Conservation Geography
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Module - 11
Economic Geography and Conservation
Lecture – 31
Transport and communication networks

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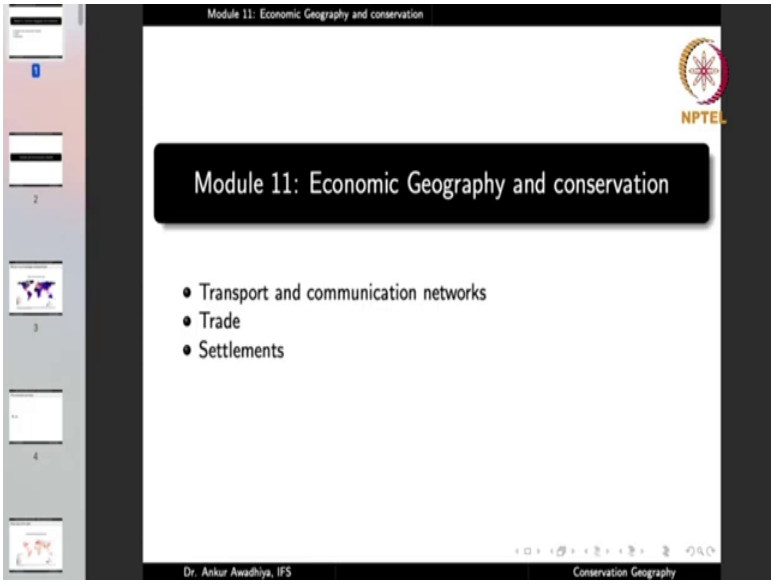

Namaste! Today, we begin a new module which is Economic Geography and Conservation. This module will have three lectures transport and communication networks, trade and settlements.

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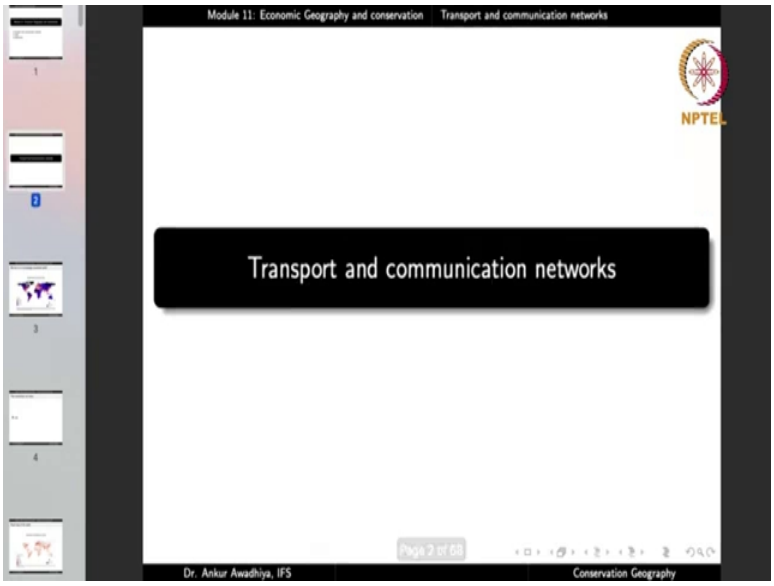

So, let us begin with transport and communication networks.

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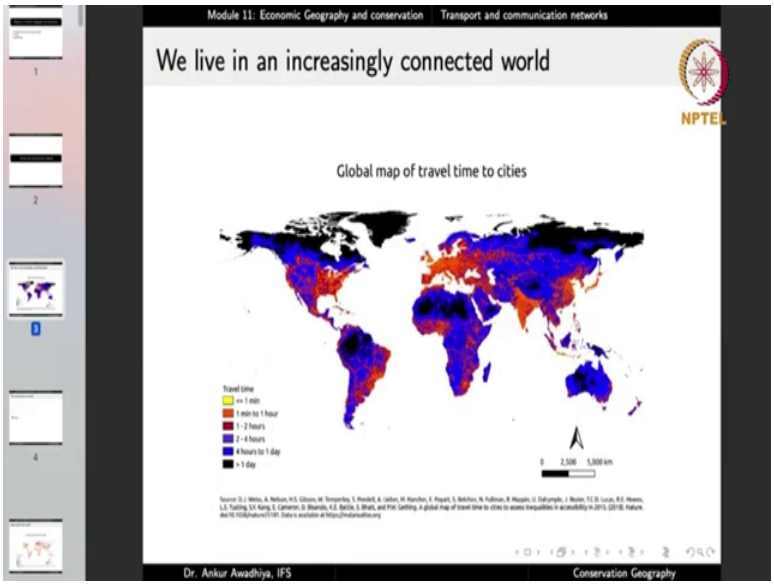

Now, we live in increasingly connected world. This chart tells us the time it takes to reach the nearest city, or conversely, if we take any point on the planet, what is the time that is needed for a person in the nearest city to reach that point. Now, we can see that the travel time to cities or the accessibility to different locations is not the same throughout the planet. There are certain areas that are very highly connected.

Areas like Europe, areas like India, areas like eastern China, areas like Japan, areas like eastern United States, these are very highly connected. That is, you can reach at any point in these

locations within a short period of time, say less than 2 hours. But there are also certain other locations such as areas in Alaska or areas in northern Canada or areas in Russia where you will need more than one day to reach that point from the nearest city.

Now, a lot of that has got to do with the kind of geography in that area. If you have an area that is in a flat plane, typically agricultural regions, you will find that the connectivity is very high. On the other hand, if there are areas that are say snow covered or that travels very up and down areas such as the mountains, then the transport networks will not be that good. It also depends on the level of development in that country, the amount of money that the country has to set up the transport and communication networks.

So, for example, we will find that there are certain areas in Brazil, where you find that the connectivity is not that good or there are certain areas in Africa, where the connectivity is not that good. Now, these are the desert areas. But if you compare with our desert, the Thar Desert, you find that here the connectivity is even lesser, primarily because the transport and communication networks have not been developed to that extent. Similarly, in the interiors of Australia you find certain locations where it is difficult to reach.

But more or less we find that in areas where we have a dense settlement of people, in those areas where lots of people live, the connectivity today is very good. So, we are living in an increasingly connected world. Now, this connectivity is coming through different modes of transport and communication. So, what are these modes of transport in communication?

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The first mode is roads. Now, roads are some of the earliest modes of connectivity, because they were very simple to set up. You just clear off an area, make it into a path, and with the passage of time, with the movement of people and vehicles, slowly and steadily the soil there will become more and more compacted and it will take the shape of a road.

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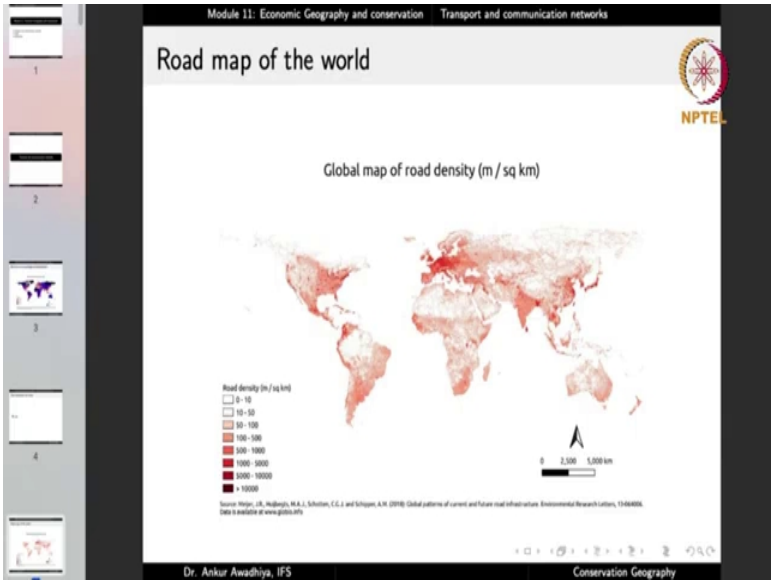

Now, if you look at the road density in the world, we find again here there is a very similar picture. There are certain areas say Europe or eastern United States or India or eastern part of China, where the road density is pretty high. There are certain other locations such as areas in the rain forest or areas in the Sahara Desert or areas in the interiors of Australia or areas in Alaska and northern Canada or areas in Russia where the road density is not that high. But more or less we can say that here again the areas where people live are pretty well connected through roads.

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Another mode of connection is railways. Now, railways require much more money, much more technology to construct than roadways.

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Third is the shipping lines. So, areas that are near the sea coast, they have the shipping lines.

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And if you look at the shipping map of the world, we find that these shipping lanes are pretty much well demarcated. So, we have this route through the Cape of Good Hope, we have this route through the Suez Canal, we have this route through the Panama Canal, and so on. Now,

when we talk about these modes of transportation, we also have to be mindful of their conversion implications.

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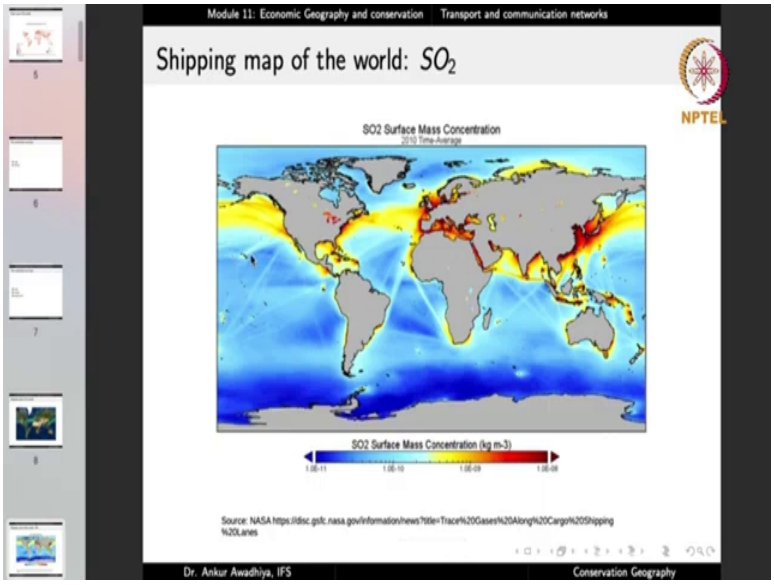

So, if we consider this shipping map and if we consider the sulfur dioxide concentration map of the world, you will find that they are pretty similar. So, for instance, here you have the Cape of Good Hope route, here you have a high sulfur dioxide concentration. Here you have this line that is moving from the south of India, and here again, we find that there is a heavy amount of sulfur dioxide concentration.

You talk about these areas that connect North America with Europe, and we find a very high sulfur dioxide concentration. And we talk about the areas here, here again you have a high sulfur dioxide concentration. And the sulfur dioxide concentration in these areas is much greater than these areas, where you do not have these shipping groups.

So, the important point to keep in mind here is that when we talk about development, when we talk about increasing the connectedness of different areas, then they also have a lot of conservation implications. The conservation implications are so high that we can even look at them from the space.

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Similarly, if we look at the individual ships that move through these areas, we find that there is a lot amount of dust that gets released through these ships. And dust as we have already observed acts as nuclei for condensation. And so, if we take a ship, we can very easily find out where, the exact route through which the ship has moved by looking at the dust nuclei in the atmosphere. So, these modes of transport and communication they have their own conservation implications.

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Other modes of connection is inland waterways, airways. And here again we find that there are certain areas that have a very high density of air routes, areas in eastern United States, areas in Europe, areas in eastern China. There are so many aeroplanes that are moving through these areas. They are the major hubs in the world.

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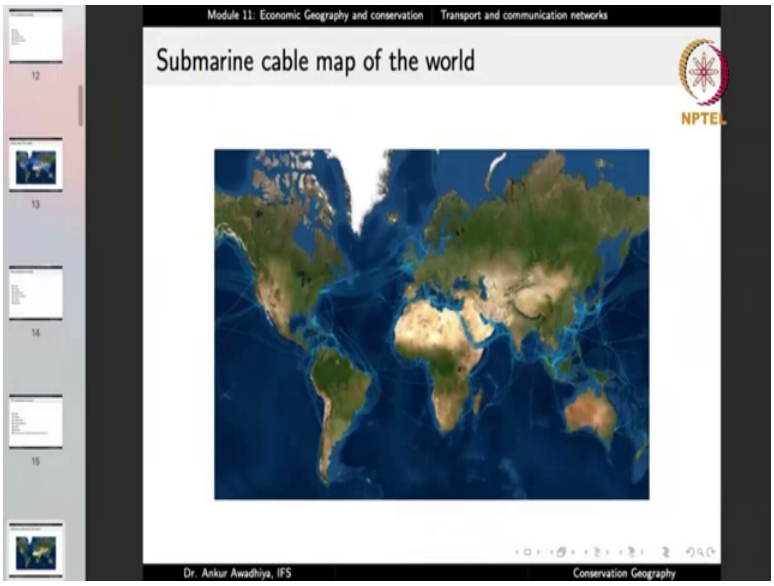

We have pipelines and we have modes of communication networks, including personal communication networks and mass communication networks, such as the use of cables. This is the submarine cable map of the world, which shows the locations where we have the submarine cables below the sea. And these are the cables that carry the data and information from one place to another.

So, for instance, when you make use of internet, the data is moving through these submarine cables to reach your devices. So, there are a lot many modes of transport and communication and these are forming networks.

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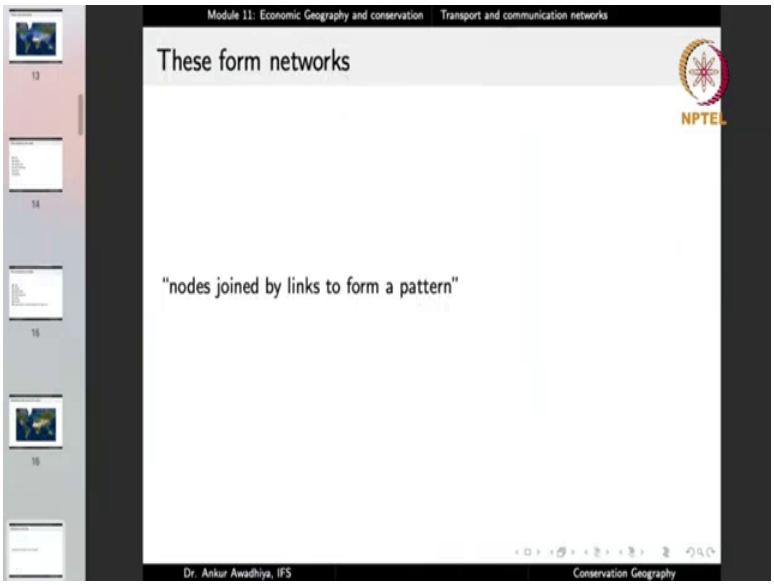

A network refers to a set of nodes that are joined by links to form a pattern. So, if you look at any of these maps, we can find that, a point like this, this is a node and this node is being joined with other nodes through these connections. And these form a pattern. So, anywhere you look, you will find that there are certain nodes in these areas. And if you look at things such as the airway maps, these are the prominent nodes.

If you look at the shipping maps, here, again, we find that there are certain nodes that are being joined through these connections. And these nodes that are joined through the connections, they form a network. So, networks are nodes that are joined by links to form a pattern.

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And these modes enrich our lives. They enable the movement of people. So, you can reach to different places on this planet through these modes of transport. They enable the movement of goods, which means that you can have access to things that are being produced in different parts of the world. They enable trade, especially world trade. So, different countries are able to do exports and imports because we have these modes of transport.

They enable goods to move within a country, especially through things like roads and railways and inland waterways. They enable the flow of ideas. And through all of these we become more and more connected to each other. There has been a spread of democracy throughout this planet primarily because these ideas were able to flow from one place to another. So, these modes of transport and communication they enrich our lives, but they also have serious conservation implications that we need to be mindful of.

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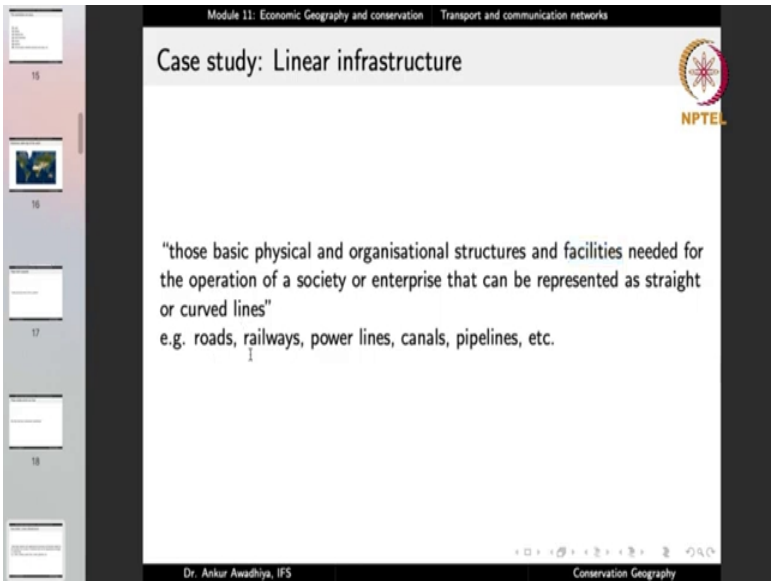

And a case here is the case of the linear infrastructures. Linear infrastructures are defined as those basic physical and organizational structures and facilities needed for the operation of a society or enterprise that can be represented as straight or curved lines. That is, when we say infrastructure, infra is below, so it is the structure that lies below. So, it forms the foundation of other structures. And this is a linear infrastructure meaning that it can be represented in the form of lines whether straight lines or curved lines. So, these are basic physical and organizational structures.

They are basic. They form the foundation of things. They include physical structures and organizational structures. That is they include both things such as roads and the organizations to create and manage those roads. So, these are basic physical and organizational structures and facilities that are needed for the operation of a society or enterprise and can be represented as straight or curved lines. Good examples are roads, railways, power lines, canals, pipelines, and so on.

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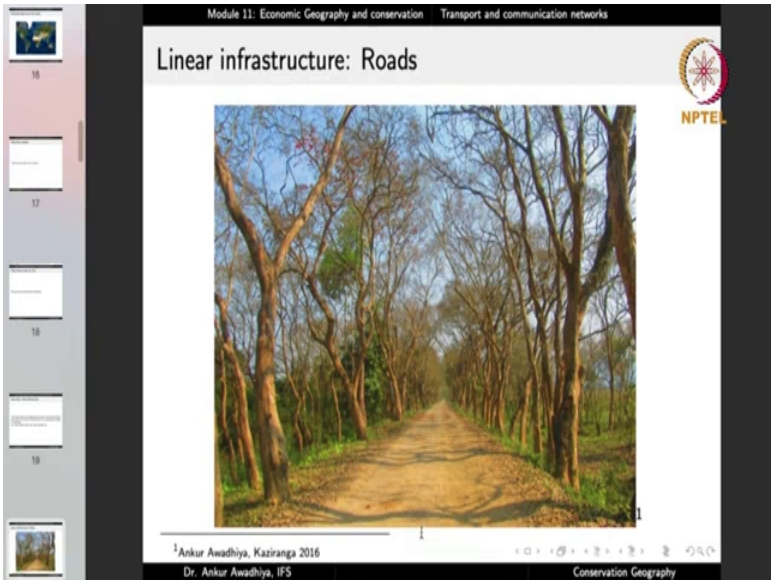

So, for example, when we talk about roads, we can represent them as a straight line or curved line. When we talk about railways, here, again, you have either a straight line or a slightly curved line. Pipelines, again, these are very linear structures.

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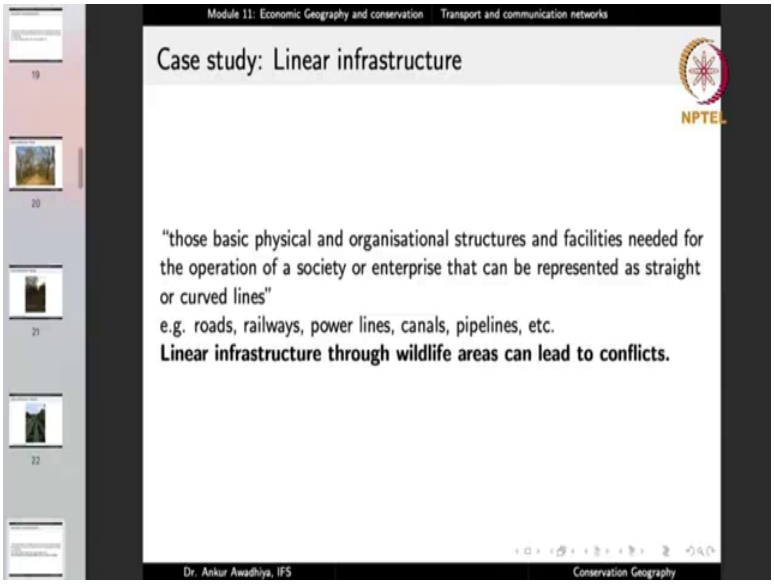

And when they move through wildlife areas, they often lead to conflicts. So, even though we say that the modes of transport and communication enrich our lives, but if we are not mindful of their impacts, if we do not mitigate their impacts on wildlife, then they can also serve as a very big source of the destruction of biodiversity. Now, how does that happen? That happens because of

conflicts. So, linear infrastructure through wildlife areas can lead to conflicts, primarily because the animals also make use of roads.

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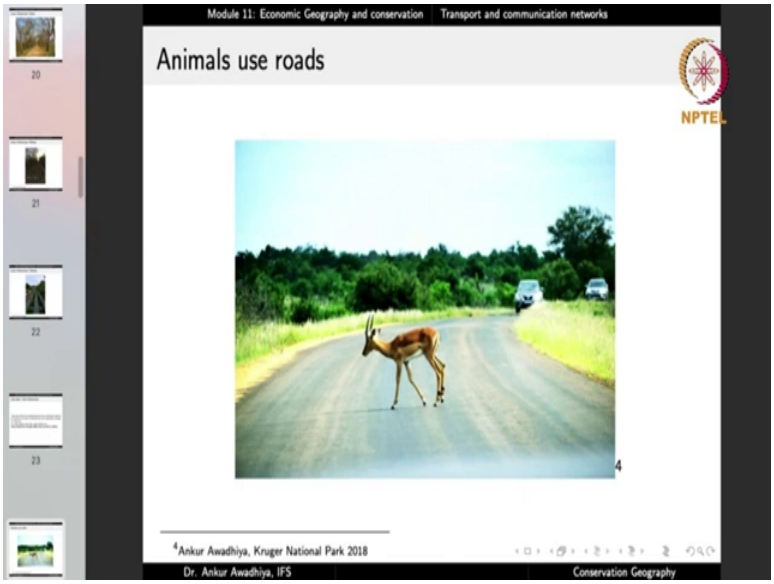

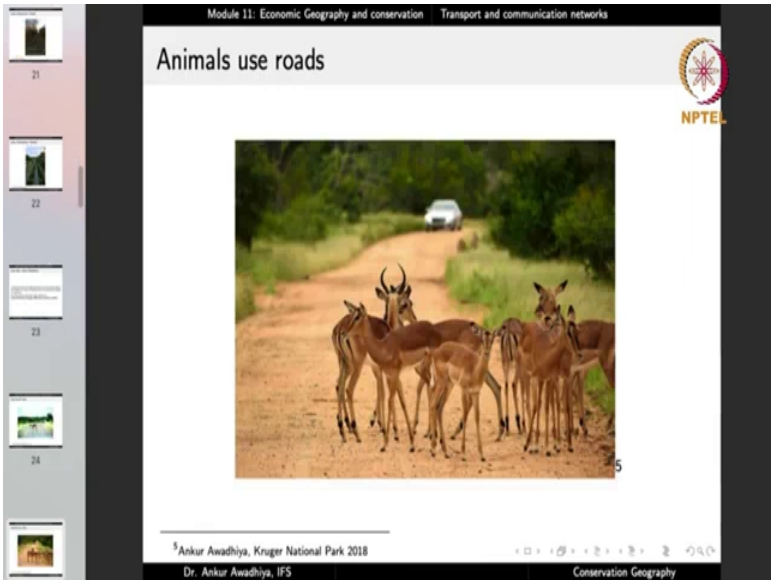

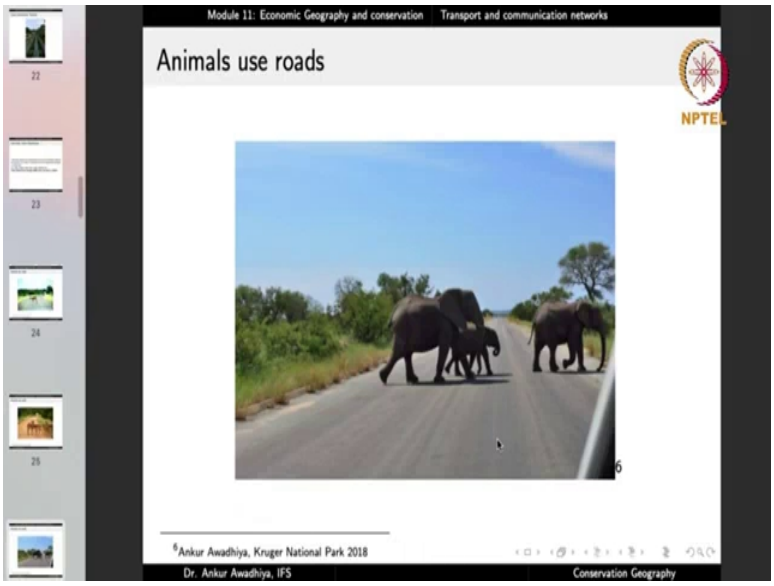
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Animals use roads
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Animals use roads

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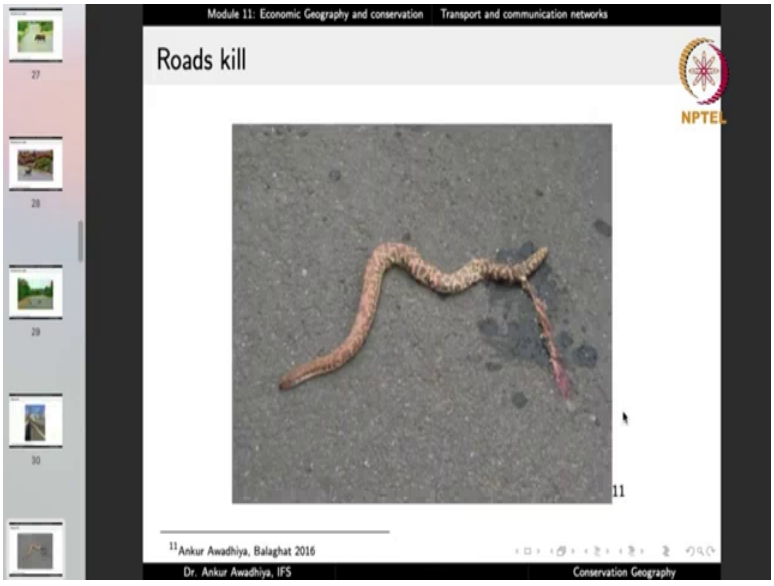
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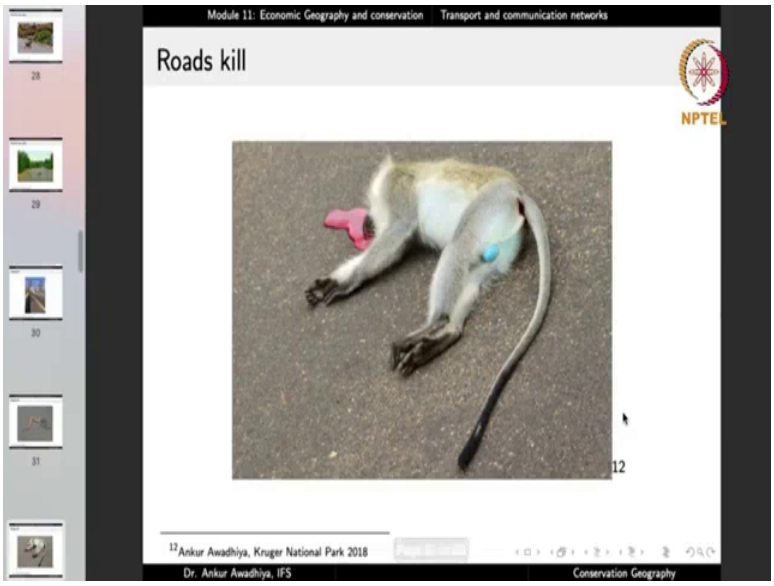

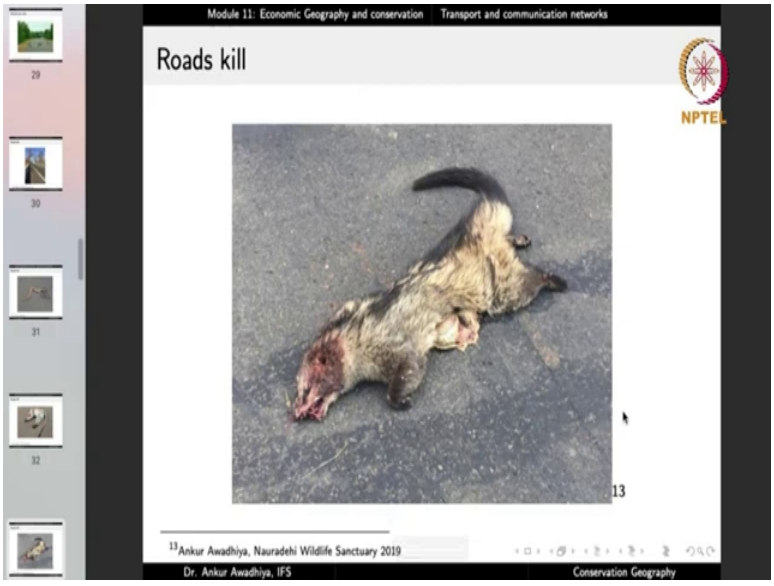

So, when the road was not here, this animal would have traveled from this point to this point freely. Now, that you have a route that has been constructed, the animals because they have a need to move, they will have to cross this road. And when they come on the road, they come into direct contact with humans and the vehicles. So, conflicts arise primarily because the animals are forced to use these roads and they include the smaller animals or the larger animals.

So, you can have movement of animals on tar roads, you have movement of animals on mud roads, you have movement of large animals like elephants, you have moment of smaller animals like pigs or macaques or even birds. So, a large number of ground dwelling birds or flightless

birds, they also move on the roads. And that often leads to tragic consequences, because roads are very good killing machines.

So, especially when you are moving through a forest area, you can find the dead bodies of several animals that are lying on the road. Because the animal was trying to cross the road, a vehicle came and it hit and the animal dies. So, you will find large number of examples. Even of animal that are say schedule 1 species that are having the highest conservation status, you will find that they are also getting killed. This is a Vervet monkey. So, you find different examples of roads that act as killing machines.

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Then roads also cause pollution, air pollution because of the exhaust and because of the dust that is streamed into the air because of the vehicular movement. They cause sound pollution, not only when the drivers use their horns to honk, but also because the vehicles when they are running, they create a sound by themselves, the sound of the engine, the sound of the air conditioners. And the animals, especially the wildlife, they are not quite used to the sounds. So, they get startled. They feel anxious. They are afraid of these sounds.

And they also cause light pollution, especially in the night hours when the vehicles are using headlamps. Now, in the night time, you have certain animals that make use of the cloak of darkness to hunt. Now, when there is a light on the road, these animals get disturbed. At times, the lights are so bright that the animals become temporarily blinded by these lights.

So, especially you will find that in the night time in the wildlife areas if there is a vehicle that is moving with their headlamps on, and there is an animal that is crossing the road, the animal looks at this vehicle and the bright lights of the headlamps falls into its eyes, and it just becomes temporarily blind. So, it does not know what to do.

Now, a normal reaction of different animals when they sense danger is to freeze at that location. That serves a very good purpose in the pristine wildlife areas, because a large number of predators are able to hunt through movement. So, if the animal moves, it is easy for the predator to see that there is something there. But if the animal just standstill, it freezes in on the location, then the predators are often not able to concentrate on the animals. And once the predator is

gone, the prey can safely move away. So, this is a response that has been evolved through evolution over millions of years.

But that has a very tragic consequence when the animal is there standing on the road. So, the animal sees the bright light. And it is normal natural mechanism is to freeze at that location. Otherwise, it would have moved, it would have crossed the road. But it stands there and the vehicle that is moving at a very fast speed, it hits that animal and the animal dies.

So, light pollution is also becoming very important in the case of these linear infrastructures through wildlife areas. So, not only do they kill the animals directly, but they also kill animals or they also disturb and harm the animals through the pollution that they cause, air pollution, sound pollution, light pollution.

And we find that there is pollution everywhere, but it becomes especially important when we talk about the loss of biodiversity. Roads also enable access to people. And especially in wildlife areas you will find that people that are moving through vehicles, they would say eat up some snacks, they will eat some biscuits or say peanuts, and they will just throw the packets out. And so we now have an access of plastics into the wildlife areas.

Plastics are a major issue even in the case of municipal areas, because they are those wastes that are non-biodegradable, they persist on the locations and they are very difficult to get rid of. But at least in the municipal areas, you have people that are employed to collect these garbage and put them into a rubbish dump or a landfill. What about the wildlife areas. In the wildlife areas, we just cannot take care of all the plastics that are getting strum there.

Once you have a plastic in the wildlife area, and typically in the case of biscuit packets or say chips packets, because they have the smell of biscuits and the chips, in a large number of cases animals mistake them for food. They eat of these plastics. And then these plastics entered into their elementary canal, the choke their stomachs or intestines. And once that happens, the animal will slowly die out of starvation, because it would not be able to eat and digest any food because the whole intestine is chocked.

Now, in the case of municipal areas, when we find cows that have eaten up these plastics, then at least you can have certain people who can take care of these cows, take them to a veterinarian and perform a surgical operation to take these plastics out. But in the wildlife areas that becomes

very difficult. So, roads cause a number of disturbances to these animals. And often at times we carry out these plastic collection drives in the wildlife areas, but then the amount of plastics and other pollutants that are being released into the wildlife areas are typically very high.

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Then, roads act as barriers to wildlife movement, which means that if an animal is trying to cross into the road and it sees a vehicle, and especially if the vehicle is at a distance or if there is a lot of sound, then the animal feels anxious, it feels afraid and it turns back. Once that happens, the animal is unable to cross the road. Now, that would not have been an issue if the animal did not have a necessity to cross the road. The point is why do animals cross the road?

Animals cross the road because they have certain push factors where they are living and there are certain pull factors in the areas that they are going towards. So, for example, in the case of the Felidae species, such as, say tigers or leopards, once the children have come of age, once they have become young adults, the males are driven out by the family itself so that the brothers and sisters do not live close by and there is no chance of inbreeding between them.

So, the males have to be driven out from their areas. So, there is a push factor that is driving the males out. And these males need another area for them to make it their home. So, there is a pull factor in other locations. Now, if the leopard or the tiger remains in its own area, then there is a constant conflict between it and its family members. The family members will just not allow this male young fellow to remain in the area. It will be driven out. But if you create a road that

becomes a big barrier, because of which the animal is not able to cross. Now, just think about the consequences.

If the animal tries to cross and it gets killed, that is a loss of biodiversity. If the animal stays in the place and is involved in inbreeding, that is also a loss of biodiversity, because slowly and steadily we will find a large number of genetic diseases that crop up in the population. Similarly, in the case of animals like elephants, so elephants are mega herbivores. They are large sized animals and they have a tremendous need to eat food, not only to sustain their bodies, but also think about the amount of weight or mass that they are carrying when they are moving. So, that requires a lot of energy and this energy will have to come from food.

Now, the elephants do not have access to very high energy providing food items, because they typically eat things like branches or leaves or bark, and they are very less in calorific values. And so to make up for the energy requirement, the elephant has to eat a lot. So, you will typically find elephants that are eating for say 16 to 20 hours in a day, anytime you see an elephant it will be eating something.

Now, if this elephant is confined to a location, if it is unable to move to different areas, then slowly you will find that all the trees have been eaten up and the forest slowly gets converted into a denuded land, because there is no vegetation covered left in the area. To ensure that this does not happen, nature has evolved a process through which the elephant is always on the move. So, the elephant will always be moving so that it is going to different areas and it is eating the vegetation. But in any area the vegetation that it eats is not of that high a quantity as to have a negative consequence on the ecosystem.

But what happens in the case of roads is that, especially the roads that move through the elephant areas, they serve to confine the animals into small pockets of land. And in those small pockets of land, what happens is that the vegetation is very quickly denuded and then we start to see negative consequences. So, the fact that roads act as barriers to wildlife movement also has very significant consequences for biodiversity.

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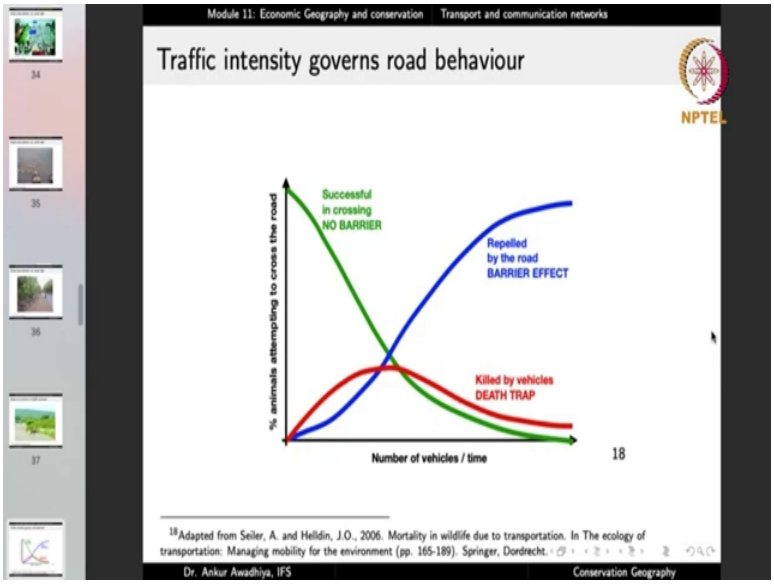

Now, this barrier effect is governed by the traffic intensity. If you make a plot between the number of vehicles plying on the road per unit time or the vehicle density on the road versus the percentage of animals that are attempting to cross the road, we will find that there are three different stages that can occur when the vehicle density increases.

In the first stage, when you have a very less number of vehicles that are plying on the road, you will have a situation that when the animal reaches the road to cross it, it is actually able to cross it, because the vehicular density is so less that there is a very less chance of the animal dyeing because of the accident, and plus because the vehicular density is very less so the animal does not see a vehicle, it does not hear a vehicle and so it is not afraid. So, very easily it crosses the road. So, that is the first stage.

Another extreme happens when you have a very high number of vehicles that are plying on the road. In such situations it appears as if the road has a wall of vehicles, because at every point of time there is some or the other vehicle that is moving through the road. There is a lot of sound, there is a lot of dust and the animal is afraid to cross the road. And so the animal will come to the road, it will stand for some time, it will see that there are so many vehicles that are plying that it gets afraid and it simply moves back. And in that case, the road acts as a barrier.

It is as if you have not just constructed a road, you have actually constructed a wall so that you do not permit the animal to move from one location to another location and this is known as the

barrier effect. So, the barrier effect goes on increasing as the number of vehicles plying per unit time increases and then it reaches a maximum amount after which it basically behaves like a wall. Whereas the animals that are able to cross, it sharply decreases with the increase in the vehicular density.

But the third thing that happens is a death trap that gets created in middle levels of vehicular density. So, what happens here is that the vehicular density is neither very low to enable the animal to cross nor is so high that the animal becomes afraid and it just not, it does not attempt to cross. The vehicular densities in between. So, the animal thinks that, okay, I will be able to cross the road. It attempts to cross the road, but then the vehicle density is good enough to ensure that there is a vehicle that comes and hits the animal and kills the animal.

That is what we are saying here is that when the vehicular density is very less, the animal will be able to cross the road. If the vehicular density is very high, the animal will just not attempt to cross the road and in both these cases the animal is safe. But when the vehicular density is in between, then what happens is that the animal is confident enough that it will be able to cross the road, because the density of vehicles is not that high to make it afraid. And so it attempts to cross the road. And once that happens, a vehicle comes and hits the animal and the animal dies. So, the road becomes a death trap.

And we find that the killing effect of the road is very less when the vehicular density is very less, because the animals are just able to cross the road without getting hit by a vehicle. The killing effect is very less when the vehicular density is very high, because the road acts as a wall, it acts as a barrier and the animals just do not attempt to cross the road. They are so afraid. But in the middle levels, the road has a maximum tendency to act as a deathtrap. So, the traffic intensity governs the behavior of the road towards the animals, whether it acts as a no barrier, it acts as a barrier or it acts as a deathtrap.

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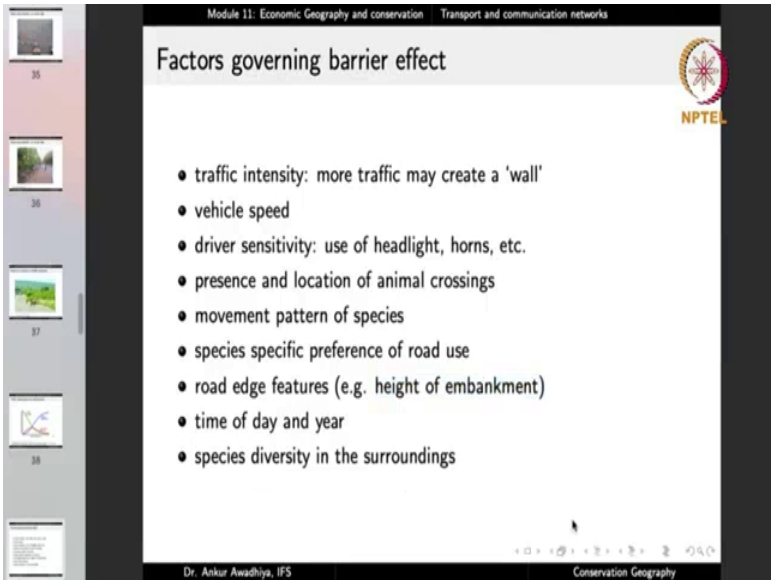

There are also other factors that govern the barrier effect. So, we have looked at traffic density. More traffic may create a wall. But it also depends on the vehicle speed. So, if the speed of the vehicles is very high, then the animals are even more afraid. And so when you find that in a forest area if there is say a speed limit of 20 kilometers an hour for the vehicles and when the vehicles are actually moving at a speed of say 90 kilometers an hour or a speed of greater than 100 kilometers an hour, then even though the road was so designed as not to act as a barrier, it will start behaving as a barrier because of the behavior of the people that are moving on the road.

So, the speed of the vehicle matters. The sensitivity of the drivers also matters. If there is a use of headlamps or there is a use of horns, if there is a lot of honking, then the animals get startled, the animals get afraid. And when that happens, then even at a lower vehicular density the road may act as a very good barrier for the animals. And thus it will accentuate the destruction of habitats or the rise in inbreeding depression in their annual populations. It also depends on the presence and location of animal crossings.

Now, animals are intelligent beings. So, if you provide the road with sufficient number and sufficient size of animal crossings, the animals will just not attempt to cross the road and they will use the crossings. A very good example of crossings is bridges. So, if a road has a lot of bridges, then the animals will just cross the area using the bridges without coming on top of the

road. So, whether a road during its design and construction has been provided with animal crossings will play a very big role on whether or not the rule will act as a barrier for animals.

It depends on the movement pattern of species. There are certain species that have to cross from one location to another location. Good examples are the fillets or the cat species or species like elephants, whereas there are certain other species that do not have to cross the areas. And so when we talk about the barrier effect, the barrier effect is more pronounced for those animal species that have to cross and less pronounced for those that do not have to cross.

It depends on the species specific preference of road use. Now, this becomes important, because in the case of animals such as snakes, now snakes require a hot surface, because snakes are cold blooded animals. And the root surface because it is black in color, it absorbs the heat of the sun, and it increases in temperature.

Now, the point with the cold blooded animals, such as the reptiles are the amphibians, is that they need to warm up their bodies to start their activities. So, you will often find that in the winter seasons in the early mornings, if you look at a rock that is exposed, you will often find a large number of reptiles and amphibians sitting on the rock, because as the rock is warm and they are trying to warm up their bodies. We find it in animals such as frogs, we find it in animals such as snakes, even animals like crocodiles or turtles.

Now, all of these animals they prefer to sit on warm surfaces. On the other hand, if you look at a species like tiger, it will generally avoid those surfaces that it is not very conversant with. So, it tries to avoid those locations where it finds that, I do not know this area. I am not sure whether this area is safe or not. So, that is the thought pattern of a tiger. So, for those species that prefer the road, primarily because of its temperature or because there is less amount of dust there, then the barrier effects will be much more pronounced for those animals.

It also depends on the road edge features such as the height of the embankment. In certain cases, we find that the embankments on the sides of the road are so high that they just do not permit animals to cross. So, that would enhance or accentuate the barrier effect of the roads. It also depends on the time of the day and the year. And it also depends on the species diversity in the surroundings.

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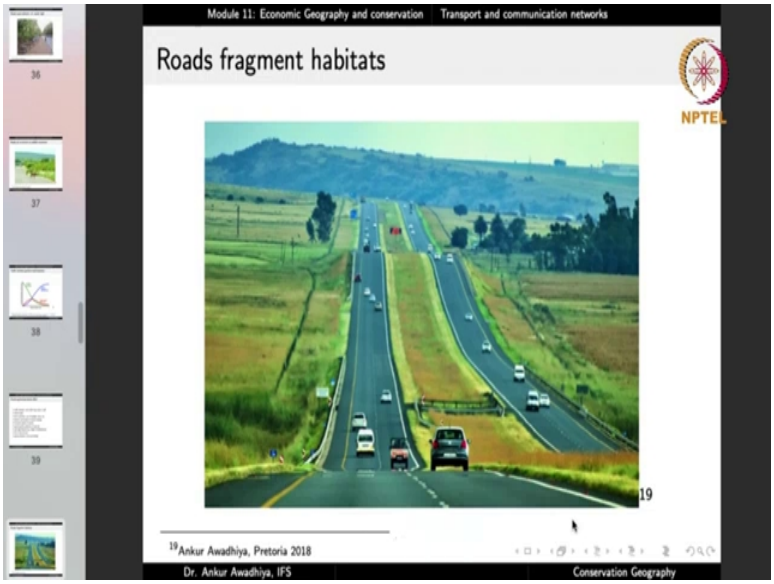

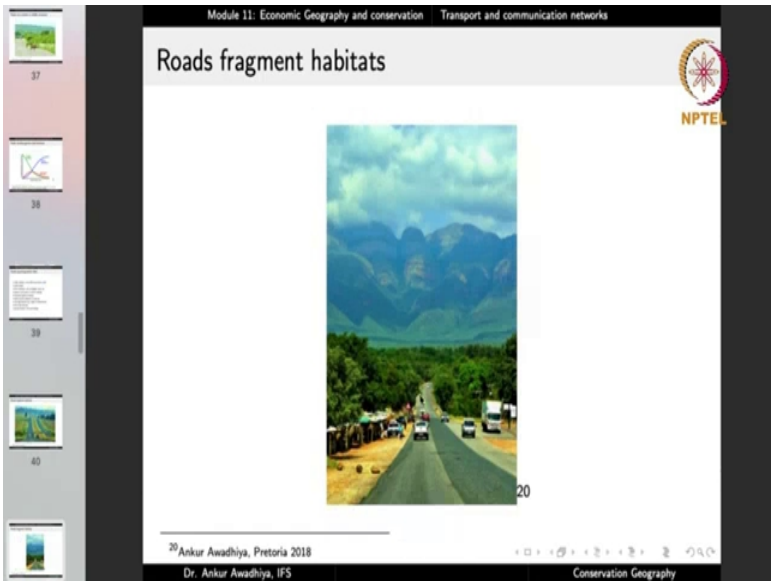

Another impact of roads is that they fragment the habitats. And we have looked at habitat fragmentation before. And if you look at any habitat, you will find that if there is a road it is dividing the habitat into smaller fractions, whether it would be a grassland habitat or it would be a forest habitat. So, if this road was not constructed then animals would have moved from this location to this location very easily. But now with this road, now the animals do not find it easy or safe to cross the road. And so now this has resulted in this fragment and this fragment in place of a contiguous forest.

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The construction of roads and other lean infrastructure often leads to loss and destruction of habitat, because to construct this railway line, you have to cut the trees. Because of their nature as linear infrastructures when they are being constructed any tree that comes on the way will be failed. And so that results in a loss and destruction of the habitat.

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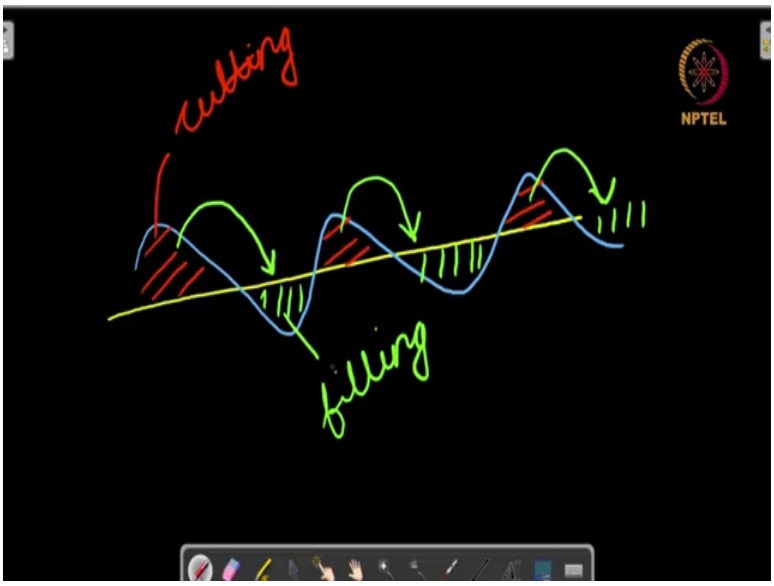
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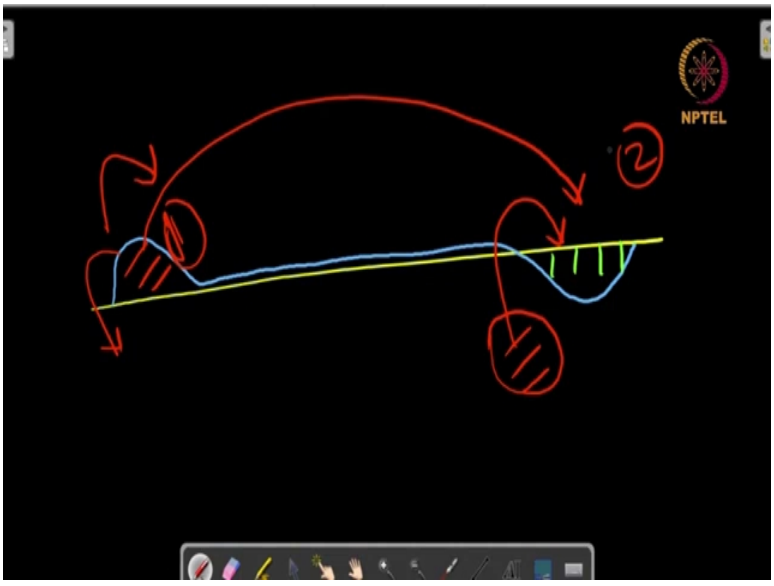
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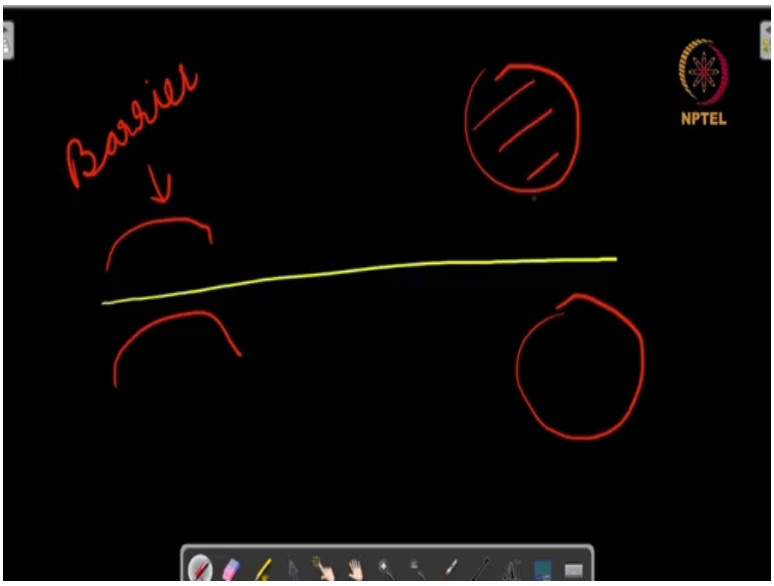

It also happens when they are being constructed due to earthwork. Now, what is earthwork? Earthwork means that typically you would prefer to have a road that is a straight road. Now, the Earth is not a straight thing. So, you will typically find that the Earth moves up and down. And so what is done is that in those locations which are above the desired locations, we will perform a cutting operation that is the Earth in these locations will be cut. And the Earth will be taken to the other location where there is a depression and it will be filled up in these locations. So, we have a cutting operation and we have a filling operation.

Now, for these cutting and filling operations you have to take out Earth, you have to dig Earth. There has to be the use of Earthmovers. Now, often we find that during the use of these Earthmovers they create big holes in the habitat. This is typically true in the case of forest areas because people are not that conscious, they are not that specific to ensure that all the material that has been cut will be the only material that will be use for filling, because at times the contractors try to avoid the transportation of materials.

Because in this case, suppose you had a situation where this is the road and the Earth moves like this, so there is a cutting, then the Earth is more or less flat and then you require a filling operation here. Now, in the best case scenario, this Earth would be cut and it will be taken to this location and there will be a filling done at this location. But what actually happens in a large number of cases is that the contractor will just cut this location, spread the Earth here on the side of the road and because he needs material to be filled here, so there will be another excavation right next to the road and the Earth will be taken out and filled here.

Now, this is just to avoid the cost of transporting the material from this location to this location. To save on the transportation cost often we find that in the forest areas, because there are typically less number of people who will be able to supervise these operations, because this is a far off area. So, typically their mentality is who is going to see what we are doing. So, let us do like this.

Now, once that happens, you will a situation where if this is the road, then in certain locations, you have created an artificial embankment on the sides of the road, because the material that was cut here, it has been deposited on the sites and on certain other locations you have big holes that have been created in the wildlife habitat.

Now, the problem here is twofold. On these locations you have created a barrier for the movement of animals, because there is this earth that is now elevated and so it does not permit the animal to reach the road that easily. And on these locations where you have large sized holes, so this is an example from Nauradehi Sanctuary, and in this large sized pit that was dug to take material to be deposited on the road, now you have a situation that the animals will not be able to cross. Now, especially in the night times you will, you may have a situation that the animal that is say being chased by a predator it just runs, it falls into this pit and it fractures a bone.

Or in certain other locations where the pits or even of a greater depth you can have a situation where an animal falls into the pit it becomes trapped there and it slowly dies out of starvation. It becomes especially important in the case of the rainy seasons, because these pits can get filled up with water and then nobody will be the visor to know what is the depth of this pit. So, they cause large scale loss and destruction of habitats. So, the embankments become a problem and these pits also become a problem.

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Here again we find, this is another example from Nauradehi, in which case this road is being expanded. So, in place of a one lane road, now they are trying to have a four lane road. And for that all the trees in this location they have been cut and now there is a large scale Earth filling operation that is required in this region. Because you can see that here the Earth is very depressed and near the road it is elevated.

So, all of this area has to be filled up so that the road is a level road. When that is done, quite a large amount of material will be required to be filled in this area and this material will come from the surroundings. So, construction causes huge loss and destruction of habitats.

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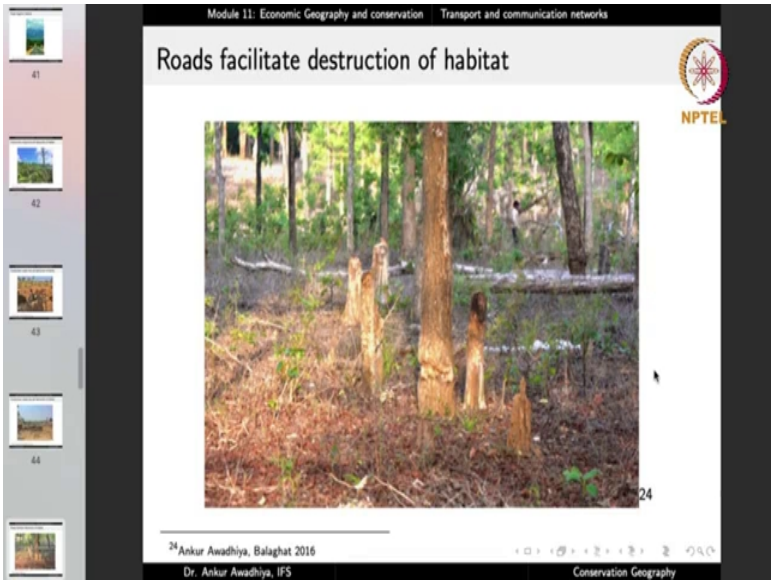

But that is not all. Roads also facilitate the destruction of habitats, because they permit people to reach into areas that were completely inaccessible before. And so when you permit people to enter into the area, you will find that in certain situations there will be cases of illegal felling of trees, because especially in the wildlife areas there is nobody to see that these areas are completely protected or not.

At times, even with the best amounts of supervision, it is possible that somebody might sneak out into the forest area, especially in say late evenings or night times, cut a few trees and then move away. And we typically find that near the roots you will find instances of felling of trees, instances of girdling of trees.

So, in the case of girdling what we will have done is that they have cut the tree at the bottom, so they have removed the bark and they have destroyed the vascular bundle of the trees. And now slowly this tree will be unable to get its food and water and it will slowly dry up. And once it has dried up, it can be very easily filled or it can be burned. This typically happens when people are clearing off vegetation to make way for say a small piece of farmland or a small piece of pasture land.

Now, that would not have happened if the road had not come to the area, because otherwise it is very difficult to enter into the forest. But roads, because they increase accessibility into the forests, they also permit people with nefarious interests, people with a criminal mindset to enter

into the forest and do things like cutting of trees. We also find instances where once the road was constructed people went inside and started to hunt for animals.

Earlier they would not have ventured to enter into a very dense forest. But now with the road around, it is very easy to enter into the forest, park the vehicle on the side of the road, enter into the forest, kill a few animals and birds and make away with the meat. So, they facilitate the destruction of habitat once they have been constructed.

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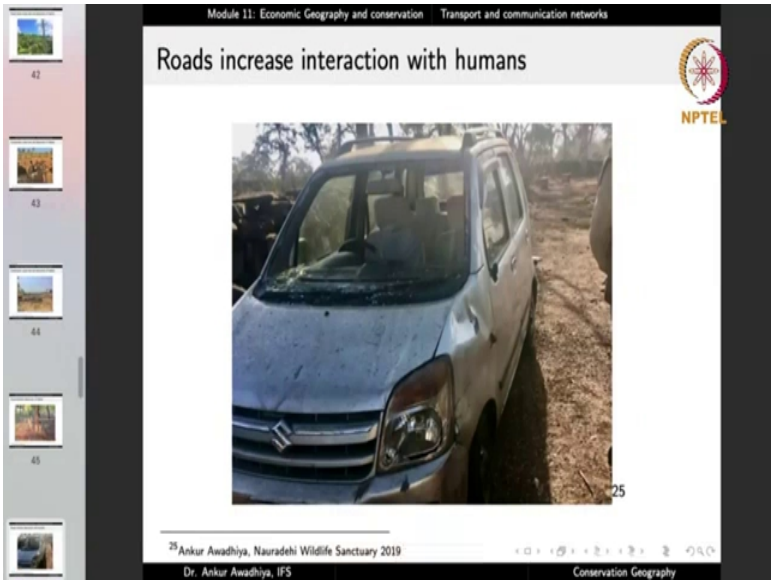

Then they increase the interactions with humans. Now, this is the example of a vehicle that was hit by nilgai and you find that the glass is completely shattered. The nilgai died on the spot. And these people were critically injured. Now, this happened because in place of moving at the designated speed of 20 kilometers an hour, these people were moving at say around 100 kilometers an hour.

Now, this interaction with humans, this interaction between humans and wildlife had tragic consequences for the nilgai, because it died. But it also had very tragic consequences for these humans, because they also met with an accident. If the road was properly designed, if it was designed in a way that the nilgai did not come on the road, then the nilgai would be saved and these people would also have been saved. So, another impact of roads is that they increase the interaction with humans that leads to injury, that leads to death, that leads to change in animal behaviors.

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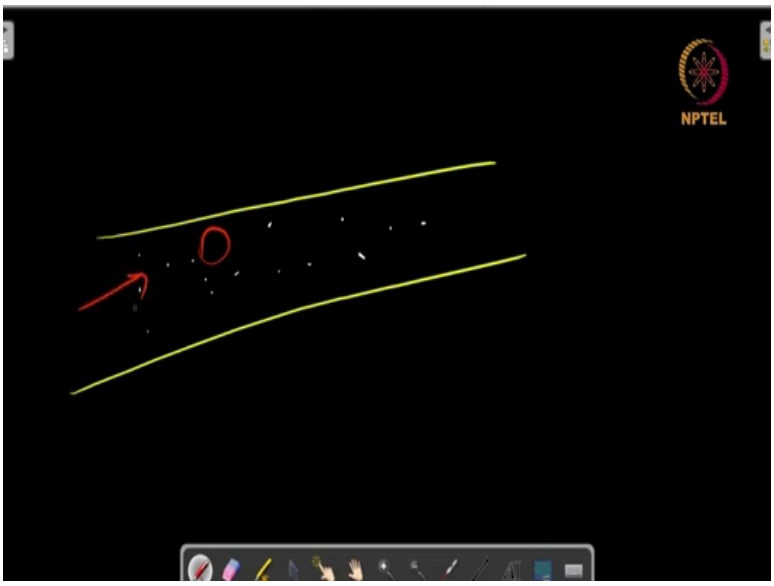

You will often find that in the forest areas, people give food to the animals, especially monkeys and langurs. They typically do that out of a religious fervor that, Lord Hanuman was related to these animals and so when we are feeding these animals, we will get certain blessings. But there are 2-3 things that happen because of this. One, the animals are getting more and more accustom to human food. In the wild areas the animals would not have access to sugary foods or salty foods or oily foods.

Now, once you make them habituated, once you make them addicted to these foods, now the animals lose interest in the food that is available in their wild surroundings. Now, they have

become dependent on human beings. Once that happens, whenever vehicle stops on the road these animals will come to these people. Now, that becomes a situation of nuisance. Why, because these animals can attach the human beings. Once that happens everybody would say that, these animals are very ferocious animals, whereas in actuality these animals are very timid animals.

If you go into a forest area where the animals have not had an interaction with human beings they are so mortally afraid of human beings that they will not approach you. They will just try to run away from the vehicles. But now once they have been given these foods again and again and again they think that if there is a vehicle that is a source of food and if the people are not giving us food we can take the food from them. So, it changes the behavior of animals. It also entices the animals to come to the road.

So, earlier the animals would have ventured into the forest areas, but now they see the road as an easy source of food and now they will frequent the areas where the roads are. And at times people just throw the food on the road. And so you now have a situation where you have this road and on this road you will find that when people have thrown food, so the food is lying on the road. Now, once you have an animal that comes to the road to eat this food, there is a very good chance of it getting hit by another vehicle. That is another issue that the roads have created.

Yet another issue is the spread of diseases. So, the animals can contract diseases like tuberculosis from human beings. Human beings can contract diseases like rabies from the animals or takes from the animals. Now, that is a bad situation for the humans and that is a bad situation for the animals as well. So, roads not only lead to a destruction of habitat they also change the behavior of animals.

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This is an example from Sariska Tiger Reserve. Now, this is a tiger reserve, but there is a set of temples that is inside. And the pilgrimages that go to the temples they have now attuned the animals by giving them so much amount of food that if anybody stops in the forest, all these animals will just come around these people in the hope of getting food.

So, you are finding macaques, you are finding langurs, you are finding pigs, you are finding peacocks and so on, all of these animals. Now, typically if you enter into a forest area, the animals will run away from you. But now when they see these people inside, they are flocking towards these people. Roads have a major change in animal behaviors.

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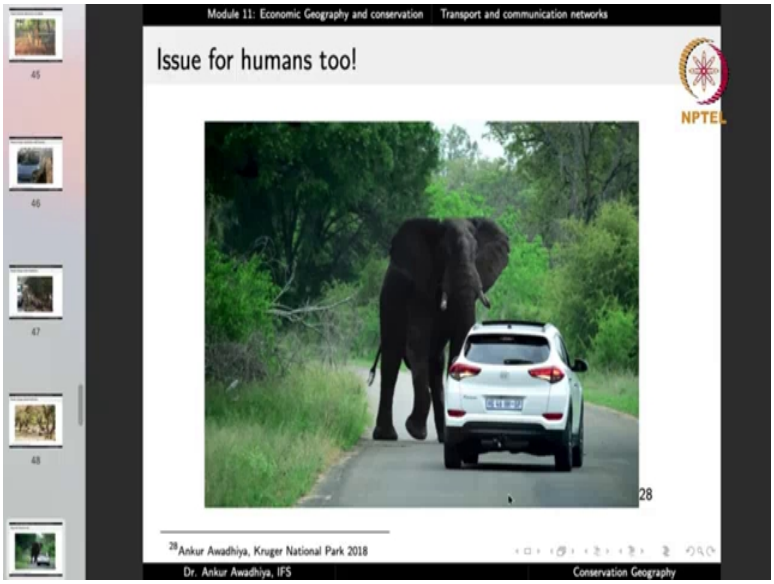

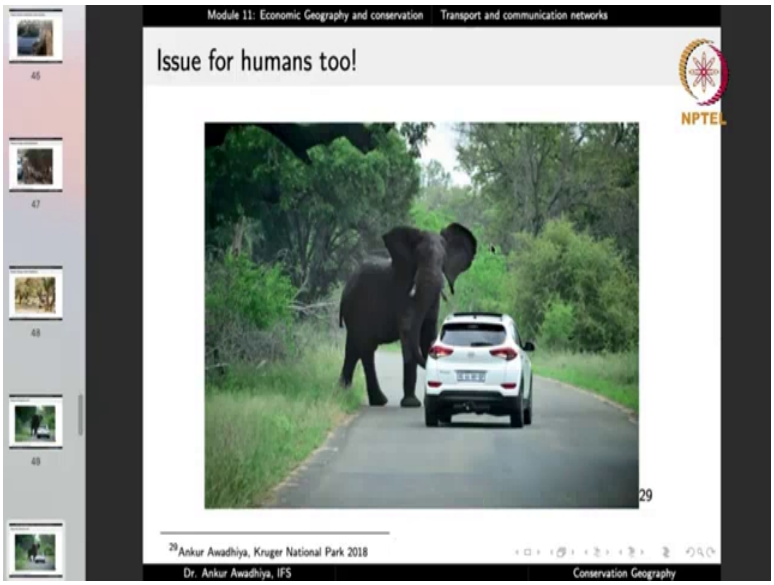

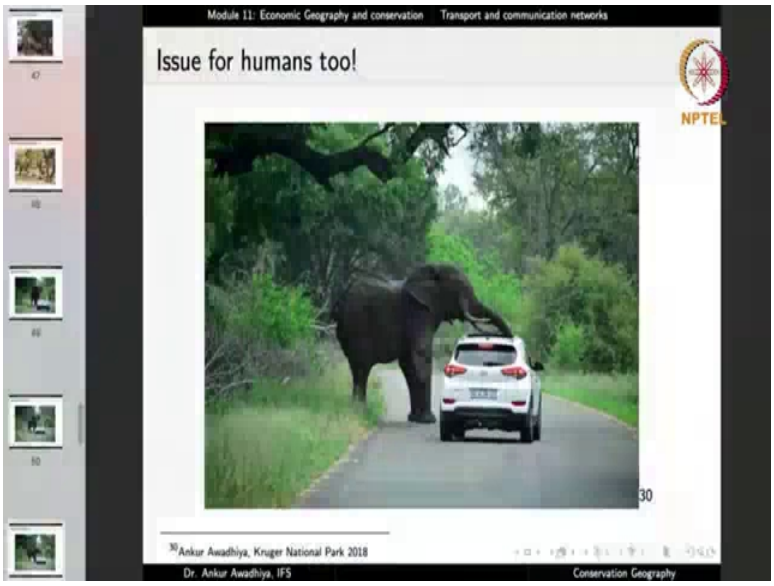

And at times this becomes very tragic for humans as well. So, this is a picture from the Kruger National Park. And there we saw that this animal was trying to cross the road. It saw a vehicle and it became extremely furious. It try to attach the vehicle. So, when you see an elephant with the ears that are now spread around like a fan, it flapping its ears, it means that its now very angry, its aggressive and it try to attach the vehicle.

So, this interaction between the animals and the humans that was created by the construction of the road in the wild life areas is having detrimental consequences not just for biodiversity but also for people. They are getting into accidents, they are getting diseases and so on.

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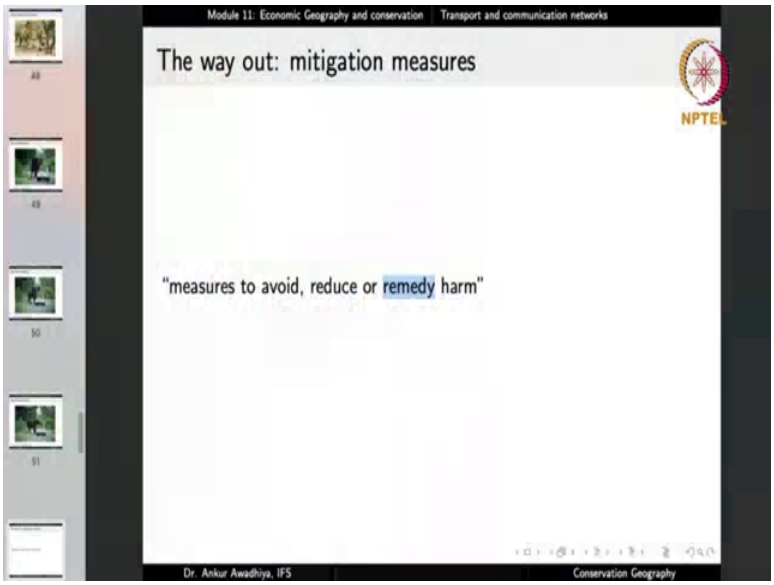

And so we have to be mindful of these negative impacts and we have to find a way out. A way out is mitigation measures which are measures to avoid, reduce or remedy the harm. Measures to avoid harm, can be create a situation when, where the animals just do not get on the road or can be at least reduce the harm.

That is, if the animals get on the road we have an alert so that the vehicles or the people are not bumping into the animals or can we have the way to remedy the harm. Often these are very simple measures. You just want to ensure that the animals do not get on the road and you need to provide them with another route that they can use to cross the area as simple as that.

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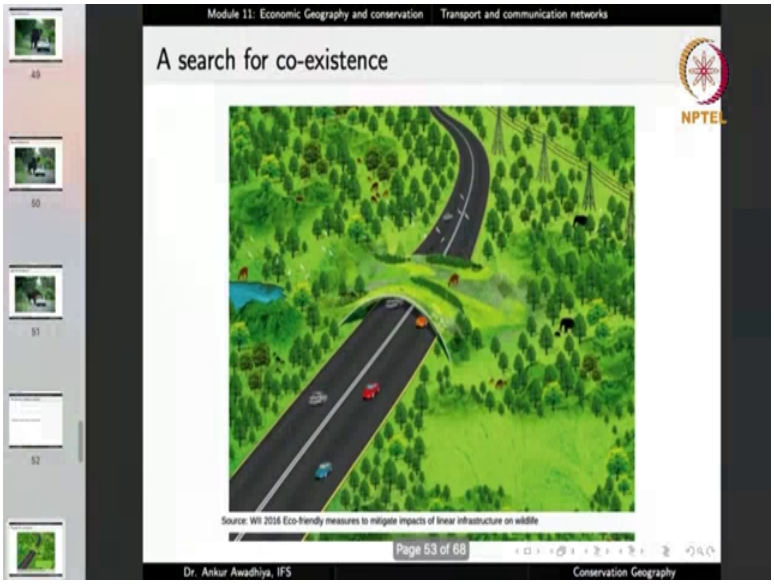

So, basically, the mitigation measures are a search for coexistence. That is we are not saying that okay these roads or these power lines should not be constructed, but at least they should be constructed in a way that the animals are also able to cross. We can have things like land bridges so that the animals can move over these. We can have things like bird deflectors. So, these are just small pieces of plastic that are attached to the wires so that the birds do not bump into them, as simple as that.

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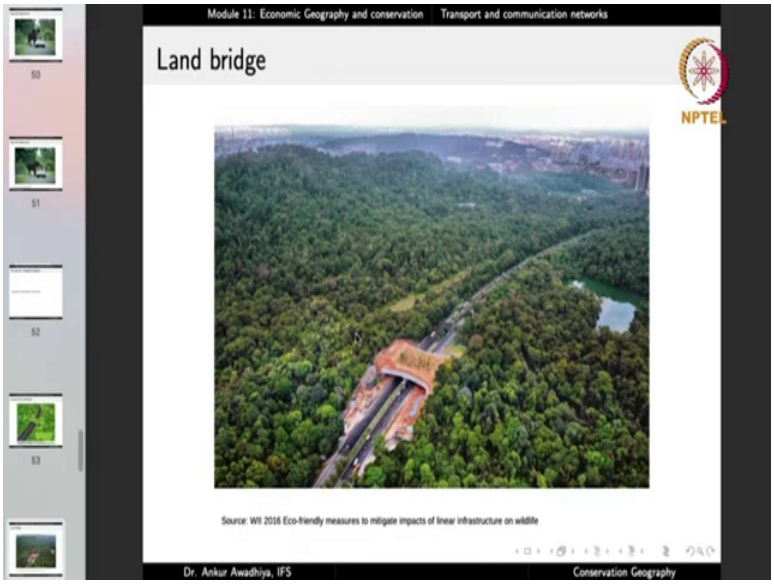

So, this is an example of a land bridge. So, in the case of a land bridge, there is a bridge that is constructed over the road so that the animals can move from one part of the habitat to another part without coming on top of the road.

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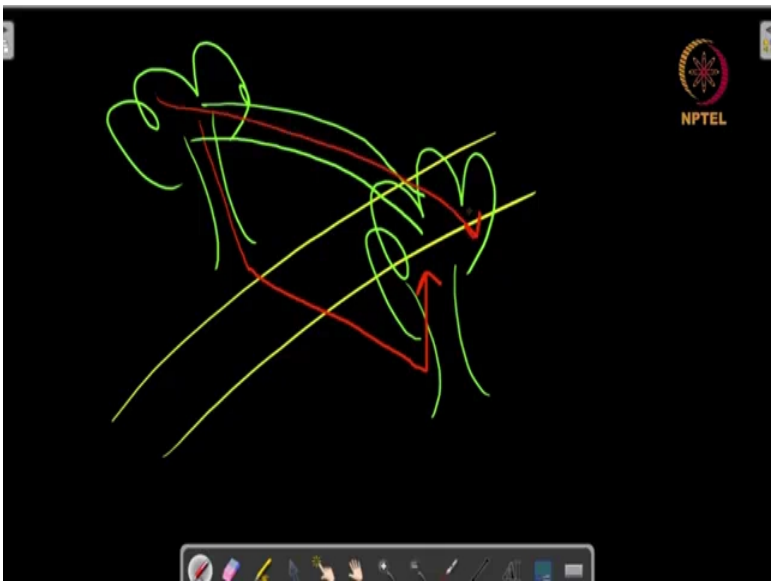

We can have things like canopy bridges, which is a bridge that joins one tree with another tree. So, the animals do not have to come down from a tree. They can just use the canopy bridge. So, in this case you have a road and you have trees here and you have trees here. Now, if the animal that lives on the trees has to cross, it does not have to come down, cross the road and then climb up again. In place of that, you just provided with a bridge here on the trees. Often this is as simple as tying a rope or as simple as say tying a few bamboo structures so that the animal can directly move from this canopy to this canopy, as simple as that.

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Or glider pole. Now, glider poles are structures that are created for those birds that cannot fly for a very long distance. So, if you have a road that has been constructed and the birds are not able to hop through the canopies, they can at least fly to this pole, they will rest for a while, then they will fly to this pole, rest for a while, then they will fly to this pole, rest for a while and now they are able to reach the next canopy. These are glider poles, as simple structures, just a pole with a flat area for perching.

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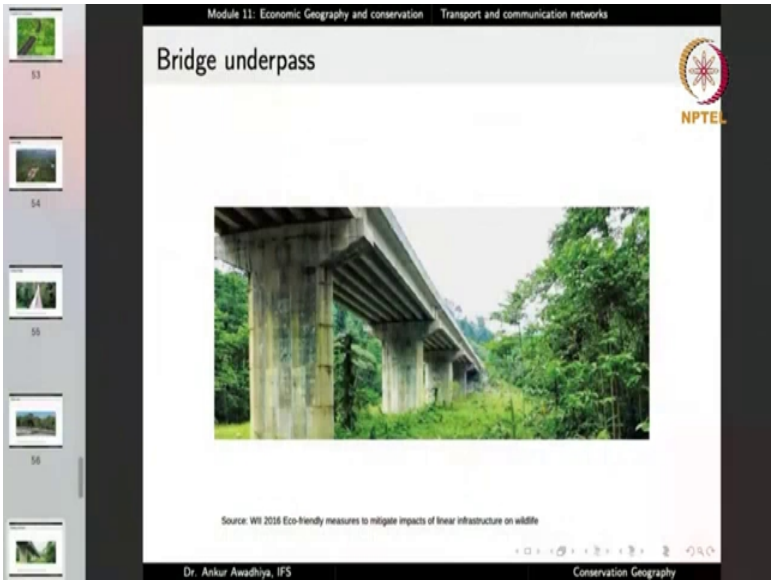

Bridge underpasses, if a bridge has to be constructed in, for the road, why not constructed in such a manner that the area below can also be used by the animals to cross the area. That is it should not be dark, it should not be so claustrophobic that the animals do not find it comfortable to use the area that is below the bridge, because in any case we humans are not going to use that area. So, just by making small arrangements we can make it useful for the animals.

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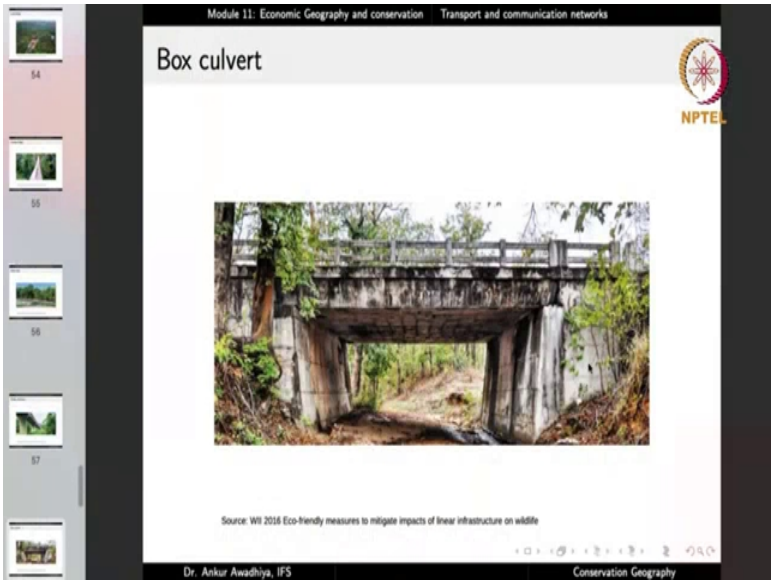

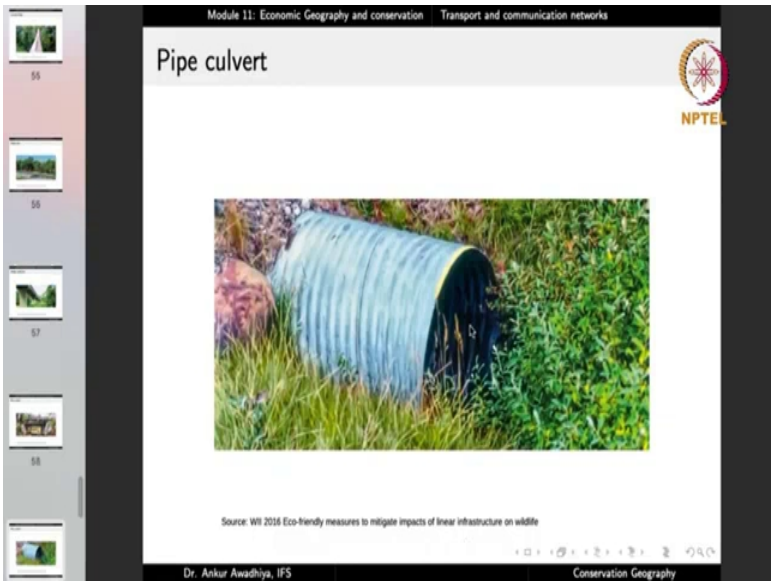

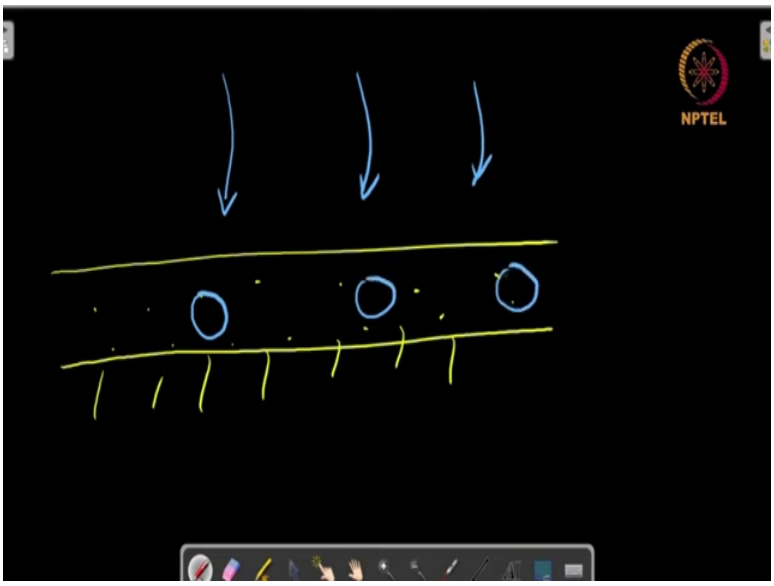

Another option is a box culvert, yet another option is a pipe culvert. Now, a pipe culvert is often needed in those areas where some amount of filling operation has been done. That is if you have a road that is a bit above the normal ground, so if this is the normal ground level and the roads is a bit above, because material has been filled up here. Now, in such a situation if water moves, then it will lead to erosion and the road will be washed away.

To avoid that, we construct certain pipe like structures to permit this water to flow from one side of the road to another side of the road. Why not design them in such a manner that they can also be used by animals to cross from below, as simple as that. Typically, it just does not require anything other than say just using a larger sized pipe, as simple as that.

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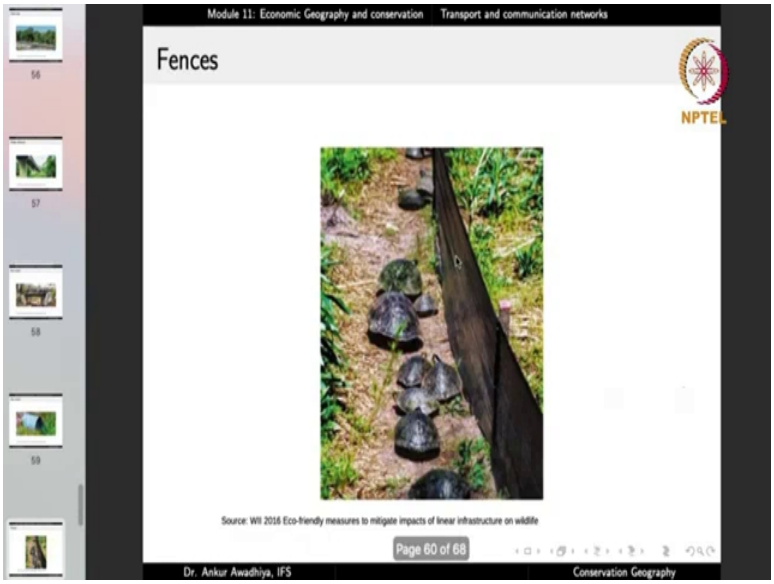

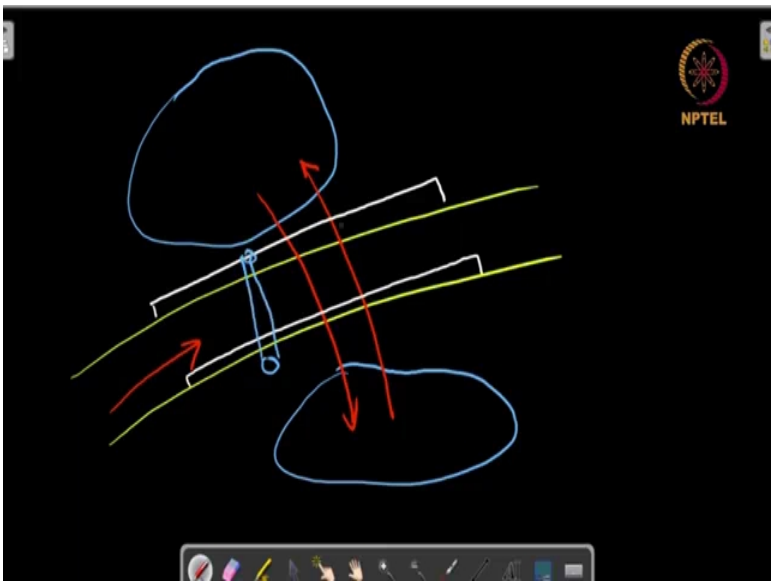

Or make use of fences in those locations where you do not want the animal to enter into the road. These are typically required for the reptiles and amphibians. So, if you have a situation where you have a road and there is a water body right next to it and perhaps another water body here, now these animals will typically cross from one water body to another water body and this is also necessary to avoid inbreeding in one water body.

Now if they cross the road, then it is very likely that the next vehicle is going to overrun them. To avoid that what we can do is that we can construct a fence on both the sides of the road so that the animals do not move on top of the road and we give them a pipe culvert to permit the

movement from one location to another location, as simple as that. So, fences are also very important mitigation measures.

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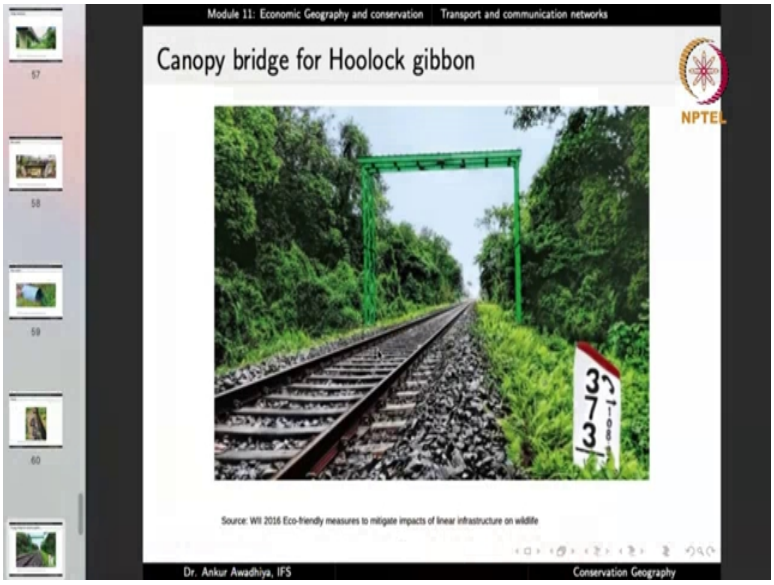

This is the example of a canopy bridge that is provided for a hoolock gibbon. So, in this case because we have a railway line here and you do not want the gibbons to cross through these railway lines, you have provided them with this structure so they can always climb move from one location to another location. Even when you have a very high density of railways that are moving.

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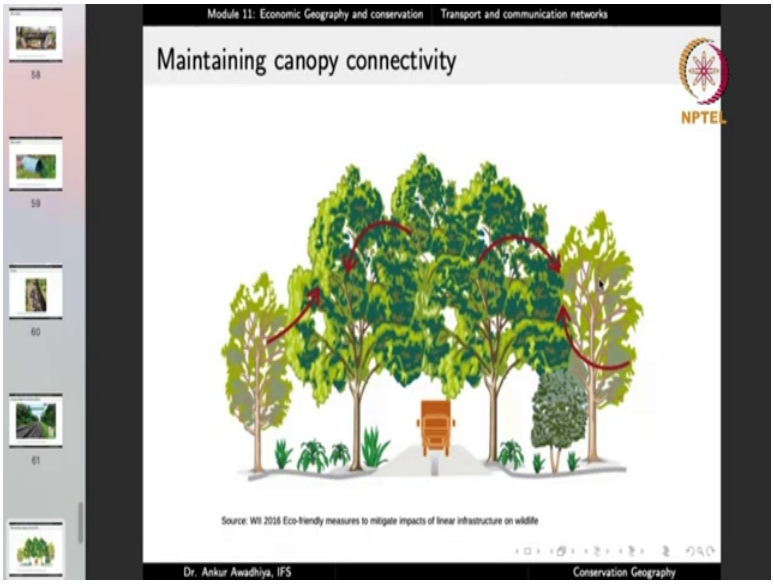

Try to maintain canopy connectivity. That is plant trees on both sides of the road that permit animals to move from above. The animals to not have to come down and cross the road, as simple as that.

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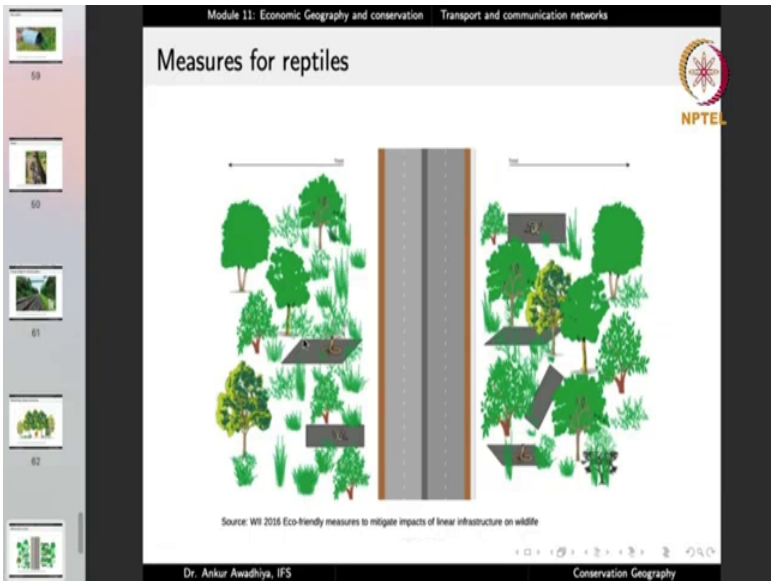

Measures for reptiles, because reptiles are cold blooded animals and they need to warm their bodies up, so they typically come on top of the roads. So, if you have an areas that is rich in reptiles construct fences on both sides of the road and paint a few rocks black in color so that they provide the animals with suitable areas for basking. If you do that you will ensure that these animals will not come on top of the road.

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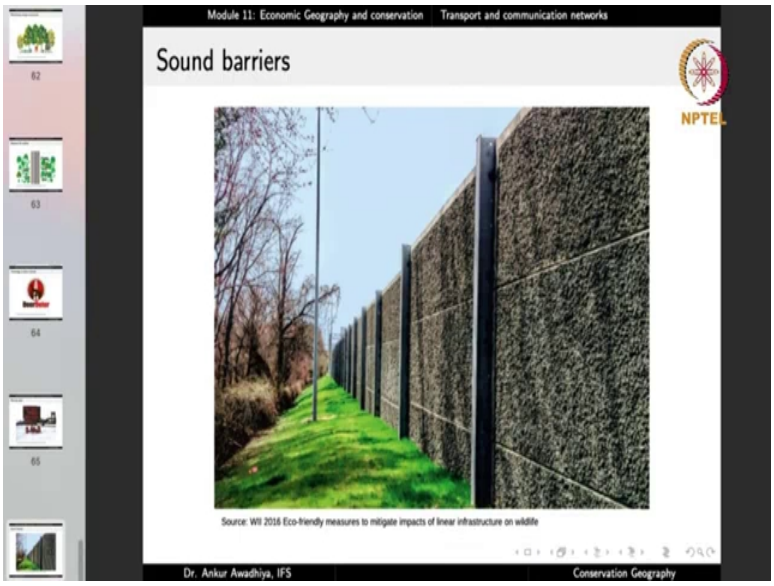

Use technology to detect animals, use technologies to warn people that there are animals that are crossing the road. That is good for the animals and that is good for wild life as well. Use sound barriers, because if there is a lot of barrier effect because of large amounts of sound we can put, install certain sound barriers. They are very important especially when we are trying to construct a bridge underpass or a culvert underpass such as a box culvert or a pipe culvert.

Now, if the area is having a large amount of sound, the animals will be afraid and typically not use these underpasses. To make them more comfortable for the animals we just have to install a sound absorbing substance, typically just a rug on the walls of your underpasses so that it becomes quite and the animals are able to cross, as simple measures as these.

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And none of these options are expensive. These options are very inexpensive. They just require a bit of though and compassion, nothing else. Is that too much to ask for? So, basically, if you look at economic geography, you will find that we always talk about the means of transportation and communication, but we hardly ever talk about their impacts on biodiversity or the mitigation measures that are required.

Only when we know that they are causing a negative impact on biodiversity and only when we know that we have very simple, very cheap solutions that are available can we insist that we require these mitigation measures. And with that we can have the benefits of these modes of transportation and communication, while also retaining the benefits of our biodiversity, while also retaining all the ecosystem services and all of this can be done very cheaply and with very little effort.

So, that is all for today. Thank you for your attention. Jai Hind!