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Lecture -58
Economics of Water Supply Systems

Hi, friends and welcome to the 12th week of discussion in water supply engineering. So far in past 11 weeks we have discussed about the various aspects related to the water supply system, we did talk about the availability of water and demand distribution and then the intake of water, we did talk about the storage system, the treatment systems, advance treatment technologies and we also discussed about the distribution systems.

Then again advances in the distribution system, automation in the distribution system. We did talk about the smart water supply system, water losses estimation and control. So practically they are most of the engineering and technical aspects related today to the urban water systems, we have discussed in the past eleven weeks but now we are going to focus is on the economics and pricing aspects of the water services.

So that is what we will be discussing in this week and this particular class we are going to talk about economics of water supply system.

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So we will start with the discussion on the economic value of water? how do we manage water? Then we talk about economic water supply project we talk about the components of the cost and value of the project, we will also discuss about the price base demand and willingness to pay and then associated price elasticity of water demand and see the procedures for economic analysis of water supply projects.

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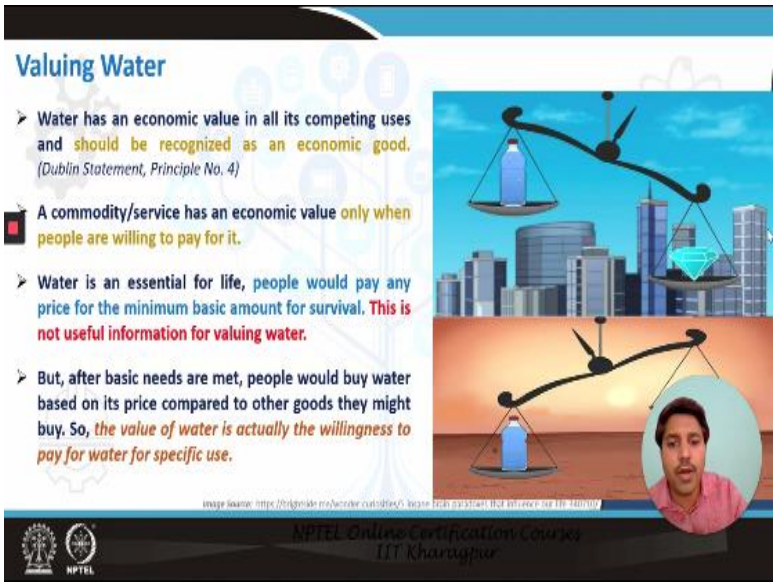

To begin with water initially is not given due value but as a sensitive problem surfaced in various part of the world, people have started recognizing it as an economic good. At on a large scale first time in the Dublin conference it was recognized that water should be considered as a economic good on all of it competing egos, this was one of the principle of Dublin theory meant the whole principle that they give and this was eventually the most accepted and the most talk able the principle of the particular conference.

So water has to be recognized as an economic good but the commodity or the service can only be recognized as an economy good or economy services if there is a willingness to pay for it, means people has to be that willingness so that they can pay for the services. If we see the price or the cost of the value of the water it is very difficult to judge the value of the water because the water is one of the very essential components for the survival.

It is a essential for life and people can any price for minimum basic amount of water for survival. If somebody is roaming very thirsty and is kind of dying without water in a desert area, he will be willing to pay whatever his belongings are just for a glass of water just for a bottle of water. He can happily give his ornaments, diamonds, gold whatever he is having just for the bottle of water because it is a question of survival.

So that way the value of that basic essential quantity of water is enormous, but this is not a useful information when we try to tag you back into the water because this is a question of survival. So people can pay anything for that water and this will not give us proper irony or what is the value of the water. The value of water in a competitive market is actually associated with how much people are willing to pay for the water as a cost to they are willing to pay for any other goods or services for that matter and this could be very different for different aspects.

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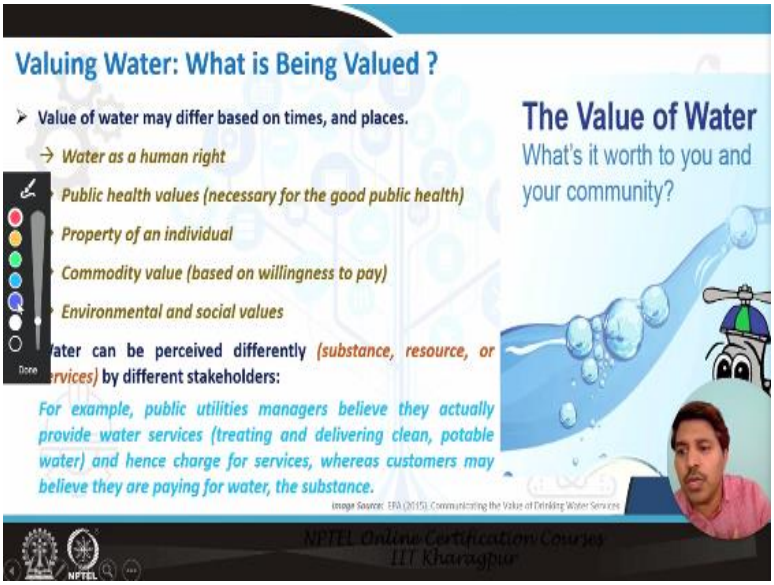

So value of water may differ based on the time and places. Water is recognized as a very basic human right, so value of that much of water is a must (()) (04:20)) water is very necessary for good public health, there are lot of as we have discussed earlier also of water borne diseases associated with unclean water or lack of water for that matter. So it has lot of public health values in that sense it is considered as a property of an individual also many times.

Because if I am owning a piece of land, and here is say pond in that or well in that. So water facility in that pond or land is belong to the owner of the property. So that weight can be considered as a property of the individual as well. It can be given commodity value based on the willingness to pay. So like we pay say 15 rupees, 20 rupees for 1 liter of water bottle at public places, market, railway station.

That is kind of another value or you will not be probably willing to pay 500 rupees for 1 bottle or we can pay 15, 20 rupees. So depending on our willingness to pay, it is a commodity value associated with the water and of course there are an environmental and social balance which are just because of this rare existence of water. So another thing is water can be like perceived differently by the different stakeholders.

Or the value associated with the water can be seen differently or by different stakeholders. Some people or some state quota might see, water is substance or some may see water as a resource or some may see water as services. Or see it will say the urban water supply. So the user group or the consumer proficiency feels that they are paying for water the substance because they are getting order delivered in their households and firms like how much is there consumption based on that consumption they are paying for the water.

Somebody is consuming 20 kilo of water, is paying some price somebody consuming 30 kilo litre of water, he is paying higher price. So depending on how much water someone is consuming, they will pay price according to that. So they think that actually they are paying for water, the substance they are consuming. But from utility perspective if you see, utility is actually abstracting water from some resource at the ground water or surface water.

Then purifying it, pumping it or putting it to the distribution system, making it available to the consumer. All theses processes, require lot of services and there is a cause associated to these services. So utility can get charging consumer for the services and not for the water. Water they are getting of any form are available in the resources. They are now probably paying for no water.

So it is one of the, from utility prospective it is one of the pricing associated with services whereas from the consumer prospective, the price is associated with the water, the substance.

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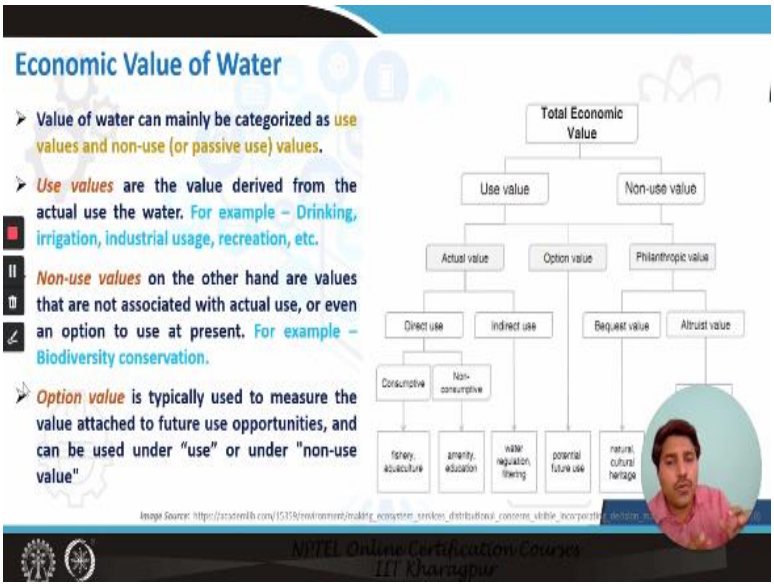

So that way depending on the stakeholder the perception may also vary. If we see the total economic value of the water, so the total economic value of water is basically either use value or non-use value, use value can also be direct use values or indirect use values. So for example, water supplied in the household, people use it for drinking, bathing, cooking, cleaning purpose it is direct use of water.

Similarly, like water use for irrigation, industrial usage, mostly are direct use values. Then water can be used for irrigation purpose or directly been used. Water is basically flowing in canal by side and then people are visiting here and all but they are not using the water they are not consuming the water but because of the presence of water there, there is a commercial activity or potential activities going on there.

So that also the water is in use, you cannot have a path saying water path without presence of water. So the water is still there it is for irrigational purpose, it is a kind of indirect use value water is still being used but indirectly use then they have consumptive and non-consumptive water is been consumed its consumptive use if it is not been consumed like indirect use values in most cases is a non consumptive use.

Then there is non-use values when the value of the water is just because of its sheer presence. For example if the water is present in the pond, that pond is having most commercial activity now say your interference that be because of water is present in the pond it is sustaining a bio-diversity, it is sustaining particular ecological system within that pond. So there is a value associated with that presence of the water.

This kind of values are known as non-use value and water is not been used. Because of the presence of the water it is having associated value there. So it could be like a biggest value or other form of value. And there are option values which can be considered either under use value or non-use values which are if water is available there so the value can be attached to its future use opportunities.

If water is present there i can use it later on for irrigation purpose or industrial supply purpose for municipal supply purpose. So for future use values if water is present there it can be used in a future there are option available for future uses and that value is included in the option use value.

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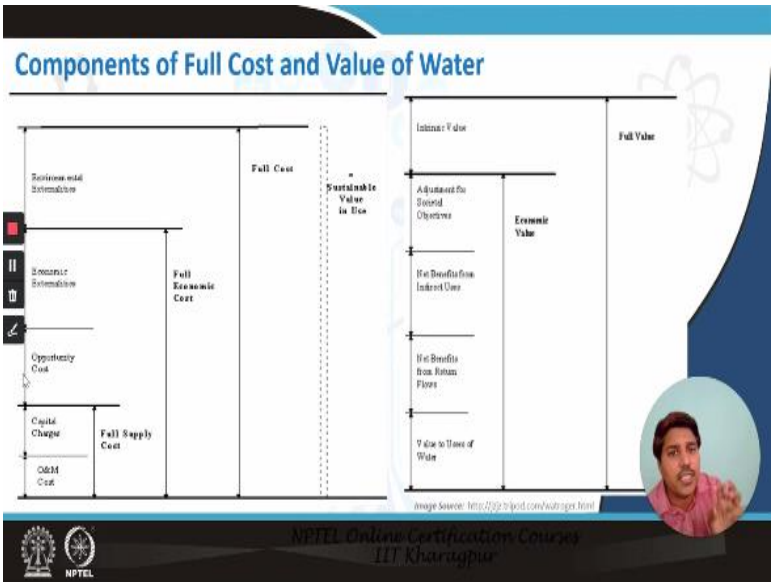

Is used in option use value, if you see the component of the cost and value of the water, from cost prospective for water services, you take an example of a how water supplies, so there is capital investment needed, so there is a capital cost of the system, there is an operation and

maintenance cost of the system, because we need to operate and maintain that system. There is opportunity cost of the water, opportunity cost means, which are the alternative uses cost.

Let us say I am using water fall irrigation purpose. What if same water goes for industrial uses, same water goes for municipal supply purpose. So what are the alternate uses if water is not been made available for those uses and instead it is been used for some particular application. So the alternate application also0 like the non-functional of those alternate application also put cost to the water which is known as opportunity cost.

If there are enough water available then there is no scarcity and the opportunity cost is going to be 0 because whatever water is required at different sectors is available. But the scares condition if water is limited and you are using water for one application then there is a like shortage of water for other application. Cost associated with that particular loss of the other activity is known as the opportunity cost.

Then there are externalities, economic externalities as well as environment externalities. Economic externalities are related to that initial externalities. So economic externalities, opportunity cost, and supply of all which includes the capital operation and maintenance cost, give the full economic counsel of the water, but still this is not the full cost. If we add environmental externalities to the full economic cost of the water, we get the full cost of the water.

Now environmental externalities means, because whenever we are using water or withdrawing water or save in any water project. If we are disturbing the natural system there are going to be some positive or negative environmental impacts of that, so for say if you are withdrawing water from a lake or from a river what kind of environmental impact it is going to create there, all these kind of cost comes under environmental extremities.

So if we add environmental extremities to the full economic cost we get the full cost of the water. Similarly at the value side there are different components of values as well like the value of user soft water directly so how much value users are paying then net benefits from the return

flow the additional water which is going as return flow and what is the benefit of that and any benefit from indirect users or the adjustments of social objectives.

So, how the social updatement or the update is happening in the society, so all these comes under economic value and then if we add the interesting value which is because of the presence of the water in the system that gives us the full value of the waters so that we will be having a different component associated with the full cost and full value of the water.

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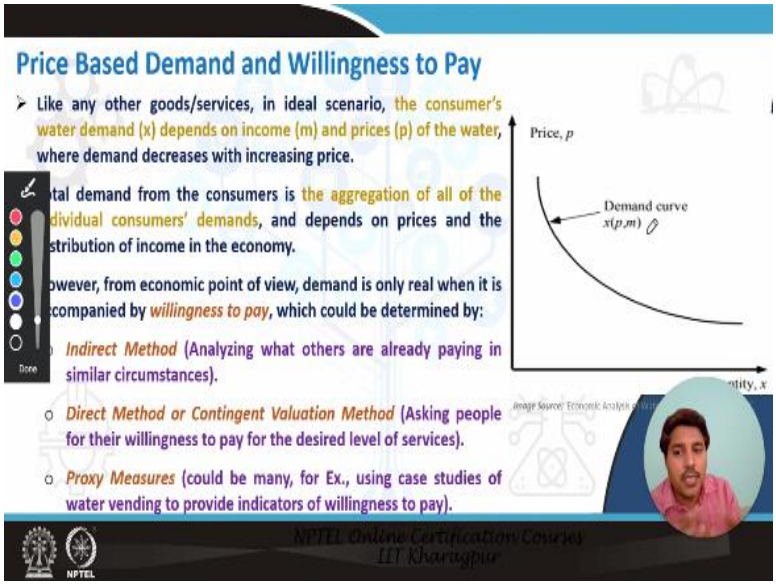

Now if we like when we are assigning the cost or value of the water it essentially like how much people are using water or how much demand is exerted from water depends on two major parameters. That is, what is the price of water and what is the income that people are having. So demand that way is actually function of price and the income if we see a demand from locality or community.

So it is going to be the aggregation of all the individual demands from the consumers. So if there are say n number of households and each household has a certain demand associated with that so the total demand going to come from n number of households if we stop that we can get the overall community demand or the overall demand for that reseller or city town whatever state we are considering.

And that essentially going to depend all the distribution of the income in that economy in that particular area and the price of the water moreover as we were discussing earlier that the value to water depends on the willingness to pay so same way demand is also real only when it is accommodating by the willingness to pay. If people are willing to pay then only demand is considered real.

Otherwise if there is no one willing to buy anything whatever price you keep of that commodity or service is useless. So willingness to pay can be determined by different methods. There are 3 major approaches which are used to determine the willingness to pay one is indirect method where we analyse what others are already paying in similar circumstances. So like in a town if you want to see a willingness of pay a similar nature town is paying certain amount for their water services.

So you can take the lead from that place and consider the similar scale of willingness to pay for this town as well. Then there are direct method which is also known as contingent valuation method which is also a direct service asking people about the willingness to pay for the desired level of services. And then last one is proxy measures there could be willing proxy measures for example the water vendors.

So people pay for water vendors for getting certain amount of water for similar type of services you can consider that people will be willing to pay at least that much amount which they are paying to water vendors. So if center utility is providing similar services or better services at least that much amount people will be willing to pay to the utility so that kind of proxy measures can also be used.

So we can either identify indirectly or we can use direct measures for certain level of services again in the willingness to pay can also directly depend on the level of services. If I am asking for willingness to pay for 24 hours clean water supply people will have unwillingness to pay. If I say that I am going to supply 4 hours of water people will have lower willingness to pay. So depending upon desired level of services how much people are willing to pay can also be estimated.

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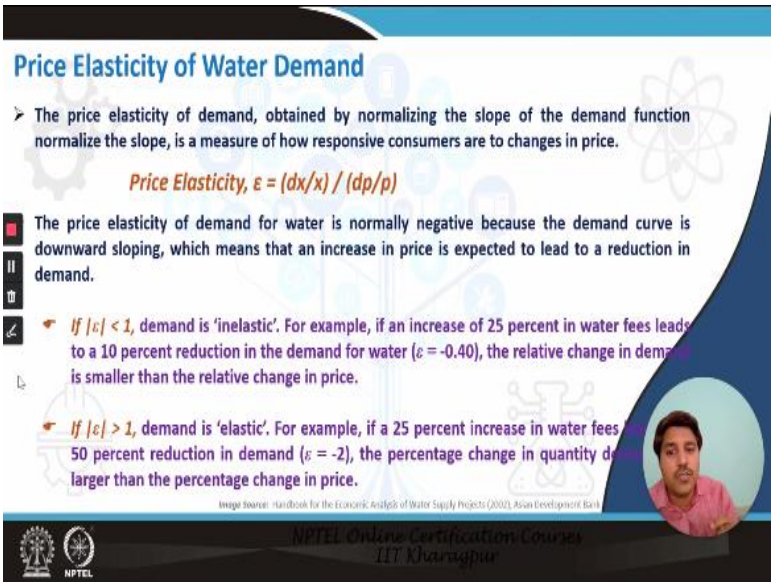

Now if we see the price elasticity of water demand that is as we are discussing that the demand depends on the price. So if we change the price so there is slightly change in the demand so the unit change in the demand or the percentage change in the demand per unit percentage change in the price is known as the price elasticity which kind of gives an idea how responsible consumers are with the change in the prices.

The price elasticity of demand is usually negative because if price increases demand decreases or the price decreases demand increases so that is why it is kind of negative scope. So the price elasticity is usually negative so if the mode of price elasticity is less than 1 that means relative change in demand is lesser that relative change in the price, if we change price by 25% only just 10%, 15%, 20% change in the demand.

Then it is basically in elastic system where the mode of the price elasticity is less than 1. In the other case when the mode of price elasticity is greater than 1 that means relative change in demand is more than the relative change in price, for example if change in price is by 25% then change in demand is going to be higher than 25%. It could be 30%, 40%, 50% so that means the relative change in demand is higher or larger than the relative change in the price then the system is known as the elastic system.

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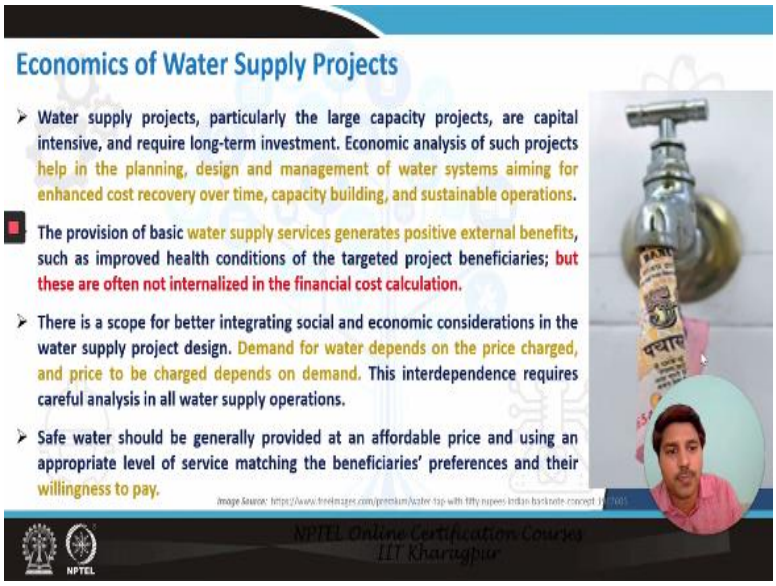

For analyzing the economics of water supply projects we must understand first the water supply are generally the capital intensive project specifically large capacity projects. So they require huge investments mostly long term investment for insuring the water services. So economic analysis of these projects helps in planning stage, helps in designing management of water supply systems and eventually proper economic analysis we can see the opportunity for the cost recovery the capacity building and the sustainable operations of such projects.

Now in addition to the cost which is invested and the recovery which can be made in the form of water tariff or water fees, these projects generate a significant amount of external benefits. There are lots of positive external benefits of course there are some cost as well but if particularly like if you look at the benefit of water supply they provide a improved health condition to the target beneficiaries and that way if we account these benefits as well.

So often we see that these projects are justified, so but what happens that most of them is these external benefits external cost is not usually included in the financial cost calculations. But the economic analysis or overall of economic analysis of water supply of projects should consider these and these are not simple things these are basically because these economic analysis of particularly water services is a tricky business.

There is a lot of interdependency there the demand depends on the price. Price depends on the demand, so then again there is a concept of willingness to pay how much people are willing to pay for getting; it has to be available also. There comes the concept of subsidy as well. So all these like must be considered while economic analysis of the projects. For evaluation of these projects economic evaluation of these projects, one must first see what are the overall economic benefits and economic cost.

And the project should be considered economically feasible only when the benefits that are generated through the project exceeds the costs invested in the project. Now again when we see that benefit cost, we actually can see from economic feasibility prospective or a financial feasibility prospective the economic feasibility and financial feasibility are two fundamentally different concepts.

The financial feasibility, usually like seeks the what are the costs that are going to be invested and what are the revenues which could be generated and if the revenue is exceeds the cost the project can be considered as a financial feasible, which is very rare case in water supply systems because that is invested is huge and recovery of that cost particularly in Indian society is difficult because tariffs are very low.

So, many times this projects may not be considered as financially feasible, but when we look at the economic feasibility, we have to analyze the project value to the society because there are. Extremities economic externalities, environmental externalities, both positive and negative are included in these projects, so the social benefits like if you are providing a good quality water to the consumers.

So that improved health conditions that are generally not included in a financial feasibility analysis, but in economic feasibility analysis that all these factors should also be considered and when we consider all these it is often seen that these The improved water management or services may kind of exceed the cost of the improvement. Now because of these projects are capital intensive.

So any standard capital budgeting method can be used to evaluate the feasibility of these project particularly the financial feasibility of these projects. There are various standard capital budgeting methods, such as benefit cost ratio, which is also known as the profitability index then payback period a net present value internal rate of return excreta, so these are the power capital budgeting methods which are available in any standard textbook.

And based on these we can basically see the appraisal of the project whether, it is feasible or not financially. So for example, if benefit cost is one we can say that project is okay, like it is finally feasible project if we see that payback period is within the design period so we can say that okay the investments that are going to make will be recovered within the lifecycle of the project so can be considered.

Then similarly after discounting we see the net present value or the internal rate of return, if it is beyond that threshold point we can accept that project. So we can use these kind of standard capital budgeting techniques for making decisions on these long term investments and see that the investment in the capital is feasible or not. The process is simple we have to look at that there is a good requirement or realization of the project.

So we need to first see the need of the project then set up the objective of the project then suitable scale of the project. We have to identify the different alternatives that are available which can be used to meet the project objective. We analyze the cost and possible recovery for these different alternatives, then we rank these alternatives or see the like use the best alternative which is say most feasible in terms of recovery.

And then we can choose the project that we can undertake we can monitor the project along with the progress of the project and finally we see that through this standard audits that whatever the intended benefits were there or intended benefits that are proposed are actually people are getting that benefit.

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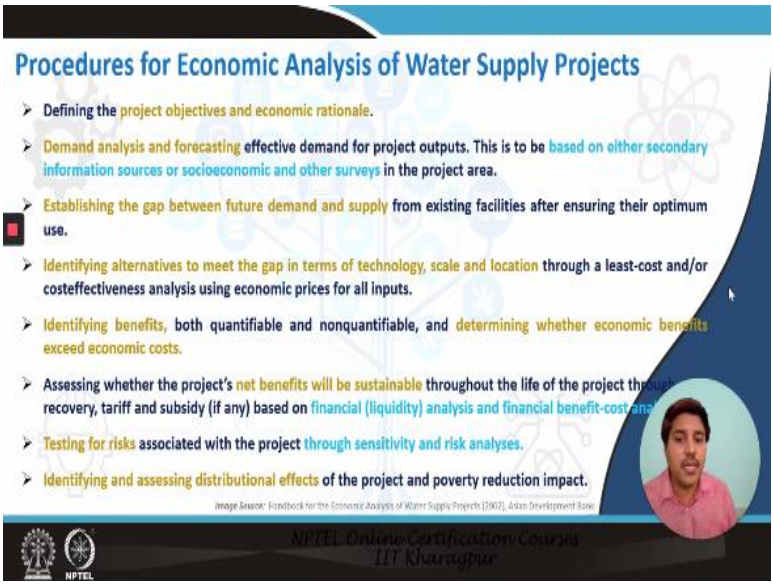

The procedure for these economic analysis is again simple we set up the objective and economic rational particularly for water supply projects, let say we take water supply projects for example, so if there is some existing infrastructure already there in place so we have to identify that when we use that infrastructure to the optimum scale, how much like how much demand it can made? And if we forecast the demand and see that still there are some gaps in the demand and the supply which can be made through this existing infrastructure.

So in order to meet that gaps between demands and supply what are the available options in terms of technology scale or location and then we analyze those options in terms of the cost benefit analysis and then see which one is the most cost effective or the least cost method for fulfilling that objective can be identified can be selected we quantify the benefits both tangible as well as non-tangible benefits.

And then overall economic benefit and economic cost we estimate and see whether the project is economically feasible, similarly the financial feasibility should also be seen that what are the direct investments that are going to be made in the project. And is the possible recovery through tariff or fees or through subsidy those sort of things so we can do a economy and financial cost benefit analysis of the system.

And if it is like if the benefits exceed the cost we can go ahead with the project also we should analyze the risk associated with the project. The standard sensitivity analysis or risk analysis and overall we should see that, what social impact that project is going to make.

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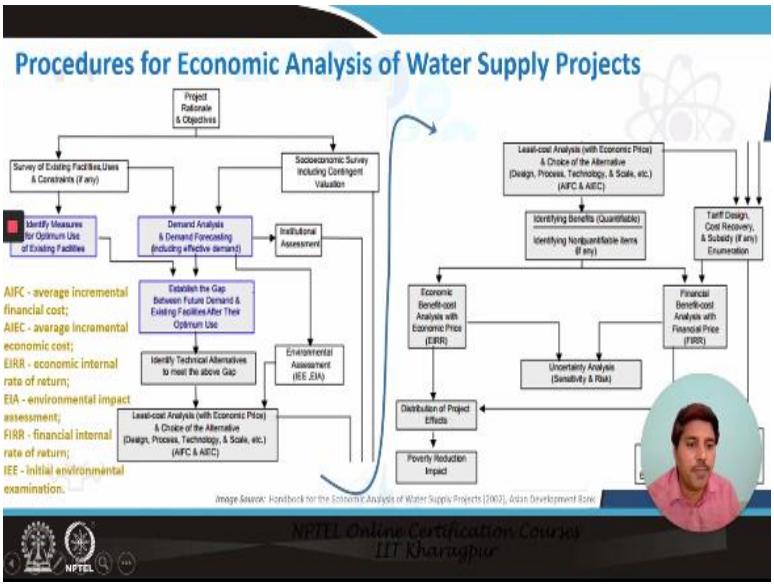

So this is representation, flowchart for the steps for the economic analysis starting from the project rationale and objective setup then through survey or social economic information. Setting up the demand analysis, identifying the gap, identifying the available technologies which can meet those gap then doing some least cost analysis or choice of alternatives in order to select the specific alternatives.

Then identifying the benefits, do a benefits cost analysis, economic benefit cost analysis and then we go for the uncertainty and risk analysis and eventually we can see that the project is physically and environmentally sustainable and we do the financial analysis for looking at the plan for the financial sustainability of the project. So this way like we can do the economic analysis of this projects and see whether they are justifiable or not but in the process

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What we need is the estimation of the cost and estimation of the recovery or tariff, so this is what we will be basically discussing next. In the next class we will be talking about how do we estimate the cost particularly the capital and operation and maintenance cost of water supply projects and then in the later lectures of this week, we will talk about the recovery aspects as well, what are the various tariff structures are used for financial recovery through the water tariffs from the consumer?

So thank you for joining we will discuss in the next class about the cost in the water supply systems, so see you in the next class, Thank you.