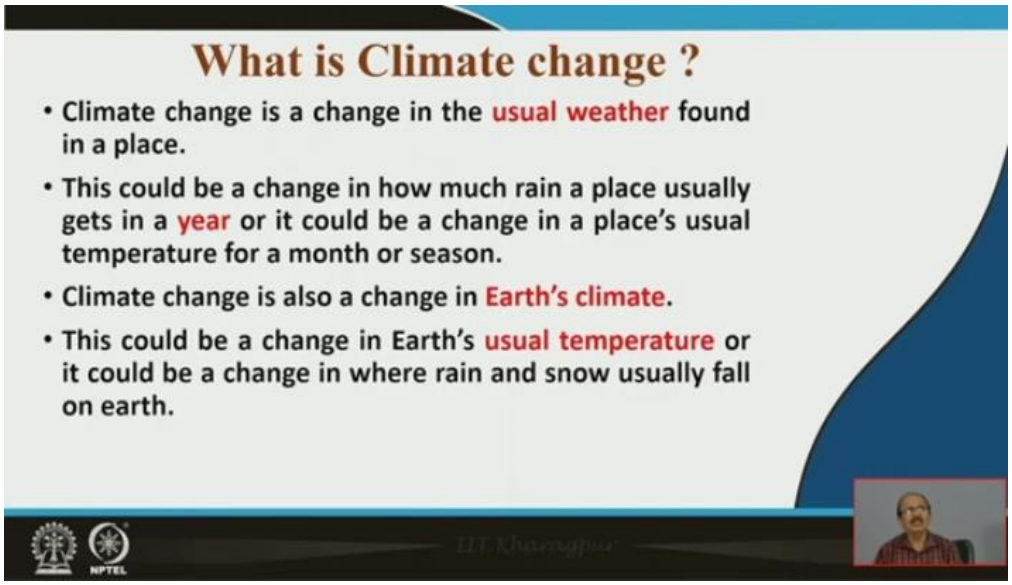

Now, what is climate change? Climate change is a change in the usual weather conditions in a certain place. What is the normal weather condition just it is changing, this could be a change in how much rain a place usually gets in a year or it could be changed in place usual temperature for a month or season? So, it has been noticed that a place which we are getting very good amount of rain are having the erratic pattern very bad rain pattern in the area.

Why it has taken place, because of the change in the climate or some places where earlier in the normal temperature conditions has now the temperature increases too much in the area. Why such change in temperature has taken place because of the change in the climate. So, climate change is also a change in your climate and this could be a change in our usual temperature or it could be a change in where rain as snow usually fall on the earth.

So because if there will be less rain, then we have seen the if there will be less rainfall then the infiltration population of rainwater will be less then what will happen the accumulation of groundwater because itself we have seen in the discussion of the hydrological cycle and the gradual and different chapters what we have discussed related to the water availability that the major amount a major component of the rainfall waste is having the wastage like surface runoff to a distant places.

Even evaporation and transpiration is also just returning the water to the atmosphere back. So, very few amounts of water is reaching to the Earth's surface, but if there will be the irregular rain pattern what will happen there will be less rainfall and if there will be less rainfall then there will be lesser chances of having the replenishment of groundwater inside the Earth's surface within an aquifer.

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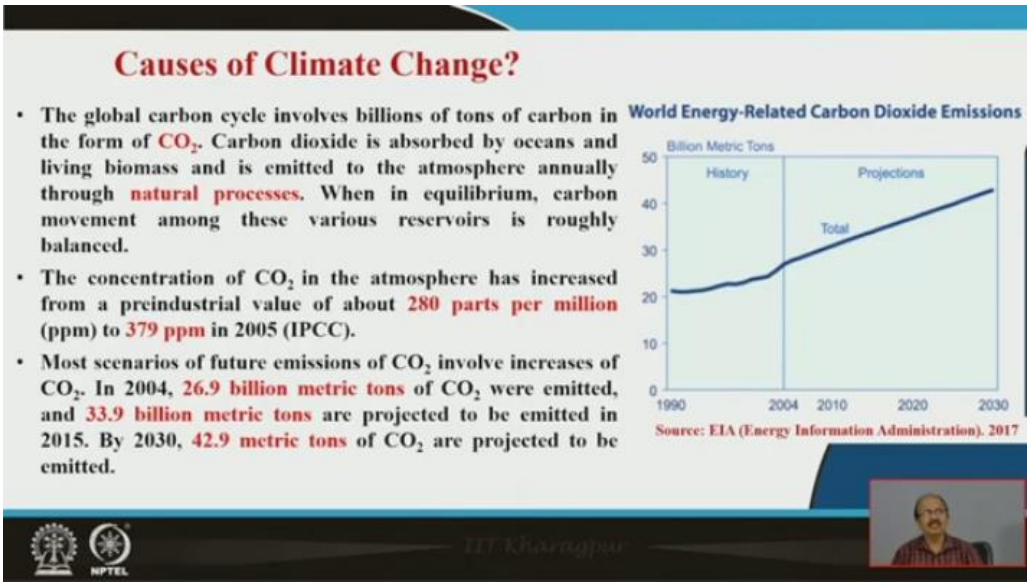

Now, what are the causes of climate change, the global carbon cycle involves billions of terms of carbon in the form of CO_2. We are knowing that in the atmosphere we are having the CO_2 as well as oxygen. So, the carbon cycle also involves billions of tons of carbon in the form of CO_2, CO_2 absorbed by oceans and living biomass. This is absorbed by the oceans and living biomass and is emitted to the atmosphere annually through natural processes.

So, again, it is coming to the atmosphere. When in equilibrium carbon movement among these various reservoirs is roughly balanced that time it will be roughly balanced, the concentration of CO_2 in the atmosphere has increased from a preindustrial value of about 280 parts per million to 379 ppm in 2005. So, earlier it was 280 parts in ppm the concentration of CO_2 and then now it has increased to 379 ppm in 2005 so the concentration of CO_2 as increase in the atmosphere.

Most scenarios of future emission of CO_2 involve increases of CO_2 in 2004 26.9 billion metric tons of CO_2 were emitted. And 33.9 billion metric tons are projected to be emitted in 2015. And

by 2030, 42.9 metric tons of CO_2 are projected to be emitted. So, these projections are given here. And most of the emission of CO_2 generally met is giving us the increasing trend in the atmosphere.

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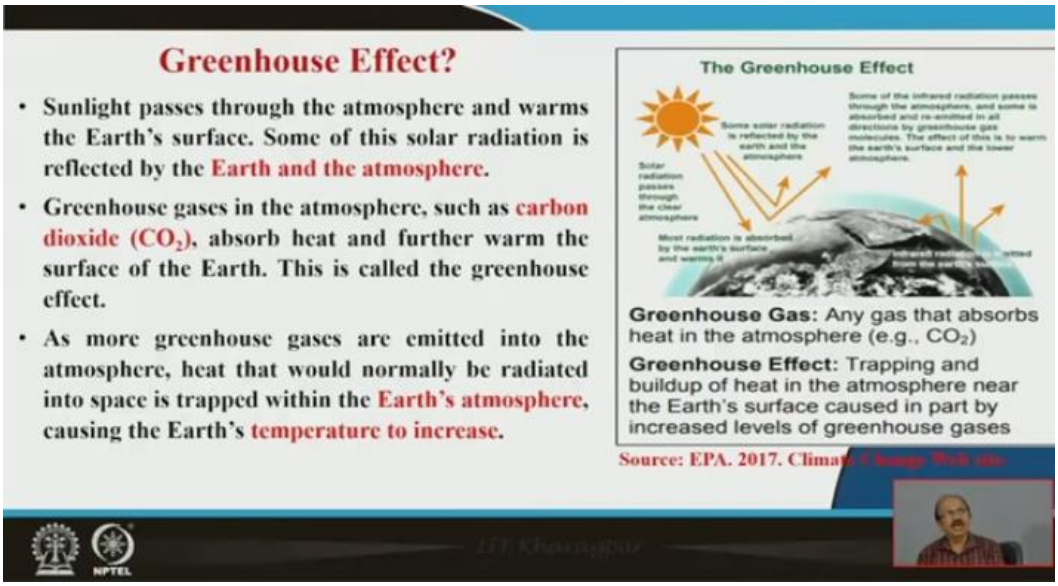

So, this is one of the reasons of the climate change increasing carbon dioxide concentration. Now, greenhouse effect, we know there is a sun light passes through the atmosphere and warms the Earth's surface. So, it is warming the earth's surface some of this solar radiation is reflected by the Earth and atmosphere also. Greenhouse gases in the atmosphere such as carbon dioxide absorb heat and further warm the surface of the earth.

So whatever the greenhouse gases remaining in the atmosphere, they are just absorbing the CO_2, just absorbing the heat and further warming the surface of the Earth, which is called as the greenhouse effect. As more greenhouse gases are emitted into the atmosphere, heat that would normally be radiated into space is trapped within the Earth's atmosphere, causing the Earth's temperature to increase.

That is why the Earth's temperature is gradually increasing, we can see that trapping and buildup of heat in the atmosphere near the Earth's surface caused in part by increased levels of greenhouse gases.

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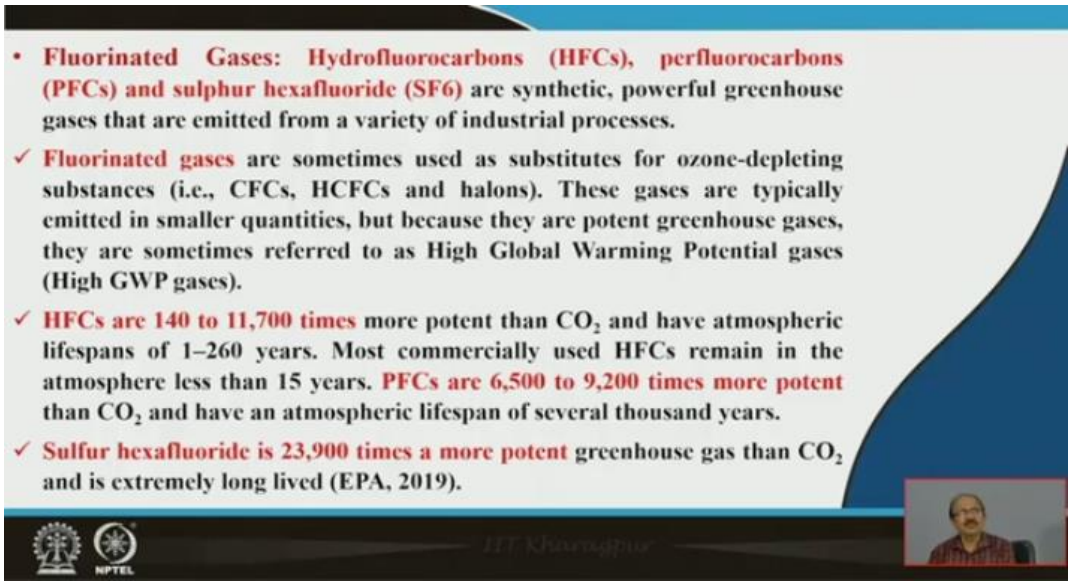

So, this is now the question is what are the greenhouse gases that trap heat, which just trapped the heat in the atmosphere are called greenhouse gases. CO_2 is the principal greenhouse gas but other gases can have the same characteristics of heat trapping effect, some of these other greenhouse gases are have a much stronger greenhouse gas or heat trapping effect than CO_2 is the methane. Methane is CH_4 for methane is 21 times more potent greenhouse gas than CO_2.

So different greenhouse gases have different atmospheric lifetimes and therefore actions to reduce emissions will take place and the time to affect the reductions of gases in the atmosphere. So these different types of greenhouse gases have different atmospheric lifetimes it remains in the atmosphere for certain duration. And during that time, when it is remaining in the atmosphere, action to reduce emission will take time to effect reductions of gases in the atmosphere.

The principal human generated greenhouse gases that enter the atmosphere are CO_2, CO_2 into the atmosphere through the burning of fossil fuels as well by that is the oil natural gas and coal.

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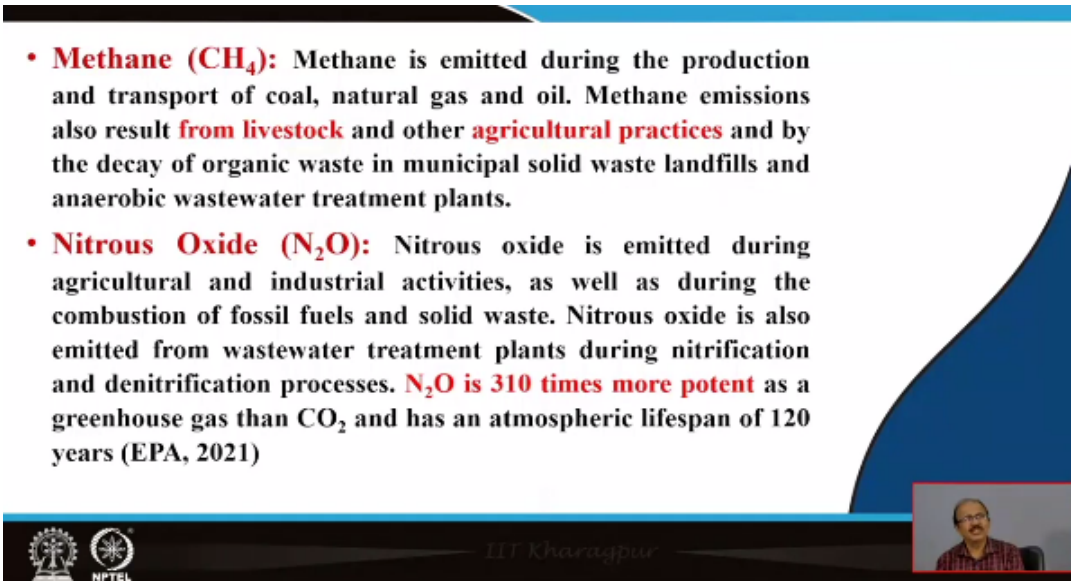

Methane is emitted during the production and transport of coal, natural gas and oil. Methane emissions also result from livestock and other agriculture practices and by the decay of organic waste in municipal solid waste landfills and anaerobic wastewater treatment plants. Nitrous oxide is the second greenhouse gas is emitted during the agriculture and industrial activities, as well as during the combustion of fossil fuels and solid waste.

Nitrous oxide is also emitted from wastewater treatment plants during nitrification and denitrification processes N_2O is 310 times more potent as a greenhouse gas than CO_2. And has an atmospheric lifespan of 120 year as per the EPA 2021.

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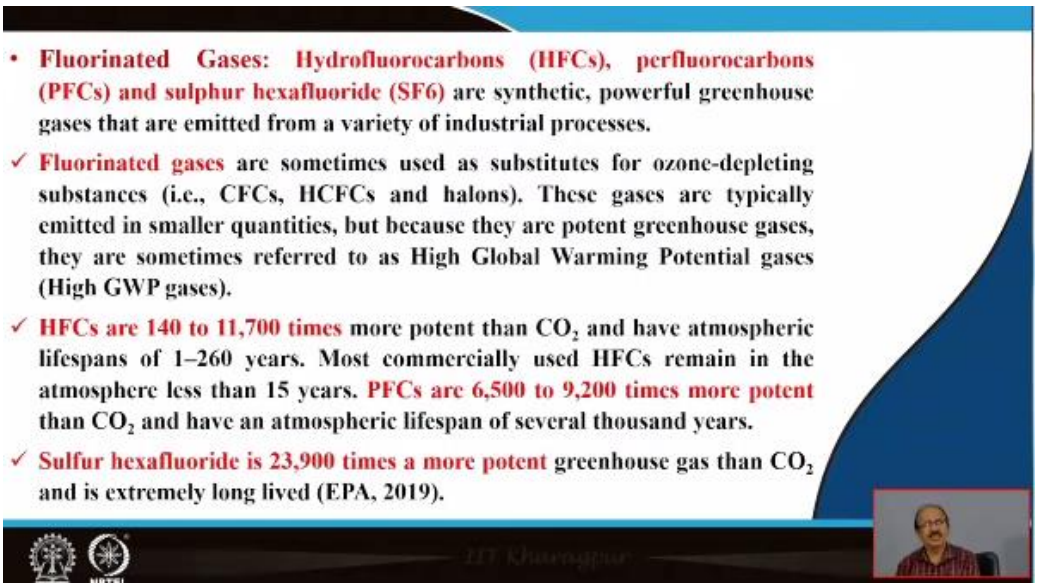

Now fluorinated gases, Hydrofluorocarbons HFCs perfluorocarbons and sulphur hexafluoride are synthetic powerful greenhouse gases that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for ozone depleting substances CFCs these gases are typically emitted in smaller quantity, but because they are potent greenhouse gas, they are sometimes referred to as high global warming potential gases and potential gases.

Now HFCs are 140 to 11,700 times more potent than CO_2 and have atmospheric lifespans of 1 to 260 years. Most commonly or commercially used HFCs remain in atmosphere less than 15 years PFCs are 6500 to 9200 times more potent than CO_2 and have an atmospheric lifespan of several 1000 years. Sulfur hexafluoride is 23,900 times more potent than greenhouse gas than CO_2, an extremely long lived in the atmosphere.

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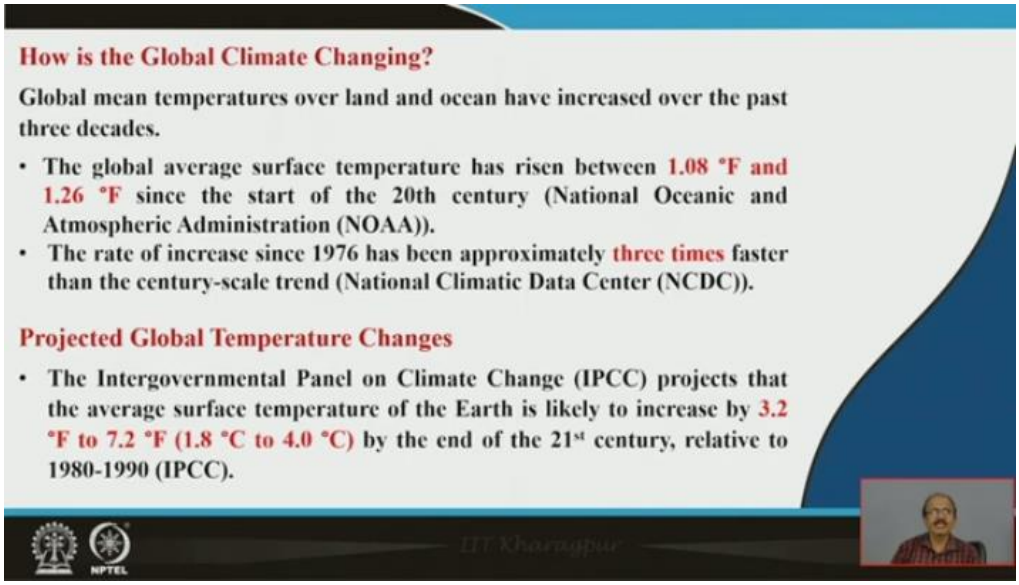

Then the question is how is the global climate changing? Because of the change in the global climate, it is also putting impact on the water sources. So global mean temperatures over land and ocean have increased over the past 3 decades we will see the record of the past 3 decades it has been noticed that the global mean temperatures over land as well as on the ocean are increasing. Global average surface temperature has risen between 1.08 °F to 1.26 °F since the start of the 20th century.

That is the NOAA National Oceanic and Atmospheric Administration. The rate of increase since 1976 has been approximately 3 times faster than the trend century scale it is the comment of by the National Climatic Data Center NCDC. Projected global temperature changes the Intergovernmental Panel on Climate Change IPCC projects that the average surface temperature of the Earth is likely to increase by 3.2 °F to 7.2 °F that is 1.8 °C to 4.0 °C.

By the end of the 21st century, relative to 1980 dash 1990. So, this is a projected global climate temperature it can seven from 3.2 °F to 7.2 °F.

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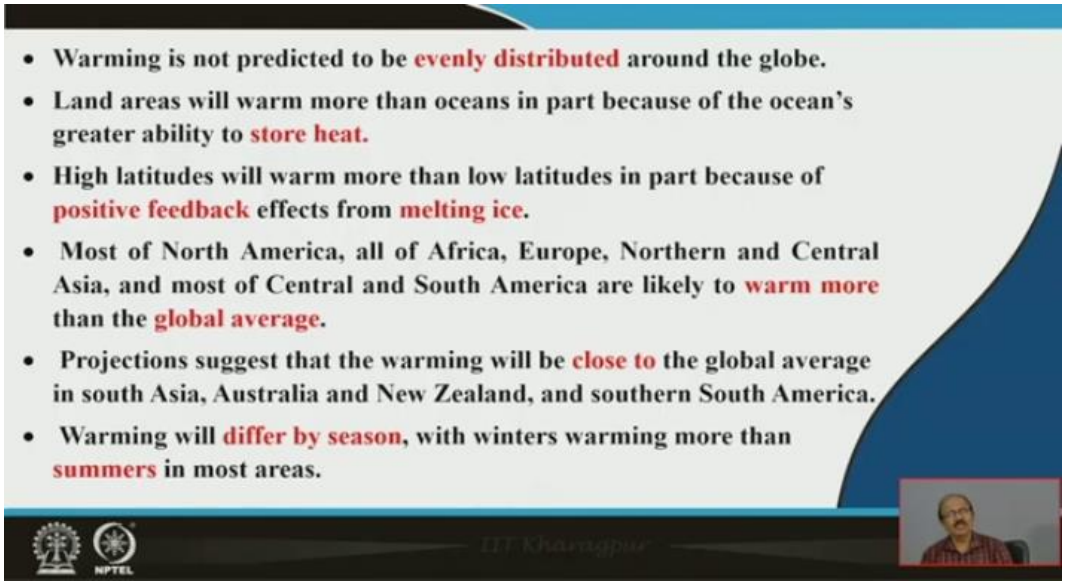

Now warming is not predicted to be evenly distributed around the globe. So it is not sure that the warming will remain equal all across the globe. Never land areas will warm more than ocean in part because of the oceans greater ability to store heat. So land area will become much more will have much more heat than the ocean because the oceans are having the availability to store the heat. High latitudes will warm more than low latitudes in part because when you take feedback effects from melting ice.

Most of the North America all of Africa, Europe, northern and central Asia and most of central and South America, are likely to warm more than the global climate. Projections suggest that the warming will be close to the global average in South Asia, Australia and New Zealand and

southern South America. But warming will differ by season it will differ by season with winter warming more than summers in most areas.

So, it is warming will differ by season with winters warming more than summers in most. So, it has been shown that the warming is generally differs from season to season. And it has also been sown that the winters warming more than the summer in most areas because of this global warming only. So warming is not predicted to be, remain even redistributed all across the globe and other high latitudes are warming more than the low latitude part because of the change in the climate effects.

So, whatever we have discussed, this is all about the water sector and the impact of climate changes in these sectors only. Thank you very much to all.