Environmental Impact Assessment
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Lecture 28
EIA Process – Impact Evaluation, Mitigation and Enhancement

Welcome to the course- Environmental Impact Assessments. And if you recollect in the previous class we covered, we looked at the first initial stage of EIA, where we looked at what kind of how we undertake screening what was the meaning of screening, then we looked at scoping. And then we looked at like, how the baseline studies are conducted and then the other like how do we identify impacts and so on. So, that, was the initial part and today we are going to look at the second phase of EIA process and in that, also we have already covered the prediction part.

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So, today we are going to look at evolution and assessment of significance of impacts here. So, accordingly, our coverage will include that, we will be looking at the how do we evaluate the significance of impact and impact and then we will also look at the mitigation, what does that, means, and then how it is undertaken its importance in the entire EIA process. And then we will also look at the how we really improve enhance the potential benefits which are there from the projects.

So, accordingly, our learning outcomes will include that, you should be able to review and synthesize these significant aspects in the overall EIA process. And you should be able to identify when it is going to come and how you have to handle it. Though a lot of details, we will look at the later part of the lectures. Then, you should be able to define what does mitigation means and then contextualize, synthesize and tell like how it is taken, how what is the current scenario. Likewise, you should also be able to review the potential benefits of any project of development projects.

So, looking at like the significance aspect, so, when we finish the impact, so, we have already seen how impact assessment is done on a very umbrella concept. So, when we finish the impact, we have to evaluate significance of the impact, which means when whatever impact is happening, what at what magnitude it is happening, and whether it is important or not. So, whether because of that, we are going to stop the project or alter the project or what we are going to do. So, in this particular stage, we evaluate that, whether the impact is significant or not, and the prime purpose of evaluating this is to inform the decision makers weathers whether the impact can be acceptable or not.

So, if it helps like as a professional, you would be placing all the impacts there and then also relating it to the significance of the decision makers can really be helped facilitated to draw conclusions regarding the proposed project. So, we see that, EIA, majorly our focus is on the impact, which is our utmost concern like mostly the entire process of EIA, the key to that, entire process is impact.

So, after that, we try to understand the significance, we see that, impact assessment is a complex process it can be dealt in different ways. But what we see that, judging evaluating significance is the most complex part of the EIA process where actually the judgment has to be made. And we say that, it is complex because it involves a combination of technical like scientific approaches, which you might have to take you need to have understanding of doors which like the what have been created in the proposal.

And then you have to make decision based on the political concerns and then the values people hold in that, particular context those places like some people might hold more value to the environment, some people, some economies might hold more value to giving jobs to people. So, in true sense, significance is a judgment. So, it depends on the nature of the environmental impact, like what environmental impact is happening was the magnitude of that, impact, how big that, impact would be. And then what will be the duration of that, impact and so on.

So, we look at all those concerns related with environmental impact. And then we look at its importance and whatever impact is happening, the range of impacts, we have seen biophysical impact, socio economic impact, so, all those range of impacts what we have seen, how important it is to us in a given context. So, based on that, the judgment is drawn, and it involves consideration of amount of change that, is acceptable to the community. So, whatever change will happen, because of what impact we have studied. So, whether those changes are acceptable or not acceptable in a given context.

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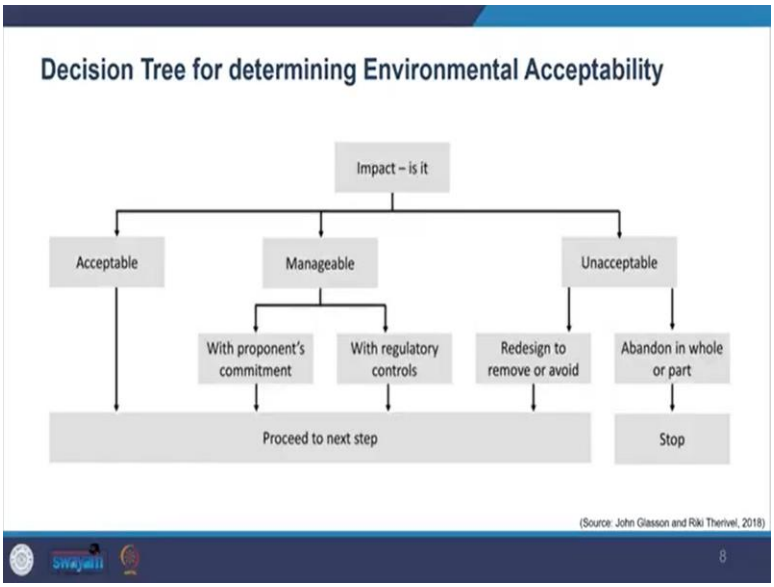

So, here you see, there are frameworks, which have been developed for the purpose of making this judgment. So, you can see the decision tree here. So, in the decision tree, you will see that, the first box which shows the impact, what impact has been identified, so, in that, you see the first one where you see the acceptability on the left-hand side, acceptable, acceptable.

So, whatever impact is happening, it is acceptable. So, you can proceed to the next step. And you might also have chances in the center you see manageable. So, when the impacts are manageable, and you can manage it with the help of commitment, what the proponent gives, like what kind of mitigations they would undertake, and so on depending how they would proceed in the in concern with their project.

So, with those commitments, you may manage the impact, so that, with that, you might proceed to the next step. So, the others segment of the same manageable aspect, you see, now, you can also manage a lot of things with regulatory control. So, how you have seen so many regulatory controls, so, all those standards, you can manage those things. So, it is also part of the policy, all the modes of policy, which we had discussed in the previous weeks.

So, here certain impacts can be manageable, and then a certain impact whatever you have found out that, can be unacceptable in many of the cases. So, in those cases, you might have to redesign or remove or avoid components, maybe you have to redesign some part of it or might have to do redesign the complete part of it, and then you might proceed to the next step.

There can be cases where completely the impacts what have been identified are unacceptable, and then the project has to be abundant has to be left out has to be declined completely or partially, and then the project would stop. So, this is how the decisions are made. So, it is a very complex decision, which one has the team the authorities have to make. So, you so this is the decision tree provided through literature.

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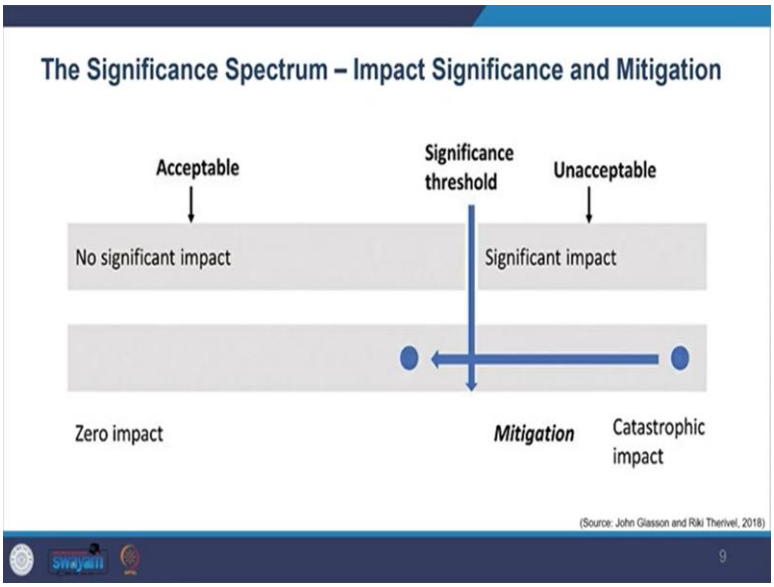

The other decision, similar framework, you see a significant spectrum. So, here again, you see similarly that, acceptable, no significant impact, so there is no significant impact in terms of negative impact. So, then you move ahead with that, and then, you might have significance threshold, where from where the significance, the level of impact is significant.

So, if it crosses those lines, then you might to certain extent, handle it with mitigation, as you can see at the bottom mitigation, or if it is stretches far to the right then it might be catastrophic impact and then it is unacceptable. So, depending upon what kind of changes are happening and whether it is acceptable or not acceptable, such kind of decisions are made, and these are the frameworks which have been worked out to help the authorities to make decisions.

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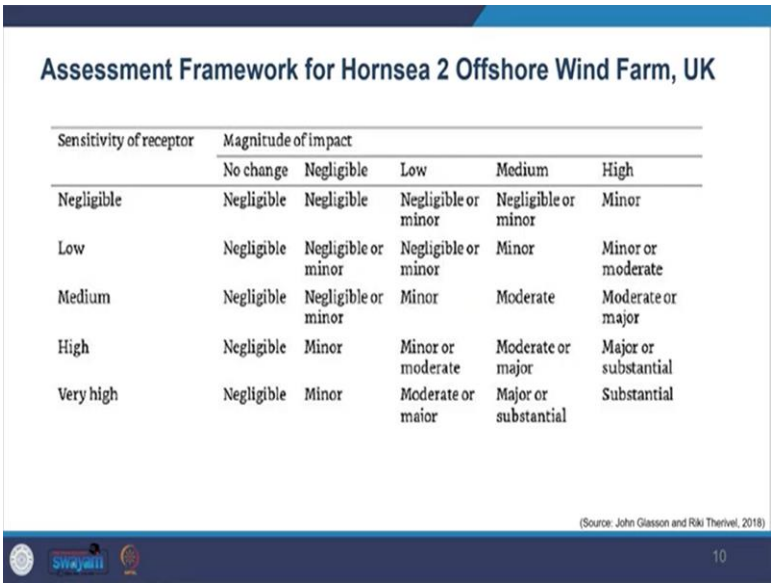

Sensitivity of receptor	Magnitude of impact				
	No change	Negligible	Low	Medium	High
Negligible	Negligible	Negligible	Negligible or minor	Negligible or minor	Minor
Low	Negligible	Negligible or minor	Negligible or minor	Minor	Minor or moderate
Medium	Negligible	Negligible or minor	Minor	Moderate	Moderate or major
High	Negligible	Minor	Minor or moderate	Moderate or major	Major or substantial
Very high	Negligible	Minor	Moderate or maior	Major or substantial	Substantial

Then you also see here another example, which is assessment framework for wind farm, it is taken from UK sample. So, you can see how the, you have the on the left-hand side you have receptors in this perception

perspective and you see that, how is the impact negligible low, medium, high very high and then what nature of impact is that, magnitude of impact, no change negligible low, medium and high. So, based on that, one takes the decision. So, this is like really, where you draw these kinds of things and tell raise the discussion like and guide people to take relative decision here with respect to significance of the project.

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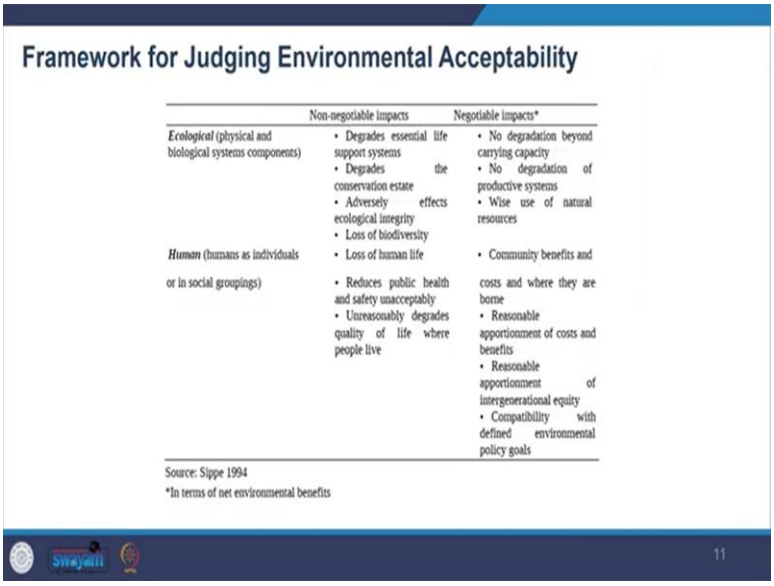

So, we see another framework for judging environmental acceptability. So, here you see how you have what are the aspects you see ecological aspects human aspects, and then you see that, non-negotiable impact and negotiable impact. So, which are non-negotiable, if these are happening, it is not going to be acceptable like for example, you can see here Degrades essential life support system Degrades the conservation, conservation estate adversely affects ecological integrity, loss of biodiversity loss of human life.

So, they are non-negotiable impacts, whereas you see negotiable impacts no degradation beyond carrying capacity nor degradation of productive systems and so, on. So, you see, these frameworks are available, which can be helpful for making drawing conclusions here. So, when you look at the significance, there are a lot of criteria's and set standards for determining significance threshold like what is that, threshold level from where you will really draw the line that, what has to be accepted and what is not to be accepted. So, for that, one looks at the range of criteria, like what criteria you are really looking at.

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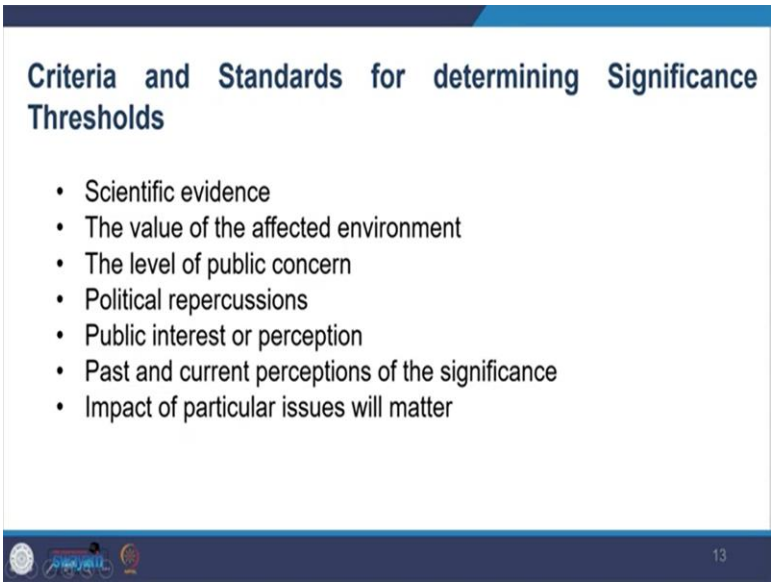

So, one looks at the scientific evidence, where available. What kind of evidence is there that, this kind of impact can happen or not happen? And then what kind of value the society places and not only the values of the society as well as the values of the decision makers. Then also we look at the values of the affected environment and then what value of we play on those environments which is being affected.

And then what are the public concern what really, what broader concerns are there and then also the political concerns and then public interest and what does public perceive about certain issues and problems. And then not only current problems, but it could be also affected by the past and the current perception of how significant those impacts are so, all these influences.

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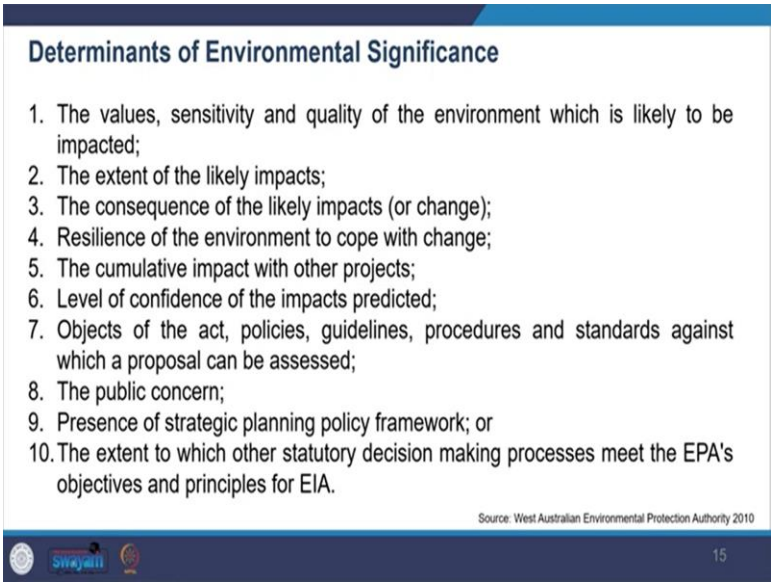

You can also see in the literature, various determinants of environmental significance like you have, this is given by APA or West Australia, where you see the value sensitivity and quality of environment which is likely

to be impacted. So, how sensitive the receiving environment is, and then the extent intensity duration, magnitude and geographic footprints, and then also the consequences of likely impacts so what will happen and then residence of the environment to cope with the chain. So, any kind of change, so, any kind of change which happens, is there a residence for the environment to adapt to that, kind of change in the public concern and then the strategic planning framework. So, this is all guided and it is the frameworks are given for this.

And then we see that, the most formal evaluation method is a comparison of likely impact against legal requirements and standards. So, these what you saw is very like, where the judgments are required, but very strange followed and distinct. And the formal way of doing it is to compare with the standards, the legal requirements. Like you have air quality standards, you have noise, standard water standards, and then you have building regulations, all of those.

So, and you have seen all of that, in our entire legal guidelines standards section we discuss to mean wise. So, you are familiar with those. So, that, is a very formal way of looking at it. So, if it is about those standards is unacceptable, if it is below that, it is in the acceptable range. So, it is very clear cut system also prevails for certain domain to make the judgment. Then now looking at range of methods for assessing significance. So, this involves interpretation and application of judgments while you adopt these methods.

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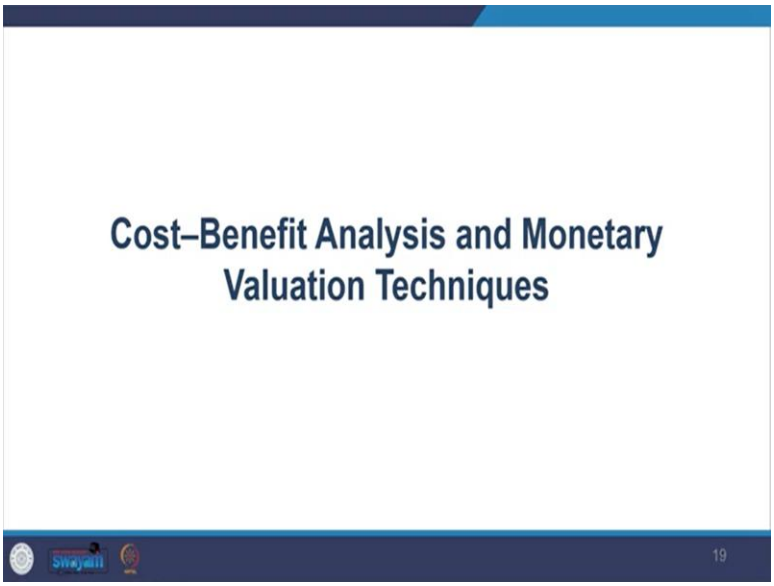

So, one of the methods what we see and it is a very traditional method, though, there has been criticism to it. So, we see is the Cost Benefit Assessment CBA cost benefit analysis as well the cost benefit assessment is like a traditional system, which had been used for making assessment or making, identifying the significance of particular impact. So, you see, the cost benefit analysis is the being very comprehensive in scope. So, it details out a lot of things and it looks at a lot of aspects here. And here, we see that, it includes a lot of relevant costs and benefits to evaluate the net benefit what we get from the project. So, we try to put monetary value to all kinds of benefits and we are all kinds of expenditure, but we are doing.

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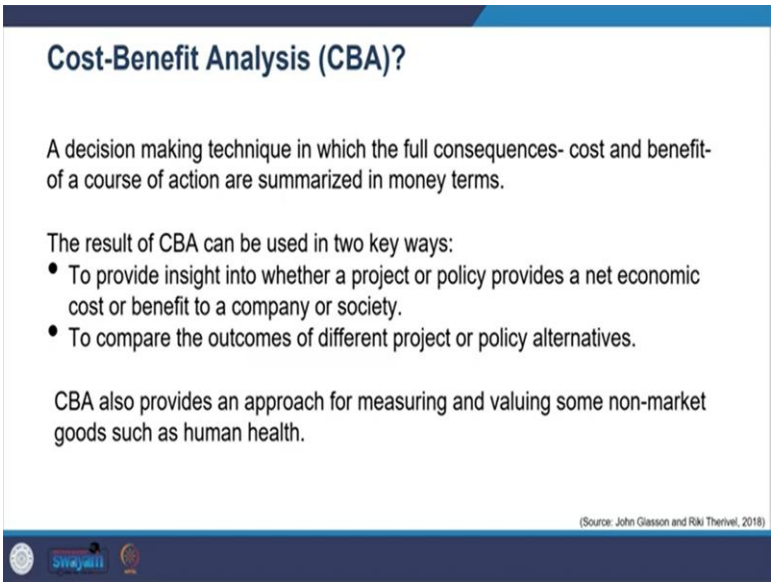

So, cost benefit analysis is seen as decision making technique in which full consequences, cost and benefits of a course of action. So, whatever actions you are going to take are summarized in form of money. So, that, is what we do in cost benefit analysis. And then the results of cost benefit analysis are like really indicate two key aspects. One is they provide insight into whether a project or a policy has some positive impact or not. So, net economic impact, or it has overall benefits to the company or to the society so, we look into that, So, it tells us by numbers, whether that, is there or not.

And then, the other key aspect to it is that, it allows to compare the outcomes of different projects or policy alternatives. So, you can compare like, which one is better, where your benefits are higher. So, cost benefit analysis also provides an approach for measuring and valuing some non-market goods such as human health. So, in this cost benefit analysis, you can also put value to certain things, which are not really has a market price, but you can also put values to the to that, So, this technique has that, capability, where it can accommodate those values as well.

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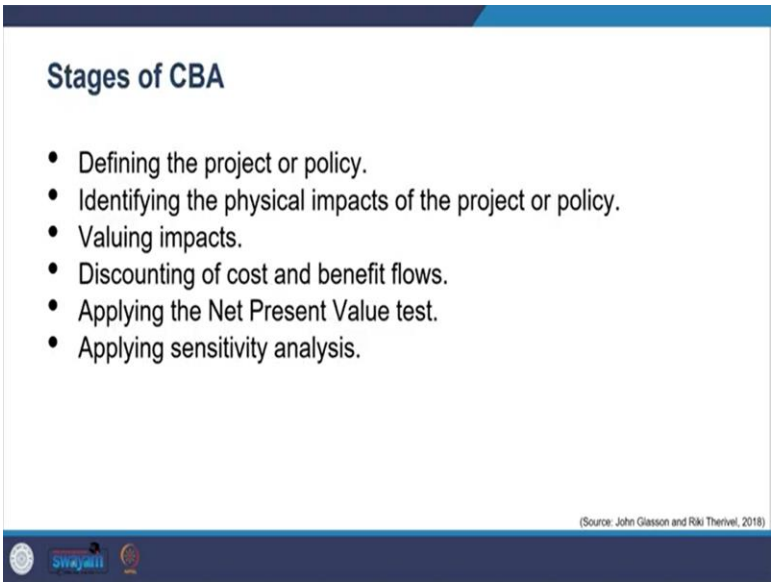

And there are certain stages to cost benefit analysis like you define the project, then you either define the physical impacts or the of the project or the policy, and then you value impacts, you assign value to the impacts, and then you also do the discounting of the cost and benefit flows. So, you see how those costs will be discounted and then what kind of benefits will come and then you look at the net present value, like what is the value today, and what benefits will get in future. And then you also look at the sensitivity analysis.

So, when I say sensitivity analysis, that, means we always in a project, we have certain reigns in which things work. So, what is what will be the minimum level and what will be the maximum level in which the benefits whatever number we are claiming would work. So, it also allows you to undertake sensitivity analysis.

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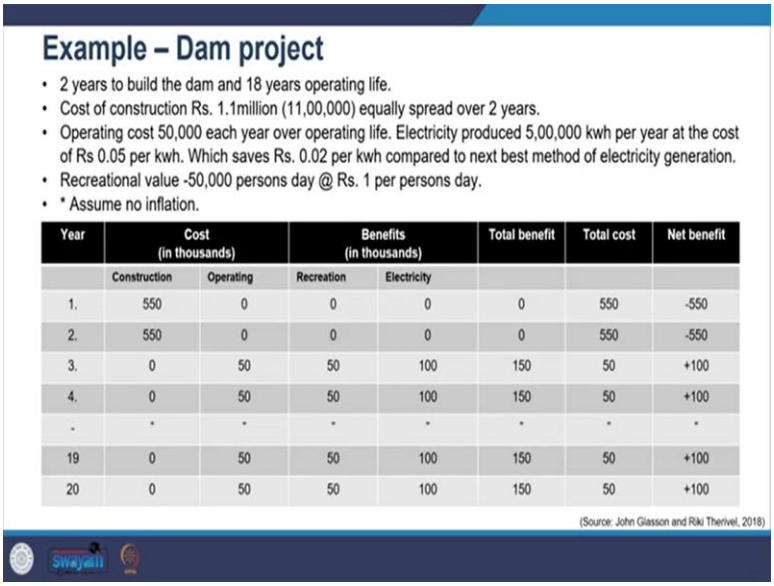

Year	Cost (in thousands)		Benefits (in thousands)		Total benefit	Total cost	Net benefit
	Construction	Operating	Recreation	Electricity			
1.	550	0	0	0	0	550	-550
2.	550	0	0	0	0	550	-550
3.	0	50	50	100	150	50	+100
4.	0	50	50	100	150	50	+100
.	.	.	.	.	.	.	.
19	0	50	50	100	150	50	+100
20	0	50	50	100	150	50	+100

So, here you can see the example of a dam project where the cost benefit analysis is undertaken. You can see how the overall cost is taken and the benefits different kinds of benefits have been given a value and then you

can see the total benefits and then the total cost. So, you are subtracting the cost from the benefits and you are seeing in the last column, you can see the net benefit. So, where you can see how the benefit is in a positive direction or in the negative direction, and how do they sum up to. And then you can see here like they have taken it for project period of 20 years. So, you can see in the first column 1, 2, 3, 4 and so on till 20 year's time.

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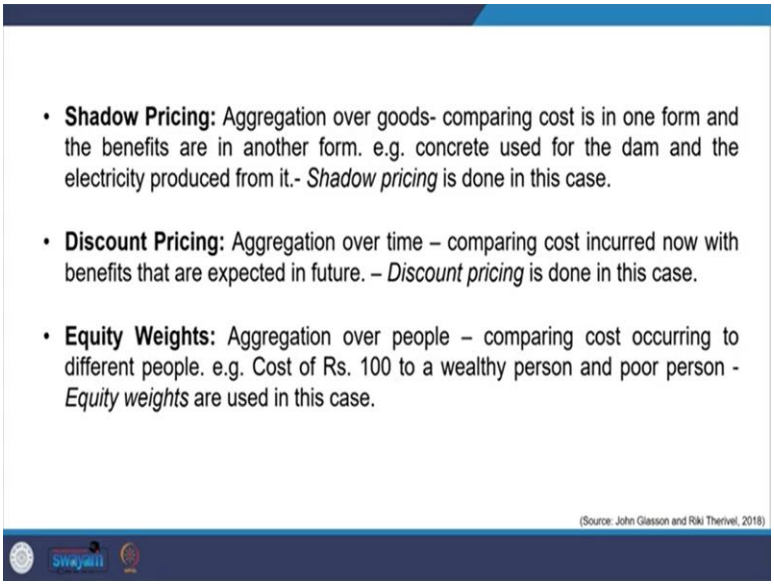

So, that, is how they are seeing and, in the process, one needs to undertake the shadow pricing, discount pricing and equity rate. So, what do we really mean by shadow pricing, it is like, you aggregate the what your goods you are getting, you aggregate it. So, for example, you compare the cost in one form, and the benefits are another form, for example, we are saying concrete use for dam, so that, is the cost investment, and then the benefit is in form of electricity produced from it. So, like, you see that, concrete is in one form, and then they produced electricity is in the another form. So, you are putting values to both of that, So, you are doing shadow pricing, you are putting applying a value to that.

And likewise, you see discount pricing, which is also said, that, aggregation over time, so the money which you are investing today, but the benefit, which you will receive, like in couple of years, and probably after like many years all together. So, that, ways you also discount the price for what benefits you are going to expect in the future. And then you also have equity rates so where, you see like, you also aggregate over the people like benefits to me like 100 rupees benefit to me to 100 rupees benefit to some other person who has less purchasing capacity, what would 100 rupees mean to that, and what would 100 rupees mean to a very rich person. So, we generally aggregate the cost across different groups so, that, is equity rates.

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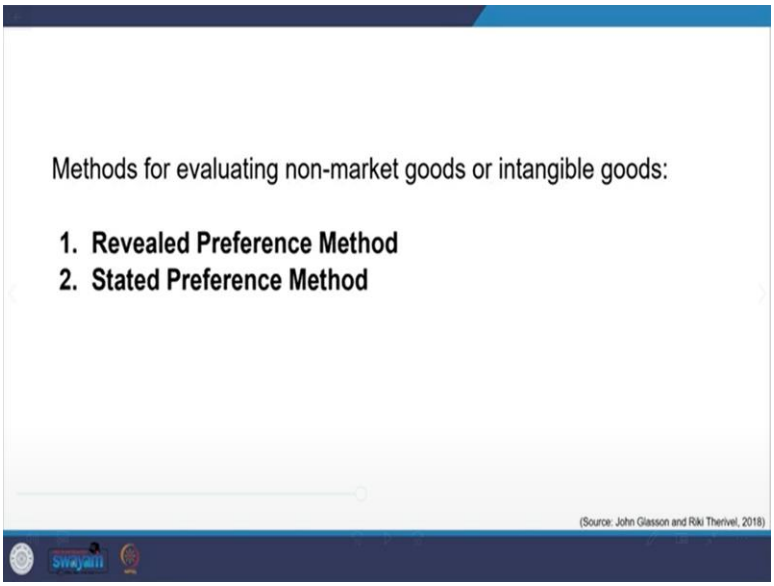

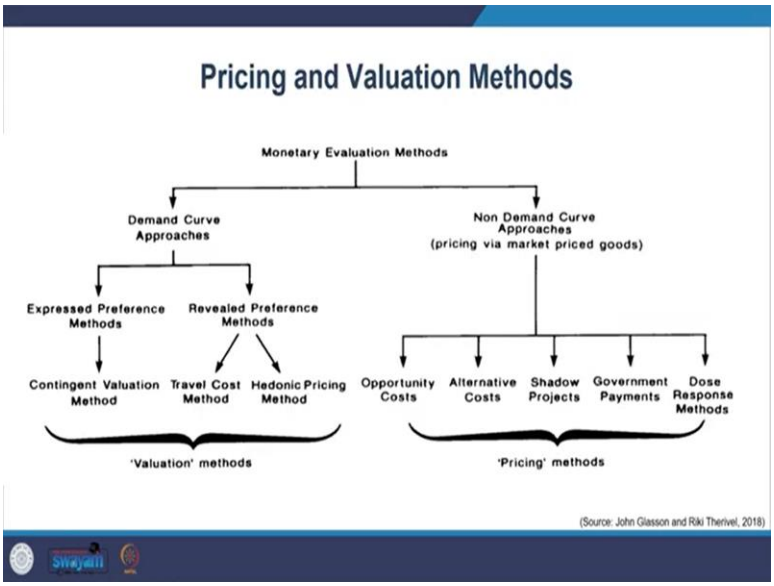

In this analysis CBA we can also assign value to non-market goods or intangible goods. And for this we use two methods which is Revealed Preference method and Stated Preference method. So, here in the diagram you can see the in the left-hand side demand curve approaches where you can see expressed preference methods and then revealed preference methods. So, these are the methods for pricing and valuation. So, these methods are there and then you can see like, what kind of pricing and valuation methods are used for the market price to goods like opportunity cost, alternative costs, Shadow projects, government payments and those response methods. So, all these we may not know all of them, it is just for your awareness that, you know that, such kind of details come.

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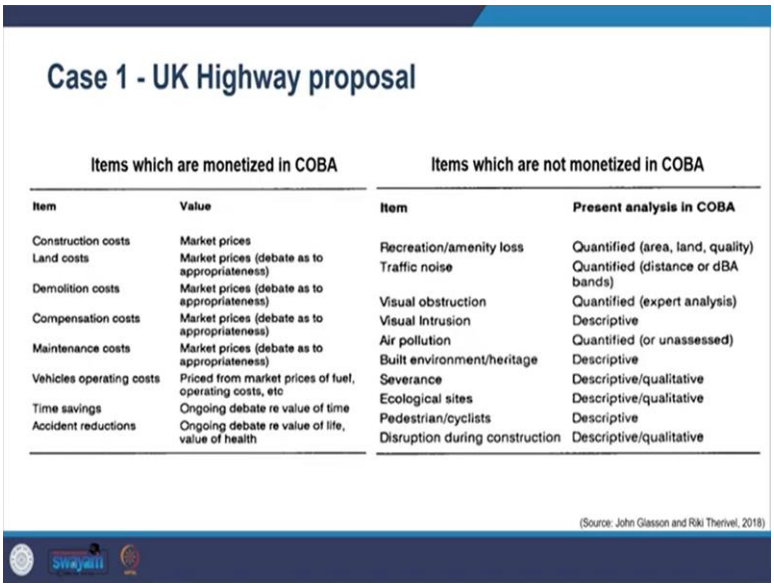

So, here in in one of the case study, you can see how they have put the value in this cost benefit analysis you can see the item construction costs, land costs. So, in on the left-hand side, you can see all the market prices, which are there. So, these are marketable costs, demolition costs, compensation, maintenance vehicle operating costs, and on the right-hand side of the table, you can see all the items that, cannot be monetized that, means you cannot really put a value to that, So, you see the recreational amenity last like you had a place where you could play but no longer you can play in that, place, or you are getting an additional place to play.

So, that, kind of loss or a gain and then you can put a quantify it with area land quality, and then traffic noise which might come with that, because of that, or the visual obstruction no longer you are able to see the beach which you had or Hill view which you had. So, those kinds of visual obstruction, visual intrusion, air pollution, all these you can really not put a money value to that, but then there are also ways how you can put a quantity to value more money to all these items.

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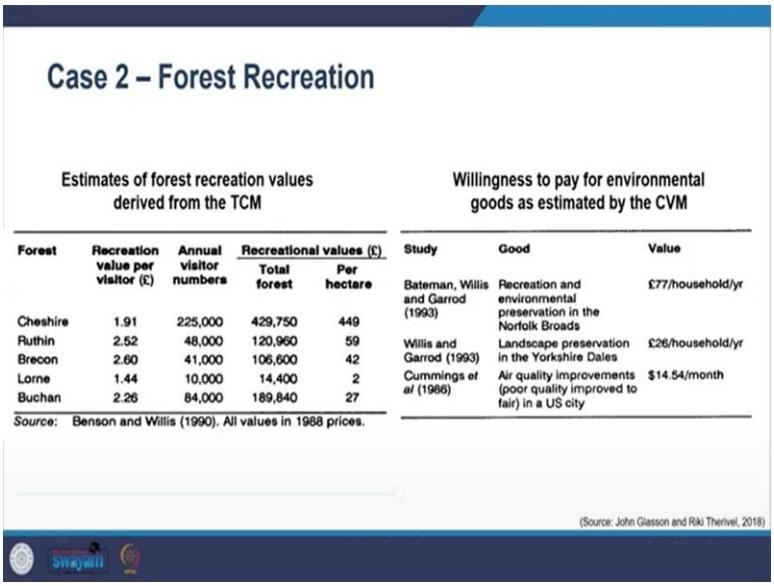

So, you see here another example how they have put value here they are calculating, estimating the value through TCM, which is, which is Travel Cost Method. So, which really looks into like how much you are willing to travel to take the benefit of this particular aspect. So, what value they have and how much they would really tap travel and pay for that, so, that, is TCM method. So, that, is another method through which you can really find out these values.

Then you have a willingness to pay for the environmental goods. So, through that, also you can work it out, like how much you are willing to pay for certain recreational and environmental things. So, how much ticket you're willing to pay for particular service and so on. So, those all help to put a value to the goods which can are not really marketable goods.

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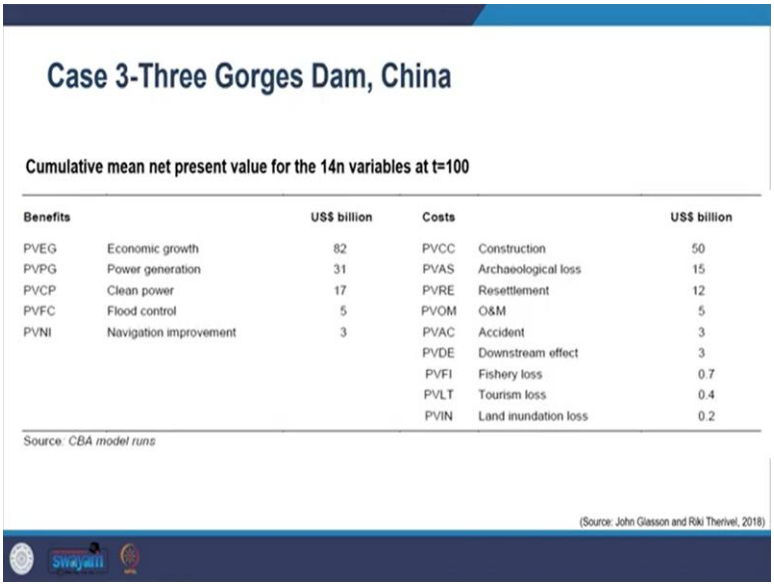

So, you can see another example here, that, is Three Gorges Dam in China, very you have these values have been given economic growth, power generation clean power, then you can see construction, archaeological loss, resettlement accidents, and so on. So, Valley has been assigned to that. So, cost benefit analysis has been, like, really, they it is very debatable and like, assigning value to these things have been debated a lot. So, but however, it is a very comprehensive way and to really identify and have a very distinct way of doing it, but then even there have been judgments about the values being manipulative or they have been taken on the lower side to show higher benefits and so on.

So, even this very comprehensive and very clear-cut method can also be manipulated or misused. So, a very little advanced version, which is said to be a better way of doing it is the Planning Balance Sheets, PBS, and its slight variation with the cost benefit analysis. And it has advantage in terms of that, it attempts to identify and enumerate and evaluate the distribution of costs and benefits between affected parties.

So, between all different groups of parties tries to identify like, what kind of costs and benefits they would have. So, you would really know who is who for whom that, project is working and for whom it is not working and how it is wading across. So, those things can be taken care of.

So, you have this, it sets this particular method sets the social account structure, and it looks at the producer and consumer in the entire process. So, that, was about cost benefit analysis looking at the another method is for significance, evaluation is scoring, weighting and multi criteria methods. So, in this you see that, multi criteria method looks in it allows to overcome lot of drawbacks, what you see in the cost benefit analysis.

So, it allows you to look at lots of multi criteria as the name suggests, it allows you to look at different criteria's. What are of concerns to us, it allows us to look into that, and then it also helps us to integrate with various stroke stakeholders and diverse it helps us to look at the different objectives also and then helps us to bring the perspective of different stakeholders. And then we can also handle different values which are assigned to the environmental change.

So, far me a job would be important for somebody their environment would be important as they might be very stable in terms of their income. So, that, this particular method allows them to take care of differing values concerning environmental change. So, we see that, even this method can be misused we see that, even this method can be misused and during this multi criteria method, we see that, we use simple scoring and weighting system.

And when we do scoring and weighting that, also generates debate that, means, how do we score and how do we wait when I say waiting system means to assigning a value to particular factor like how much water is important to me, how much beauty is important to me, how much culture is important to me, how much air pollution is not acceptable to me.

So, how do we really give weightage assign a value to that, So, those things are done here, but then this is a lot it generates a lot of debate. So, scoring may be used, like for both qualitative and quantitative skills. So, you can have scoring for in both ways and according to what kind of information is available to you, regarding the impact under consideration.

And then through weighting, we try to find out the relative importance of various impact types, what important we assign. And like for example, relevance of water pollution impact and impact, and then if there is impact happening on the rare flower, so what value we would assign to both of them. One side the water pollution other side as impact on the rare flower.

So, different impacts may be allocated weights, normally numbers we give normally numbers to it out of the total budget that, is we have 10 points to be allocated between three impacts. And like, there are experts who do that, or that, can be by the community representatives who can do that.

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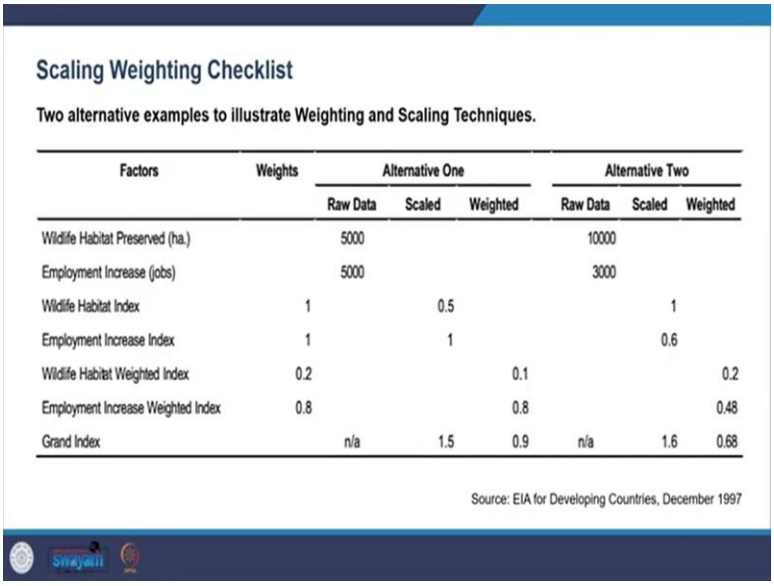

So, in this example, you can see here scaling, weighting checklists. So, this the checklist here and you see how two alternatives are seen here. So, you can see in the first column, you can see all range of factors like wildlife habitat, employment, wildlife habitat index, employment increase index, so they have been converted into index and then how we are weighting it. So, you in the second column, you can see that, wildlife has one weight unemployment increase has one weight. So, that, means in whichever context we are talking about, we are giving equal weightage age to body aspect.

And then we are looking at like, how much is the change, you can see that, all in the alternative one you have wildlife habitat preserved is 5000 whereas in the alternative two you have wildlife preserved which is 10000. So, you are preserving more of the wildlife and employment increase in the first alternative is 5000 whereas in

the second alternative is 3000. So, how do you really look at that, and how do you uh scale that, so you can see in alternative 1 the actual score is coming 0.5 and in the alternative two it is coming 1.

And for wildlife habitat index and in the employment increase you can see it is 1 and 0.6. So, that, is one highest value divided by the smallest value that, is how that, has been done to take out that, 0.5 and 0.6. And then you see that, in the wildlife habitat weighted index you are now taking out the weights. You are assigning weights, so in that, context you are seeing that, wildlife has been assigned 0.2 weight whereas employment increase weighted index has been assigned 0.8. So, that, means in that, context you are giving more weightage to increase in the employment compared to wildlife habitat.

So, wildlife habitat is given any change in that, is given 0.2 whereas employment is given 0.8. So, then you look at that, and then you see that, how much will that, have as per the scale and then you get the value there 0.9 and 0.68. So, you can see that, which value is higher and which one is a more feasible one option for you. So, that, is how we look at the scaling and weighting methods so what how do you scale it and how do you weight it.

Then you also have ranking of alternatives so you can also use ranking like you can give them like which one is first and second and third in the order so you can also have ranking. And ranking can be done with respect to alphabets also or you can have 1 2 3 you can have a b c or you can have not-significant, significant and very significant so you can also find out that, way. More other aspects other method which is also very often used is Delphi approach which uses individuals weight individuals weight from which group weights are then derived. So, you ask a lot of people their what weight they assign to particular thing and then you have a group weight you derive group weight from that.

So, wherever possible it is important that, the scoring and weight weighting should be used to understand like what kind of exchange we are doing so what kind of compromise or what kind of adjustment we are doing we are adjusting with the wild life or we adjusting with the job what are we really settling in for. So, when we do their scoring and waiting it helps us to understand that. And all these scoring and weighting can also be built on the GIS and you can also do it on the overlay map. So, GIS is geographic information system where you can have different layers of maps and then you can have all the values and it can process all the values and combination and show you different scenario.

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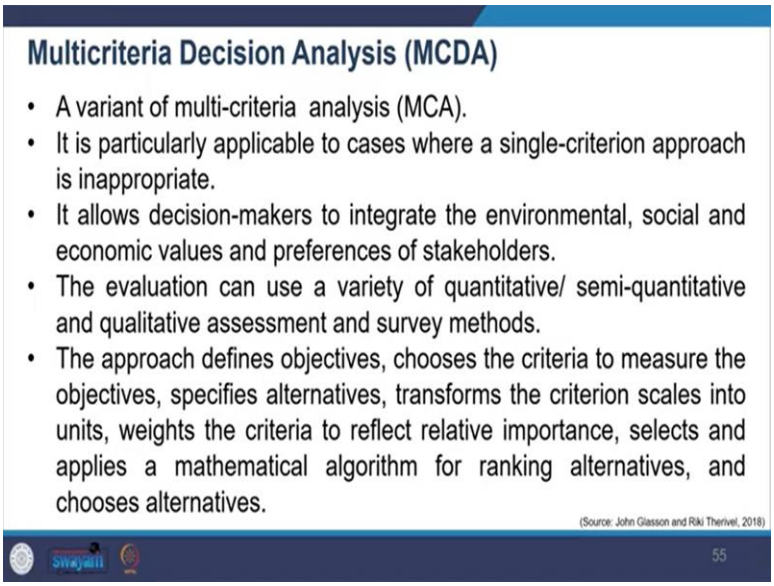

So, further, looking into multi-criteria decision analysis you also have multi-criteria analysis MCA and this is also emerging. And you see lot of examples where these have been used and has been used a lot. And this allows decision makers to integrate the environmental social economic values and preferences of stakeholders and while overcoming the monetization of the intangible non-monetary attributes. So, here you see that, this allows you, you are not really putting money value to wildlife for something but you are taking it the way it is so it is allowing you to process the information and allowing you to make the decisions based on that, without assigning a monetary value to that.

So, typically this approach has very defined objectives you can choose between the criteria's which criteria's you have to take then are going to also choose among the alternatives like the example which you saw and you can transform different kind of parameters like we did in the wildlife and employments. We could translate that, into one unit and we could compare those alternatives.

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Checklist and Matrix System

Simple checklist developed for the Huasai-Thalc Noi Road Project
(source: National Environment Board. 1980)

Items	Nature of Likely Impacts: Adverse ST	LT	R	IR	L	W	Beneficial ST	LT	SI	N
Aquatic Ecosystems		x		x	x					
Fisheries		x		x	x					
Forests		x		x	x					
Terrestrial Wildlife		x		x		x				
Rare & Endangered Species		x		x		x				
Surface Water Hydrology		x		x		x				
Surface Water Quality		x								
Groundwater	*	*	*	*	*	*	*	*	*	*
Soils										
Air Quality	x				x					
Navigation		x			x					
Land Transportation								x	x	
Agriculture							x			x
Socioeconomic								x		x
Aesthetic		x			x					

Legend: x indicates potential for type of impact; R denotes Reversible; W denotes Wide; ST denotes Short Term; IR denotes Irreversible; SI denotes Significant; LT denotes Long Term; L denotes Local; N denotes Normal

Source: EIA for Developing Countries, December 1997

The checklist is prepared in the form of a table, that looks something like this-

No.	Questions to be considered in Scoping	Yes/No?	Which Characteristics of the Project Environment could be affected and how?	Is the effect likely to be significant? Why?
1. Will construction, operation or decommissioning of the Project involve actions which will cause physical changes in the locality (topography, land use, changes in waterbodies, etc)?				
1.1	Permanent or temporary change in land use, landcover or topography including increases in intensity of land use?			
1.2	Clearance of existing land, vegetation and buildings?			
1.3	Creation of new land uses?			
1.4	Pre-construction investigations eg boreholes, soil testing?			
1.5	Construction works?			
1.6	Demolition works?			
1.7	Temporary sites used for construction works or housing of construction workers?			
1.8	Above ground buildings, structures or earthworks including linear structures, cut and fill or excavations?			
1.9	Underground works including mining or tunnelling?			
1.10	Reclamation works?			

When answered, it looks like this-

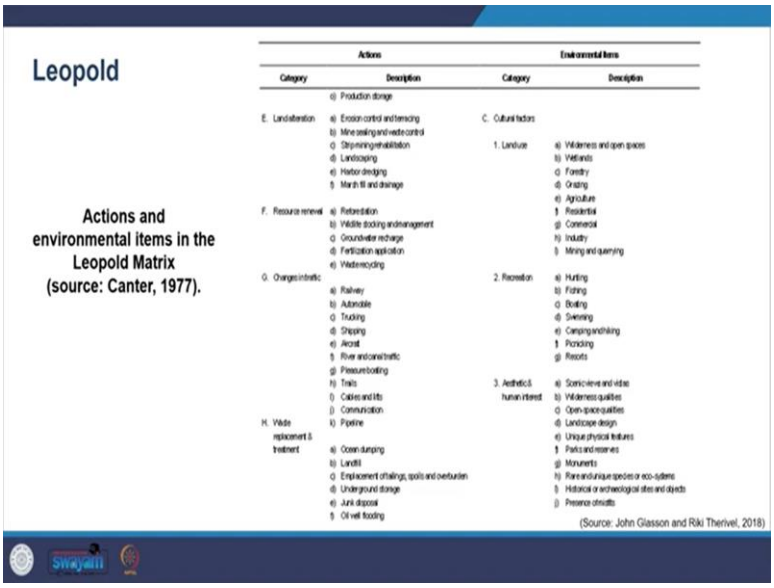
3.4	Are there especially vulnerable groups of people who could be affected by the project eg hospital patients, the elderly?	Yes	Project location is adjacent to regional hospital and long term care centre. Potential for significant noise and other disturbance during construction	Yes - Hospital environment may become much noisier over one year construction period.
4. Will the project produce solid wastes during construction or operation or decommissioning?				
4.2	Municipal waste (household and or commercial wastes)?	Yes	New population will generate household and other wastes	No- there is ample local waste management capacity
5. Will the project release pollutants or any hazardous, toxic or noxious substances to air?				
5.3	Dust or odours from handling of materials including construction materials, sewage and waste?	yes	Earth moving during construction could be dusty in dry climate and affect neighbouring habitats and residents	Yes - Habitat is internationally protected and vulnerable to dust deposition. Condition of hospital patients could be worsened by exposure to dust
6. Will the project cause noise and vibration or release of light, heat energy or electromagnetic radiation?				
6.3	From construction or operational traffic?	yes	Heavy traffic flows for import of material during construction affecting residents and hospital	Yes - noise levels already elevated by traffic and industry
7. Will the project lead to risks of contamination of land or water from releases of pollutants onto the ground or into sewers, surface waters, groundwater, coastal wasters or the sea?				
7.2	From discharge of sewage or other effluents (whether treated or untreated) to water or the land?	Yes	Increase in municipal sewage flows from new residents	Possibly - depends on requirement for new treatment facilities

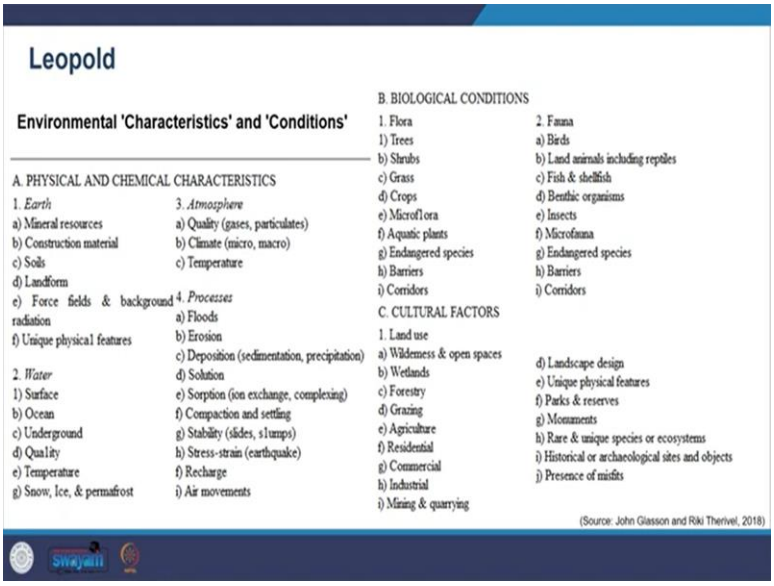
Source: ec.Europa.eu

Leopold

Actions and environmental items in the Leopold Matrix (source: Canter, 1977).

Actions: Category	Actions: Description	Environmental Items: Category	Environmental Items: Description
A. Modification of regime	a) Exotic fauna introduction	A. Physical & chemical characteristics	
	b) Biological controls	1. Earth	
	c) Modification of habitat		a) Mineral resources
	d) Alteration of ground cover		b) Construction material
	e) Alteration of ground water hydrology		c) Soils
	f) Alteration of drainage		d) Land form
	g) River control & flow modification		e) Force fields & background radiation
	h) Canalization		f) Unique physical features
	i) Irrigation	2. Water	
	j) Weather modification		a) Surface
	k) Burning		b) Ocean
	l) Surface or paving		c) Underground
	m) Noise & vibration		d) Quality
B. Land transformation & construction	a) Urbanization		e) Temperature
	b) Industrial sites & buildings		f) Recharge
	c) Airports		g) Snow, ice & permafrost
	d) Highways & bridges	3. Atmosphere	
	e) Roads & trails		a) Quality (gases, particulates)
	f) Railroads		b) Climate (micro, macro)
	g) Cables & lifts		c) Temperature
	h) Transmission lines, pipelines & corridors	4. Processes	
	i) Barriers including fencing		a) Floods
	j) Channel dredging & straightening		b) Erosions
	k) Channel retaining walls		c) Deposition (sedimentation, precipitation)
	l) Canals		d) Solution
	m) Dams & impoundments		e) Sorption (ion exchange, complexing)
	n) Piers, seawalls, marinas & sea terminals		f) Compaction & settling
	o) Offshore structures		g) Stability (slides, slumps)
	p) Recreational structures		h) Stress (rain/earthquake)
	q) Blasting & drilling		





So, here you can see the matrix what we see here the all the criteria items which you can see here from aquatic fisheries and so on. And then adverse and beneficial so those examples you can see here. And then you can see others checklist where it is allowing you to take care of all the parameters. Then you also have existing Leopold matrix matrices which allows you to take care of all the aspects. You can see the range of aspects which have been covered however it has been criticized for being more focused on the geo physical geophysical aspect of the environment.

But this can this method can be modified and used. Then you can see like the range of parameters which Leopold matrix has you can see the physical and chemical characteristic earth atmosphere water cultural factors biological conditions all these are there. You can see the mining querying all these aspects which are there and how you can really put values and have the significance and then assign it in a very simple matrix.

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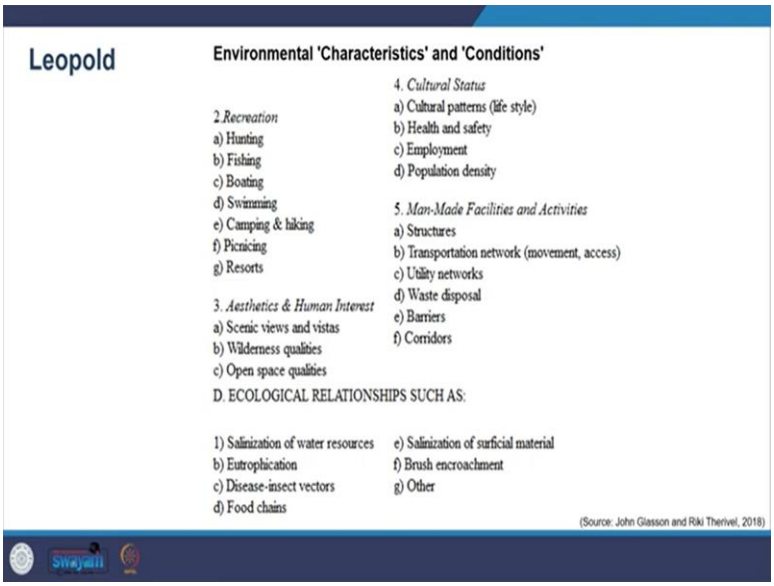

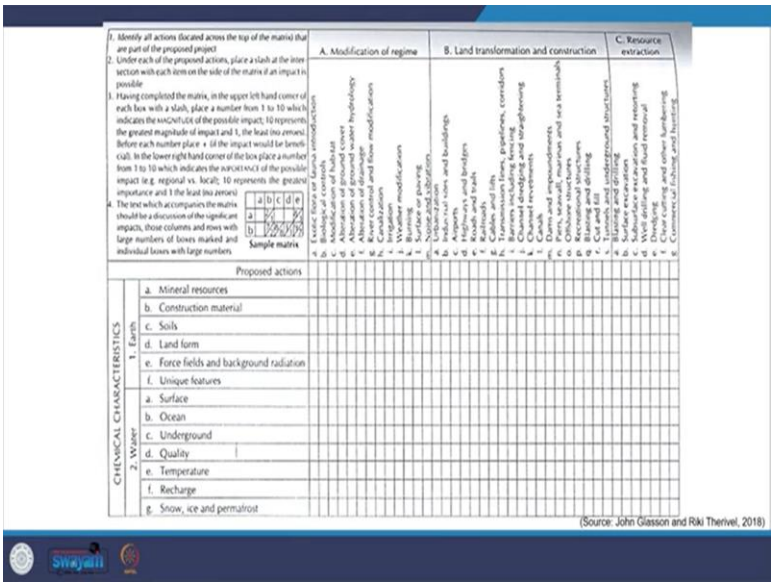

And you can see how the overall matrix would look like. So, this matrix is very comprehensive in covering both the physical biological and socio-economic environment as well. So, you see that, and however it is you can see that, it would be difficult to accommodate too much of information but it is very easy to communicate.

So, many times for the communication aspect also you use such matrices because it is easy to read there are so many aspects which come in the process. So, it is very easy for to communicate and others to understand what is really happening here. So, all these approaches what you are seeing can be used independently as well as it they can be used in combination and now a lot of these are being used with GIS. And then you can also see cost benefit analysis can be also clubbed with multi-criteria decision analysis as well.

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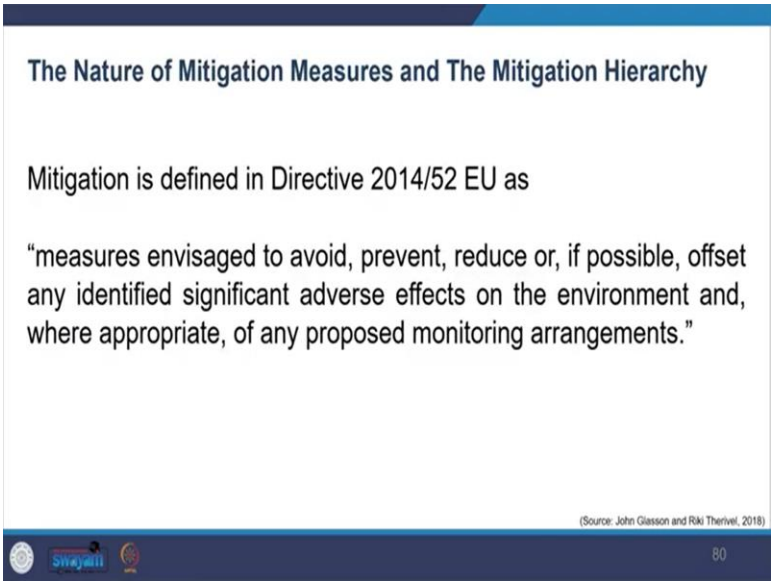

So, now looking at the another component of his mitigation and enhancement so now we are talking about mitigation. So, mitigation is like what kind of measures what kind of protection you are going to take how what kind of care you are going to take to avoid or prevent or reduce whatever kind of impact is going to happen as per your study. So, how you are going to offset any of those significance of a significant impact which you have adverse impact in particular you have identified from your study. So, how you are going to reduce it or you know how you are going to prevent it how you are going to avoid it so that, is what you take care in the mitigation aspect so you call it mitigation measure.

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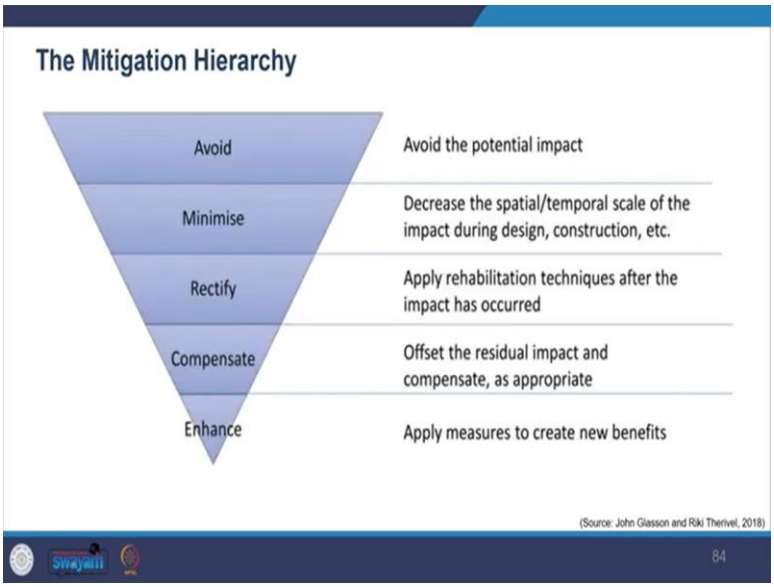

And we see mitigation is that, of a mitigation hierarchy with the primary focus on the avoidance step followed by more secondary consideration of the subsequent reduction and compensation and steps. So, even this mitigation is like you deal in a hierarchical manner which is called the mitigation hierarchy. So, it is just not that, you avoid or think but when you are not able to mitigate where you are not able to avoid then what are the steps you can take. So, the basic principle behind mitigation hierarchy is that, first you try to prevent allowing it first thinking of if it is better if it does not happen those kind of impact.

And when if it happens then how you can reduce or how you can compensate for that. So, here you can see the diagram here you can see that, more and more effort has to be made to avoid any kind of impact. Then in case where the impact happens how do you reduce the impact how do you minimize the impact and then how do you rectify it by the technological intervention how do you reduce that. And if other impacts if nothing can be done not avoided not minimized or not rectified how do you really compensate the people for that, or any recipient for that. And then the other part is how do you really enhance the impact of the project.

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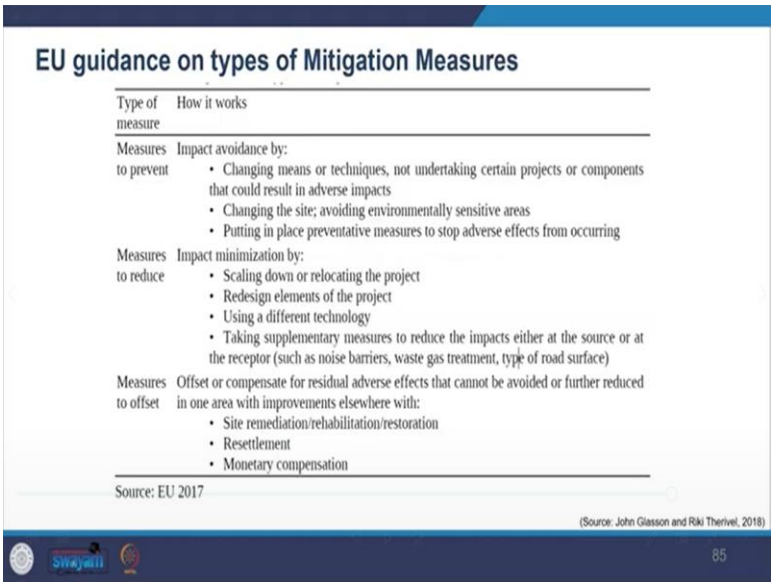

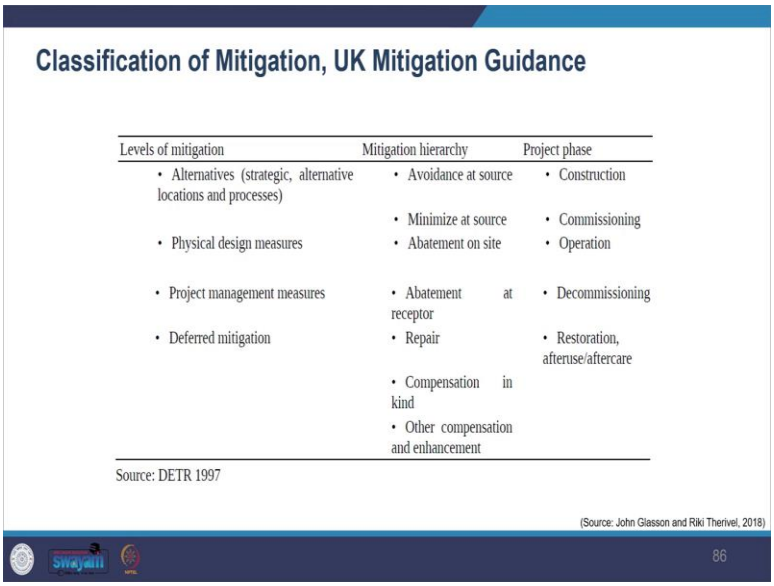

So, you can see EU guidance in this aspect as well and then there are other classification of mitigations like what kind of mitigations can be done you can have alternators physical designs project management measures deferred mitigation. So, you can have alternatives in your project and then you can also have design measures where you can improve the technology you can improve the way you approach the problem.

And then you can also do improve things by managing the project in certain way and then you can differ have a deferred mitigation that, you can sequence the mitigation in order. So, you see the mitigation hierarchy avoidance at the source minimize at the source abatement on site then repair compensation in kind and other compensation and enhancement and this all can be seen in the project phase wise.

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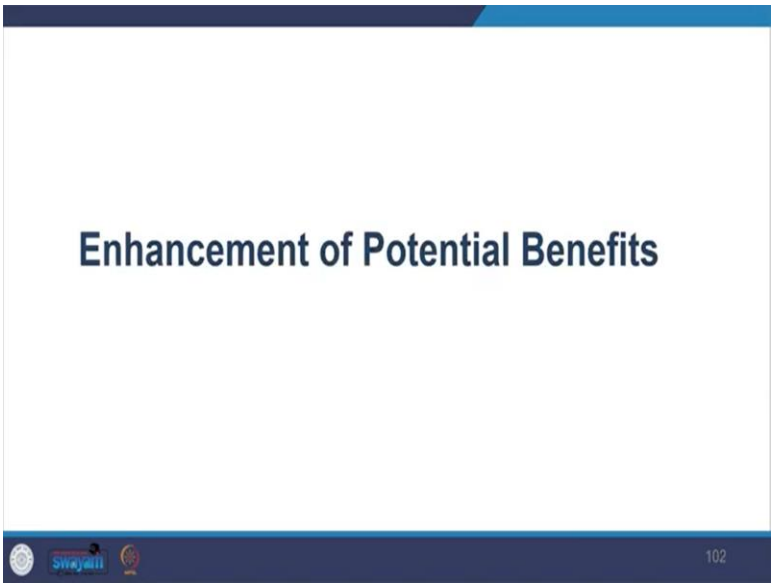

Now, coming to the other parts of this is enhancement of potential benefits so how do we really enhance the potential benefits. So, in any project there are impacts but then how do we really focus on the positive impact and how we can improve it and enhance it so that, is what we look in this aspect. And you can enhance the positive impact of the project and enhancement focuses on the positive impact.

So, this would mean going beyond just the mitigation just not really whatever impact is happening you just reduce that, but you really focus on much more so this would not really be inclined with the EIA requirement but much more about the policies and other interventions and responsibilities the proponents take care of.

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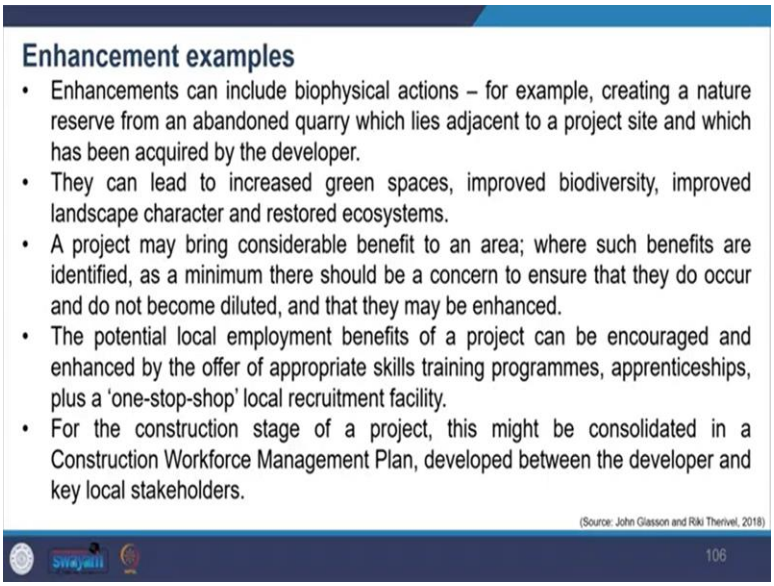

So, the examples of enhancement may include that, the projects like if you have a query abundant query that, can be used as a natural nature reserve. Then if you have certain green spaces so you can improve the biodiversity of the space. And then certain socio-economic activities can be taken up so all those include.

And then plus when you have certain coming up then you can have training center where you can create build capacity to train people so those kinds of enhancement can be done here. And then also when for the project, the projects are executed then the procurement management, through the procurement management plan, local people can be involved so the benefits of the economy percolates to the local people.

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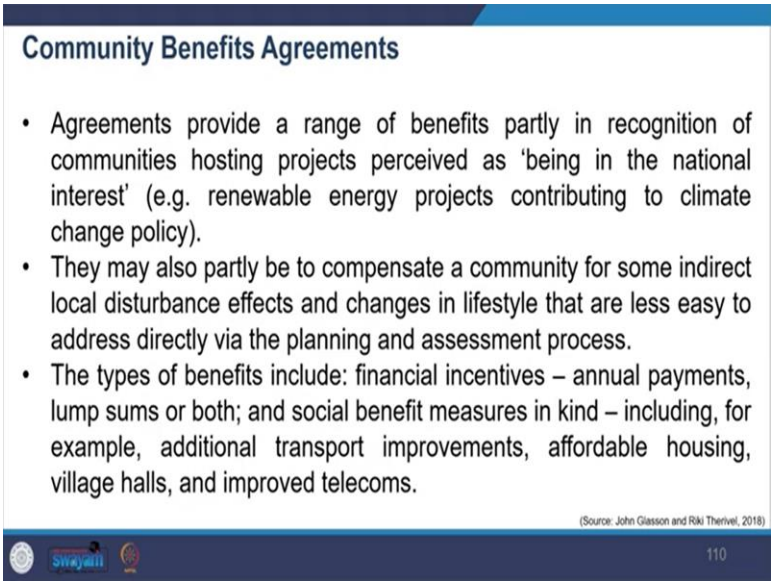

And then, there is also community benefits agreement. So, they are also like, how community really benefits from all the process is taken care of and these benefits include financial incentives as well as you have other social benefits like, you can have transport improvements affordable housing village halls and improved telecoms and so on so that, way you can improve it. And then, you have certain community benefit agreements especially for Indigenous people as well, you will see and then IIA, also gives guidelines on how to take care of it.

So, this you also see that, all this assessment helps you to see what kind of trade-offs what kind of exchange you are making how you are what negative impact you are taking and what positive impacts you are taking what you are compromising for what so it allows you to take care of that.

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So, winding up here today, we looked into how do we really evaluate the significance of any impact. And then how do we also try to understand mitigation and mitigation measures and then we looked at ways to enhance potential benefits. And then, had developed a cons little understanding about the trade-offs.

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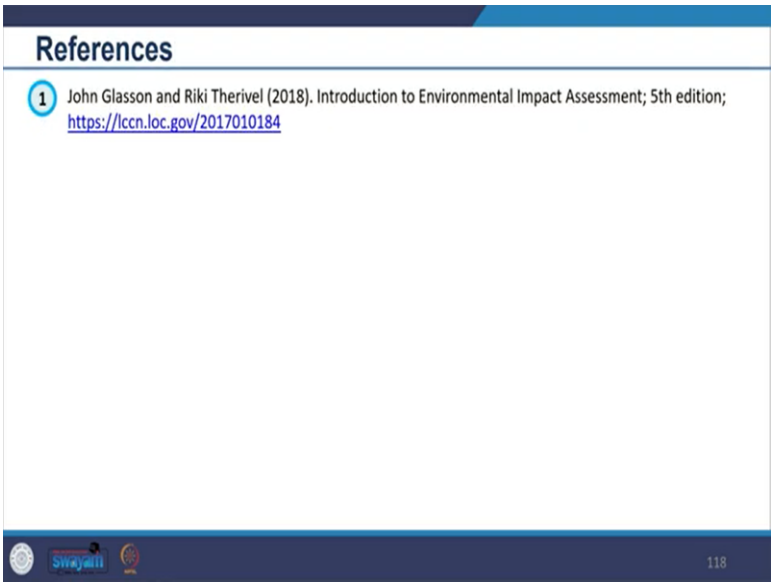

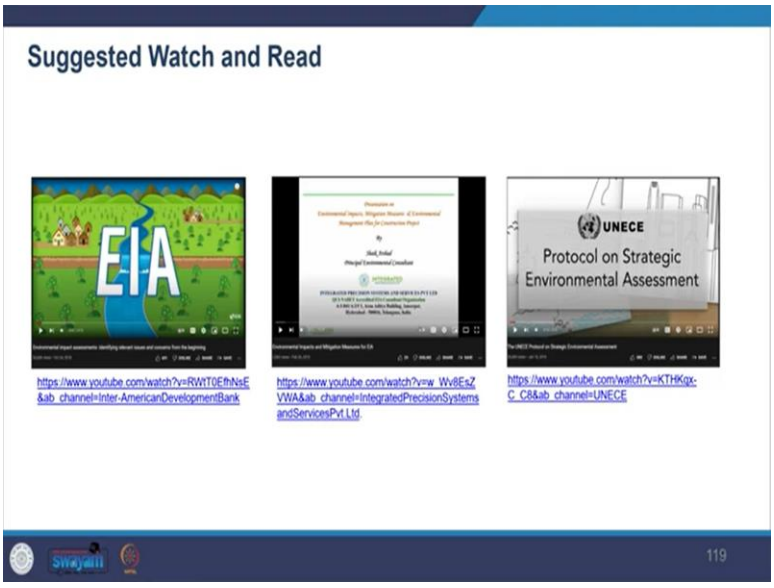

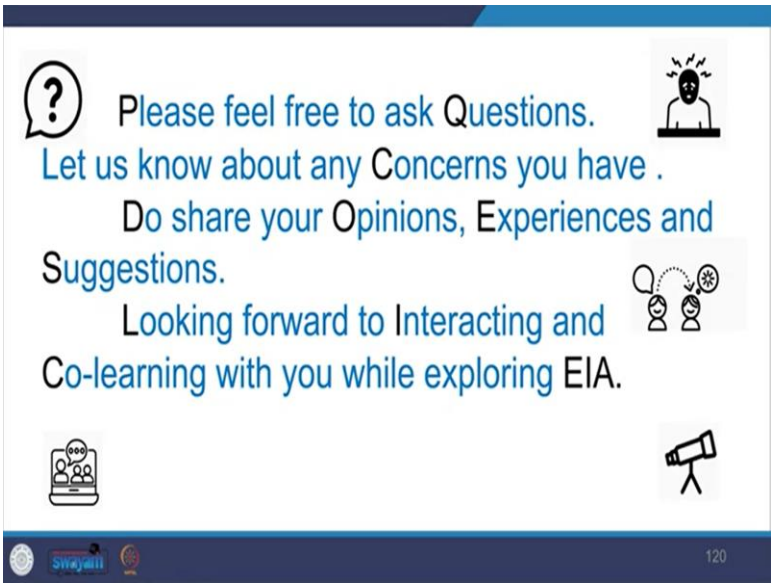

So, this was the key reference for this particular session we looked at Glasson and Riki Therivel book here, key reference and these are the suggested watch and read. Please feel free to ask questions and let us know about any concerns you have, do share your opinions experiences and suggestions. Looking forward to interacting and co-learning with you while exploring AI thank you.