Conservation Geography
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Module - 10
Resources and Conservation
Lecture – 30
Mineral and energy resources

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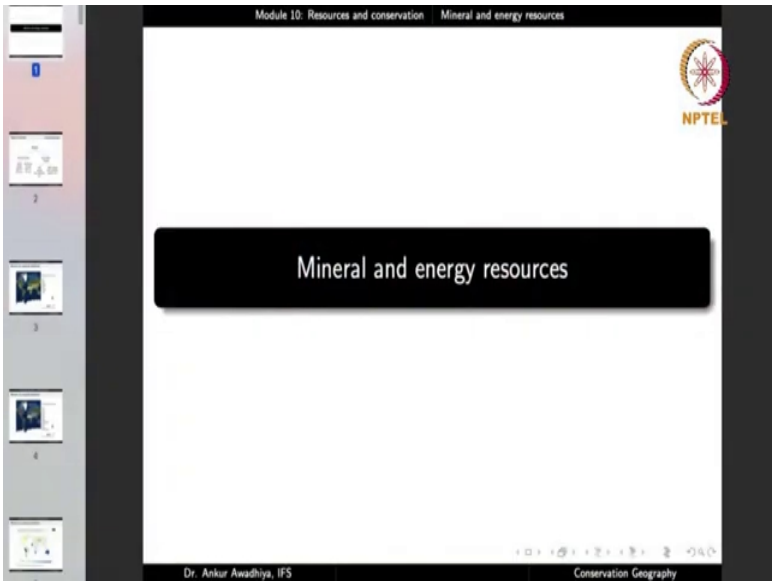

Namaste! We carry forward our discussion on resources and conservation and in this lecture we shall have a look at mineral and energy resources. Now, we have had a look at minerals, before when we were talking about rocks and minerals. So, you will remember that, when we talk about minerals, they are naturally occurring, they are inorganic solids with a definite composition and a definite atomic arrangement.

And we saw that there are a very large number of minerals, some of which are important when it comes to forming rocks. But there are also a large number of minor minerals. Now, several of these minerals have economic importance. So, for example, when we talk about a thing like calcium carbonate, or when we talk about halite, that is sodium chloride, then sodium chloride has also uses in our daily life and also in the case of industries.

Similarly, if we talk about minerals that have metals, then we can extract those metals out of those minerals. And the minerals that have an economic importance go by the name of ores.

Now, when we talk about minerals from an economic point of view, we expand the definition a bit. Because now we are not just talking about geology, we are talking about economics.

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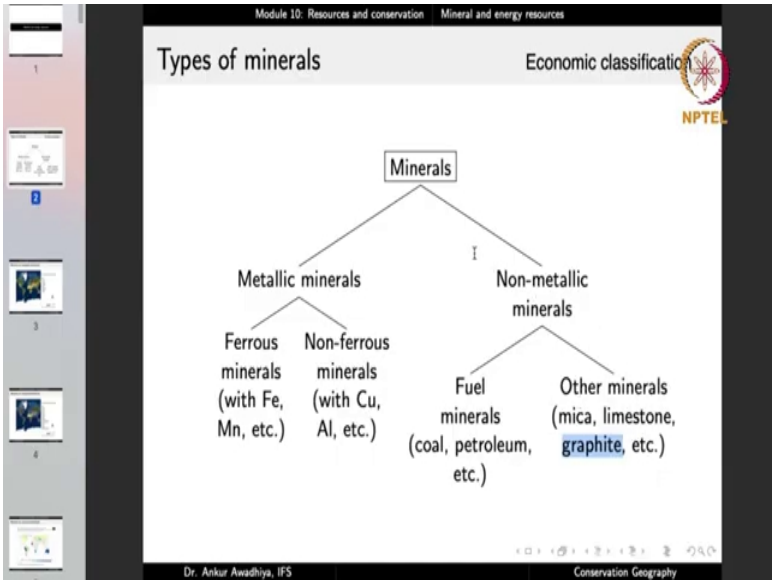

And from an economic point of view, we have this classification of minerals. Now, the important thing to note here is that, we even include things like petroleum, as a fuel mineral. Now, petroleum is in the form of a liquid. So, it will not come under the classic definition of minerals, which is inorganic solids, because this petroleum will have a large number of organic liquids.

So, this will be just opposite, or diametrically opposite to what our geological definition of minerals was, but we included in the economic classification of minerals. So, we include things like petroleum and even natural gas, when we talk about the economic minerals. And from an economic point of view, we can divide minerals into two categories, there are metallic minerals from which we can extract metals and there are non-metallic minerals in which case we do not extract metals from them.

And especially not those metals that have a very high economic value. So, from metallic minerals, we have two categories, we have ferrous minerals, ferrum means iron. So, these are the minerals from which we get iron, or those metals that are related to iron. So, these minerals will have elements like iron and manganese. And we have non-ferrous minerals, from which we get non-iron metals things like, copper, or Aluminum, gold, silver, and so on.

When we talk about non-metallic minerals the ones from which we do not extract metals, we have fuel minerals that are used as fuels, such as coal, petroleum and natural gas. And we have other minerals, such as mica, limestone, and graphite, etc. Now, if you look at an example here such as graphite. Now, graphite has economic importance, it is not a metallic mineral, because it does not provide us with any metals, it is not a fuel mineral, because it does not provide us with a fuel, it is mostly carbon and it has got other industrial and daily applications.

And so we classify it as other minerals, in the category of non-metallic minerals. So, from an economic point of view the minerals are of two categories we have metallic and non-metallic minerals, in the case of metallic minerals, we have ferrous minerals which provide us with iron and we have non-ferrous minerals. In the non-metallic minerals, we have the fuel minerals and we have the non-fuel, or other minerals, such as mica, or graphite. So, this is the economic classification, that you should be mindful of.

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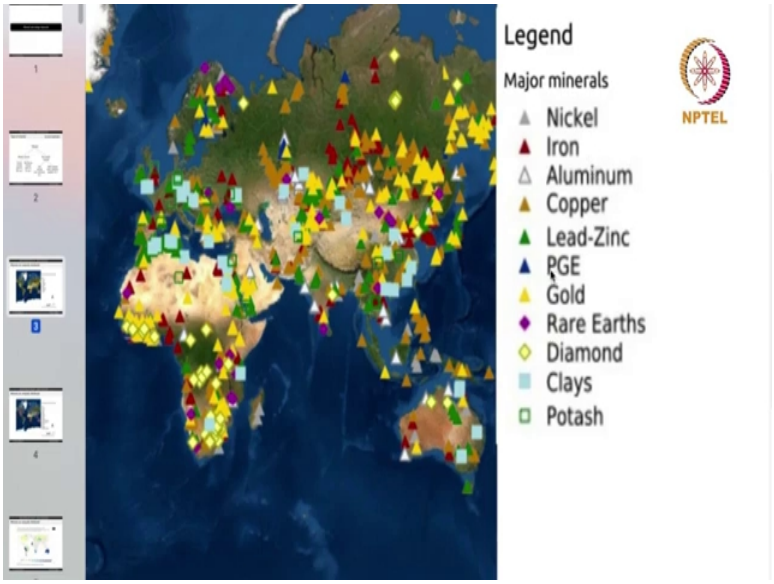

Now, when we look at the distribution of these minerals, we find that the minerals are very unequally distributed. So, there are certain locations, that have minerals and there are certain other locations that do not have an appreciable quantity of minerals. Now, in this case when we talk about an appreciable quantity of minerals, we are only looking at it from the economic point of view, not from the geological point of view.

Because in all the locations we will be having rocks, or we will be having soil. And the soils because they are derived from rocks, they also have minerals, the rocks are also a group of minerals. So, we have minerals everywhere, but a large quantity of those may not be of economic importance. So, in this lecture we are looking at mineral as a resource.

So, we are emphasizing that, we are only talking about the economic minerals. Now, if you look at the global distribution of selected minerals and here we have the major minerals. So, we are talking about the minerals that provide us with things like Nickel, or Iron, or Aluminum, Copper, Lead and Zinc and so on.

Now, in this map you will have an idea, that if you look at our country India, then there are certain locations, there are locations say in the states of Bihar and Jharkhand, in the states of Madhya Pradesh, or Odisha, or in the states of Karnataka, and Kerala, where you are finding certain minerals. But if you look at areas in Uttar Pradesh, there is not an appreciable quantity of economic minerals that are being extracted from Uttar Pradesh.

Now, this is because in the case of Uttar Pradesh, we have the flat northern plains, that are made up of alluvial deposits. And when we talk about economic minerals, we are talking about things like mines. Now, in the case of mines, there is a big size rock, that you are drilling and you are breaking and you are extracting the mineral. If that rock is covered by a very large depth of soil, then probably it will not be economical to extract the minerals out of that location.

And so we find that a large number of minerals, or mineral deposits in our country, occur in the Deccan peninsula, where we have large igneous deposits. So, we have large igneous rocks and during the process of cooling and solidification, which led to the formation of the igneous rocks, then in a large number of cases, the minerals assorted themselves out, that is we saw earlier that in the case of minerals, because they have definite atomic arrangements.

So, they are able to form crystals. So, in certain locations a certain quantity of crystals will be found, which will be easier to extract, because it is then a concentrated deposit of that particular mineral. Whereas, when we talk about areas with soil, or areas with sedimentary rocks, then the rocks, or the igneous rocks, from which these sediments were derived, they have been completely weathered out.

And so the minerals that were there, they are now in a very diluted form. And so you find it very difficult to extract them especially economically. And so a large quantity of the mineral deposits will be found in the igneous locations. Another location, where we find large mineral deposits is the sea coast, because in the case of sea coast, a large number of heavy minerals, especially those

that have importance in the atomic industry, they will get deposited, because there is a continuous action of waves that is taking away the other minerals.

And so concentrating the deposits there. You will also remember that, when we talked about Wegener's theory, we had talked about placer deposits. And we said that in the case of placer deposits, there is a rock that bears a mineral and there is a river, that is weathering this rock. And it is carrying the eroded sediments to another location and depositing them there.

When that happens the minerals get concentrated, because the heavier metals, or the heavier minerals will accumulate in those areas, whereas the lighter minerals will be carried away. And so that location again will become very important from the economic point of view, because you have a concentrated deposit of a certain mineral.

So, when we talk about the economic minerals, there are certain locations, locations that have either igneous rocks, or locations that have placer deposits, or locations that are having sea coast, where you will find an appreciable quantity of a particular mineral, which makes it economically feasible to extract the mineral from that location.

And this is exactly what we are observing in this particular map. So, if you look at large stretches of Russia you will find that there is hardly any mineral, that is being extracted there, there is hardly any mineral that is being extracted in this location, there is hardly any mineral that is being extracted in this location in Brazil and South America.

Whereas, if you look at the western coast you find a dense accumulation of minerals. Here again on the western coast of the US, you are finding a dense concentration of minerals, economic minerals. Here in Africa, you are finding a dense concentration of minerals here, but not in most of the Sahara Desert.

In the case of Europe, you are finding a dense concentration here. And so the important thing to note is that, the minerals are unequally distributed, they are not distributed equally throughout the world. This is about the major minerals.

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If you look at the minor minerals, the ones that give us antimony, or barite, or beryllium, or cobalt, or fluorites. Here again we find a very similar thing, you find certain locations where these are concentrated and certain other locations where these are not concentrated. And so the minerals are unequally distributed throughout this planet.

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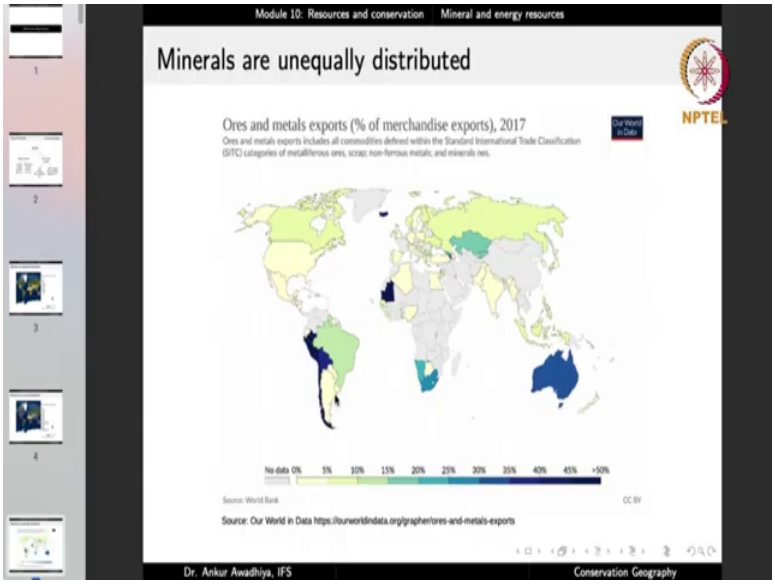

And this unequal distribution also shows itself in terms of the dependence of different countries on minerals, especially for their exports. So, if you look at this chart, we will find that areas in South America, such as Chile, they are heavily dependent on minerals as their exports, areas like South Africa, areas like Australia, for these countries we have a large share of exports, that is being dominated by the export of minerals, that is the economy and especially the international trade for these countries is largely dependent on the mineral trade.

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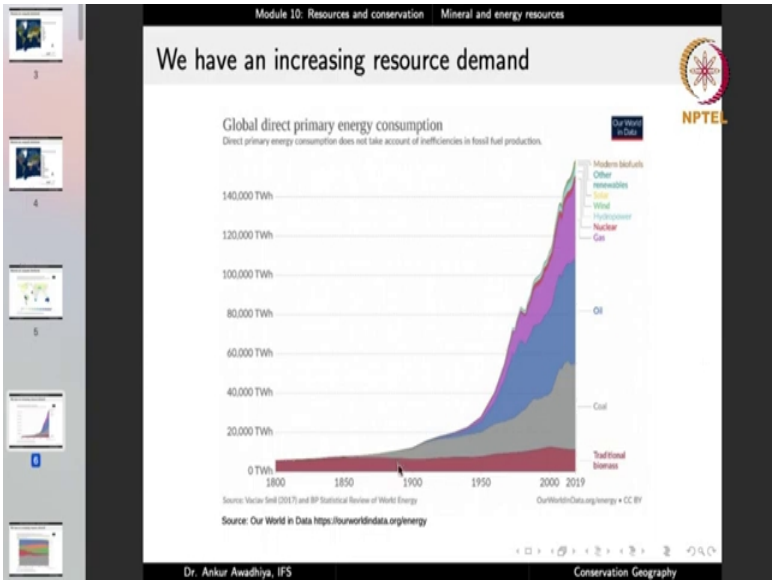

But the important thing to note is that overall, we have a resource demand that is increasing. So, if you look at the global primary energy consumption, from the year 1800 to date, we find that there has been roughly an exponential increase in the energy resource demand, throughout the world. And we can also see that the share of different sources of energy that has also been changing. In the 19th century especially, in the first half, the majority of the primary energy consumption was because of the traditional biomass.

Then from 1850 onwards, the share of coal started to increase. Then in the 20th century, we find that the share of oil started to increase. Then later on we became more and more dependent on gas, that is the natural gas. And the other sources of energy like nuclear, or hydro power, or wind, or solar, and other renewables, modern biofuels, they also started to begin roughly in the 20th century.

And they are now holding an appreciable share in our primary energy consumption. So, basically we are now tapping a large number of sources, earlier we were only dependent on traditional biomass, plus a very small portion of coal and oil, which is so small that it is not showing itself on this chart. But now the energy consumption is very high.

So, here you can see that in the 1800s, we had an energy consumption, which was roughly 500 to 600 terawatt hours. But today in the global scale, it has exceeded 140,000 terawatt hour, that is we are roughly using a one and a half lakh terawatt hours of primary energy in the world. Now, this is on a longer time scale of around 220 years.

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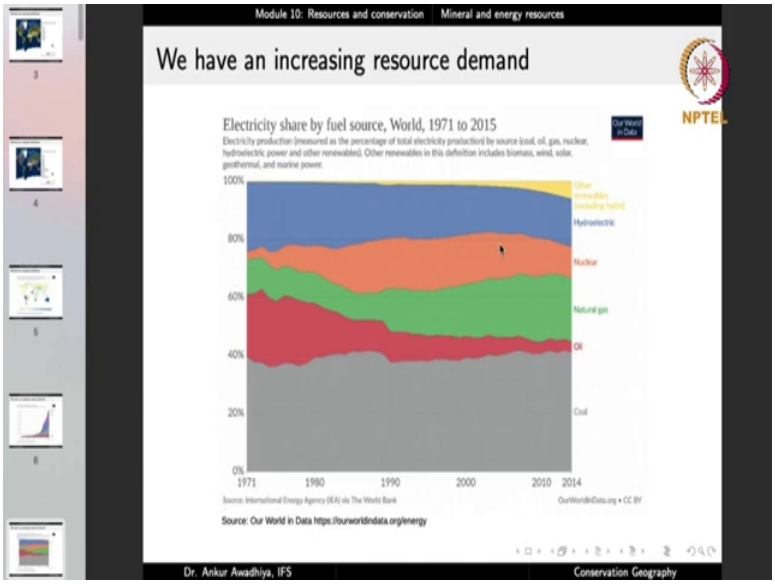

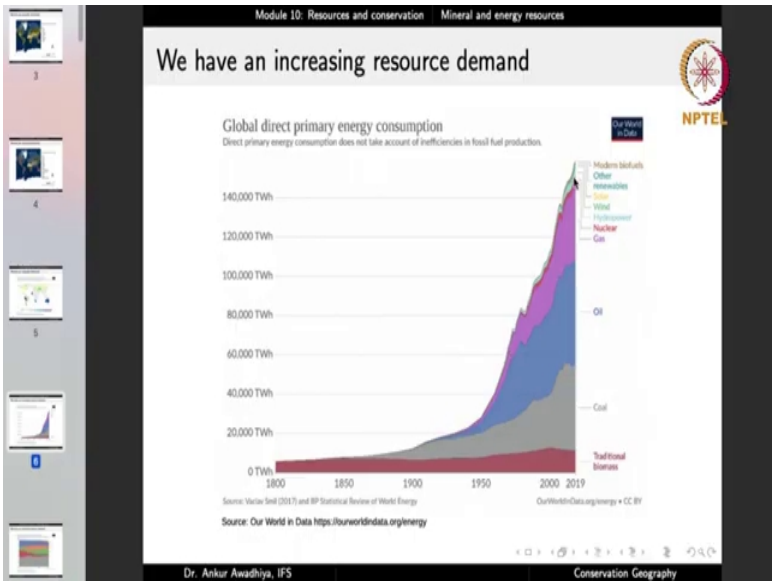

But even on a shorter time scale, say from 1971 to 2014, we find that our use of different sources of energy has been changing. So, in the 1970s, we were using coal for making roughly 40 of our electricity, this share has more, or less remained constant.

But then, if we see this curve we find that the total amount of energy that we were producing in the 1970s was roughly 60 000 terawatt hours, today it is roughly 150,000, that is there has been an increase of roughly two and a half times. But the share has remained more or less constant.

So, then to it was 40 percent, today also it is 40 percent, meaning that we have created more capacity in our thermal power plants, we have either made more number of thermal power plants, or we have increased the capacities of the existing thermal power plants.

But we have done it in a manner, that earlier also we were using coal for meeting roughly 40 percent of our electricity needs, even today it is roughly 40 percent of our electricity needs. Then in the 1970s, roughly 20 percent of our electricity needs were being met by oil. Now, this has reduced considerably over this period, primarily because oil has now become more and more expensive.

Then in the 1970s, we had a smaller share of electricity being made through natural gas, the share has now increased, especially because natural gas is now more available through processes such as fracking. Now, in the case of fracking, we use a process to create fractures in rocks. So,

that the natural gas can easily be collected out, and with this technology we can now tap more and more sources of natural gas. And so our share of natural gas has been increasing.

In the 1970s, a very small fraction of our electricity was being made through nuclear sources, that increased with time as we created more and more nuclear power stations and we increased the capacities of the existing nuclear power stations. But especially after the Fukushima incident, in japan, the share of nuclear has been going down.

Then in the 1970s, we were making roughly 25 percent of our electricity using hydroelectric power plants, that share has now decreased. Now, this share has decreased not because we have been shutting down the hydroelectric power plants, in fact we have constructed more number of hydroelectric power plants and increased the capacities of the existing ones.

But the share is going down primarily, because the share of other sources has increased. So, we are now making more electricity using other sources than hydroelectric. And so the share of hydroelectric has been going down. Another thing to notice is that, the other sources primarily the, the renewable sources were very small in share in the case of 1970s, but they have now become very appreciable, roughly 10 percent of the electricity demand is now being met through renewable sources, like wind power, or solar power and so on.

And this is the electricity share by different fuel sources. Now, the important thing to note here is that our shares of the non-renewable sources, such as coal, oil and natural gas, they have actually decreased, even though a bit but they have actually decreased, which is a good thing.

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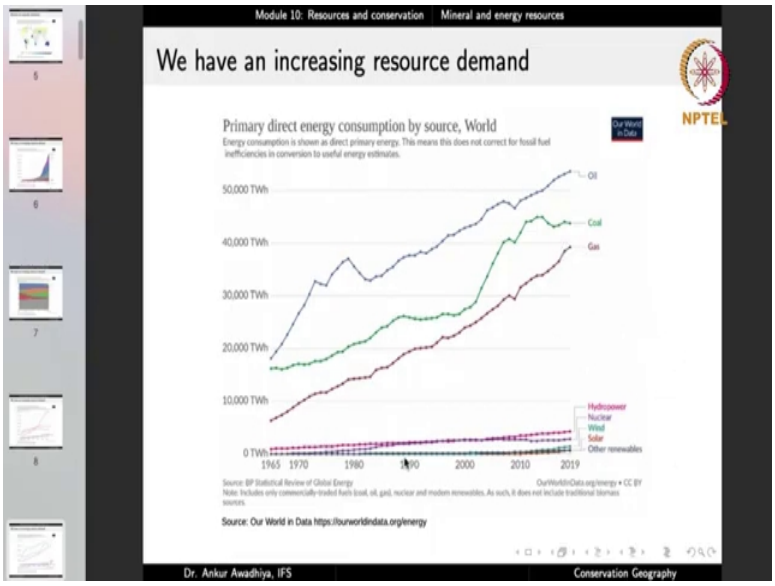

Now, if you look at the energy consumption in different areas, we find that the energy consumption in Asia pacific, that has been increasing roughly exponentially. Whereas, in the case of Europe and North America, that has now roughly reached a plateau. So, we are not, not observing a very great amount of increase in energy consumption in these regions. They are more or less saturated.

In the case of middle east, again we are finding an exponential increase in the case of south and central America, it is now plateauing, in the case of Africa, it is on an increasing trend. So, in most of the countries, or in most of the regions of the world the consumption of energy is either increasing, or it is remaining roughly constant, nowhere it is decreasing which tells us that we have a largely increasing resource demand.

If you look at different sources, then oil has been increasing, coal has been increasing, it has now roughly reached a plateau. But again more or less there is an increasing trend, in the case of gas there is a very rapid increase and for other sources, we can see that they are also increasing a bit.

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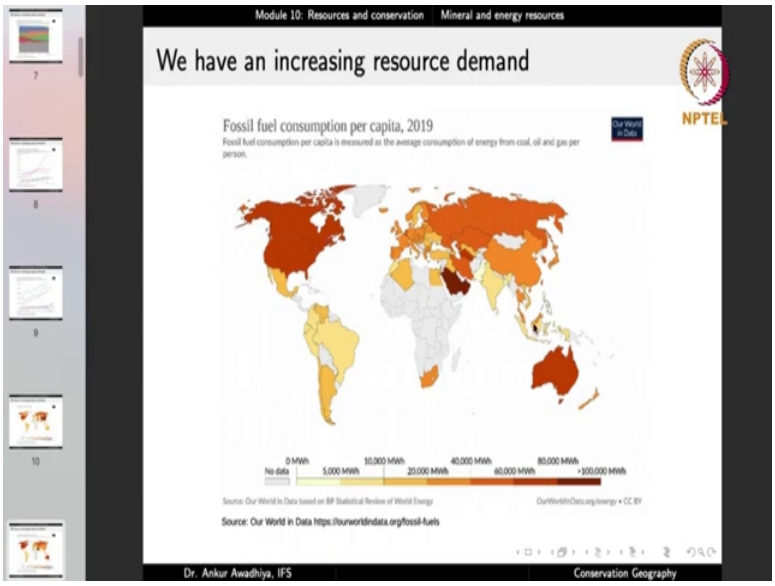

If you look at fossil fuel consumption in different areas, we will find that areas like the US, or areas like China and Russia, and even India, we are having a very large amount of fossil fuel consumption. But if you look at it in a per capita manner, we will find that in areas like US and Canada, or Australia, or in the Gulf areas, we have a very high per capita fossil fuel consumption. In India and China, because the populations are large.

So, the per capita consumption becomes less. So, essentially if we talk about people in India and China, we are placing a less amount of burden per person on the fossil fuel consumption. Whereas, because of our large size populations, the total impact is still very considerable. So, we are doing good individually, but on a cumulative scale, we still have a very large amount of resource use in our country.

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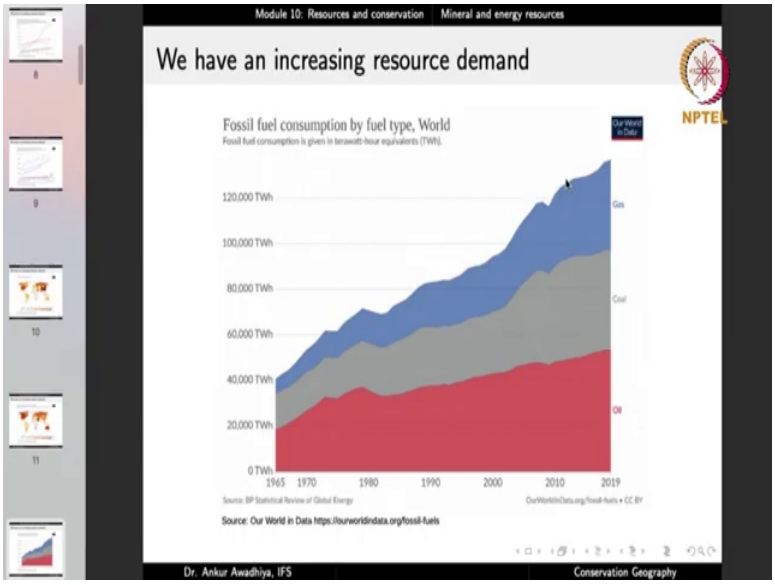

If you look at the consumption of different fuel types, we find that oil is increasing, coal is increasing, and gas is increasing.

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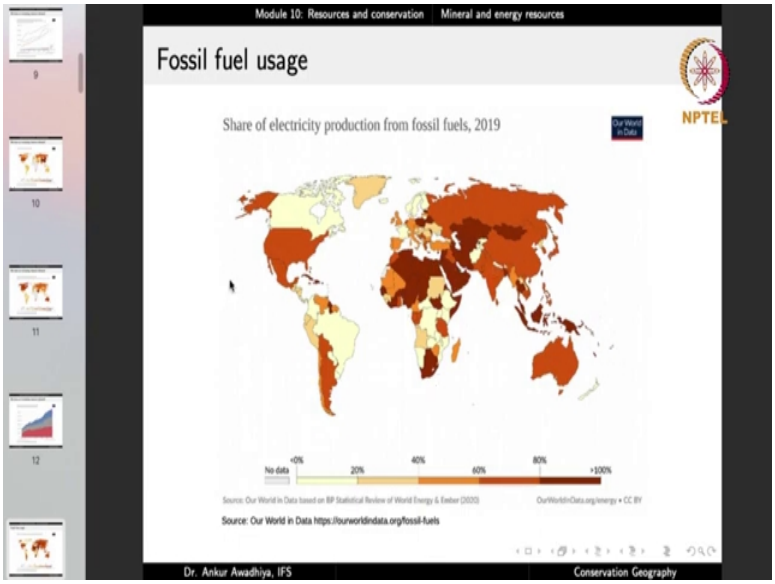

If you look at the share of electricity production from fossil fuels, we find that in areas in the Gulf, certain areas in central Asia and certain areas in north and west Africa and south Africa, we

have a very large proportion of electricity, that is being made through fossil fuels. Followed by areas like India, Pakistan, China, Russia, Australia, US and so on.

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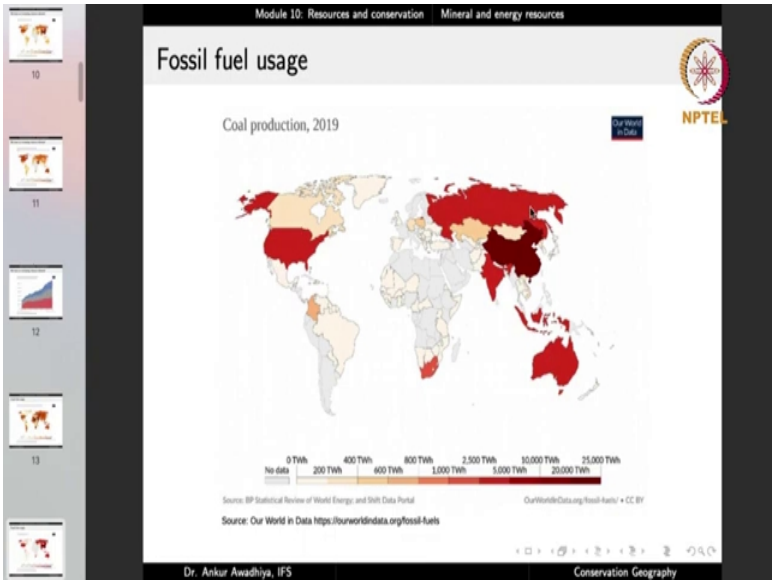

If you look at the coal production in different countries, China is number one followed by US, Russia, Australia, and India.

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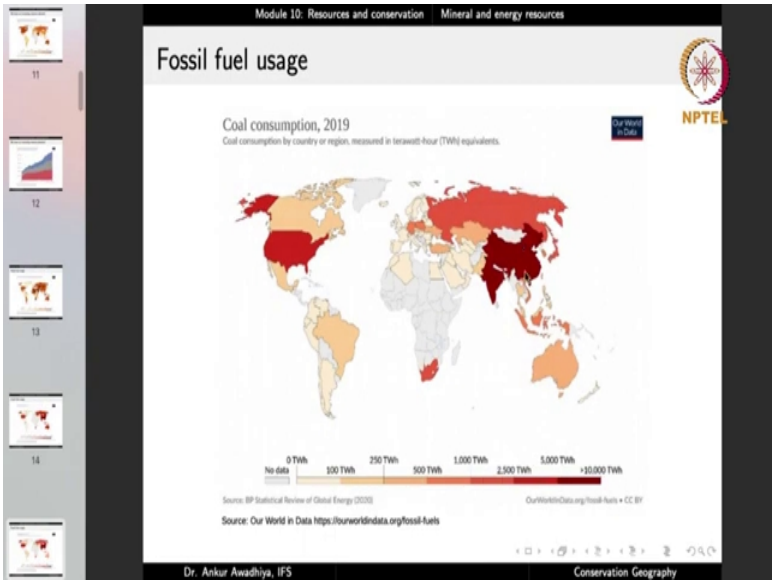

If you look at the consumption of coal, then China and India have a very high coal consumption, because in our country even though we are not producing a very large amount of coal, we are importing a large amount of coal.

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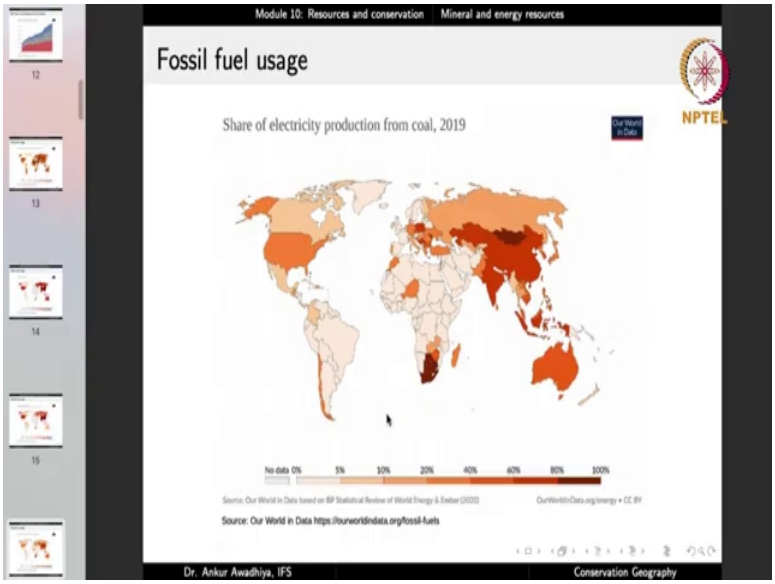

If you look at the share of electricity production from coal, we find that areas like Mongolia, or south Africa, they are producing the largest share of their electricity using coal. Now, coal becomes very important from the point of view of conservation, because it is a very polluting source of fuel.

So, if countries make use of coal, if countries burn coal, then the Sulphur, that is present in the coal that also burns, it forms Sulphur dioxide, it is emanated into the atmosphere and then it comes down with the rain and that leads to a large amount of acid rainfall, which not only kills plants and trees, but it also harms things like buildings.

So, if you have buildings that are made up of spray things like marble, then you will find that there is a large amount of weathering that happens in these buildings. And so coal usage has to be decreased.

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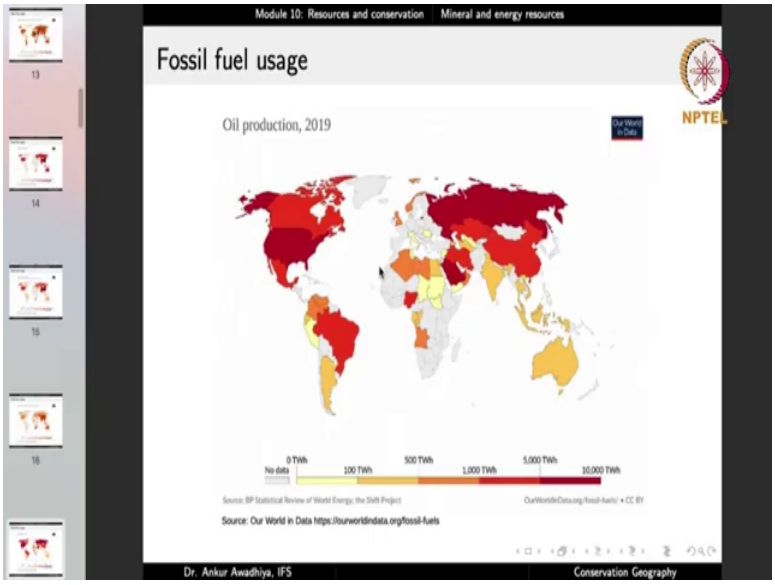

If you look at oil production, then we have Saudi Arabia, US, and Russia, that are making a very large quantity of oil.

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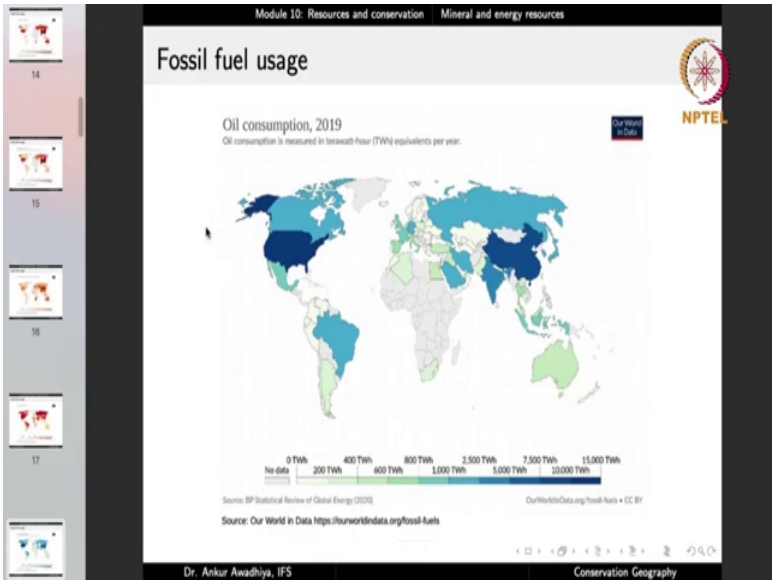

If you look at oil consumption, we have countries like China and US, where the oil consumption is very high.

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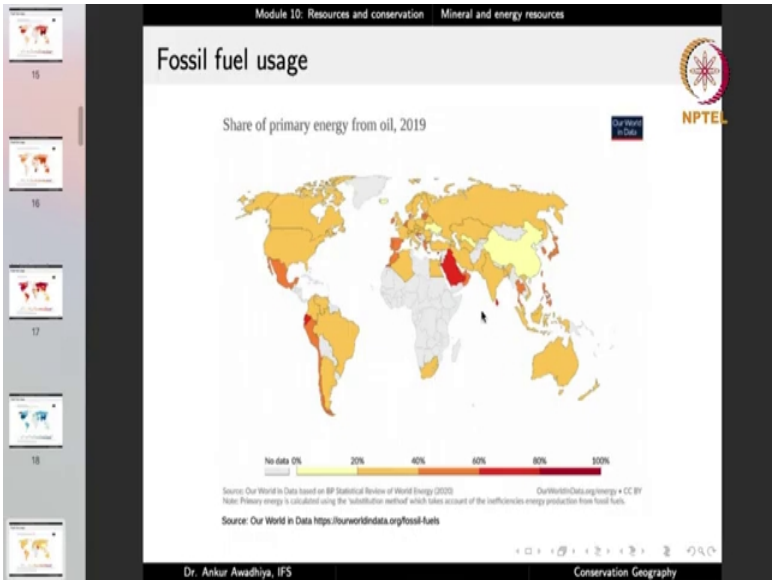

If you look at the share of primary energy from oil, the picture changes, it is more in the case of the Gulf countries and some parts of south America.

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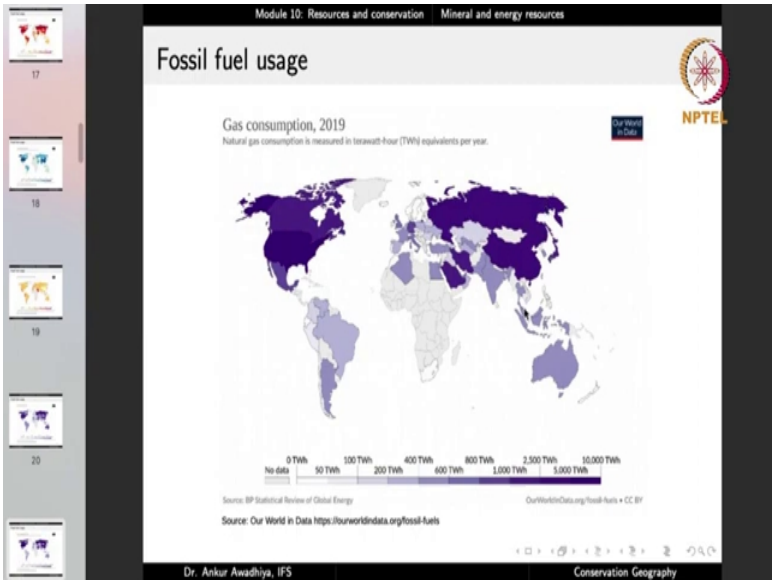

If you look at gas production US and Russia, are producing very large quantities of natural gas. They are also consuming, but we also find areas like China that have a very large consumption of natural gas. Now, they are not very large producers, but they are importing the natural gas.

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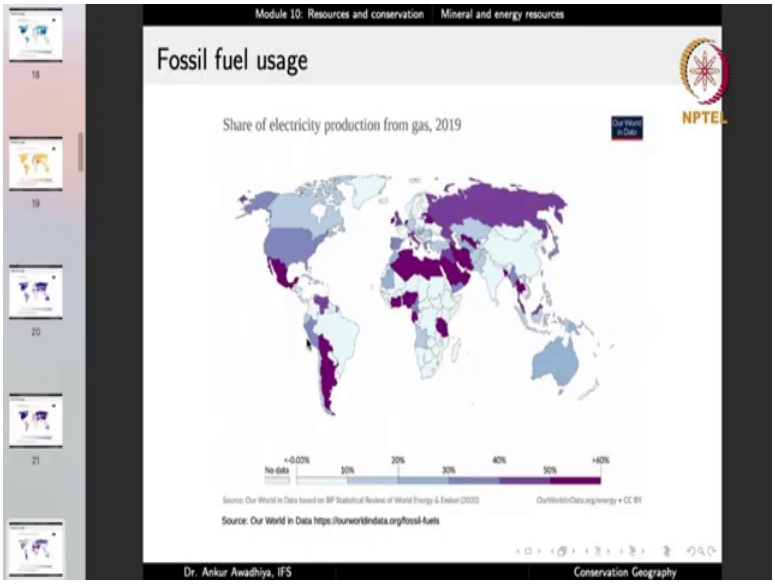

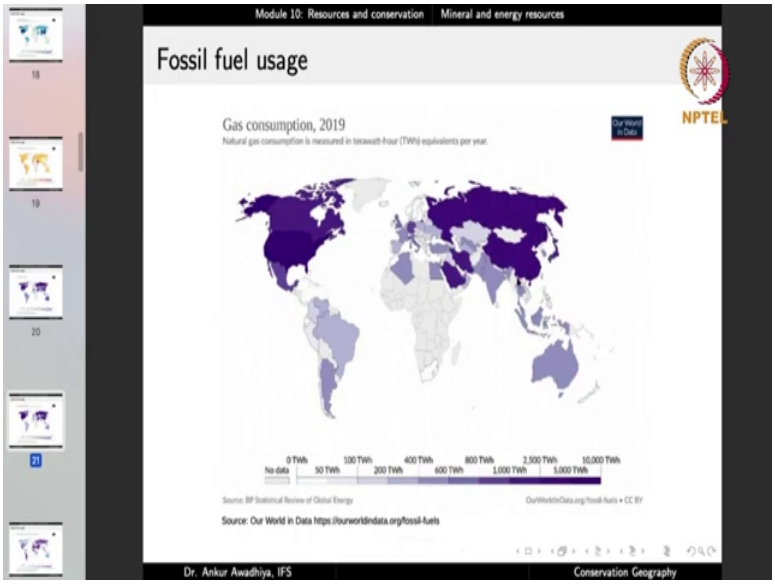

If you look at the share of electricity production from gas, the picture changes completely. So, this shows us that in the case of China, they are not using the natural gas primarily for electricity production, but for other uses. If you look at electricity production, then areas in the Gulf, or northern Africa, or areas like Argentina, or Mexico, you have a very large product large proportion of electricity, that is being made using the natural gas.

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If you look at the coal reserves, then we have large coal reserves in countries like the US, or Russia, or China or India, or Australia.

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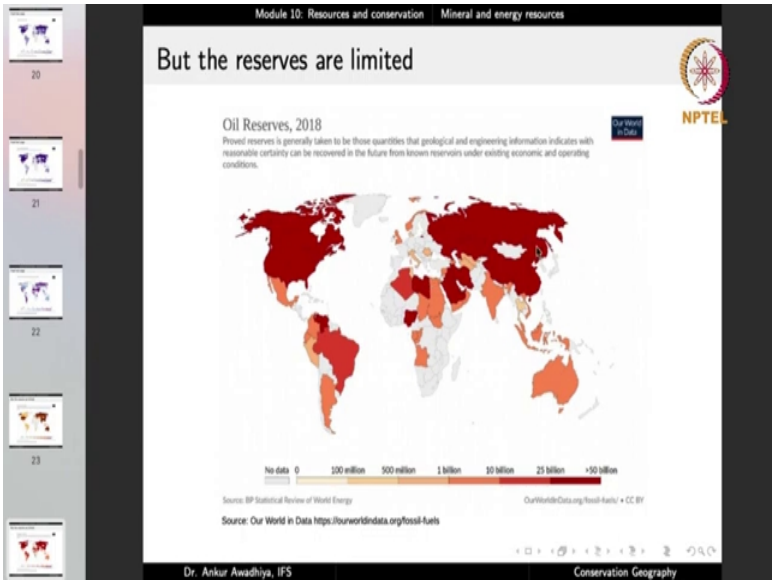

If you look at oil reserves, we have large oil reserves in US, Canada, parts of the gulf and northern Africa, Russia, and China.

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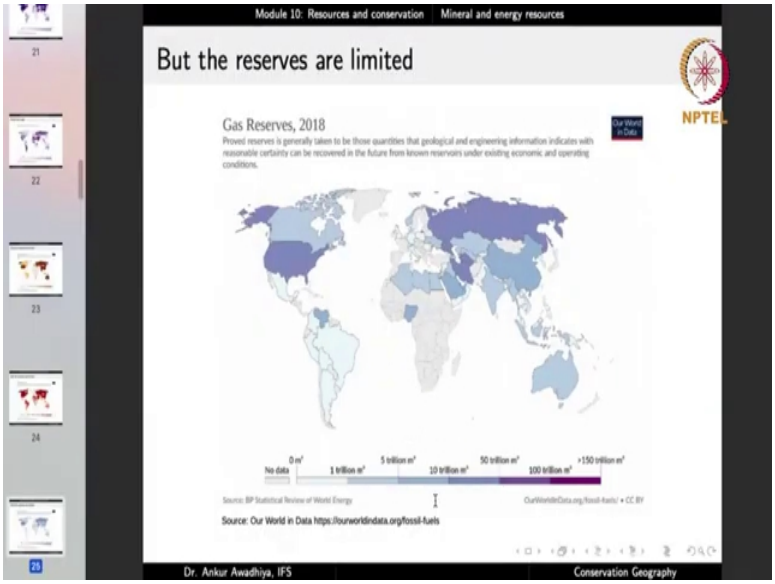

If you look at gas reserves, we have large gas reserves in US, Russia, and areas in central Asia. Now, two things become important here, one is that our reserves of different resources are limited, we do not have an infinite amount of resources on this planet. And in a large number of cases these resources have already been prospected, surveyed and quantified.

So, for instance if we talk about the US, the gas reserves are between 10 and 50 trillion cubic meters, not more. Similarly, if you talk about China, the gas reserves are between 5 and 10 trillion cubic meters. So, the resources are limited, the second important point is that not all the countries have these resources.

So, if we talk about areas in Africa, especially the south of Africa, we have very little amount of gas reserves. And so the usage of these resources will be very lopsided, those countries that are producing these resources, or that have sufficient money to procure these resources, import these resources, only those are the countries that will be able to make use of these resources.

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But not only that, another thing is that we cannot use all of these resources. So, if we look at the amount of carbon, that we have if this chart is showing us the global fossil fuel reserves, we cannot use all of that, especially because when we use these fossil fuels, we release carbon dioxide into the atmosphere, that results in global warming and climate change.

Now, there has to be a cap on the amount of carbon, that we can release into the atmosphere, because more and more amount of carbon that gets released into the atmosphere, the greater will be the amount of global warming. Now, all over the world the consensus is that we should keep it below 2 degrees.

So, we can heat up the planet, but if we heat the planet more than 2 degrees, then the impacts will be tremendous, below 2 degrees also we have large impacts, but above 2 degrees things will start to go really out of control. And so if you look at the carbon budget for 2 degrees, out of these resources we can only use roughly one third and two thirds will have to be kept as unburnable reserves.

Because if you burn them as well, then we will have a situation that goes completely out of control. So, the resources are limited, they are localized and we cannot use all of them, what is the option of label, well we will have to look at certain other options. We will have to bring

down our energy usage, we will have to bring down our resource usage and probably shift to renewable sources of energy.

Now, this is extremely important, because even our current extraction of different resources is leading to large scale impacts.

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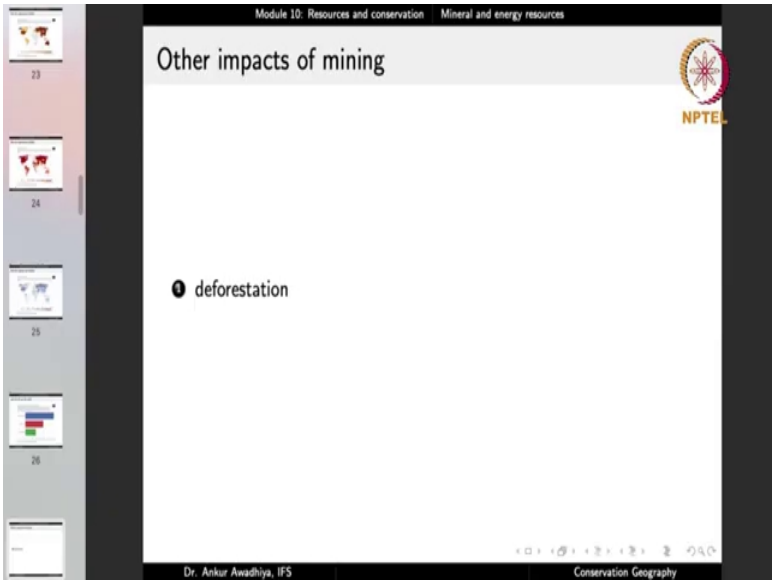

So, if you look at the impacts of mining, we have things like deforestation.

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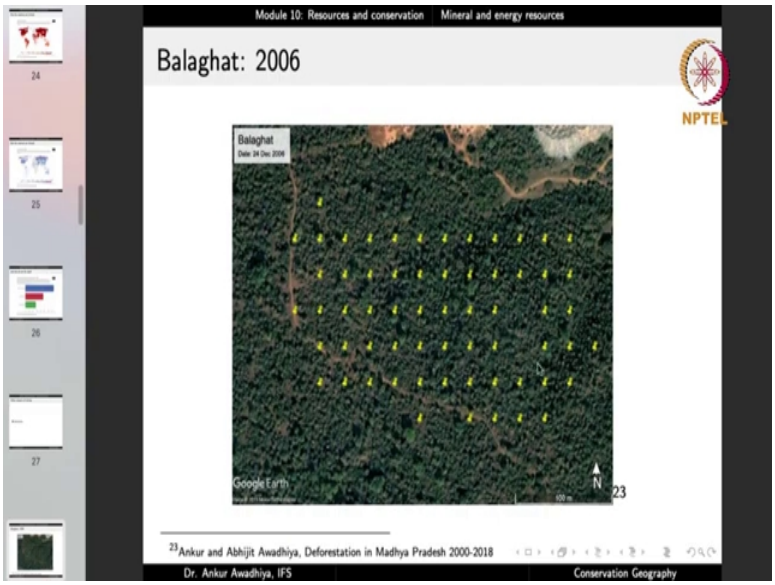

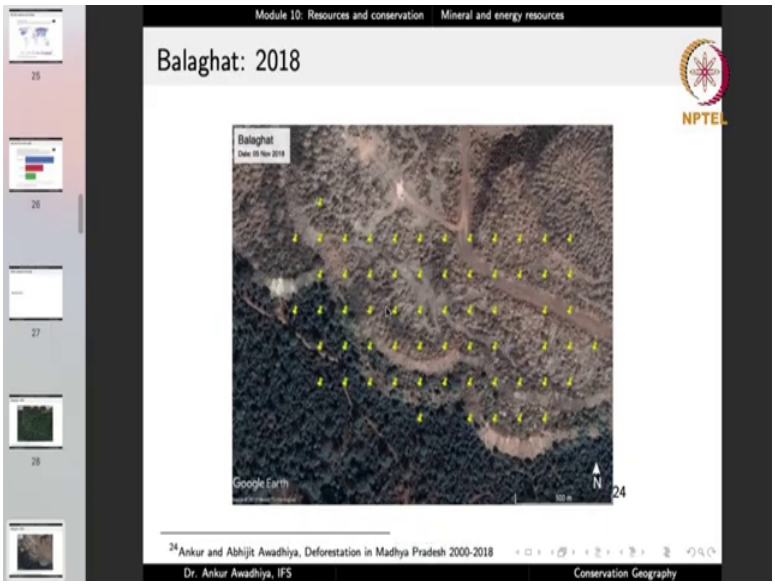

This is an area in Balaghat, in the year 2006, and you can find that we have a lush green forest in this area. This is the same region in 2018, and all of these forests have been removed to make way for these mines.

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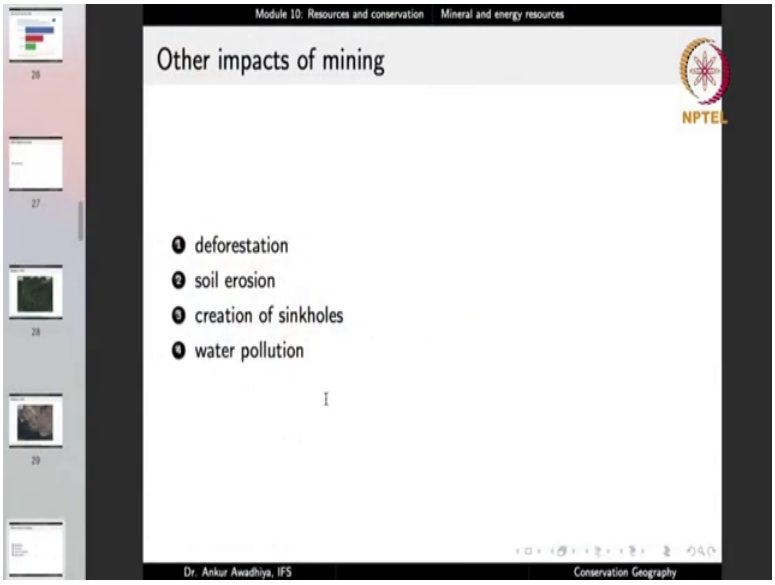

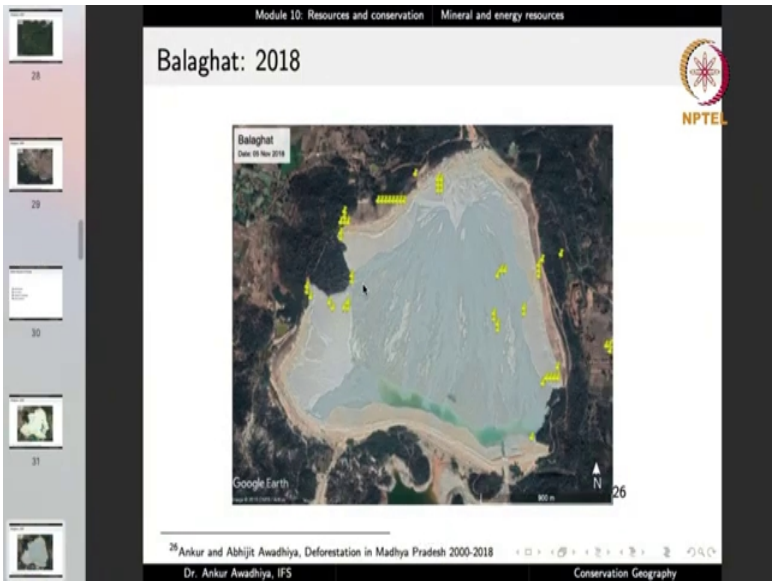

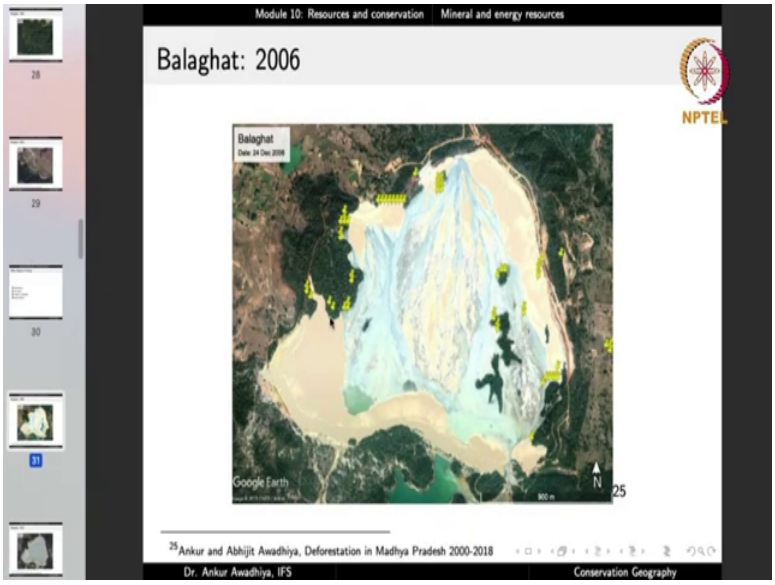

In the case of mining, we also find large scale soil erosion, because the ground cover is removed the soil is now completely exposed to the elements of nature. And so we find large scale soil erosion, that has large amount of environmental consequences. And also a large number of economic consequences. We find creation of sinkholes in different areas, we find water pollution.

And in certain cases the water is extremely toxic. In the case of Malajkand mines in Balaghat, this is the situation. So, this is the tailings dam of the Malajkhand mines, which are one of the most prominent copper mines in our country. Now, when there is an extraction of copper that

happens, then quite a large amount of waste products are also generated, especially in the form of minerals that are soluble, or dissolved in water.

Now, this water which is a contaminated water, it cannot be released into a river, because that will lead to a very large scale environmental consequence. So, we create large size dams and in these dams, this water is kept and we allow this water to evaporate. So, that the toxic elements, especially the copper salts in this case they become more and more concentrated and later on we will be able to process them.

But if you look at this stealing stamp, we find that if you concentrate on this area, now this is the tailing stamp in 2006, this is the tailings time in 2018. So, in this area we find that there is a deforestation that has happened. If you look at these areas, here we find trees in 2006.

Now, the trees are gone. Now, nobody went to these areas to cut these trees, but what happened is that because the water is very toxic, so the trees just died off. Now, if this water reaches our ground table, ground water table, or if it reaches into our streams, or rivers, there will be a large-scale death of organisms.

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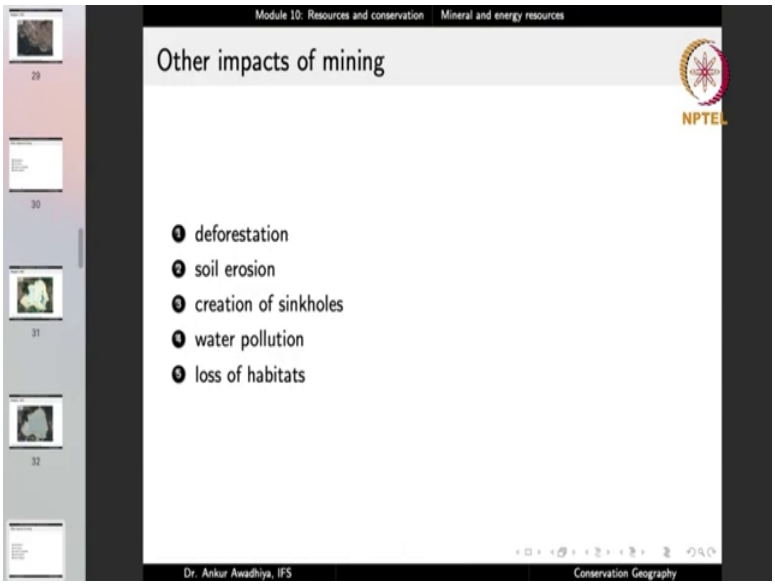

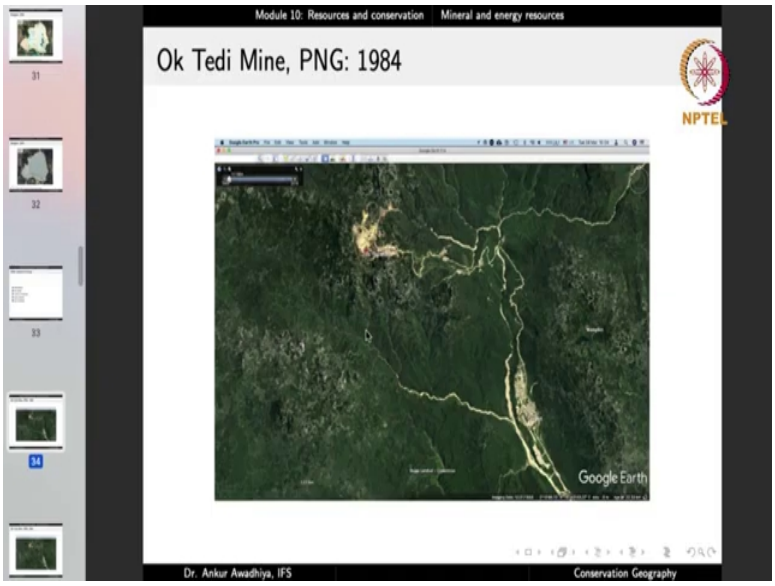
Module 10: Resources and conservation
Mineral and energy resources
Ok Tedi Mine, PNG: 1984
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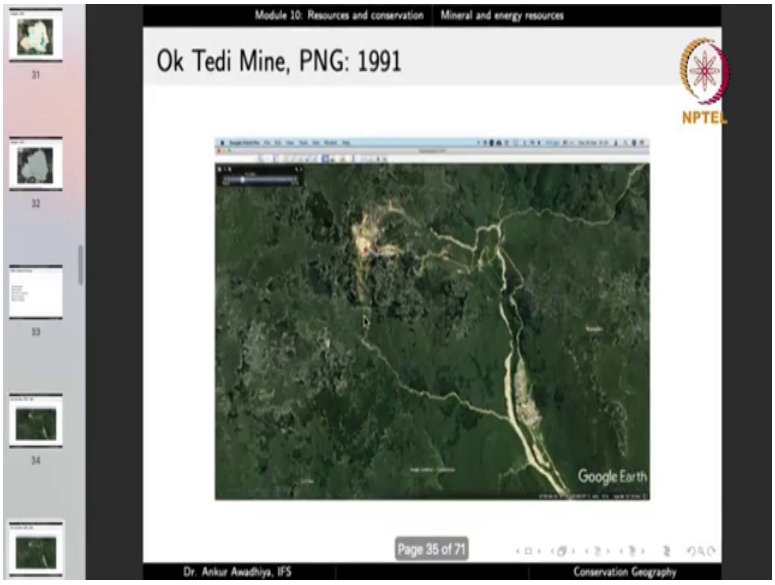
Conservation Geography


Module 10: Resources and conservation
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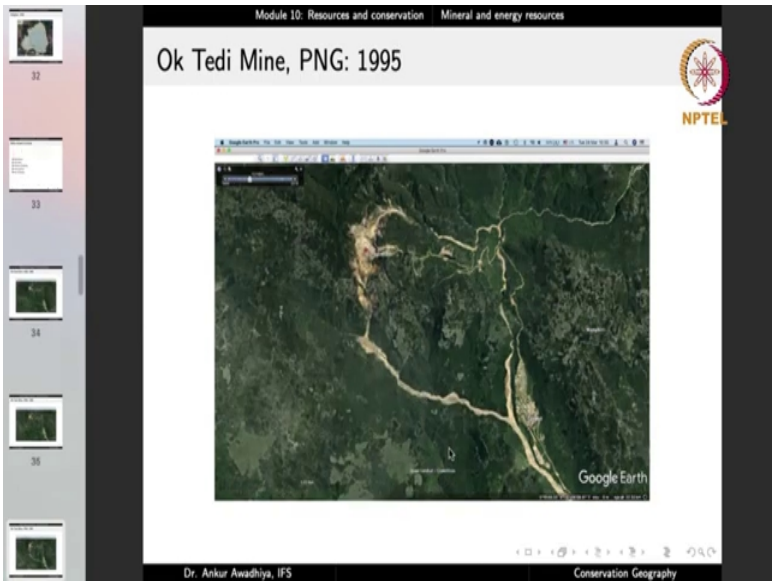
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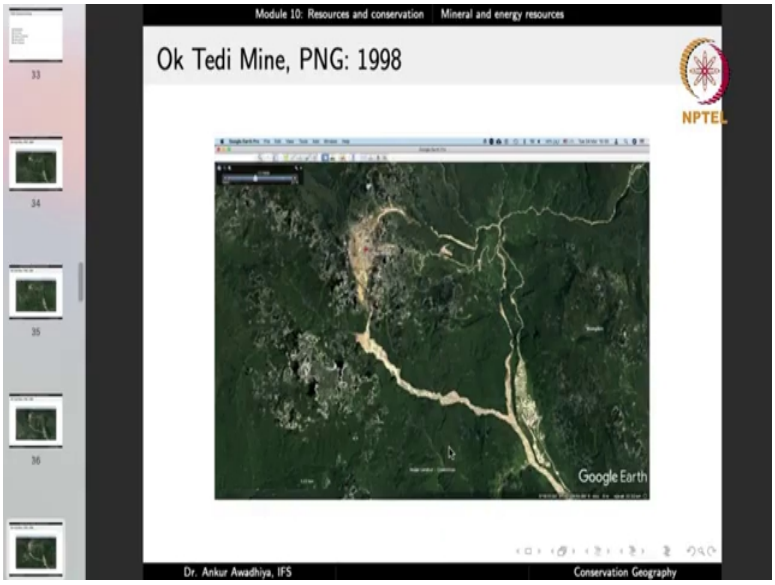
Module 10: Resources and conservation
Mineral and energy resources
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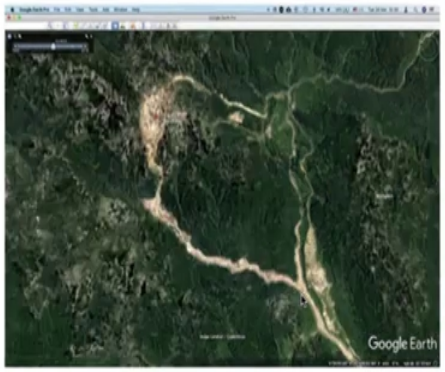
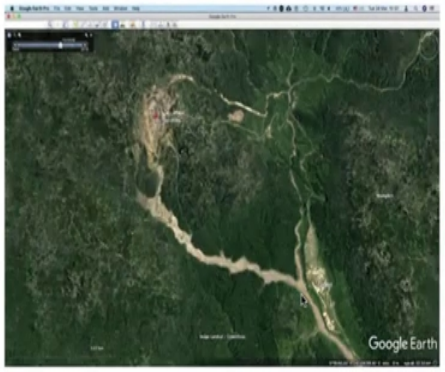
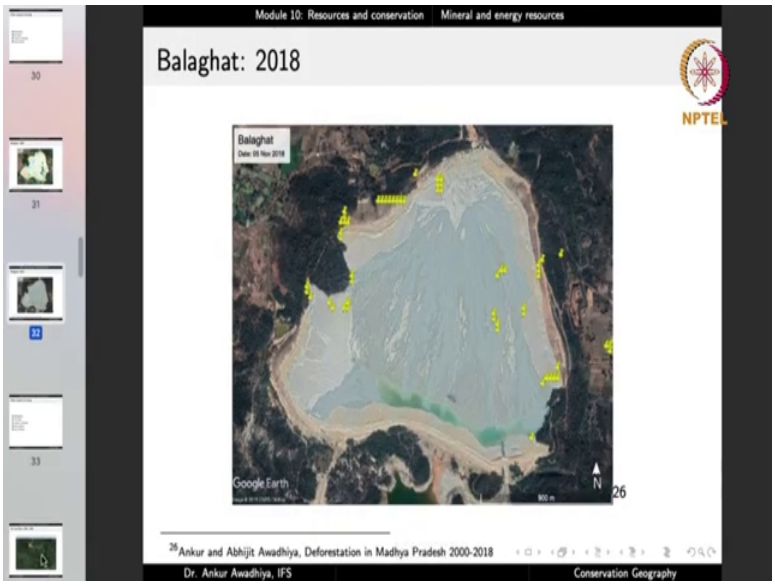
Ok Tedi Mine, PNG: 2002



Ok Tedi Mine, PNG: 2006





Another impact is the loss of habitats. Now, this is a picture of the Ok Tedi Mine, in Papua New Guinea in the year 1984. Now, this is a mine, that mines, gold, silver and copper. Now, the thing with this mine is that there was no (())(30:18), that was created and most of the waste material was directly dumped into the river.

So, what is the impact of that, now we saw that in the case of the Balaghat Malajkhand mines, there is a death of trees that happens. And we can observe a very similar thing in the case of these Ok Tedi mines as well. Now, in this case, the material was directly dumped into the river and here we can observe this river. And this is the mine.

So, in 1984 the mine was of a smaller area, then with time it expanded. Now, here you can observe that when the waste material was dumped into the river, you find that there that the trees around the river they are dying off. And so earlier we find that this is a very small stream, because on both the banks, we have the trees. But with the death of trees this has now become very prominent.

By 1995 you can see that all of these areas have now trees that are lost. This is 1998 expanded even further. So, you can now have an idea about the toxic effects of the waste materials in a mine, the mine has also increased in size. So, there is a loss of habitat here, because the trees have been cut and the areas are being mined, but there is also a loss of habitat in these downstream locations. Because of the toxic impacts, this is 2002, 2006.

Now, by 2006 this mine has become very large and a large area has also been deforested, because of the toxic elements. So, from 1984 to 2006, we can find that there is a large destruction of habitat that has happened, because of these mines. So, this is another impact of mining.

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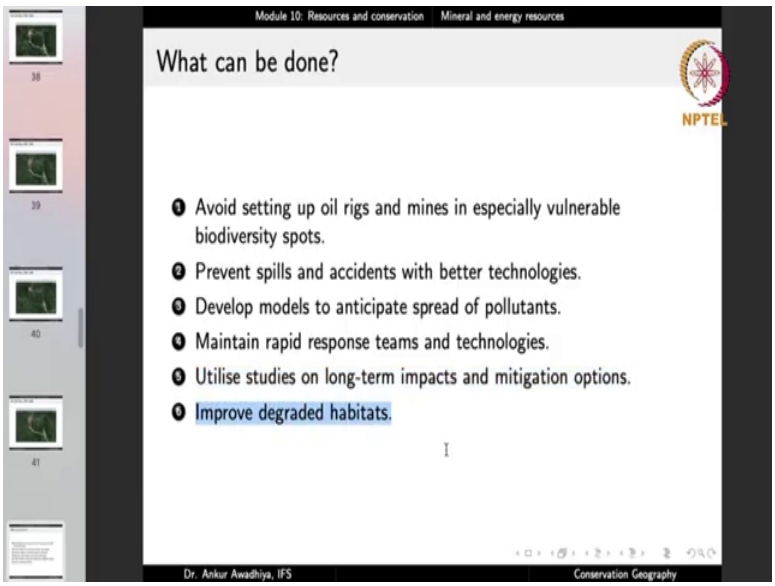

So, what can we do to reduce these impacts? Well one we can avoid setting up oil rigs and mines in especially vulnerable biodiversity spots. So, essentially what we are saying is that, if you have to do mining at least do not do it in those areas where you have large amounts of biodiversity, the biodiversity hot spots. But the problem with this argument is that, you will always hear people say that okay we cannot do mining in those areas, where people live.

And so the areas where people live are completely out of bounds. So, the only thing that remains is the forest and wherever we do mining there will be impacts and we need these resources, because the world has a large amount of demand for these resources. So, if not in the forest areas, then where? So, this is one important consideration that is leading to the loss of biodiversity in different areas.

And if we are not mindful and if we are not strict about not allowing mining in the biodiversity rich areas, then we will be contributing to the loss of these biodiversity, or at least if you are setting up a mine try to prevent spills and accidents with better technologies.

But the problem with this argument is that, installation of technology maintenance of devices requires money and each country is trying to reduce the amount of inputs that needs to be made to mine these minerals. So, where are you going to cut the cost, for cutting the cost the easiest option is not to have any of these technologies and to make a system that is very accident prone.

So, either the pollution controlling devices are not getting installed, or even if they are getting installed they are not getting maintained. So, this is another drawback of mining that we are observing. At least develop models to anticipate the spread of pollutants, but then development of these models again requires cost, you will have to hire scientists, you will have to make use of the educational institutions, the research institutions to develop models.

But then who is interested in developing these models, hardly anybody, because the mining companies do not want that, they just want to hush a lot of these things up. Because if it comes out that so and so areas will get damaged, then probably people will protest. So, in a large number of cases we find that these models are not being developed, or they are not being developed to that large in extent.

So, we are just keeping our eyes closed. Maintain rapid response teams and technologies. In certain areas it has become legally mandated to maintain them, but again we find that in a large number of cases there are cost cuttings that are happening. Utilize studies on long-term impacts and mitigation options, this again should be done. And if nothing else at least try to improve the degraded habitats, that is if an area has already been degraded because of mining, or because of the release of these toxic effluents, at least try to improve them, try to bring them back.

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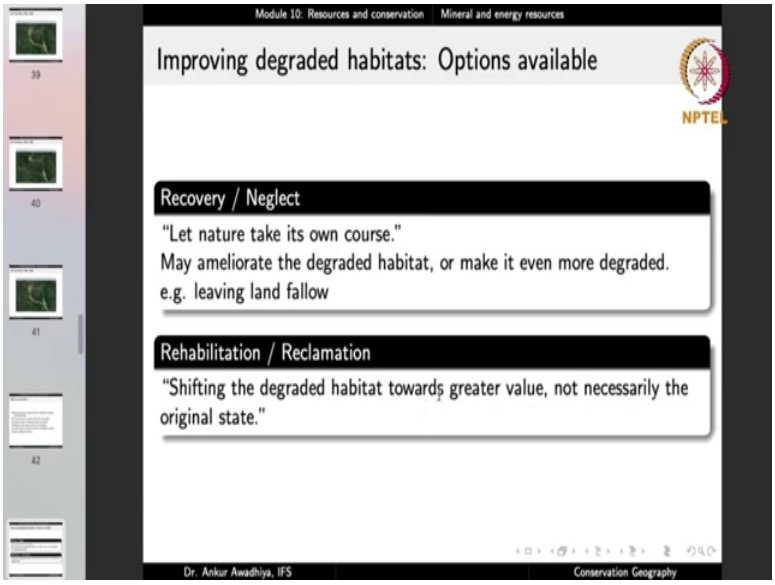

And in this context, we have several options that are available, options include things like recovery of the habitat. In the case of recovery, you do not do anything, you just neglect that habitat and you let nature take its own course. Now, this is based on the expectation that, when an area is left to itself, then the process of ecological succession will begin and nature will bring in those organisms that are able to live in that degraded habitat.

And slowly and steadily, the area will improve itself, a good example is leaving land fallow. So, this is something that people used to do in the case of agriculture. So, you have a piece of land. you grow crops and after the land has reduced in its fertility levels, you just leave that land as such and with the passage of time you will have plants like grasses, or plants like some Leguminous plants will come up into that area and slowly the nitrogen levels will go up.

With the passage of time you will also find more and more weathering that happens and with that new minerals will be released into the area. And when you come back to that area say after the passage of a few years, then you will find that the fertility is now appreciable enough. And so you can again make use of that piece of land for agriculture.

But the issue with this option is that, it may ameliorate the degraded habitat, or it can make it even more degraded. Because when you are not doing anything, it is possible that there will be

large scale soil erosion and all the soil will be lost. And once you have lost the soil, then there is no option that is available for this area. And so it becomes even more degraded.

So, this is an option that is a lazy option, we mostly do not try to make use of it, we instead go for things like rehabilitation, or reclamation of the habitat, which means shifting the degraded habitat towards greater value, not necessarily the original state. That is if you have a forest, there has been a large scale mining and once the mining is over and you are given a degraded habitat you at least plant a few trees there. Now, if you plant trees you will ensure that the soil remains intact.

Now, in this case, the trees may or may not be the trees that were there in the original forest. But at least you try to maintain a ground cover. So, you can even plant exotic trees to ensure that your soil remains in place. So, that is rehabilitation, you are shifting the degraded habitat towards greater value, because and a land that is covered with trees has more value than a land that is not covered with trees and not necessarily the original state.

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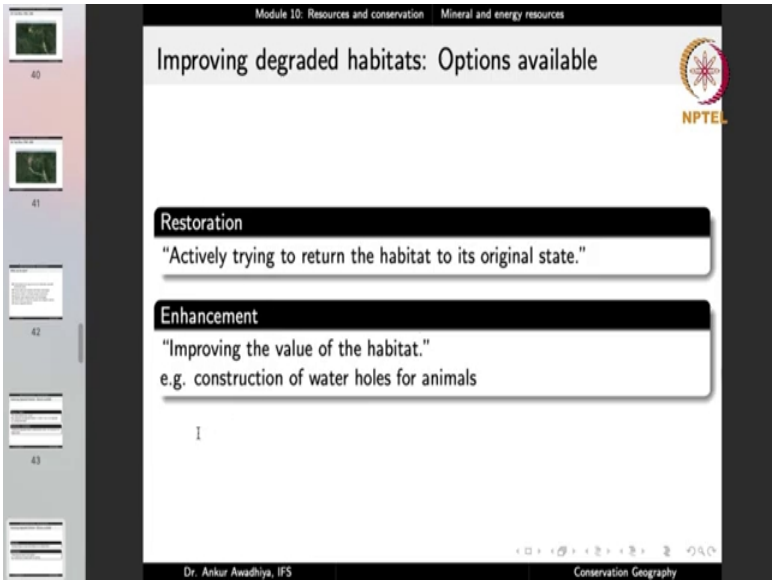

Or you can try to bring the habitat back to the original state. Actively in the process of restoration. So, if you try to restore the area you will make a list of what species were present in the area before the mining occurred and you will plant those species, preferably, in that

proportion that were there in the original forest. So, you are trying to bring it back to the original state, actively not passively.

Another option is enhancement, improving the value of the habitat, such as construction of water holes for animals. So, in this case you have a degraded habitat, but you say that okay we do not have sufficient money, we do not have expertise, or we just simply do not care. But at least what we can do is? We can at least create a few puddles, where the animals can have water. So, we are trying to improve the habitat a bit. So, that is the option of enhancement.

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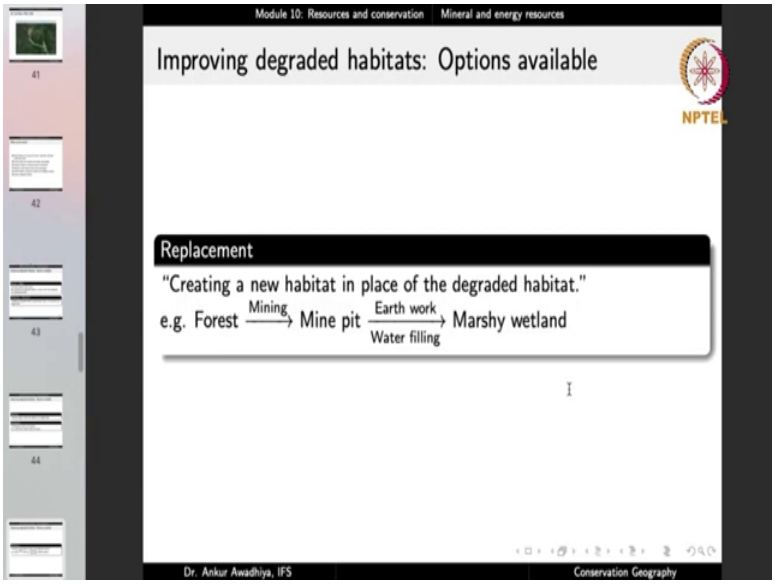

Or you can have the option of replacement, which is creating a new habitat in place of the degraded habitat. So, in the case of replacement you can completely change the habitat, for example you have a forest, there is mining you generate mining pits and once the mining is done you perform certain amount of earth work, that is put certain amount of soil into the area and then fill the pits with water.

And so now you have a Marshy wetland, you began with a forest, but you ended up with a Marshy wetland. So, this is a completely new habitat in place of the degraded habitat. But in certain cases, the amount of degradation will be so large, that it may not be economically, or technologically possible to bring the habitat back to the original state. And so you go with the option of replacement.

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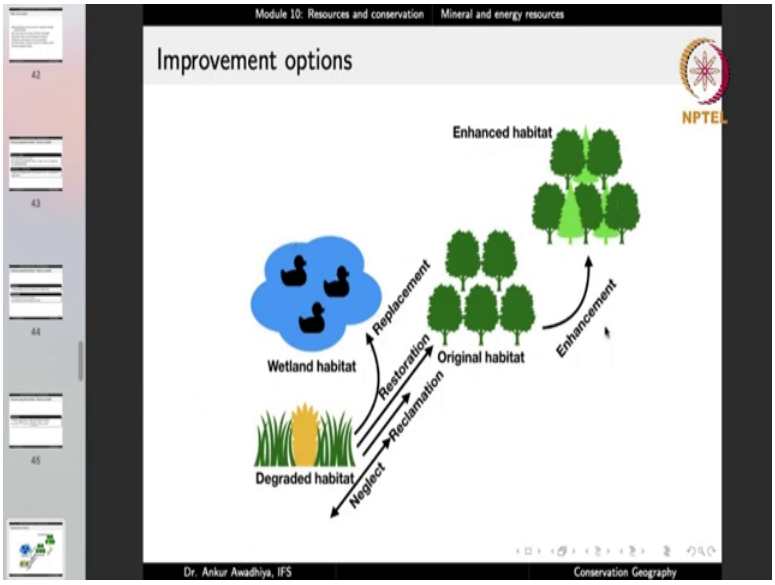

And if we were to depict it with an image, we can say that if there is a degraded habitat, we have several options, you can either neglect it. So, that it improves by itself, or it becomes even more degraded, or you can try to perform a reclamation, or complete restoration to the original habitat, or you can try to enhance the habitat by doing certain operations, that increase the value, or you can go with the option of replacement, where you completely change the habitat.

So, there are several options that are available and one or more of these options should be made use of. So, that the amount of impacts that we make on the nature is reduced.

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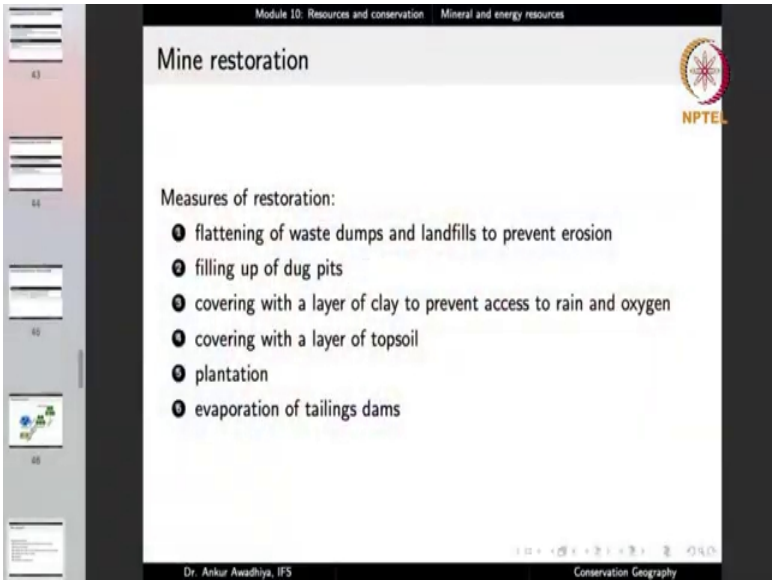

So, if you look at say mine restoration, we will have several measures that will be done, flattening of waste dumps and landfills to prevent erosion, filling up of duct pits, covering with a layer of clay to prevent access to rain and oxygen, covering with a layer of topsoil, followed by plantation and evaporation of the tailings dam. So, that you are able to concentrate the waste products and then probably you will collect them and move them into certain other locations. So, these are the steps that need to be done for the restoration of a mine.

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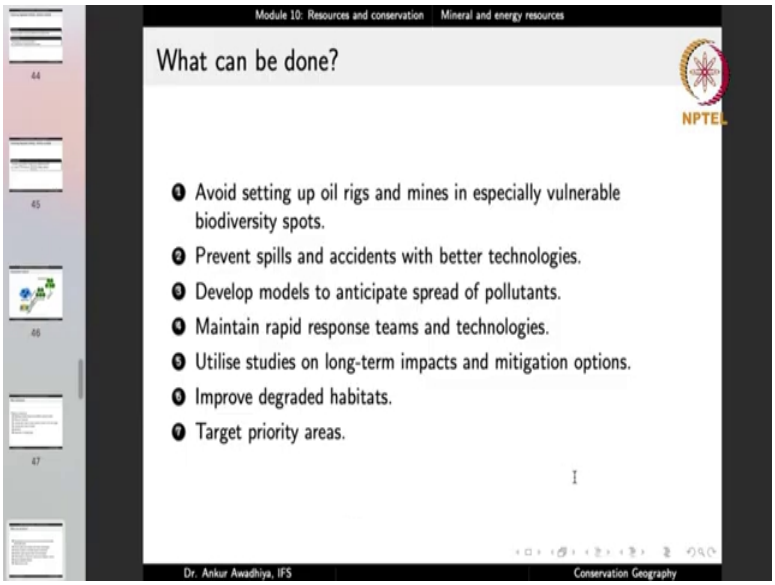

Another thing that we can do is to at least target the priority areas, if we cannot perform these operations everywhere, at least do them in the priority areas, especially those that are rich in biodiversity.

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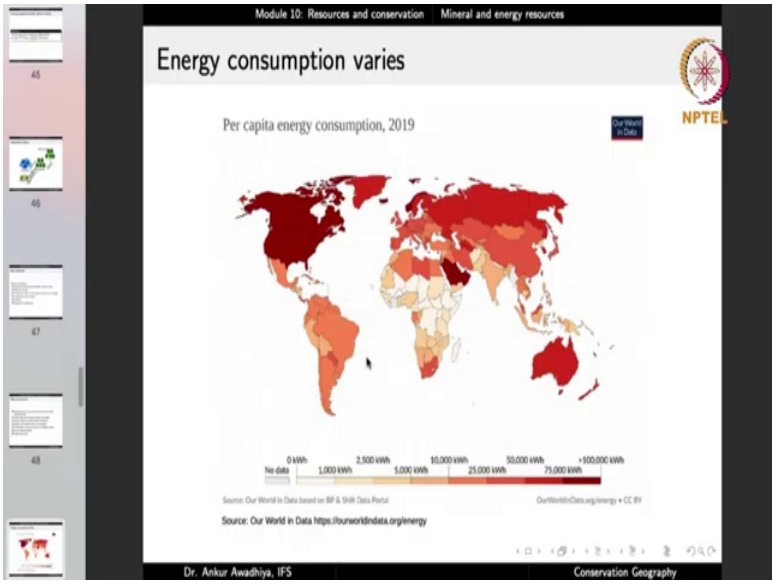

But here we can also talk about one other aspect, we had to perform all these operations, because we took out the resources from the earth, we had to perform these operations, because we did mining. But do we also have an option to not do the mining. So, in this context, we can see that the consumption of resources varies across the world.

So, if you look at the per capita energy consumption, we have certain areas like US, or Canada, or Saudi Arabia, that have a very high per capita consumption of energy, than say areas in Europe, or areas like Africa, or areas like south America, that is the per capita energy consumption is different in different areas. The question is what does this depend on?

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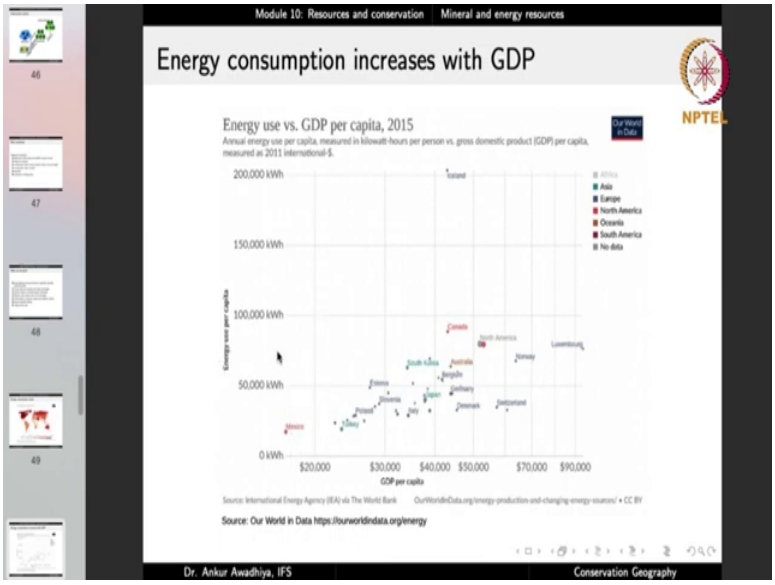

So, if we drew a curve between the energy usage and GDP per capita, we find that as the GDP per capita increases, the energy usage per capita also increases, that is if people have more money, then they will use more amount of energy roughly.

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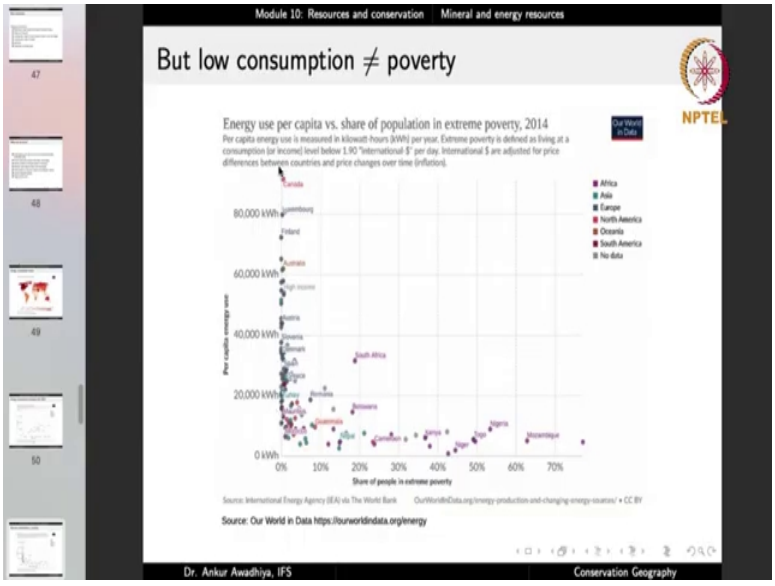

But this is not always the case, because if you look at the amount of poverty in different countries, in this curve we are looking at the share of people that are living in extreme poverty

versus the per capita energy usage, extreme poverty is defined as living at a consumption, or income level that is below 1.9 international dollars per day, which is the the dollar that is adjusted for price differences between countries and price changes over time, which is inflation.

So, essentially what we are looking at here is that, what is the percentage of people who are living in extreme poverty, they are not able to meet their own needs, versus the per capita energy usage in these countries. So, if you look at those countries, where there are roughly 0, percent people who are living in extreme poverty.

So, in these countries everybody has the ability to meet their basic resources, or basic needs. Here again we will find that, we have countries that have very less per capita energy use and we have countries that have a very high per capita energy use. Now, a portion of this difference can be explained by the fact that different countries are in different geographical locations. And so there will be different requirements for things like say heating, or cooling.

But more than that it tells us that, even if you move towards a stage of development, where everybody is able to meet their own needs, you can have the option of using more electricity, or more energy, or less energy, that is we have the option to change our resource usage, even while maintaining a stage of development. And this is sustainable development. So, it is a development where everybody is able to meet their own needs, but in such a manner that we do not overuse the resources.

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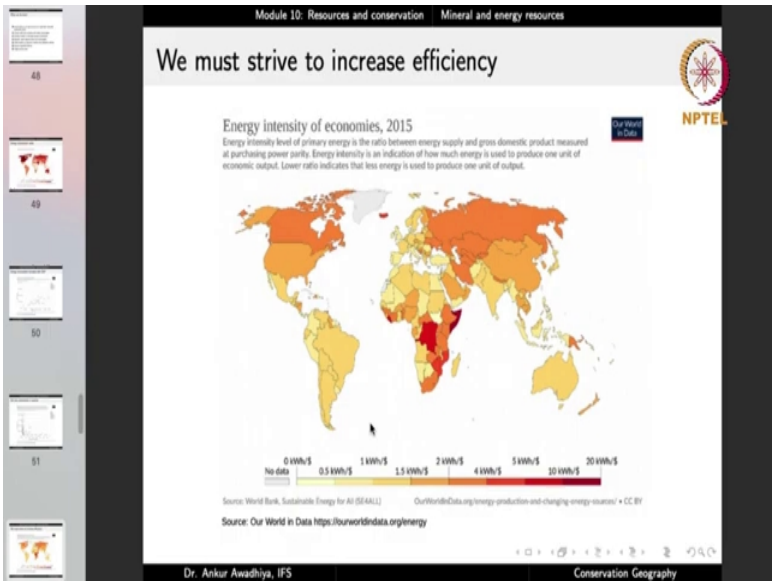

And so we must strive to increase the efficiency of usage, if we look at the energy intensity of economies, here again we find the same thing. Energy intensity is the amount of energy that a country needs to create one dollar of GDP. So, here we can find that, there are certain countries such as say Australia, or India, that require a very less amount of energy, say 1 kilowatt of 1 kilowatt hour of energy to generate 1 dollar of GDP.

Whereas, there are certain countries especially the countries in Africa, that require a very high amount of energy, for the same increase in GDP. Basically, this is telling us that, there are certain countries that are more efficient in using their energy. So, that a smaller amount of energy use creates a large amount of GDP growth.

And there are certain countries, that are not that energy efficient, they are mostly wasting their energy without bringing about a large difference in the GDP. So, we have the option of increasing the efficiency of energy use. So, that we are able to bring about the same amount of development, but by using lesser amount of energy. But how can we do that?

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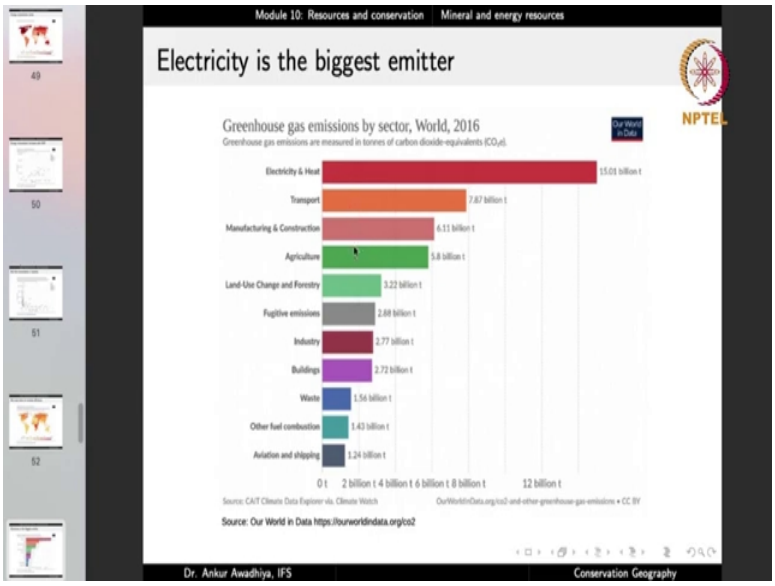

Well if we look at the energy usage in different sectors, we find that electricity is the biggest emitter of carbon into the atmosphere, carbon and greenhouse gases. And so if we were to concentrate our efforts in things like electricity and heating, or transportation, or manufacturing and agriculture, we will be able to bring about a large amount of change. But just by looking at these four, or five sectors.

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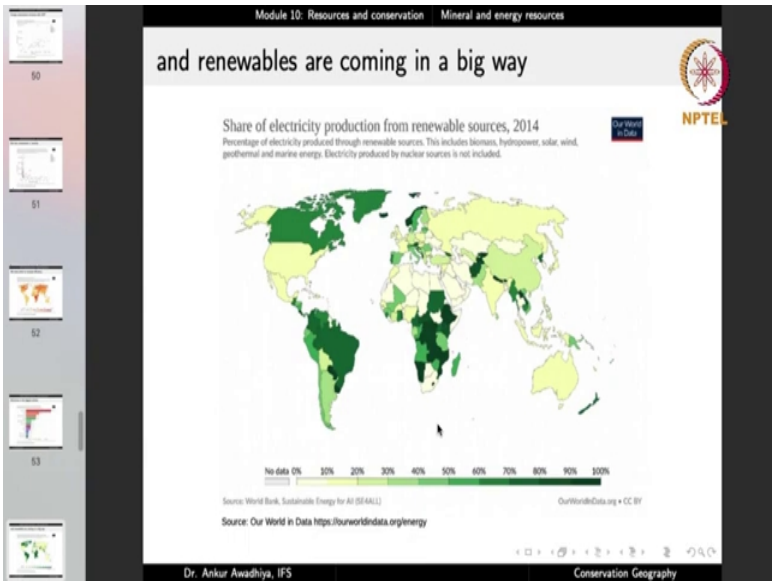

Now, in the case of electricity, we can shift towards renewables. Now, if we shift towards renewables, we will be using lesser amounts of fossil fuels, lesser amount of fossil fuels means

that we will not have to do that much amount of mining. We can reduce our fracking expeditions and we will be able to get the same amount of electricity, but without these negative impacts.

And renewables are actually coming up in a big way, especially in countries of South America and Africa, because they are now shifting more and more towards the hydropower sectors.

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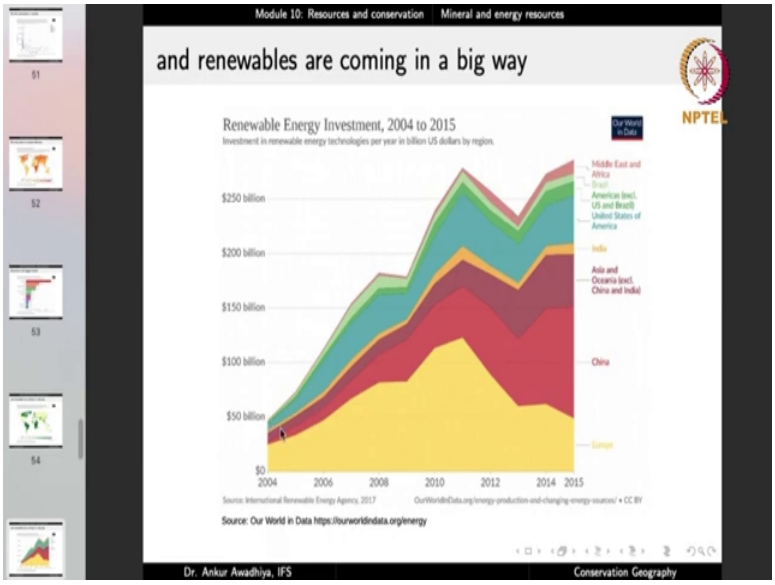

If you look at the renewable energy investment with time, we find that the investments in a large number of countries are now increasing. And so more or less we find an increasing trend in the amount of investment, in the renewable energy sector.

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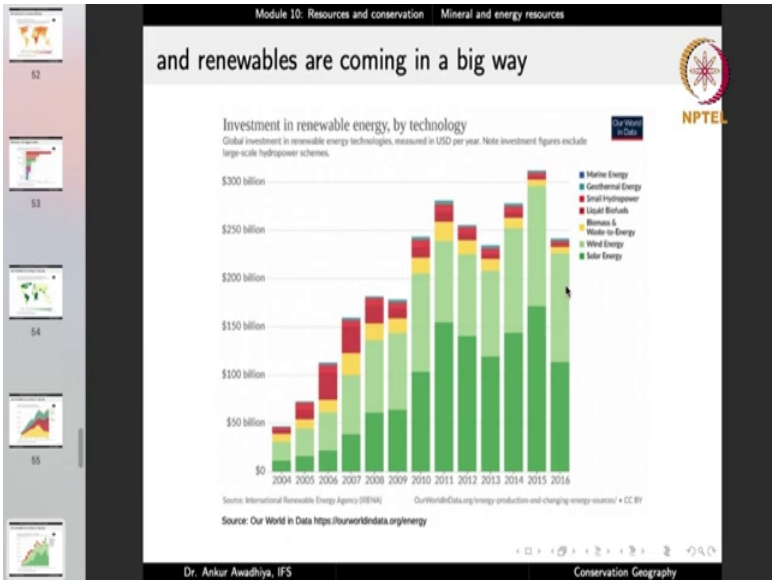

And this investment is in different technologies. So, we are finding large investments in solar energy, wind energy, biomass energy, liquid biofuels, small hydropower sectors, geothermal energy and marine energy.

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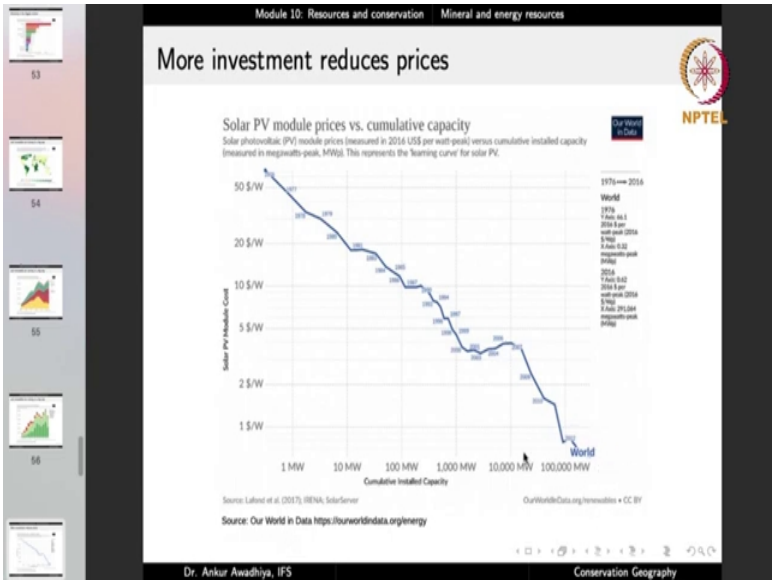

And with more and more investment, the prices are going down. If you look at the solar photovoltaic module prices versus the cumulative capacity, if or when we had a cumulative capacity of less than 1 megawatt in the world, that is in the 1970s, each what of elect of module required an investment of 50 dollars. Today it requires in an investment of less than a dollar.

So, basically more and more amount of investment, means that we have now more and more production capacity, better technologies and that is now bringing down the prices. So, now the renewables have become very much competitive, as compared to the other sectors like coal, or gas, for the generation of electricity.

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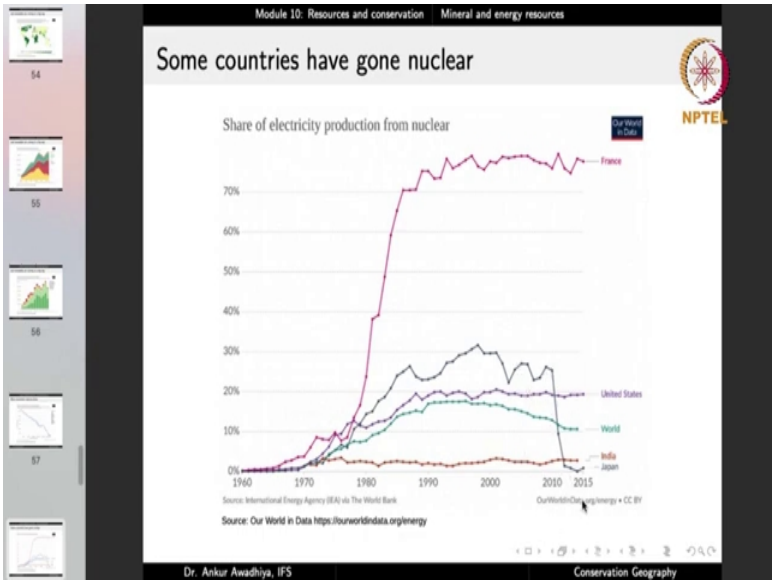

Some countries have even gone nuclear and if you look at France, the share of the electricity production from nuclear is more than 70 percent. In the case of countries like the US, they have now platitude and in the case of countries like Japan, they increased a lot. But then after the Fukushima Daiichi incident, now that is going down. Now, going towards nuclear is also a good option, because it does not generate greenhouse gases. But there is the factor of safety.

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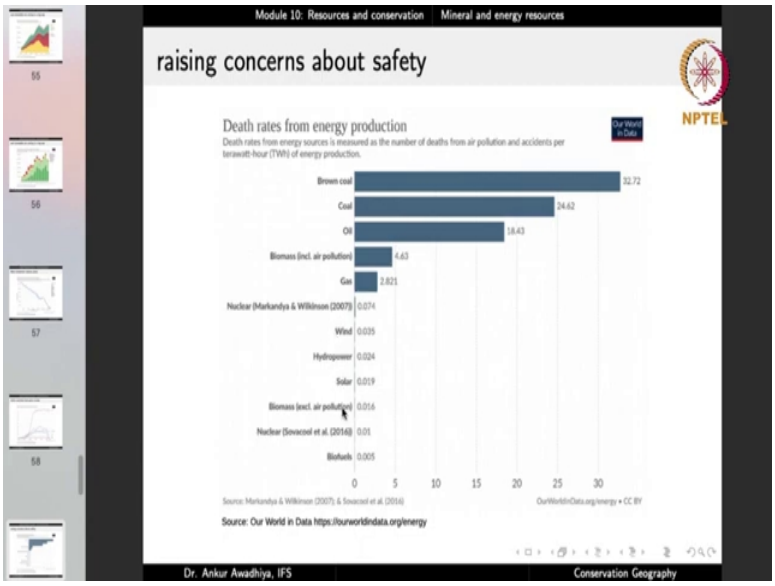

And if you look at the concerns about safety, if you look at the death rates from energy production, that is the number of deaths and accidents per terawatt hour of energy production, we find that, nuclear is down here, that is in the case of coal as many as 32.72 people die, or are involved in an accident per terawatt of energy production. In the case of other coal it is a bit less, in the case of oil it reduces further.

But it is still very high, in the case of biomass it reduces, even further in the case of gas it is even lesser. But in the case of nuclear energy, we have just 0.074 deaths and accidents per terawatt hour of energy production, it is much safer. Even things like the renewable energy such as wind, or hydropower, or solar, they are very safe.

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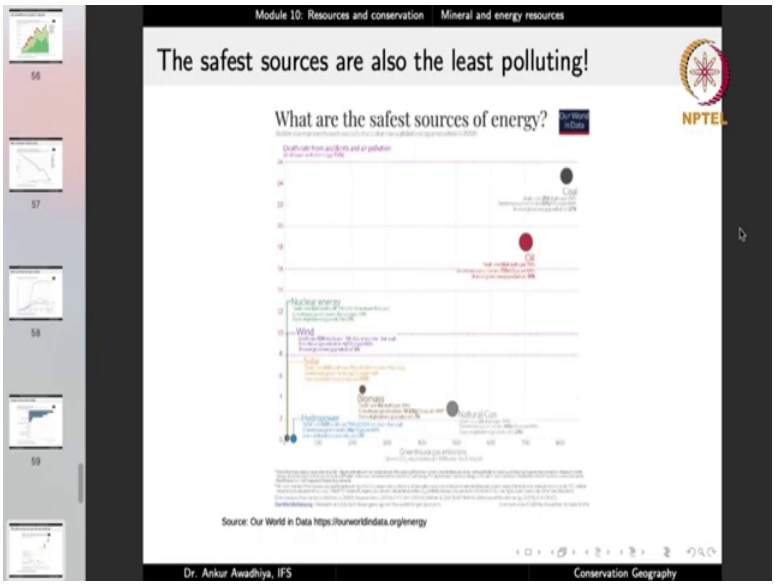

And the best thing is that the safest sources are also the least polluting, if you drew a curve between the greenhouse gas emissions, versus the death rate from accidents and air pollution, we will find that there is roughly a straight line, more amount of greenhouse gases that are emitted more is the death rate as well. So, the sources that use, or that emit less amount of greenhouse gases are the safest sources, even better. So, we can increase our energy efficiency and we can also shift to renewables, they are also much safer sources of energy.

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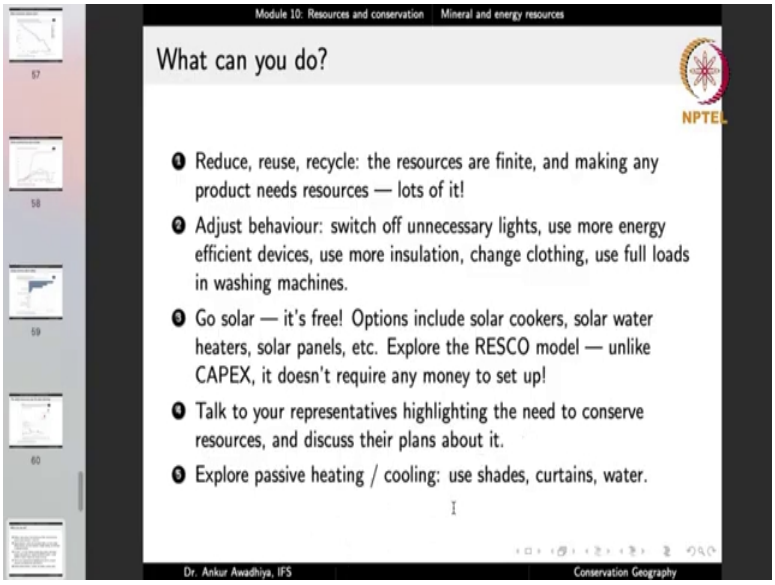

So, what can we do on a more personal scale? Well we can reduce, reuse and recycle, resources are finite and making any product needs resources lots of it. And so if you reduce the amount of consumption of anything, be it food, be it electricity, be it say things like furniture, things like clothes, you are contributing to reducing the use of resources.

Because any object requires resources not just material, but also energy resources. We can try to adjust our behaviors, switch off unnecessary lights, use more energy efficient devices, use more insulation, change clothing according to the climate, use full loads in washing machines. Now, these are easy things, none of them is a very tough thing, go solar it is free, options include solar cookers, solar water heaters, solar panels and so on.

In the case of a RESCO model, which is renewable energy service company, you do not even have to pay anything, unlike the CAPEX, or the capital expenditure model, it does not require any money to set up. So, basically what happens in the case of a RESCO model, is that there is a company that makes an investment into solar panels, but it needs space to set up those solar panels.

And you can provide your rooftop space to that company and the company will come install the solar panels, do the maintenance and you have a profit sharing agreement with that company. So, the electricity that gets generated it is sold to the government and the money that is received is

shared between you and the company. So, there is no out-of-pocket expenses to be done by the user.

You can talk to your representatives especially the MPs and MLAs, highlighting the need to conserve resources and discuss their plants about it, or you can explore passive heating and cooling options, such as using shades, or curtain and water.

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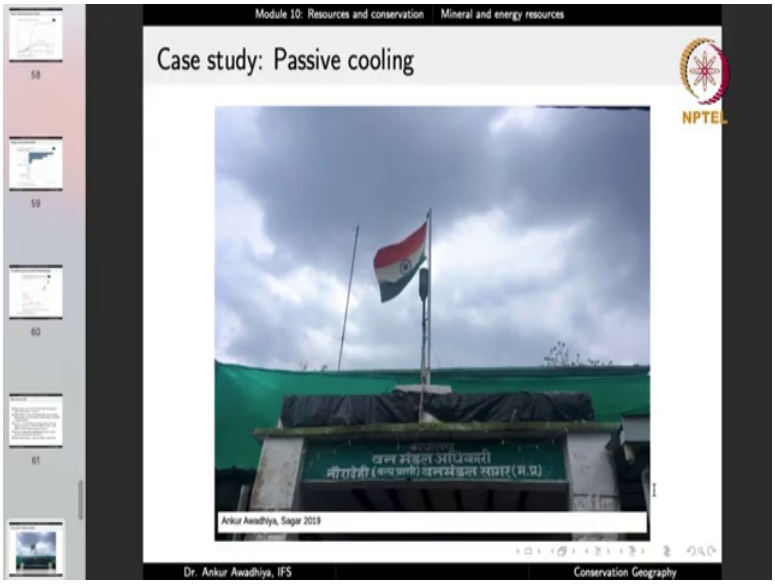

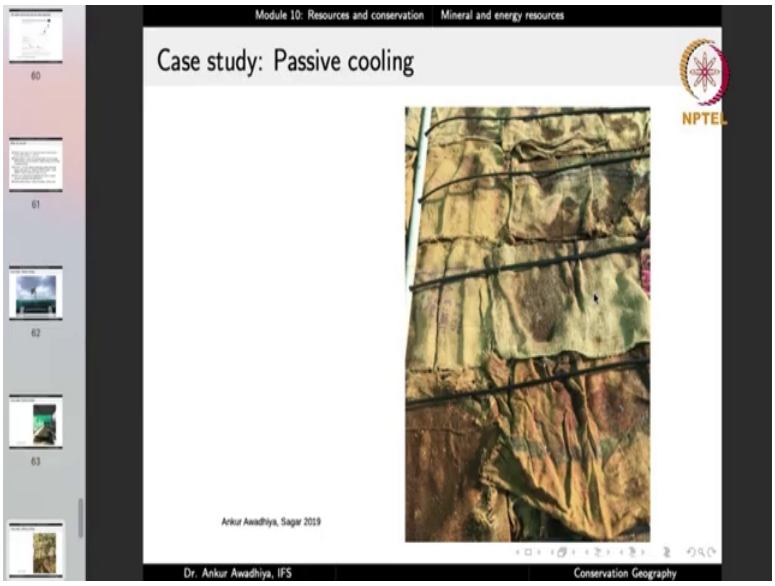
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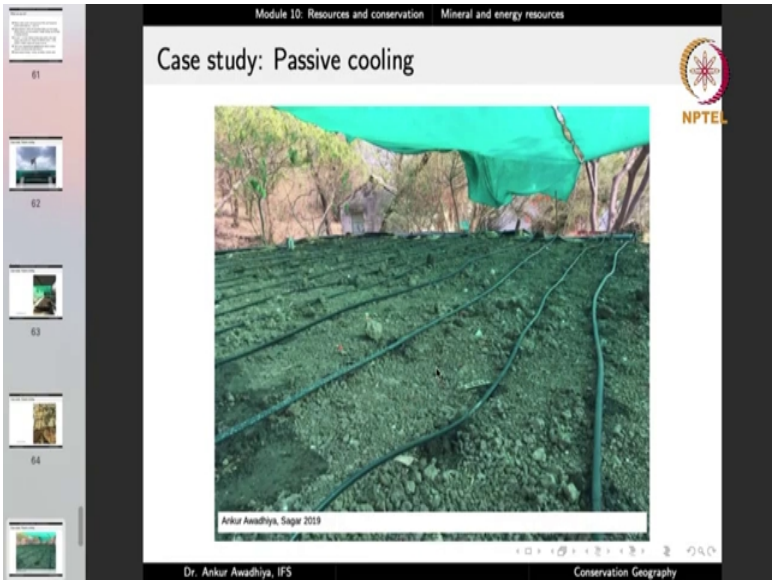
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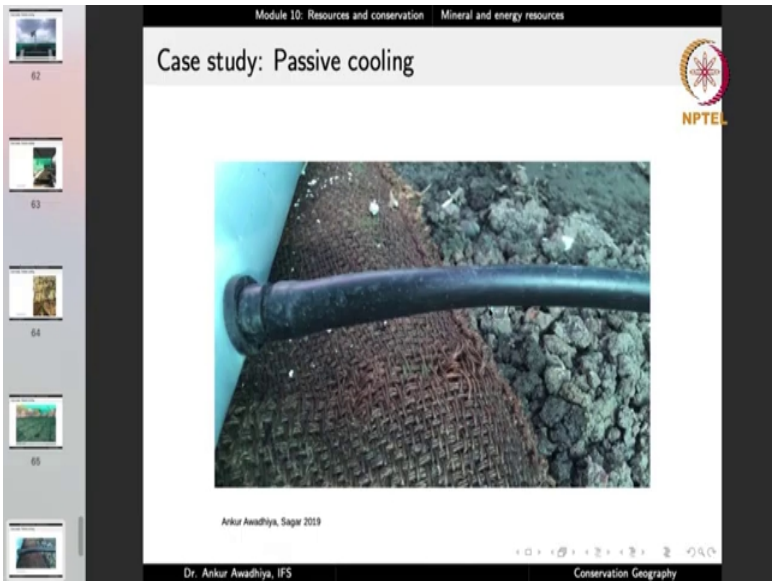
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An example of passive cooling is what we did when I was the DFO, in Nauradehi Wildlife Sanctuary. So, we had this office and on the rooftop to reduce our expenses on air conditioning, what we did was? We installed a pond liner, so pond liner is basically a very thick sheet of plastic, that is generally used to create artificial ponds.

So, it is a very thick sheet of plastic it is resistant to UV light and it is also resistant to small amounts of bumps and tears. So, this plastic sheet was installed on the top of the roof, then we put some gunny bags, used gunny bags and installed a drip irrigation system. And on top of this, we installed these green nets, which are basically used in the case of nurseries to regulate the amount of light and heat, that comes to different plants.

Now, once you have installed this and the drip irrigation system is turned on. Now, because this is a drip irrigation system, it requires a very small amount of water, we typically required like less than 20 liters of water energy. And the and then we also put in some more amount of soil. So, that we could even grow grasses on the top.

And this drip irrigation system, it just releases a drop of water every now and then. So, this can be regulated and within a short period of time this whole soil becomes moist and in the peak of summers, the sunlight is stopped by this green net. So, the roof does not become heated and there is also this evaporative cooling, that is happening, because of the evaporation of water.

And because of that, the temperature of the building reduces a lot. So, you have the impacts of the green net and the impacts of this evaporative cooling.

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And both of them together you can reduce the building temperature by as high as 10 degrees. Probably even more in your locations, if it is an even drier location. Now, in this case we did not cut short on the comfort, because we needed to cool the building in the summer months and we were able to bring down the temperatures by as high as 10 degrees, without using any electricity.

So, basically everything that we needed once the system was installed was just a few buckets of water, to run the drip irrigation system nothing else. The building becomes cooler and you do not have to pay large electricity bills and even better that electricity that you would have used if you did not have such a passive cooling system, that electricity would have come from say a thermal power plant, which again releases carbon dioxide into the atmosphere.

So, by doing a simple modification to the roof top, by going with a passive cooling option, you can not only save money, but you can also save the planet.

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So, essentially the crux is you should try to reduce your expenses to save the planet. If you reduce your expenses, if you use less resources, then you are already helping the planet, you are already lending a hand to saving the planet. So, that is all for today. Thank you for your attention. Jai Hind!