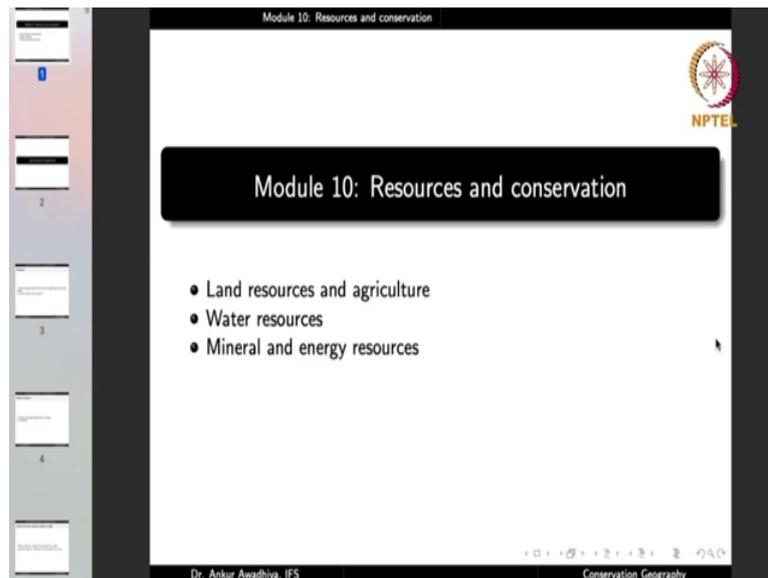


Conservation Geography
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Indian Institute of Technology Kanpur
Module - 10
Resources and Conservation
Lecture – 28
Land resources and agriculture

Namaste! Today we begin a new module which is resources and conservation.

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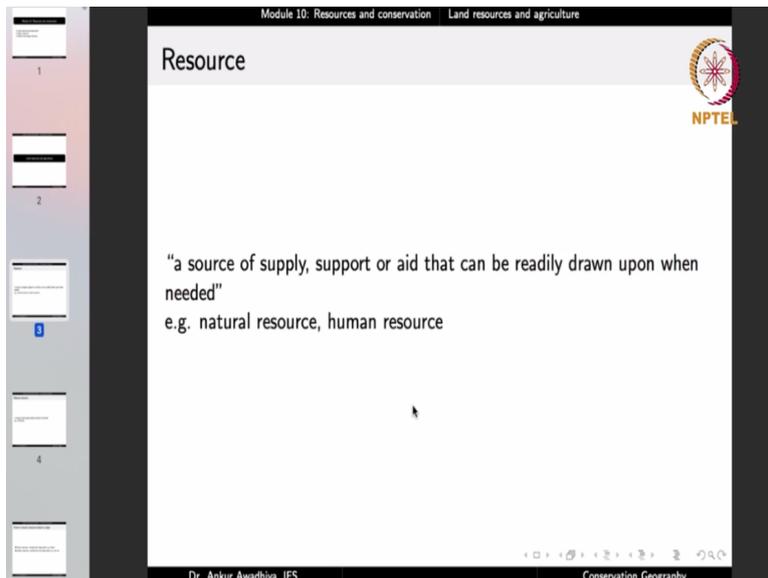
This module will have three lectures land resources and agriculture, water resources and mineral and energy resources.

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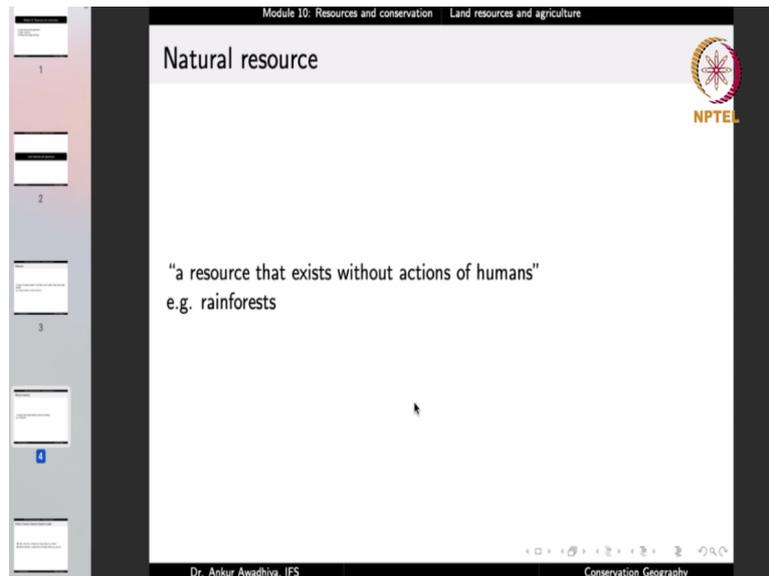
So, let us begin with land resources and agriculture. Now, when we talk about resources the first question that comes to mind is what is a resource? When do we call something as a resource?

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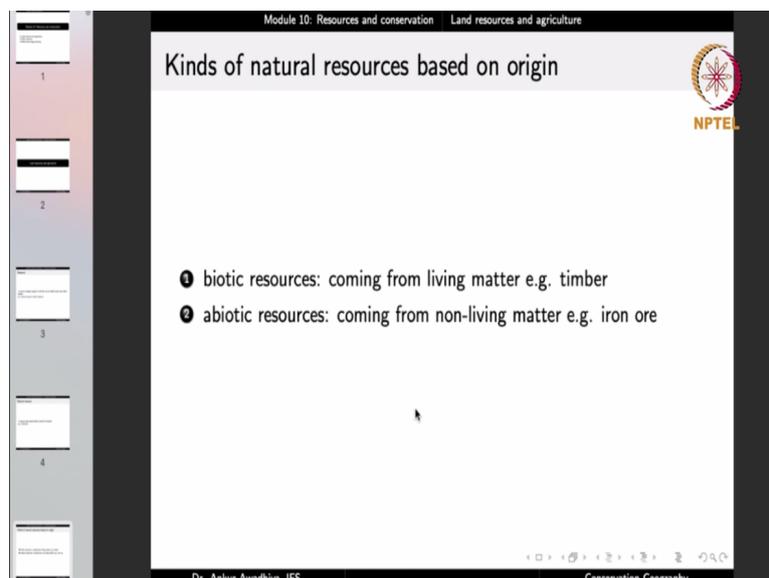
So, a resource is defined as a source of supply, support or aid that can be readily drawn upon when needed. So, a resource is a source; source of supply of something, support or aid and the good thing about the resource is that it can be readily drawn upon when needed. So, you can use this particular source when you needed. Examples include natural resources and human resources.

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So, a natural resource is a resource that exists without the actions of humans. So, we do not need to do anything and they exist because of which they are in natural resources it includes rainforest.

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Now resources can be differentiated or classified in several ways on the basis of their origin we can have biotech resources. Now, biotech resources are those that come from living matter or from biological things such as timber. So, if you have a forest and this forest has lots of trees then this is a resource because you can make use of the timber. So, this forest is a source of a supply; supply of timber that can be readily drawn upon when you needed.

So, if you need timber you can always go to the forest and harvest the timber because of which your forest is a natural resource. Now this is a natural resource, but among the natural resources this is a biotech resource because this timber is coming from biological organism in this particular case trees. Now together with biotech resources we also have abiotic resources those that come from non-living matter such as iron ore.

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Module 10: Resources and conservation Land resources and agriculture

Kinds of natural resources based on renewability

NPTEL

- 1 renewable resources: those resources that can be replenished naturally e.g. sunlight
- 2 non-renewable resources: those resources that either form slowly or do not naturally form at all in the environment e.g. coal

Dr. Ankur Anandhig, IIS Conservation Geography

Another classification is on the basis of renewability. So, we have renewable resources and non-renewable resources. Renewable resources are those resources that can be replenished naturally such as sunlight. So, when we talk about sunlight we have sunlight every day. So, nature is replenishing the supply of sunlight because of which it is a renewable resource, it is a replenishable resource.

Another resource is a non-renewable resource those resources that either form slowly or do not naturally form at all in the environment examples things like coal. Now coal takes millions of years to form. So, it is formed so slowly that if you use of all the coal sources or all the coal reserves that you have then it will again take millions of years to produce the next supply of coal and because of this we call it a non-renewable resource.

The nature is not able to renovate soon enough. So, on the one hand when we talk about the renewable resources we will never run out of them because the nature is replenishing them whereas when we talk about non-renewable resources then we may very easily run out of them and once we have used up our stocks then we may have a situation where there is no more of the non-renewable resource that is left.

And even more so because nature either does not produce it now or when nature produces it, it produces it at such a slow pace that it does not matter.

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Module 10: Resources and conservation Land resources and agriculture

Kinds of natural resources based on stage of development

NPTEL

- 1 potential resources: those resources that may be used in the future e.g. oil that has not been drilled
- 2 actual resources: those resources that are currently being used after surveying, quantification and qualification e.g. timber from forest
- 3 reserve resources: the part of actual resources that can be developed profitably in the future e.g. low concentration ores
- 4 stock resources: those resources that have been surveyed but we lack the technology to use them e.g. hydrogen for nuclear fusion

Dr. Ankur Anandhig IES Conservation Geography

Then on the basis of the stage of development we can have resources classified into four categories. So, we can have potential resources those resources that maybe used in the future example oil that has not been drilled. So, we are not currently using that oil, but we can use it in future because of which it is a potential resource. Then we have actual resources those resources that are currently being used after surveying, quantification and qualification such as timber from forest.

So, if there is a forest and we are taking timber out of it then it becomes an actual resource because it is currently being used and typically we make use of a resource after surveying quantification and qualification because we need to know how much of the resource do we have, where do we have it and of what quality do we have it. So, when we talk about actual resources those are the resources that are actually currently being used.

Then we have reserve resources. It is the part of the actual resources that can be developed profitability in the future example low concentration ores. So, when we do a mining operation we can have high concentration ores and we can have low concentration ores. Now high concentration ores have a higher concentration of the requisite mineral that you want typically metals.

Now because the concentration is high enough it is profitable to extract those ores and use them on the other hand there are also a large number of ores where the concentration is not high enough today. So, today it is not profitable to use those, but with advancements of

technology probably we will be able to increase our efficiency, bring their own cost and in that time it will become profitable once again.

So, those are the reserve resources they are part of the actual resources. So, they are actually currently being used, but we do not use them because they are currently non-profitable, but they can be developed profitability in the future. So, currently we do not use them we just leave them as such to come back in a later stage. Now, when we talk about a large number of mines especially those for the precious metals.

So, when we talk about things like gold mines or silver mines then currently people are going into those areas where the mines used to operate sometime in the past because in the past our technologies were even more primitive and so people could make use of only very high concentration ores and so they left those ores that had high concentration and low concentration.

Now our technologies are much more developed, so we can make use of the high concentration ores. The highest concentration ores have already been used, but the high concentration ores we are still using them, but we are leaving out the low concentration ores, probably sometime in the future it will become profitable to extract the metals from the low concentration ores as well; so these are the reserve resources.

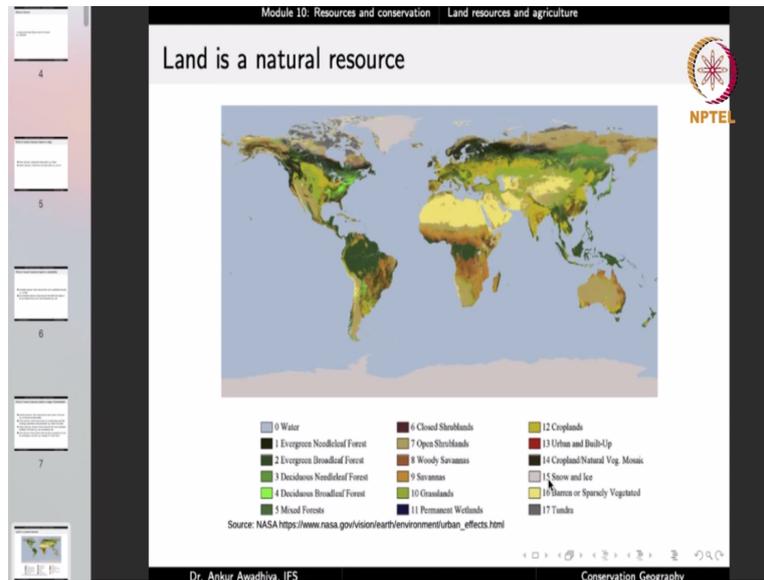
Then we have stock resources those resources that have been surveyed, but we lack the technology to use them; example, hydrogen for nuclear fusion. So, similar to the nuclear fusion that occurs in the stars we can also perform nuclear fusion on the land, a very good example is a hydrogen bomb. So, when we use hydrogen bomb we are actually using the fusion process to join hydrogen nuclei together and to produce helium.

And in this process a tremendous amount of energy is released, but currently it is only being used for destructive purposes because we lack the technology to make the energy release in a slow manner in which we can actually use it for say the generation of electricity. Now we know how much amount of hydrogen do we have on this planet because most of the hydrogen is in the form of water and we know how much amount of water we have.

But if we wanted to use this hydrogen for nuclear fusion purposes we currently lack the technology and so we will say that these are stock resources. They have been surveyed, but

we lack the technology to use them. So, on the basis of stages of development, natural resources can be potential actual reserve or stock resources.

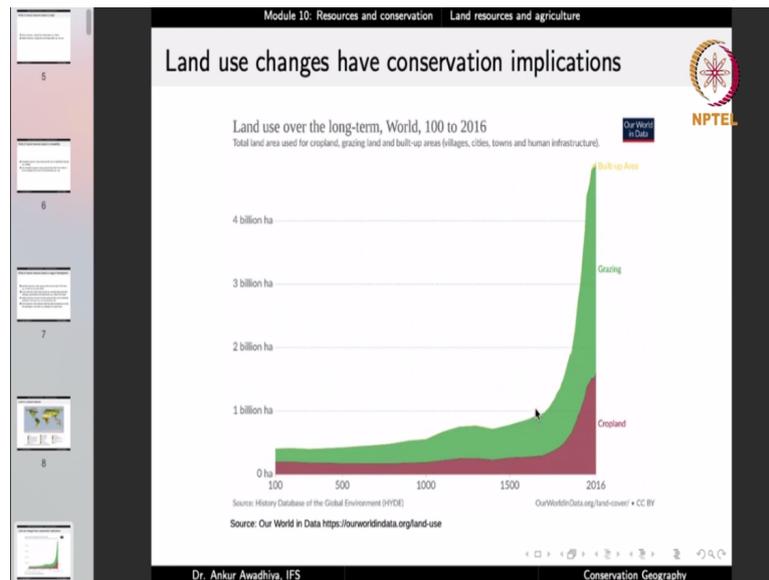
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Now one of the most important resources is land. So, land is all of the lithosphere and when we talk about land currently the land is divided or is covered by different kinds of vegetations. So, we can have evergreen needle leaf forest, evergreen broadleaf forest, deciduous forest, mixed forest and so on. Now, this is the natural distribution of vegetation on the planet, but what we humans do is that we can convert these portions for our own use.

So, for example, most of Brazil is an evergreen forest, but we can cut these forest free of the land and probably use that land for agriculture or for raising cattle. So, the land is a natural resource, but land use has been changing.

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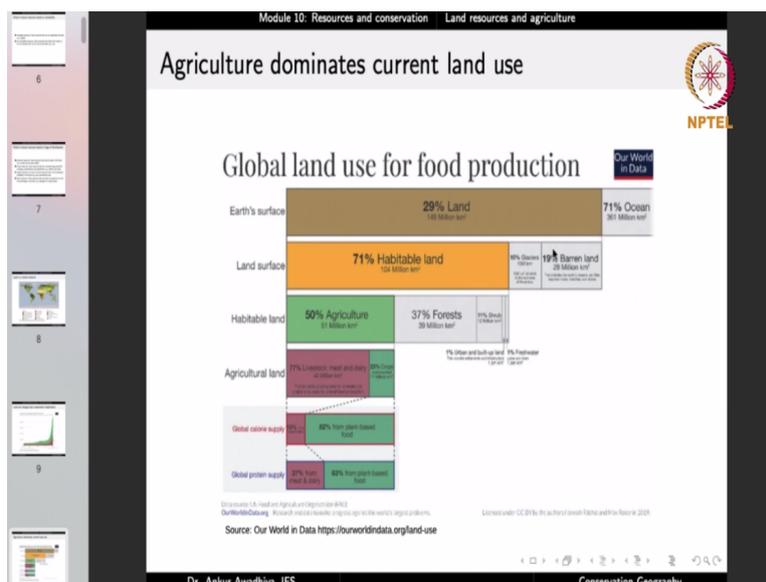
And these land use changes have large conservation implications. So, if we look at the land use over the long term. So, from 100 AD to the 21st century we will find that the proportion of land that is being used for crop lands it has been slowly rising. Earlier the rise was very little, but now with the advent of technology now we can increase it at a very fast pace. If we look at the amount of land that is under grazing that has also been increasing.

And if we look at the amount of land that is under build up area so in these regions it is very difficult to see the yellow line, but here we can very clearly discern that there is a substantial amount of built up area. Now the amounts of land or the portion of land for agriculture or for grazing or for the buildup areas they have been increasing primarily because of two things.

One our population is increasing. So, we now need more food we now need more milk, we need more houses, but even as important as this is the fact that now we have the technology to make these changes. Earlier even if somebody wanted to make a change in the land use pattern of the world they did not have sufficient resources to do that.

After all how many trees can a person cut in a single day, but today with the advent of machines we can make large scale destructions. Now this technology is permitting us to make land use changes in a very fast manner and that is giving us conservation implications and two of the major land uses today are crop land and grazing.

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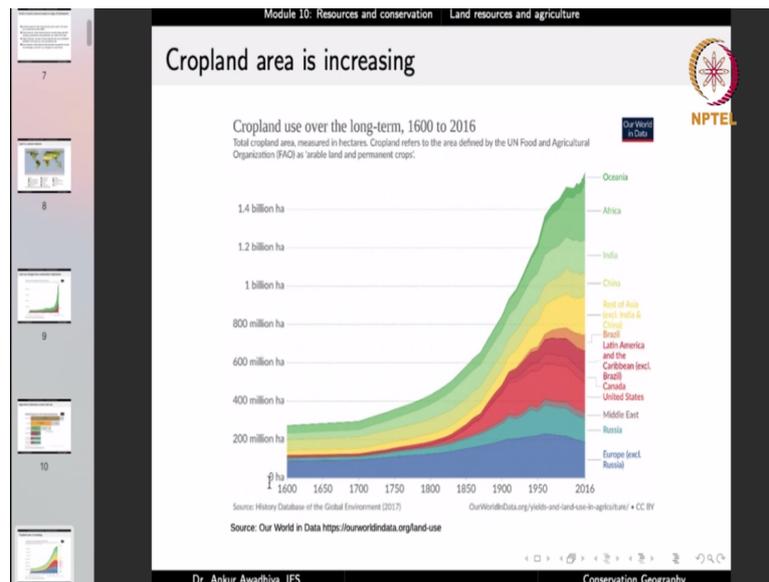
So, essentially agriculture dominates the current land use. So, if we look at the Earth surface 29 percent is land and the rest is water. Now out of this 29 percent we have 10 percent which is glaciers, 19 percent of this 29 percent is barren land and 71 percent is habitable land that is if we remove the glaciers and the barren lands this is the area that is available. So, this is 104 million square kilometers and of this 71 percent as much as 50 percent is being used by agriculture.

And 37 percent is being used by forest and rest we have the shrubs and other areas. So, of all the habitable land 50 percent is being used for agriculture. So, agriculture dominates the current land use and out of this 50 percent, 77 percent of this 50 percent is being used for livestock and dairy that is for cattle and for grazing and only 23 percent is for crops. So, crops still comprise the minor portion of the agricultural land.

But the good thing about crops is that they provide the majority share of the global calories that is they are the predominant sources of food. As much as 82 percent of the calories are being taken from the plant based foods and they are supplying 63 percent of all the global protein supply. So, the essential things to note here is that the major portion of the lithosphere is habitable land out of which as much as 50 percent is being used for agriculture.

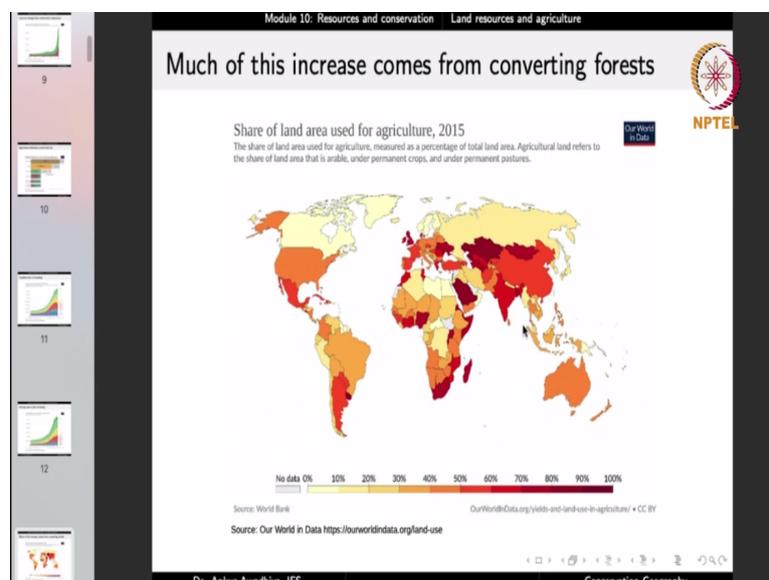
And in agriculture the dairy and animal rearing dominates, but it provides very less amount of food and it provides a less amount of proteins.

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Now, if we look at both of these we will find that the crop land use has been increasing over the years. So, in this chart we have the years so from 1600 AD to 2016 AD and on the y axis we have the area that is under cropland use and if we can find that the curve is increasing over the years and there is an increase everywhere, there is an increase in Oceania, increase in Africa, India, China all the areas we are finding an increase. Similarly, if we plotted grazing area; grazing area also is increasing everywhere.

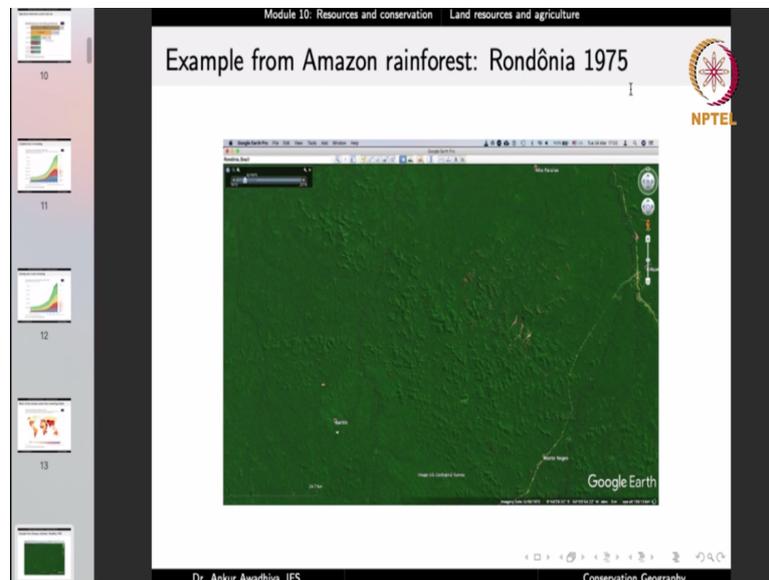
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And much of this increase is coming from converting forest. So, where do we get the land to cultivate and do rear cattle in a majority of cases we are taking this land from the forest. So,

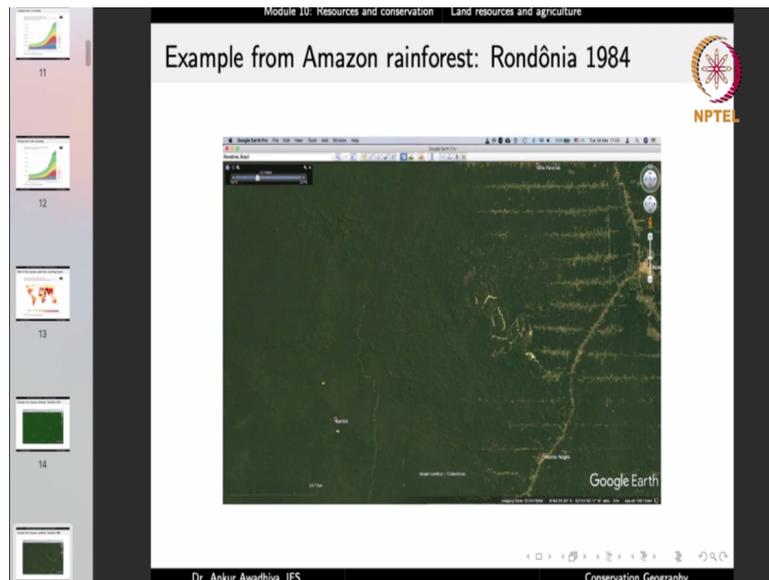
we do a clear cutting of the forest and convert that land into our crop fields or grazing areas and in a large number of countries the majority of the land area is now agriculture. In some countries as much as greater than 90 percent so in this chart we can see that in large number of countries a very great amount of land is under agriculture.

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And we can look at what kind of changes it brings about by looking at this example of rainforest deforestation. So, this is from the Amazon so this is an area in Brazil that is known as Rondonia and this is the satellite imagery of Rondonia in 1975. Now, if you concentrate on this road this is something that is going to be common in the next few images. So, this is Rondonia in 1975.

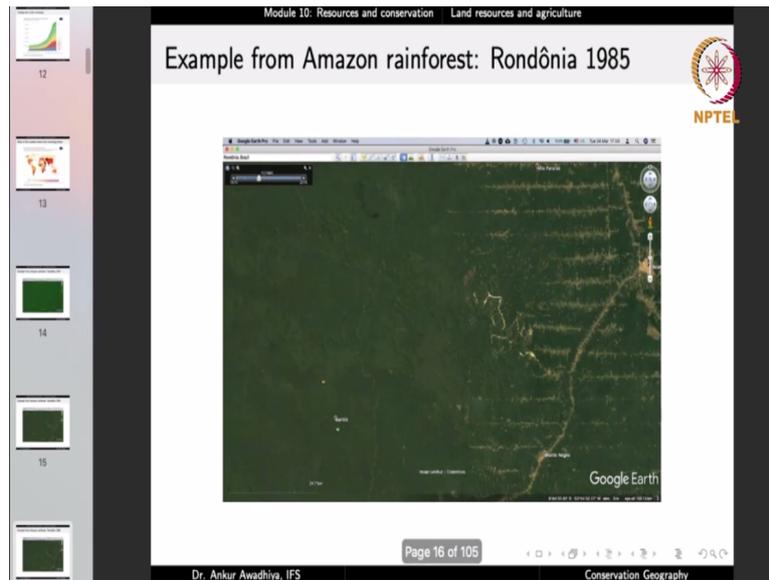
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This is Rondonia in 1984. So, in one of the earlier lectures we had talked about the impacts of linear infrastructure such as road. Once you make a road, once you have dissected a natural habitat you permit people access into the forest areas. Now this access typically brings about a large amount of destruction in the forest.

So, in this picture what we can observe is that once this road was build people had access inside and now they started to cut trees. So, there is this strip on which the major chunk of forest cutting is happening and then people are cutting on both the sides of this small track similarly here, similarly here. So, in 1975 it was all green by 1984 we are now observing large scale deforestation.

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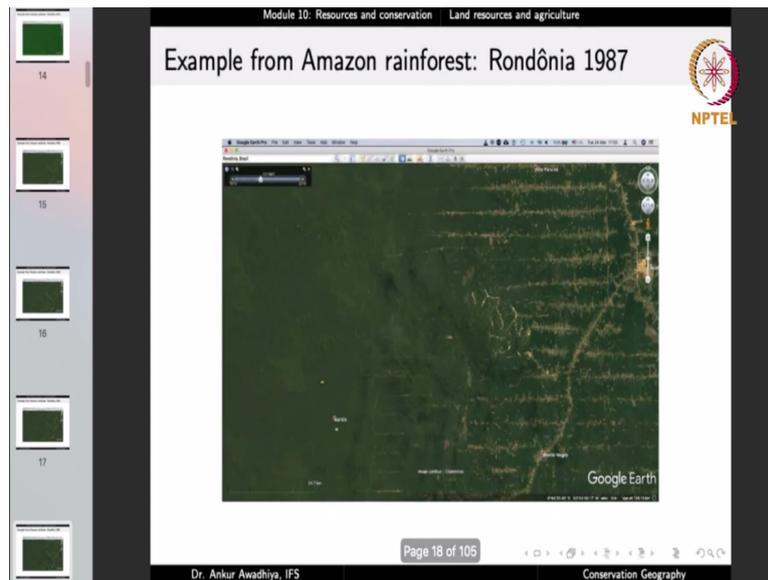
This is 1985.

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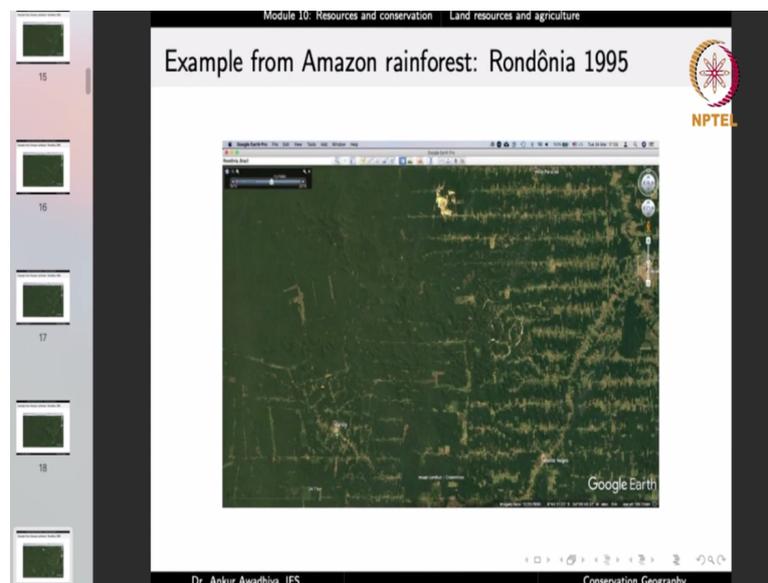
1986.

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1987.

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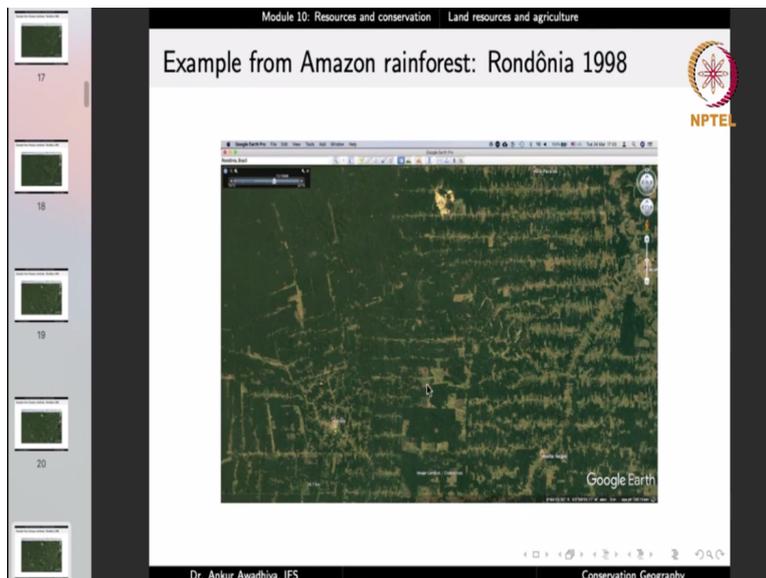
1995. Now you can observe this road is the same, but now more and more amount of area is being taken out from the forest it is being deforested.

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1996.

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1998 and now you can observe that in a large number of these areas we are now also observing agriculture both croplands and cattle rearing. So, these square shaped plots are very commonly observed when the land is shifted into agricultural purposes.

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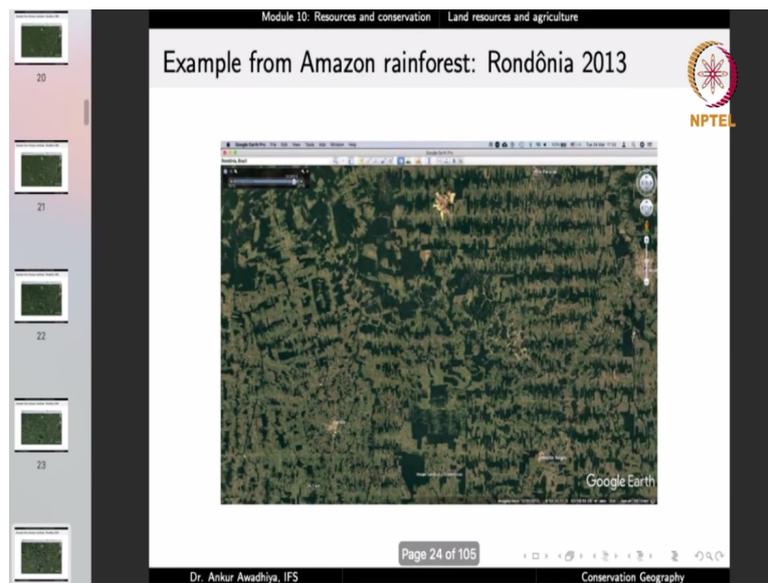
So, 2002 now you see that these crop lands are now also increasing. Now you will again make a correlation with the habitat fragmentation that we were talking about. So, once you have people that have entered into the forest area now they will require certain lands to make their own needs. So, the people who have entered inside they also need food supply so they will start with a small field or they will say keep a few cattle and slowly and steadily this portion will increase to the detriment of the natural forest. So, this is Rondônia in 2002.

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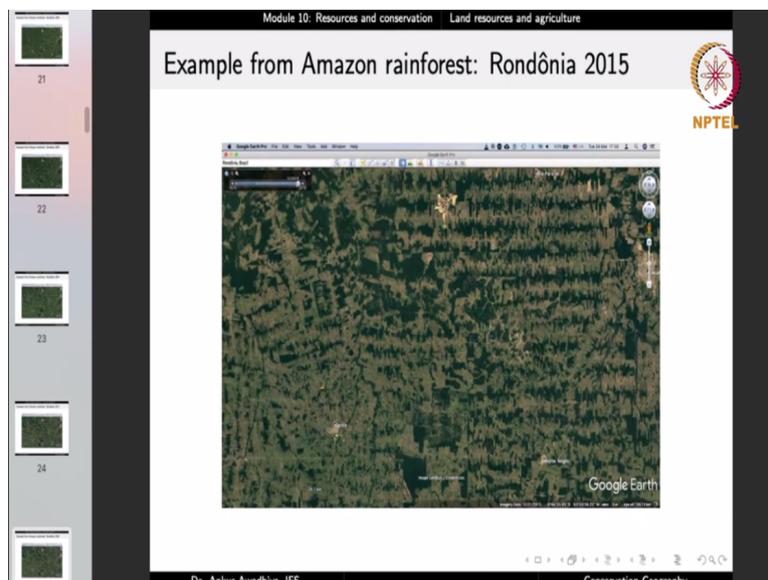
This is 2007.

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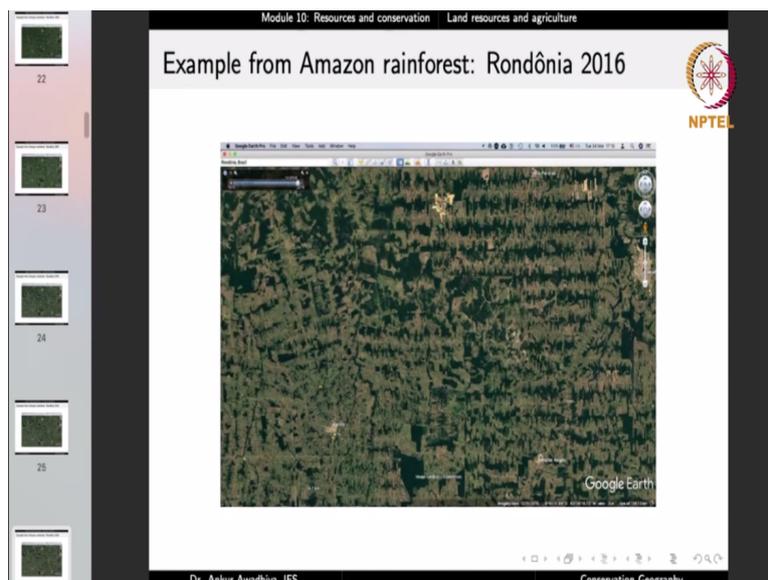
This is 2013.

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2015.

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2016. So now hardly any portion of the forest is left. So, you will remember that we had talked about things like attrition. So, the small patches that are left of the natural forest they are now getting more and more smaller because people are eating away into these forests. They are using up these forest not just for timber, but also they need the land for cultivation and for cattle rearing.

So, this is Rondonia in 2016 so this is Rondonia in 1975 and this is Rondonia in 2016 and here again if you track this road. This road is the same in 1975 and in 2016 we still have this road which led to this large scale destruction of the forest. Now once this forest has been destroyed there will be large scale ecological imbalances which we are already observing in large portions of the world.

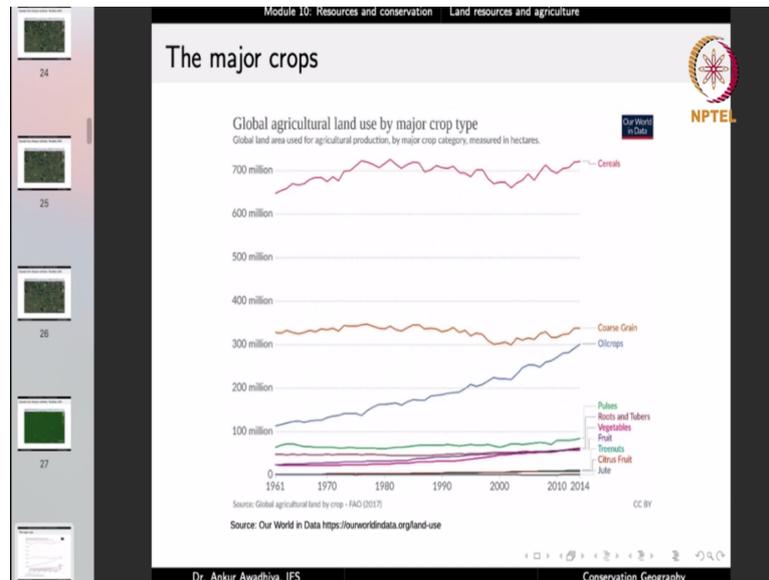
Once these areas have been cleared the soil moves away, the biodiversity gets lost, we are finding more and more amounts of floods, more and more amount of sediments that are getting deposited in different areas and so on. At the same time in this deforestation had not occurred these forest were a storehouse of carbon, they were doing carbon sequestration during the process of photosynthesis and taking carbon dioxide from the atmosphere and storing it in their bodies in the form of biomass.

But once this area is cleared then all of this carbon has been lost. Now not only because the wood once it has been removed it decays or it is burnt, but also because when you have a well functioning ecosystem quite a lot of carbon is also stored in the soil in the form of decaying

matter in different stages. So, once the tree cover is lost all of that carbon in the soil is also released back into the atmosphere and today when we talk about global warming.

When we talk about climate changes, a very big portion of the carbon is also coming from these deforestation activities. So, agriculture has huge impacts on land use and also on the functioning of different ecosystems.

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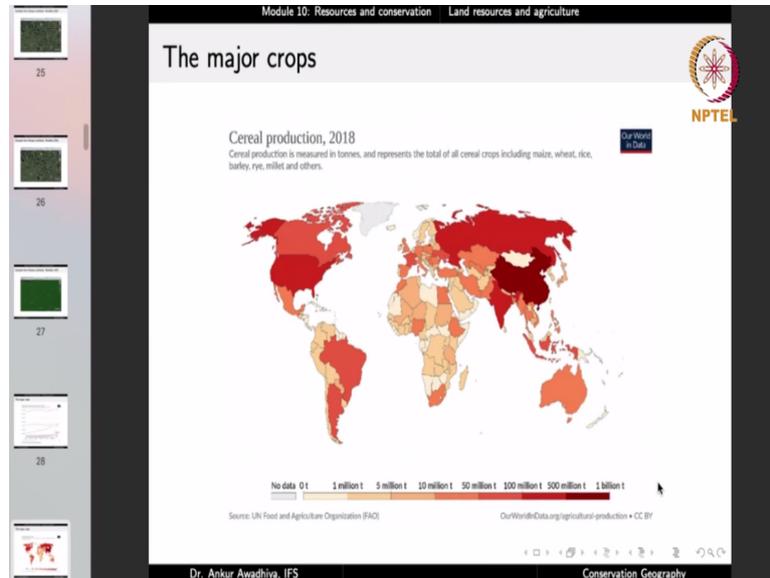
Now when we talk about the diversion of land for agricultural purposes what are the actually cultivating and where. Now, if we look at the global agricultural land use by major crop types and here we are having the areas in hectares. So, around 700 million hectares of land is under cereal cultivation. Cereals includes things like rice and wheat; around 325 million hectares is under coarse grains like Jowar, Bajra, or ragi.

The land under the oil crops has been increasing very fast. So, from around 100 million hectares in 1961 to around 300 million hectares today. So, the share of oil crops has been increasing primarily because of large scale deforestations that have been done to grow oil palm. So, with industrialization now more and more of our food is processed food and to make that process food if you look at the labels of any of the process foods you will find that it will have palm oil or palmolein oil.

Now this palm oil has been grown in a large number of equatorial rainforest by clearing them. So, large portions of the forest are clear field and then the area is mostly burned to completely clear the area and then the oil palms are grown there. So, the share of oil crops

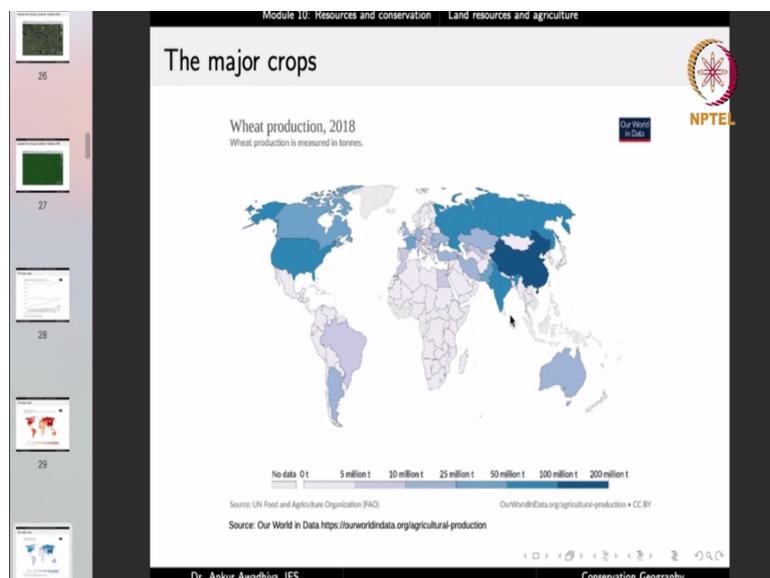
has been increasing very fast because now more and more of the world is shifting towards processed foods. And then a small portion is under pulses, roots and tubers, vegetables, fruits, tree nuts, citrus fruit and jute. So, these are the major crops.

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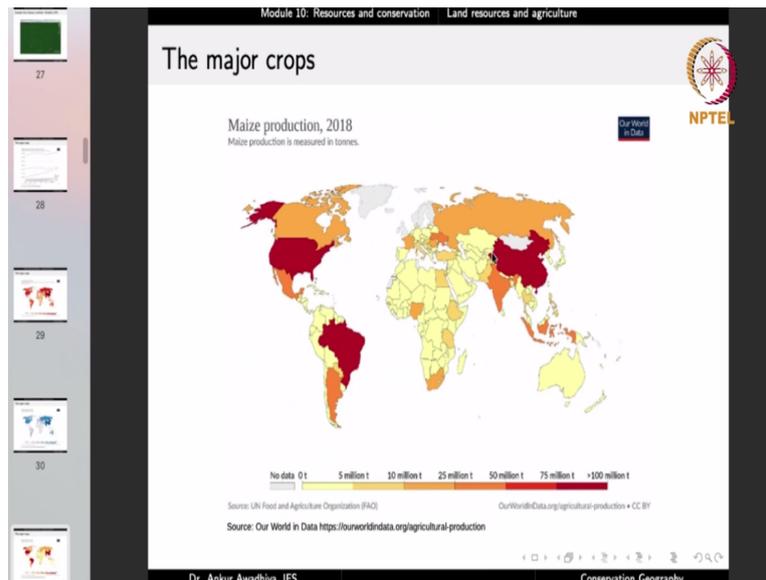
And different areas have different productions. So, if we look at cereal production we will find that China is one of the biggest serial producers, then we have the US, India and Russia, whereas other areas do have cereal production, but in a smaller quantities.

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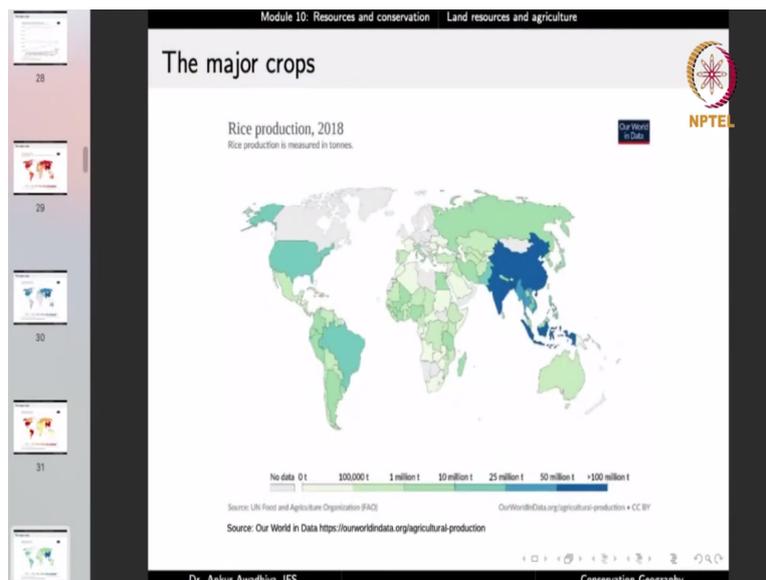
If we look at wheat production China is one of the largest producers of wheat and appreciable production also happens in US, Russia and India.

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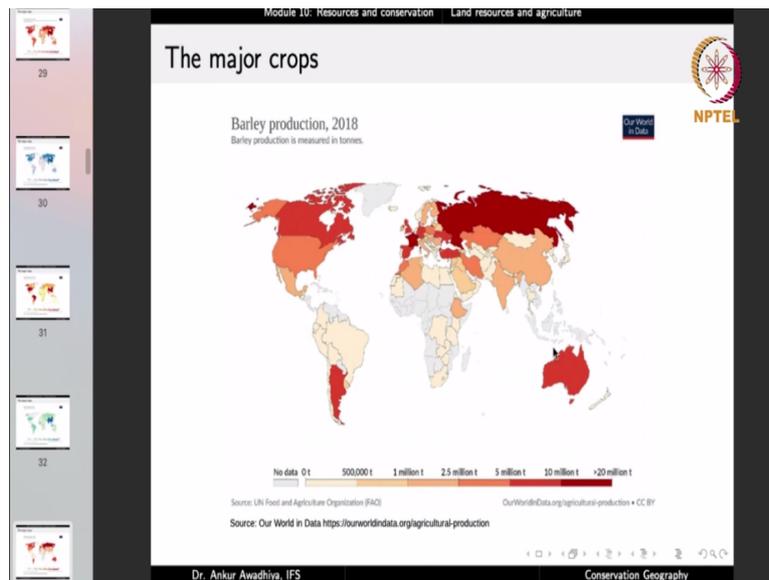
Maize production again we have China, US and Brazil. So, in these charts what we are observing is that the impact of different crops is different in different areas because culturally or because of the climate different areas are growing different crops.

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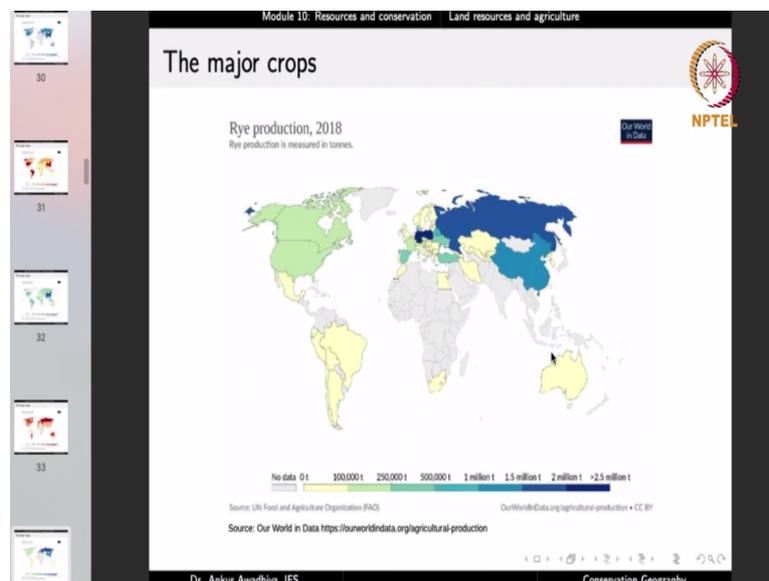
Now if you look at rice production, the majority of rice production is in China, India and South East Asia.

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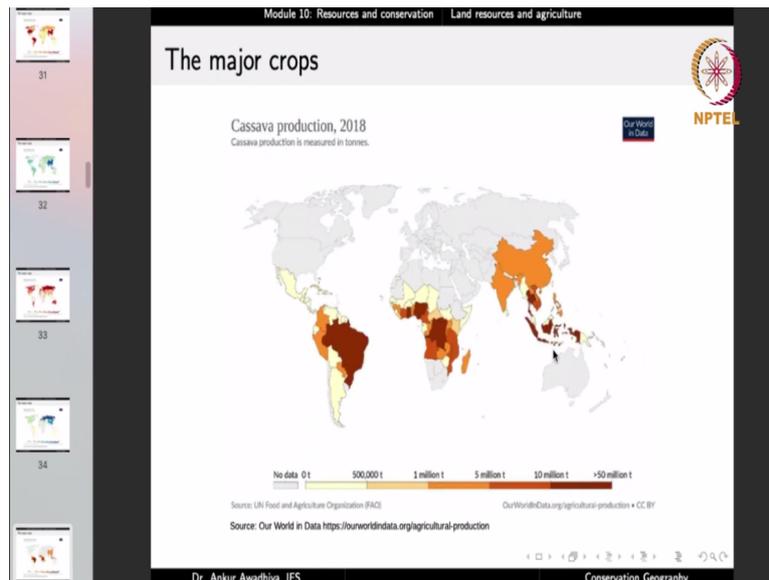
Barley production you will have Russia and some countries in Europe like France.

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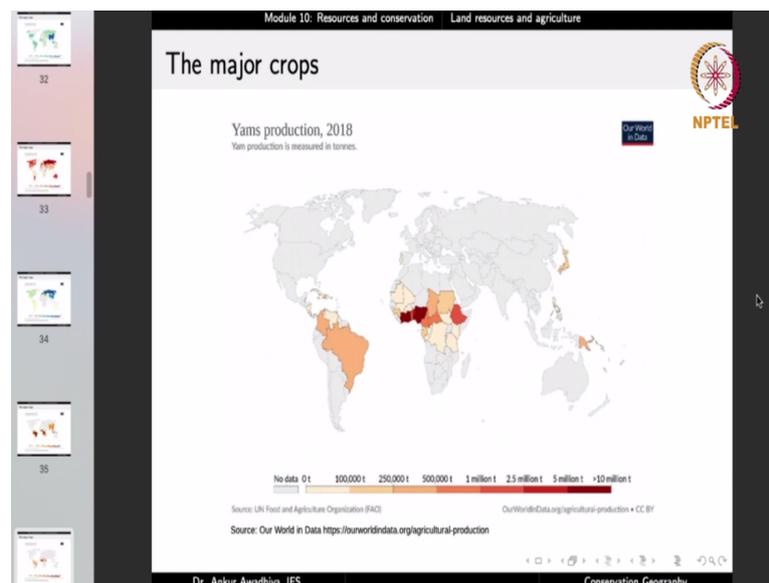
Rye production again you have Russia and a few countries in Europe.

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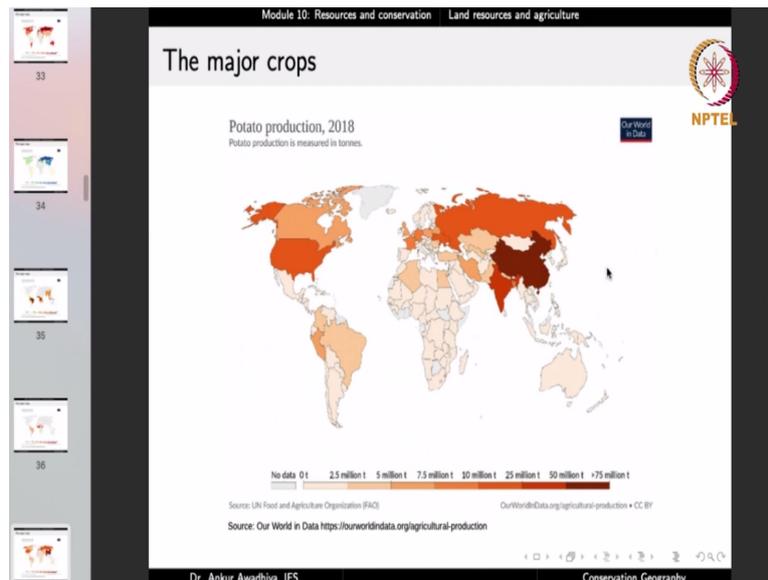
Cassava production; now Cassava is a root crop so this is mostly grown in areas in Africa and in Brazil and some parts of South East Asia.

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Yams mostly in Africa, South America, Japan.

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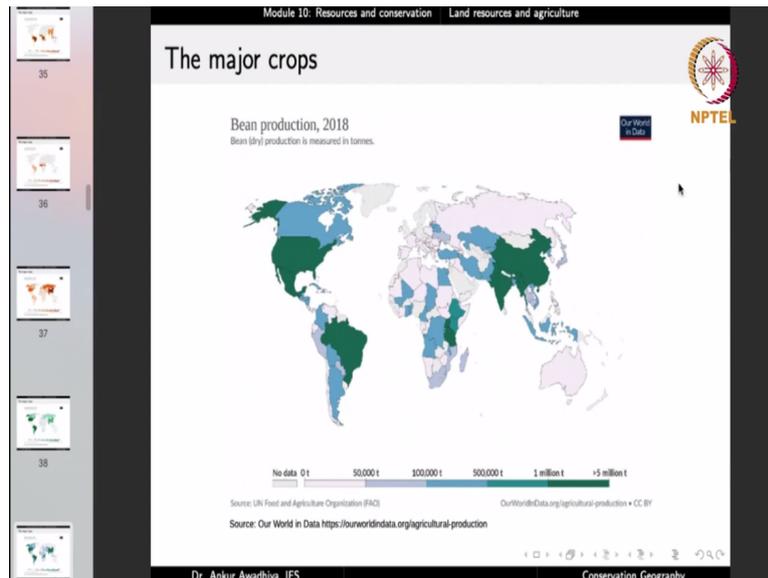
Potato you have China is one of the largest producers followed by India, US, Russia and a few European countries.

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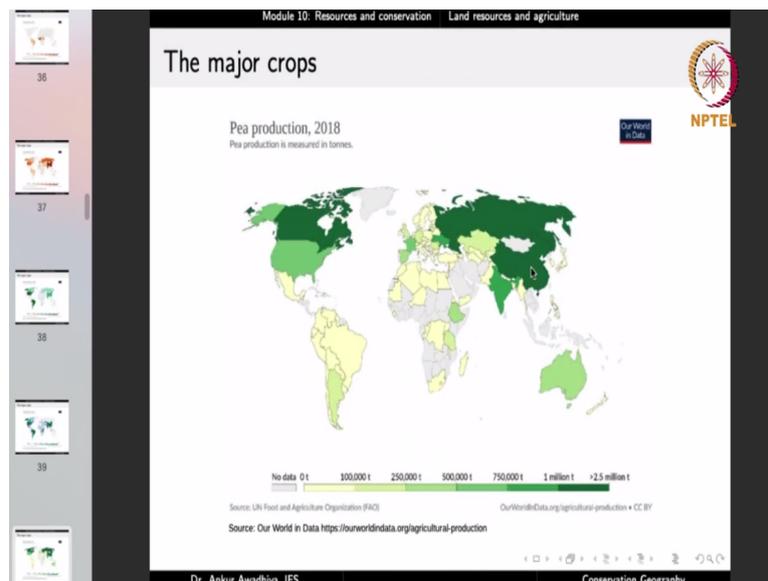
Soya beans here we have US and Brazil. So, when we talk about the deforestation in Brazil a major chunk is being used for soybean production. So, there are two things because of which there is a large scale deforestation in Brazil. One is for the production of soybeans and two is for cattle rearing.

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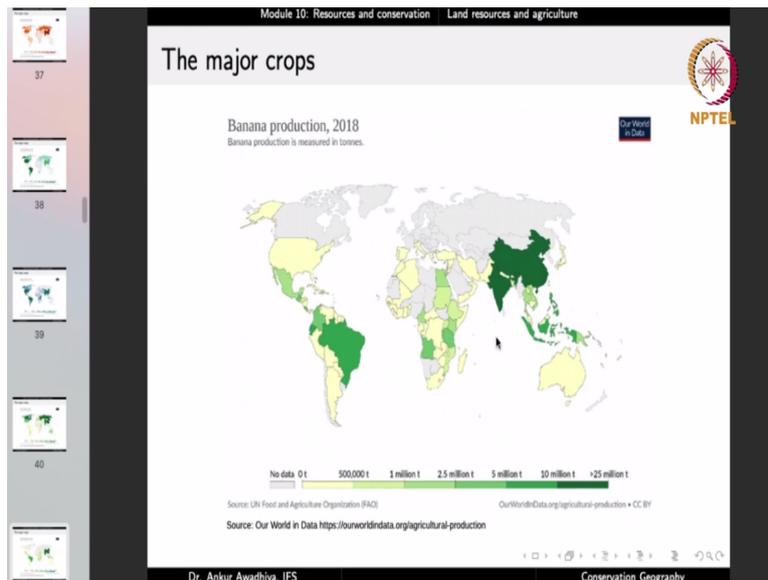
Then if you look at bean production you have large number of countries primarily China, India, US, Mexico and Brazil.

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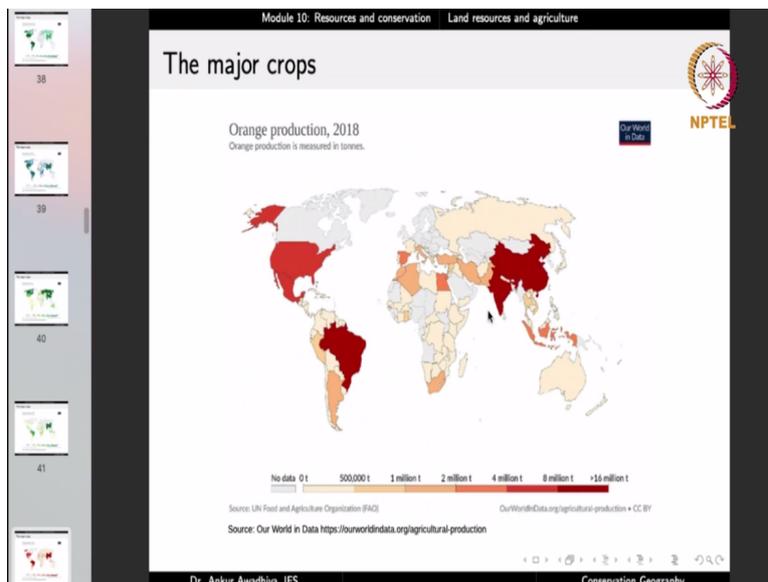
Pea production again you have China. So, you will find that China is a very large producer of most of the food crops. So, in peas you have China, Russia and the US.

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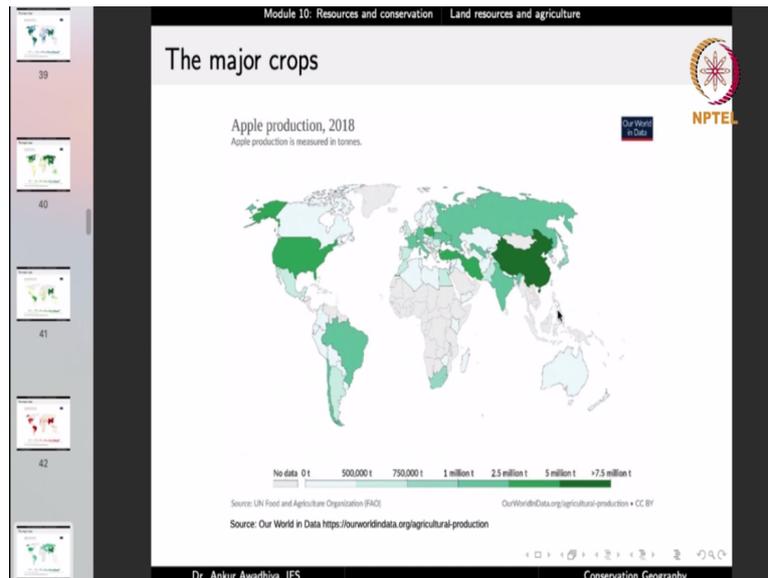
Bananas again you have China and India plus Brazil is also a big producer.

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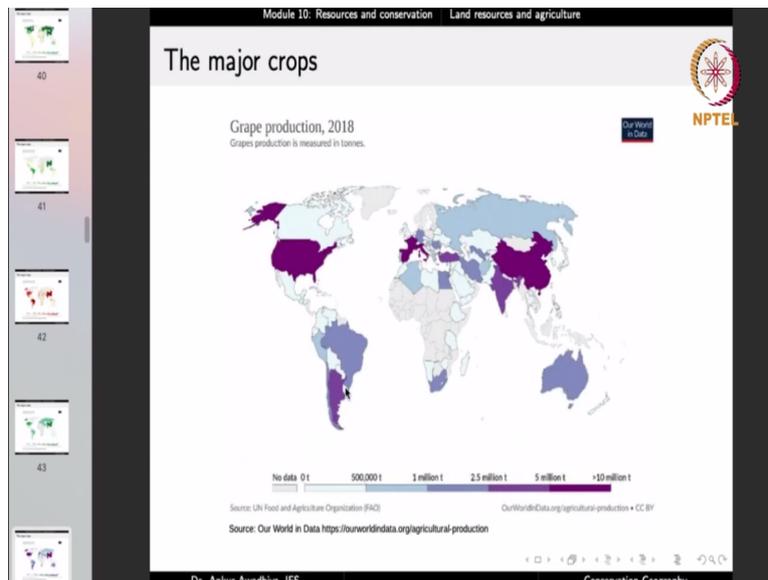
Oranges again you have China, India and Brazil.

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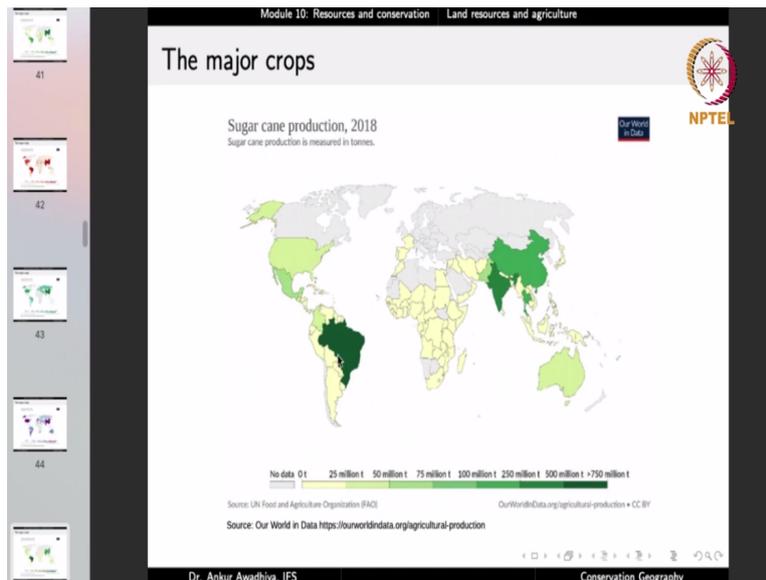
Apple again you have China plus a small share in the US and in Asia.

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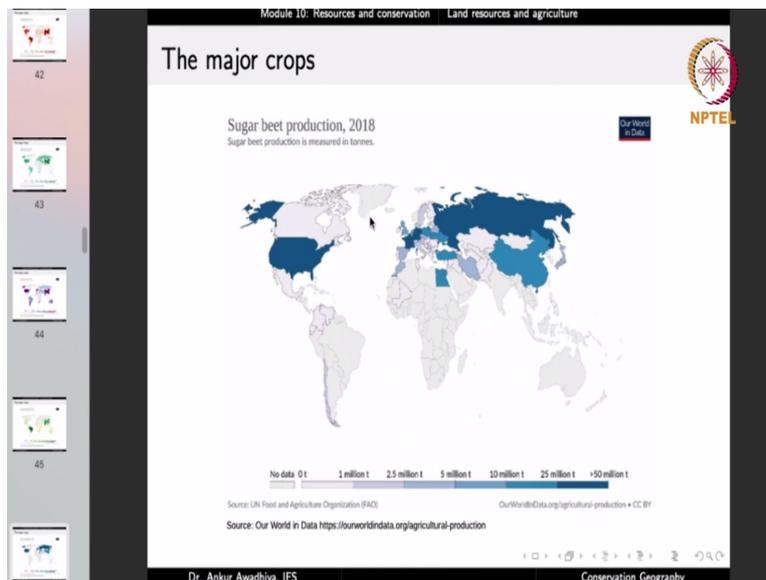
Grapes again you have China you have the US and a few European countries.

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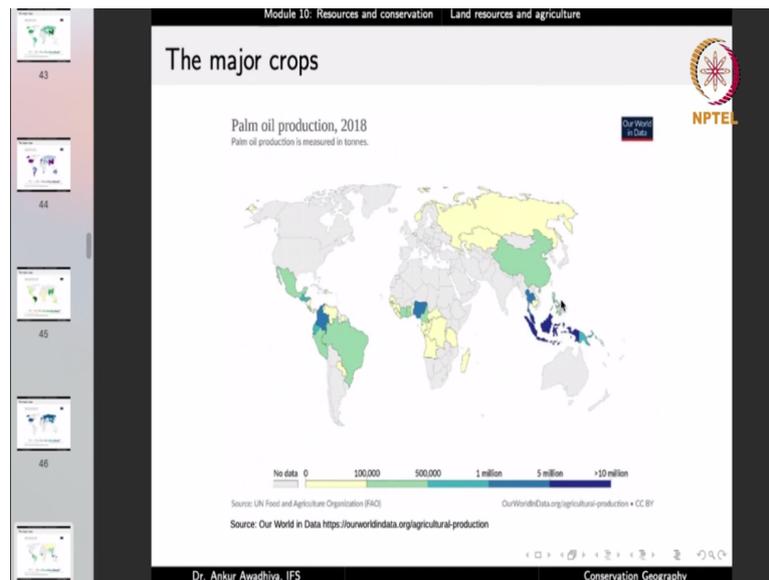
Then in sugarcane we have number one is Brazil followed by India and China.

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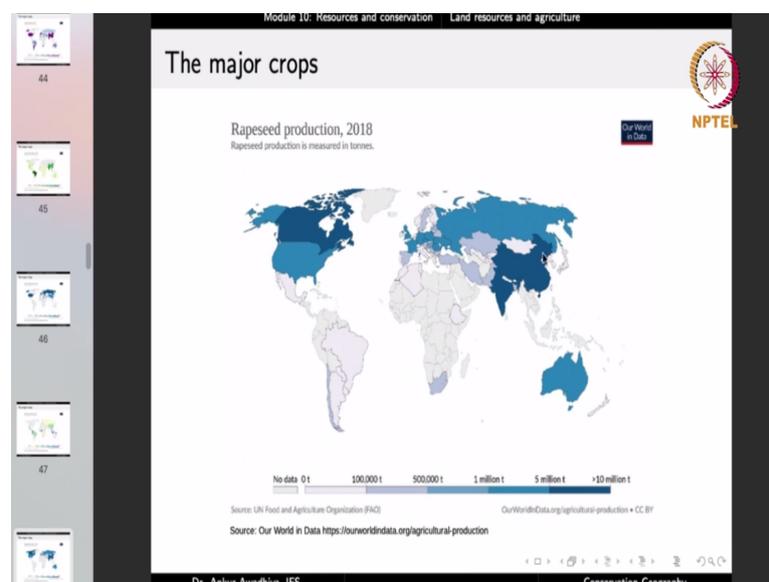
Sugar beet is mostly grown in colder areas so areas like Russia or France or the US.

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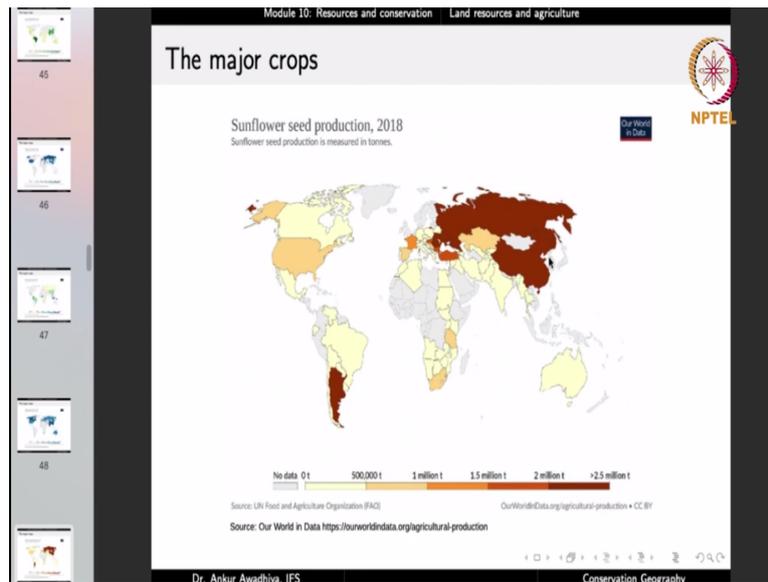
Palm oil production is mostly in the equatorial areas. So, here again palm oil is another crop because of which we are seeing larger scale deforestation typically in South East Asian nations such as Indonesia. So, a large portions of these lands are being clear field, burnt and use for palm oil production. Nations in Central and South America and in Africa and also China are also important producers of palm oil.

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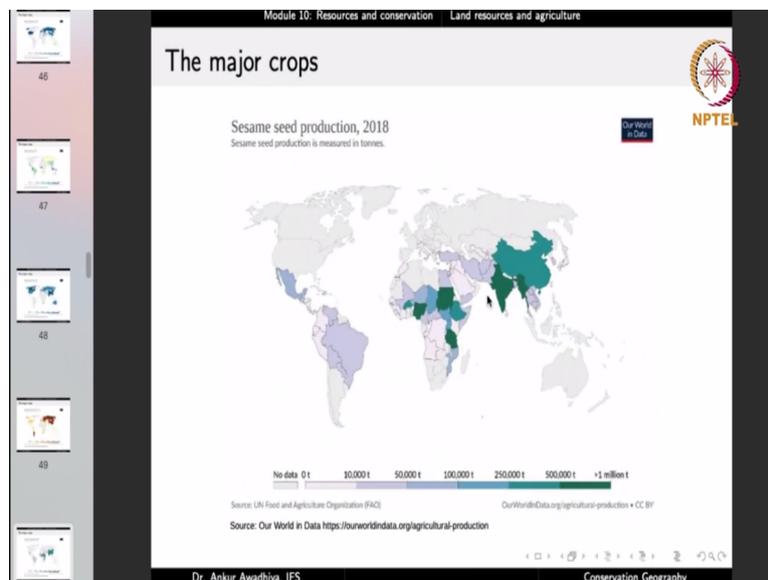
Then rapeseed or mustard production here again we have China, India, Canada and these are followed by Russia, the US, Australia and some countries in Europe.

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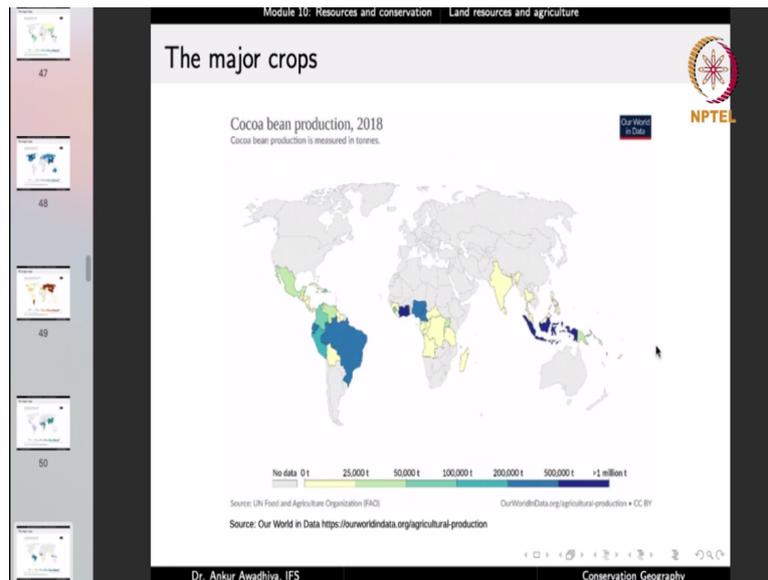
Sunflower seed production again you have China, you have Russia and we have Argentina.

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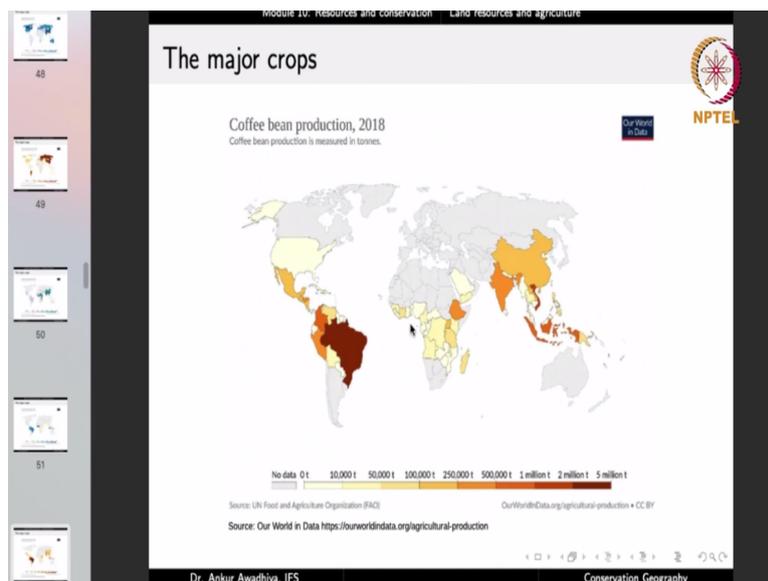
Next in Sesame seed production we have India, Myanmar and a few countries in Africa that are the largest producers.

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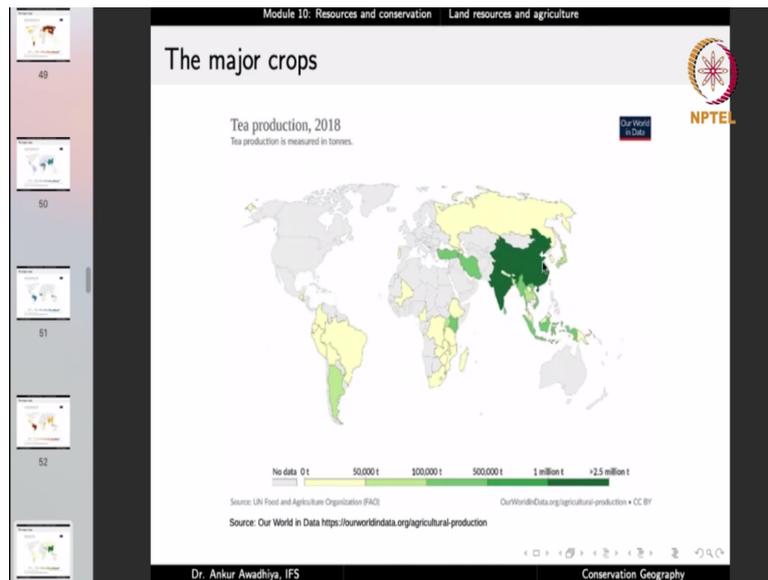
Cocoa bean production is very prominent in Brazil certain countries in Africa and in South East Asia.

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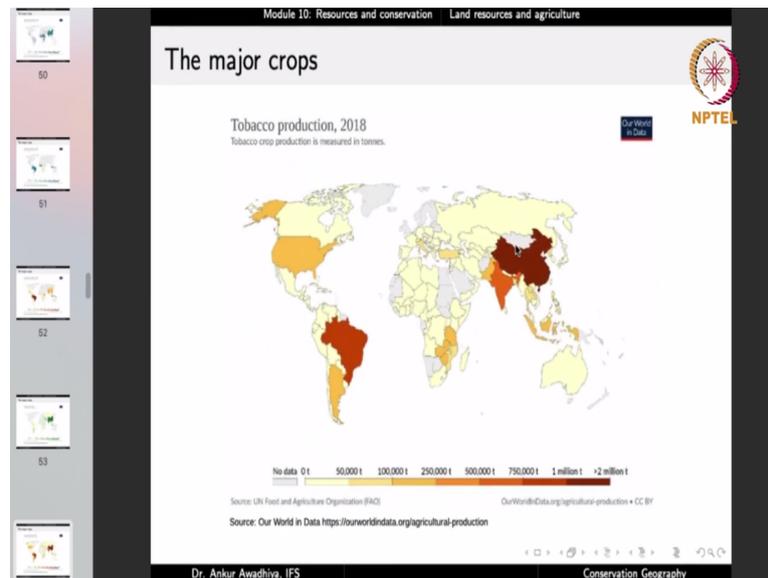
Coffee again is more of an equatorial crop so we have large production in South America, Africa, India, China and South East Asia.

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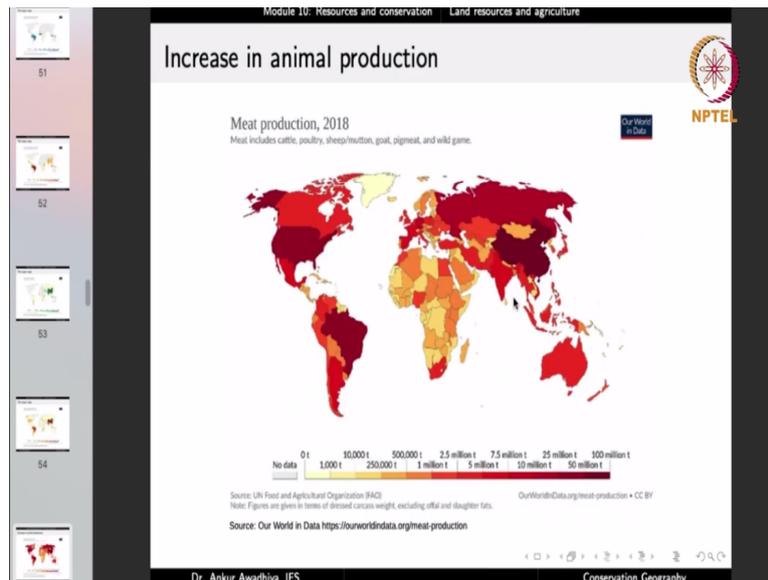
Tea production India and China are the largest producers.

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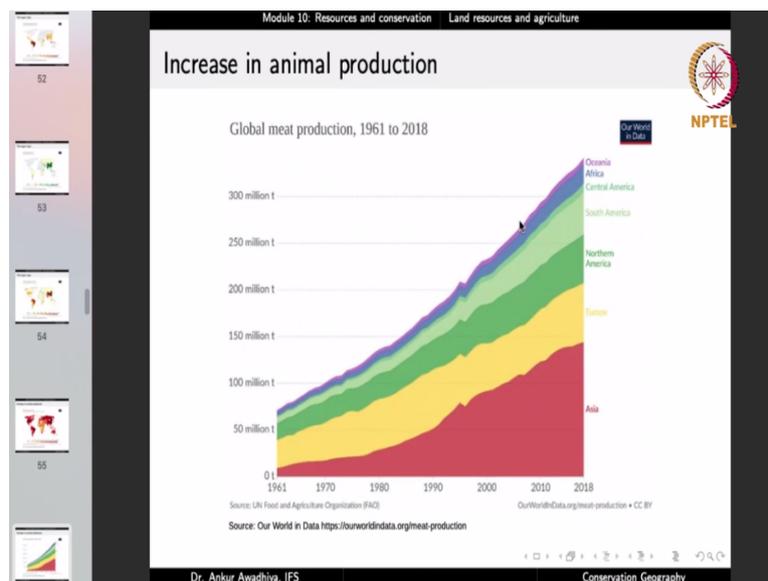
Tobacco production the largest producer is China followed by Brazil and India.

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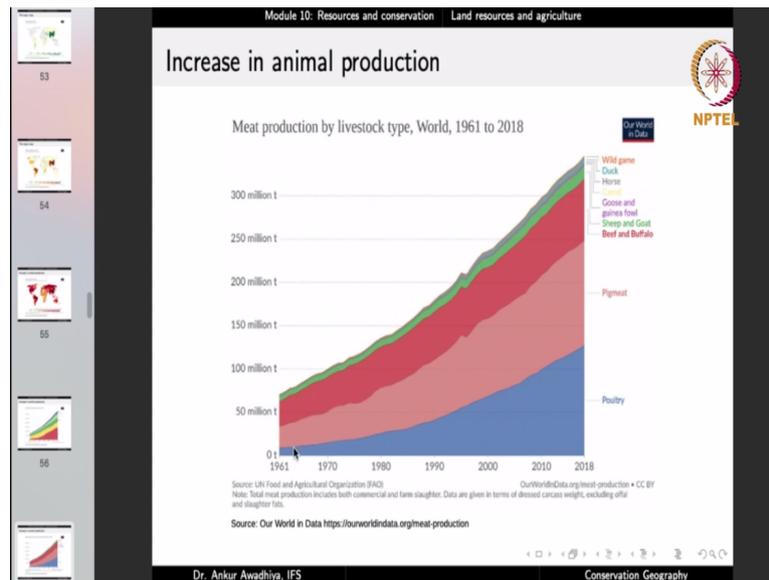
Then if you look at animal production then meat production again China is the leader followed by US and Brazil and Russia.

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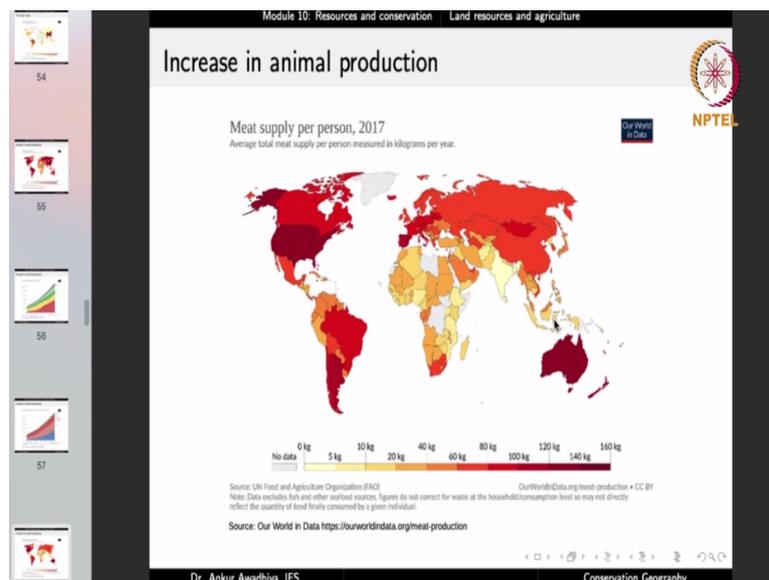
And if you look at the trends in animal production, if you look at the global meat production it has been increasing. So, from 1961 to today it has been increasing and the increase is there everywhere. In Asia there has been a very rapid increase, but we also have increase in Europe, North America, South America and other areas.

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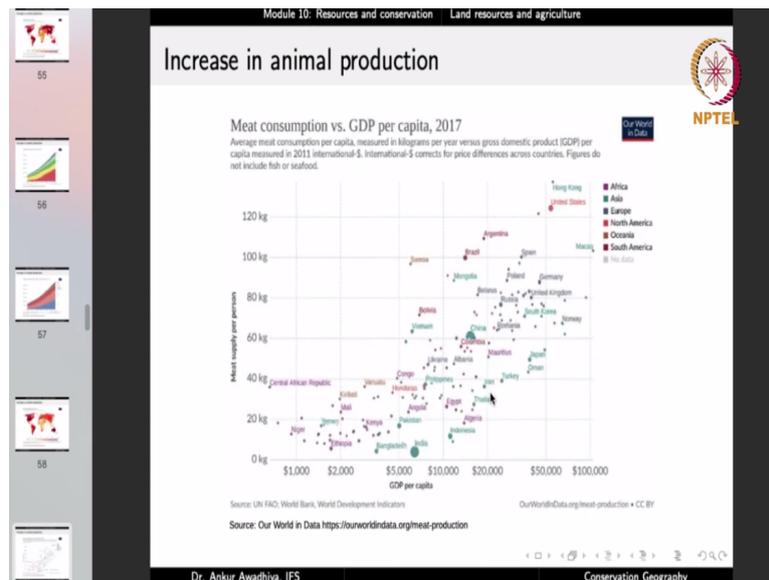
Now of these animals the majority is poultry and poultry has also shown a very fast increase, primarily because people prefer to eat poultry and it is easy to rear. Next, we also have a large section that is eating pig meat, followed by beef and buffalo, sheep and goat, Guinea fowl and other species.

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Now, if you look at the meat supply per person then it is maximum in the case of US, in the case of Australia followed by certain countries in Europe and South America.

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Now the important point to note here is that when a country becomes more and more rich when a society has more amount of money with it. Typically, we observe that the amount of consumption of meat increases. So, meat is typically a more expensive food and when people have more amount of money and they shift their preferences to this expensive food.

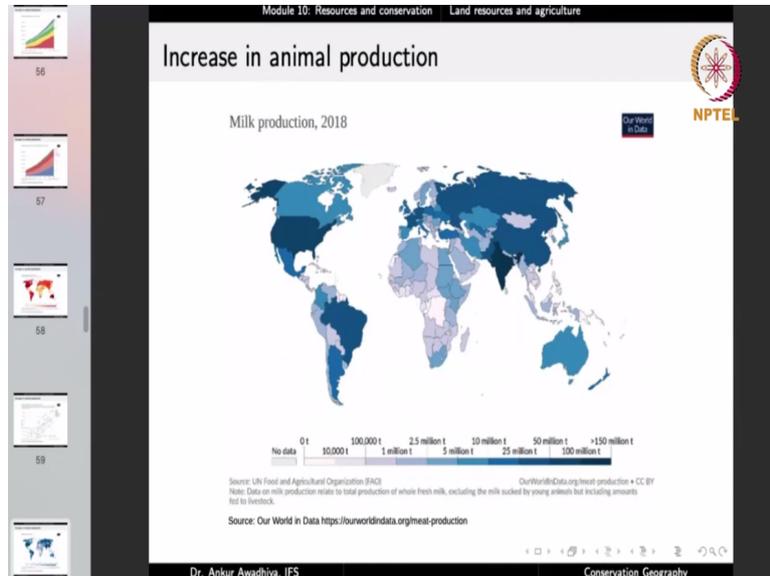
So, we had already observe that when we talk about land use then the major chunk of land under agriculture is being used for the animal rearing and not for the cultivation of crops. But if we look at the amount of calories or the amount of proteins that meat provides or these animals provide it is a minor share as compared to the crops.

Now this explains why it is more expensive because for a smaller amount of calorie, for a smaller amount of proteins you have to devote a very large chunk of area for its production. Now, if we drew a plot between the GDP per capita, so on the x axis we have GDP per capital which is representing the amount of affluent in a society.

And on the y axis we have the meat supply per person and we can observe that there is an increasing trend. So, when people have more money they consume more meat. Now this is becoming important because as more and more people are shifted out of poverty and the affluence levels in different portions of the world are increasing now people are demanding more and more meat.

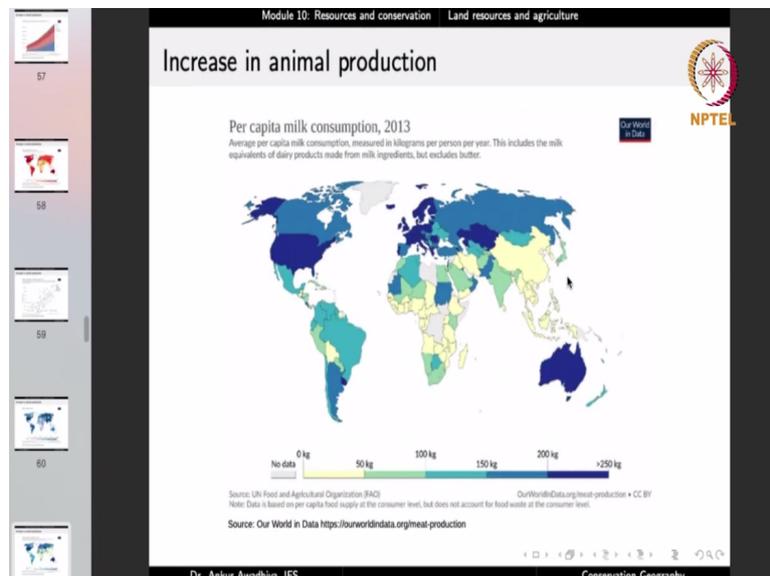
Now in that case we will require an even larger share of land to be used for rearing these animals for a very portion of calorie and protein intake and that would increase our impacts on the ecosystems. Typically, because large chunks of forest will have to be clear field and converted into pasturelands.

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Now, if we look at milk production India is one of the largest producers in milk followed by US and Russia.

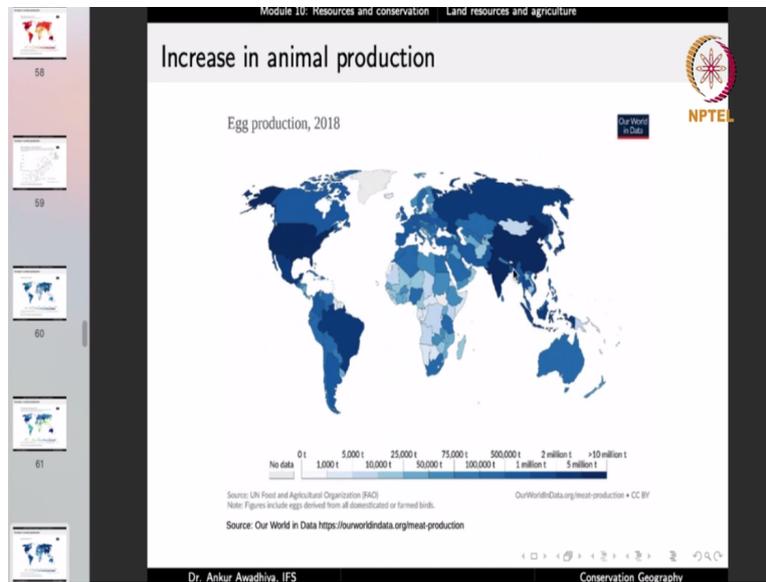
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But if you look at per capital mil consumption then India does not fair that well. The per capita milk consumption including the milk products is very high in the case of US, Australia

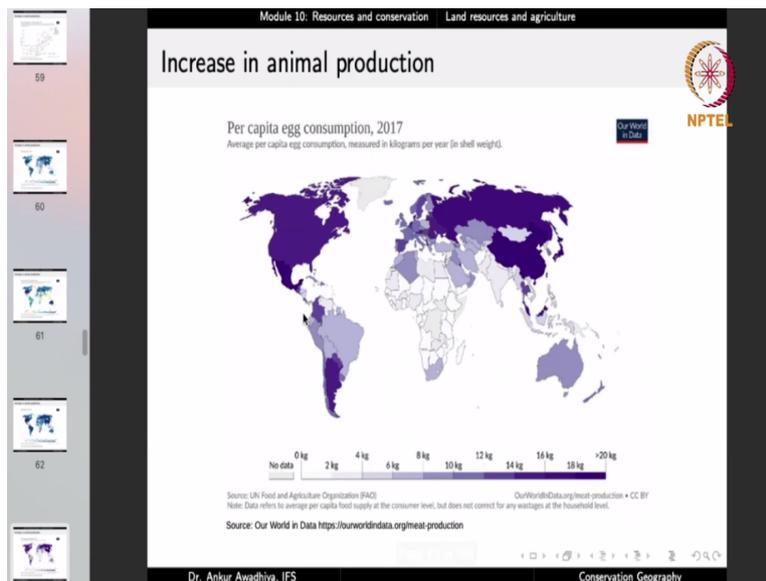
and certain European countries because in our country the population is so large that the per capital milk consumption becomes smaller even though we are the largest producers of milk in the world.

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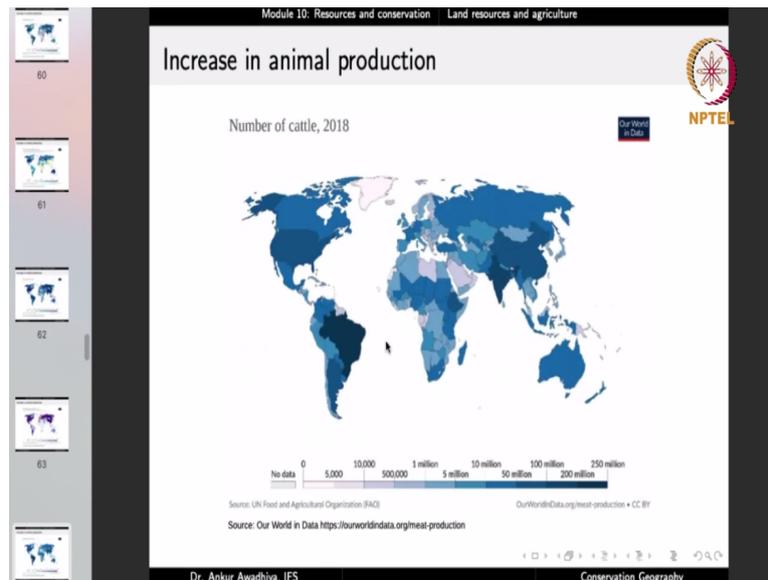
In the case of egg production the largest share is China, India and US.

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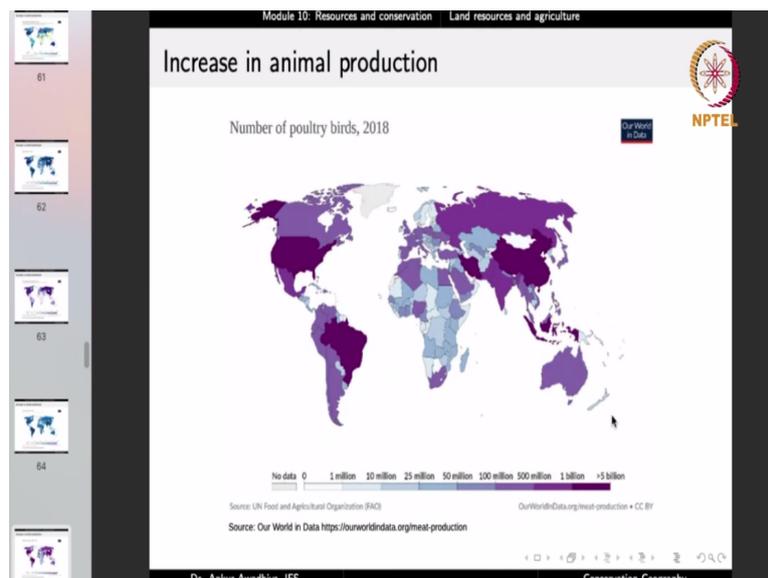
But again if you look at per capital egg consumption India does not fair that well.

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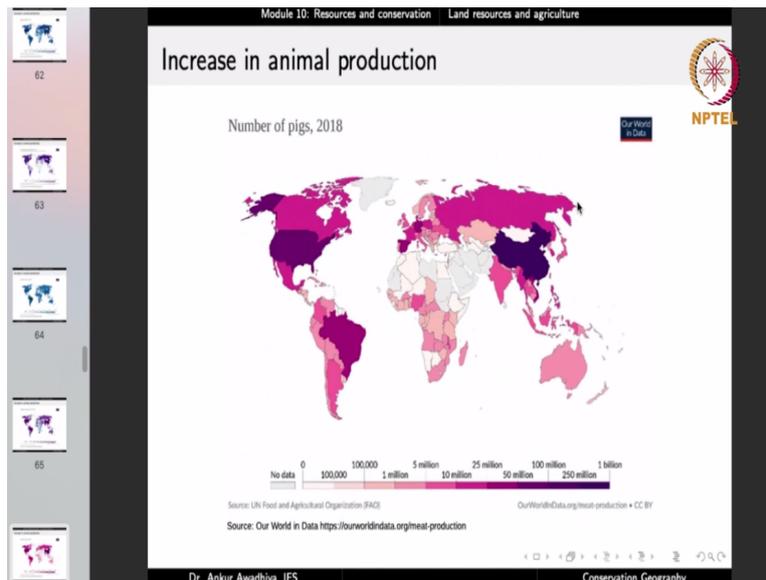
If you look at the number of cattle the highest number of cattle are in Brazil and in India. Now in India most of the cattle are being used for milk production in Brazil most of them are being used for the production of meat.

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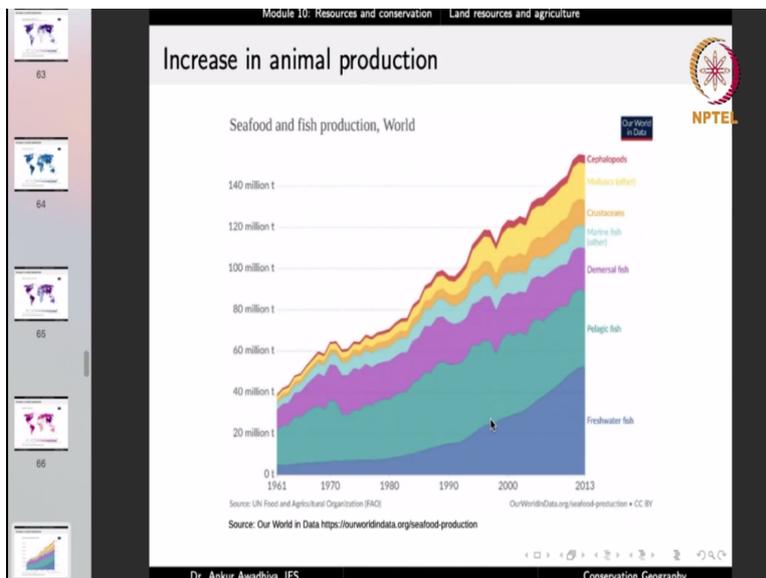
If we look at the number of poultry birds it is the highest in case of China, in the case of US Brazil and certain other regions of the world.

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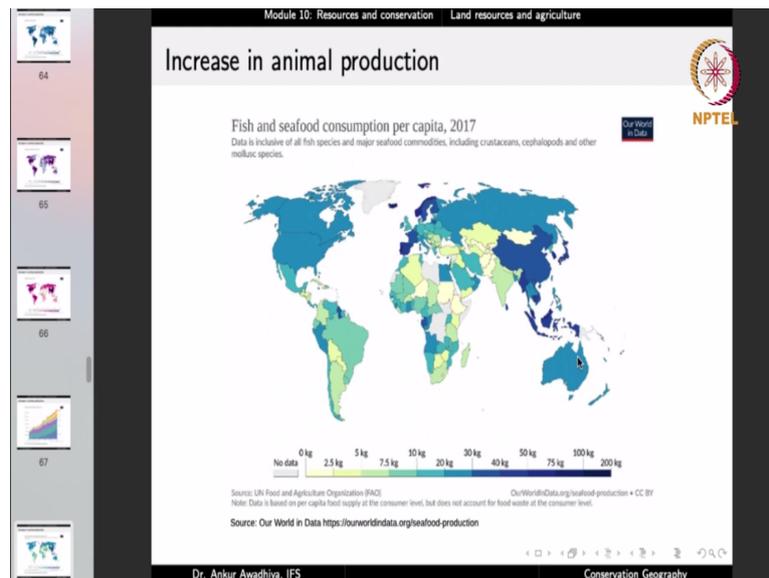
If we look at the number of pigs it is highest in China followed by the US and Brazil.

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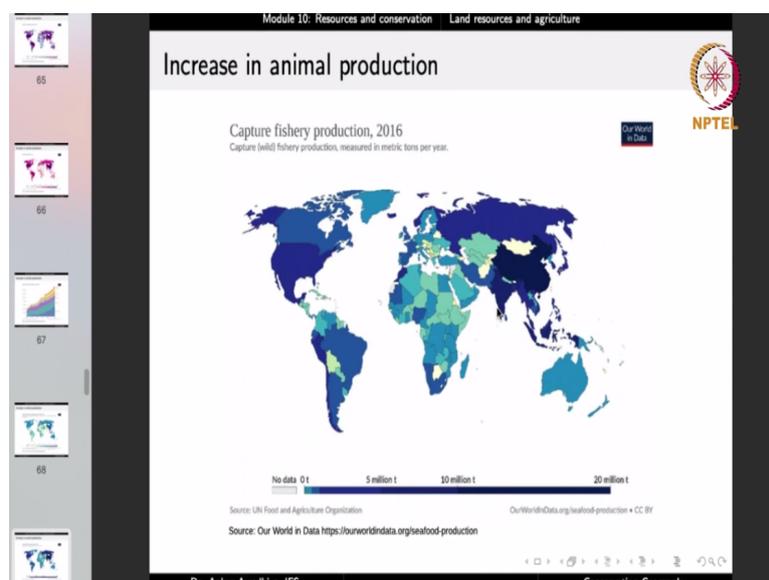
Then we look at the marine and aquatic animals then the sea food and fish production again has been increasing. So, if we look at fresh water fish they have been increasing Pelagic fish, increasing Demersal fish, increasing marine fish, increasing and so on. So, now the world is using a very great amount of seafood so our consumption has been increasing.

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Now, if we look at the fish and seafood consumption per capita we will find that a large number of countries especially those that are near the sea coast they are having a very large amount of fish consumption. So, primarily we have countries like Spain, France, Finland and Sweden and here we have Myanmar, South East Asia, Japan we have China so you have a very large amount of sea food consumption per capita in these countries.

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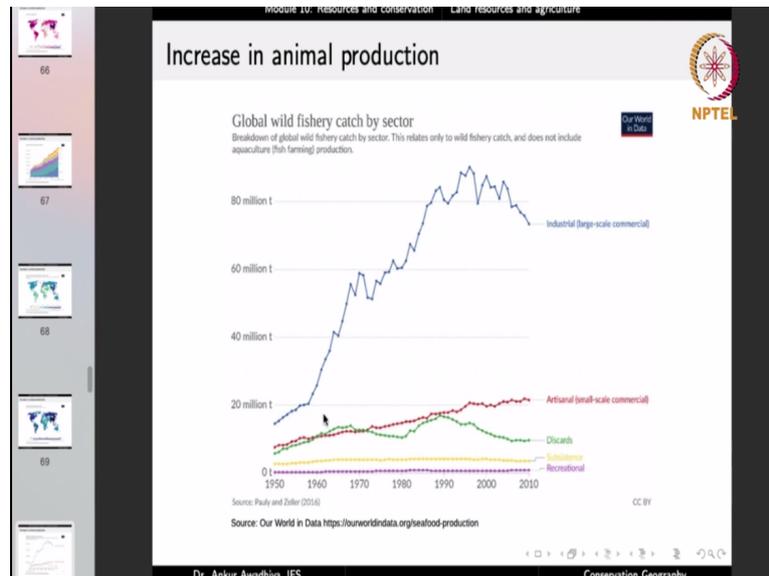


If we look at capture fishery; now capture fishery refers to the fishes that are captured from the wild conditions typically the ones that are being captured from our oceans. Now that is capture fishery so in the case of capture fishery large sized boats and ships venture into the

oceans used large size trawlers and nets, catch a large number of fishes and bring them to the shore.

Now, if you look at capture fishery then China holds the majority followed by India, certain countries in South East Asia, the US, Russia and certain countries in Africa and South America.

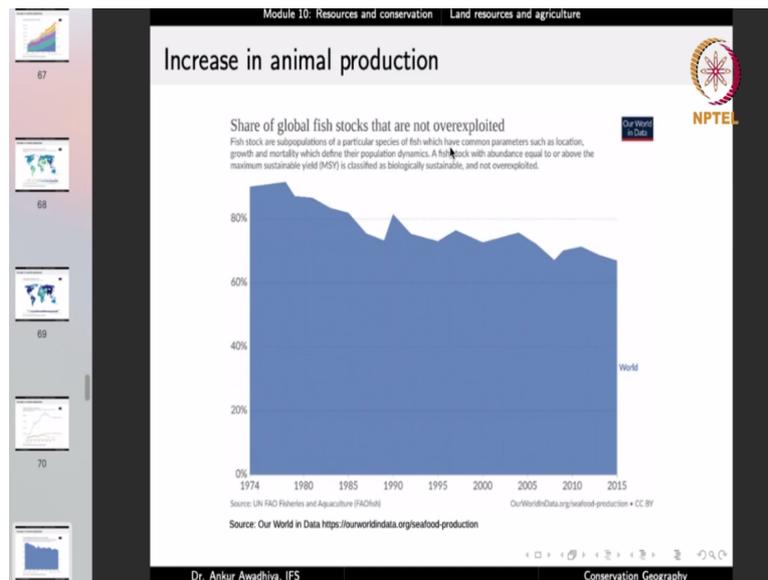
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Now, if you look at the global wild fishery catch by sector we will find that the industrial or the large scale commercial fishery it is increased like anything. So, in the 1950s we were capturing like 15 million tons of fishes, but then it increase to as high as say around 100 million tons. So, from 15 to 100 in a span of just 40 years, 45 years, but then we overused our resources and so the industrial fishery is now towards a decline.

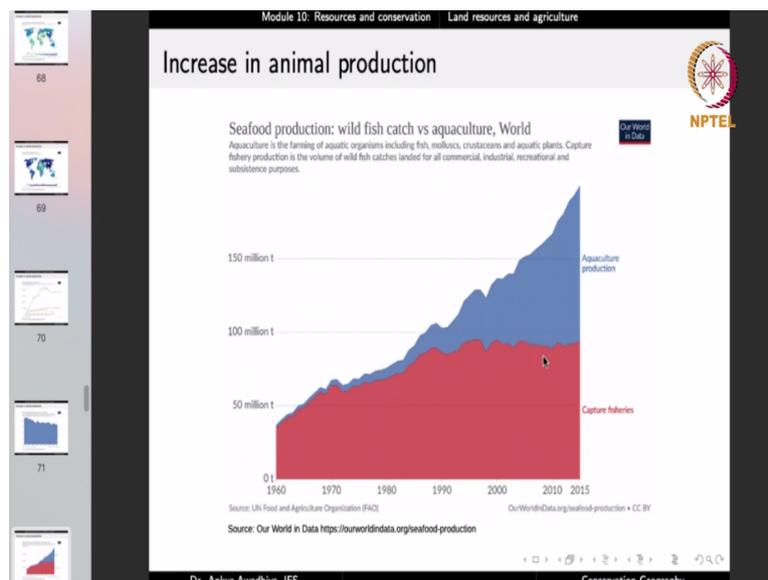
Fishery it is now on the decline because we have over utilized our resources. The small scale commercial fishery is still on the increase and in a large number of cases this fishery is happening in the large size lakes then if you look at the number of discards they increased till the 1990s. So, there was this one hump then another hump and now it is on the decline and a small amount of sustenance and recreational fishing is also happening.

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Now, if we look at the share of global fish stocks that are not overexploited we see that there is a decreasing trend that is roughly around 65 percent of our stocks are not overexploited and around 35 percent of our stocks are already overexploited which is a very serious cause of concern.

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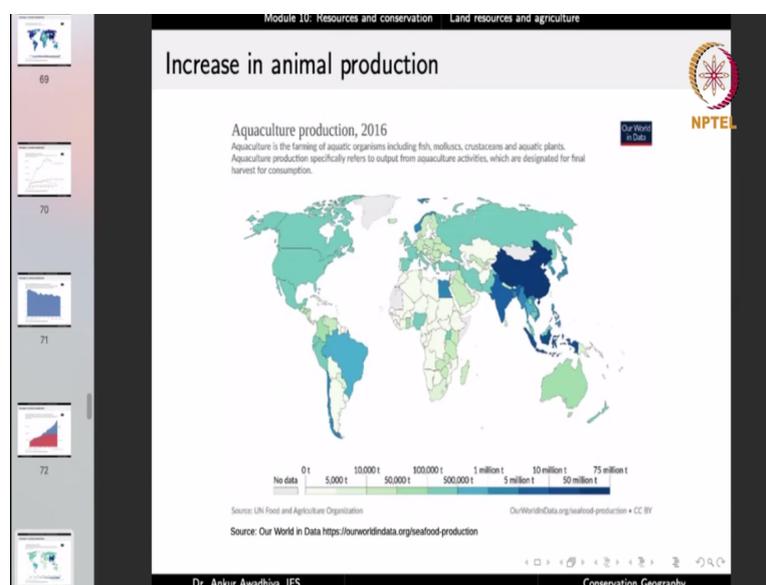
Now, if we look at the capture fisheries versus aquaculture, you will observe that the capture fisheries they have already reached the peak so now this cannot increase any further. So, now more and more attention is being shifted towards aquaculture. Now aquaculture is the

farming of aquatic organisms including fish, mollusks, crustaceans and aquatic plants. Now, if this aquaculture has to increase where would the land come from?

Now, it turns out that we are now using more and more of our natural ecosystems. The natural ponds and lakes into aquacultural uses. In certain cases people are also taking large size trenches on the land putting up a sheet of plastic and filling it up with water to be used for aquaculture purposes. Now again here we can observe that now we require more and more amount of land to meet our requirements of fish.

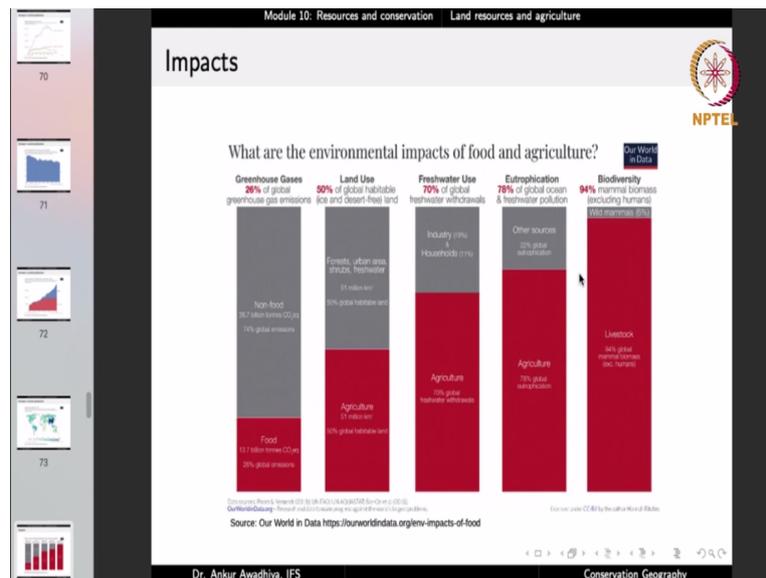
Now, where would this land come from? Again it is coming from the natural habitats. So, everywhere you can observe that we are using more and more of our natural ecosystems in converting them into our own purposes.

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If we look at aquaculture production we find that China and countries in the South East Asia are now the largest producers of aquaculture products.

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Now all of these is not without impacts. We are observing large amounts of impacts on the ecosystem. If we look at the greenhouse gases then 26 percent of the global greenhouse gas emissions is coming from the food sector. If we look at land use we have already observe that 50 percent of the global habitable land is now under agriculture. If we look at fresh water use 70 percent of the global fresh water withdrawals are happening for agriculture.

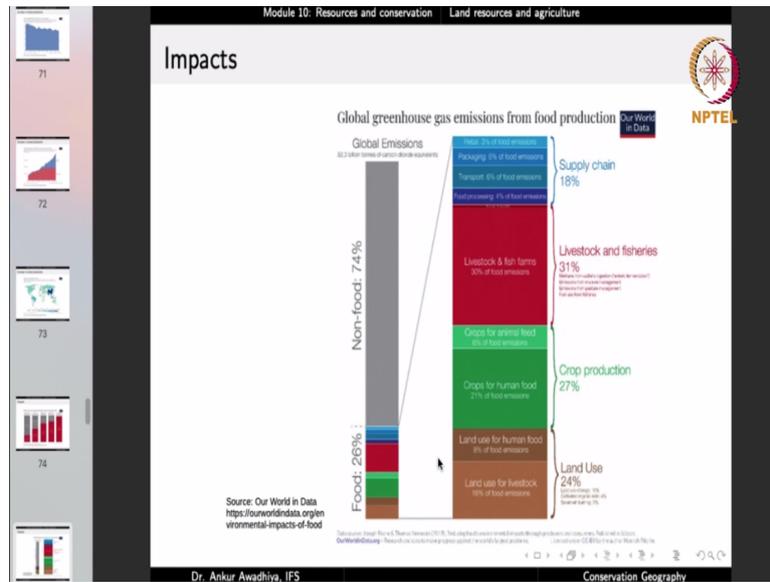
78 percent of global ocean and fresh water pollution including Eutrophication is because of agriculture because we are using large quantities of fertilizers and manures in our crop lands and when it rains then these fertilizers and manures make their way into the water bodies. Once they reach there the algae bloom like anything, the aquatic plants bloom like anything, they take up all the space in the water body and when they die and decay then all the oxygen is used up.

And the lakes becomes a dead lake that is Eutrophication and as much as 78 percent of this Eutrophication can be ascribe to the agricultural sector. If we look at biodiversity then of all the mammals in the world excluding humans 94 percent of the mammalian biomass is now livestock that is animals like cow, buffalo, goat, sheep and only 6 percent of the whole biomass of mammals is vested with the wild mammals.

So, we are taking away all of their habitats and we are using them for our own purposes. So, the livestock populations are increasing and the mammalian populations are decreasing. So, these are some sorts of impacts that we are having. Large portion of greenhouse gas

emissions, land use, fresh water use, Eutrophication and other pollution and biodiversity loss all of that because of agriculture.

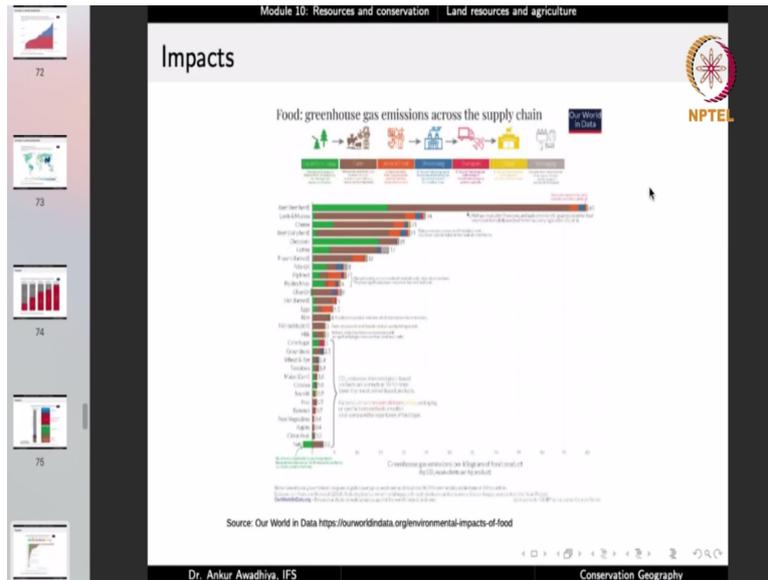
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Now, if you look at the greenhouse gas emissions. So, we saw that 26 percent is coming from the food sector and if we look at where is this 26 percent coming from? So, if we convert that into 100 percent we find that 24 percent is coming because of changes in the land use. Crop production is giving 27 percent, livestock and fisheries are giving out 31 percent and supply chain is giving out 18 percent.

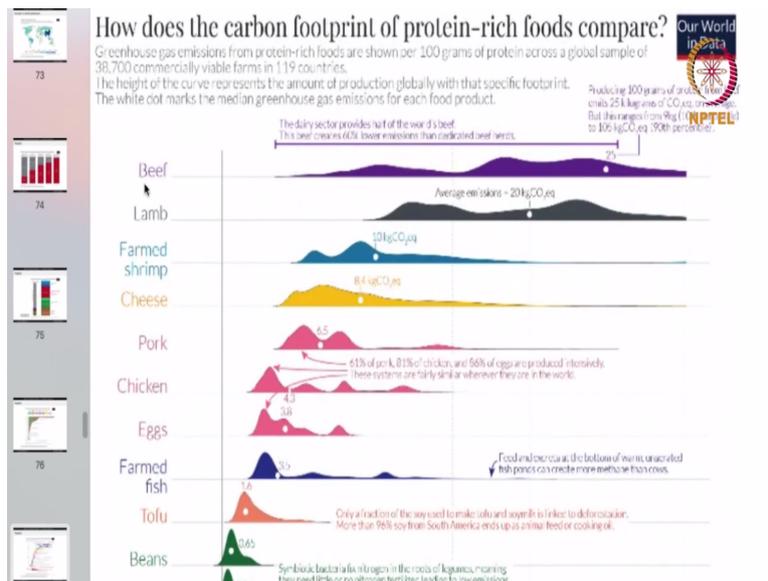
So, when we talk about food production there is greenhouse gas emission everywhere when we convert land to be used for agricultural purposes. When we grow crops when we rear animals and when we transport things when we process things to make process foods everywhere there is a greenhouse gas emission that is occurring.

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And greenhouse emissions leads to global warming and climate change and in this case there are certain food products that are playing in a very large role. So, if we look at things like beef or lamb and mutton and cheese we find that the amount of greenhouse gas emissions is very large.

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Now, if we look at the amount of greenhouse gas emissions then if we consider beef then we are producing 25 Kg of carbon dioxide equivalent for producing 100 grams of proteins in the form of beef. So, it is a highly greenhouse gas intensive source of protein. If we look at lamb

it is 20 Kgs, if we look at farmed shrimp it is 10 Kg now 10 Kgs of carbon dioxide released for just 100 grams of proteins in the form of shrimp.

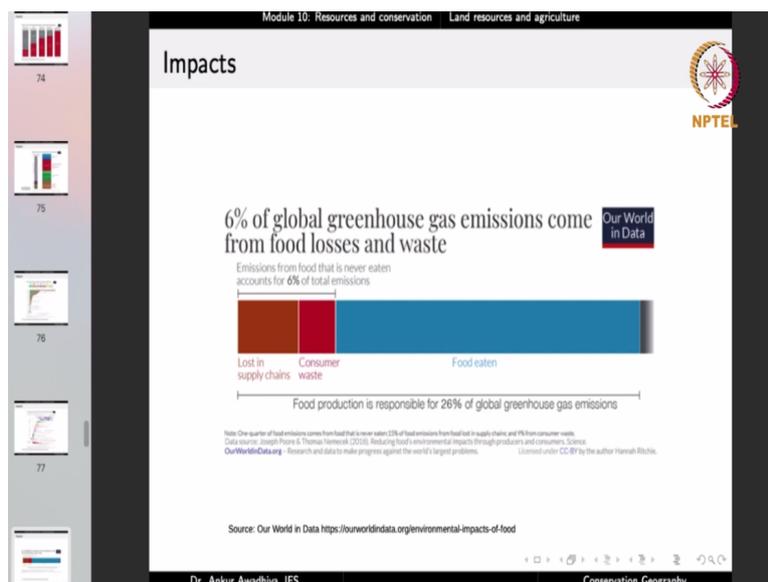
In the case of cheese it is around 8.4 Kg for Pork it is 6.5 Kg, chicken is 4.3, eggs is 3.8. Farm fish 3.5 Kg, Tofu which is coming from soybean is 1.6 Kg. Now above this line we are seeing all of these are the non vegetarian products, animal resource proteins. Now, animal source proteins give out the majority of share of greenhouse gas emissions when we talk about the gases emitted per 100 grams of proteins.

But if we look at the vegetarian sources then Tofu is 1.6 Kg, beans is 0.65 Kg, peas is 0.36 Kg, so 360 grams of carbon dioxide release to make 100 grams of protein and in the case of many nuts it is negative. So, it is minus 0.8 Kg 800 grams of carbon dioxide are absorbed, sequestered and stored, taken away from the atmosphere for every 100 grams of protein. So, the different food products have different impacts that is the important thing here.

This means that if we wish to reduce our impacts on the ecosystems one easy way out is to change the dietary preferences by shifting away from animal source foods and by shifting towards plants based foods we can reduce the impacts on the environment because by doing that we will contribute in releasing less amount of carbon dioxide into the atmosphere and we will contribute towards less amount of diversion of forest for the cultivation of food because if we shift to the plant sources then we get the same amount of calories and proteins from a smaller portion of land.

And so if we shift to plant sources of energy, plant sources of food then because the efficiency of food production increases so our impacts will be lessened because we will be requiring a smaller portion of land to produce sufficient amount of food for everybody. So, that is a more sustainable way of getting our food. Now remember that when we talk about sustainability we need to meet everybody present needs, but not the wants of everybody. Now, needs can fulfilled by the plant sources of food very easily.

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Another major change that we can do is by reducing the waste as much as 6 percent of global greenhouse gas emissions are coming from food losses and waste that is if the food production is responsible for 26 percent out of this 26 percent a sum of 6 percent is because of the food wastage. Food is lost in the supply chain and also people waste food when they are eating. When we are talking about the food loss in the supply chains we are talking about the food that gets crushed or that gets rotten during the supply process.

And when we talk about the consumer level food wastage we are talking about people who are buying more amount of food, but they are unable to consume it within time and so they throw it out. Once that happens we are not just talking about food and money we are also talking about the impacts to the environment, the rays of greenhouse gases that has happened during the production and transport of this food that is also a wasteful impact that we are making to the environment.

So, this is again something that can very easily be sorted out. So, easy ways are to shift to plant based food sources and to reduce the amount of wastage that we do at own personal level and also at the level of the supply chain.

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The image shows a slide from an NPTEL presentation. The slide is titled "Impacts I" and lists 11 impacts of agriculture on ecosystems. The impacts are numbered 1 through 11. The NPTEL logo is visible in the top right corner of the slide. The slide is part of a presentation on "Module 10: Resources and conservation" and "Land resources and agriculture". The presenter is identified as "Dr. Ankur Awadhya, IFS" and the subject is "Conservation Geography".

Module 10: Resources and conservation Land resources and agriculture

Impacts I

- 1 Deforestation
- 2 Soil erosion
- 3 Increased sedimentation
- 4 Climate change
- 5 Increase in soil salinity
- 6 Increase in soil alkalinity
- 7 Death of soil biota
- 8 Death of pollinators and biodiversity
- 9 Water logging and water contamination
- 10 Eutrophication
- 11 Disruption of food chains

Dr. Ankur Awadhya, IFS Conservation Geography

And this is very essential because of the numerous impacts that agriculture is causing to the ecosystems. We have looked at deforestation, but it is also increasing soil erosion, increasing sedimentation in the water ways, climate change especially because of global warming and an increase in soil salinity and soil alkalinity because of two reasons.

One is the over doing of irrigation. So, when we put water to the plants then this water typically brings with it certain salts that are released during the weathering process of rocks. Now, when this water has been put to the plants the water slowly gets evaporated, water is also absorbed and it is transpired, but the salts are left in the soil.

So, this increases the salinity of the soil at the same time in the case of a large number of fertilizers you can have certain ions that are left in the soil. So, for example, say if you add say sodium nitrate into the soil then the plants if they use up the nitrate portion the sodium portion would remain increasing the alkalinity of the soil.

Now, increase salinity and alkalinity make the soil infertile and at the same time they also lead to the death of soil biota because a large number of organisms cannot live under such conditions. At the same time the overuse of pesticides is leading to the death of pollinators and biodiversity. We are also getting cases of water logging, water contamination, Eutrophication and disruption of food chains.

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Module 10: Resources and conservation Land resources and agriculture

Impacts II

NPTEL

- 1. Disruption of water flow: reduced river flows, disruption of lentic habitats, disruption of wetlands, reduced discharge to sea, increasing depth of water table with consequences for numerous plants, stagnation and proliferation of disease vectors
- 2. Land subsidence
- 3. Impacts of GM crops
- 4. Pollution

Dr. Ankur Awadhya, IFS Conservation Geography

Disruption of water flow because of reduced flow into the rivers or disruption of lentic habitats, or disruption of wetlands, reduced discharge to the sea, increasing depth of water table with consequences for numerous plants, stagnation and proliferation of disease vectors. Now, these are all different impacts of agriculture on the ecosystems there is subsidence of land that is happening especially in those areas where the land is being built upon or the land is being irrigated from above and the water table is being depleted from below.

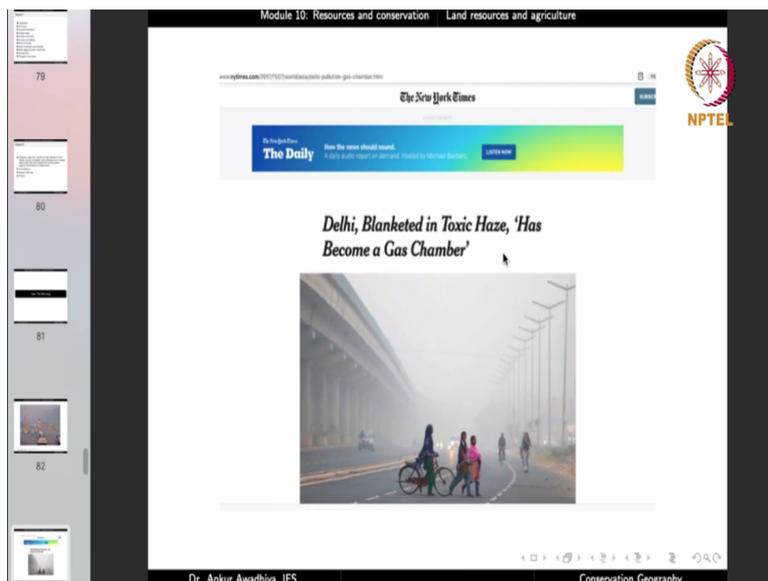
So, in those cases the land would just subside it would come down. Then we also have impacts of the genetically modified crops that are now being used and there is a large scale pollution that is happening because of agriculture. Now these are not just theoretical aspects we are observing them in our daily lives. These are impacting the human development of our societies because of which we have to be very careful and a good example is brought from the Delhi smog in our country.

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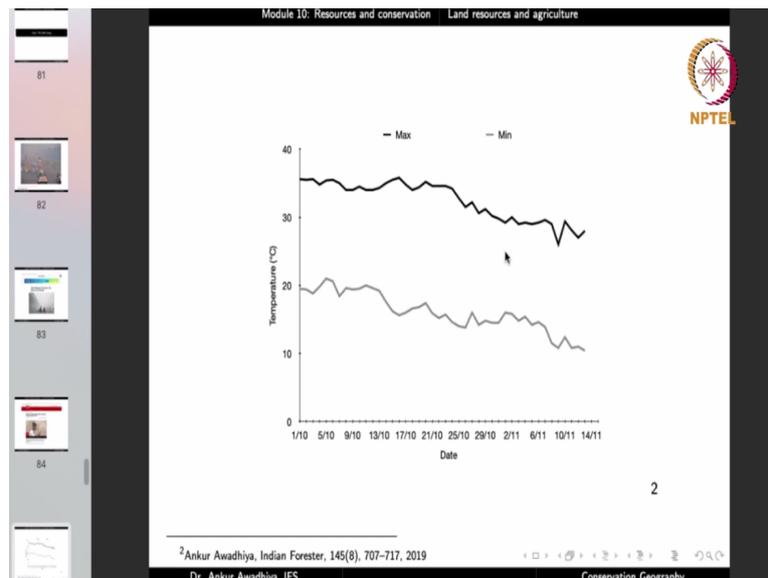
Now we know that in the winter months Delhi is full of smog. So, smog refers to smoke plus fog so this is a foggy condition that has been created near the ground and it is full of smoke.

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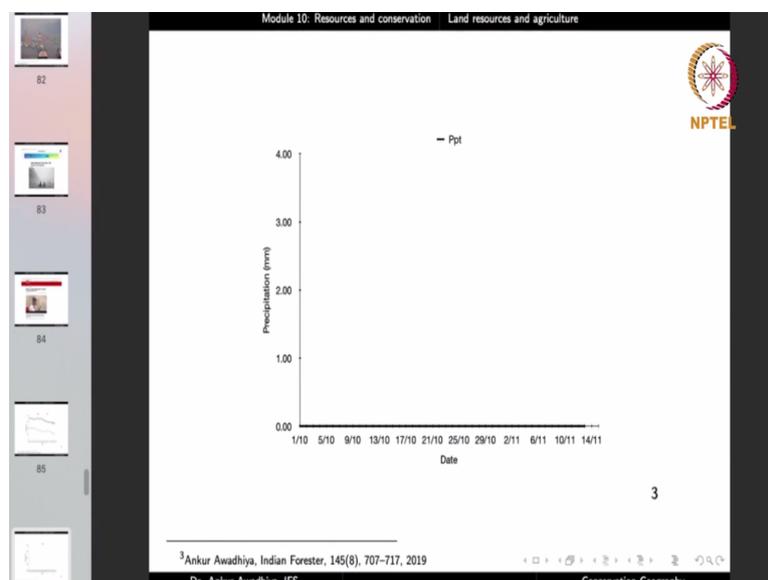
Now the question is what is causing this? So, every year we get these news items that Delhi blanketed in toxic haze has become a gas chamber or that millions of masks are being distributed because Delhi has become a gas chamber.

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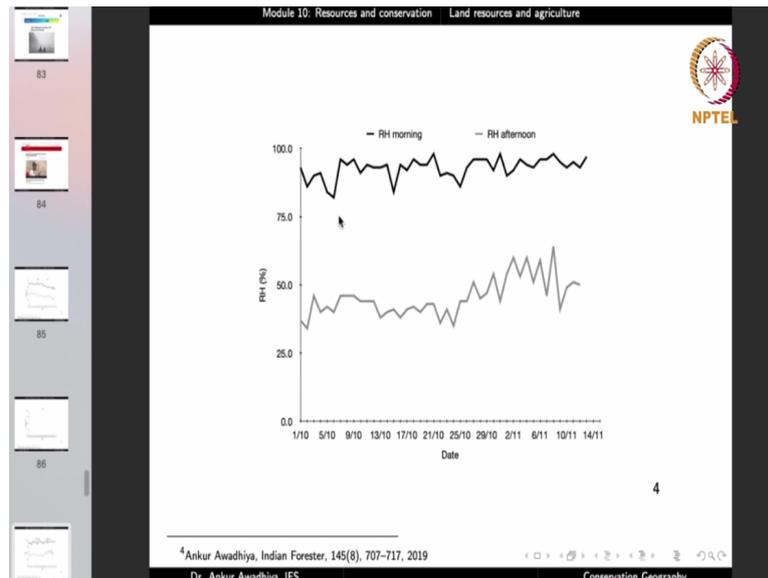
Now the question is why does Delhi become this gas chamber? And we can have certain insights from the geographical point of view. If you look at the temperatures in Delhi during these periods. So, here we have plotted from 1st of October to 14th of November. In this period if you look at the maximum and the minimum temperature both are towards the decline because these are the cold months; these are the cold weather seasons and so the temperatures are going down.

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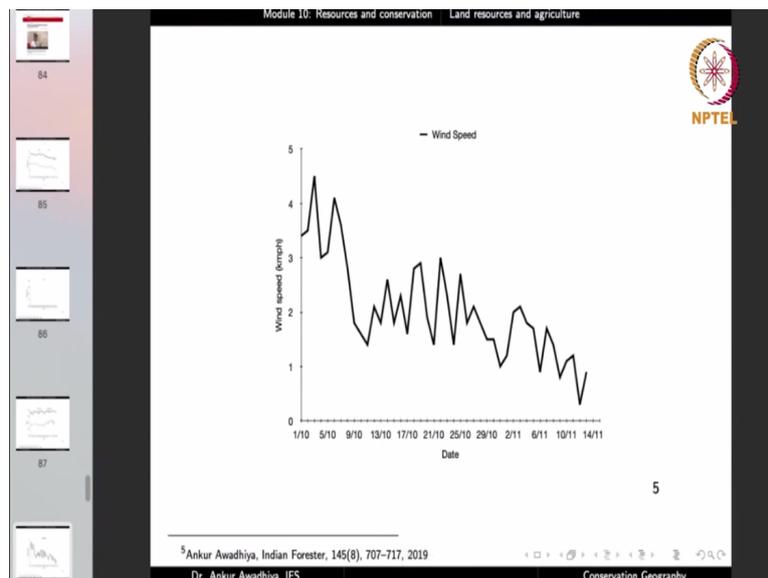
Now, if you look at the precipitation then we will find that in Delhi there is hardly any precipitation in these months.

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If we look at the relative humidity then we will find that in the morning the relative humidity is very close to 100 percent because the air temperatures are going down. Now when you have a high relative humidity it creates a very good condition for the creation of fog because the water in the air in the form of water vapor it condenses on the smoke and dust particles and it creates a fog.

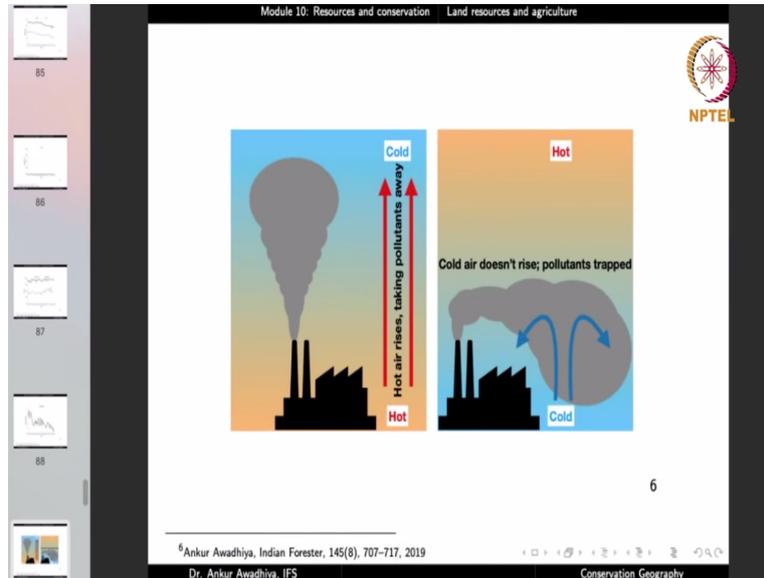
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Now, if you look at the wind speed the wind speeds are also towards the decline. Now this is important because if you have high wind speed then any pollutants that is there in the

atmosphere it will be diluted out it will be spread to large areas. Now in this case the wind speeds are pretty low.

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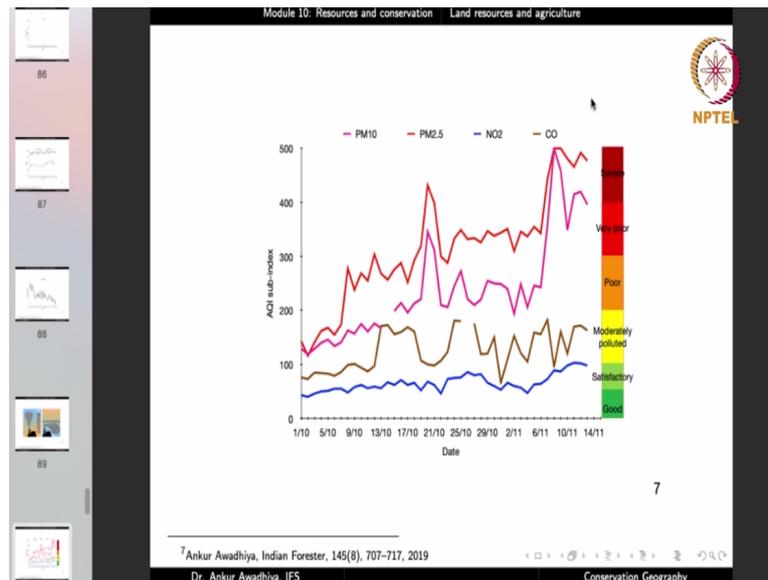


Now in these conditions we have a condition of temperature inversion. Now what happens is that in a normal day the Earth is warm because it is being heated by the sun whereas the upper layers of the atmosphere in the troposphere they are colder. Now because hot air rises that takes all the pollutants away. So, in the summer months you would not find a smog or a very toxic condition in Delhi.

But in the winter months what is happening is that you have a ground that is cold and the air above is a bit warmer than this cold air. Now, in these conditions because the cold air is denser so it stays down and it is covered by this lid of the hot air. Now, these cold air does not rise so any pollutants that are released into this air these will remain trapped in this air.

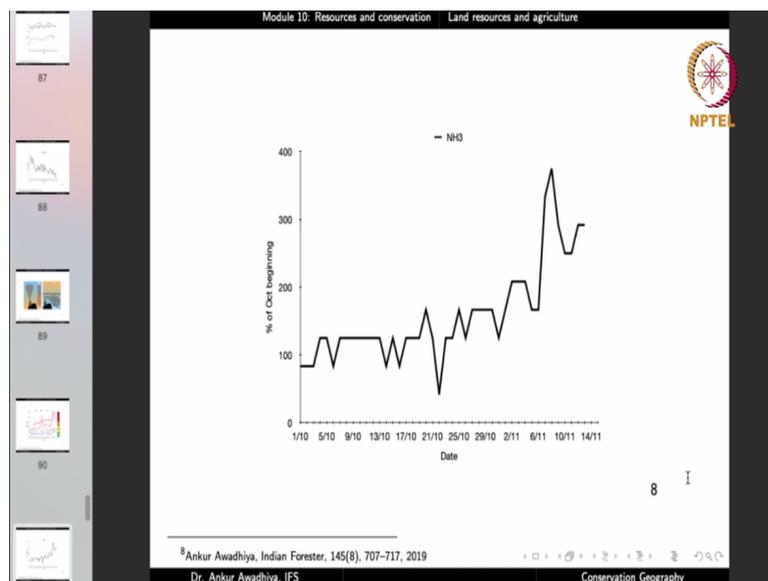
So, once you have this condition of temperature inversion if you release any pollutants into this air those pollutants will stay put. So, after while it does not matter where the smoke is coming from you release any smoke and the smoke will be kept there because the conditions are such that winds or convection current are not able to take them away.

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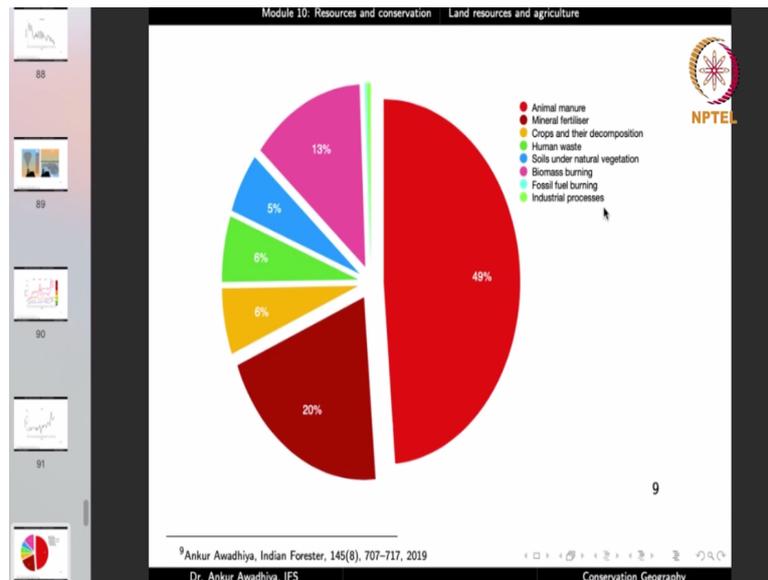
And it is during these periods that we observe an increase in the PM10 concentration, PM2.5 concentration, nitrogen oxides and carbon monoxide.

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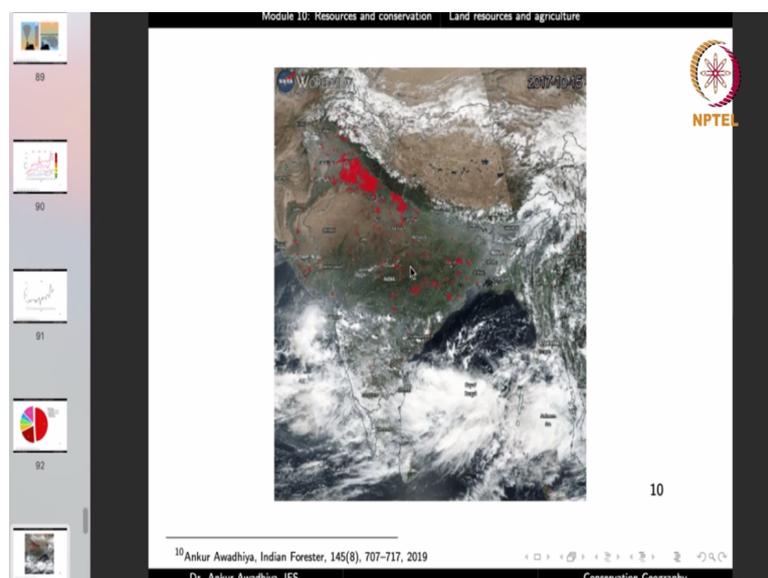
Now, if we look at different pollutants. So, if you look at say ammonia; so ammonia shows an increasing trend.

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Now if we look at the sources of ammonia we find that the largest source is animal manure, but then animals do not increase or decrease the manure production. So, this is something that remains constant every month. The second is mineral fertilizer that also roughly remains the same then we have crops and their decomposition, human waste, soils under natural vegetation and biomass burning. Biomass burning is 13 percent of ammonia.

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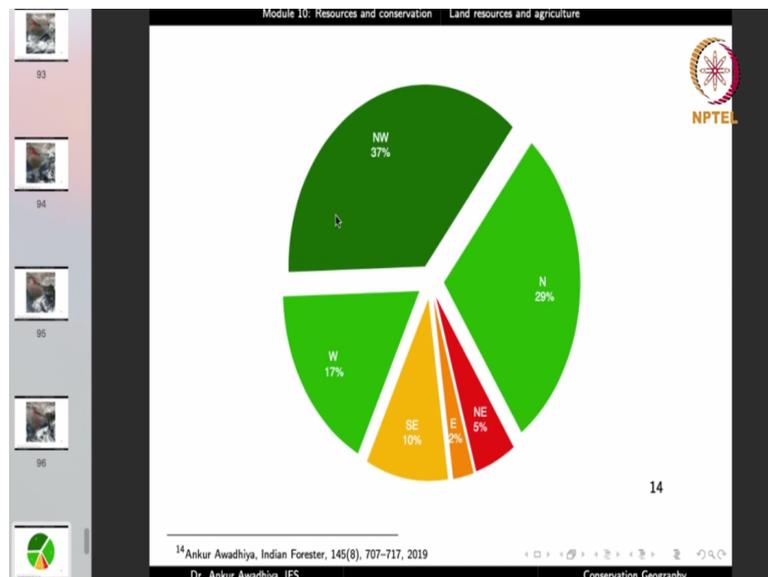
Now is there any area where we are seeing biomass burning. So, if we look at the satellite images and here we have the heat signatures. So, these are the fire signatures that satellites

are seeing and here we can observe that in Punjab and Haryana and certain portion is in UP and also certain other sporadic locations in India we are observing fires.

Now these fires are happening because the farmers are clearing their fields of the previous cultivation and preparing the fields for the next cultivation. So, this is an easy way out you burn the whole of the crop land because you have already taken the grains out and the troubles that remains if they are burnt then the whole area will be cleared in no time and so we are observing the heat signatures, fire signatures.

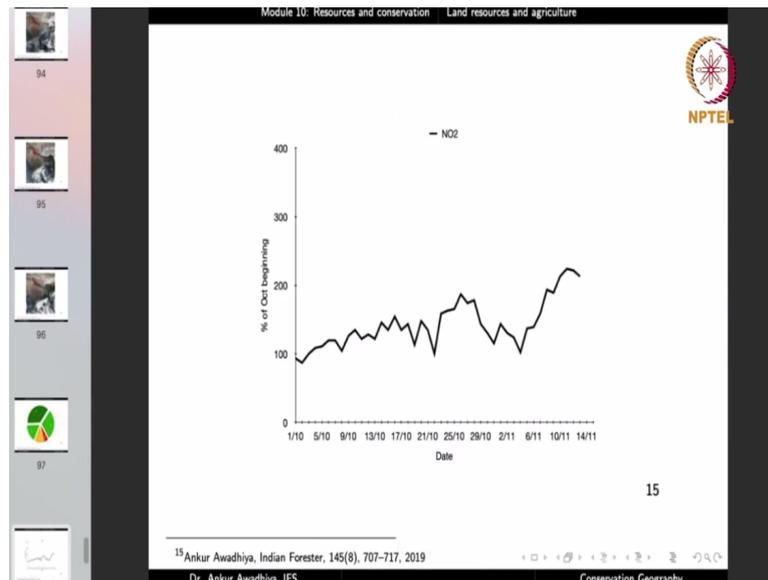
So, this is the fire signature on 15th of October. This is the fire signature on 25th of October see that still there is a large amount of stubble burning that is happening. This is the fire signature on 4th of November still you have a large amount of stubble burning in these areas this is from 10th of November. Again Punjab and Haryana you find a large amount of cropland burning.

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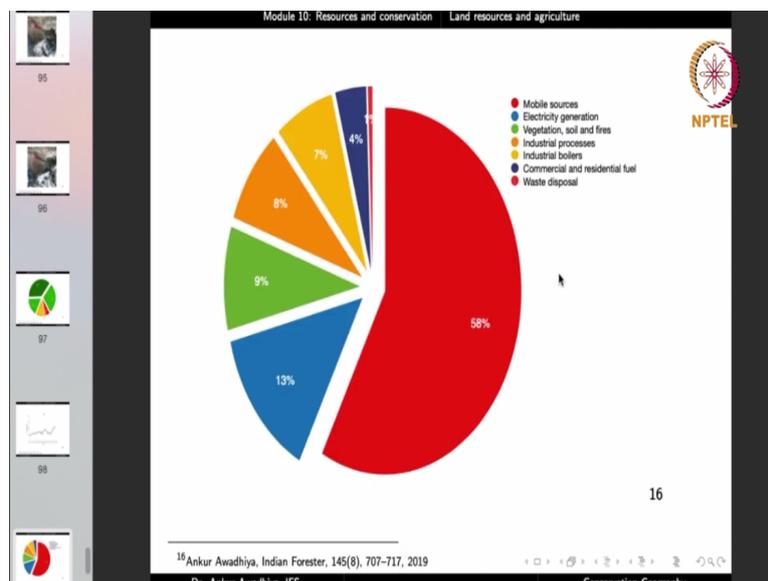
And if we look at the wind directions the majority of the winds in Delhi are coming from the North Western direction so they are bringing these pollutants. Now remember that the wind speeds are very slow and so the wind will slowly bring in these pollutants, but it is not fast enough to take them away. So, it is slowly bringing these pollutants into Delhi and into other surrounding area, if it were fast enough then the pollutants would have dispersed in no time.

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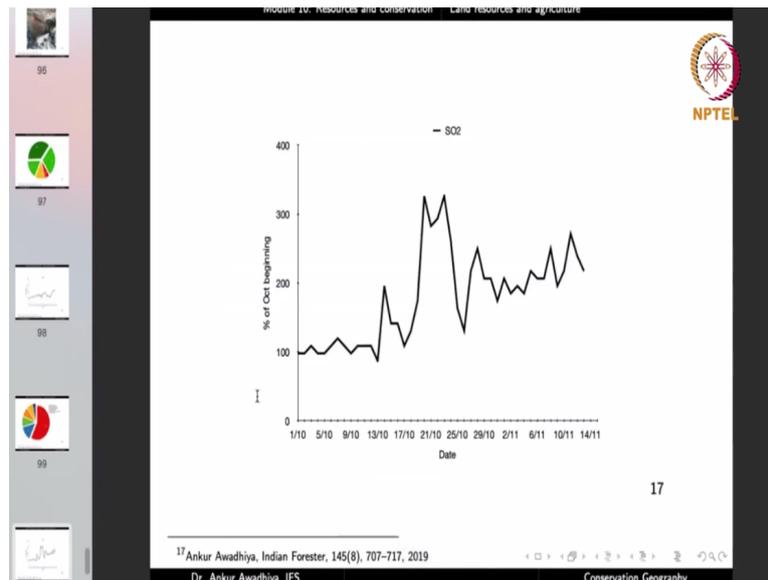
If you look at nitrogen dioxide concentration they show an increasing trend.

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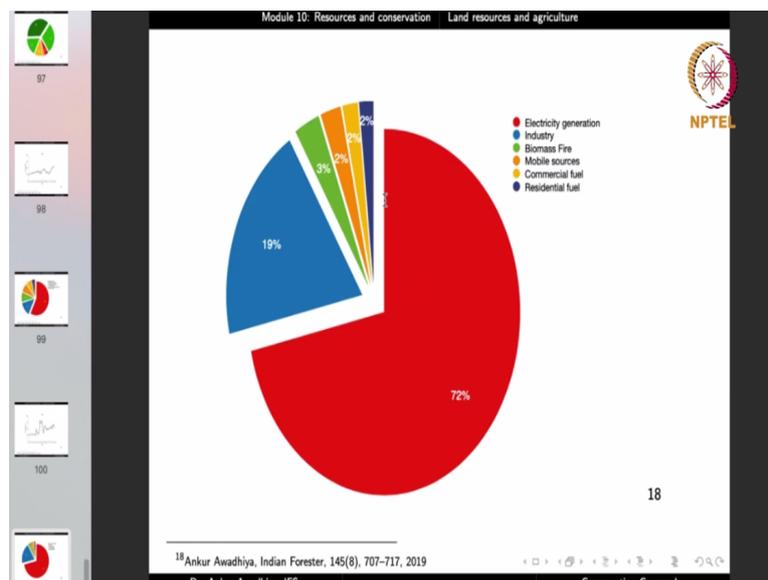
Now what are the sources of nitrogen dioxide? The major source is automobiles so as much as 58 percent of nitrogen dioxide in the atmosphere is coming from the mobile sources especially automobiles. Now Delhi has a very high car concentration and so it is inevitable that the nitrogen dioxide concentrations would increase when you have a situation of temperature inversion because any nitrogen dioxide that is released into the air it stays put it does not move away. So, overtime the nitrogen dioxide concentrations would increase.

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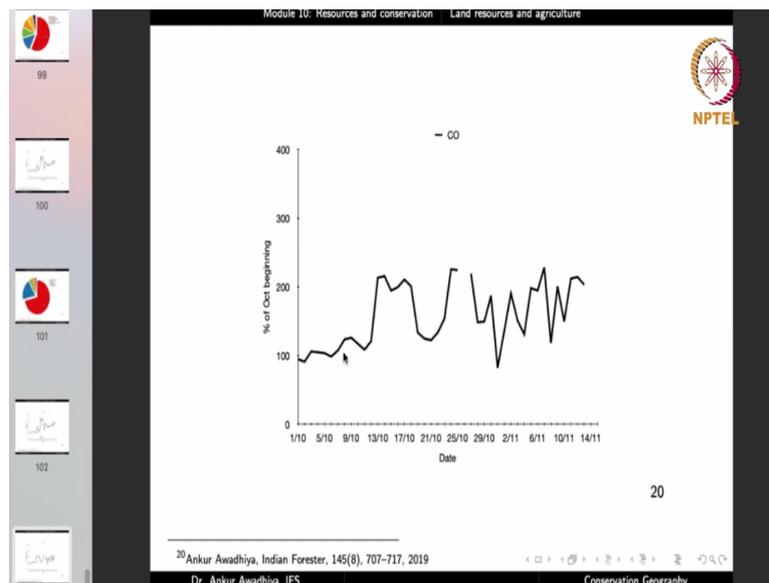
If we look at sulfur dioxide concentration it shows an increasing trend, but there is also a sharp peak here.

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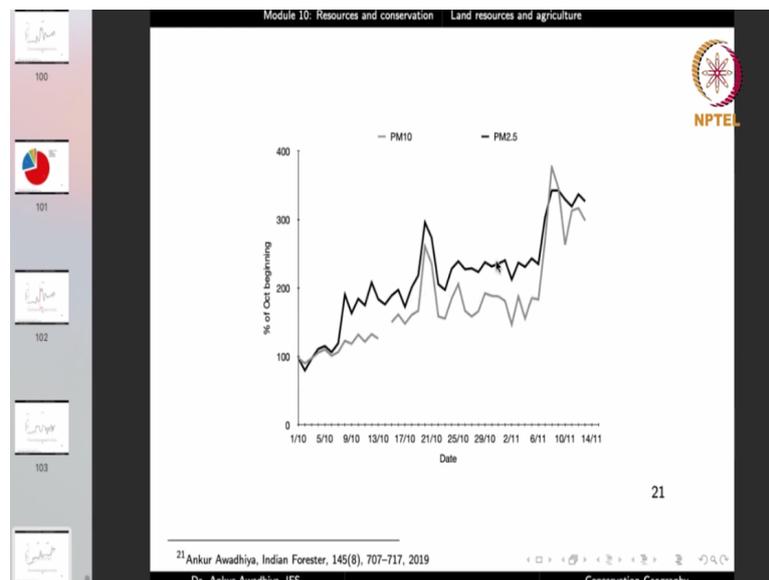
Now, what are the sources of sulfur dioxide the largest source is electricity generation. So, sulfur in the coals when it is burnt it produces sulfur dioxide and Delhi also has thermal power stations which are producing the sulfur dioxide which is being released into the atmosphere, but we also have the festival of Diwali and when people burn crackers they also release a large amount of sulfur dioxide. So, this peak this hump is because of the crackers are mostly because of the crackers that are being burnt during the Diwali festival.

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If we look at carbon monoxide concentrations they again show an increasing trend which is expected in the temperature inversion period.

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And all of these combined are leading to an increase of PM10 and PM2.5 concentrations. So, basically if we look at a situation like Delhi smog we cannot just pinpoint a single source because all of these sources are contributing. Once you have a situation where there is temperature inversion the air is not going anywhere so if anybody is releasing pollutants into this air the pollutant concentration would go up.

But what is important to note here is that the agriculture sector is also contributing and in a major way because of the stubble burning that is happening in these times. So, when we talk about land as a resource we find that a major chunk of land is being used for agriculture and this is also having a large number of negative impacts on the environment which has very important ramifications for conservation. So, that is all for today. Thank you for your attention. Jai Hind!