Water Economics and Governance

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Lecture – 20
Valuing Water: Full Value and Losses

Hi everyone. So, earlier this week we have been discussing the valuation of water resources and water services we did discuss about the different approaches to identify the different components of the value. So, in this concluding session we will be talking about the, what is the full value of the water? What is the scale of losses particularly in the urban water supply that undergoes because that is a loss of value, so that is what we will be discussing in this concluding session.

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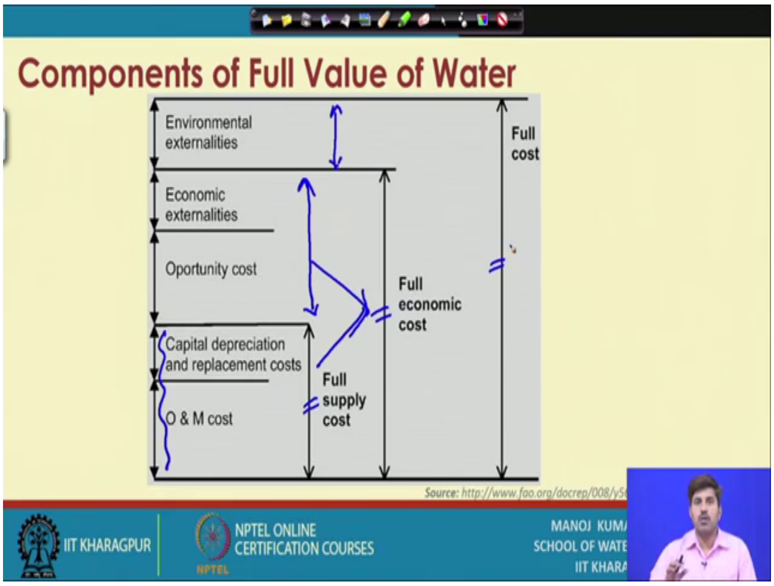

If you see the component of full value of water, so we have already discussed about the different cost or different value of the water, so generally when we say that water services or water is under supply either for irrigation purpose or for the domestic purpose, so this supply cost or the full supply cost typically will include the capital cost and the O and M cost.

So, O and M is operation and maintenance cost which is on a recurring basis and capital cost is a non recurring cost which is typically and done at the beginning of the typically invested at the beginning of the utility construction or utility installation.

So, capital cost or the; it is depreciation and replacement costs either can be taken, so that way the combination of these two gives us the full supply cost. Then there is a opportunity cost like what are the alternate uses of the water if that water is not being used for this purpose for any alternate purpose how much cost? or how much value this water contains? So, that will be estimated under opportunity cost and then there are economic externalities which are coming from the; which are being generated from the other economic aspects.

So, this economic externality and opportunity cost again when added, so this gives us the full economic cost. So, your full supply cost plus your economic externalities and opportunity cost in combination will give the full economic cost and if the environmental externalities is added in that the environmental externality is in form of what are the impact on to the environment? Or what has the benefit on the in power in environment?

So, this economic externalities and environmental externalities are the two form of externalities which could be either positive or negative, because impact of a utility impact of a service can be positive also or can be negative also on the environment, similarly on the economic aspects of the society it could be positive or it could be negative. So, whether it is positive or negative it is taken into the account and that way the; if all things is added, what we get is the full cost of the water. So, these are the different components that are obtained at for the full cost of the water.

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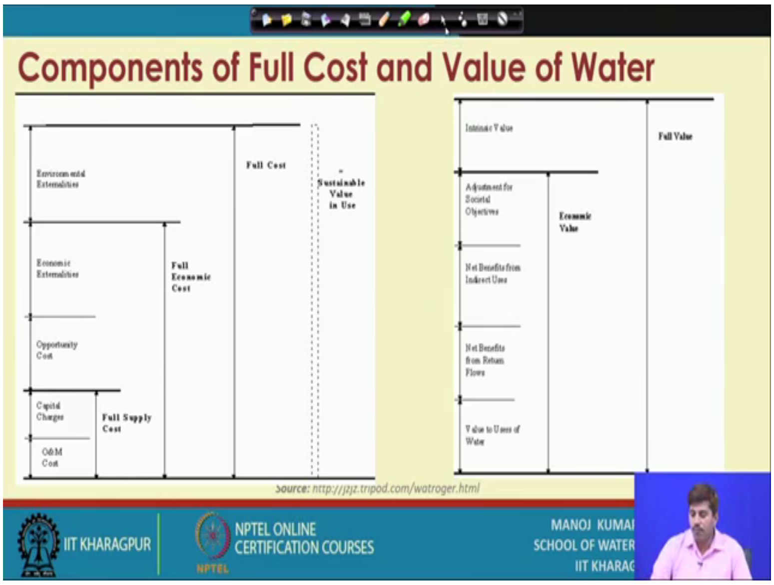

Now, if we need to see application of water or application of a utility or certain particular application or use of water is sustainable or not, so we need to compute it is full cost and the total value also, so if it is cost and value are reasonably in the same range we can say that use these sustainable or other way you can say that use is actually not sustainable. So, that way if you see the full cost we already discussed what are the O and M cost? Capital cost? Then there is a opportunity cost economic environment and environmental externalities.

Similarly, on the value side we get the value of user of water then what is the net benefit from the return flows? Because if water is being used for a purpose there would be some return flow out of that water. So, what is going to be the net benefit of that? The net benefit from the indirect uses to the society, then adjustment for the social objective if there are any, so all those gains are will in combination give you the economic value of the water.

And if the intrinsic value is added to this economic value like intrinsic value due to the intrinsic factors of the utility operation so that in combination gives the full value. So, that way full value and the full cost can be estimated and eventually can be compared for the sustainability analysis purpose.

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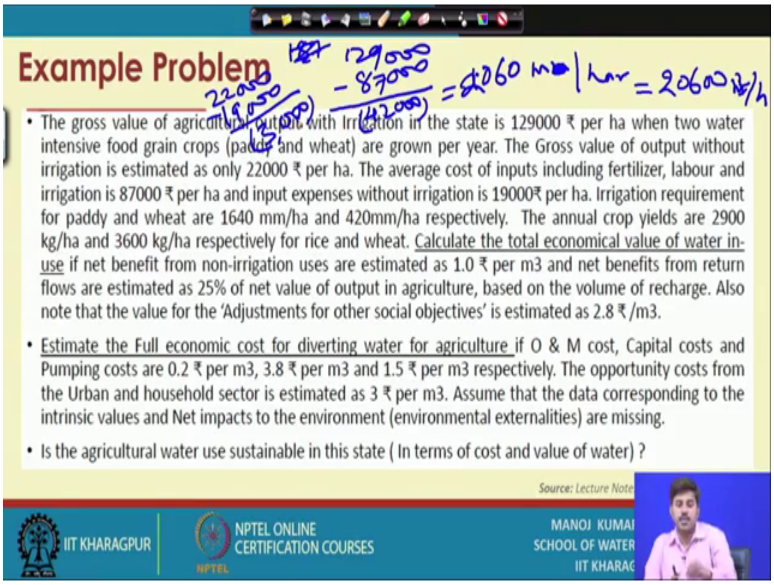

So, this is an example problem of a similar scale. So, where the gross value of agricultural output with irrigation in a state is given as 1,29,000 rupees per hectare, when two water intensive crops paddy and wheat are grown in a year cycle the gross value of output ah without irrigation is estimated only 22,000. So, this difference will give us the difference due to the irrigation.

Now the average cost of input including; fertilizer, labor and irrigation is 87,000 per hectare and input expenses without irrigation is 19,000 per hectare. So, irrigation requirement are also given for paddy and wheat which is for paddy it is 1640 and for wheat it is 420, so that way if you see the total irrigation requirement in a year cycle is going to be the 2060 mm per hectare or if you want to convert in a meter cube, so one needs to multiply with the area, so this 2060 mm would be 2.06 meter and then you multiply with 10,000 so what you get is 2060 meter cube per hectare, water is being used for irrigation further you see that the total output is 1,29,000 at a cost of 87,000.

So, what is the gain with irrigation? So that is going to be 187 sorry 1, 29,000 minus 87,000 which is the cost so that way this difference which is going to be the 42,000 will actually be the net profit for the irrigated crop and in a year while opposed to that you have 22,000 is the value of this crop production and 19,000 is the value of the expenses, so you see the net gain here is 3,000 for non-irrigated.

So, 22,000 minus 19,000 so net gain here is just 3000 for non-irrigated. So, when you are putting this much of water for irrigation purposes your income is actually changing from 3,000 to 42,000 so that way we can determine the per unit water how much additional income has been generated and that is what will give us an idea of the sort of economic value of that water.

Irrigation and 3,000 without irrigation, so additional output or additional value due to irrigation is 39,000. And water input is 20,600 so net value of output in terms of rupees per meter cube is 1.89, so that is the net value of output from the irrigation.

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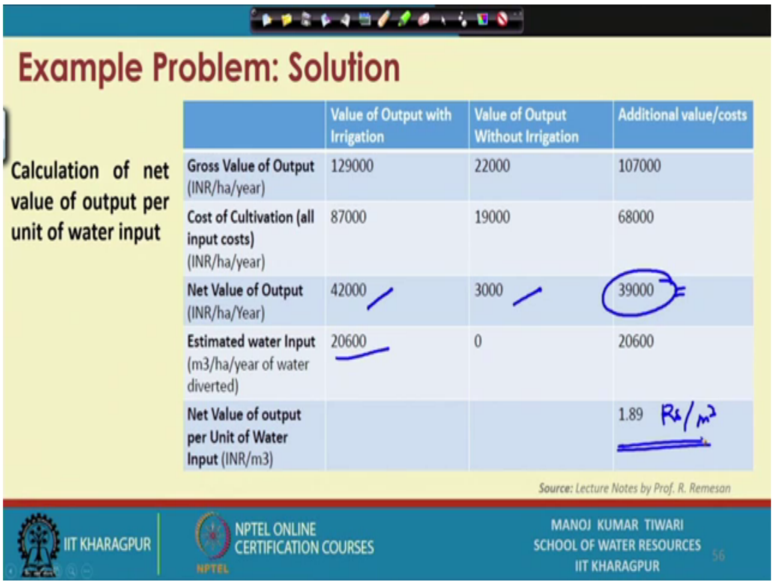

So, if you see the question again. So, that is there now for the total cost it further says; that, the net benefit from non irrigation uses are estimated as 1, so there are additional benefit from non irrigation uses of that water which is 1 rupee per meter cube and net benefit from return flows the after irrigation whatever flows is returning to the system of is 25 percent of net value of output in agriculture. So, the net value of output was 1.87, so it will be taken as one fourth of 1.87 which is 25 percent of 1.87. Based on the volume of recharge also note that: The value for the adjustment for another social objective is estimated as; 2.8 rupees per meter cube, so that way you see that 1.89 was the total value ok.

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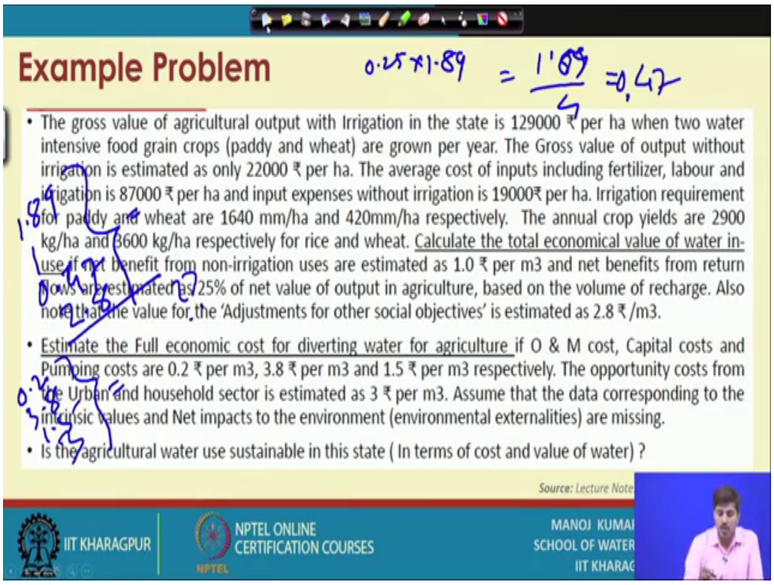

We have 1.89 as the net output. Then we have other benefit non irrigation benefit as 1 rupee per meter cube these are all per meter cube in rupees and return flow is 25 percent of the net value of this, so basically 25 percent of 1.89 so 0.25 times 1.89 which will be 1.89 by 4, so it is 0.4 and around 0.47 so 0.47 is going to be coming from here and then the adjustment for other social objective is 2.8. So, the summary of this is going to be the net gain.

Now for the full economic cost of diverting water to the agriculture if O and M cost capital cost and pumping cost are; 0.2, 3.8 and 1.5. So, there are three types of cost O and M cost which is 0.2 pumping cost which is 3.8 and sorry capital cost which is 3.8 and pumping cost which is 1.5, so these are the three cost assume that the know the opportunity cost is also given that a opportunity cost for the urban and household sector of that water is 3 rupees per meter cube, so this becomes your opportunity cost.

Assume that the data corresponding to the intrinsic value and net impacts to the environment are missing. So, externalities are missing the uppermost component in the tables which we are seeing is actually missing, so eventually you need to compare the sum of this with sum of this in order to see if the system is sustainable or not, so that can be seen here.

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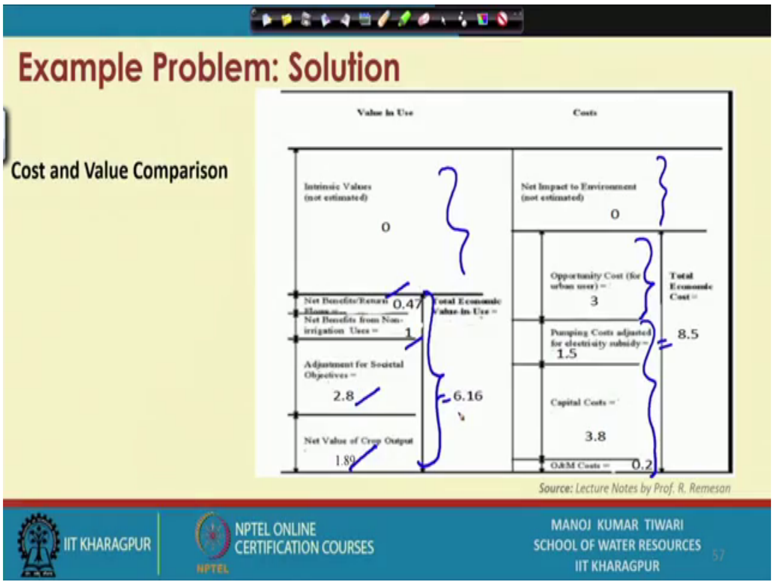

So, that is your total economic value and total economic cost. So, if you see the total economic value as we were discussing earlier we have estimated, so 1.89 is from the crop output then adjustment of social objective is 2.8 non irrigation uses is 1 and net benefit from return flow is 0.47 this value is unknown to us and this makes the total economic value is 6.16.

On the other hand the O and M cost is 0.2 capital cost is 3.8 and pumping cost is 1.5, so this is the total cost and then added opportunity cost, because otherwise the water would have gone to the domestic sector is 3, so this makes a total of 8.5. So, now you see the; although the like environmental cost or this thing is unavailable, so if you exclude the unavailable factors you see that the total cost is actually more than the total gains.

So, that way this system may not actually be sustainable for ah for the irrigating these crops in such a fashion. So, this kind of analysis can actually lead to conclusions related to the appropriate or beneficial social uses of the water. Now, when we are assigning a value to the water, so there is a huge water which undergo losses and that also needs to be encountered, generally when we say that; we are pumping this much water and then supplying here and there so either for irrigation purposes or domestic sector.

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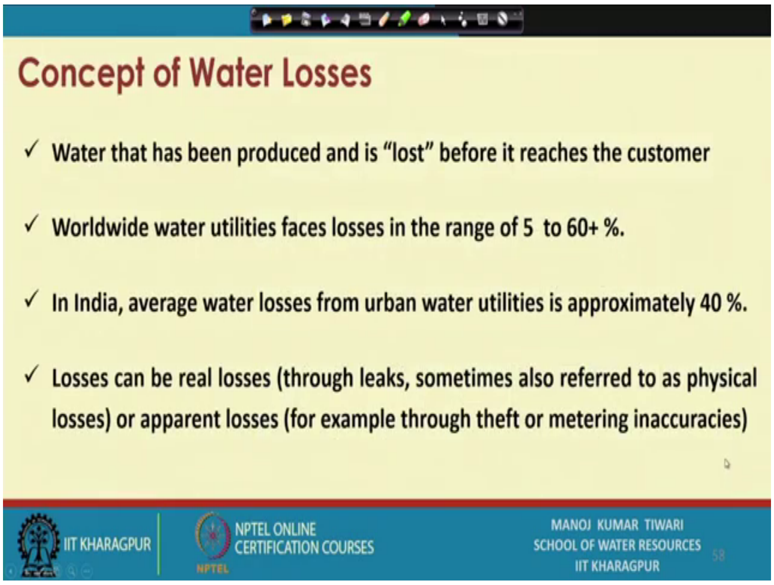

Irrigation sector it is ok because it is based on the per area hectare and mostly water is not quantified in terms of meter cube or a specifically; however, for domestic sector it is very important because domestic water is also incurs larger costs, it needs purification, it needs processing. So, there are expenses of infrastructure there are expenses of chemical treatments all dis infections all these expenses makes the water costly and after these expenses are done if water is not meeting it is intended use if it is getting somewhere lost in between supply systems. So, that sort of creates another problem.

So, water losses are that which has which has been the water which has been produced and is lost before it reaches customer. So, that is what typically is referred as water loss, now worldwide water utilities face losses in the range of 5 to greater than 60 percent, so at places the water losses are actually higher than 60 percent.

In India also average water loss ranges between 35 to 40 percent generally; however, if you see the entire range it is as low as maybe 78 percent for very well managed utilities like; Jamshedpur and such places, to as high as over 60 percent in many poorly managed city where in fact, there is no proper accounting of how much water is going is getting lost, because the systems are unmetered so people do not know precisely how much water is actually not reaching the intended consumers.

The losses can either be real or can be apparent, which sort of means that from what is the form in which they are originating? So, real losses are actually truly physical losses and a form of water in the distribution system including like; if there is a leakage or system overflow, if your storage reservoir is overflowing, tank is overflowing, if there is a fracture in the pipelines, so there is huge water is getting leaked from that pipeline, so those kind of physical losses which actually is losses in true sense is actually taking place. So, these are referred as real losses or physical losses.

These losses inflate the water utilities production cost because if let us say for example; 20 percent of water which is intended to supply is getting lost somewhere through leakages and other means so; that means, the utility has to be at the burden of additional 20 percent water and probably that will be translated to resource so it makes the it puts an additional stress on to resource as well.

So, utility which is having a loss of for examples: ay 20 percent and if they want to supply if they want to supply hundred L P C D water to their consumers. So, probably they will have to extract water at a rate of 120 or 125 L P C D, so that even after the losses they can able to supply that 100 liters per capita per day to their consumers. So, for the supplying of 100 L P C D they stress on to resource is going to be higher, so those kinds of implications are attached to the physical losses.

There are apparent losses which are actually non physical losses and they occur in the utility operation due to the various reasons which could include the; metering inaccuracies, so if there is inaccurate metering means it is not getting accounted where water where that water is going or if there is a handling in the data error or if there is a theft or these sort of like issues actually tend to make water unaccounted we do not know how where that water is going and it is actually considered as a loss, though in real sense that water is not lost it has maybe gone for some uses, but not recorded properly ok.

So, either it is gone through stealing or somebody has stole that water or it has basically been supplied, but not recorded due to metering and accuracy or data entry errors all this kind of system.

So, this type of loss is usually put financial stress onto the utility because they do not generate any revenue, if you are not having an accounting of these waters even if they have gone to some sort of uses but if one is do if the utility is not having record of it in their record book it is actually entered as a loss. So, that is the class of the apparent losses.

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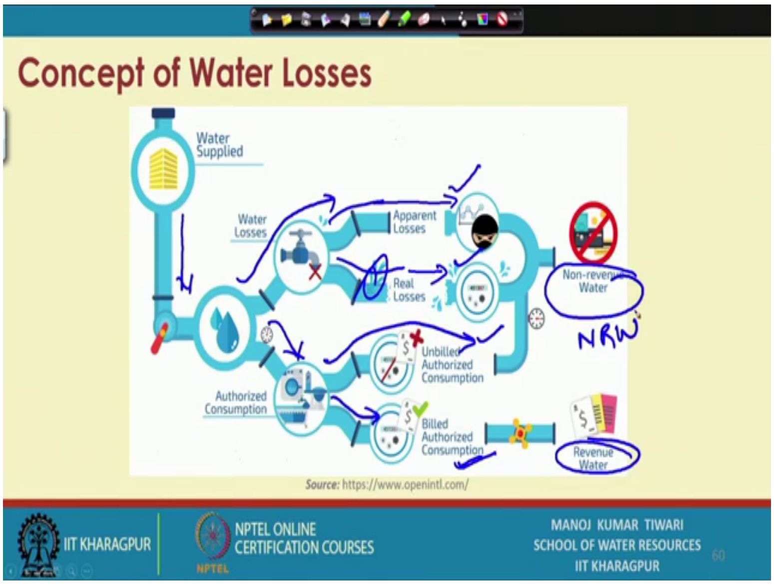

Now, you see when the water is supplied it actually it can go 2 routes. So, one is the authorized consumption, which is properly metered which utility knows where water is going and then among the authorized consumption again it can actually go to the meters which are billed properly and on which utility generates revenue. So, this is referred as revenue water ok.

On the other hand some part of this is actually is known and is recorded utility know that this much of water is going for this purpose, but they do not charge that. At times many institutions are made the water charges for several institutions or public utilities or ah some let us say recreational facilities are made free by the utility itself, so those water consumptions although are recorded that this much water has gone for this particular purpose, but that water has not generated any revenue, so that cannot be included in the revenue water or the water which has generated revenue.

Then there are water which is not recorded, which is not authorized consumption, so the unauthorized consumption as we were discussing could be either in the form of leakage if there is leakage somewhere, so those kind of losses which is your real losses which one can never sort of get the knowledge of and there are apparent losses which are due to stealing theft or in inappropriate metering and accuracy record entry in accuracy system failures, so these kind of losses.

Now, you see all three of these components whether this or this or this or either like even if it is authorized, but unbilled consumption. So, either that or your real losses or your apparent losses are not generating any revenue, so this in total is called non-revenue water or N R W typically. So, this N R W in these edges is a term frequently coined by the water utilities to get an idea of how much share of their water is generating in revenues? And how much share is not generating any revenue?

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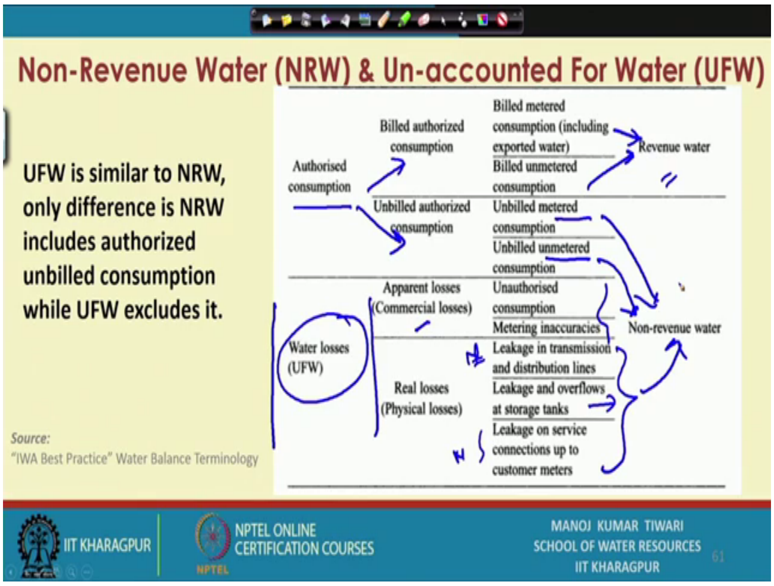

So, the share that does not generate or does not produce any revenue is referred as non-revenue water. The international water association which is I W A has actually given a pro forma for water budgeting of the water utilities, so that is the in the I W A based practice manual, the I W A suggests international water association suggests; that the, budgeting of water for a water utility is to be done in a pro forma which is sort of prepared after too much of deliberation.

So, again they say that it is it almost state the similar thing which we are discussing earlier, so there would be authorized consumption which will be which could be billed or which could be unbilled, now the billed authorized consumption could be either from metered or unmetered the connections. So, even if it is not metered even if let us say; some consumption is not metered, there are bulk consumption which utility is just sending unmetered connection, but they are getting some charge onto that water. So, that should go to the revenue water because it is generating revenue.

Onto other hand the unbilled authorized consumption which is either metered or unmetered in the any form is actually should be coming to the non revenue water as it is not generating any revenue and of course, the water losses which is either apparent losses which are also called as commercial losses the unauthorized consumption or metering an accuracy, so they will be non revenue water and real physical losses, which is either leakage in the transmission and distribution lines and then how much is the leakage and overflows at the storage tank? And then leakage on the service connection up to the customer meters.

So combination of all three although they probably needs to be calculated independently, because if you want to do an water budget in this pro forma you have to compute all these independently. So, how much it is total is there which is adding to the non revenue water? The independent calculation in a way helps to identify the real problem areas, where is the problem and is at a larger scale and then one can actually sort of take remedial steps in order to improve the situation.

For example: let us say, you figure out that there is leakage in transmission and distribution lines is negligible and leakage in this service connections are again negligible so; that means, your major physical losses is coming from the storage or overflow tanks and you need to put attention there in order to control it. So, those kind of implication can be drawn when it is independently estimated all the components of physical losses or commercial losses.

The losses the physical and commercial losses in combination are typically referred as water losses which is given a term U F W which means unaccounted for water. So, this unaccounted for water is essentially the combination of apparent losses and real losses and if one adds the unbilled authorized consumption which is accounted, but not build then you get the total non revenue water.

So, that is the difference between the U F W and N R W; where, N R W includes authorized unbilled consumption also while U F W does not include that. So, that way the estimate of losses can be made for water utility.

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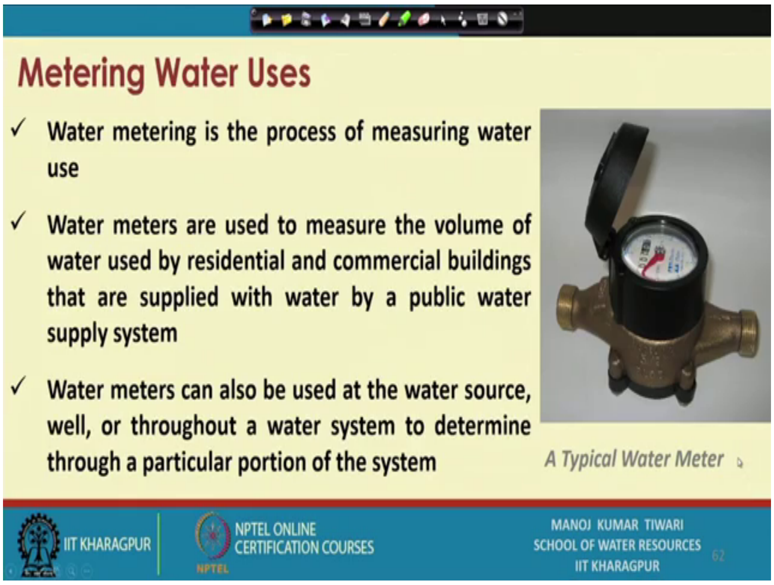

Now, for the purpose of estimation of the losses or for the purpose of valuing water or quantifying water one needs to know how much water is being supplied. Or how much water is being flowed? So, for larger irrigation project and all that we have canal and then we can measure the velocity or the overall discharge in those systems, but in the domestic sector it is done through the water meters. So, then typical water meters means water meters need to be installed at the consumer and probably in order to know the consumption of a consumer a specific consumer.

So, the water meter of course, as the name suggests it is the process of measuring the water. So, it generally the water meter that comes will give the instantaneous flow reading, as well as a cumulative flow reading that how much water has passed through this meter in a specified time period. So, that way they will measure the volume of water used by the residential or commercial building which is supplied by public water utility typically they can be used as source as well or throughout the water supply system for determination of flow at the different juncture or different points.

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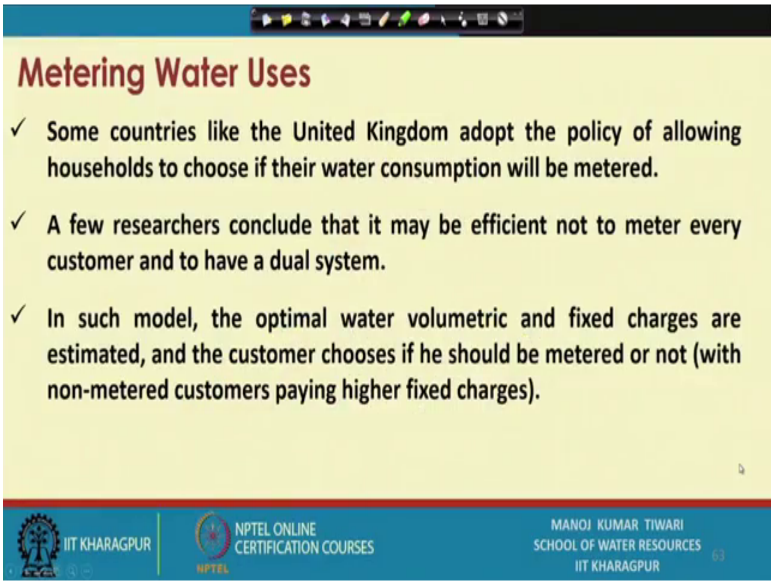

Now, the metering of users for water is a critical aspect because it incurs huge costs. So, if all the consumers has to be metered, so there will be significant amount of cost and that to avoid that there are different metering regimes that are proposed, because many countries in the united kingdom adopt a policy of allowing households to choose if they want to metered or not metered, many places metering is intensely not provided ok there has been studied which has been sort of concluded that it may be in facts socially or economically efficient to not to meter all the customers, because the advantages coming off out of the meeting all the customers may not be significant and may not be justifiable.

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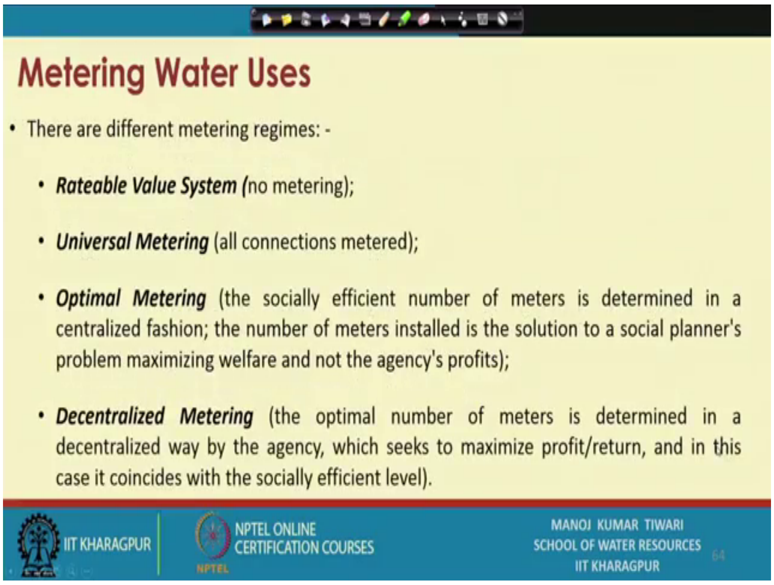

So, in such cases the optimal metering of water can be done. So, there are different regimes for a metering water uses it is there is a rate able value system where there is no metering done then there is a universal metering where all connections are metered then there is a optimal and decentralized metering, where efficient number optimum number of meet like meters are calculated and installed and this optimum number can be computed based on the social efficiency which gives you the optimal metering or the utilities efficiency which generally gives the decentralized metering policy.

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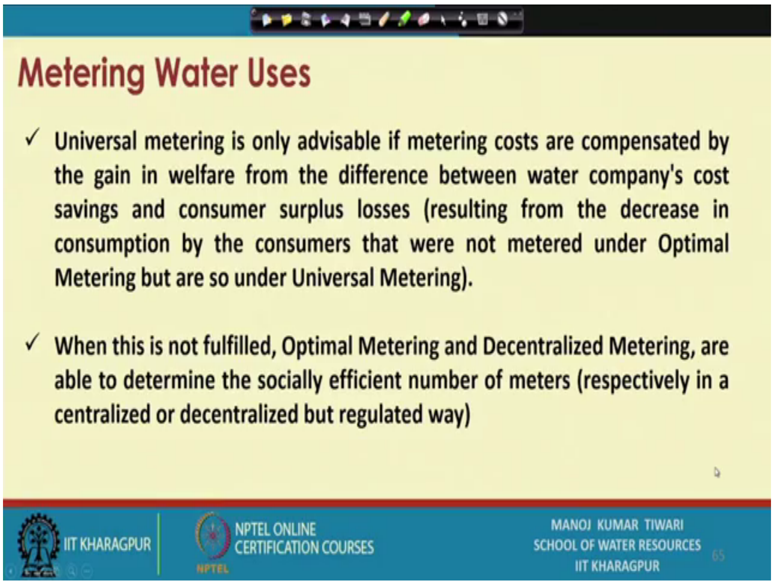

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So, those kind of metering can be adopted. Universal metering may not be encouraged at every time though. Now, the when we get an idea of the value of the water or the price of the water fair share of the value of the water, one can adopt these several economic instruments for water management.

So these economic instruments typically used market based signals that motivate desired type of decision making what type of decision is to be made? So, they either provide financial reward or for the desired behavior or impose certain type of cost for undesirable behavior. So, for example: We see that the optimum use of water is this or value of the water is this here is these are the option values of the water for alternate uses and this might be the more socially relevant options or in order to list they cut down the value.

So, for example: In a domestic tariff system you can say that the consumers which are using water less than 10 kilo liters per day will pay a small charges or just token amount of a charges because they will be get rewarded by the utility for water conservation, while the consumers which are consuming; let us say, more than 15 kilo liters will pay much higher prices because as a penalty for the using high water penalty for consuming more water or probably going for the wasteful uses of water.

So, those kind of those kind of economic instruments can be added in the management practices in the tariff designs and all that which we are going to discuss next week. So, this is to be basically seen.

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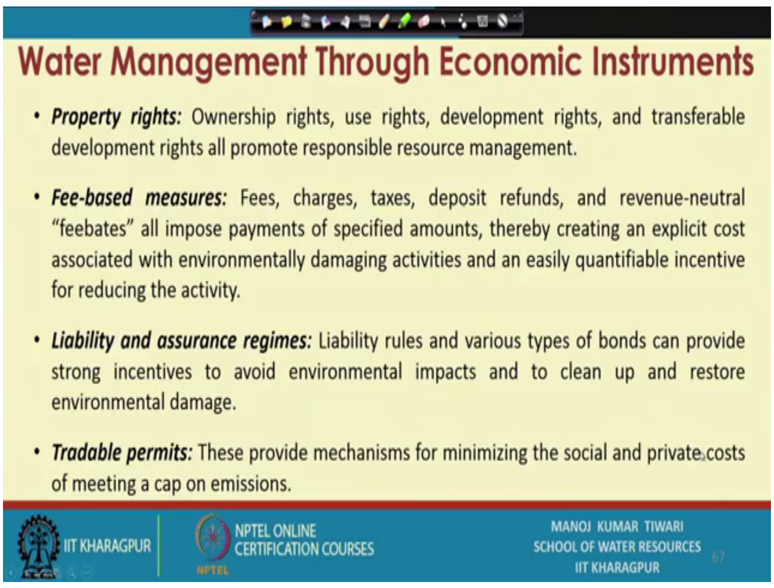

Now, the there are various economic instruments through which it can be managed there are property rights then fee based measure we can put fee charges to excess deposit refund all these thing. Then there are a liability and assurance, so what kind of when; let us say, somebody owns a water body or somebody is given a responsibility what are their liability rules? And what are various types of bond that can provide strong incentive to avoid environmental impacts and clean up the resource? And then tradable permits, so that these like they can provide a mechanism for minimizing this social and private cost of meeting a cap onto the various type of emission.

So, these various water management principle can be adopted based on the economic instruments; mostly through fee, charges or taxes and it could be let us say for example: For water services we can have a like; tariff which includes for drinking water, sewage, irrigation, raw water.

Industrial uses we can put a tariff for that or in the form of charges or in the form of basically fee at times we can put abstraction charge or pollution charge if somebody is abstracting water or additional water from a resource he need to pay obstruction charge or if somebody is releasing or emitting pollutants into the natural resources into the natural waterways he need to pay a pollution charge which basically polluted a following a polluter pay principle kind of scenario.

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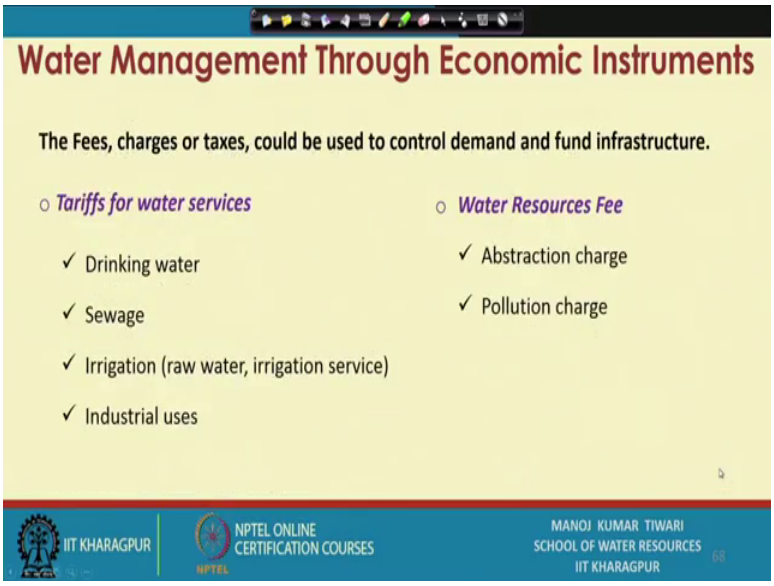

So, those kind of strategies can be employed to manage water and we will taking clue from this, we will discuss the how the water tariffs are set for the particularly targeting the urban water supplies in the next week. So, we will end this session here for this week and next week we will be talking about how water is priced? And what are the typical criteria or constraint or different pricing structure that are adopted for pricing water.

Thank you.