Water Economics and Governance
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Lecture – 35
Economics of Demand and Sectoral Allocation

Hello everyone. So, in this concluding lecture of week 7, we will be talking about the economics of demand and sectoral allocations to start with the consumers demand depend on income and price of the goods and services for any good that way same is with the water. So, eventually the demand is going would be depending on; what is the income and what is the price, ok.

You see, for example, certain product certain; let us take an example of water bottle itself.

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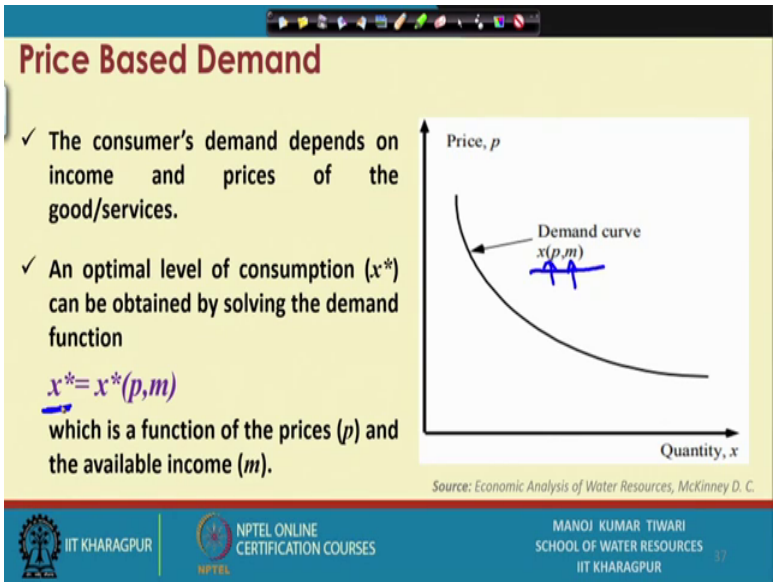

So, water bottle the demand for water bottle is will depend on what is the price of water bottle and what is the income general [FL] where in a train; for example, if you consider where people are expected; more people are expected from lower income group, they do not tend to buy 15 or 20 rupees water bottle, rather, they will go and fill the platform or these days, we have arrow water available for filling in the bottles at the railway platform.

So, they will go there pay 5 rupees and fill their bottle over there as opposed to buying the water. So, because primarily their income is low, while the people from high income group generally traveling in the higher classes do not mind spending 15-20 rupees for getting that water bottle. So, there you see for the same priced product there is a demand from one section from a higher income group section not from the lower income group section.

So, that way demand is actually a function of the income as well as demand is a function of price because if we see for the same income group people the if that water bottle is available in 2 rupees a bottle, they might considering buying that, but if that water bottle is available in a 20 rupees price, they avoid doing that and look for the other alternatives. So, for the same income group people, if you see it is the price of the water or price of any particular good is actually the function of; sorry, the demand for a particular good is function of the price as well.

So, eventually, this way the net demand becomes function of price as well as the income. So, an optimum level of consumption or the optimum demand can be obtained by solving the demand function the demand function which is actually a function of price as well as income or money. So, that we can optimize this function and an optimum level of demand can be estimated by the optimization of this demand function which varies typically like this. So, that is how an optimum demand can be estimated for any particular good or any particular services.

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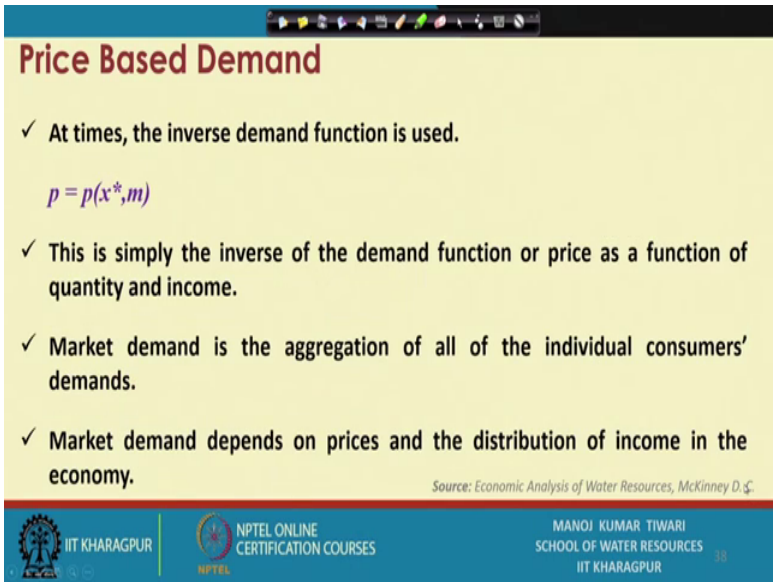

At times, the inverse demand function is also used. So, what is the inverse demand function? Inverse demand function is actually the inverse of the demand function where price is a function of quantity as well as income. So, here the price becomes a function of quantity or we can say the demand in a way the quantity of consumption is what is what the demand is. So, it becomes the function of quantity as well as income the market demand or the overall market demand is the aggregation of all individual consumers demand if there are demands going to be arising from the different consumer section.

So, we can add up the demands by independent consumers and get the overall market demand for that product this market demand depends on the price and the distribution of income in the economy because if for the same product price is going to remain the same and if we if we are willing to get the total market demand for example, the considers the back the same example. So, for the demand of a bottled water; bottled mineral water at a railway platform will depend on the price of that bottle and how many different income group people are passing through that station or available at that station as a consumer.

So, that will give the total demand the demand might not be much from the lower income group people demand might be very high from the higher income group people and a moderate from the middle income group people. So, that way the overall demand will actually depend on to the price and the distribution of this income group in the economy.

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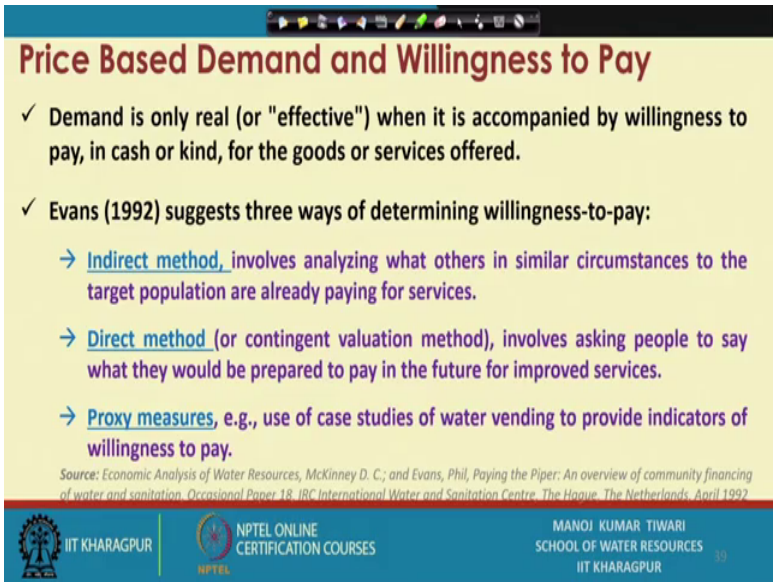

The demand is only real or effective if it is accompanied by the willingness to pay either in form of cash or in form of the kind ok.

For any good or services offered. So, cash payment is of course, the monetary payment or the kind payment is the value of their; the value of efforts or value of time is also considered over there. So, for example, if I am getting a water bottle at a cost of 5 rupees from r o unit installed at a platform and I am getting the same water bottle at a cost of 7 rupees in the in the my coach trained coach.

So, many people may consider going there and filling the water bottle for 5 rupees and coming back many people think, no, it is like because there is additional effort needed in terms of time or needed in terms of moving out of the coach and getting that water filled bringing it back. So, they consider that this much effort is not probably worth 2 rupees saving for me and so, that that is sort of a like in kind payment can be considered.

So, or any effort human like for project only if I am giving my work hours if I am giving my services to some project or some activity. So, that is my in kind contribution because I have given that many day hours which I would have otherwise utilized for some other activity. So, that may not be the in cash expenditure, but there is some in kind expenditure attached to it. So, the demand will actually be a function of the willingness to pay either in cash or in kind.

So, for example, for a units providing water bottle filling at the station need the willingness to pay of people to pay 5 rupees for filling a water bottle as well as in kind willingness to pay in form of getting out of their coaches and moving out to that specific point queuing up and then filling up the bottle. So, there is going to be that kind of willingness to pay or that kind of willingness to spend that much effort or time should also be there in order to have a market for that.

So, evens have suggested 3 ways of determining this willingness to pay which is very important indirect method which involves analyzing what are others in similar circumstances are paying then there is a direct method or contingent valuation method which we discussed earlier which involves asking people to say what price they will be willing to pay for a particular service or improved services and then there is a proxy measures which use case studies of water wending to provide the indicators of various indicators of willingness to pay.

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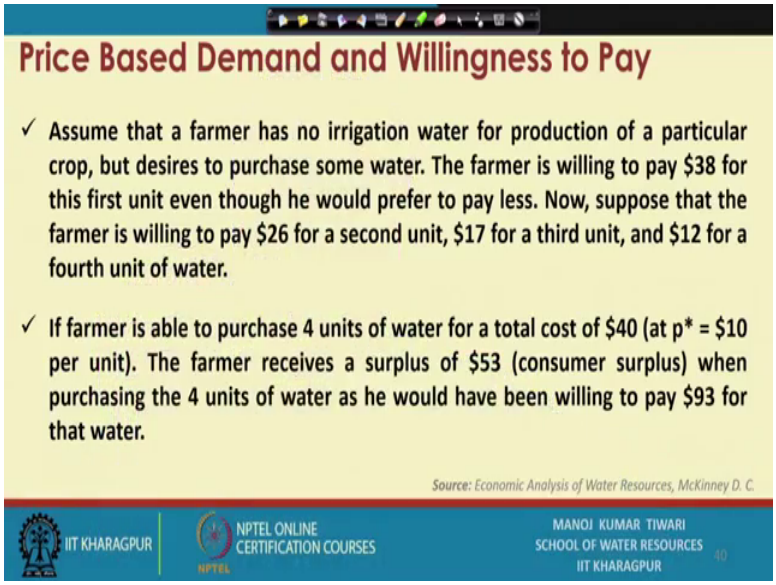

Now, assume that a farmer has sort of low irrigation water for production of a particular crop, but desires to purchase some water now the farmer is let us say, we willing to pay 38 dollars for the first kilometer or first unit of the water, then 26, then 17 and then 12 dollars accordingly, for third fourth second third and fourth unit of water subsequently. Now, if he is able to purchase 4 units of water at a cost of 40 so; that means, he would he was actually willing to pay much higher a price for that because for first unit only he is

willing to pay 38, then 20, 16, then 12. So, that way he is willing to pay probably in 93 dollars for the 4 units of water which he has got on a sort of under a very good deal you can say at or the optimum price of 40 dollar 10 dollars per unit. So, that way he has received a surplus of 53 dollars because he was willing to spend more, but he has got it cheaper. So, that is called consumer surplus.

Because there is a saving from the consumer end and this the difference between this 93 and 40 which is basically the 53 dollars is will be known as consumer surplus when purchasing the 4 units of water by the farmer.

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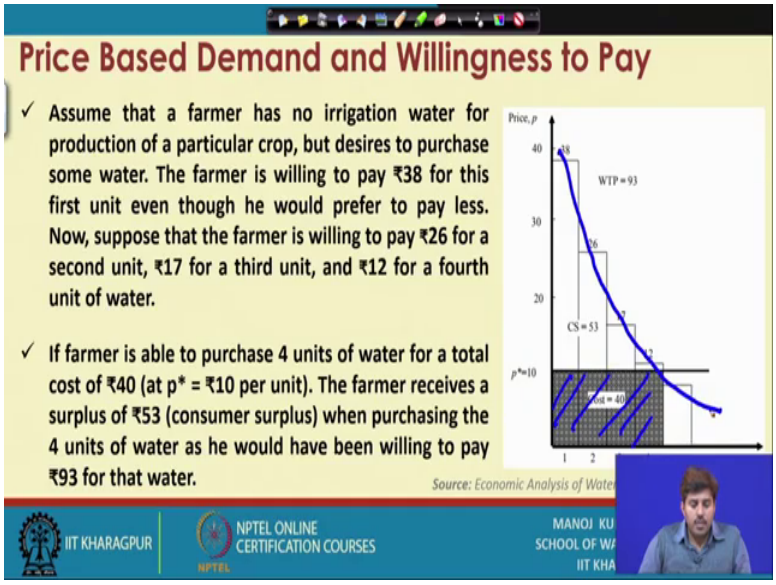

So, if you see this consumer surplus thing over here the net cost here is under this line. So, the cost here is 40 unit and this is how he is willing to pay. So, of course, the demand is means for first unit the demand is going to be or the willingness to pay is going to be the higher.

Because if he is deprived of any other these things. So, he needs that thing to kick start and then subsequently it is likely to decrease. So, you can see that a curve like this is expected in terms of willingness to pay as well. So, this way the farmer which is sort of able to save the 53 as a consumer surplus would actually be profitable in terms of in terms of marginal gains as if we consider like the taking clue from the earlier this thing if we consider that fractional amount of a unit water can be purchased.

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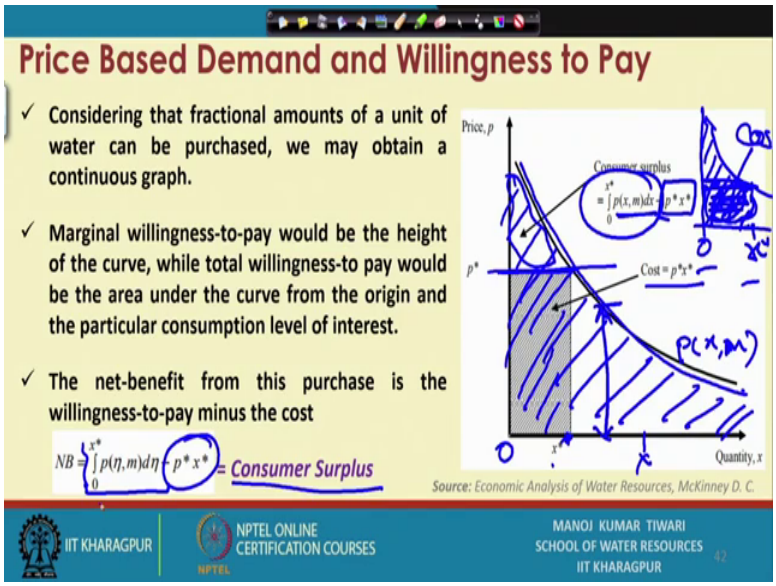

So, we may obtain a continuous graph earlier we had a if you see the earlier slide we had that for first unit his consumption is this, then his consumption is then his willingness to pay is this, then willingness to pay reduces accordingly, if this unit size is made further smaller.

So, probably for the first one he will be willing to pay because this is going to be again this also can be split. So, this is probably the average value for the first unit. So, maybe a fraction of the first unit he would be willing to pay high and then low and then further low and then further low and then further low that way the average comes over here. So, if you happen to see the trend is like this. So, similarly, if we consider a very small elemental fraction that can be procured the willingness to pay curve is going to be like this that is what is expected and it can be seen then the willingness to curve will be something like this as this line is there.

Now, if somebody has able to get a product at price p optimum price P. So, this becomes his cost and this becomes his consumer surplus over here as we have discussed earlier this is going to be the consumer surplus now if we convert this to a continuous function instead of decrease discrete function. So, the marginal willingness to pay is the height of the curve at any given point of time.

So, for this particular quantity my marginal willingness to pay is going to be this much and if one wants to see the total willingness to pay. So, the total willingness to pay would

be the total area under this curve. So, the complete the entire area under this curve is going to be willingness to pay and for any particular value this is my 0 and for any particular optimum consumption let us say the x star or for example, let us say this value the entire area under the curve if this is my curve ok.

Let us say this is my curve. So, starting from 0 to if this is the consumption that I am expecting. So, at this point this entire area under curve is the total willingness to pay how do we get a area under the curve by integrating it between these within these limits. So, if this is p which is actually a function of as we discussed earlier the price is going to be the function of cost and the money available income available or the quantity and income available.

So, that way it is going to be a function of this and the integration of this is going to give me the area under the curve if p is my price. So, p into x star will be the cost of the services or cost of the water now if I reduce the area under the curve with the cost, this is my cost if I reduce this area under the curve with my cost what we get net is the consumer surplus. So, my consumer surplus that way is going to be my consumer surplus over here is going to be the area under the curve between from 0 to x star and the cost. So, that is how a consumer surplus also can be estimated.

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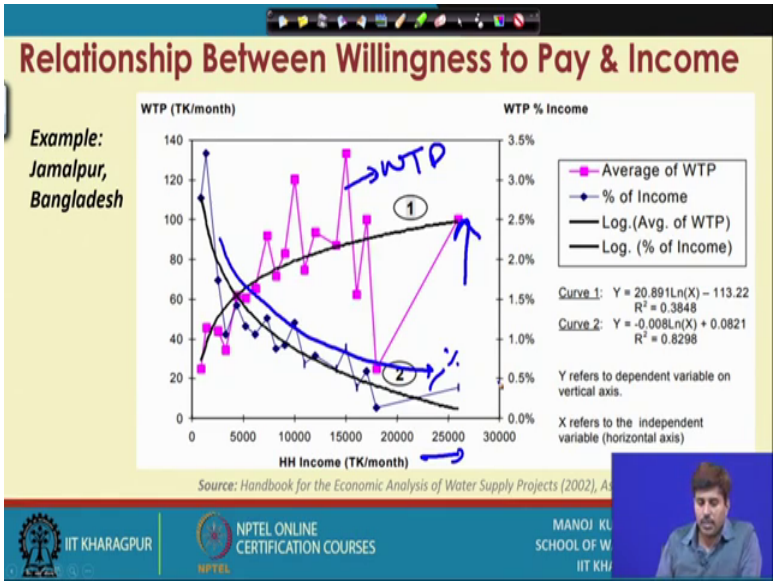

Now, this is a typical example of willingness to pay which is from Jamalpur of Bangladesh available in the Asian development bank report. So, this says that you can

see that here the red line is the average of willingness to pay the; this values are average of the willingness to pay this is the willingness to pay and the black one or the; this blue line here is percentage of income. So, as you see the income is increasing this is the income axis. So, when the income is increasing the willingness to pay is also increasing because this is the willingness to pay. So, this is getting higher and higher on to y axis ok.

So which was expected. So, this was demonstrated from a study as well.

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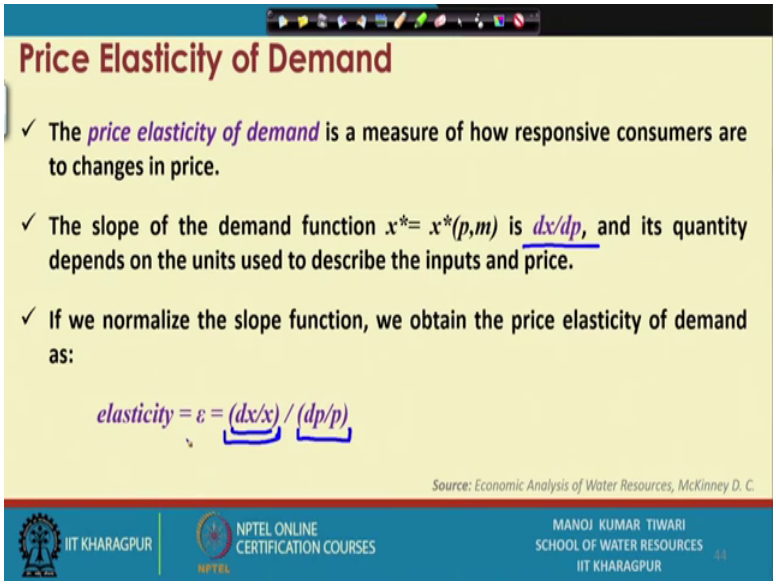

Now, the you see the if the slope of this demand function is d x by d p which is the slope of the demand function and its quantity will depend on the units used to describe the input prices because with the changing unit as we see we can make we took the example where there is a discrete function when we say that one unit of water and we converted that to a continuous function. So, if one is going for a discrete analysis. So, the unit or the quantity that will be broadly depend on what is the unit which is used to describe the input and the prices.

Now, if we normalize that unit because the scale could be different. So, if we normalize that scale means like we normalize the x value with respect to x changes in the x with respect to x. So, this becomes d x by x and changes in the p with respect to p. So, this becomes d p by p the ratio of this is called price elasticity of the demand or elasticity. So, this elasticity gives an idea of how responsive the consumers are to change in the price

how the when there is a change in the price d p by p a normalized change in the price what is the normalized change in the demand with respect to that price change is what describes the price elasticity of the demand ok.

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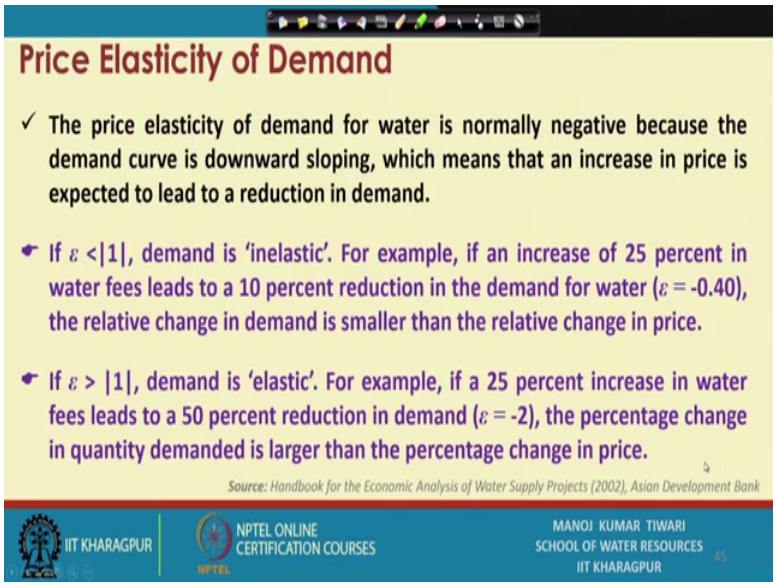

So, the price elasticity of water is normally negative because not only for water actually for all major products is actually normally negative because the demand curve is downward sloping. So, the slope is going to be the negative or in other way also you can see that when prices increase the demand decreases or when the demand. So, when prices we are going to increase the demand is going to lesser and that is why a negative slope is very much expected.

Now, if the absolute value of this price elasticity is less than one the demand is called inelastic. So, for example, if you see there is an increase of 25 percent in water leads to ten percent reduction in the demand. So, a larger increase in the price and a smaller reduction in the demand; so, you we get a demand elasticity epsilon value of minus 0.04 which is the absolute value again point 4 is less than one so; that means, that relative change in the demand is smaller than the relative change in the price and the system is inelastic as opposed to when the absolute value is greater than one the demand is considered to be elastic.

For example if this 25 percent increase is leading to a 50 percent reduction in the demand. So, this gives us a epsilon value of minus 2 and the absolute epsilon value is

greater than 1. So, then the prices change in the quantity demanded is larger than the percentage change in the price. So, with unit percentage change in the price the demand is actually reducing much drastically over here; so that kind of systems are called elastic systems.

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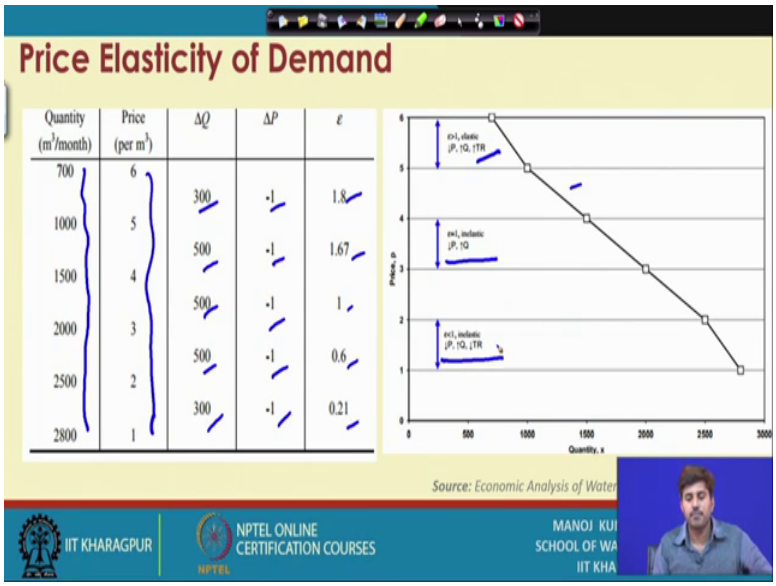

This is an example of price elasticity of the demand where you see that this is the quantity and this is the price. So, as the price reduced the quantity increased or we can see otherwise as the price increase the quantity reduced. So, this is the change in the quantity this is the change in the price unit price and if one sees this is what is the this is what is the price elasticity of the demand.

Now, if one plots this price elasticity of the demand or if one plot plots the price versus this one can see that for this particular sector the epsilon value is greater than one. So, it is a elastic system while this is also going to be elastic system while this is actually exactly one and this is less than 1. So, it is in elastic system. So, those sort of analysis are helpful.

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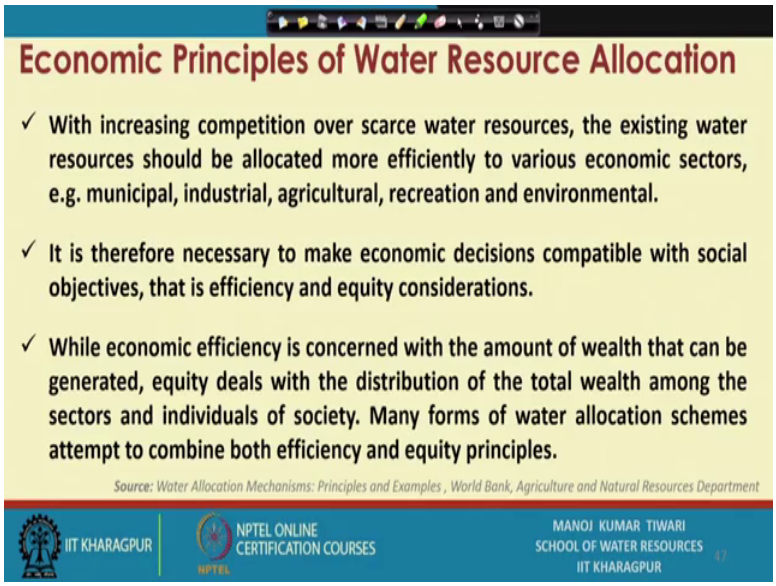

Particularly in the demand management or economic analysis of the demand.

Now, when we go for the water resource allocation based on the economic principle we clearly understand that because the competition is increasing and water resources are scared. So, the existing water resources should be allocated more efficiently to different economic sectors including municipal sector agricultural sector industrial sector recreational sector environmental sector or power sector different competing uses and therefore, it is necessary to make the economic decisions compatible with the larger social objectives.

And the sort of understand that the efficiency and equality consideration needs to be taken care of while making the resource allocation between the alternate choices. So, economic efficiency is generally considered as the amount of wealth that can be generated equity deals with the distribution of the total wealth among different sectors and individuals of the society many forms of water allocation schemes attempt to combine both the efficiency as well as equity principles.

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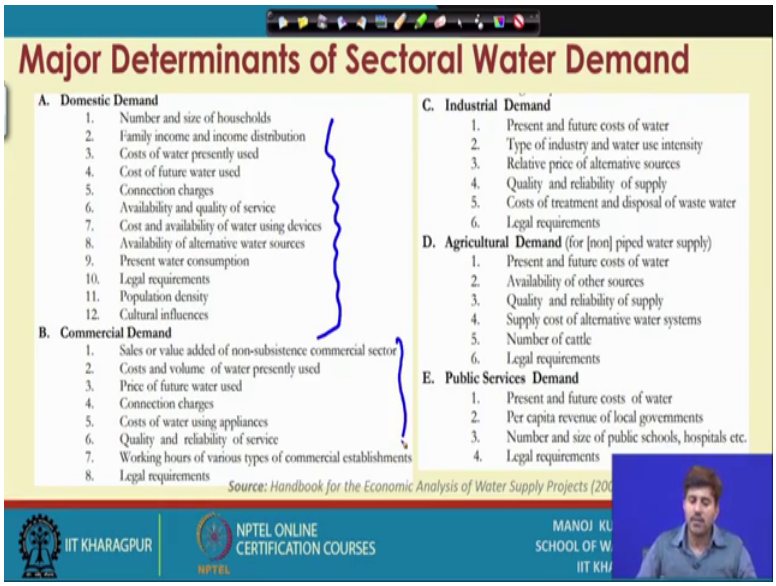

So, they try to be socially equitable as well as attain the economic efficiency, the major determinants for sectoral water allocation or sectoral water demands rather from different sectors are generally known it. It needs a comprehensive view to understand that what is going to be the major determinants for the domestic demand like what is the number of size household family size, family income, all the cause, then legal requirement population density all these things similarly for commercials what is the scale or value of the non subsistence commercial sector the cost and volume of the water presently used what are the pricing structure that is going to be what is the cost what is the quality and reliability of services legal requirements.

Same for the industrial sector for agricultural demand you need to see that the present and future cost of water or what are the opportunity cost of the water the availability larger area needs to be irrigated. So, supply cost what are the alternate approaches. So, all these; so, that way for all the different sectors we have certain guiding determinants that needs to be properly evaluated the water allocation mechanism if we see.

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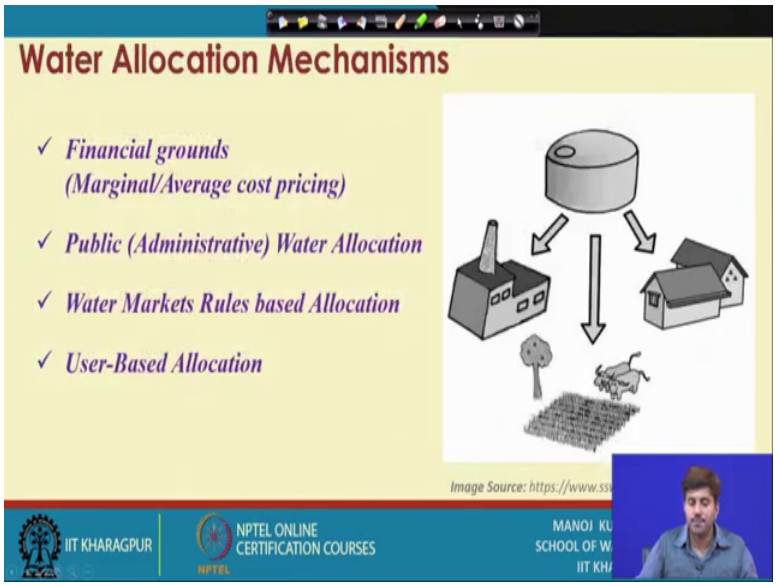

So, there are various ways suggested for water allocation mechanism there are financial grounds on which water can be allocated which incorporates marginal or average cost pricing as we discussed earlier then there are public or administrative water allocation where an administrator or government decides how much water is to be sent to what sector that could be based on the rationales or based on the demands from different sectors or could be based on sole political ambitions and political objectives at times.

So, that is one approach for the water allocation of course, all of this has several advantages and disadvantages associated with it then there are a water market rules based allocation how are the exact precise market rules in a competitive market fashion and how it can be basically the tradable water rights how we can incorporate they them for the water allocation purpose and then there are a user based allocation which is rather more scientific and see that how the different sectoral demands is arising from the user based consumptions and how they should be allocated.

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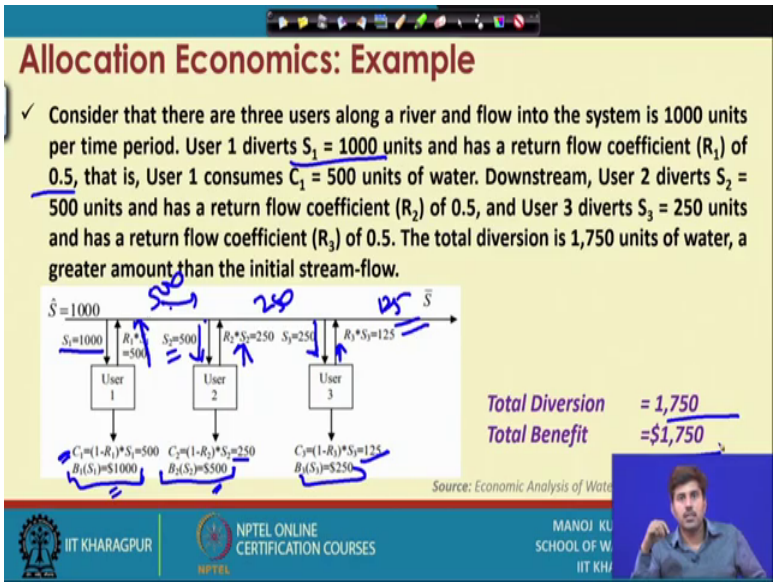

So, take a typical allocation example actually which considers that there are 3 users along a river and flow into the system is thousands units time per period. Now user 1 derives the S 1 units of water and has a return flow of 0.5. So, this is your user one total he is taking 1000 units of water almost like entire water he is taking, but he is sending back again the 500 units of water ok.

So, his consumptive uses are actually because he is taking thousand and he is returning 500. So, his consumptive uses is just 500, but he is getting the benefit on the entire thousand which he is using and generating let us say thousand dollars as a revenue in the downstream there is another user S 2 which is again because there is 500 left in the river. So, he is taking that 500 his consumptive uses are also again 50 percent. So, he is consuming 250 units and returning 250 back to the system ok.

The return flow coefficient for him also is 0.5. So, he is returning again half of it back to the system he is also earning on to the thousand v sorry 500 units used at one dollar per unit. So, 500 dollars he is also earning there is another third user who is getting because when he is returning there is a 250 left in that. So, he is getting that 250 he is again consuming half of it as a consumptive uses and earning 250 dollars and returning the half of it. So, 125 is still remaining in the system.

So, you see that the total diversions have been 100 was diverted here 500 here 250 here. So, total diversion was 1750 and total benefits was the 1750 dollars that way now

consider a second case for the same user group that way where again there are 3 users, but user one decides to sell the entire diverted amount to another user outside the basin for a price of one point one dollar per unit.

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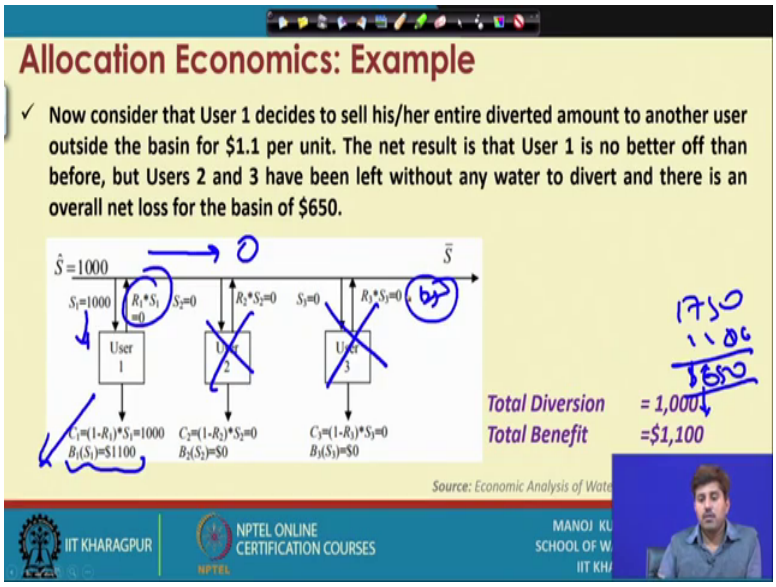

So, he is again diverting the thousand and is not returning anything back into the system. So, for here onwards the flow is flow is 0 and there is user 2 and user 3 becomes sort of nonexistent because there is no flow in the rivers. So, they cannot divert any water he is just using it and he is sort of selling it or using it and selling a product at eleven hundred all of the users have become consumptive uses.

So, the total diversion is just thousand and total benefits is eleven hundred now for user one it could be a beneficial model, but for overall rivers basin if you see the net river basin because they have not the others have not been left for any water that they can divert. So, there is a overall net loss of 615 because earlier there was 1750 and now there is just eleven 100. So, there is a net loss of 650 dollars and there is no flow in the river ultimately they were leaving some 125 flow also in that case.

So, this model this allocation model is not justified because if you see the entire river basin or entire it is not justified from the economic prospective of the overall community it is not justified for the environmental prospective of overall community because this stream is running dry from this point onwards sorry, now let us consider another scenario

where user one decides to only sell the amount of his her previous consumptive uses sorry.

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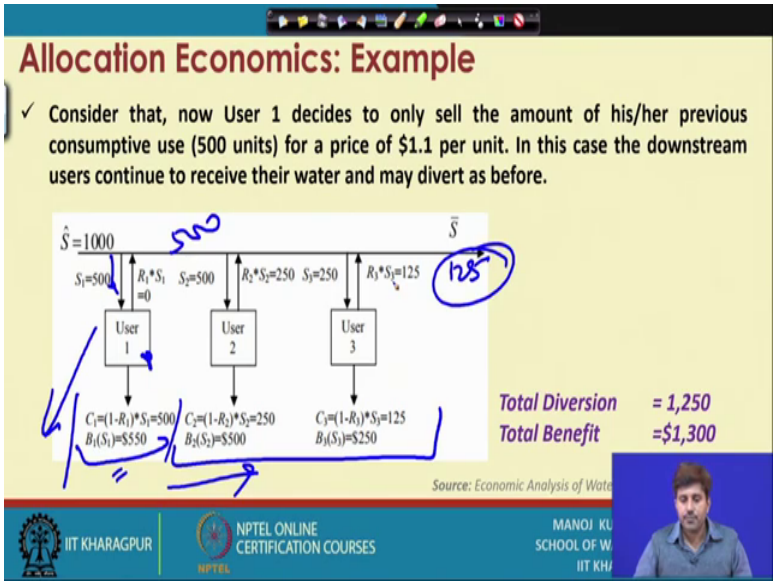

So, the 500 which he was diverting he is selling at one point one and that way getting a benefit of 550, he is just withdrawing 500 now. So, 500 is still left and rest other 2 users are still able to use that. So, subsequent scenario it remains the same for him because he is not returning. So, his investment might be decreasing for per unit investment he might still be beneficial, but overall economy if you see the entire base in earlier he was producing thousand dollars now he is producing just 550 dollars.

For the same concept amuses because there is no return flow. So, if he abandoned his services and just try to sell the water allocated to him still he can make some benefit out of it without affecting the others. So, the total diversion becomes 1250 and total benefit is coming out of 1300 dollars. So, this could be another model that may where there is a approximate loss of 450 dollars overall there, but the river is still having 125 units of water in it this stream is still having some water left into the it and that way this the allocation is at least better than the previous one.

So, that is how the economic principles or economic concepts can be used for the water allocation.

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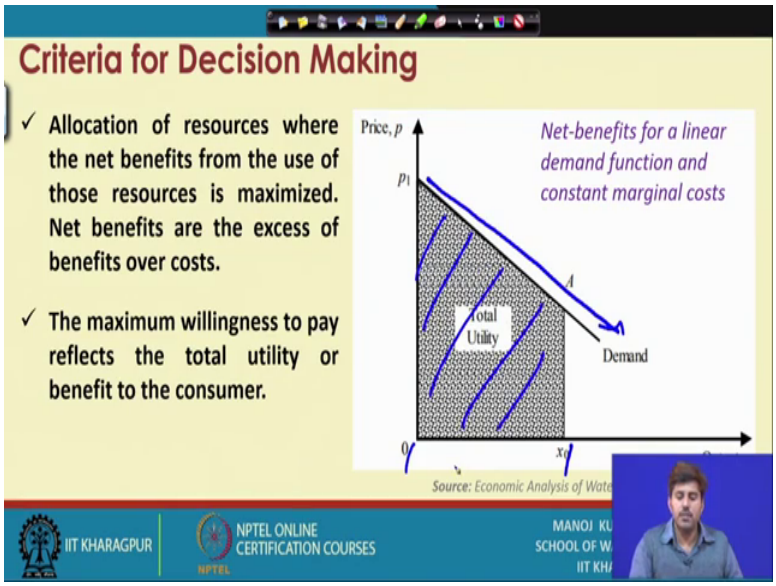

Now if we see the criteria for decision making the allocation of resources where the net benefits from the use of these resources is maximized. So, that is one of the basic criteria that the resources should be allocated in such a way that net been it from the use of these resources is maximized.

Now, benefit is not only in terms of the financial benefits the benefitting involves all the benefits the social benefit the externality is V every other intangible aspects as well. So, the net benefits are the access of benefits over cost as we discussed earlier the maximum willingness to pay reflects the total utility or the benefit to the consumer.

So, what is the utility to the consumer or what is the benefit of that water to the consumer. Consumer is eventually going to be willing to pay based on that only. So, earlier we see sort of exponential demand function now if you see your demand function is linear take an example of a linear demand function. So, for a linear demand function the net benefit for a linear demand function is going to be the total utility which is the area under this curve between the demand scale of demand.

So, this is going to be the total utility if this is my demand function and this is going to be one of the criteria in order to see if I can use this or if I can basically approve this project or not the surplus or net benefit is shared between producer and consumer.

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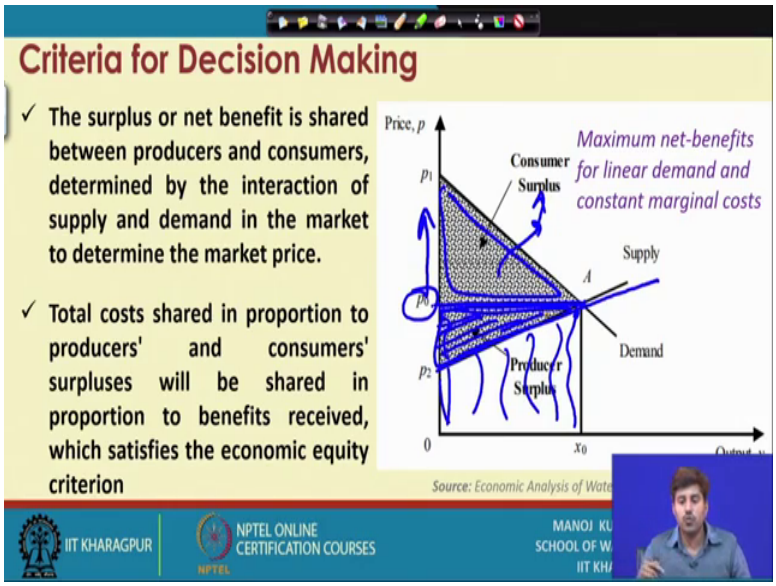

So, the net benefit one seeing here can is not necessarily the benefit with the consumer only there could be the producer benefit as well.

So, just recall the earlier discussion. So, if a consumer is paying at a price of p 0 at a cost of p 0 so; that means, this is what he is paying for that and as we discussed earlier the upper portion of this curve the is going to be as a consumer surplus while this is the cause that we are considering, but if the supply function we can say or a positive cost function we take. So, if let us say this is my supply function.

So, it means that cost will be actually covered under this net cost and whatever the gain over here in this zone because user is paid at this price. So, the user benefit is only beyond this, this is going to be the cost of supply. So, this is the net cost of supply or this p 2 is the cost at which the supply is being done. So, you see over here the rest is going to lie with the producer. So, this is going to be the producers margin or producer surplus.

Now, the total cost shared in production to producer and consumer surplus will be shared in proportion to the benefits received which satisfy the economic equality or economic equity criteria. So, that is very important over here it has to be economically equitable and that is to be seen from such analysis ok.

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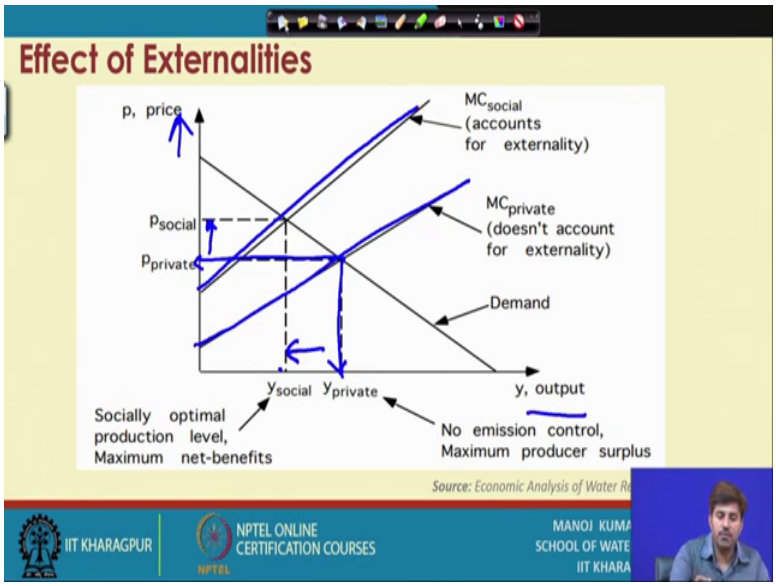

So, further the effect of externalities can also be included in such scenario we have if you see we have this as the output scale and this as a price scale if that way. So, if we exclude the social externalities we can see that for a lesser price we will be able to get more output or produce more output. So, that is my private price and private cost and this is my marginal cost under private conditions when I am not accounting any externalities. So, it does not account any externalities.

Now, what happen if we account externalities? So, of course, if we account in social or environmental externalities the cost is likely to increase because and the net benefit is likely to decrease we will have to incorporate the social cost and we will have to reduce the demand or we will have to reduce the output in order to meet the social externality. So, this could be the socially optimal production level where the net benefits are maximum this value and for that there would be social cost.

So, I will get again another marginal curve which is social which accounts for externalities. So, this way which marginal cost pricing is used whether to including externality or excluding externalities is to be seen and it is obvious that the if we consider for the externalities it is likely to be more stringent in terms of the net benefits for a given cost.

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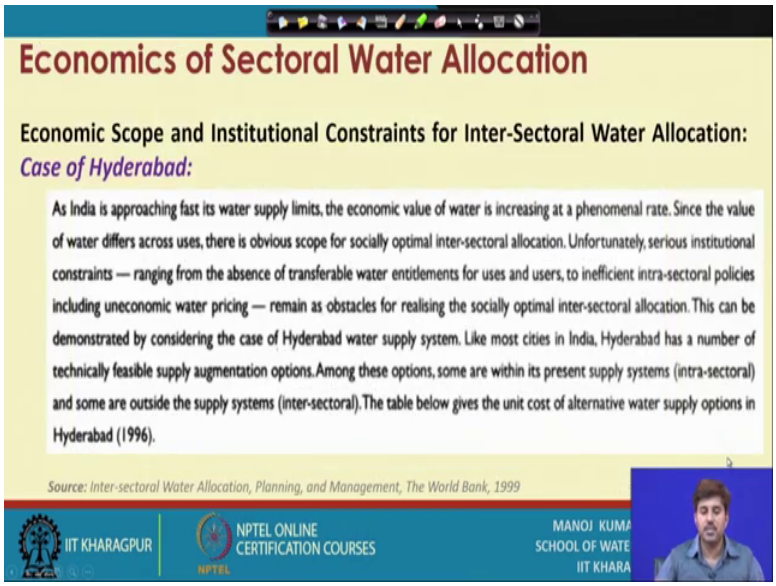

So, we will take a quick example from the case of Hyderabad that how the economic scope and institutional constraint deal in the, inter sectoral water allocation this is available in the World Bank report of 1999. So, the Hyderabad particularly like most other cities in India has a number of technically feasible supply augmentation options and among these options many are actually within the present supply system or within the supply system when this was analyzed and some would likely to be the outside supply system. So, there is a, inter sectoral allocation and there is a possibility of intra sectoral allocation as well the options evaluated was listed over here ok.

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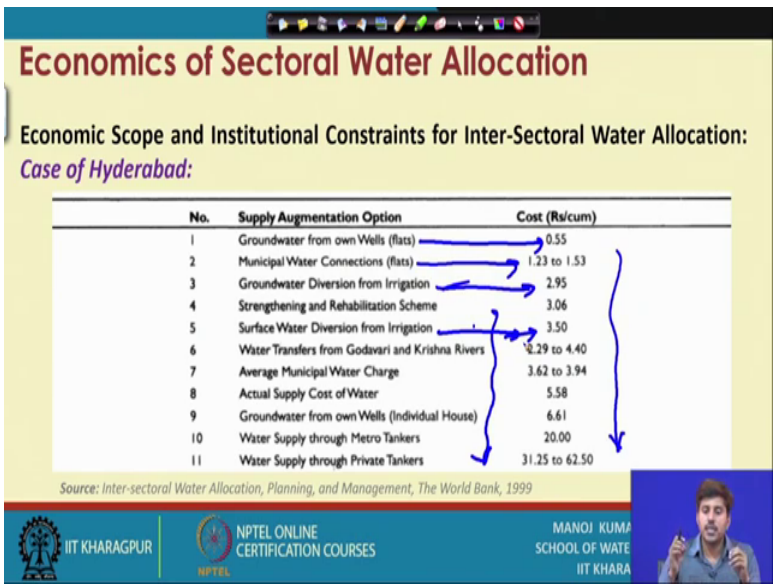

So, there is basically a groundwater from own wells the municipal water connections the ground water diversions from irrigation then that way there are different possible allocations and what is going to be the associated cost in rupees per cumec was estimated as reported in the this world bank report. So, now, you see that the cost associated with different options varies drastically.

However some of these options could have the same objective fulfilling for example, for flats groundwater from own well will cost 0.55 and municipal water connection would cost between 1.23 to 1.53 right. So, this is both of these option are going to serve the same purpose this is actually allocation for the municipal water supply; however, the rates or the approaches are different similarly we can have further for irrigation purpose.

Let us see there is a ground water diversion for irrigation or surface water diversion for irrigation again the same objective fulfilling at a different rate from different sources. So, that way there is a possibility of, but irrigation allocation is a different than municipal allocation similarly a industrial allocation who is going to be the different from other type of allocation.

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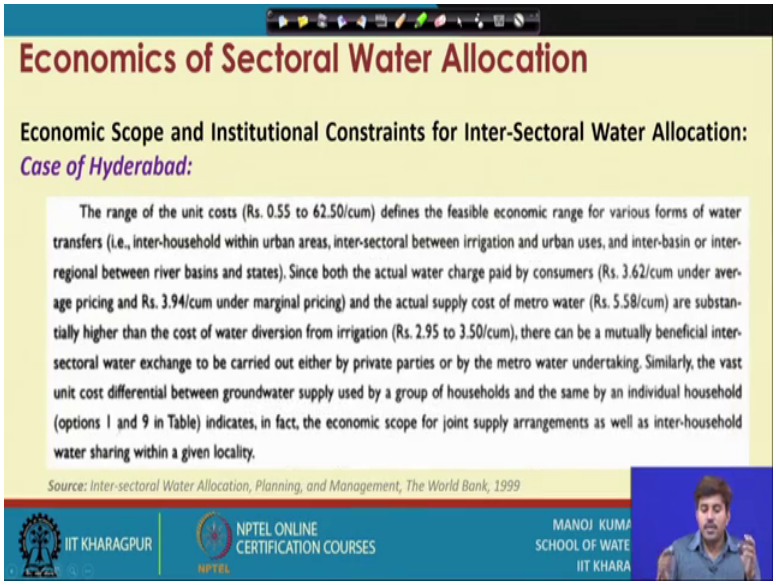

Now the point here is that the different allocations over here under different options basically provide a variety of alternatives ok.

So, the range of unit cost defines the feasible economic range for various forms of water transfers. So, whether it is inter households within the urban area or inter sectoral between the irrigation and urban uses or inter basin or inter regional between the river basins and states. So, those kind of analysis needs to be looked upon ok.

Now, you see they are both actual water charges paid by the consumers under average pricing and marginal cost pricing and the actual supply cost of metro water in this list provided earlier are sort of certainly higher than the cost of water diversion from irrigation. So, there can be mutually beneficial inter sectoral exchange between these sectors similarly the individual households using ground water supply or a group of households by the same fashion actually there are different options listed at point one and nine in the table they can be evaluated for trade off or for exchange between of the allocation in similar fashion.

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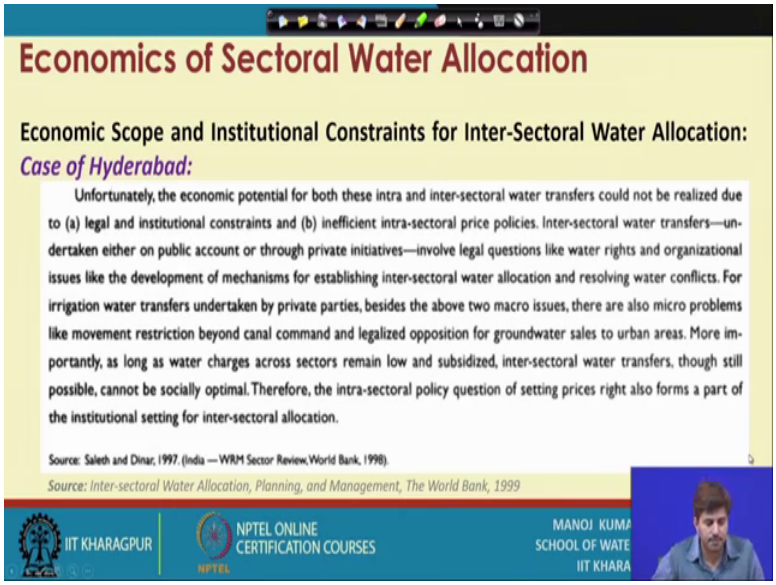

However unfortunately if we see the larger prospective the economic potential for both the intra and inter sectoral water transforms generally are not realized due to legal and institutional constraints and due to inefficient intra sectoral price policies. So, this needs to be holistically understood should properly be taken care of and the intra sectoral policy question for the setting of prices or to the right scale in the right form considering the financial constraints and the financial objectives is of very high importance.

So, we will end this discussion over here and in this entire week we basically discussed how the financial analysis can be used for the small objectives of the making choices between alternatives or the demand is management. So, all these aspects we discussed this week we will be talking about various approaches various methods of capital budgeting when we evaluate the overall project whether that project should be considered financially rewardable or not in the next week.

Thank you.