

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 whether the impact can be acceptable or not.

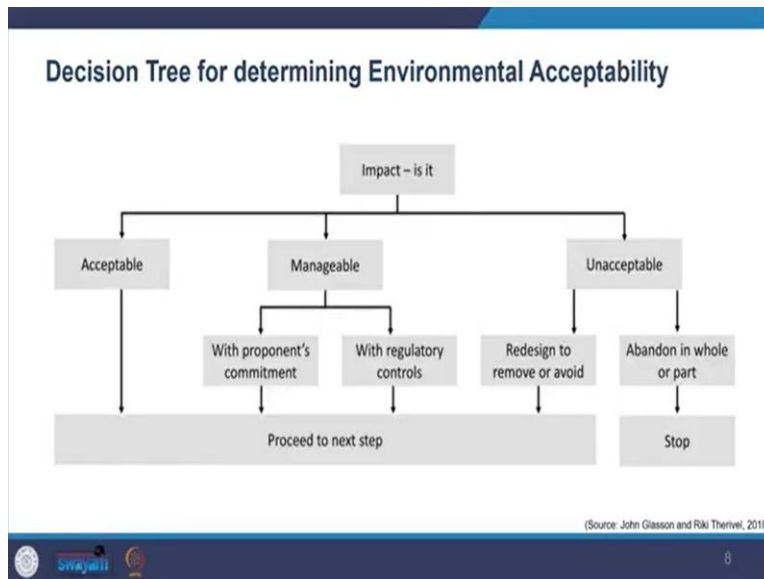
So, if it helps like as a professional, you would be placing all the impacts there and then also relating it to the significance of the decision makers can really be helped facilitated to draw conclusions regarding the proposed project. So, we see that, EIA, majorly our focus is on the impact, which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

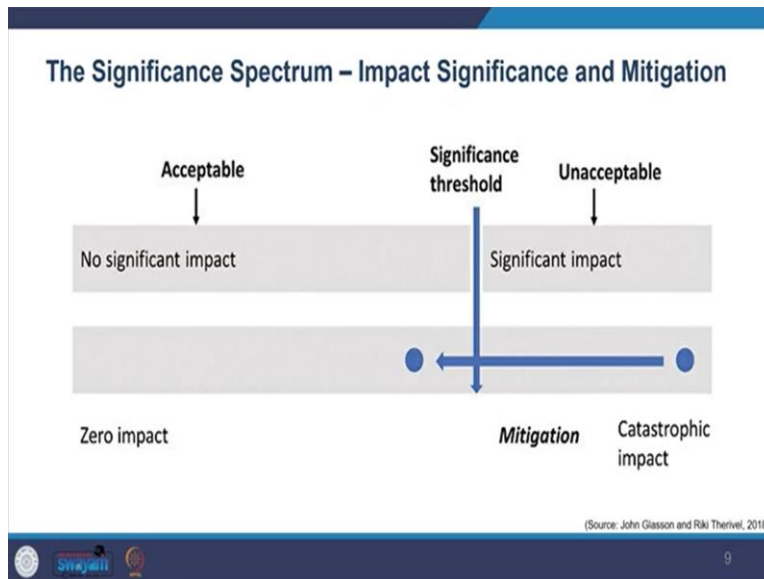
So, whatever impact is happening, it is acceptable. So, you can proceed to the next step. And you might also have chances in the center you see manageable. So, when the impacts are manageable, and you can manage it with the help of commitment, what the proponent gives, like what kind of mitigations they 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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Assessment Framework for Hornsea 2 Offshore Wind Farm, UK

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 major	Major or substantial	Substantial

(Source: John Glasson and Riki Therivel, 2018)

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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	Non-negotiable impacts	Negotiable impacts*
<i>Ecological (physical and biological systems components)</i>	<ul style="list-style-type: none"> • Degrades essential life support systems • Degrades the conservation estate • Adversely affects ecological integrity • Loss of biodiversity • Loss of human life 	<ul style="list-style-type: none"> • No degradation beyond carrying capacity • No degradation of productive systems • Wise use of natural resources
<i>Human (humans as individuals or in social groupings)</i>	<ul style="list-style-type: none"> • Reduces public health and safety unacceptably • Unreasonably degrades quality of life where people live 	<ul style="list-style-type: none"> • Community benefits and costs and where they are borne • Reasonable apportionment of costs and benefits • Reasonable apportionment of intergenerational equity • Compatibility with defined environmental policy goals

Source: Sippe 1994
*In terms of net environmental benefits

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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Criteria and Standards for determining Significance Thresholds

- Scientific evidence
- The value of the affected environment
- The level of public concern
- Political repercussions
- Public interest or perception
- Past and current perceptions of the significance
- Impact of particular issues will matter

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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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Determinants of Environmental Significance

1. The values, sensitivity and quality of the environment which is likely to be impacted;
2. The extent of the likely impacts;
3. The consequence of the likely impacts (or change);
4. Resilience of the environment to cope with change;
5. The cumulative impact with other projects;
6. Level of confidence of the impacts predicted;
7. Objects of the act, policies, guidelines, procedures and standards against which a proposal can be assessed;
8. The public concern;
9. Presence of strategic planning policy framework; or
10. The extent to which other statutory decision making processes meet the EPA's objectives and principles for EIA.

Source: West Australian Environmental Protection Authority 2010

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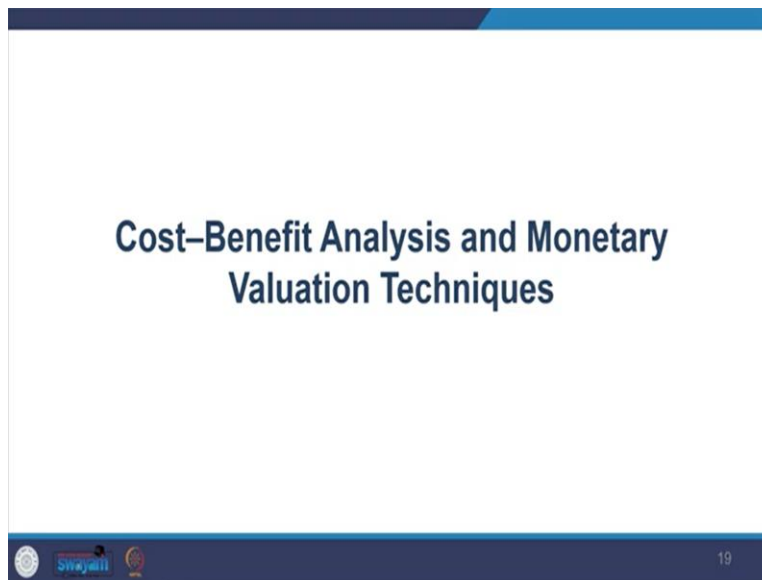
You can also see in the literature, various determinants of environmental significance like you have, this is given by APA or West Australia, where you see the value sensitivity and quality of environment which is likely

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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Cost-Benefit Analysis (CBA)?

A decision making technique in which the full consequences- cost and benefit- of a course of action are summarized in money terms.

The result of CBA can be used in two key ways:

- To provide insight into whether a project or policy provides a net economic cost or benefit to a company or society.
- To compare the outcomes of different project or policy alternatives.

CBA also provides an approach for measuring and valuing some non-market goods such as human health.

(Source: John Glasson and Riki Therivel, 2018)

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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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Stages of CBA

- Defining the project or policy.
- Identifying the physical impacts of the project or policy.
- Valuing impacts.
- Discounting of cost and benefit flows.
- Applying the Net Present Value test.
- Applying sensitivity analysis.

(Source: John Glasson and Riki Therivel, 2018)

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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Example – Dam project

- 2 years to build the dam and 18 years operating life.
- Cost of construction Rs. 1.1million (11,00,000) equally spread over 2 years.
- Operating cost 50,000 each year over operating life. Electricity produced 5,00,000 kwh per year at the cost of Rs 0.05 per kwh. Which saves Rs. 0.02 per kwh compared to next best method of electricity generation.
- Recreational value -50,000 persons day @ Rs. 1 per persons day.
- * Assume no inflation.

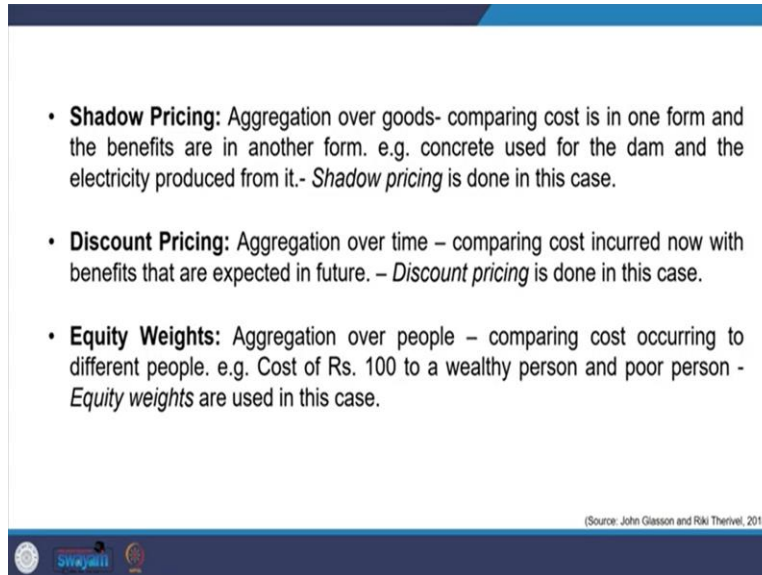
Year	Cost (in thousands)		Benefits (in thousands)		Total benefit	Total cost	Net benefit
	Construction	Operating	Recreation	Electricity			
1.	550	0	0	0	0	550	-550
2.	550	0	0	0	0	550	-550
3.	0	50	50	100	150	50	+100
4.	0	50	50	100	150	50	+100
-	-	-	-	-	-	-	-
19	0	50	50	100	150	50	+100
20	0	50	50	100	150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

(Source: John Glasson and Riki Therivel, 2018)

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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- **Shadow Pricing:** Aggregation over goods- comparing cost in one form and the benefits are in another form. e.g. concrete used for the dam and the electricity produced from it.- *Shadow pricing* is done in this case.
- **Discount Pricing:** Aggregation over time – comparing cost incurred now with benefits that are expected in future. – *Discount pricing* is done in this case.
- **Equity Weights:** Aggregation over people – comparing cost occurring to different people. e.g. Cost of Rs. 100 to a wealthy person and poor person - *Equity weights* are used in this case.

(Source: John Glasson and Riki Therivel, 2018)

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.

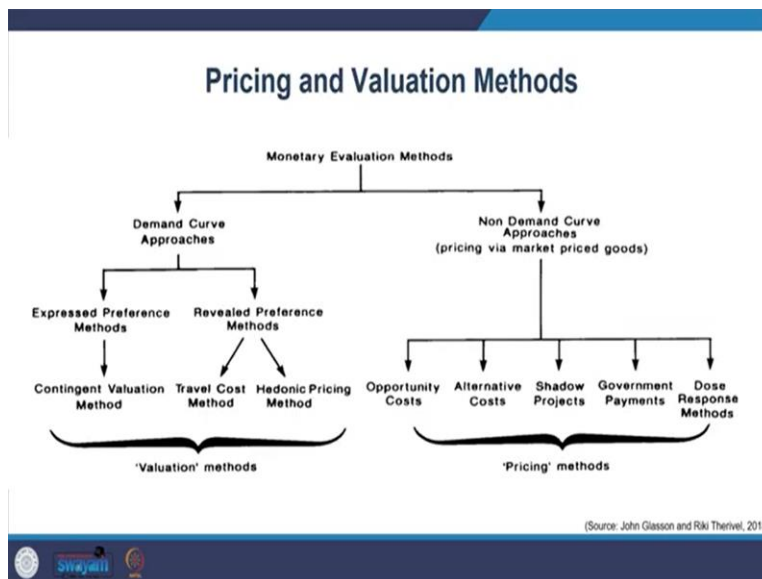
And likewise, you see discount pricing, which is also said, that, aggregation over time, so the money which you are investing today, but the benefit, which you will receive, like in couple of years, and probably after like many years all together. So, that, ways you also discount the price for what benefits 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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Methods for evaluating non-market goods or intangible goods:

1. Revealed Preference Method
2. Stated Preference Method

(Source: John Glasson and Riki Therivel, 2018)



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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Case 1 - UK Highway proposal

Items which are monetized in COBA		Items which are not monetized in COBA	
Item	Value	Item	Present analysis in COBA
Construction costs	Market prices	Recreation/amenity loss	Quantified (area, land, quality)
Land costs	Market prices (debate as to appropriateness)	Traffic noise	Quantified (distance or dBA bands)
Demolition costs	Market prices (debate as to appropriateness)	Visual obstruction	Quantified (expert analysis)
Compensation costs	Market prices (debate as to appropriateness)	Visual intrusion	Descriptive
Maintenance costs	Market prices (debate as to appropriateness)	Air pollution	Quantified (or unassessed)
Vehicles operating costs	Priced from market prices of fuel, operating costs, etc	Built environment/heritage	Descriptive
Time savings	Ongoing debate re value of time	Severance	Descriptive/qualitative
Accident reductions	Ongoing debate re value of life, value of health	Ecological sites	Descriptive/qualitative
		Pedestrian/cyclists	Descriptive
		Disruption during construction	Descriptive/qualitative

(Source: John Glasson and Riki Therivel, 2018)

So, here 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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Case 2 – Forest Recreation

Estimates of forest recreation values derived from the TCM

Forest	Recreation value per visitor (£)	Annual visitor numbers	Recreational values (£)	
			Total forest	Per hectare
Cheshire	1.91	225,000	429,750	449
Ruthin	2.52	48,000	120,960	59
Brecon	2.60	41,000	106,600	42
Lorne	1.44	10,000	14,400	2
Buchan	2.26	84,000	189,840	27

Willingness to pay for environmental goods as estimated by the CVM

Study	Good	Value
Bateman, Willis and Garrod (1993)	Recreation and environmental preservation in the Norfolk Broads	£77/household/yr
Willis and Garrod (1993)	Landscape preservation in the Yorkshire Dales	£26/household/yr
Cummings et al (1986)	Air quality improvements (poor quality improved to fair) in a US city	\$14.54/month

Source: Benson and Willis (1990). All values in 1988 prices.

(Source: John Glasson and Rik Thérivel, 2018)

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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Case 3-Three Gorges Dam, China

Cumulative mean net present value for the 14n variables at t=100

Benefits		US\$ billion	Costs		US\$ billion
PVEG	Economic growth	82	PVCC	Construction	50
PVPG	Power generation	31	PVAS	Archaeological loss	15
PVCP	Clean power	17	PVRE	Resettlement	12
PVFC	Flood control	5	PVOM	O&M	5
PVNI	Navigation improvement	3	PVAC	Accident	3
			PVDE	Downstream effect	3
			PVFI	Fishery loss	0.7
			PVLT	Tourism loss	0.4
			PVIN	Land inundation loss	0.2

Source: CBA model runs

(Source: John Glasson and Rik Thérivel, 2018)

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 stakeholder 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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Scaling Weighting Checklist

Two alternative examples to illustrate Weighting and Scaling Techniques.

Factors	Weights	Alternative One			Alternative Two		
		Raw Data	Scaled	Weighted	Raw Data	Scaled	Weighted
Wildlife Habitat Preserved (ha.)		5000			10000		
Employment Increase (jobs)		5000			3000		
Wildlife Habitat Index	1		0.5			1	
Employment Increase Index	1		1			0.6	
Wildlife Habitat Weighted Index	0.2			0.1			0.2
Employment Increase Weighted Index	0.8			0.8			0.48
Grand Index		n/a	1.5	0.9	n/a	1.6	0.68

Source: EIA for Developing Countries, December 1997

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.

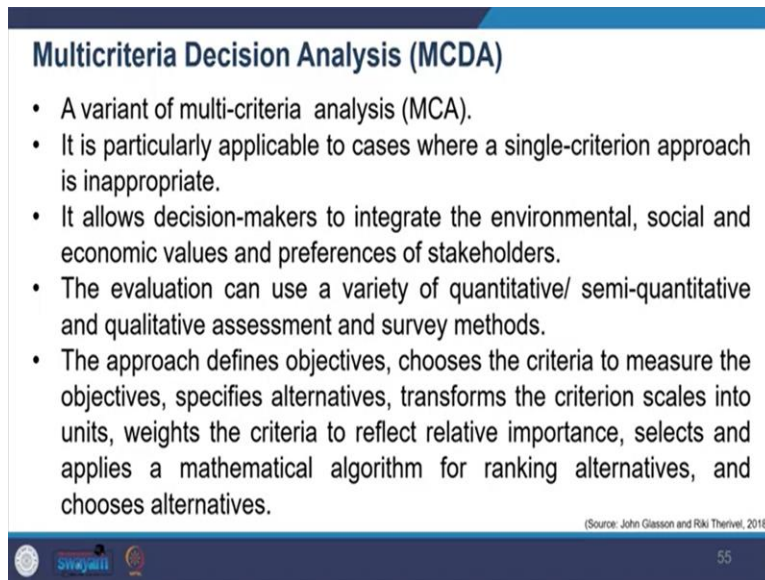
And for wildlife habitat index and in the employment increase you can see it is 1 and 0.6. So, that, is one highest value divided by the smallest value that, is how that, has been done to take out that, 0.5 and 0.6. And then you see that, in the wildlife habitat weighted index you are now taking out 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.

(Refer Slide Time: 37:26)



Multicriteria Decision Analysis (MCDA)

- A variant of multi-criteria analysis (MCA).
- It is particularly applicable to cases where a single-criterion approach is inappropriate.
- It allows decision-makers to integrate the environmental, social and economic values and preferences of stakeholders.
- The evaluation can use a variety of quantitative/ semi-quantitative and qualitative assessment and survey methods.
- The approach defines objectives, chooses the criteria to measure the objectives, specifies alternatives, transforms the criterion scales into units, weights the criteria to reflect relative importance, selects and applies a mathematical algorithm for ranking alternatives, and chooses alternatives.

(Source: John Glasson and Riki Therivel, 2018)

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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.

(Refer Slide Time: 38:52)

Checklist and Matrix System

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

Items	Nature of Likely Impacts										
	Adverse					Beneficial					
	ST	LT	R	IR	L	W	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	X	X	X	X	X	X	X	X	X	X	X
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; ST denotes Short Term; LT denotes Long Term; R denotes Reversible; IR denotes Irreversible; L denotes Local; W denotes Wide; SI denotes Significant; 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	Removal 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 (soils, 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 water (household and/or commercial) wastes?	Yes	New population will generate household and other wastes	No - there is ample local water 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 environmentally 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 into the ground or into sewers, surface waters, groundwater, coastal waters 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 sewer flows from new residents	Probably - depends on equipment for new treatment facilities

Source: ec.Europa.eu



Leopold

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

Actions		Environmental Items	
Category	Description	Category	Description
A. Modification of regime	a) Eolic tunnelisation	A. Physical-chemical characteristics	
	b) Biological corridors		
	c) Modification of habitat		
	d) Alteration of ground cover		1. Earth
	e) Alteration of ground-water hydrology		a) Mineral resources
	f) Alteration of drainage		b) Construction material
	g) River control & form modification		c) Soils
	h) Canalization		d) Land form
	i) Irrigation		e) Force fields & background radiation
	j) Weather modification		f) Unique physical features
	k) Burning		
	l) Surface paving		2. Water
	m) Noise & vibration		a) Surface
B. Land transformation & construction	a) Urbanization	b) Ocean	
	b) Industrial sites & buildings	c) Underground	
	c) Airports	d) Quality	
	d) Highways & bridges	e) Temperature	
	e) Roads & trails	f) Exchange	
	f) Railroads	g) Snow ice & permafrost	
	g) Canals & ditches		
	h) Transmission lines, pipelines & conduits	3. Atmosphere	
	i) Barriers including fencing	a) Quality of gases, particulates	
	j) Channel straightening & dredging	b) Ozone (more, more)	
	k) Channel retaining walls	c) Temperature	
	l) Canals	4. Processes	
	m) Dams & poundments	a) Floods	
	n) Piers, levees, marshes & sea terminals	b) Erosions	
	o) Offshore structures	c) Deposition (sedimentation, precipitation)	
	p) Recreational structures	d) Solution	
	q) Rangeland utilization	e) Sorption (ion exchange, complexing)	
		f) Compaction & settling	
	g) Stability (slides, landslides)		
	h) Stress (mechanical, chemical)		



Leopold

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

Actions		Environmental Items	
Category	Description	Category	Description
	<ul style="list-style-type: none"> ⓐ Production storage 		
E. Land stabilization	<ul style="list-style-type: none"> ⓐ Erosion control and fencing ⓑ Muck seeding and hydro control ⓒ Strip mining rehabilitation ⓓ Land regrading ⓔ Harbor dredging ⓕ Marsh fill and drainage 	C. Cultural factors	
		1. Land use	<ul style="list-style-type: none"> ⓐ Wilderness and open spaces ⓑ Wetlands ⓒ Forestry ⓓ Grazing ⓔ Agriculture ⓕ Residential ⓖ Commercial ⓗ Industry ⓓ Mining and quarrying
F. Resource renewal	<ul style="list-style-type: none"> ⓐ Rehabilitation ⓑ Wildlife stocking and management ⓒ Groundwater recharge ⓓ Fertilization application ⓔ Wilderness recycling 	2. Recreation	<ul style="list-style-type: none"> ⓐ Hunting ⓑ Fishing ⓒ Boating ⓓ Swimming ⓔ Camping and hiking ⓕ Picnicking ⓖ Resorts
G. Change in traffic	<ul style="list-style-type: none"> ⓐ Railway ⓑ Automobile ⓒ Trucking ⓓ Shipping ⓔ Aircraft ⓕ River and canal traffic ⓖ Pipeline building ⓗ Trails ⓓ Cakes and lifts ⓖ Communication ⓗ Pipeline 	3. Aesthetic & human interest	<ul style="list-style-type: none"> ⓐ Scenic view and vistas ⓑ Wilderness qualities ⓒ Open space qualities ⓓ Landscape design ⓔ Unique physical features ⓕ Parks and reserves ⓖ Monuments ⓗ Rare and unique species or eco-systems ⓓ Historical or archaeological sites and objects ⓖ Presence of fossils
H. Waste replacement & treatment	<ul style="list-style-type: none"> ⓐ Composting ⓑ Landfill ⓒ Encapsulation of sludge, spills and other fluids ⓓ Underground storage ⓔ Junk disposal ⓕ Oil well flooding 		

(Source: John Glasston and Riki Therivel, 2018)

Leopold

Environmental 'Characteristics' and 'Conditions'

<p>A. PHYSICAL AND CHEMICAL CHARACTERISTICS</p> <p>1. <i>Earth</i></p> <ul style="list-style-type: none"> a) Mineral resources b) Construction material c) Soils d) Landform e) Force fields & background radiation f) Unique physical features <p>2. <i>Water</i></p> <ul style="list-style-type: none"> 1) Surface b) Ocean c) Underground d) Quality e) Temperature g) Snow, ice, & permafrost <p>3. <i>Atmosphere</i></p> <ul style="list-style-type: none"> a) Quality (gases, particulates) b) Climate (micro, macro) c) Temperature <p>4. <i>Processes</i></p> <ul style="list-style-type: none"> a) Floods b) Erosion c) Deposition (sedimentation, precipitation) d) Solution e) Sorption (ion exchange, complexing) f) Compaction and settling g) Stability (slides, slumps) h) Stress-strain (earthquake) f) Recharge i) Air movements 	<p>B. BIOLOGICAL CONDITIONS</p> <p>1. <i>Flora</i></p> <ul style="list-style-type: none"> 1) Trees b) Shrubs c) Grass d) Crops e) Microflora f) Aquatic plants g) Endangered species h) Barriers i) Corridors <p>2. <i>Fauna</i></p> <ul style="list-style-type: none"> a) Birds b) Land animals including reptiles c) Fish & shellfish d) Benthic organisms e) Insects f) Microfauna g) Endangered species h) Barriers i) Corridors <p>C. CULTURAL FACTORS</p> <p>1. <i>Land use</i></p> <ul style="list-style-type: none"> a) Wilderness & open spaces b) Wetlands c) Forestry d) Grazing e) Agriculture f) Residential g) Commercial h) Industrial i) Mining & quarrying <p>2. <i>Landscape design</i></p> <ul style="list-style-type: none"> d) Landscape design e) Unique physical features f) Parks & reserves g) Monuments h) Rare & unique species or ecosystems i) Historical or archaeological sites and objects j) Presence of misfits
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(Source: John Glasston and Riki Therivel, 2018)

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 quarrying 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.

(Refer Slide Time: 40:07)

Leopold Environmental 'Characteristics' and 'Conditions'

- 2. *Recreation*
 - a) Hunting
 - b) Fishing
 - c) Boating
 - d) Swimming
 - e) Camping & hiking
 - f) Picnicing
 - g) Resorts
- 3. *Aesthetics & Human Interest*
 - a) Scenic views and vistas
 - b) Wilderness qualities
 - c) Open space qualities
- 4. *Cultural Status*
 - a) Cultural patterns (life style)
 - b) Health and safety
 - c) Employment
 - d) Population density
- 5. *Man-Made Facilities and Activities*
 - a) Structures
 - b) Transportation network (movement, access)
 - c) Utility networks
 - d) Waste disposal
 - e) Barriers
 - f) Corridors

D. ECOLOGICAL RELATIONSHIPS SUCH AS:

- 1) Salinization of water resources
- 2) Eutrophication
- 3) Disease-insect vectors
- 4) Food chains
- 5) Salinization of surficial material
- 6) Brush encroachment
- 7) Other

(Source: John Glasson and Riki Therivel, 2018)

1. Identify all actions located across the top of the matrix that are part of the proposed project.

2. Under each of the proposed actions, place a slash at the intersection with each item on the side of the matrix if an impact is possible.

3. Having completed the matrix, in the upper left hand corner of each box with a slash, place a number from 1 to 10 which indicates the magnitude of the possible impact. 10 represents the greatest magnitude of impact and 1, the least (no zeros). Before each number place + if the impact would be beneficial. In the lower right hand corner of the box place a number from 1 to 10 which indicates the seriousness of the possible impact (e.g. regional vs. local; 10 represents the greatest importance and 1 the least (no zeros)).

4. The text which accompanies the matrix should be a discussion of the significant impacts, those columns and rows with large numbers of boxes marked and individual boxes with large numbers.

Sample matrix:

	a	b	c	d	e
1	10	10	10	10	10
2	10	10	10	10	10
3	10	10	10	10	10
4	10	10	10	10	10
5	10	10	10	10	10
6	10	10	10	10	10
7	10	10	10	10	10
8	10	10	10	10	10
9	10	10	10	10	10
10	10	10	10	10	10

(Source: John Glasson and Riki Therivel, 2018)

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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Mitigation and Enhancement

The Nature of Mitigation Measures and The Mitigation Hierarchy

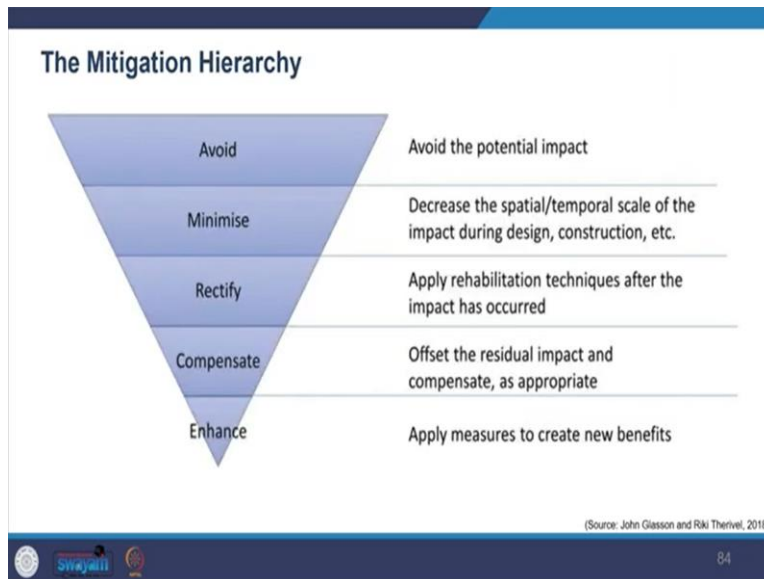
Mitigation is defined in Directive 2014/52 EU as

“measures envisaged to avoid, prevent, reduce or, if possible, offset any identified significant adverse effects on the environment and, where appropriate, of any proposed monitoring arrangements.”

(Source: John Glasston and Riki Therivel, 2018)

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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EU guidance on types of Mitigation Measures

Type of measure	How it works
Measures to prevent	Impact avoidance by: <ul style="list-style-type: none"> • Changing means or techniques, not undertaking certain projects or components that could result in adverse impacts • Changing the site; avoiding environmentally sensitive areas • Putting in place preventative measures to stop adverse effects from occurring
Measures to reduce	Impact minimization by: <ul style="list-style-type: none"> • Scaling down or relocating the project • Redesign elements of the project • Using a different technology • Taking supplementary measures to reduce the impacts either at the source or at the receptor (such as noise barriers, waste gas treatment, type of road surface)
Measures to offset	Offset or compensate for residual adverse effects that cannot be avoided or further reduced in one area with improvements elsewhere with: <ul style="list-style-type: none"> • Site remediation/rehabilitation/restoration • Resettlement • Monetary compensation

Source: EU 2017

(Source: John Glasson and Riki Therivel, 2018)

Classification of Mitigation, UK Mitigation Guidance

Levels of mitigation	Mitigation hierarchy	Project phase
• Alternatives (strategic, alternative locations and processes)	• Avoidance at source	• Construction
• Physical design measures	• Minimize at source • Abatement on site	• Commissioning • Operation
• Project management measures	• Abatement at receptor	• Decommissioning
• Deferred mitigation	• Repair	• Restoration, afteruse/aftercare
	• Compensation in kind • Other compensation and enhancement	

Source: DETR 1997

(Source: John Glasson and Riki Therivel, 2018)

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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Enhancement of Potential Benefits



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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Enhancement examples

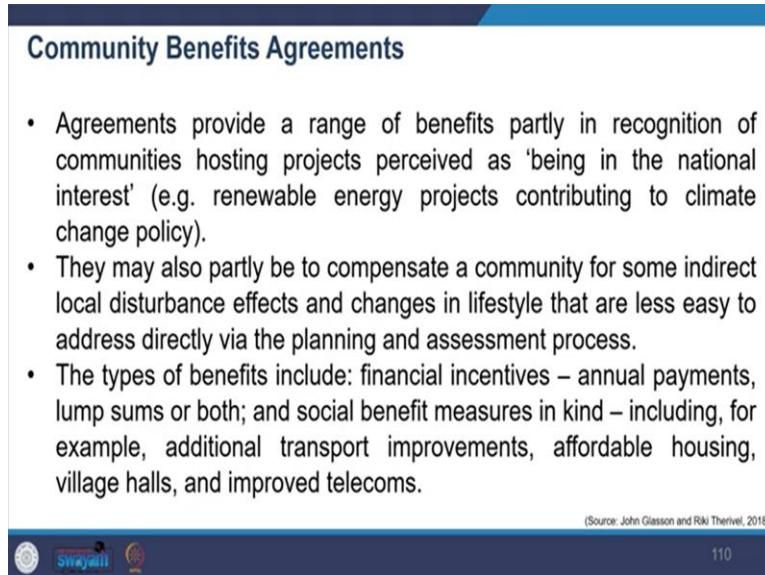
- Enhancements can include biophysical actions – for example, creating a nature reserve from an abandoned quarry which lies adjacent to a project site and which has been acquired by the developer.
- They can lead to increased green spaces, improved biodiversity, improved landscape character and restored ecosystems.
- A project may bring considerable benefit to an area; where such benefits are identified, as a minimum there should be a concern to ensure that they do occur and do not become diluted, and that they may be enhanced.
- The potential local employment benefits of a project can be encouraged and enhanced by the offer of appropriate skills training programmes, apprenticeships, plus a 'one-stop-shop' local recruitment facility.
- For the construction stage of a project, this might be consolidated in a Construction Workforce Management Plan, developed between the developer and key local stakeholders.



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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Community Benefits Agreements

- Agreements provide a range of benefits partly in recognition of communities hosting projects perceived as 'being in the national interest' (e.g. renewable energy projects contributing to climate change policy).
- They may also partly be to compensate a community for some indirect local disturbance effects and changes in lifestyle that are less easy to address directly via the planning and assessment process.
- The types of benefits include: financial incentives – annual payments, lump sums or both; and social benefit measures in kind – including, for example, additional transport improvements, affordable housing, village halls, and improved telecoms.

(Source: John Glasson and Riki Therivel, 2018)

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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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Summary

- 1 Impact Evaluation and Importance of Significance
- 2 Mitigation
- 3 Enhancement of Potential Benefits

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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.


(Refer Slide Time: 47:36)

References


- 1 John Glasson and Riki Therivel (2018). Introduction to Environmental Impact Assessment; 5th edition; <https://lccn.loc.gov/2017010184>

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Suggested Watch and Read



https://www.youtube.com/watch?v=RwT0EhNse&ab_channel=Inter-AmericanDevelopmentBank



https://www.youtube.com/watch?v=w_Wv8EzVWA&ab_channel=IntegratedPrecisionSystemsandServicesPvt.Ltd



https://www.youtube.com/watch?v=KTHKqxC_C8&ab_channel=UNECE

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Please feel free to ask Questions.
Let us know about any Concerns you have .
Do share your Opinions, Experiences and
Suggestions.
Looking forward to Interacting and
Co-learning with you while exploring EIA.

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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.