Water Supply Engineering
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Lecture - 05
Urban Water Services and Water Supply Systems

Hello friends and welcome to this fifth class which is the last for this week on water supply engineering. So far, we have discussed about the basics of why water is important. Then we discussed about the availability of water in the second lecture, how water is available and how it is distributed across the globe and specifically in our country.

Then we talked about various uses of the water, what are the different sectors where water is used and which sector poses what fraction of demand and how this demand is changing? What are the driving forces behind this changing demand. In the last class we discussed about several issues and challenges that are there in the water sector.

So in this final class for this week, we are going to talk about generic urban water services and water supply system, which will be basis for this course and our subsequent discussion will primarily will be focused on water supply systems particularly supply systems not in just distribution, but overall water supply starting from getting the water from source to the supplying it to the consumer end.

So that is what we are going to discuss in the next 11 weeks in this course and this particular lecture we will have a brief outline of what urban water services are, what are its different components and what are its different elements.

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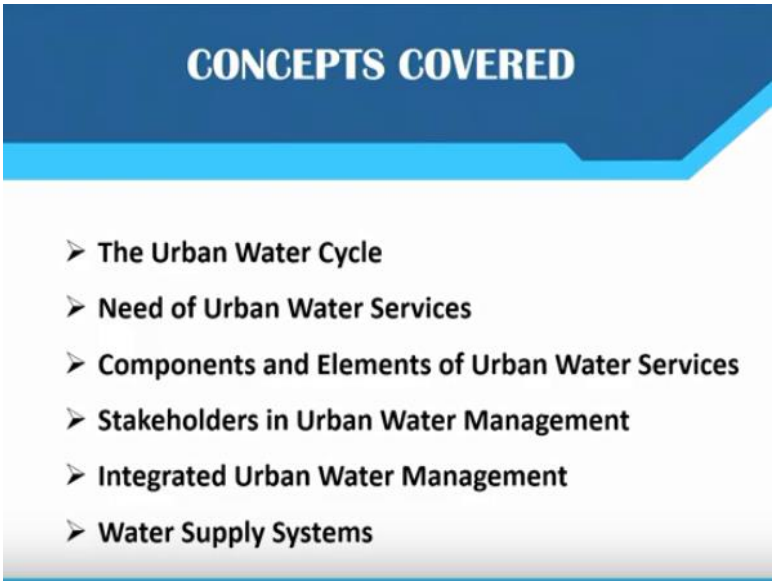

So what we are going to cover in this is about the urban water cycle, why we need urban water services, specific urban water services? Then what are the various components and elements of urban water systems? Who are the stakeholders in the urban water management? We will touch upon the concept of integrated urban water management and then we will have an introduction to the water supply systems.

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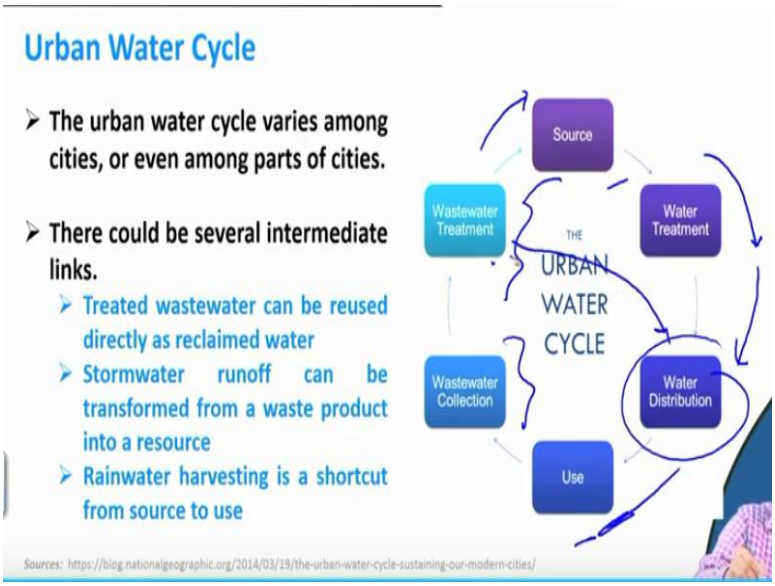

So to begin with, if we talk about urban water cycle, so urban water cycle is essentially how water is moving in urban space okay. So there is going to be a source of water and from this particular source the water will actually for urban requirements or urban needs, water has to come to the user level from source to the user level. In between it passes through a treatment stage because the water usually available at source is not of the quality which can be directly used.

So in order to convert it to a usable form or usable quality, it has to go through certain treatment processes. So there will be a step of water treatment and then the treated water is distributed to the user. So through a water distribution system the water comes to the user level. Now once water is used by user after using the water user eventually generates some kind of sewage or wastewater.

If industry is the users they generate effluent. If the municipal consumers are users they generally produce sewage or wastewater. So we generate wastewater. So wastewater has to be collected and then it has to be treated and eventually it is disposed of to the source, again back to the source. It usually goes to the natural resources back again. These are conventional urban water cycle.

Of course, there are several intermediate links could be there, okay. Like the treated water can be reused as a reclaimed water. So instead of this water going directly to the source, can actually come to a distribution system or can directly come to the user base okay. So all those like this water can come here or this water can come here okay.

There is a storm water component in urban water cycle which is not depicted here, but it is there. So the rainfall that comes in urban space actually gets collected in the form of storm water. So that storm water can also be transferred to a source to a resource from generally the storm water is considered as a waste form of water and is channelized to the either untreated or partially treated form of the storm water goes to the our water resources.

But after treatment, it can actually be considered as a resource as well. So there will be another link. Rainwater harvesting is another shortcut because in the form of source we get the rain water as well and that can actually directly be used without going to the treatment or distribution systems if appropriate rainwater harvesting mechanisms are made available.

So that way this cycle is basically complex although you see the six blocks here, but it could be more than six in fact, and there could be several intermediate links in the urban water cycle.

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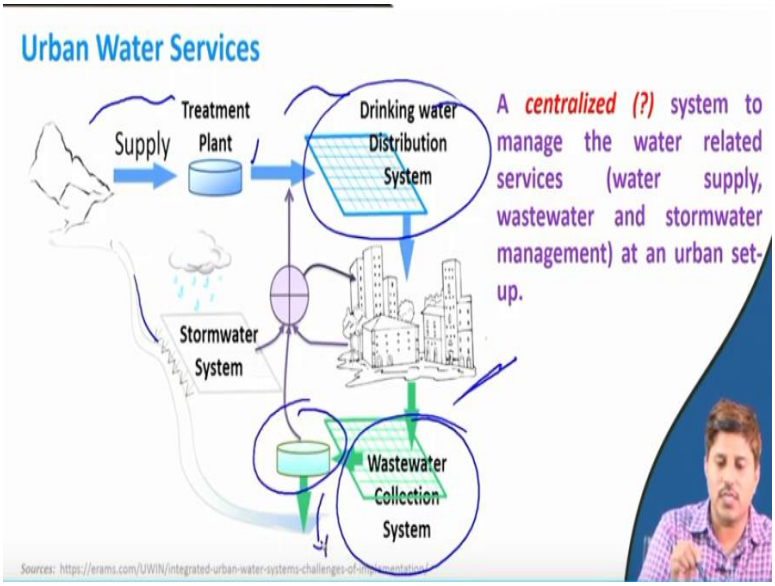

Now if we see the what exactly we mean by urban water services, so urban water services is to provide a service or operate or manage a system which links these different components of urban water cycle. So as we just saw, there has to be a source. So we will have a say water source which could be a river or groundwater or anything and then from source it is transported to the treatment plant.

Then it goes to a drinking water distribution system then it is supplied to a urban space. From there wastewater is collected and then it is basically treated and again goes back to either resource or this can actually be recycled as just we were looking in the other cycle. So the wastewater collected here can actually be treated and go back here and act as a resource.

Similarly, the storm water which is collected either it can go to directly the sources or this can also be considered as a resource, which can eventually be either directly reused or reused after treatment and distribution. So that way these are the different steps and these different steps of urban water cycle is managed through kind of a system, which is we usually refer as urban water systems or urban water services.

So in most cases, when we talk about urban space, it is a centralized system, but it is not necessarily it has to be centralized, it could be decentralized as well okay. So a system, a centralized system often which manages the water related services, which includes water supply, wastewater management, storm water management in an urban setup is usually referred as urban water services.

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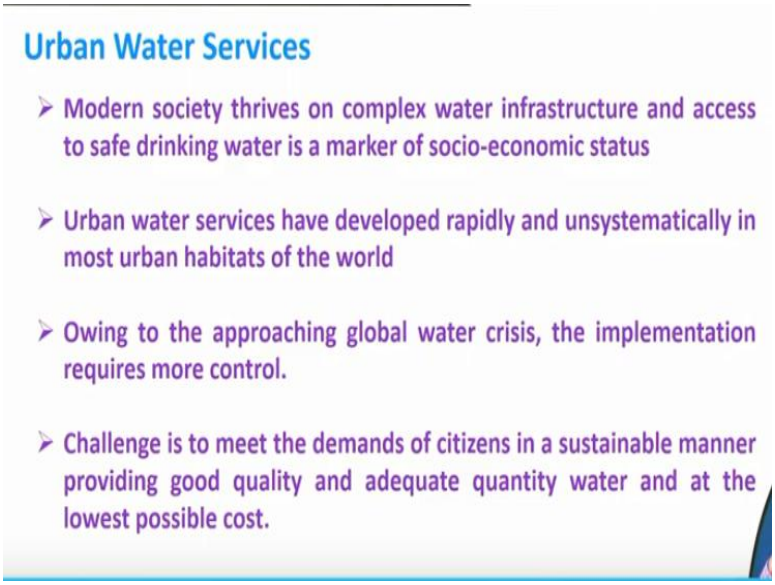

So our the current society thrives on basically kind of complex water infrastructure and access to safe drinking water is a marker of socio economic status, okay. The person getting good 24/7 water supply in their homes are generally considered to be well off; whereas people in slums, in small towns, in the other places generally do not get that good facilities in terms of water supply.

In slums you do not have house to house connections. There might be just one stand post for several households and people come and fetch water from that stand post okay. In small towns you do not get that frequent water supplies.

Even in the bigger towns also bigger cities metropolitan cities also you may get water for just a few hours whereas there are some posh colonies or systems or residential blocks these days we are going to we see several residential complexes coming in which kind of promise 24/7 water supply system. So it kind of becoming a marker of the socioeconomic status, okay.

Traditionally these services have developed rapidly and unsystematically. So we did not give proper planning and proper kind of thought process behind developing the urban water services. If there is a requirement of water, if there is a demand of water from some section there is abrupt system was put for obstruction of water.

It could be groundwater or nearby lake or river and then some sort of treatment process was given and then water was made available to the consumer. There was no proper planning that how much is the demand, from which sector, if you are withdrawing water at this rate for how long it is going to sustain? What about the future expansion, how the future expansion is going to be, how the demand is going to be increased.

So all those thought processes were missing and it kind of not only in India, but across the world, it has developed in the past in kind of very unsystematic manner, okay. And this particularly imposed have lot of challenges on the existing urban water supply systems. There is an existing system in place which is not able to meet the demand, so how to augment that.

Destroying the complete existing infrastructure is also uneconomical, but it is difficult to kind of augment it or enhance it to the level of meeting the demand. Then where from the source, where is the source located, how the supply is going to met, what is the amount of water available in the sources all that are actually going to create more problem.

And particularly since as we discussed in the earlier class that we are approaching towards a global water crisis. So the implementation of the urban water services requires more and more control and we are more focusing on the urban because as we discussed in the last class that there is a very prominent and evident population shift.

Our population in the urban space is now almost 40% which will overshoot the rural population. So in a few years time, we will see almost more than 50% people living in the urban space and there is a greater need of management in the urban space, because we have limited space, we have limited resources, but the population density is very high, the demand is very high.

As opposed to the rural places where the amount of resources available might be more and the population density is less. So as a result, the stress on the water services is relatively lesser as opposed to the urban spaces. The major challenge is going to meet this demand of citizen in a sustainable manner and at the same time, ensure the good quality and adequate quantity of water supply to the consumers at the reasonable price or the lowest price possible.

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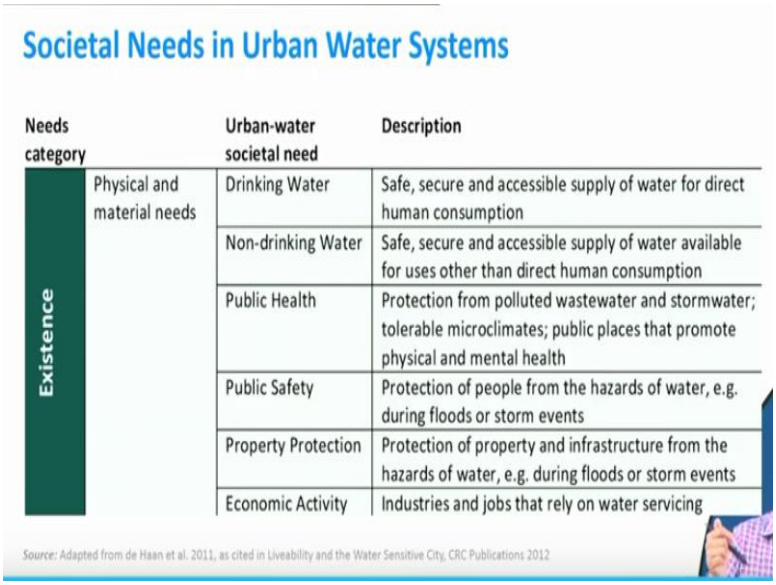

So these are some of the issues and challenges that we are going to face in future. Now why we need the urban water system? So there is basically the need is for the existence. So there could be basically the physical and material needs. So we need water for drinking purpose, non drinking purpose, public health purpose, public safety purpose, property production purpose, and then various economic activities including industries and job that relies basically on the water servicing.

So all these requirement, all this requirement is there for societal need of the water in an urban space where there is a question of existence of this.

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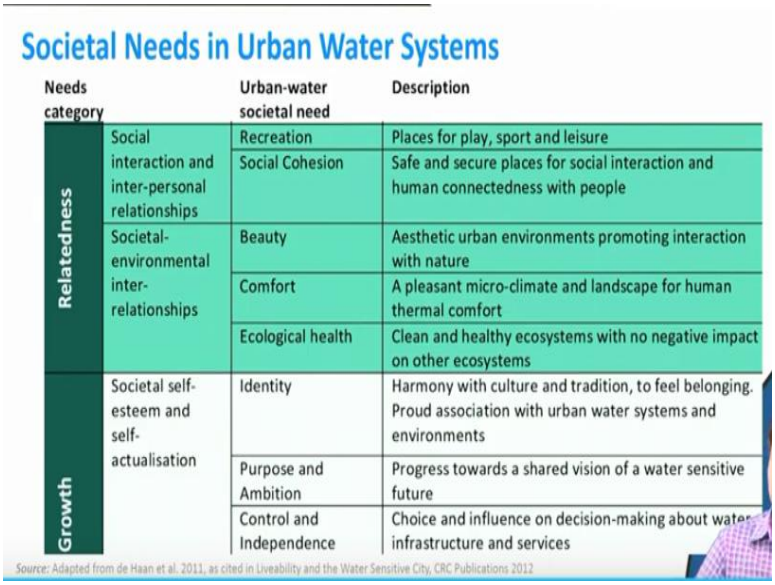

Societal Needs in Urban Water Systems

Needs category		Urban-water societal need	Description
Relatedness	Social interaction and inter-personal relationships	Recreation	Places for play, sport and leisure
		Social Cohesion	Safe and secure places for social interaction and human connectedness with people
	Societal-environmental inter-relationships	Beauty	Aesthetic urban environments promoting interaction with nature
		Comfort	A pleasant micro-climate and landscape for human thermal comfort
		Ecological health	Clean and healthy ecosystems with no negative impact on other ecosystems
Growth	Societal self-esteem and self-actualisation	Identity	Harmony with culture and tradition, to feel belonging. Proud association with urban water systems and environments
		Purpose and Ambition	Progress towards a shared vision of a water sensitive future
		Control and Independence	Choice and influence on decision-making about water infrastructure and services

Source: Adapted from de Haan et al. 2011, as cited in Liveability and the Water Sensitive City, CRC Publications 2012

Then there is a relatedness; we need water for several related activities which are not directly linked to the existence but still very important in urban space and can be considered as a societal need. So there is basically water is required for social interaction and interpersonal relationship. So basically the recreation purpose there has to be places for play, sport, leisure and these many of these actually depends on water okay.

And then there would be basically places for social cohesion, those kind of thing. Then socio-environmental inter-relationship. So in terms of aesthetic urban environment, you go to a city which is completely dry even though all the services is there, but if you are going to a city which is kind of completely dry, you would not feel good aesthetically.

So there has to be kind of aesthetic urban environment which promote interaction with the nature and interaction with the nature includes greenery as well as the water bodies, okay. So that has to be there. Then there has to be a comfort kind of criteria where is basically a microclimate and landscape for human thermal comfort. This is very important because the places which are devoid of water does not have that much of temperature resistance as opposed to the places where there is a lot of water body.

If you go to see the properties of water, chemical or physicochemical properties of water, water has very high specific heat and as a result has a huge ability to maintain temperature. So that way and then there is of course, ecological health, so clean and

healthy ecosystem or kind of river bodies or lakes or those kind of thing. So they are the relatedness needs for the urban water in the kind of societal aspects.

And then there is aspect of growth where societal self esteem and self actualization how the society grows, okay. So there is a need related to that, so that will be basically what is the identity, what is the purpose and ambition and how to control and independence the basically these things.

There has to be choice and influence on decision making about how water infrastructure and services are going to be visualized okay. How we how kind of we propose a vision for the water sensitive cities, okay so that a water sustainable and water sensitive cities so that we value these as a resource as well and that is only when we can grow in a sustainable fashion.

So these are some of the aspects for which we need urban water system and we need good urban water system.

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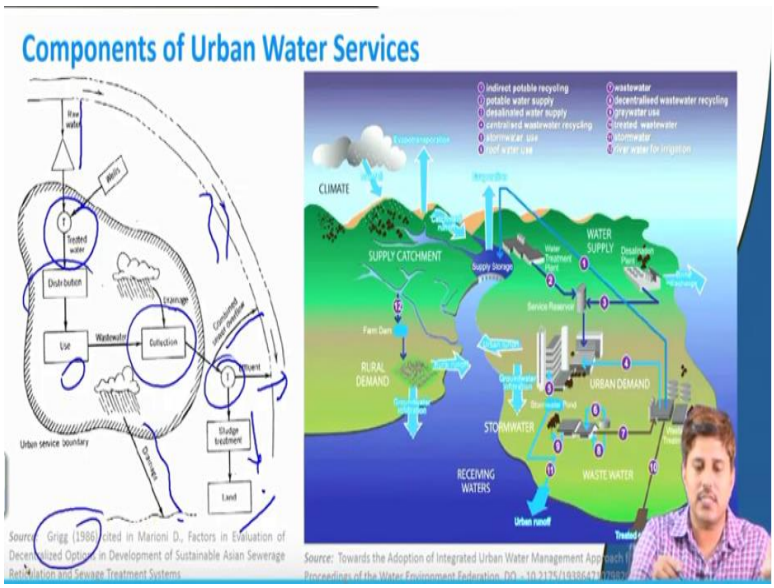

Which can sustainably manage the water resources at the same time fulfilling the requirement of the water from the different sectors. So if we see the various components of urban water system, it is more or less similar to the urban water cycle what we were discussing okay. So in a urban water system if we look at the components, so traditionally there has to be raw water which will get treated then distributed then it will be used.

Then there will be wastewater which will be collected, again it could be treated. There would be sludge generation, that will be treated and going to the land whereas, the treated water effluent will again get back to the natural water bodies, okay. The rain water can also be coming in the form of drainage to the water bodies or can come in the form of combined sewer.

So where the sewer and storm water both flows together to water bodies. So this was actually a traditional approach, not much emphasis was given on to the recycle in this time. This was proposed by the Grigg in as back as 1986. Whereas these days when we talk about the urban water system, we put substantial emphasis on the recycling as well. So this is a more recent kind of system and we can see there are various components of urban water services over here, okay.

There is going to be indirect potable recycling, then potable water supply, then desalination, desalinated water supply, if there is that kind of source. Of course, this is not applicable to all the places. Then has to be a centralized wastewater recycling system. There could be storm water use system, rooftop rainwater harvesting systems, and then using of that harvested rainwater.

Then wastewater is another component. Decentralized wastewater recycling could be a component. Grey water could be a separate component. So grey water is essentially the waste or sewage wastewater coming from the bathroom, kitchen those places everywhere in the household except toilets and urinals. Then the treated wastewater is going to be a component. Storm water is going to be a component.

River water for irrigation going to be a component and all these components would be linked to each other through a complex cycle. So these are the various components of a typical urban water cycle in today's time.

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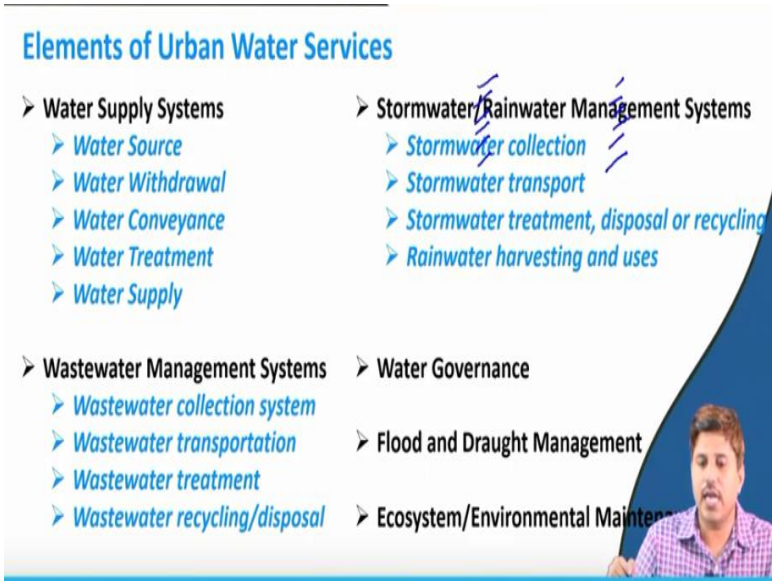

Where we have all sorts of the all sorts of components integrated together in a urban space. Now if you see the various elements of urban water cycle, there are three major elements. There has to be a water supply system, there has to be a wastewater management system and storm water or rain water management system. So these three are the essential physical components of essential physical elements of urban water supply system.

Under water supply system we will have a water source then a water withdrawal mechanism then water conveyance system treatment facility and then a distribution or supply system. In the wastewater management system again we have several kind of several level of infrastructure. So there has to be a wastewater collection system in sewer network.

There has to be wastewater transportation system which will be again through sewerage network it will be transported. Then a wastewater treatment facility has to be there and then treated wastewater could be either recycled or disposed off. So we have to have appropriate recycling or disposal facility for the wastewater. So this will be a component coming under the wastewater management system.

Then elements under storm water or rain water management system would be the collection part. So if we are collecting rainwater, so rainwater harvesting and its uses. If you are collecting storm water, so the storm water drainage system we have to have

as a storm water collection. Then storm water transport because storm water is generally managed in a centralized way.

So we have to transport this storm water and then that once it reaches to the place so it can be treated and then disposed off or recycled. So all those things will, there would be a variety of option. It can be disposed off untreated, it can be treated and partially treated and then disposed off or it could be treated and then recycled. So these generally are the physical elements.

Then apart from these there has to be a water government system. So how this water is being governed, how the different elements or different system or different sub components of the urban water systems are being governed. Then there has to be flood and drought management which are the accidental cases and there has to be a ecosystem or environmental maintenance system as well in the urban water space.

So these are the various elements which basically has to be considered in an urban water systems.

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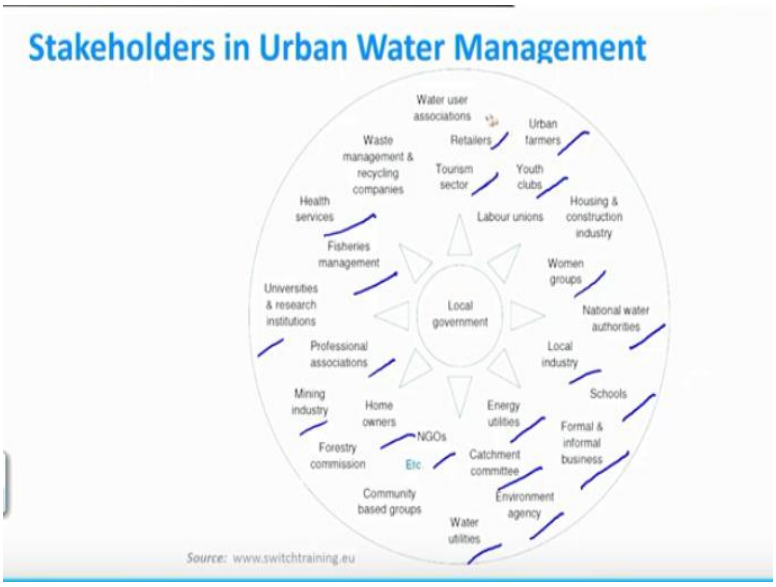

Based on these elements and if we talk about the as we had that there has to be a governance system as well which is an important part, how do we govern our water in an urban space, whatever water is available, how to govern that and this governance brings us to the different level of stakeholders, okay. So we have to have different level of stakeholders in the water governance.

Generally the water is governed at local governance, local government level. So our local government will be governing the water but then there are going to be several stakeholders in that okay. There has to be health services then fisheries management then universities and research institution, professional associations, mining industries, homeowners.

There has to be an NGOs, water utilities, environmental agencies, catchment communities, energy utilities, then various industries, schools, business houses, National Water Authorities then various self-help groups, woman groups, urban farmers, youth clubs, tourism sector, various retailers, Water Association. So there could be like several stakeholders okay as we see.

So whosoever is getting directly or indirectly impacted by the water services, by the urban water systems automatically becomes a stakeholder. Now how much it is getting influenced by the water services, so different stakeholders may get different level of influence, they may have different level of say. It is not that all the stakeholders are equally important.

Like if you are talking about urban water services, so generally the residences or the homes are our prime target. So they are one of the most important stakeholders, okay. The government who has to manage are the important stakeholders. The operator of the treatment utilities or distribution systems are the important stakeholders.

Apart from that, as we see that there would be several peripheral stakeholders who directly or indirectly get impacted by this or have a say or want to have a say in the water distribution. So industries like okay so there has to be a representation from the industries in decision making, there has to be representation from the civil societies, which is basically a group of the kind of consumer you can believe in that way.

They have to have a say. The farmers, agricultural group, industrial group, forestry group, fisheries group, health services, then hospital, industries, schools, academicians. So all these different type of people should be considered as a stakeholder and should be playing a role or even if they are not playing a role should

be given due thought when kind of conceptualizing the water services that how and how much they will get impacted and how their interest can be protected through the proper water services.

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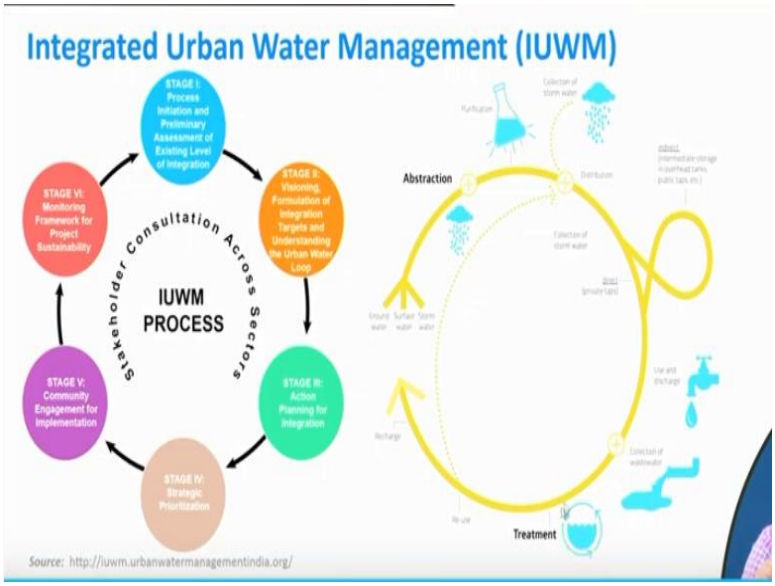

Now there is a kind of New Age concept on integrated urban water management systems which is IUWM it is known as. So IUWM is actually a process where as we were just seeing that in a urban water system, there are going to be several components, there are going to be several elements. Now when we were just saying that earlier, development of urban water services or planning of urban water services has been quite haphazard and irregular way.

So that means there was no linkage in these different components. Say the water supply system, somebody is ensuring water supply system so he will withdraw water from a river and then ensure the supply of that water but not giving due attention that what is going to happen to the wastewater which is being generated.

Similarly, a waste sanitation division will be interested in collecting the water and then processing it and then disposing off without thinking what is going to happen to the natural resources okay how it is going to impact the quality of the river or quality of the lake where they are going to they are going to dispose off the treated or partially treated or untreated wastewater.

The Water Resources Management guys did not give due attention that how to fulfill the services. Similarly, the agricultural divisions did not give due emphasis how to kind of withdraw water and how much water to leave in the river for its own survival. So there are like not due thought process was given to each and every component, each and every element of urban water cycle.

It was done in a bits and pieces, in a patches. Now the concept of integrated urban water management suggest that we kind of take all the stakeholder or at least most of the stakeholders together and then through a consultation process across different sectors, we develop a plan for ensuring the sustainable urban water services, which is able to meet the criteria of environmental safety, criteria of long term sustainability.

And can meet the criteria of fulfilling the sectoral water demand in the most judicious and justified way, most equitable way. So there has to be kind of engagement between the all the stakeholders taking the interest from all the stakeholders then analyzing the plan, comprehensively seeing what are the available resources at our hand, how much water can be withdrawn, what are the demand from these different sectors.

How it can be judiciously distributed, how we can integrate the used water back into the water cycles instead of disposing of the used water, how we can treat that as a resource so the treated wastewater can be recycled back into the urban setup may not be for potable uses, but for non-potable or other uses. So then how the storm water can also be integrated.

So considering storm water as a resource considering waste water as a resource, and then of course trying to see the sustainability of existing resources. Trying to comprehensively analyze demand from the different sectors and then how we are going to abstract in a most economic way, how we can distribute the water in a most judicious way.

So all those concept integrating, keeping the interest of all the stakeholders in mind, involving all the stakeholders in planning, execution and decision making process, we can come up with a integrated urban water management system, which is getting more popularized these days.

So this kind of encompasses all the aspect of water like starting from the source to water abstraction, to purification, then collection of storm water, then distribution, then its uses and then collection of the wastewater, treatment, then its reuse back, how much is going to get recharged back into the environment. So all these analysis, comprehensive analysis in a integrated fashion will lead to a integrated urban water management.

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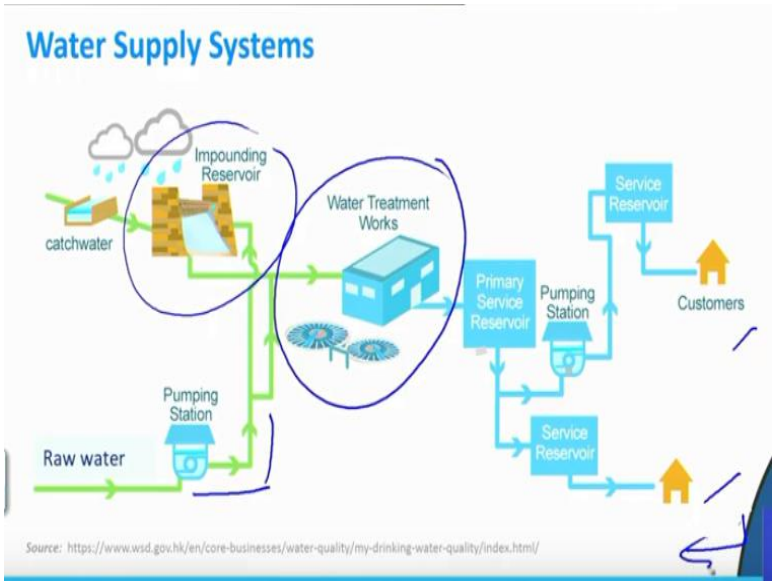

Now, so that is a generic concept, integrated urban water management. It has not been actually practiced as a whole anywhere. It still being practiced in bits and pieces in a smaller setup because it is not easy to kind of consider all components of a complex urban water cycle as we just discussed.

There are different patches different elements sub elements and components in urban water cycle and having a comprehensive analysis of all the elements of urban water cycle is not an easy job. So that is why there has to be like at what scale it is most optimum. So people are trying IUWM practices at different scale okay. It is still in the kind of inception stage.

However, for this particular course we are going to more focus of course, the concept IUWM and all that are good. But we are going to give more focus on to the water supply system as this course is about water supply engineering. So we will be talking

different aspect, components of the water supply system. Now water supply system as you see we get raw water from a source and then we pump that water.

So there would be a kind of pumping facilities or pumping system, okay and then it could be actually stored in a impoundment or direct water and then from there it goes to the treatment work. So water is treated and then treated water is distributed and to the consumers and after use then we come to the different parts of urban water cycle which is related to the wastewater collection and management.

So wastewater collection, we are not going to discuss in this course. Our domain of this course is limited to this part only.

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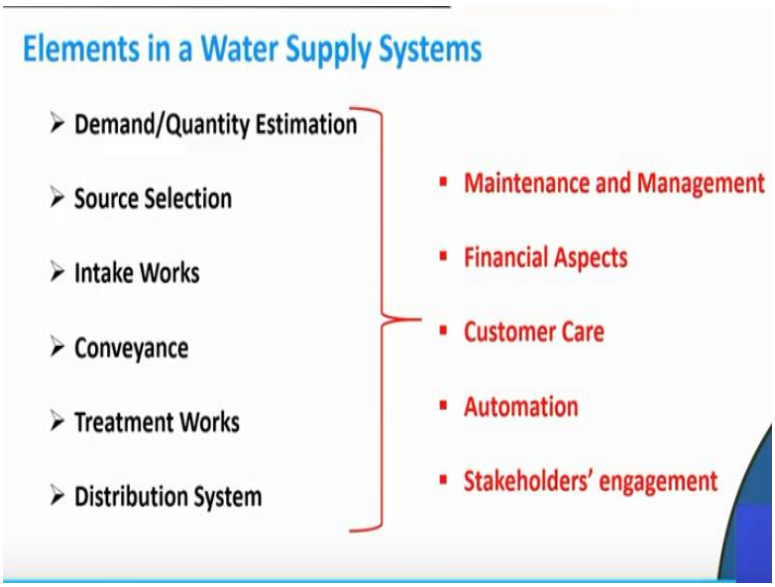

So what we are going to discuss in this particular course, is the different elements in a water supply system. So there is going to be the demand and quantity estimation. This is one of the very important element because when we plan a urban water supply system, we have to have an idea of how much water is needed from different sectors. So first and foremost thing we have to have an idea of the demand of the water.

So the demand and or quantity estimation is one aspect. Then how do we select source, how do we abstract that water from source. So what are going to our intake works and then once the water is withdrawn from the source, it is transported to the treatment facilities. So before it reaches the treatment works, there will be a conveyance system which is raw water means generally.

So we will talk about that and then after treatment it goes to a distribution system where it is sent to the end consumers. So this is what will be discussed in this course. Now these are the more or less physical aspects, but then there would be maintenance and management of these systems, the financial aspects of the water supply systems how because it is going to supply water to the consumers.

So what is the principal or philosophy of the customer care? How we integrate the various stakeholders including the end consumers. The role of automation in the water supply system.

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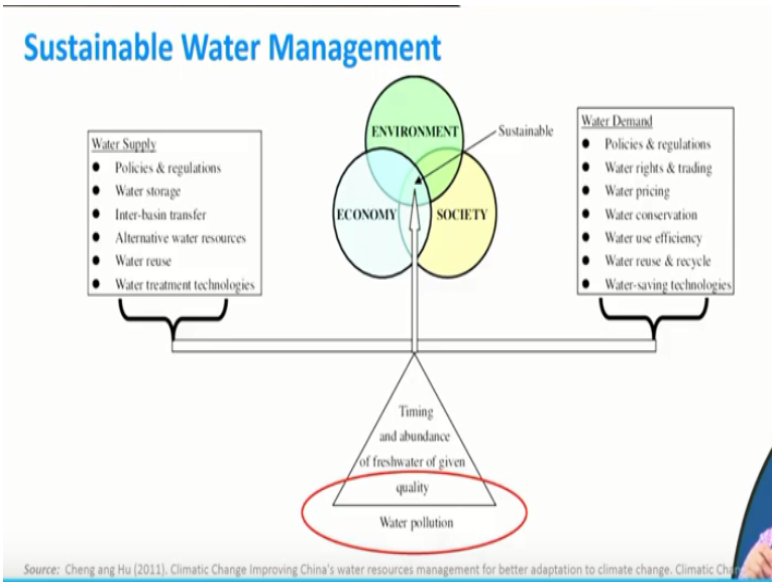

So all this actually are important components of urban water supply system and we will touch upon these different components. Our main idea is towards going for a sustainable water management. So in water supply, sustainable water management is basically when we get a balance between the environment, economy, and society, okay.

So we will have to look at the demand side of the water where there are the demand will get affected by based on the policies and regulation, based on the rights, based on the pricing of the water, how we are going to conserve water, what are the use efficiencies, whether we are going for reuse and recycling or what are the various water saving technologies.

So that will actually cover the demand side of the water and then we have a supply side. So in supply side again, what are the policies and regulation for supply, how much water we can store, how is the inter-basin transfer. So transfer of water from one basin to another basin. Then what are the various alternate water resources? How much reuse is possible? How much waste water can be considered as a resource?

And then what are the various treatment technologies, okay. Now integrating these two we have to keep the demand and supply part on the balance for obtaining a sustainable water management. And we have to look at the timing and abundance of fresh water of given quality as well as what is the extent of pollution, water pollution. So how much water is available at a given point of time.

And what quality of water available at a given point of time, so based on this information, how we can ensure a balance between water demand and water supply will take us to a sustainable water management concept. So with this we will conclude the discussion in this particular week, week one. And in the next week we will start now talking about the first part of a supply system.

So how we can kind of go as a first part for estimation of the quantity or demand estimation. And then subsequently, we will start discussing on the physical infrastructure of the water supply system. So thank you for joining and see you in week two.