Environmental Impact Assessment
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Lecture – 27
EIA Process – Impact Prediction

Welcome to the course Environmental Impact Assessment. In the previous class, you had seen that we started with the process in detail and we had looked at this very briefly late before also.

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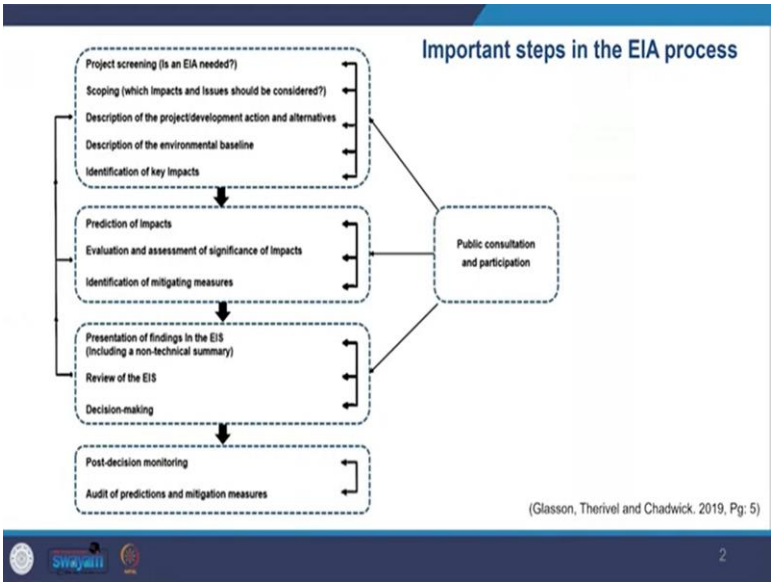

So, today, we are going to look at the second box here in the image. And here we will look at the prediction of impacts. So, this is one of the very important parts of EIA, and the entire core lies here. So, for this purpose, we are going to look at it in certain detail and our key reference for this particular section is chapter 5 from the book Introduction to Environmental Impact Assessment by Glasson and Thorable.

So, prediction is a key part of the EIA process and if you look at EIA primarily it is the prediction part. And you will see that this prediction is not just a linear process, but you go backward and forward and then you keep improving the process. So, we are going to look at this impact prediction part like the process part of it, the methods, and other things, we will look at it later in the method section.

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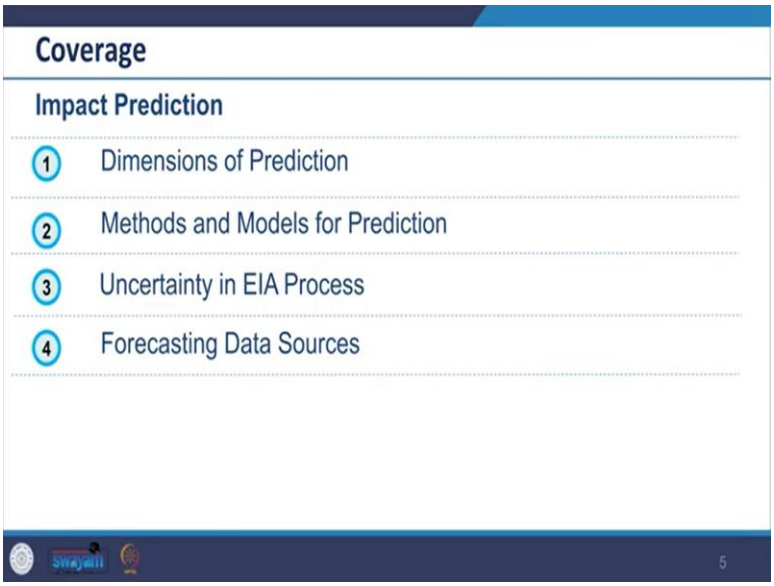

So, accordingly, our coverage would include that we will look at different dimensions of predictions. We will look at what are the methods and models of prediction, or we will just look at them in a very umbrella term and not get into the details when we deal with the method section we will look domain wise different methods and models that are available for prediction purpose, we will just take a very generalized view here. So, further, we will look at the uncertainty, which is involved in prediction, because we are predicting and prediction is always uncertain, there is a certain level of uncertainty which is involved.

We will look at like how we what kind of data sources are used for forecasting purposes. So, accordingly, the learning outcomes would be that. So, after completion of this, you should be able to identify different dimensions of predictions, you should be able to name them you should be able to identify them. Then you should be able to generally review or synthesize the overall methods and models that are used for prediction purposes, and then you should be able to discuss various uncertainties which are the EIA process in the prediction components. Then you should be able to identify and discuss various kinds of data sources that are used for prediction purposes.

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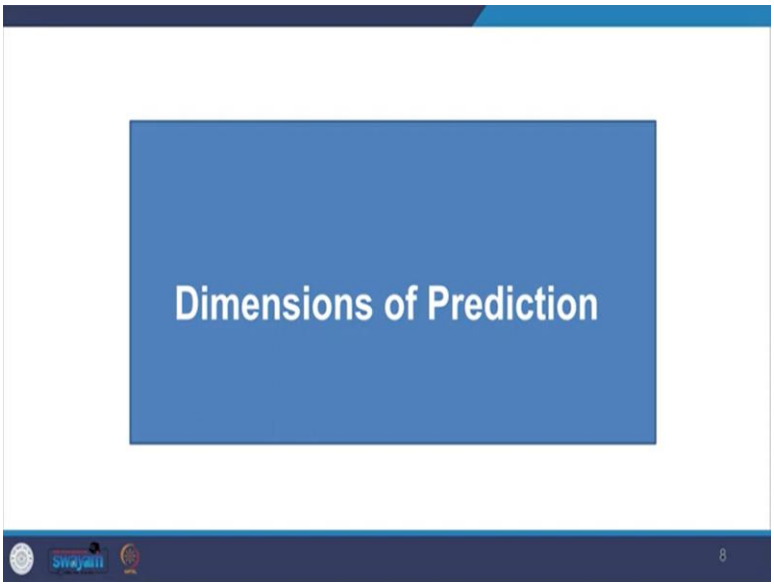

Now, moving on to the prediction part, we first see how to predict the impact like, what methods and models will be used in the prediction. In this section, we will look at various aspects of prediction like, we will look as how to predict the impact, and what methods and models will be used in prediction. We will be learning how to look at the limitations of any prediction methods as well. So, looking at the dimensions of protection, what do we have to predict?

So, the purpose of any prediction is to identify the magnitudes like to what extent the impact will happen with or without the proposed project like what is going to happen, what kind of impact will happen and what extent will it happen, and we look at it from the perspective of when the project comes as well as when what will happen irrespective of the project.

So, through the prediction, we also try to determine the significance as well like, what will be the significance of that particular impact. So, what is the first step you undertake in the prediction the first step of prediction is that you look at the legislation like what is required in the country you are in and what kind of law requirements are there.

So, the very when you are given the assignment to undertake prediction the first thing that you will do is to look at the legislation of that particular region or country you are working in what kind of laws you have to abide by, and what kind of prediction requirements you might have to do. So, that would be the starting point.

So, you will be referring to all the range of legislation guidelines, standards and all of these we have already discussed in the past few weeks about or domain-wise all different legislations which will which might be applicable at the local level, regional level country level, or at the like, how you would be aligning your things for the convention as well.

So, based on that, you would prepare a list of indicators and check what kind of changes are likely to happen. So, prediction involves the identification of potential change in indicators of relevant environmental factors, as you look into the biophysical socio-economic and all these factors. So, the prediction was like what kind of real change is going to happen?

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So, you can see here, that we see air quality standards and water quality standards from CPCB as an example, so, based on that you would see like, is the change going to be beyond this range which is given So, that is how you check. So, you saw an impact in the first initial stage of the EIA process as well.

So, there you tried to identify which impact to consider and look at, at a broader category of impact concerning with the project. So, when you remember and look at the first box, which we saw, if we were also identifying impacts there, but that we were doing to narrow down to see what kind of impacts would happen, but at this stage will calculate or undertake the impact prediction.

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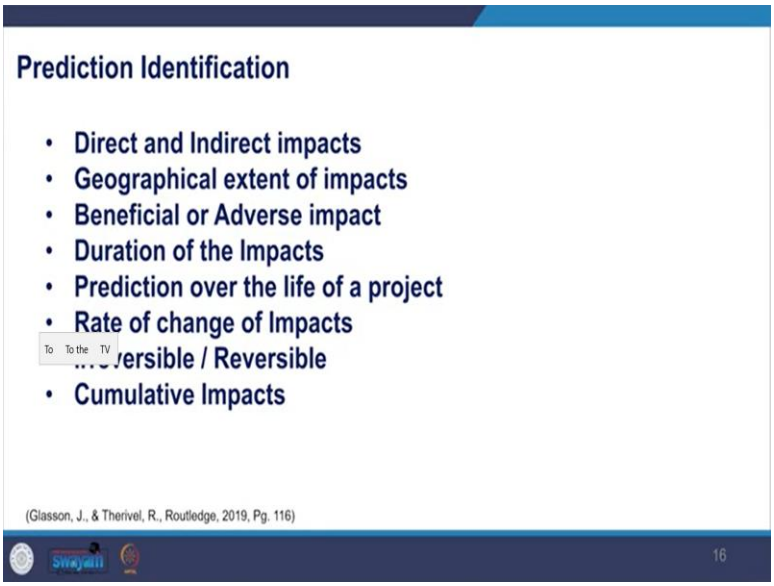

So, in the prediction process, you try to identify and you try to identify war to try to identify the direct and indirect impact as you can have we have talked about the range of impacts if you recollect what was direct and bad and what was indirect impact. Like direct impact is like having air pollution and then air pollution leading to health problems, which would be air pollution would be direct impact and health problems would be indirect impact.

So, you try to identify all those problems concerning your project. So, with this, you can use very simple Cause and Effect diagrams to indicate like really, how what kind of things are happening. Then you will see, to what geographical extent the impact will take place where whatever impact is happening, that air pollution, will it be just like, few meters from the sides, or it will be at the regional level, or the pollution can be at the national level or the international level.

So, what level whatever impact is going to happen, how, how far would it the geographical extent would be so we will be looking at that. Then whether the impact is beneficial or adverse, whether they are positive or negative, you are going to look at that aspect. And then you all would be also required to look at the duration of the impact, like how will the duration be short term or whether the duration will be long term. Whether it will go on for generations together?

When you look at the prediction, you see the life of the project, like you would look at the different stages of the project, like you look at the construction, you look at the operational and also like how or when do you decommission all these stages, you look at what kind of impact will happen, and then you predict you predict all of those.

So, you will also look at the rate of change of impact. So, you will not just look at the impact because the impact means there is going to be some kind of change. So, you are also going to look at the rate of change of

impact. So, how fast that change is going to happen will it happen in due course of time slowly, or it will be a rapid change and most often rapid change is not acceptable for something happening very rapidly?

So, you have to take care of those things. and try to find out what kind of problems can occur. And then you would also look at the reversibility or irreversibility of a particular impact so, we had discussed these kinds of impacts before also. And then you would also look at whether the impact would be cumulative, whether it will keep on adding eventually, so those all things have to be checked here. So, when the impact is slow, with a slow build-up, an impact may be more acceptable, like if the impact change changes happen slowly, it is much more acceptable than the rapid change.

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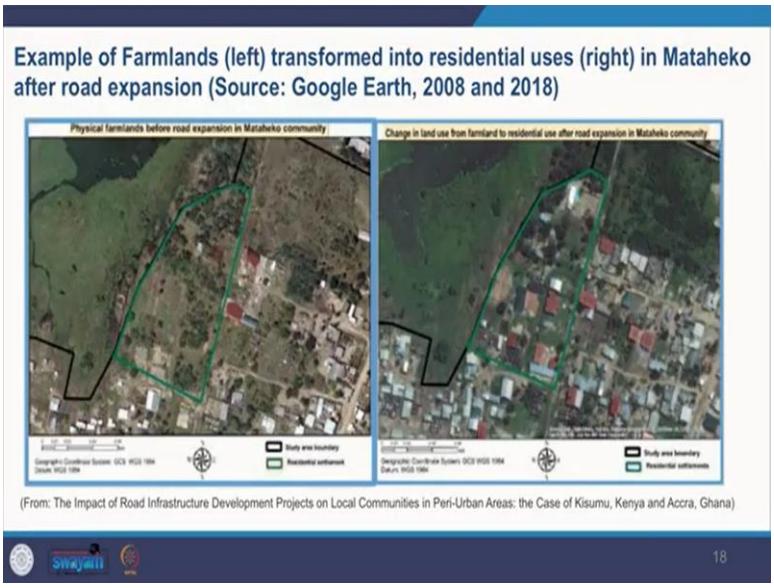

So, in the example, you can see the farmland on the left transformed into residential uses right after the road expansion, so you can see how that has been done. And here you can see that sometimes because of tourism or any kind of thing, a lot of things drastically change. So, some of the changes were where the changes are very rapid, those things are not acceptable.

So, that is what we saw about the hub, like the different dimensions of prediction. And there is another term that we would like to get a little clarification on. So, when we look at prediction, we also look at the magnitude of the prediction and the significance of the impact that we are looking at.

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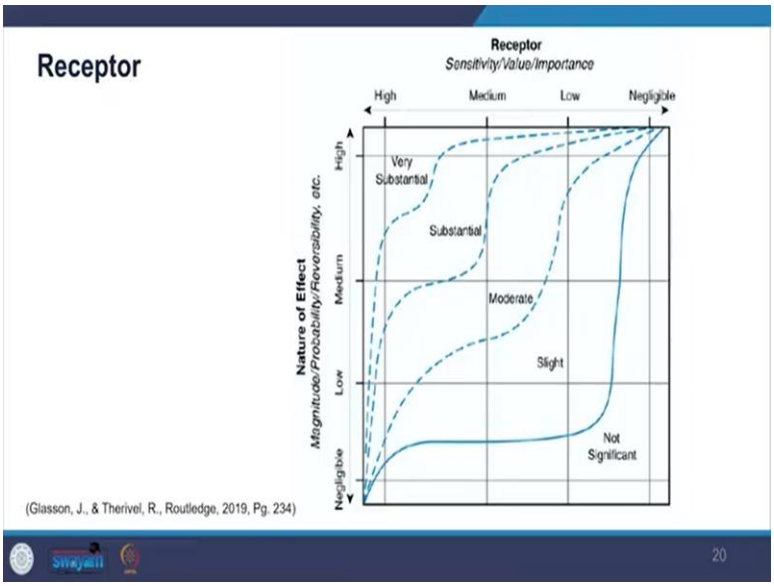

So, in this figure you can see, in the figure, you can see that on this graph, you can see the vertical line, which shows the magnitudes probability and reversibility and so, on the nature of the effect and the x-axis, you can look at the sensitivity value and the importance which align to that. So, whenever an impact is seen, whether the impact is negligible low medium, or high, it will depend on the sensitivity of the receiving component.

So, if the receiving component irrespective of the low effect, the sensitivity is very low then it would be very high the significance would be very high. And even if the impact is very high in terms of magnitude probability or reversibility, if the importance assigned to that particular impact is much less than also you would not consider it to be significant, and you would still allow those kinds of changes.

So, that is the difference between magnitude and significance irrespective of how big the impact is, but if it is acceptable in terms of who is the recipient what value they assign to it, or how important that factor is for that particular context, based on that, you decide the significance or the importance of that particular change.

So, you see how prediction can be both a subjective and objective process. So, you see that, irrespective of how scientifically you have made those calculations and determined the impact of the other component, how significant it is, would be more of a subjective concern, or it will depend a lot on the context in which we are dealing with. Another thing that you would like to clarify here is whether your prediction should be quantitative or qualitative.

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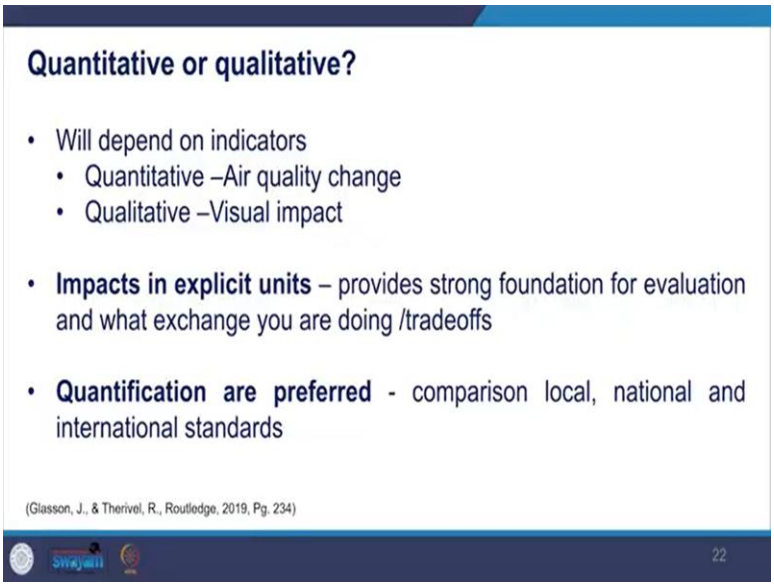

So, it will all depend on when you are doing the prediction, it will depend on the indicators, what kind of indicators you are dealing with, for example, when you are dealing with, like air quality change, then it is a lot of data is readily available, and there are standards and guidelines. So, a quantitative approach is preferred for that.

And then when you are dealing with a certain kind of social survey, you are looking at the satisfaction level, it will be this no way you can do the quantification of it so it will be qualitative. And then another example could be when you are doing a visual assessment, you are looking at the visual impact, then the kind nature of the, your prediction would be qualitative. So, depending on what indicator you are picking up, you have to choose between those methods.

And it is desirable that whenever you determine them, but you take it in very units, it is better to have numbers. When you have numbers it is provided it provides a very good foundation considerable strong foundation for evaluation that allows you to compare it with other localities' nationalities, and you can compare it, with the international standards as well.

So, you also need to take care of probability while predicting. So, what are the chances that the predicted impact will happen? So, what are the chances that, so you are predicting something but then there is a certain level of uncertainty in the technique you are using or what kind of data you are using? And so, there is like, you also need to express that and be call aware of that and communicate that.

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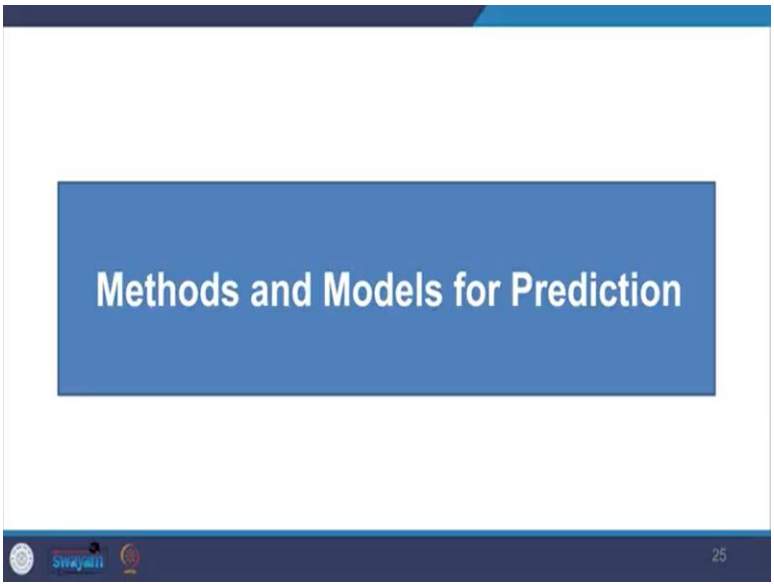

So, now, looking at how to predict we shall look at the methods and models for prediction. Here we are looking at the umbrella level. Prediction models are constructed on theories like how the environment functions and how factors influence and interact. So, most of the time, when you are predicting your development, you are using a prediction model, most of them will be based on certain levels, certain theory scientific theories on how things work, how the air moves, how evolution happens, and all those things. So, it will be based on certain theories. So, you need to know are the persons who whom you assign the tasks should know about those theories.

So, these models will be based on such kinds of theories. So, you find mathematical and computer-based models and what do you see in mathematical models in mathematical models, you represent the behavior of the aspect like how that particular aspect is going to behave in the environment through the use of mathematical functions. So, whatever theory you have is translated into a formula mathematical function, and then based on that the model is created. So, you would select them based on the scientific knowledge available and what is used in practice in your context. You may also put in statistical analysis or you may undertake a combination of both and use the computer for the purpose.

So, you see that model can have various ranges, you can have simple or complex and dynamic mathematical models, mathematical models can be like also spatially segregated like you can have you can do griefs and you can also average them out and look at various factors together in an aggregated manner and also segmented manner. And then you can also have very location-specific models as well, which would predict what kind of local change, or net change would happen in that particular study area.

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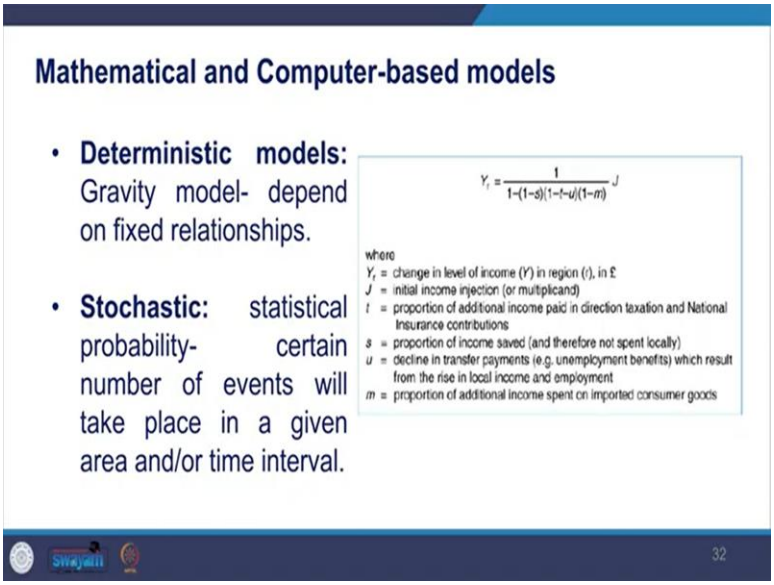

So, mathematical models can also be divided into deterministic and stochastic models. So, you can have like both these types, so looking at deterministic models, like you have the gravity model that is based on the fixed relationships. So, you only like the relationship where you put the parameters and it tells you what is going to happen, and then the stochastic models, which are also the statistical models or the probability models tell you with a certain degree of uncertainty. So, what are the chances of this going to happen, and what level of uncertainties are there?

So, in looking at the example of a deterministic mathematical model, you have a socio-economic impact predictor, here you can see a use. You see here a change in the level of income with the J indicating how much money is invested into an economy. Then you see them at various levels like local, regional, or national levels, and how that increased the income in the economy by some multiple of the original investment, which has been made, you can see the example here. So, you, when you look at this you can modify these models or even use them independently for each subdomain you see.

Like, you can see for each activity, what kind of employment will be generated. So, like during the construction time, what kind of employment would be generated during its running time what kind of employment would be generated and so, on? You can also look into various other segments. So, you can modify those models as well.

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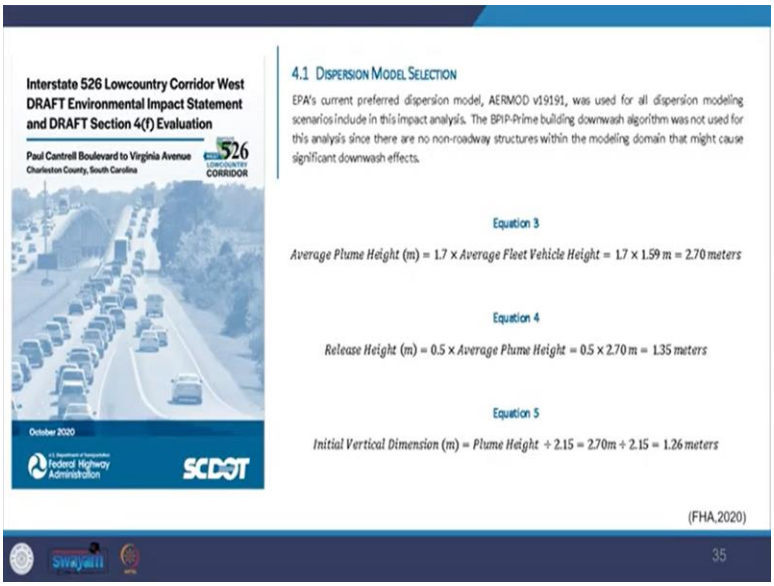

So, taking from the example in this example, from the interstate, low country corridor west. So, you can see the EIA report here and you can see how they have for the air pollution, how they have used the model here. So, you can see all the equations, equation 3, equation 4, and all these equations are there. So, average plume heights release height and initial vertical dimensions to how they are using the formula to make the prediction. So, when you look at the statistical model, you have the regression model, you have principal component analysis, so, you can describe the relationship between data and then you can also test the hypothesis and you can also extrapolate data.

So, you can also find a lot of sophisticated representation and then, you can also use like fly flight through or walk through computer graphics, where you can show how your proposed project would come. And then how in different scenarios, how the environment would change and how what kind of land use might change what kind of visual impact would happen, how the evolution would happen, and to what extent it would happen. So, you can use all those kinds of sophisticated representations as well. Further, you see, you also have expert judgments and analog models. So, in the expert judgments, you take inputs from the experts and then you make judgments such judgments can make use of some of the other predictive methods.

So, you can use cause effects networks or flowcharts can be used like what impact would it have on the other and so on. You also have certain software related to that for expert judgment purposes. The expert judgment can also draw on the analogous model which means something very similar, where you are recapturing and recreating that environment. So, from the analogous model also expert judgment can be made. So, these models include comparing the impacts of the proposed development with similar existing developments comparing the environmental conditions it one site with those of a similar site.

So, you have a reference like what happened at that particular site. So, based on that similar situation, what do you expect to have a similar situation in yours, and how that impact is quite possible to happen in your place or

as well? So, analog models can be developed from site visits, literature searches all also by monitoring and reviewing undertaking case studies from similar kinds of projects. Then the nature of secondary data and case studies are all available. Then there are a range of other studies EIA studies that are available which can also be used as references. So, we also see other kinds of prediction models like you also see GIS-based Environmental Modeling.

So, where you can have the spatial depiction as well as all the attributes can be taken care of and you can integrate GIS with other kinds of models and all the variables can be integrated with the statistical and algorithm mathematical models all can be integrated with the GIS model. And you can do buffer analysis over analysis of all this.

So, those were some overall methods that one can use for impact prediction and all of these would vary from domain to domain. So, how do you choose among these like which prediction method you are going to use and adopt in your particular case? So, your choices depend on the impact of which you are going to consider.

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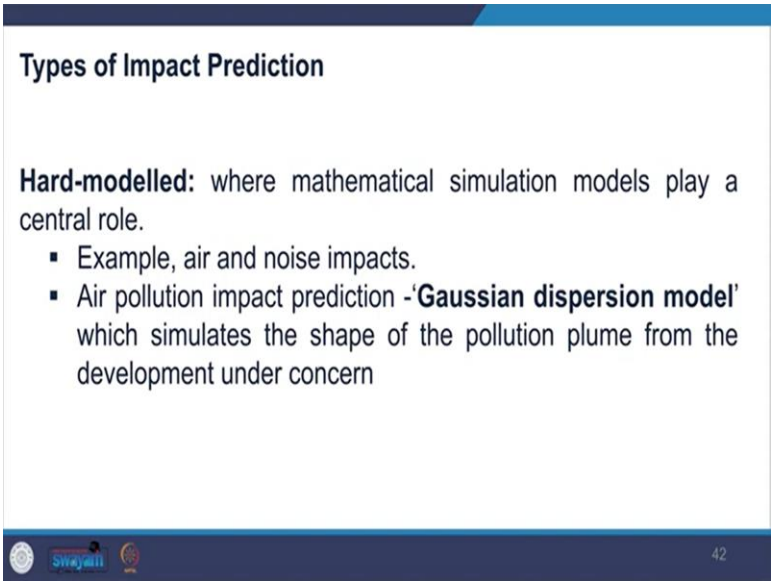

So, it will depend on the domain in which you have to predict, and then you have to look at the types of impact prediction. And like, you might also have like, there are certain categories which are identified like you have a hard model where mathematical simulation models play a central role. So, there are things aspects, where hard modeling can be done, and mathematical simulations can be used.

So, for example, as we have already seen air and noise impacts, mathematical models are available. So, for that, it is very readily available. So, you would be asked, depending on the nature of the project, you would be required to undertake the mathematical simulations for that. We see that the Gaussian dispersion models are there, so, we will also see them when we look at the air domain later.

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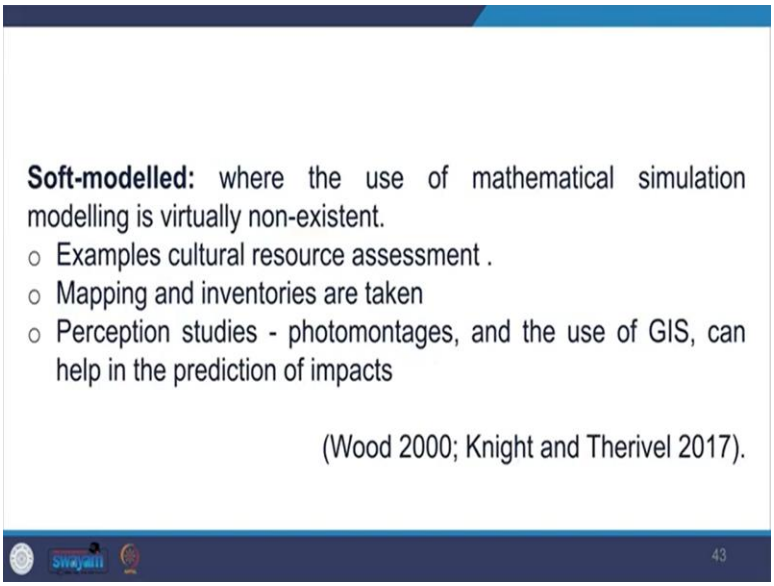

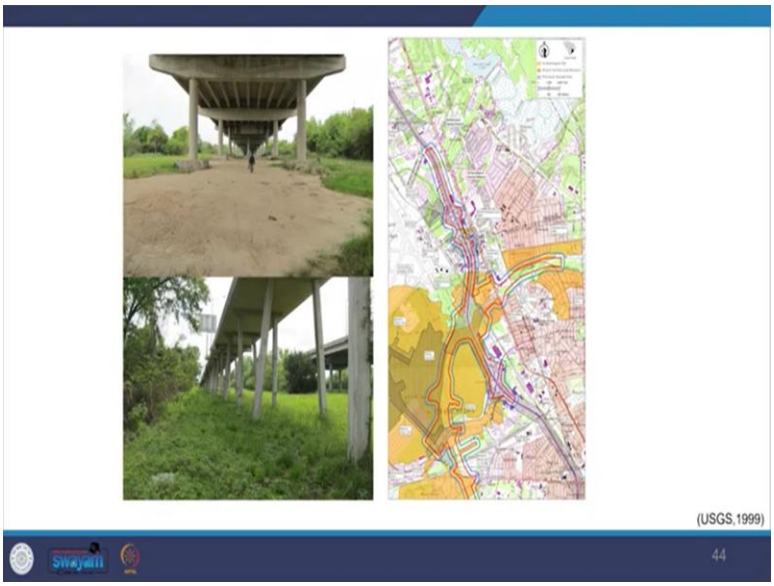

Then you also have a soft model where the use of mathematical simulation modeling is like there are no models, for example, you can see cultural resource assessment. So, in this object type, you do not find mathematical simulations in these. So, here you use mapping inventories and perception studies you can use photo montage is like, where you can compare one photograph over the actual scenario projected scenario over the existing scenario and communicate through pictures. So, photo montage can be used and you can also use GIS to indicate, understand that prediction, and then communicate the prediction. So, for example, you can see the cases here in how photographs have been used, and maps have been used to communicate what kind of changes. So, there is no mathematical model involved, but taking the help of more maps and pictures.

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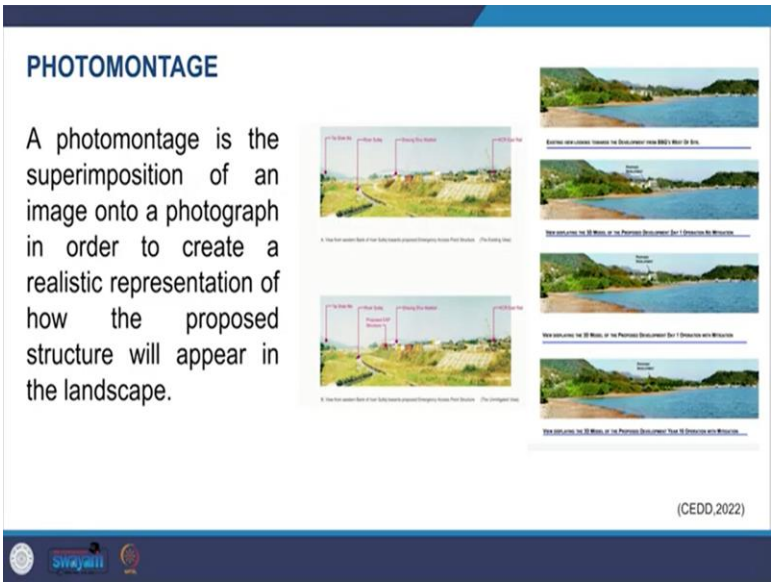

So, here also you can see the photo montage, which shows how the proposed landscape would change in the image, you can see the existing landscape and then how the proposed activity would change the landscape likewise, in any other images also, you can see how what kind of visual image will be created when the project comes.

So, you can see here that, if we try to just explain what is photo montage, photo montage is the superimposition of an image onto the photograph to create a realistic representation of how the proposed structure will appear in the landscape. So, you take a series of photographs of the area, and then you superimpose it for the proposed development and digitally edit and show how the visual thing will eventually look with the proposal.

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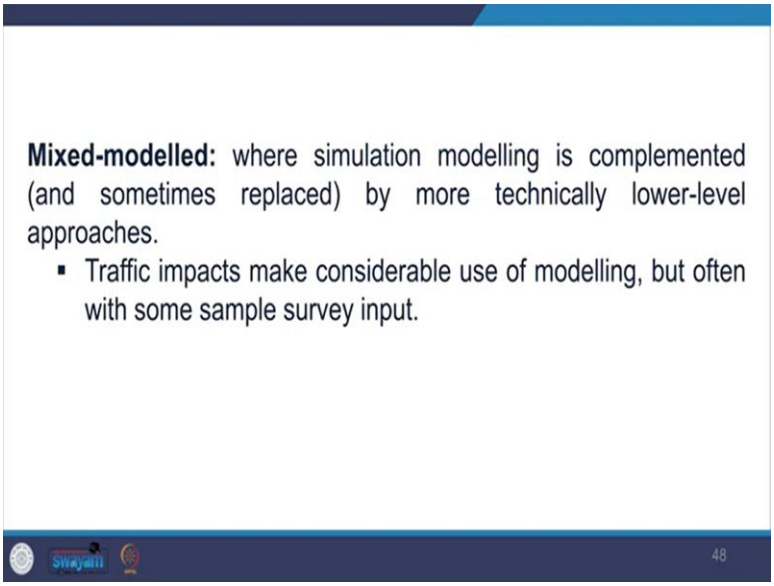

So, you also find mixed models where you use simulation modeling with other technically low-level approaches. So, you can use a combination of things like you can have traffic impact can be studied with

modeling, and it can be supported with the sample survey and other kinds of visual service, and the same can go with the socio-economic impact studies and so on.

So, when you choose the prediction methods, you need to take care, of how appropriate it is for the task. So, if you have less time if you have fewer resources, and if you have people, you do not have people who can undertake that, and the time is a constraint and then even the legislation does not require it. So, you might not decide to go for that particular choice of method which might be expensive and time-consuming.

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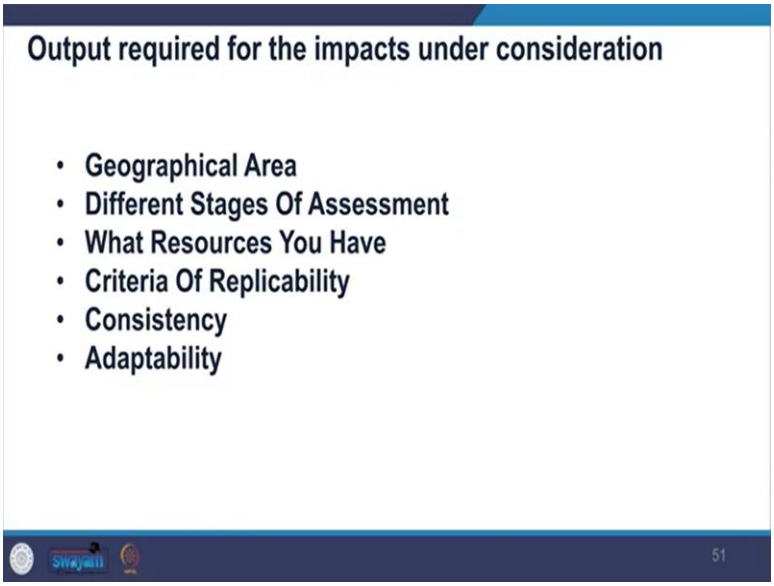

You choose all these methods based on what kind of output is required what kind of impact has to be undertaken, what geographical area you are dealing with, and what kind of different stages you will have in the assessments. What resources do you have? How much time do you have? What kind of data is available? Many times data might be not available to undertake those kinds of mathematical models. And then what kind of expertise you have to undertake that so depending on that you would choose. And then whether it is replicateable or not and whether your team can adapt to those things or not. So, based on that you decide. So, in many cases more than one method is suggested can be appropriate for instance range of methods available for predicting patterns or air quality is seen in many of the cases.

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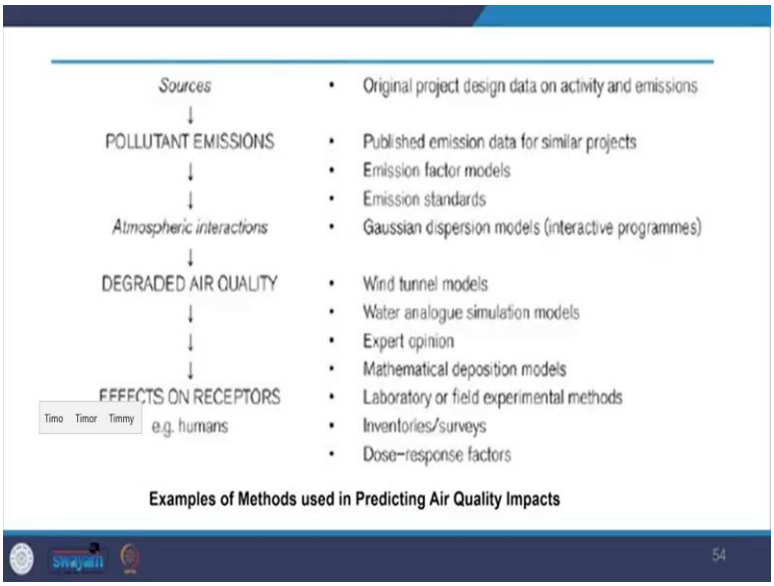

So, in this example, you can see a range of methods you can have for the air quality impact. So, you see pollutant emissions, and atmospheric interaction degraded air quality effects on receptors. So, for all that you have a range of methods, so you can have like to identify the sources you can have the original project design. Then for pollutant emissions, you can use the published emission data emission factor models emission standards costs in dispersion models, you can use it for atmospheric interaction. Then you can degrade air quality for that you can use wind tunnel model water analog simulation model expert opinion.

And then for the effects on the receptor, you can have laboratory or field experiment methods and then you can have inventories and those response factors. So, those things you can undertake. And then you see a lot of formal methods have been used in many of the cases and then there are much more complex methods where it is not important to use the complex method.

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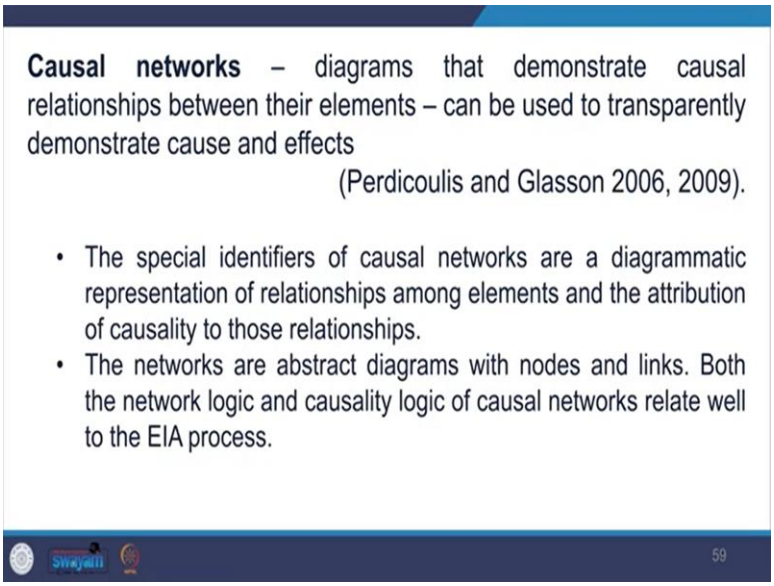

So, you see here you have also found a causal network in a production. So, a causal network diagram demonstrates a causal relationship between the elements that can be used and it helps you to identify what kind of impact will happen.

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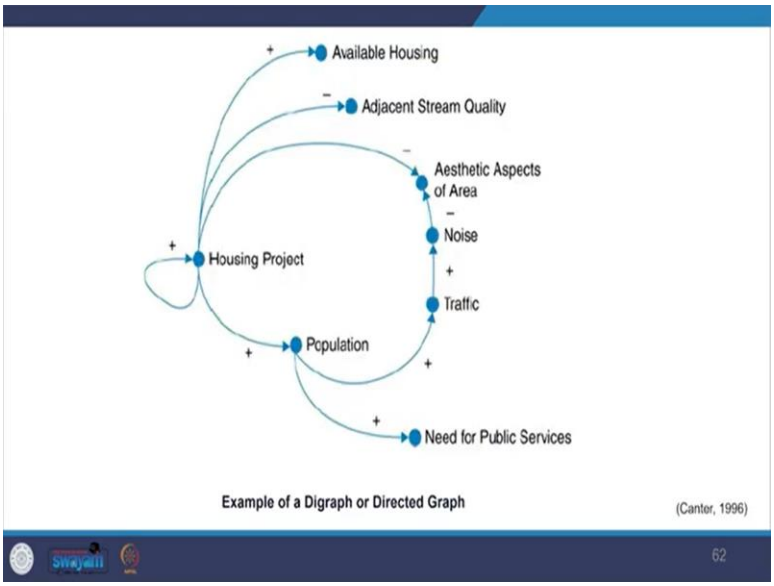

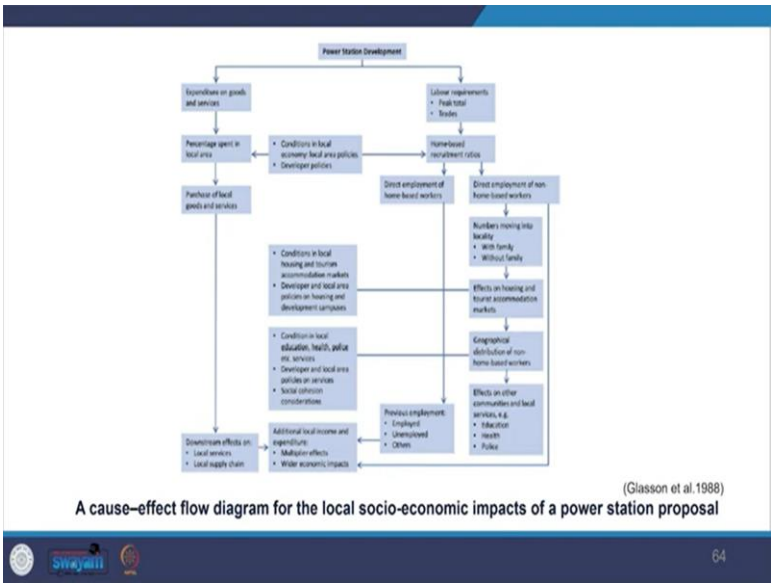

Here you can see how a housing project will have impact on the positive impact on the available housing. Then it will hurt the edges and stream quality and how it might hurt the aesthetic aspect of the area. And then how it will have a positive impact on the population and then how it will have a positive impact on the traffic and noise. So, you can see this diagram causal diagram here. So, that also helps you to identify various kinds of things.

Then you can also see the cause-effect flow diagram here. Here you can see how this power station development that would would lead to another like what kind of impact will happen on the expenditure on goods and services. On the other side you can see labor requirements ah peaked total and traders and then you can see how one connects to the other those kinds of things can be seen here.

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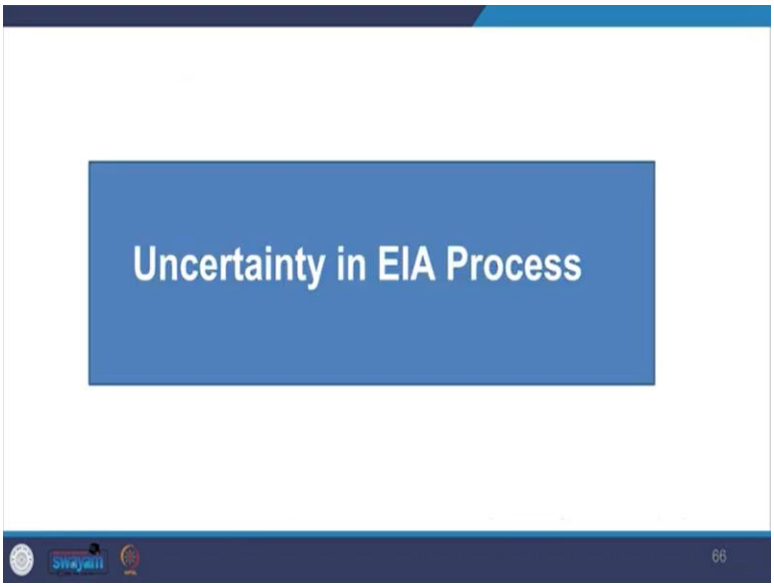

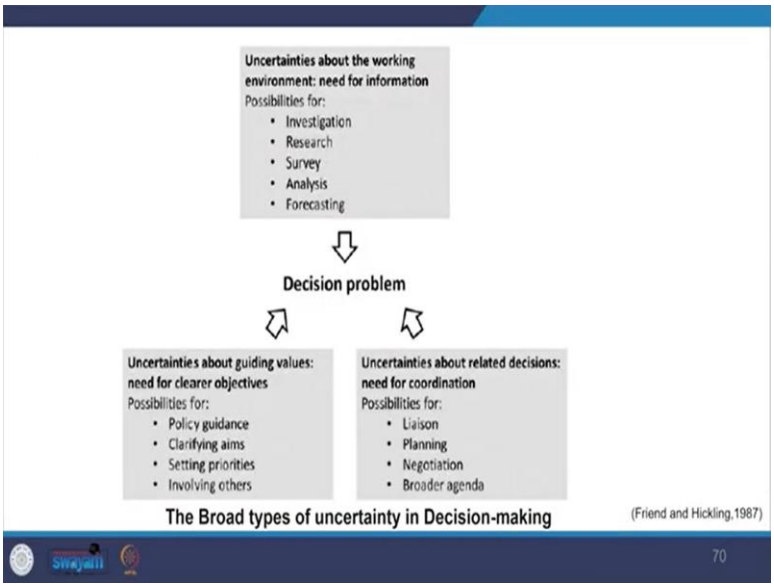

So, now looking at the uncertainty in the EIA process how do we handle that uncertainty? So, uncertainty is bound to happen in an EIA process and has to be mentioned. So, there are certain uncertainties that you might see uh and they come from the accuracy of prediction and what kind of prediction methods have been used.

So, you any kind of work when you are doing even if you are not doing the prediction but your team is doing then you based on what kind of prediction they are using and what kind of accuracy that prediction provides based on that you can make a judgment about the certainty with which they would claim certain things would happen.

Then it would also depend on the kind of data they are putting in and what kind of consistency or inaccuracy is there if there is incomplete information then the prediction model prediction which has been done there would be a larger level of uncertainty in that. So, you see a range of uncertainties so uncertainties about the working environments in which the research is done.

Then the uncertainties about the guiding values like under which guidance you are working and then there is uncertainty about the decisions and how things have been made. So, these majorly or from all these things also uncertainties come. The lowest uncertainty is usually seen in the project screening because you are using the list system and other things and then there the lowest uncertainty happens. So, how do you handle all these uncertainties?

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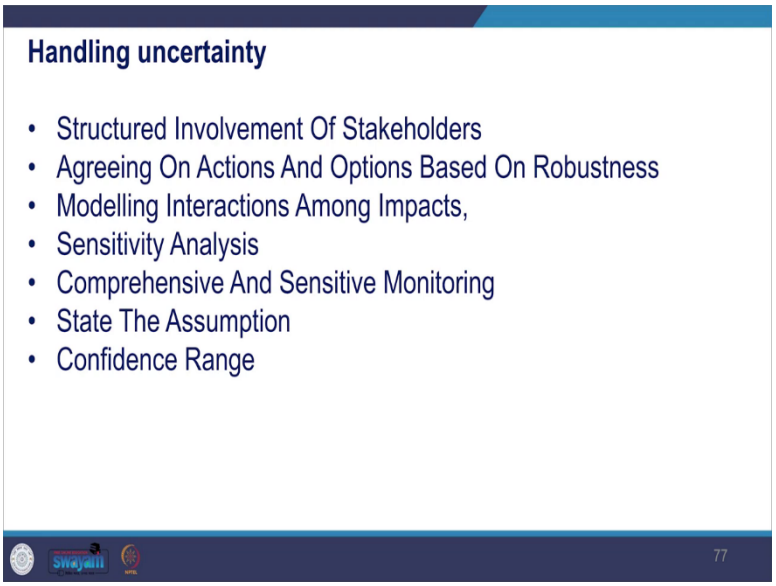

So, there are various ways to cope with uncertainties so you can have structured involvement of the stakeholders. And then agreeing on actions and options based on the like what is the robustness of the project and how various factors are considered. So, when you take all those factors and you take action on those then it reduces the uncertainty. And how all these impacts like you would be doing impact for various domains so how those interact with each other and how you are synthesizing it and taking out the information so that all reduce the uncertainty and then also undertaking sensitivity analysis.

And then also comparing also giving comprehensive and like very responsively monitoring the project so that all allows you to handle the uncertainty. So, when you provide a confidence range you have a certain level of confidence for the actual outcome so that is also given by the percentage which you handle.

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Some forecasting data sources — international and UK

Source (international)	Brief summary of content
World Economic Forum (WEF)	The WEF (Global Risk Report) (2018) works with experts and decision-makers across the world to explore the most pressing risks that we face. A perception survey highlights four concerns: persistent inequality and unfairness, domestic and international political tensions, environmental dangers, and cyber vulnerabilities. A section on Future Shocks warns us that in a world of complex and interconnected systems, feedback loops, threshold effects and cascading disruptions can lead to sudden and dramatic breakdowns

Source (international)	Brief summary of content
United Nations Environment Programme (UNEP)	The UNEP Global Environment Outlook 5: environment for the future we want (GEO) project (2012) reviews the way ecosystems and the atmosphere are responding to patterns of unprecedented consumption and production — patterns taking place on a planet of 7 billion people, rising to more than 9 billion by 2050. It includes a wealth of Information on environmental trends (atmosphere. land, water, biodiversity, chemicals and waste), continental trends and sustainability goals and targets on the way to 2050.

Source (international)	Brief summary of content
Organization for Economic Cooperation and Development (OECD)	In Environmental Outlook ro 2050 (OECD 2012), the organization reviews economic and social trends, using mode-based projections that will influence environmental changes. Key environmental impacts considered include climate change, biodiversity loss, water scarcity and the health impacts of pollution. The research can help in recommending policies to reduce detrimental environmental impacts. The outlook is seen as grim, if we fail to transform policies and behaviour

Source (international)	Brief summary of content
World Business Council for Sustainable Development (WBCSD)	• In Vision 2050 (WBCSD 2010), the 29 mayor companies of the Council (e.g. Boeing, Rio Tinto, Sony and Vattenfall) Identify megatrends in socio-economic variables and use them to project to 2050. Identified mega trends Include: population, agriculture, energy, mobility, buildings and consumer choices. • There is a degradation crisis, but also an opportunity — with sustainability as the key driver

Source (international)	Brief summary of content
Intergovernmental Panel on Climate Change (IPCC)	The IPCC undertakes scenario analysis for climate change, socio-economics and the environment, assessing the interactions between socio-economic parameters and greenhouse gas emissions up to 2100. The IPCC Data Distribution Centre holds data on population and human development, economic conditions, land use. water, agriculture, energy and biodiversity

So, now look at the data sources for forecasting so you can have some current data for forecasting. So, you have key international and UK sources which are briefly mentioned here so you can see the World Economic Forum which provides information you have United Nations environmental program. Then you have an organization for economic cooperation and development so they also provide the information. Then you have the World Business Council for Sustainable Development as well and you have an intergovernmental panel on climate change that also provides you data and guidance on undertaking it.

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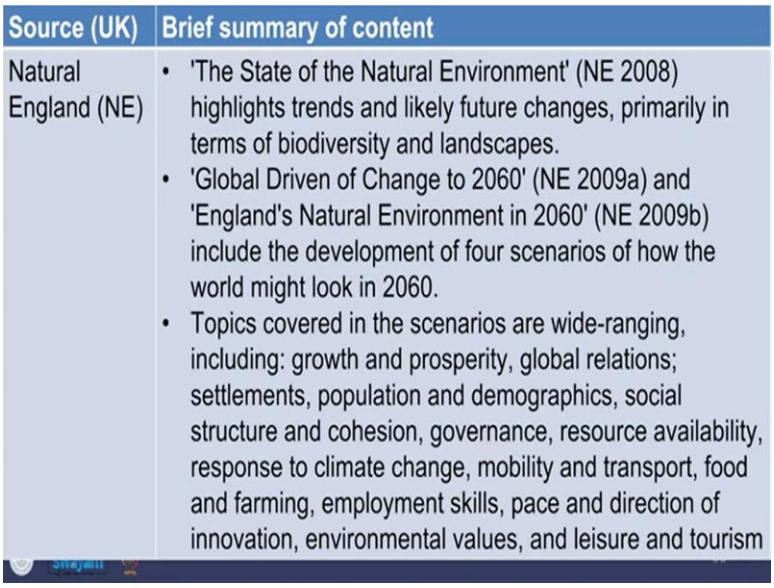
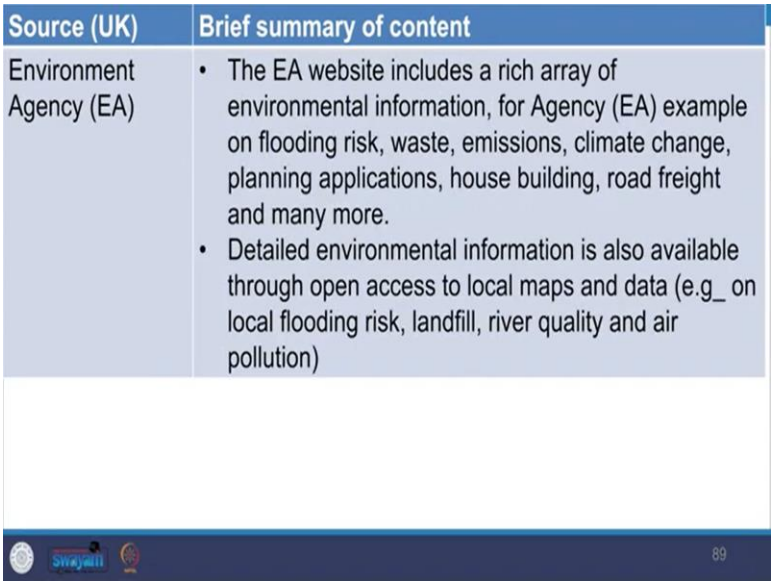
Source (international)	Brief summary of content
European Environment Agency (EEA)	• The European Environment — State and Outlook 2015 report (EEA 2015) is an integrated assessment of Europe's environment that includes data at global, regional and country levels, as well as cross-country comparisons. • It focuses on the 2015-2020 period, but also looks beyond and sends a clear warning of the risks of environmental deterioration, in turn affecting human well-being and prosperity. • The analysis calls for more integrated policy-making

Source (UK)	Brief summary of content
Department for Food and Rural Affairs (DEFRA)	• Brief summary of content England Natural Environment Indicators (2017) provides a vety useful traffic lights (green positive, red negative, amber neutral) assessment of trends across many environmental receptors, including species, water quality, marine ecosystem, land use, raw material consumption, ecosystem services and several others, with a wealth of disaggregated data in map and table format.

Source (UK)	Brief summary of content
Department for Business, Energy and Industrial Strategy (DBEIS) —[Incorporating previous Department for Innovation and Skills (DBIS) and Department of Energy and Climate Change (DECC))	A 2050 Pathways Analysis (DECC 7010) seeks to illustrate how an 80% reduction in greenhouse gas emissions by 2050 can be achieved. It considers different economic sectors, possible future energy choices and subsequent emissions. It also includes a calculator tool to show to show impacts of different levels of energy use — with scenarios ranging from' little effort to 'extremely ambitious • DBEIS and its predecessors have been undertaking foresight projects since 2002, 'forecasting' for periods of up to 80 years into the future. The projects use expert advice to outline a range of possible outcomes to assist decision-makers. • Examples of reports include: • Future of the Sea, 2018 • Land Use Futures, 2010 • Sustainable Energy Management and the Built Environment, 2008





Then you have European agency European environment agency that also provides you a guidance. Then the Department for Food and Rural Affairs Defra also provides you with information. As well as you see department for Business and Energy and Industrial Strategy also provides. And then Natural England environmental agencies. So, all of these are there for your guidance here.

So, now looking at the evaluation and assessing the significance you see that here you have a sensitivity of the receptor on the one side and then you see the magnitude of the impact. So, depending on what is the sensitivity of the receptor and then what magnitude of the impact is there. So, even if the receptor has the higher holding capacity so the or less value is assigned then a high magnitude impact can also be taken and would be less significant in that case. So, there is a framework given to that the detail of which we will see in the next session.

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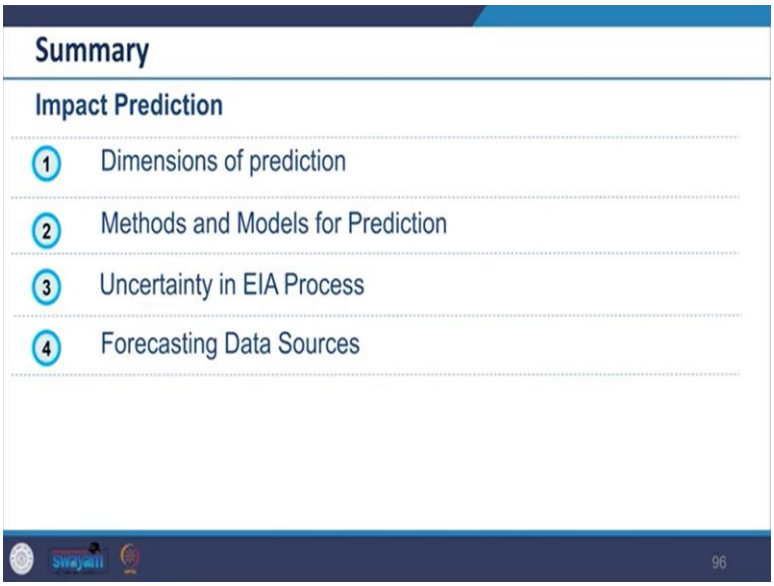

So, summarizing what we covered today we looked at the dimensions of prediction, then like what all you take care of when you consider prediction. Then we looked at the umbrella methods and models used for prediction and then we looked at the component of uncertainty and EIA prediction. And then we looked at various sources of data for forecasting so that was all the coverage for this particular session.

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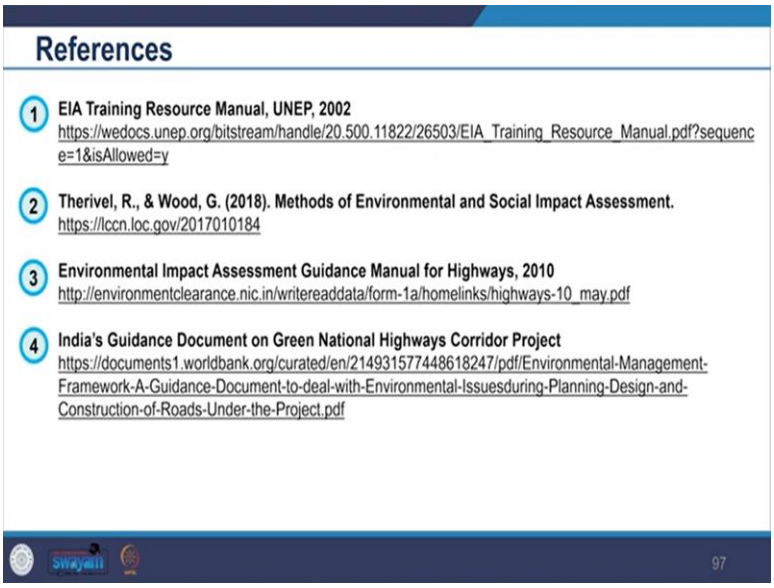

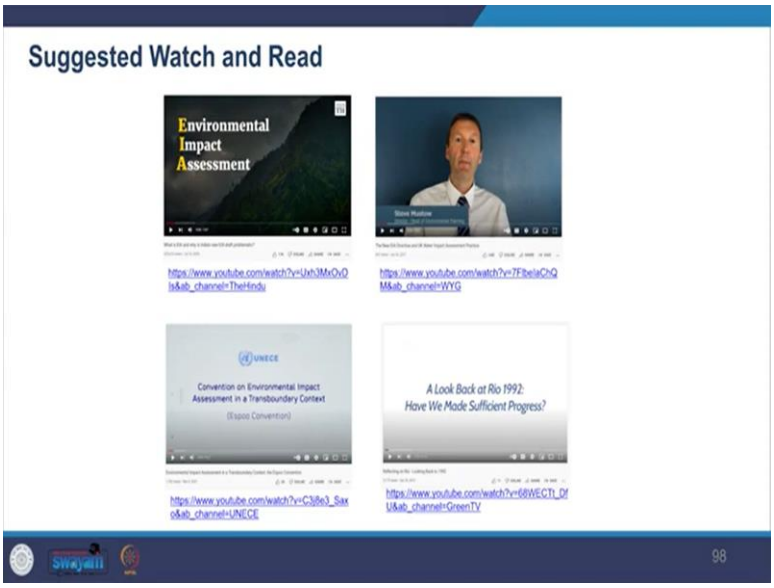

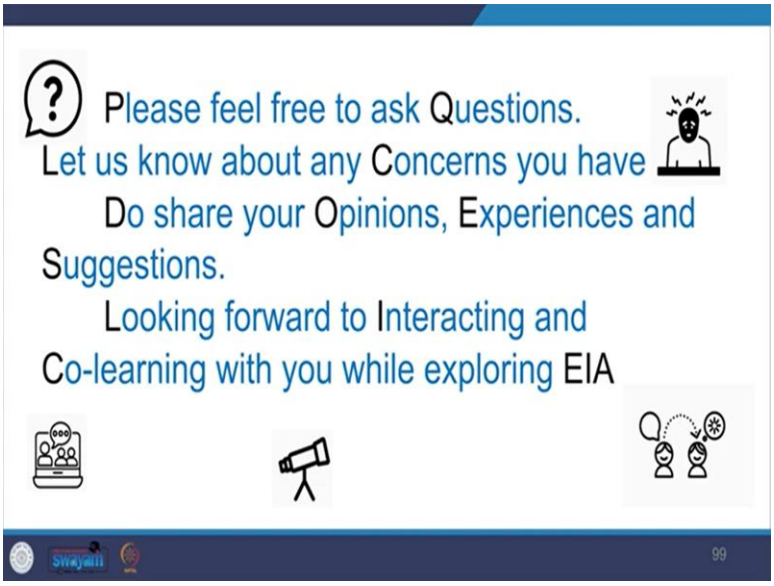

These are the key references that we used for this particular session and these are the suggested watch and read. Please feel free to ask questions let us know about any concerns you have to share your opinions experiences and suggestions looking forward to interacting and co-learning with you while exploring EIA thank you.