Environmental Impact Assessment
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Lecture 45
EIA Methods – Transport

Welcome to the course Environmental Impact Assessments. In today's class, we are going to look into EIA, particularly for transportation. So, with regards to that we are going to look at what are the definitions and concepts involved when we deal with transportation. Though the domain is in itself it is a big domain but with the EIA we are going to look at very selective things.

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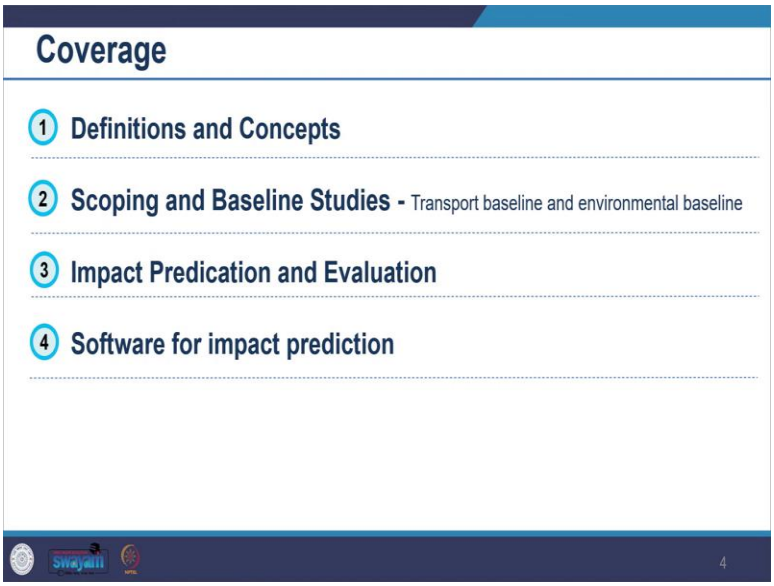

So, we will look at definitions and involved concepts that we would require for EIA purposes. And then we will be looking at like what kind of things we undertake during scoping and baseline study about transportation baseline, as well as when we undertake environmental baseline.

Further, we will look at related impact prediction and evaluations, so what kind of impact transportation projects have and how do we undertake prediction and evaluation. Then we will look at the associated software, which is available for impact prediction. So, we will not get into the details of this software or how we perform that but we will just look at what all things are available to us. So, that would be the coverage.

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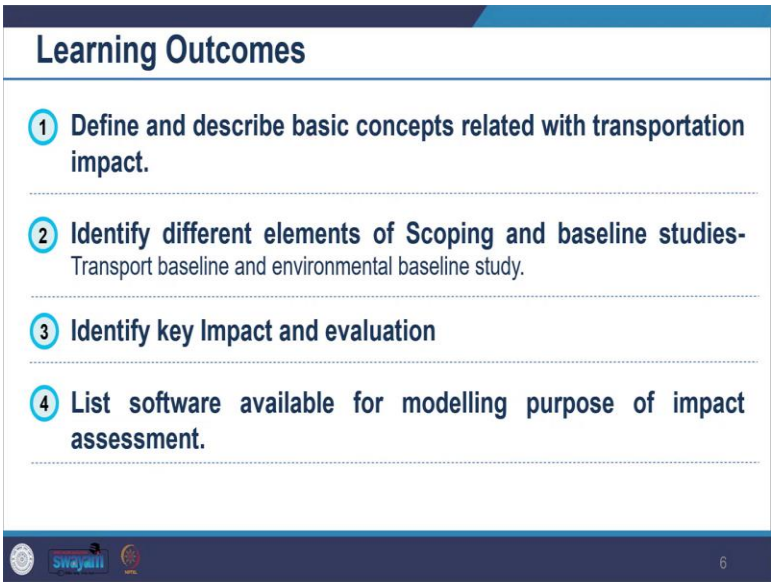

So, accordingly, the learning outcome, the expected learning outcome from you is that you should be able to define and describe basic concepts related to transportation and in the domain of Environmental Impact Assessments. Further, you should be able to identify different elements of scoping and baseline studies like what you need to undertake and then you should be able to identify key impacts, what happens in the case of transportation projects.

And then how do you undertake evaluation, you should be able to identify software related to that. So, that is the learning outcome expected from you. If we look at like any kind of transportation project, where it is, what is the nature of the project, what is the location, and what kind of development is happening, in the case of transportation project it determines the nature of trips to and fro from the site.

So, for example, if there is industry coming up then how many people would go and come, and what would be the nature of that movement, would be different compared to a mall which is there or relatively if there is a transportation hub itself? So, with the nature and the location of the project, the kind of trips to the site and from the site will vary a lot. So, that one needs to understand.

And when we see that when we are doing EIA for transportation itself, like transportation project itself, like we are doing EIA for road, we are doing EIA for the airport, or doing EIA for rail links and so on, that will require detailed assessments of all the environmental impact as the part of the legal requirement itself. So, any infrastructure project would also need that.

And apart from that, in all the EIA projects, wherever you do EIA even if they are non-transportation related areas, then also it has an impact on the transportation as we talked about any kind of urban development projects or for that matter, industry coming up or a mall coming up. So, irrespective, they are not transportation-related projects, but then that also, when you are doing EIA, will have an impact on transportation.

So, for both these natures of projects, whether it is a transportation project or any other kind of project, we will generate the need for transportation, and it will also impact transportation as well as it will have an environmental impact. These environmental impacts may include noise and vibration, air pollution, and also impact on biodiversity and then community severance, which means dividing the community or stress to the community.

Then there can be visual interference, there can be accidents and they can be, like it can create a good access for some but it might obstruct access to some other people. So, all these kinds of environmental impacts can happen.

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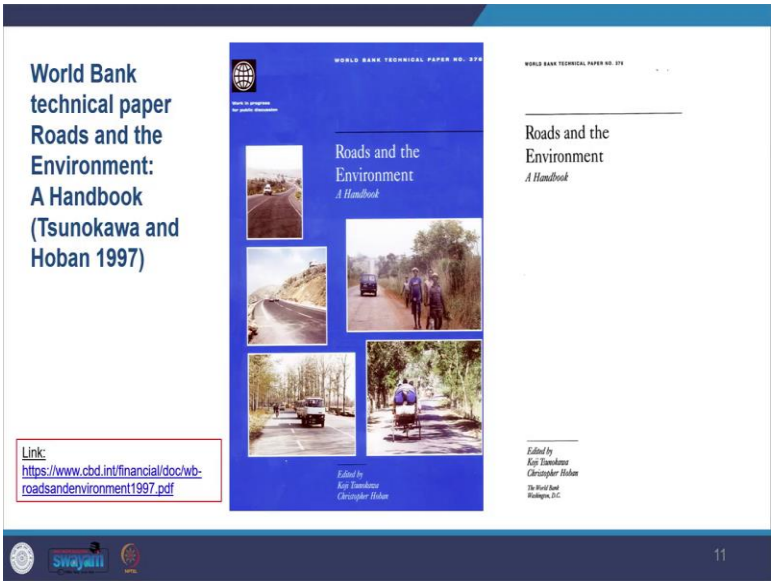

So, as we had also seen before when we studied the guidance and legal legislation aspect related to transportation, the World Bank provides you inputs. It has a handbook on Roads and the Environment which tells you how to undertake EIA concerning transportation projects, or how you handle the technical aspects of roads and related EIA.

So, that handbook provides you with all the methods to design and carry out how to undertake effective EIAs, and for the wide range of projects, it tells you. So, you can also look at that. So, I have given you the link to that particular handbook here. Looking at, how important transportation is, even if it is not a transportation project then also you will have an impact on transportation. So, in all kinds of EIA, you might have to undertake this particular aspect.

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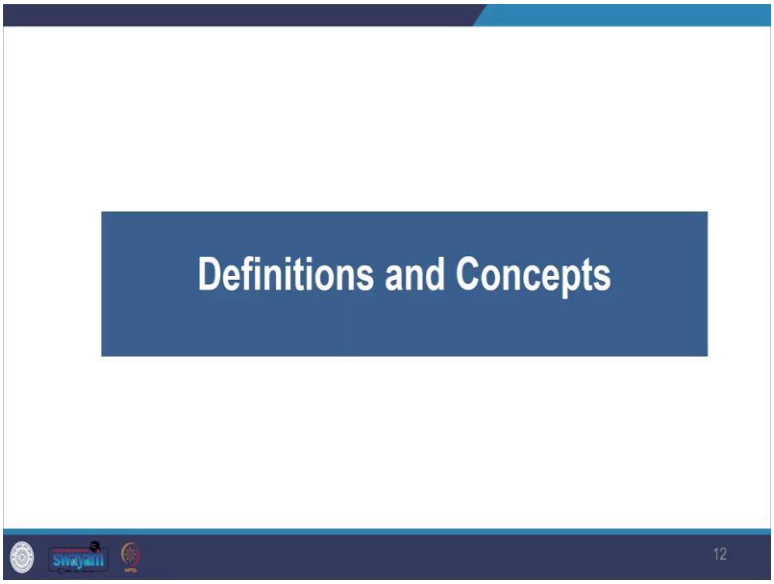

So, now moving on to looking at the definitions and concepts, related to EIA in the transportation domain. So, we see that there is like how do you model, when you try to understand transportation what is the demand for transportation.

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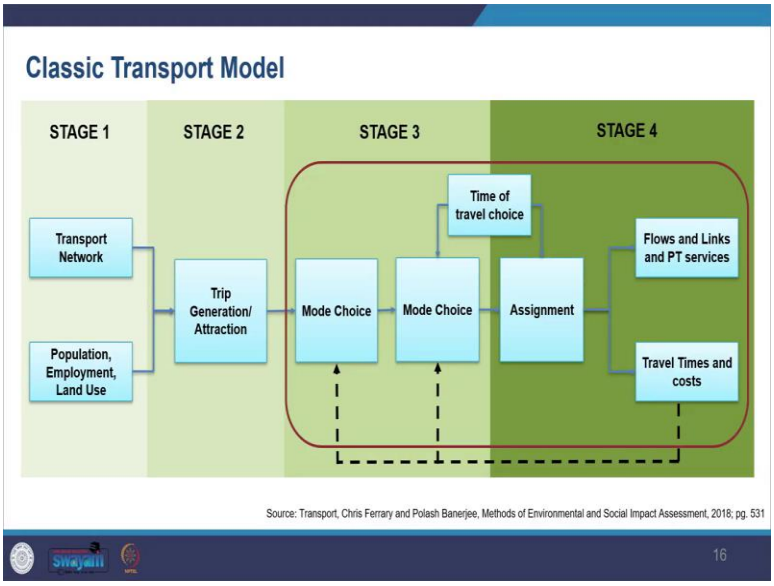

You have, like basically it has it is divided into the four-stage model, a very generalized model. That was developed decades ago and as you can see these four stages are in the first stage, you identify like how you are going to zone things, how the network system would be, how things will be connected, how one land use would be connected with the other land use and how the transportation network would be.

So, think about your cities and see how the commercial areas are, how the residential areas are, and how the bus service or any kind of public transportation, all those networks, work in your place, visualize that with the zoning and then the kind of network you have. So, that is the first stage of identifying those zoning and the network which are there. So, that is usually done in the transportation project.

The second stage is like collecting data on what kind of population is there, what kind of land use is there, and then how the traffic flows. You model that and you also estimate the total number of trips generated. So, how many trips are generated because of the population that is moving? And how it attracts each zone, which is all identified and modeled.

So, you see how the movement is between all kinds of land users, what is the population size and how people are moving. So, the important part here is that you look at the number of trips, and what is generated, that is what you look at in the second stage. And then you look at Stage 3, where you have a distribution of origins and destination like from where people are originating, when they are moving, and then where they are going.

So, origin and destination are other key aspects that you take into consideration while these input data would be required for you to understand the environmental aspect of this. And then further, in Stage 4, you assign trips by mode. Like by which mode people will go, they will go by walking, cycling, their private vehicles, or public transportation.

So, you look at then when people are moving, how many trips are there but then you assign them mode-wise. So, that is the standardized way of when you handle a transportation planning project. So, the output of such models, when you do that, you do undertake all these assessments, the key output of this model is that you provide estimates of traffic and or passenger flow on what kind of link you are working on.

So, that is what is, what comes out, what is the traffic, what will be the passenger flow. When you have this from the planning stage, then this becomes an input for your EIA, where you would now predict and estimate or model the environmental effects. So, that is what we do, and that is what we are going to see here. So, these are some basic, very basic concepts of transportation.

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So, looking at different modes of transportation, I did talk about different modes. So, in the picture, you can see the different modes which are there. So, once you have the trip ideas then you divide how many trips would be made by different modes, you can see here. So, when you talk about trips you also look at, like you have terms like new trips and pass-by trips.

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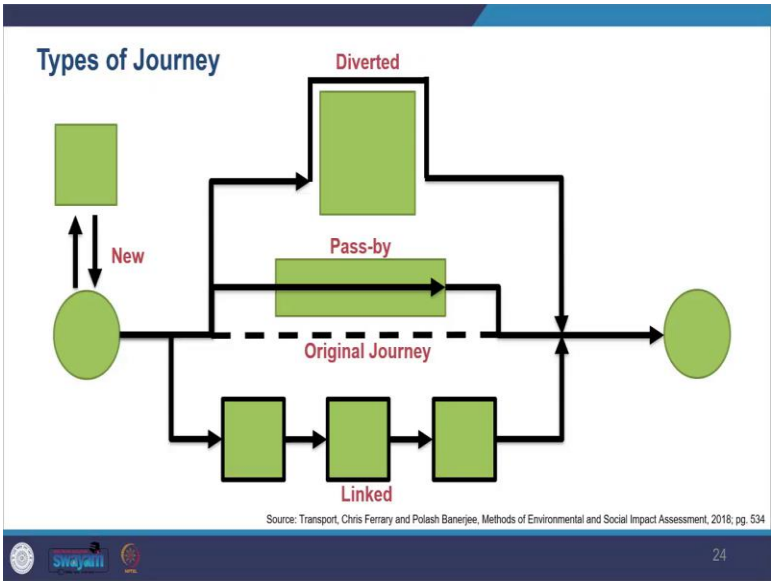

So, looking at these terms, new trips, what do we mean by new trips? So, new trips are those trips that did not occur anywhere else on the transportation network. So, you are generating new trips because of whatever development is happening in your place. You are creating people to move from one place to another. So, you are generating new trips in that particular network. So, that is called new trips.

And then another term is pass-by trips. So, pass-by trips are made as a part of another journey. So, there is another journey going on and with that, you make a pass-by trip. Like you have, you stop at a place, like when you are going from your work to your home then you stop, halt at certain places. So, that is called a pass-by trip. So, you need to understand the characteristics of how people are moving.

Then you also have diverted trips. So, diverted trips are also similar to pass-by trips, but if you look at it, it involves a longer diversion. So, people move away from their scheduled travel patterns for a longer time. And they spend more time, and so that is what you call a diverted trip.

Further, you also have linked trips which are trips with multiple destinations that you move from one stop to the other, then the other, and so on. So, you have linked trips. So, you have seen these terms here. Then you also look at the terms of transfer trips. So, this term means trips that are already being made and that would be transferred to the proposed development.

So, people who were already moving to that particular destination but because of the new development, would just, those trips would be moved to another destination. So, that is transferred trips. So, another term that you

need to know is peak traffic flow. So, this is one of the most significant parts when you understand the traffic problems. And this gives you, like what is the, at what time the traffic flow would be the highest.

So, usually, these are over the weekdays morning or evening, you must have realized when you have a lot of traffic jams and time, at a particular hour you have these. So, it can be when everybody is moving for work and school, or they are returning from work and school. So, that could be your peak hour. So, you need to understand that term as well. There is another term which is community severance.

So, this is defined as the phenomenon where you have a new road or a rail line that comes up or any kind of fast-moving traffic. So, that creates a barrier, and then that cuts the existing lines of travel or communication. So, maybe from one part to the other, you have people staying together but then your transportation whatever you are building newly, divides the same community. So, that is called community severance. So essentially, it practically divides the community into two. So, that was about some very, very, very selective definitions and concepts.

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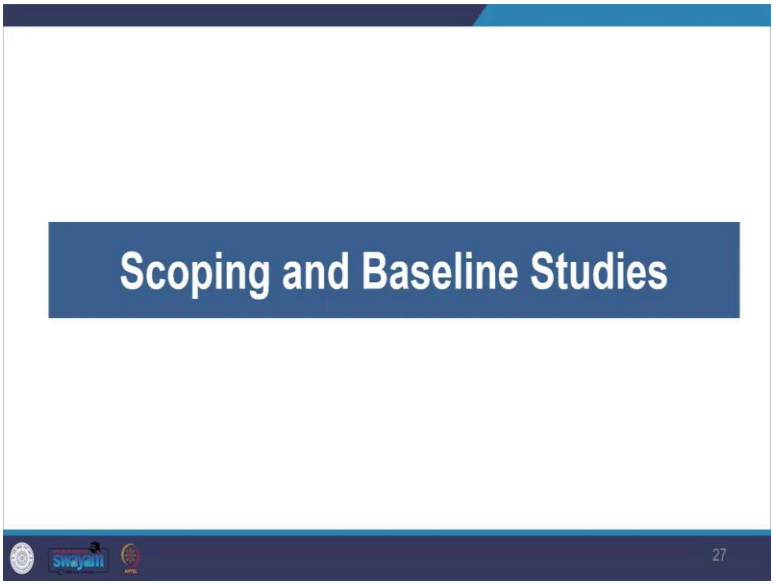

So, now moving on to scoping and baseline studies, so, in the transportation project when you undertake EIA, so while you are doing scoping you are deciding how much you need to study and you are also trying to assess what is the ground situation in the baseline study, what exactly you look at?

So, in the case of transportation, when you are dealing with transportation, you look at the planning context, like in which environment, which context, the urban, rural, where, what kind of situation is where the development of the proposal is happening, where the proposal is coming to come up.

And then what kind of highway trips, generation, and trip distribution would happen, so the terms which you got familiar with. And then the idea is that we did not end up making everything but we try to optimize all the resources we have. So, how do we use public transportation, are we using it to its complete capacity or not, and

then how we are taking care of the people who are walking, and cycling,? So, are we using to an optimal level, all the networks which are available to us?

So, another aspect is to look at sustainable travel and how we are promoting it. So, all these have to be taken care of, when you are deciding for scoping of your project. So, what assumptions you are making related to the project that you are coming up with, and then what are the safety issues involved, and what kind of mitigation do you plan to undertake in the project?

So, all that has to be, you see that mitigation all this comes at a very later stage of EIA but one needs to take care of it from, in practice from the beginning also because it will have implications in all other paths.

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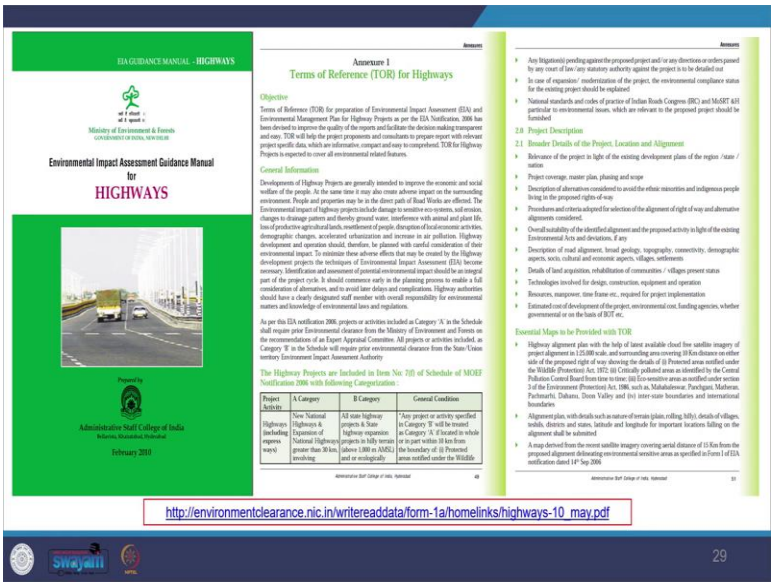

So, here, in this manual from MoEFCC, we, can see how we have terms of reference, TOR for highways. And within that, you have project descriptions where you tell why the project is relevant in terms of existing development plans. The 0.. 1, I am talking about here, and then, what the project will cover, what is like the initial planning area, plan, master plan, what it is telling, what is, how, what is the scope of it, what we are trying to achieve through that, and what kind of alternatives have been planned.

I have, we have looked at all these sustainability aspects, and we have made use of optimal, all, like we are optimizing all the resources. And then what procedure we have followed what is the suitability of what we are proposing in the case of a highway, what kind of alignment, and what we are choosing for how the highway be built? So, all that has to be discussed in the project description.

And then highways in particular deal with a lot of land acquisition, rehabilitation of the communities, and then what is their present status. So, all that needs to be described here is like, that all highway projects have to deal with land acquisition. And then, and which we have already seen, and then you also have all the technology

which will be involved in the design, construction, equipment and operation and the kind of manpower and then about the project, how do you plan to handle it.

So, all that has, is detailed out in case you can see this. I have also given you the link to this particular TOR. So, you can have a look at it. Then there is another case that we have been discussing in, all our EIA.

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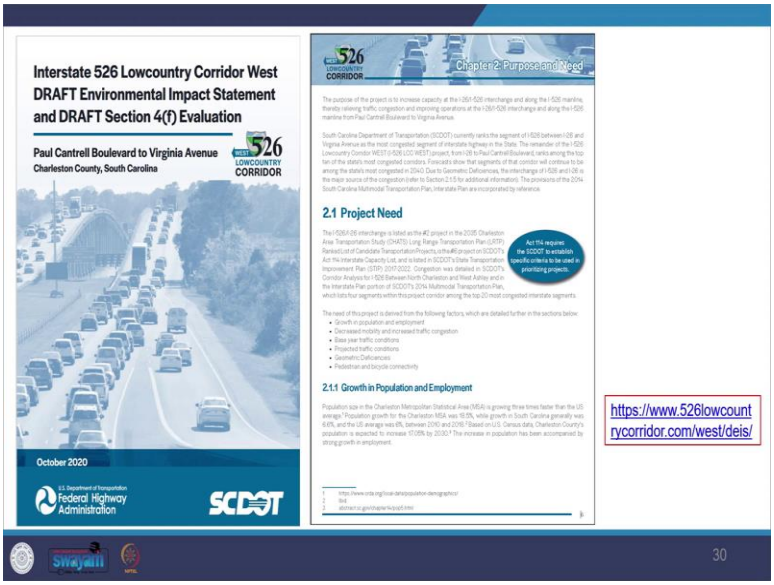

So, you see that you have Lowcountry Corridor West DRAFT. So, here also you can see at the center 2.1 project need and then they are also discussing 2.1.1 growth and population and employment. So, the flow chart which you saw and then how, what kind of information has to be provided. So, you can see in the example here.

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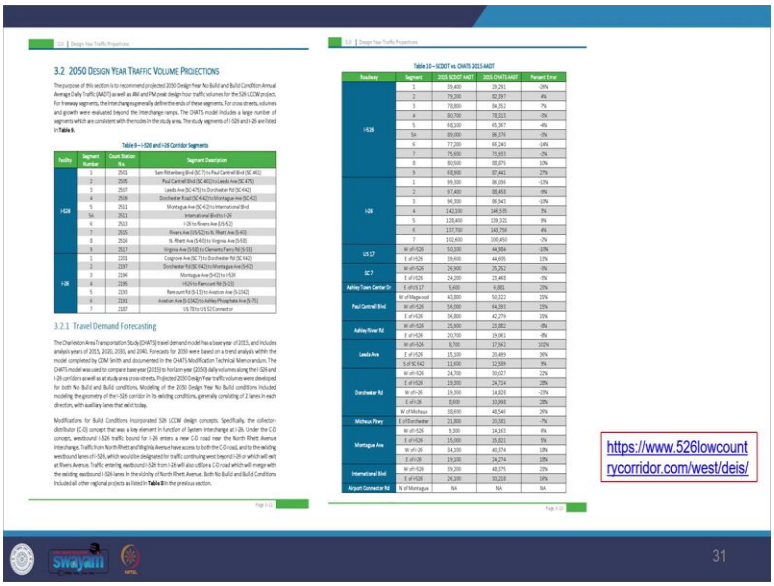

And then you can see how they are also looking at the traffic volume projection here, travel demand, forecasting. And then you can see in the table here how roadway-wise they are, in like for every segment, they

have projected the demand, travel demand. And they have used two methods, what you can see here, and then they have seen that which one projects, their travel demands better. So, you can see that here.

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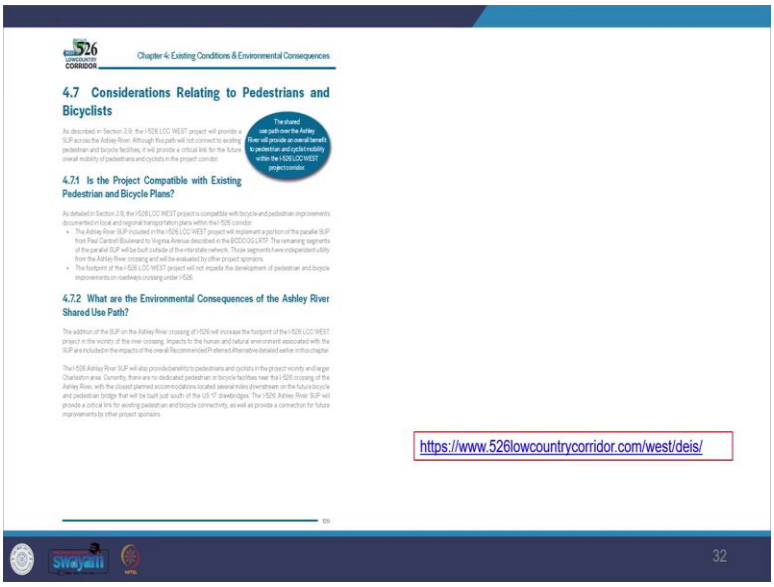

And then in the same they have, like, looking at the sustainability options like they are looking at the pedestrian and bicyclist, how the consideration has been made. And ensure that whatever project they are doing is required to address the needs of the people here.

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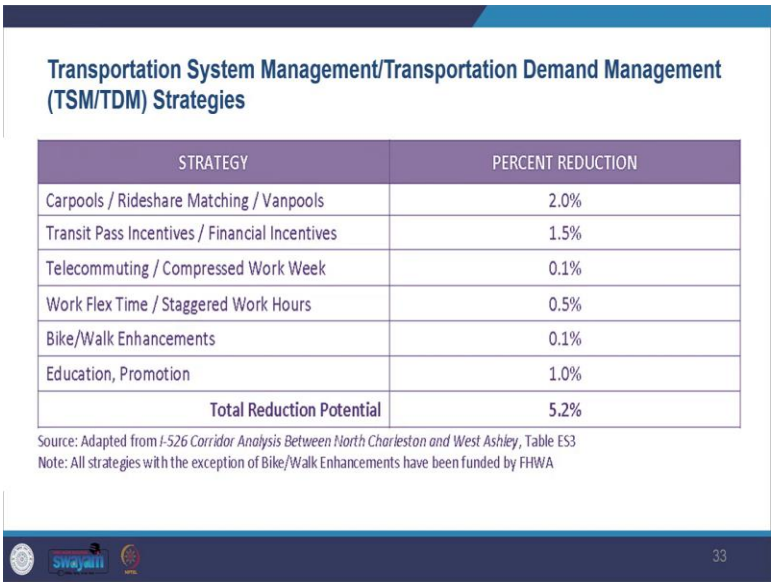

So, here you can see how they have also worked out the transportation system management, and transportation demand management. So, in this image, you can see how they have looked into all the aspects. So, you see what strategy they adopted to make it more sustainable, they have looked at the carpool, rideshare matching, and then the vanpool as well as shown here.

Then also the transit pass incentives, what kind of policies are there which they have looked into. Then telecommuting, compressed work week, like how the work pattern has been organized to handle the traffic. Then they look at the walk environment, and how they are enhancing those work environments. And then how they are working on educating and promoting the sustainable pattern here. So, you see those things here.

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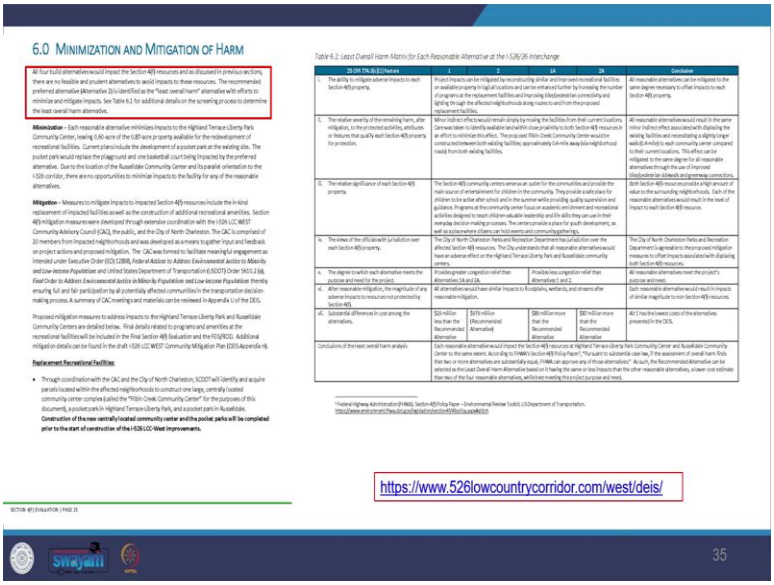

And wherever they have also tried to take the mitigation measures within the scope and implementation strategy. So, here you can see minimizing, minimization, and mitigation of harm. So, how they are undertaking that, you can see here from their report. I will be sharing this report with you. So, you can see that here. You can just note down the numbers. It is an extensive report, so just to understand the concept of it.

So, you can see in Table 6.1 taken from the report itself, so you can see how they have come up with the overall harm matrix, and the damage matrix for every alternative. So, they have done that. And then you can see how factor-wise they are looking at the ability to mitigate adverse impact to each section and so on. Then they compare it and then they arrive at conclusions. So, how they are also taking care of the minimization and mitigation of all the damage here? So, it has to be taken care of in the initial scoping level itself.

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So, here in the example you will see from the same report that they have, that no matter what kind of project is there, there is some kind of harm that happens. So, how they are going to undertake, how they are going to take care of that. So, the mitigation, how they are going to control that damage.

So, here you see that area, here from this particular case that which was getting, which had to be rehabilitated, relocated some of the infrastructure of theirs. So, they identified it. As you will see the Figure 6.1, they have prepared a draft that shows the proposed replacement of the community center.

So, how, which facility they are replacing, relocating? So, that is what they are proposing here. So, all these things have to be taken care of in the scoping stage itself. So, we also saw with the example. So, now look at how you undertake the transport baseline study. So, what all you need to undertake in that?

So, within the transportation baseline you see that you would be required to detail all the transportation details here and these things if you see that it varies from project to project, it varies from context to context. So, you have to take care of it, but then this is a very standardized, general aspect that I am talking about here.

So, you have to take care of the site layout. You have to, generally, the project description would have site layouts, it will have what kind of accesses are there, what kind of layout is there along all the modes, and then what the land use surrounding what kind of infrastructure, what kind of services, and what kind of character is there.

Further, you need to provide like what is the existing scenario with public transportation and at what frequency it is there, the current services are there. And what kind of public transport changes are expected to happen in that place. And then you need to also give the data on current traffic flows on all the links which are there and the junctions which are there.

So, all this detailed study has to be undertaken. And you also need to identify these study areas. So, what study area you will take, and then what are the critical links, interconnections, and junctions that you are going to study, you need to highlight those details here when you do the transportation baseline.

You also need to understand and you need to show and undertake accident records of, all the local roads. And you have to undertake it for like what is mentioned, you would like to take it for 3 to 5 years period. And then you have to also undertake qualitative and quantitative studies.

And you have to describe and present that characteristic of the nature of travel which is happening because of the kind of development which you are proposing here. And then what is also the parking facility in the area, and what kind of parking demand you would be generating as well as what parking strategy you are adopting in this case?

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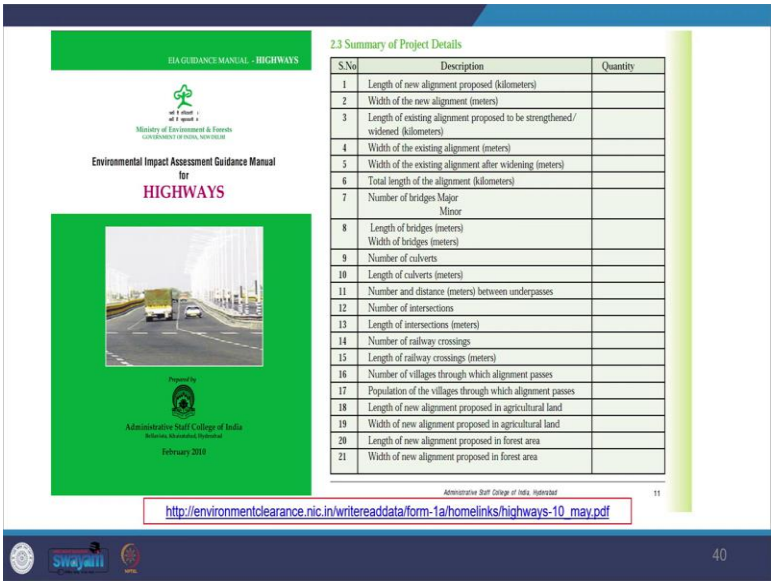

So, looking at again the Highway manual. So, here in the summary of the project details you can see serial numbers like 21, or what details you provide for the project, length of the new alignment, and width of the new alignment. And look at the details, the technical details which will be provided here with all kinds of elements which will be there in your project. So, you can see from another like Lowcountry Corridor, U.S. example as well.

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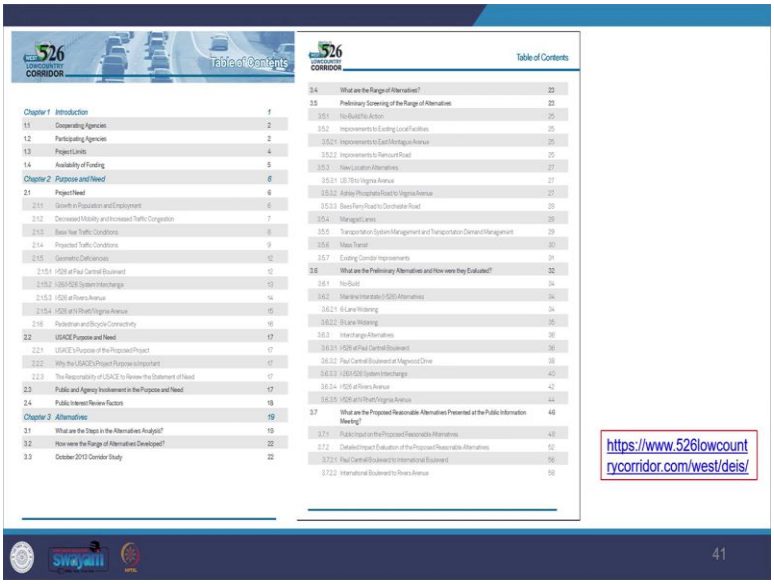

You can see how I have just snipped the table of contents. You can see how it has Chapter 2 which deals with the purpose and need. You can see Chapter 3 talks about the alternatives. Then you have like, how you are doing, screening the alternatives, and how you are evaluating the alternatives.

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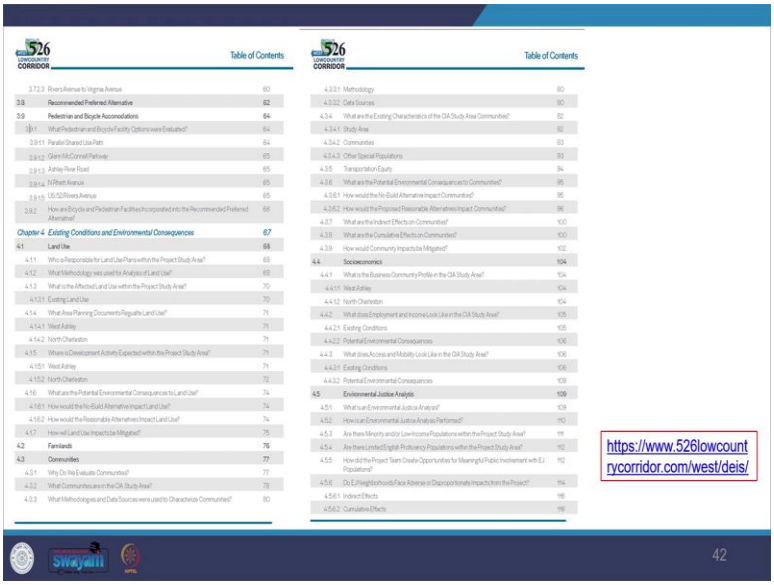

Then what kind of, chapter 4 deals with the baseline assessment? So, you see how intensively they are studying the land use, they are studying different like farmlands, community, the socio-economic aspect, the environmental justice analysis, they are taking.

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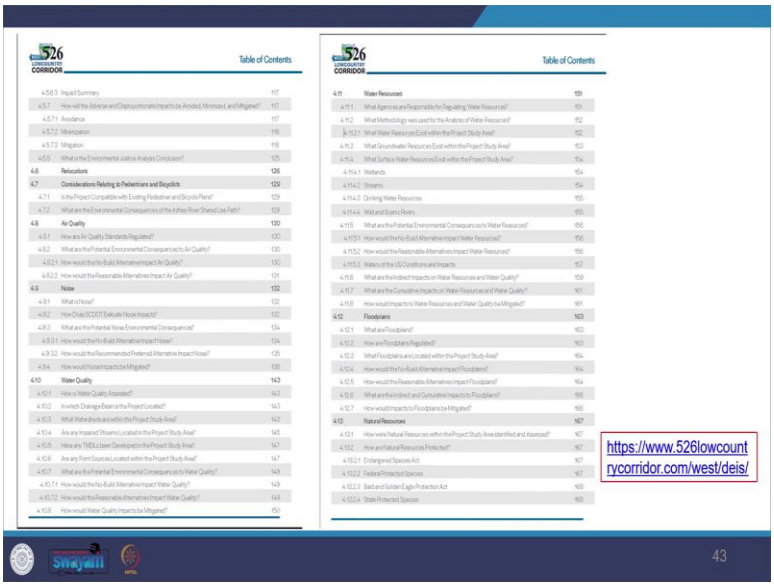

Then you see how the other, air quality, noise, water quality, water resource, flood plain, natural resource, or all this information which you have already seen in other forms of EIA, are the domain of EIA methods. So, that all would be covered here.

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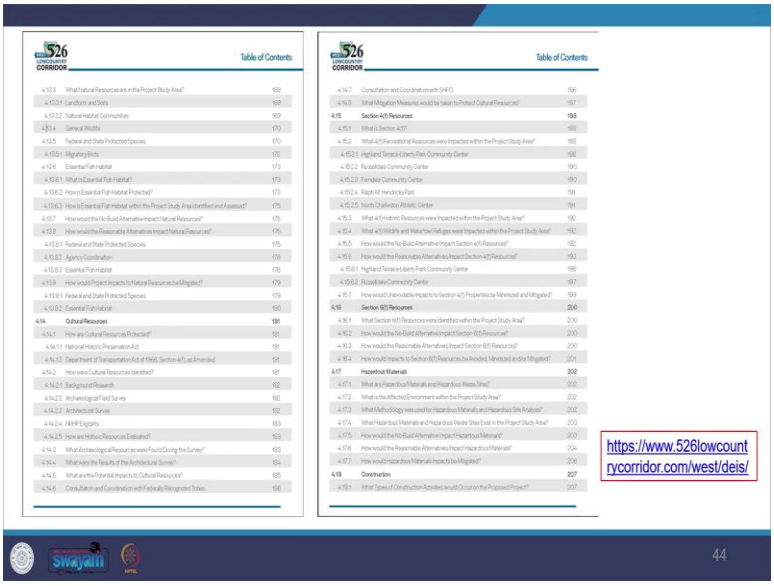

So, see the intensive details which are there.

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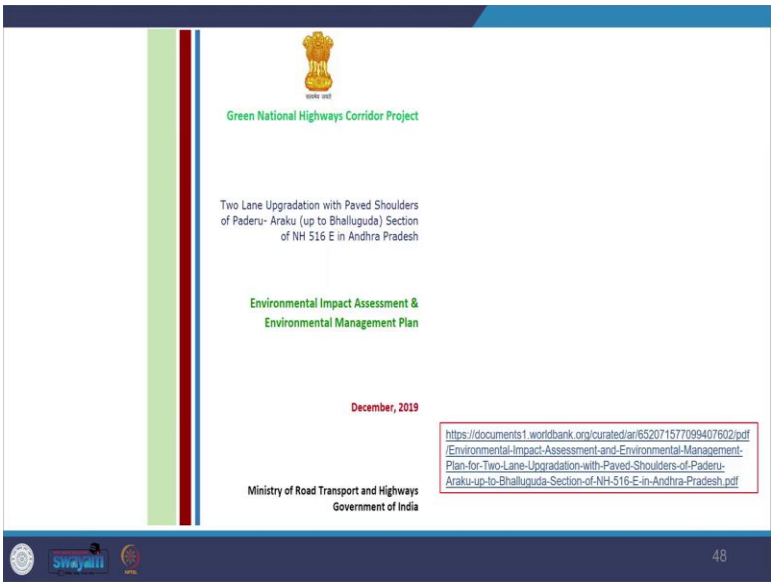

So here, I have taken another example. You can look at this Green National Highway Corridor project from Andhra Pradesh. You see the EIA report here. So, I have given you the link as well.

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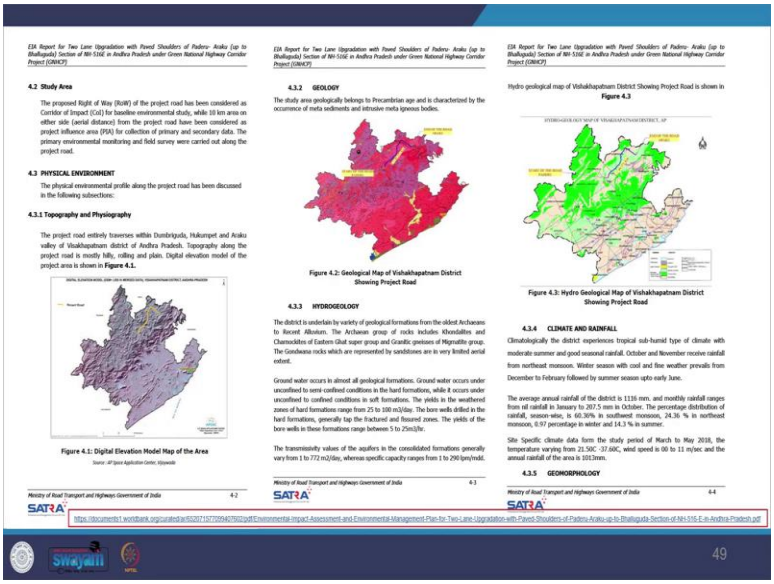

So, you see how they have provided all the details. You can see the 4.2 study area and the physical environments, you can see the geology, hydrology, climate, and rainfall, all those intensive details are provided.

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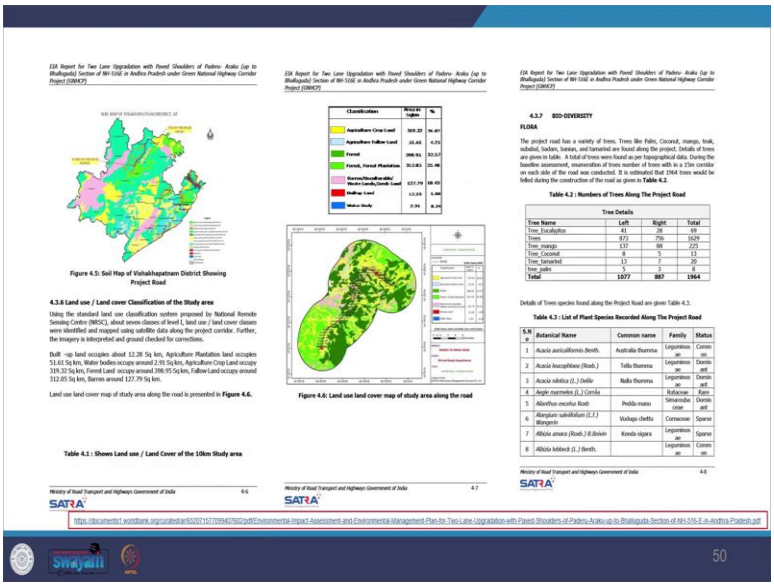

You can see the land use biodiversity which you have already studied about.

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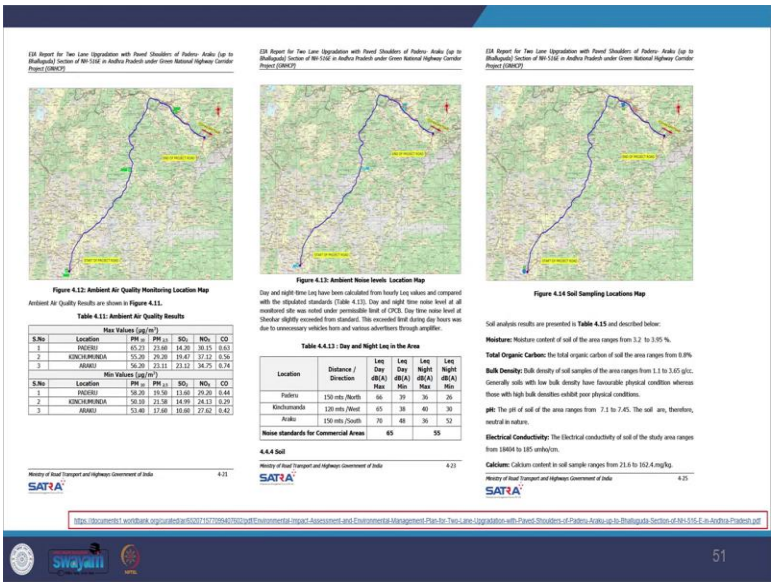

And then look at the ambient air quality, and ambient noise level in the center you can see. Then you can see the soil sampling. So, all those intensive detailed studies are here. So, yeah, I have given you the link also. So, you can download that and flip through the report.

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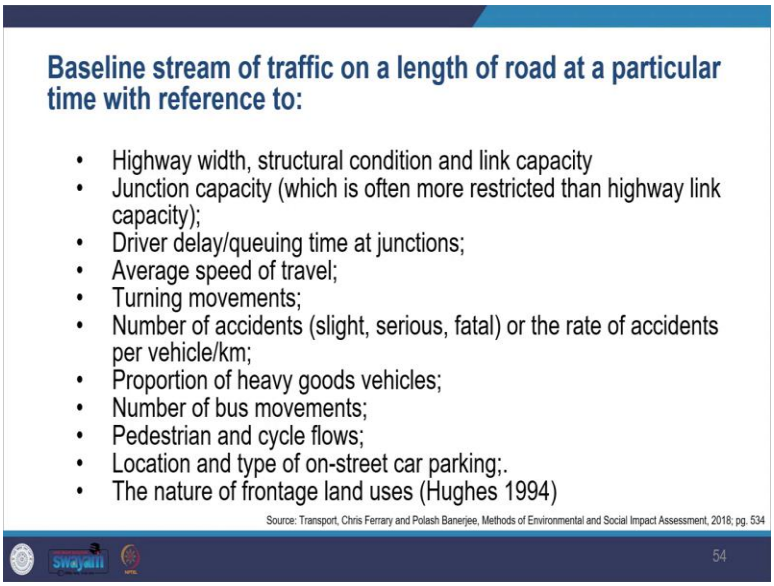

So, it is also required that you describe the baseline of this traffic on the entire stretch that you are working out. And you need to look at all these details, highway width and junctions, the delay which will happen, average speed, the turning movements, number of accidents, proportions of heavy goods vehicles, so all that has to be given. Plus you need to give the number of bus movements, pedestrian and cycle flow, location and types of on-street car parking, and the nature of frontage land uses.

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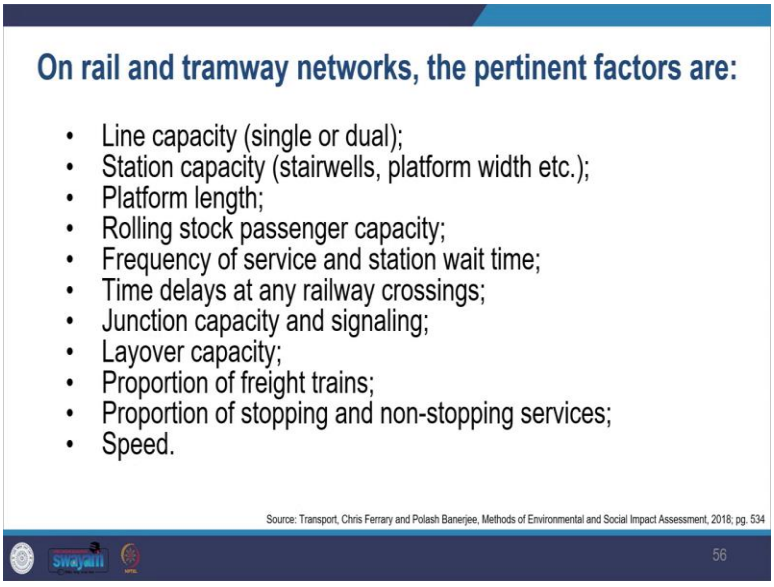

So, when you are doing the same for rail and tramway, then you need to provide this thing, aspects. So, you need to provide the line capacity, whether is it single or dual, then you have to tell about station capacity, and you might have to tell about the platform length. Then what kind of passenger movement is there, what kind of capacity is there, what frequency of service is there, what kind of delays are there, what is the junction capacity, signaling issues?

Then layover capacity, proportion of freight trains, how many freight trains come, how many passenger trains come, comparatively, what is the proportion, how many trains stop at a particular area, and then what is the speed. So, all that has to be taken care of when you deal with that kind of project.

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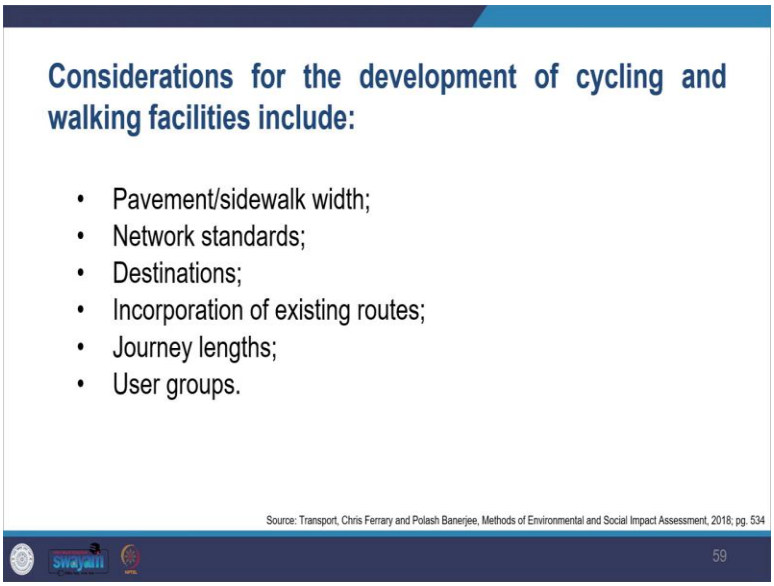

When you are dealing with cycling and walking facilities, then that time you have to deal with like what is the pavement, what is the sidewalk width, you need to look at the network standards, how well they are, all the cycling and walking are well connected, what is their destinations, and how these routes are linked, and then the, what is the journey they make, and what are the different user groups are there.

So, that all has to be described in your project depending on the nature of the project which you are doing. So, that is about the transportation baseline. So, given what nature of the transportation projects you have, you have to give all those kinds of details. So, now related to that, we will look at the environmental baseline.

So, you, all these projects will have an impact on like, it will have an impact on air quality, it will have an impact, it will have a greenhouse gas impact because there will be a lot of vehicles moving. And then there will be the impact on the community, economic impact, there will be a cultural impact, ecology impact. So, it will have an impact on several domains, what we see here.

And another like, you will have key health and safety issues, there will be since it is related to land acquisition, resettlements, you might also have issues, concerns about indigenous people, and how the land use, landscape, and townscape are going to change, noise and vibration, what will happen to the water resource or the soil type and geology in that area.

So, the environmental impact, the nature of environmental impact for transportation projects is very wide and very intensive. There will be certain direct impacts in the case of new transportation projects. There can be indirect impacts, which lead to changes in the transportation system. So, all these have to be covered, so when

you look at the environment. So, all these, we have already seen the range of it. So, I am going to not cover that aspect here, but that all has to be taken care of in the transportation aspect here.

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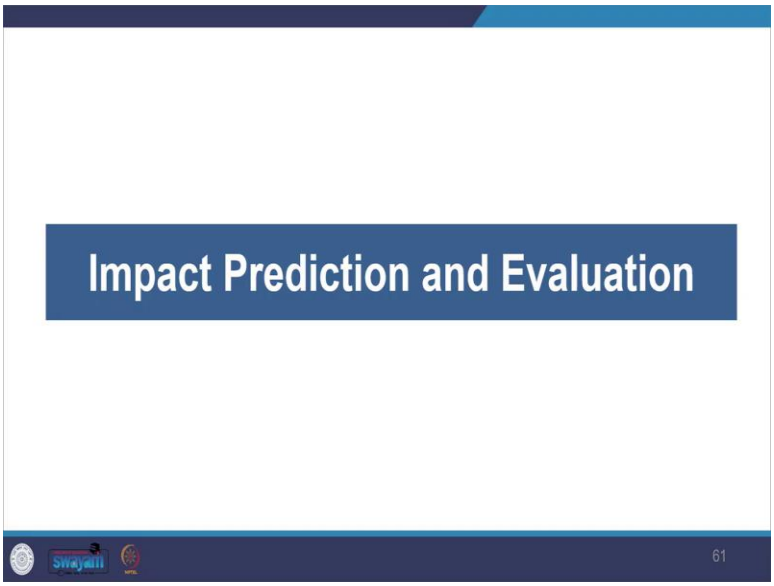

So, now looking at impact prediction and evaluation, how do you undertake that? While you are reviewing and assessing the transportation impact, you are required to have a lot of to and fro approach, iterative approach you need to take. And when you take that it helps you to improve like what kind of sustainable options are there, and what interventions you are taking.

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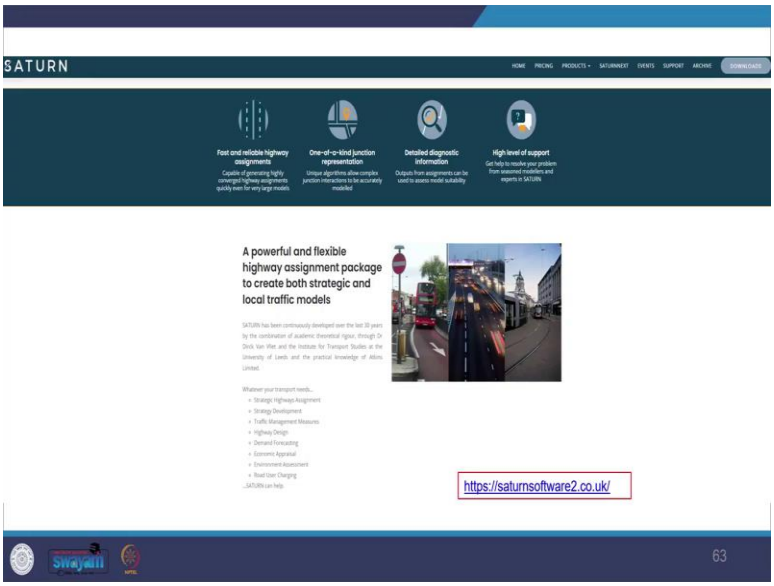

To take care of that, so you have a lot of software which is available which is used in this. So, you can see SATURN which is said to be a very powerful and flexible assessment package, and it helps users to create both strategies and use it for local traffic modeling here. And based on what kind of needs are there, it helps people to use it.

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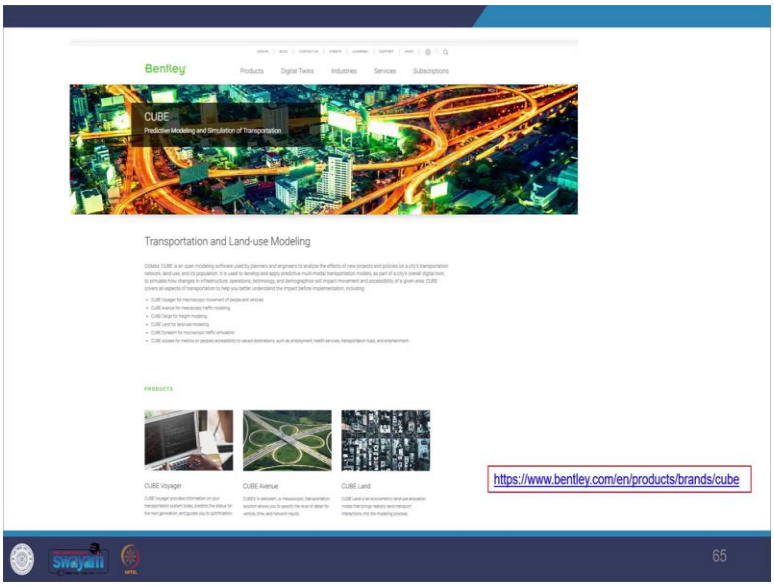

Then you also have City Labs which is like CUBE, the software name is CUBE. It is also an open modeling software that is used by planners, it is used by engineers, and they analyze what kind of effects the new project, the proposed project, or the policy change will have on the transportation network in the given context, and what impact it will have on the land use and what kind of impact it will have on the population.

So, this software is also there. This is used to develop and apply predictive multi-modal transportation models. So, you looked at different modes, so it helps you to have a multi-modal transportation model. So, you can see across what different modes it can, what is happening. So, it can create, and replicate the completes, like whichever part you are doing. So, it can create a digital twin. So, the CUBE can do that.

It can help you to stimulate the changes, what kind of changes will happen in infrastructure, operations, technology, and then what kind of change will happen in demographics because of the kind of accessibility change that will take place here. So, I have given you the link, you can see more about the software here.

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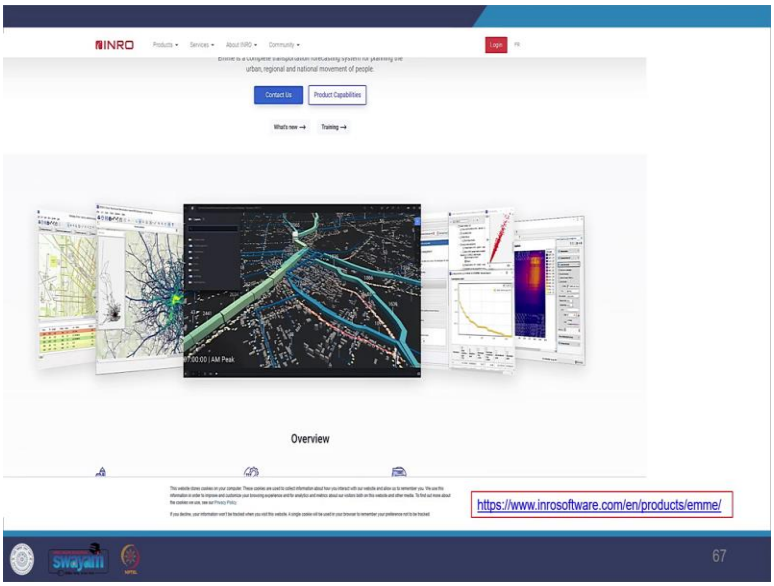

Then there is another software, you see INRO. It is so again transportation forecasting system for planning. And it is it can be used at the urban level, or regional level or it can be used at the national level as well to plan things. So, I have given you the links to this as well.

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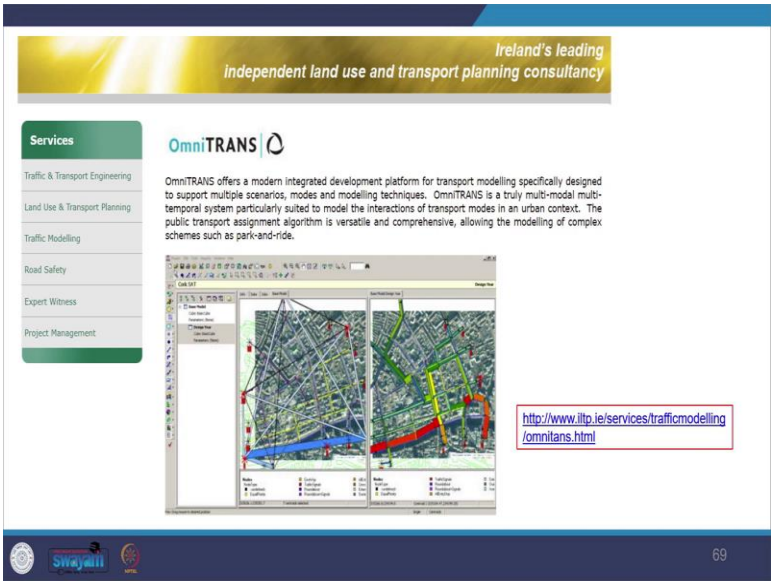

So, then another one is OmniTRANS. This again takes care of the multi-modal and multi-temporal transport modeling and it helps you to look at all static and dynamic assignments, like what will happen in case, you can see with the changes as well. So, it helps you to model even public transportation.

You can do how accessible the scenarios are, it helps you with planning, it helps you for designing, and also looking at the operations and traffic management part. So, this is said to be a very powerful tool. And it is it also comes with transportation data processing and analysis. So, I have given you a link to this as well.

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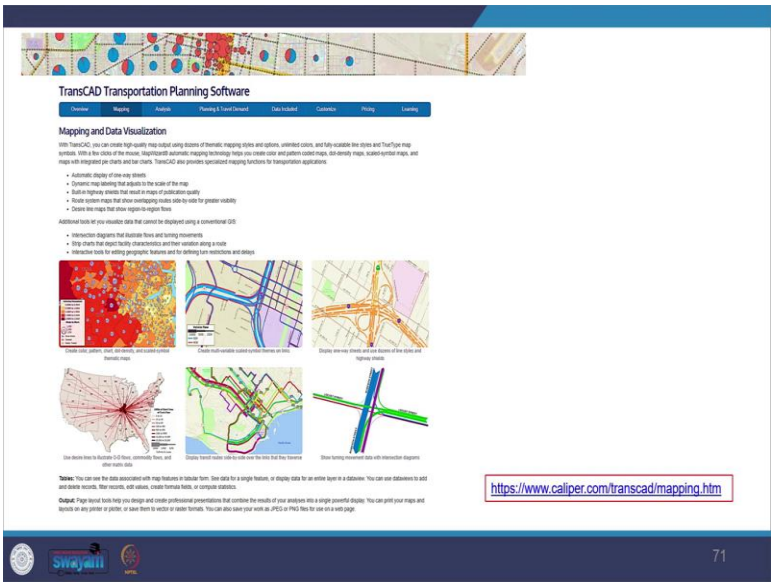

Then you also have TransCAD which is linked to a geographic information system that is designed, for the transportation professionals so they can store data, they can display, manage, and analyze various transportation data. So, this one combines GIS and transportation modeling. So, you have been hearing about GIS, so this one helps you to combine the both transportation aspect as well as GIS aspect. So, I have given you a link to that as well. So, you can see how it allows you for mapping and data visualization.

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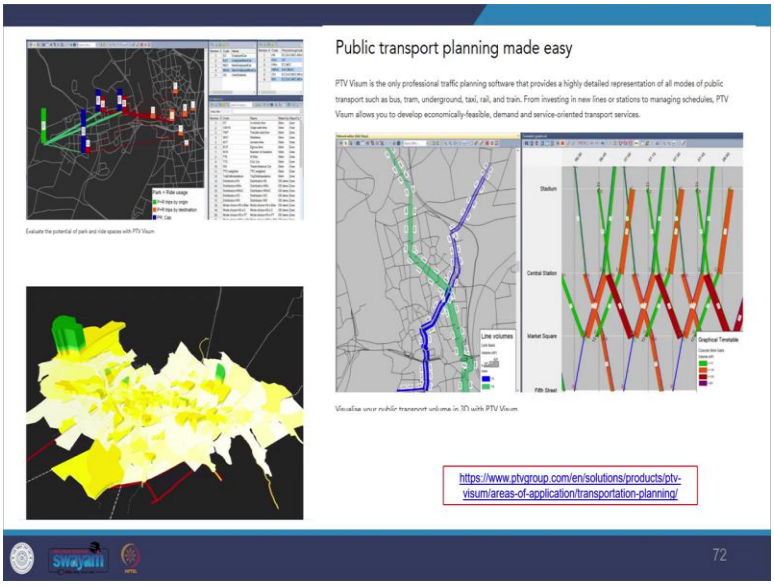

So, you can see different modes which are there, here.

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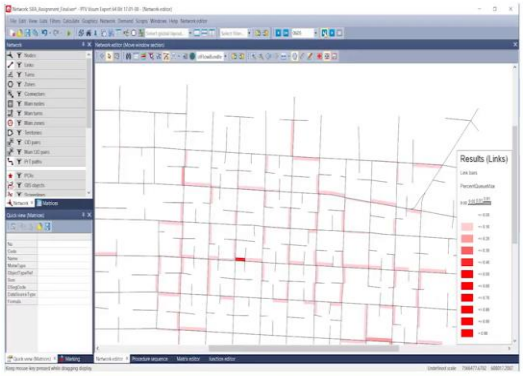

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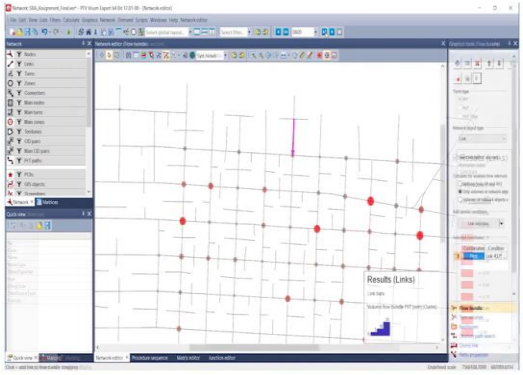

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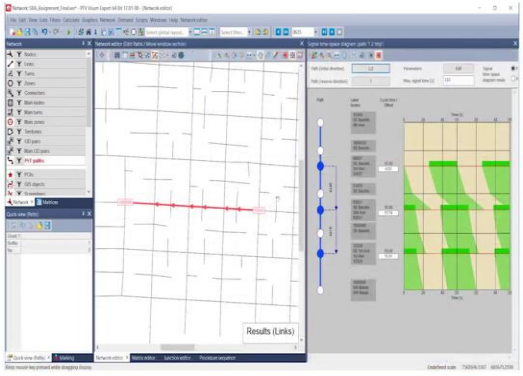

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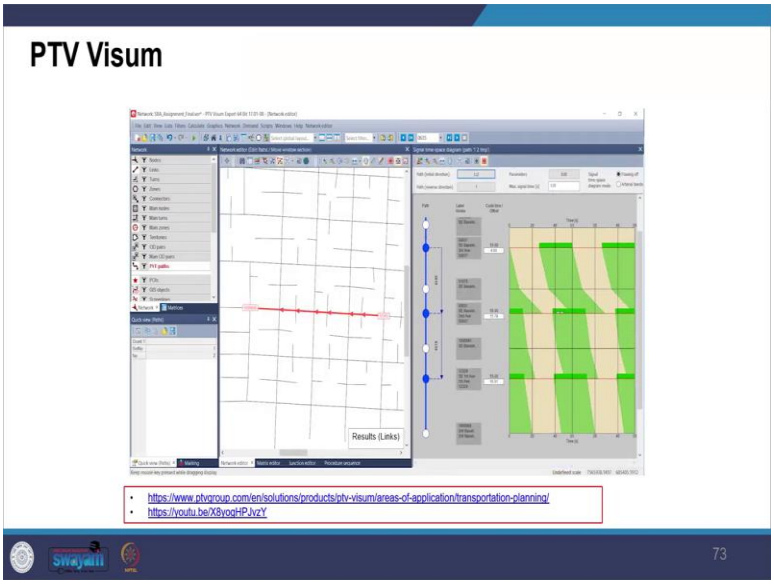

Then you can also see PTV Visum. So, this also, you can see how it is simulating the environments.

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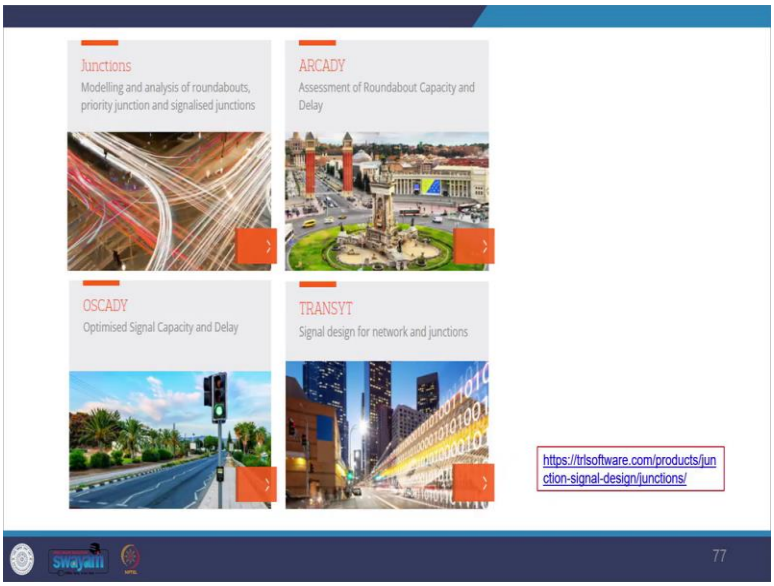

So, if you see the range of software which are available, they might not give you a very detailed study but they might give you a very overall understanding of the place. So, you also have software that can give you very specific junctions and streets analysis as well. So, you have nCap and PICADY software as well which can give you a very detailed to a very large-scale understanding here.

So, PICADY is used for predicting capacity, what kind of delay would happen in that and then what are the accident risks at any particular junction, intersections which you see. So, whichever is your important intersection, you can look at that. So, I have given you the link to this as well, so if you are interested you can go through that. So, this one works with, like, for all these modeling you give like what kind of trips like I talked about.

Input data has to be given, so person trips and then it would break down into transport mode and then you would predict the impact and what impact it would have on that. So, you also have like a lot of data sources which are there. So, you have a tricks database that helps you to analyze and build a scenario. So, you can, when you do not have all the data with you, then you can also refer to similar cases, and similar case studies and you can, from those study you can infer and transfer, like draw inferences from your case.

So, you also, based on these, with the data you predict, trips, and then you also check with what will happen with the project and what will happen without the project. Like, when you do nothing, so you need to check the scenarios with that, and you need to check the scenarios with when the development will happen. So, all that has to be taken care of within your baseline study.

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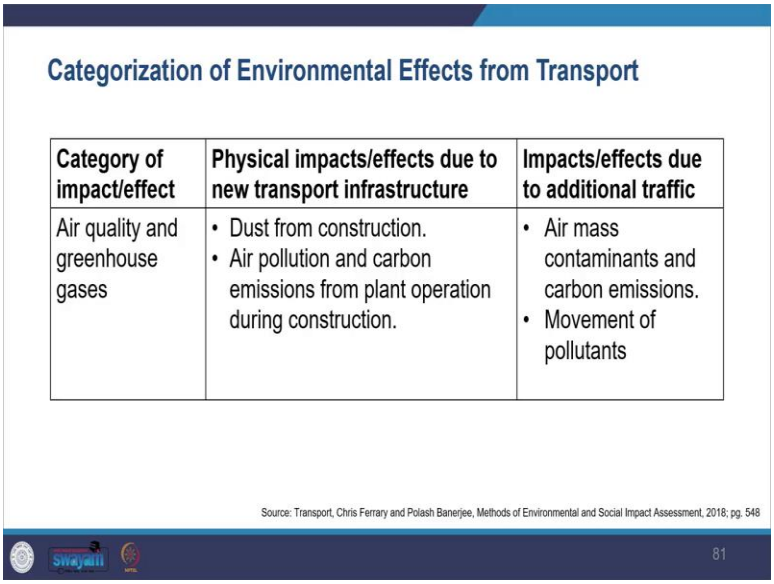

So, now we are going to look at the environmental impacts of the transportation projects. So, if you look at various categories of impact, you have like, air quality and greenhouse gases, so that we have already seen. Like, there could be dust from the construction, there could be air pollution, and carbon emissions. So, that can be there, and then in the case of transportation in particular, you look at the nitrogen dioxide, you look at the particulate matter.

And you might also look, choose what pollutant to look at depending on what kind of fuel is used most in your context. So, you look at the difference in roadside particulate matter and nitrogen dioxide with or without project and near the area. So, you make all those kinds of analysis and then you also look at what are the vulnerable groups especially those who will be prone to this respiratory illness.

It could be children, it could be the elderly which would be of particular concern. You may also keep in mind that your transportation project can also have an impact beyond the local situation. So, we have talked about this before also in initial lectures. So, it can go beyond the boundary also. So, that also needs to be taken care of. So, like, photochemical reactions of vehicle pollutants in the atmosphere.

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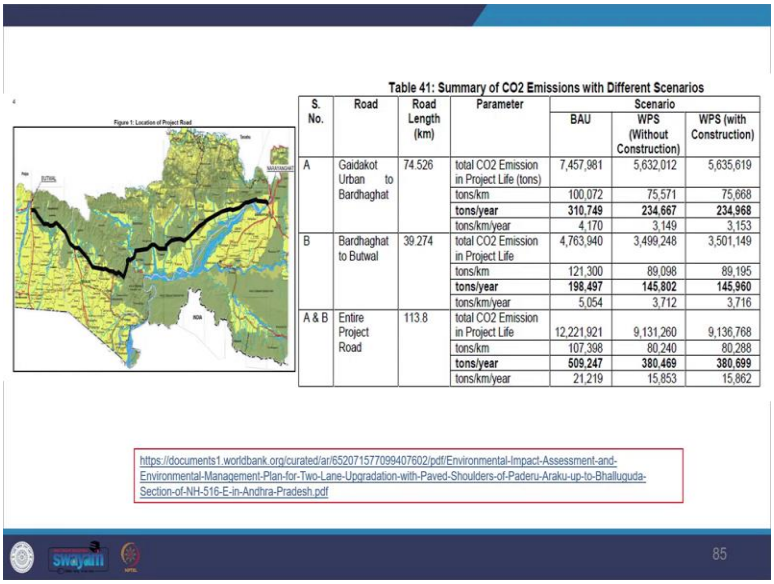

Taking this example from the EIA report from Nepal, you can see that here. So, how they are presenting that impact here? So, you can see the road component that they are discussing, the length of the road, and then what kind of parameters they are looking at and what that is the emissions with different scenarios. So, they are looking at this. I have given the link to this as well.

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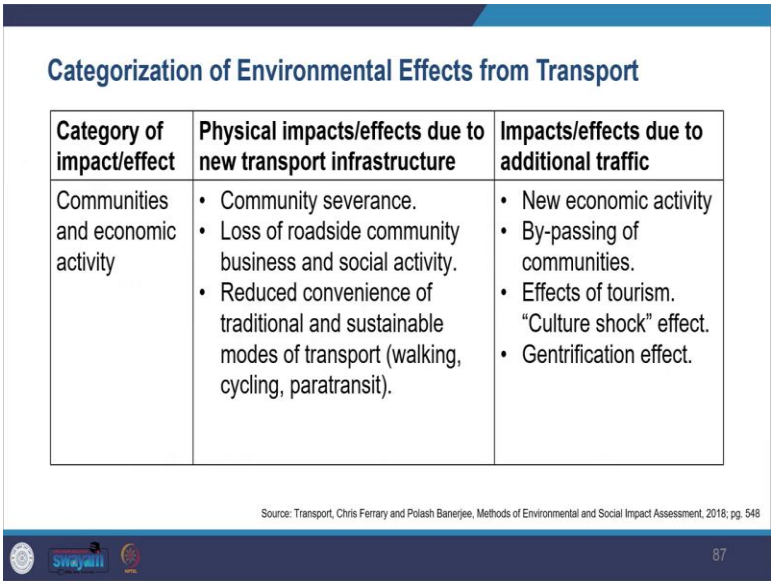

Then you have communities and economic activity. So, community severance can happen, and we tried to understand that concept. Then loss of roadside community, business, and social activity, reduces the convenience of traditional and sustainable modes of transport. So, that can happen. And then what the social interaction of people can reduce.

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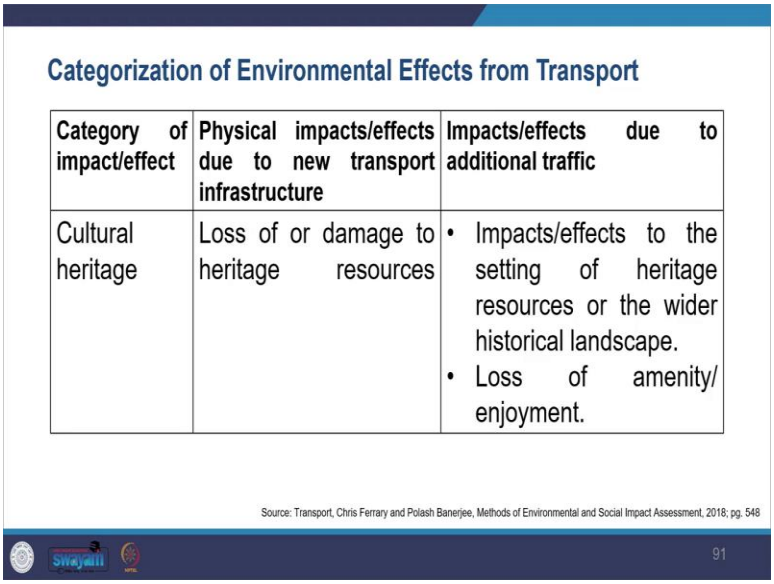

And then it can also influence the cultural heritage, there can be loss and damage to heritage resources which can happen.

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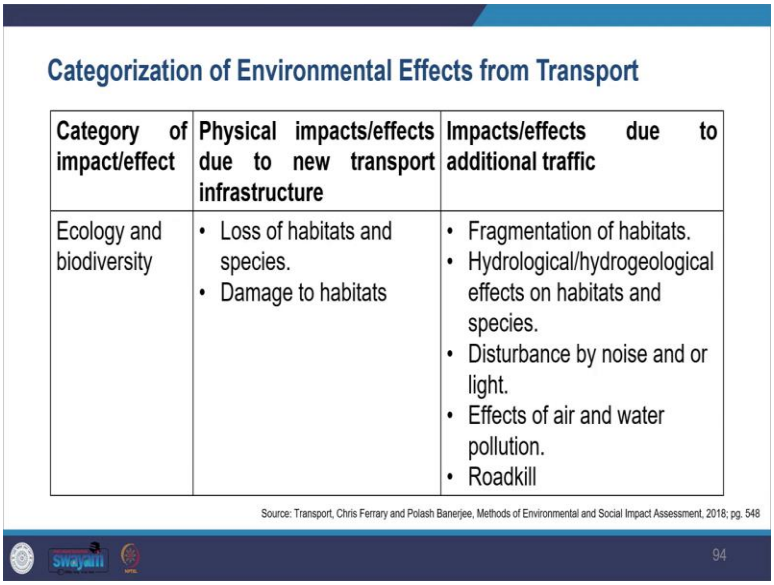

And then you can also have ecological and biodiversity loss.

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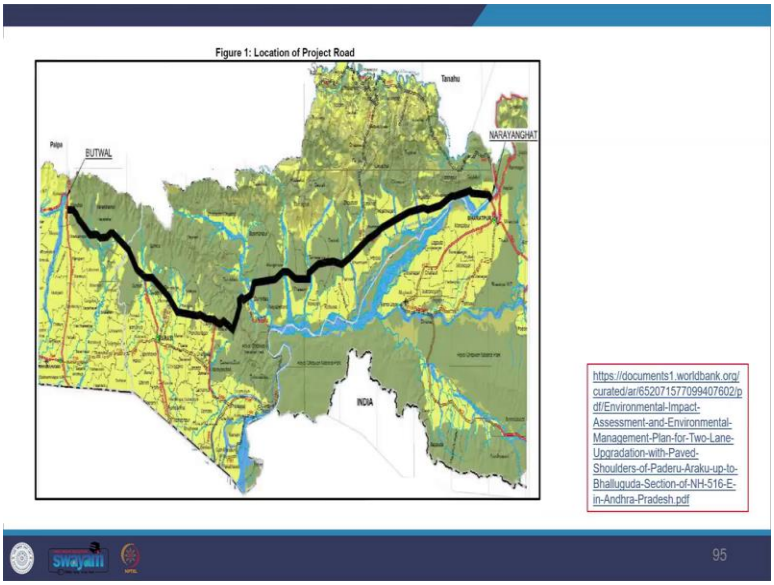

And in this example again, from Nepal, you can see how they are analyzing all that project detail.

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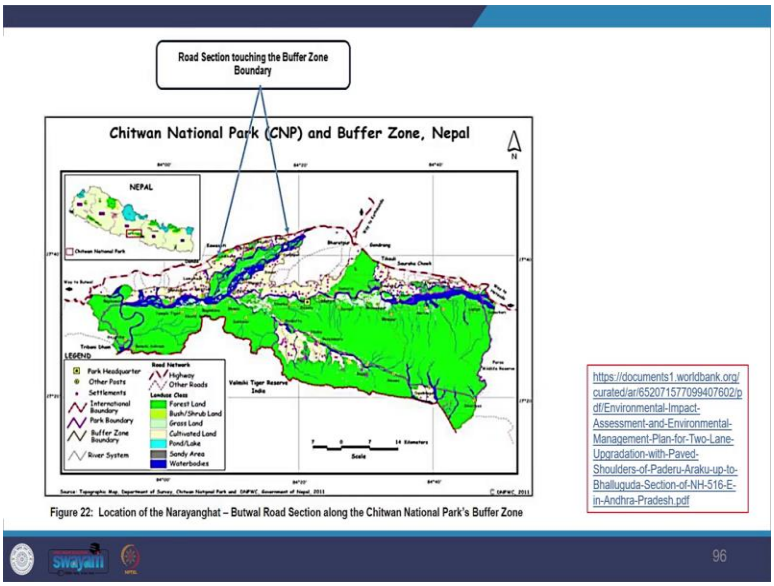

Like what kind of biodiversity it is going to influence.

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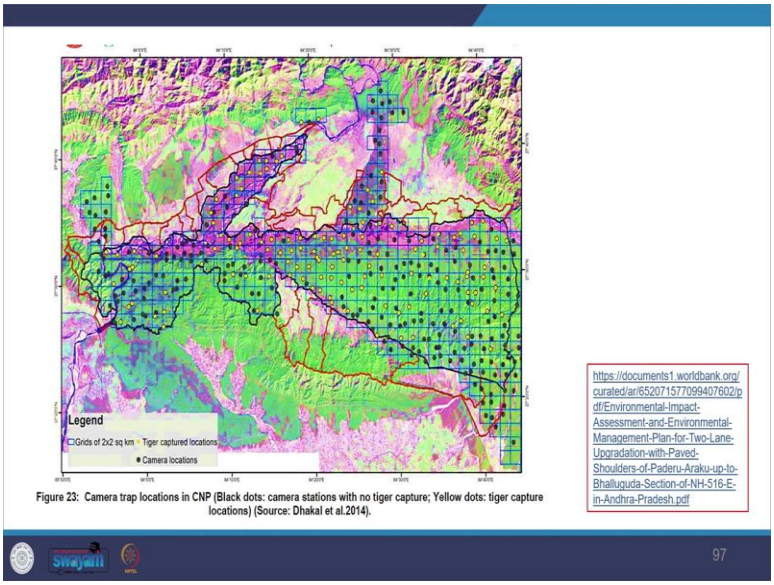

Figure 23: Camera trap locations in CNP (Black dots: camera stations with no tiger capture; Yellow dots: tiger capture locations) (Source: Dhakal et al.2014).

And see the intensive grid system they have created and how they are documenting all kinds of different, so for the linear project how they are going to do the impact assessment.

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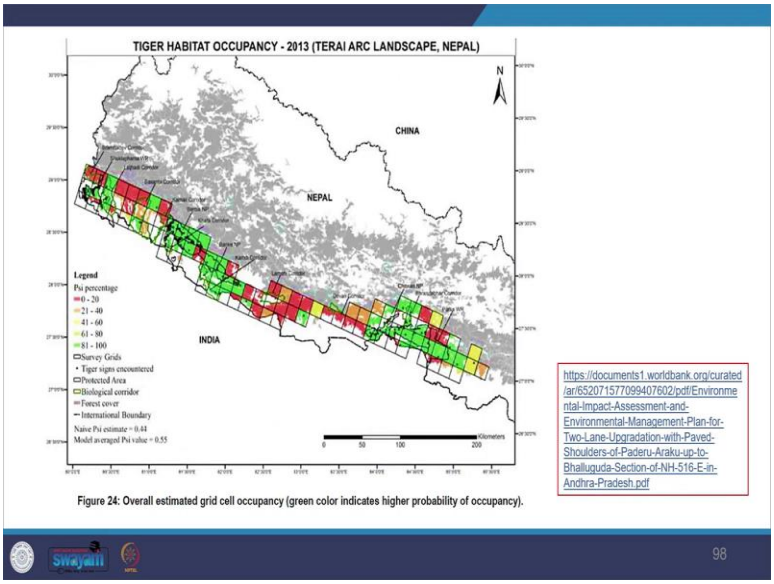

Figure 24: Overall estimated grid cell occupancy (green color indicates higher probability of occupancy).

So, you look at tiger habitat occupancy which they are looking through the grid system here.

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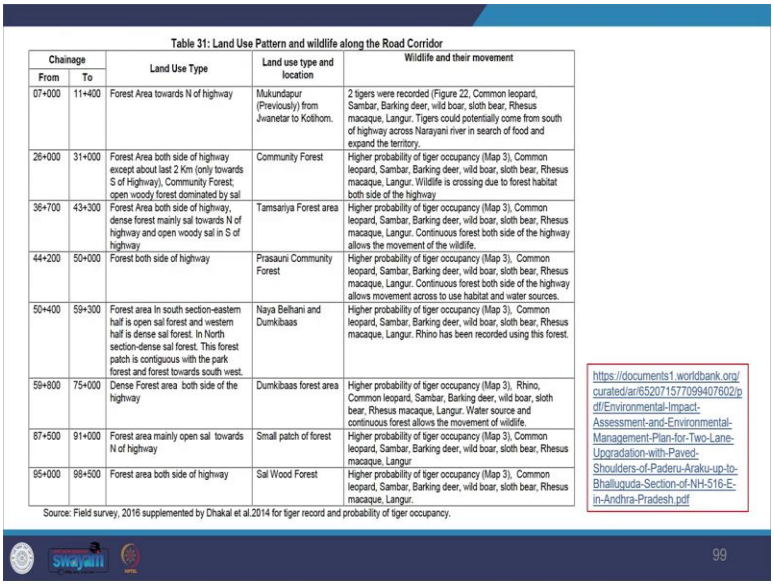

Table 31: Land Use Pattern and wildlife along the Road Corridor

Chainage		Land Use Type	Land use type and location	Wildlife and their movement
From	To			
07+000	11+400	Forest Area towards N of highway	Mukundapur (Previously) from Jwanetar to Kotihom.	2 tigers were recorded (Figure 22, Common leopard, Sambar, Barking deer, wild boar, sloth bear, Rhesus macaque, Langur. Tigers could potentially come from south of highway across Narayani river in search of food and expand the territory.
26+000	31+000	Forest Area both side of highway except about last 2 Km (only towards S of Highway), Community Forest; open woody forest dominated by sal	Community Forest	Higher probability of tiger occupancy (Map 3), Common leopard, Sambar, Barking deer, wild boar, sloth bear, Rhesus macaque, Langur. Wildlife is crossing due to forest habitat both side of the highway
36+700	43+300	Forest Area both side of highway, dense forest mainly sal towards N of highway and open woody sal in S of highway	Tamsariya Forest area	Higher probability of tiger occupancy (Map 3), Common leopard, Sambar, Barking deer, wild boar, sloth bear, Rhesus macaque, Langur. Continuous forest both side of the highway allows the movement of the wildlife.
44+200	50+000	Forest both side of highway	Prasauni Community Forest	Higher probability of tiger occupancy (Map 3), Common leopard, Sambar, Barking deer, wild boar, sloth bear, Rhesus macaque, Langur. Continuous forest both side of the highway allows movement across to use habitat and water sources.
50+400	59+300	Forest area In south section-eastern half is open sal forest and western half is dense sal forest. In North section-dense sal forest. This forest patch is contiguous with the park forest and forest towards south west.	Naya Belhani and Dumkibaas	Higher probability of tiger occupancy (Map 3), Common leopard, Sambar, Barking deer, wild boar, sloth bear, Rhesus macaque, Langur. Rhino has been recorded using this forest.
59+800	75+000	Dense Forest area both side of the highway	Dumkibaas forest area	Higher probability of tiger occupancy (Map 3), Rhino, Common leopard, Sambar, Barking deer, wild boar, sloth bear, Rhesus macaque, Langur. Water source and continuous forest allows the movement of wildlife.
87+500	91+000	Forest area mainly open sal towards N of highway	Small patch of forest	Higher probability of tiger occupancy (Map 3), Common leopard, Sambar, Barking deer, wild boar, sloth bear, Rhesus macaque, Langur
95+000	98+500	Forest area both side of highway	Sal Wood Forest	Higher probability of tiger occupancy (Map 3), Common leopard, Sambar, Barking deer, wild boar, sloth bear, Rhesus macaque, Langur.

Source: Field survey, 2016 supplemented by Dhakal et al.2014 for tiger record and probability of tiger occupancy.

https://documents1.worldbank.org/curated/ar/652071577099407602/pdf/Environmental-Impact-Assessment-and-Environmental-Management-Plan-for-Two-Lane-Upgradation-with-Paved-Shoulders-of-Paderu-Araku-up-to-Bhalluguda-Section-of-NH-516-E-in-Andhra-Pradesh.pdf

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And then how they are also looking at the land use pattern and wildlife along the road corridor here. So, we have already seen what kind of methods have to be followed for this.

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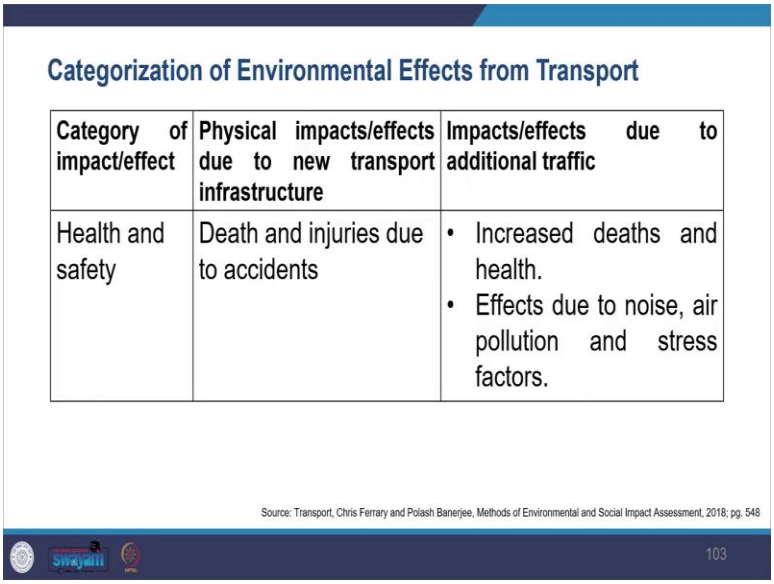

Categorization of Environmental Effects from Transport

Category of impact/effect	Physical impacts/effects due to new transport infrastructure	Impacts/effects due to additional traffic
Health and safety	Death and injuries due to accidents	• Increased deaths and health. • Effects due to noise, air pollution and stress factors.

Source: Transport, Chris Ferrary and Polash Banerjee, Methods of Environmental and Social Impact Assessment, 2018; pg. 548

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And then you also need to look at health and safety. So, there can be a lot of deaths and injuries due to accidents because of this. So, it can directly impact people through increased deaths and injuries due to accidents. You can have transmission disease because of people traveling, including sexually transmitted disease and so on. It can also lead to contamination of the local water supply, and then, air pollution can happen and that can lead to health issues. And then there can also be noise pollution that can also lead to health issues.

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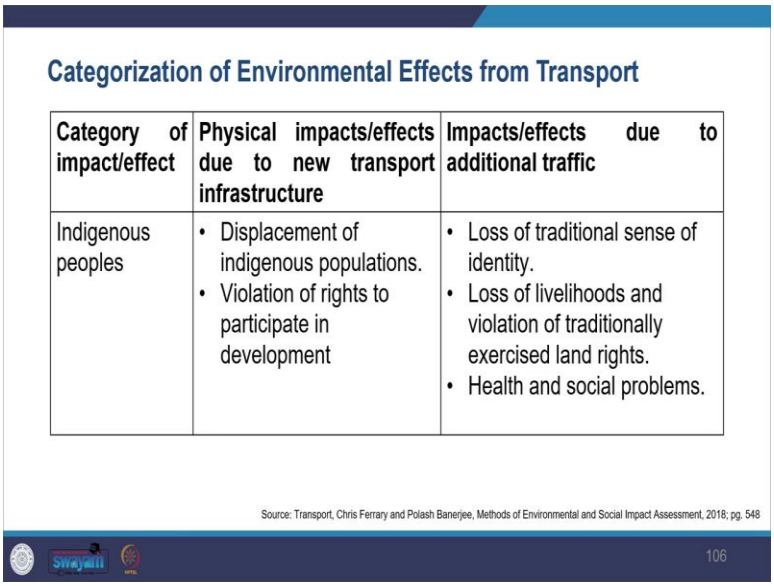

Then the concern about indigenous people, and displacement of the indigenous population can happen. Your project can also lead to a violation of the rights to participate in the development. So, all that can happen here. So, it is said that transportation infrastructure increases accessibility and movement, and that can lead to a lot of changes in the lifestyle of the indigenous people. And often it makes it difficult for them to maintain their tradition and custom. And then it also exposes them to a lot of external pressure.

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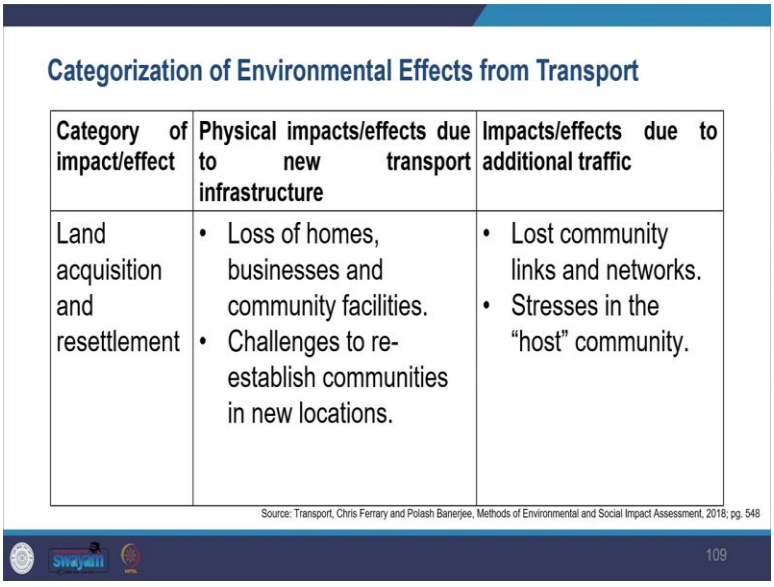

And then this unavoidable case of land acquisition and resettlement. So, people lose homes, businesses, and facilities. And so one has to undertake an intensive process.

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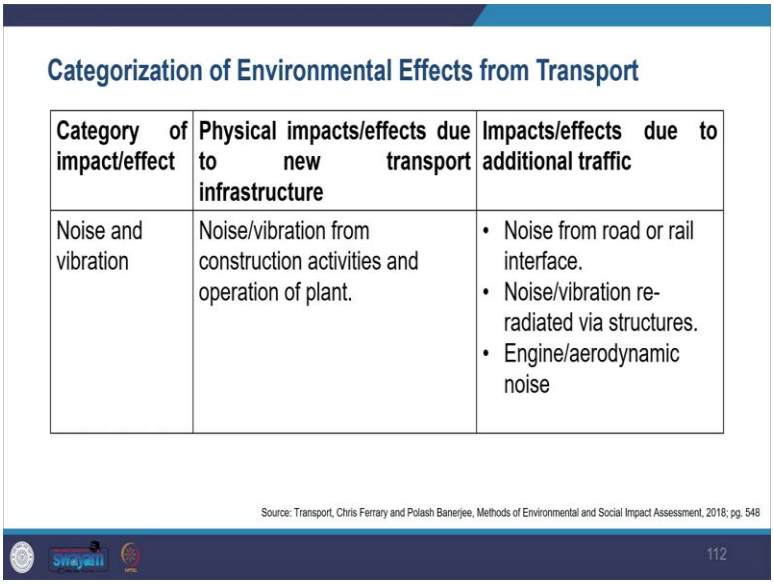

Then you have noise and vibration, that has like, this also we have already looked at. So, you have models to undertake it. So, you see that you have models for noise or modeling estimation from road traffic. So, you have FHWA's Mena 2, then you will have Optima, then you have MicroBrute, so that all those lists are given to you. So, these all are available for noise modeling from road traffic. So, you can see this.

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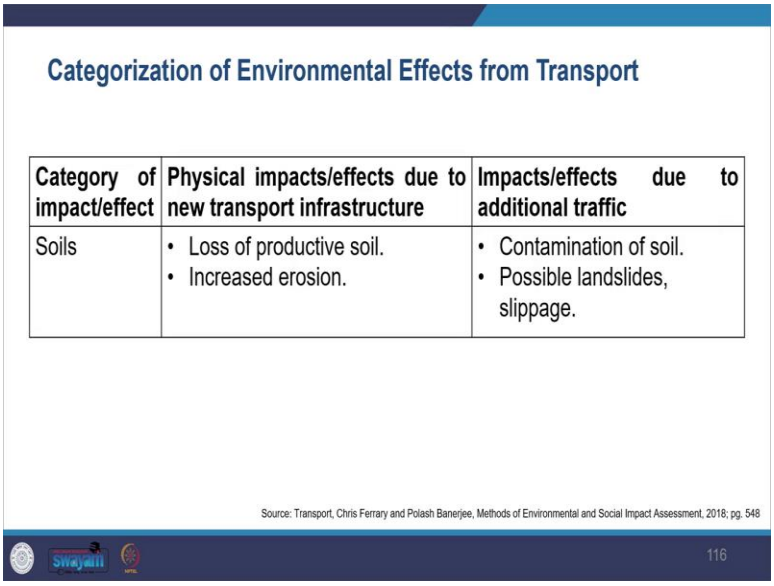

Then you also have an impact on soil. Because of the compaction and increased erosion the soil character changes.

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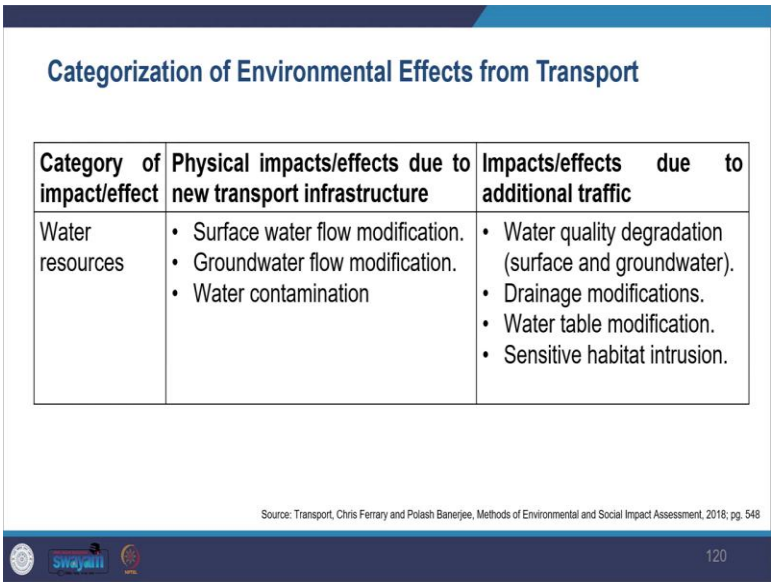

You have water resource issues. So, if you look at the key issue that happens because of the transportation infrastructure, you have a loss of productive soil. You see erosion increases because the gradient changes, soil contamination also happens because of the drainage runoff containing metals and rubber, more and more exposure happens, and then there is also a cumulative effect.

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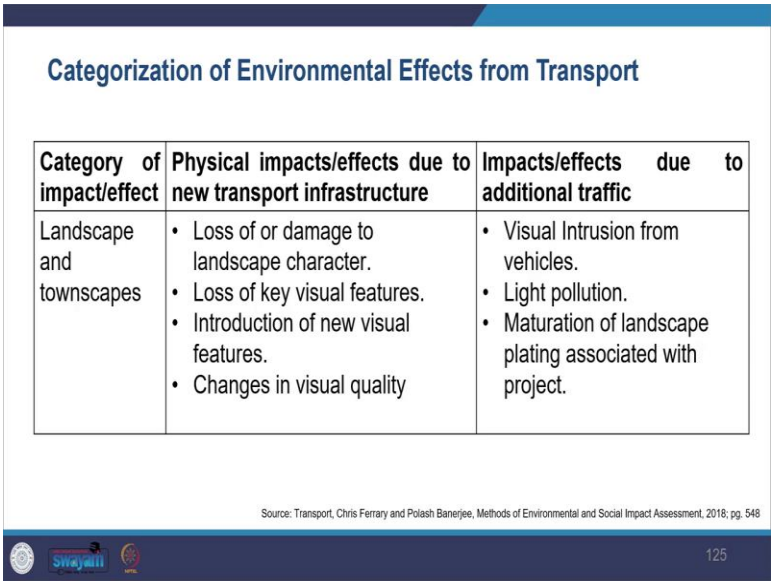

So, there would be also a change in the landscape and townscape. So, we are also going to see how one undertakes landscape impact assessments. So, that is going to change the landscape character, and there can be a loss of key visual features. And then there can be new visual features which can also come here. So, that can also happen here.

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So, then you have the reporting components where you need to take care of it. So, here you see the summary of impact, so all these projects are present in this summary, though the style varies, how they do it.

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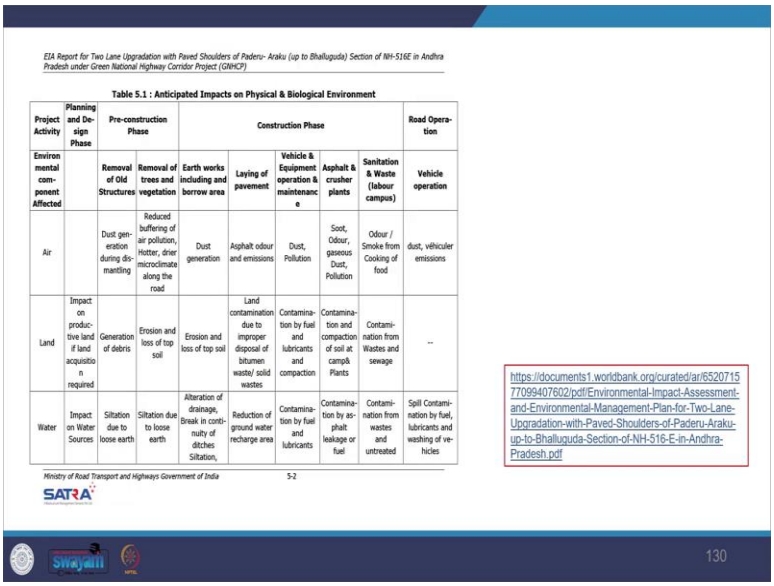

So, here again, you can see how anticipated impact on the physical and biological environment from this project. So, you can see here from the Andhra Pradesh project, you can see how they are summarizing it with the air, land water. Likewise, you can see all the areas. You can see air, land, water.

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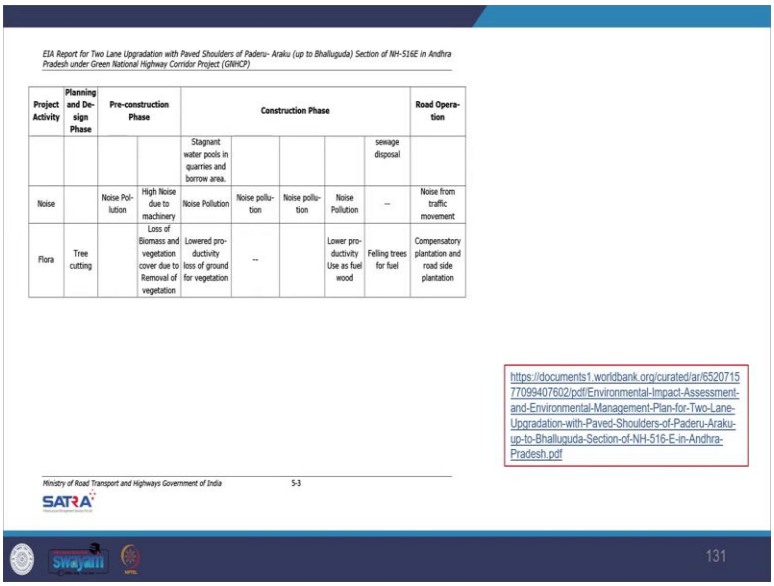

You can see noise and flora.

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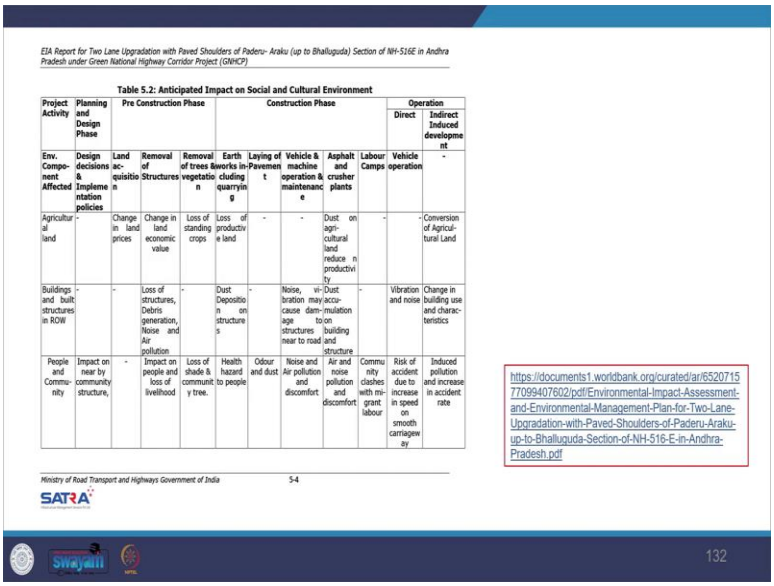

You can see agricultural land, buildings, and built structures in right of way, people, and community.

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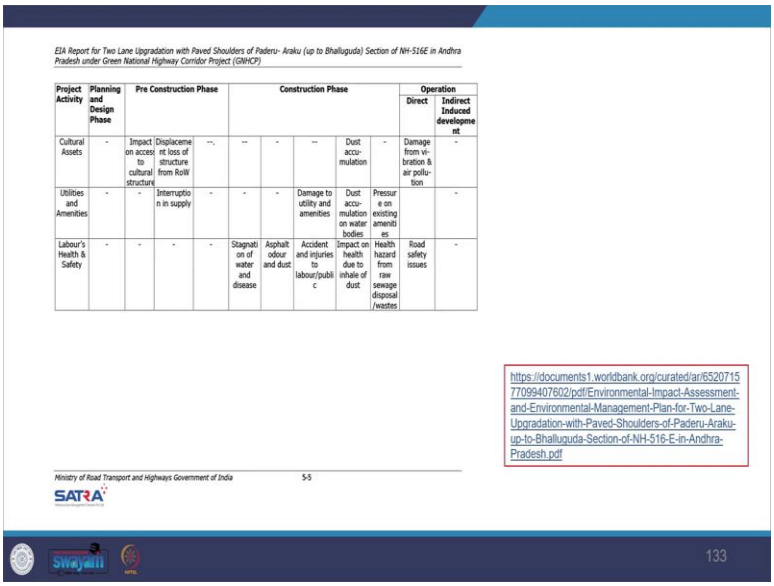

Culture assets, utilities and amenities, labor health and safety. So, all these give, summaries, like one has to also give the summary of all kinds of impact which were happened. So, all this is given. So, in the end, you need to summarize all the intensive details study you have done. The style can vary. So, that was all about the transportation EIA.

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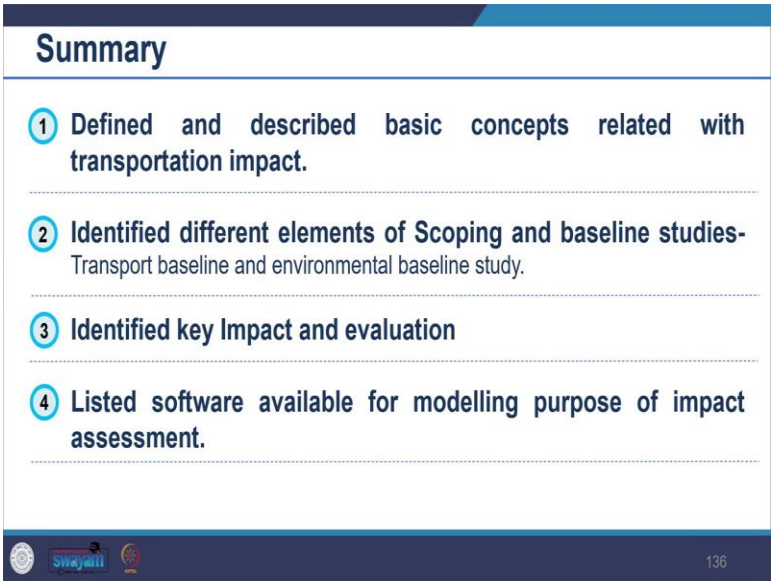

So, summarizing what we covered today, we looked at the concepts, and certain definitions, very limited ones, to understand the transportation impact. Then we looked at different elements of scoping and baseline studies about transportation baseline, and how we undertake that. Then we did for environmental baseline study. Then we looked at the key impacts and how we evaluate them and then we looked at some of the software available for modeling purposes of, impact assessment.

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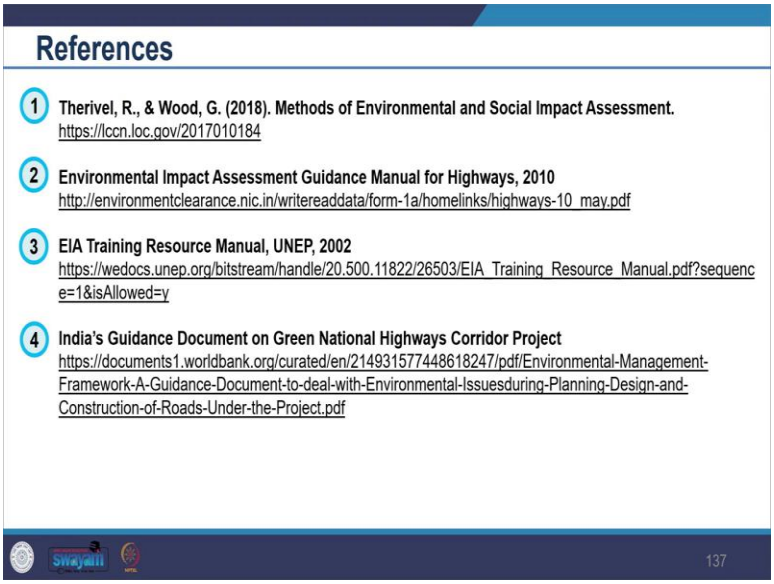

So, these were the references. Our key reference is Therivel and Wood's book Methods of Environmental and Social Impact Assessments, and then all the guidance and manuals that we have used.

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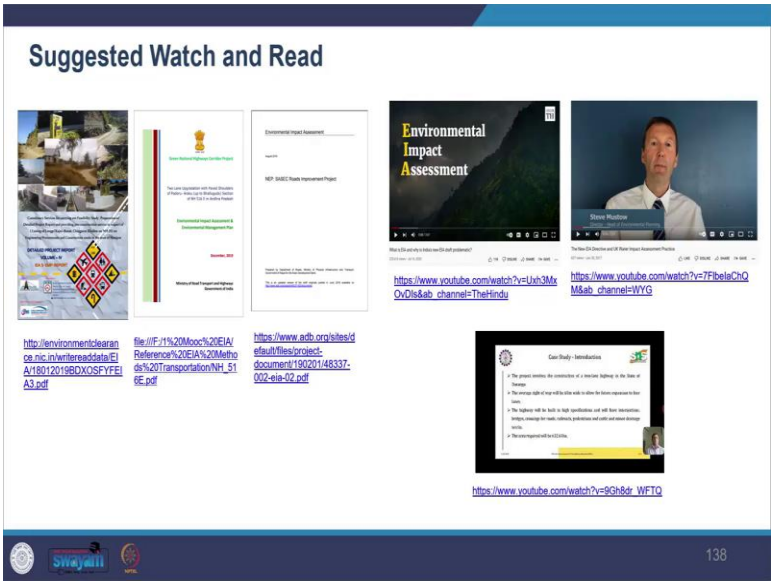

And also the projects, which I had shown you. The links to those projects have been provided so that if you wish, you can download and read them further.

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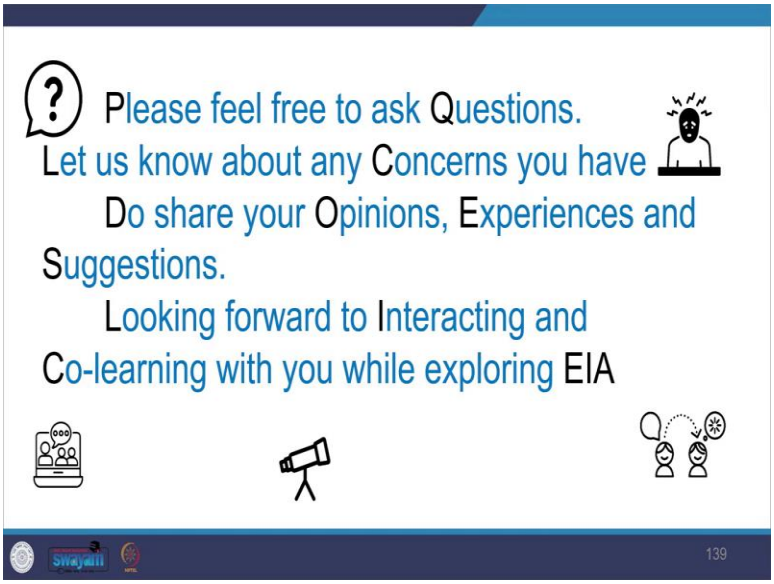

So, our coverage is limited but please feel free to ask questions. Let us know about, any concerns you have. Do share your opinions, experiences, and suggestions. Looking forward to interacting and co-learning with you while exploring EIA. Thank you.