Water Supply Engineering
Prof. Manoj Kumar Tiwari
School of Water Resources
Indian Institute of Technology-Kharagpur

Lecture - 06
Concept of Water Demand

Hello friends and welcome back. Last week we discussed about some of the very basic concepts related to the water supply systems. We did talk about various sources of the water, various uses of the water, what are the various components of a water supply system in general. So now we will narrow down our discussion in this week and what we are going to talk is the water demand.

So we did discuss about water uses last week. Now when we were discussing uses, we talked about the municipal uses, then agricultural uses and industrial uses. So all these different classes of uses we discussed. Now when we try to put through a system for meeting water requirements of a society or a city or a town, we have as a first thing we need to do is figure out how much water is required.

So that is what basically we will be discussing in this particular week. And in this lecture, we will be focusing on the basic concept of the water demand.

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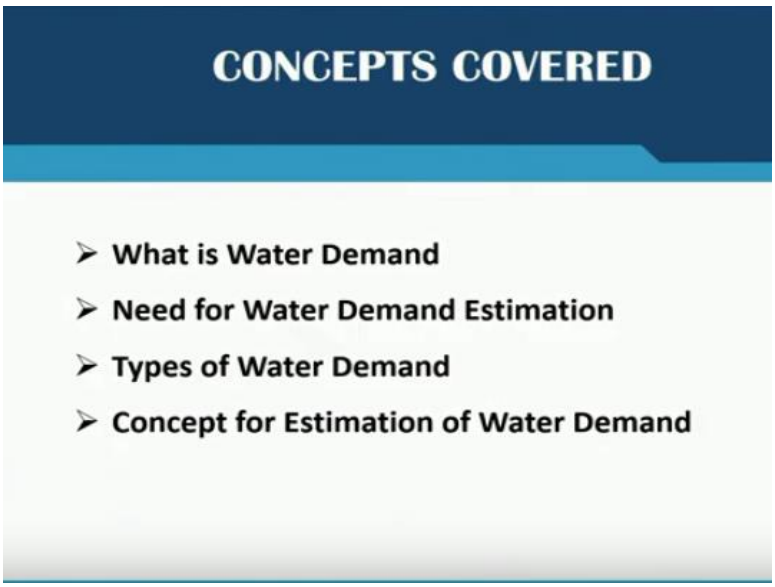

So things that we are going to cover is what is water demand. We will talk about the need for water demand estimation. Also we will see what are the various classes or

various types of water demand and what is the basic concept for the estimation of water demand.

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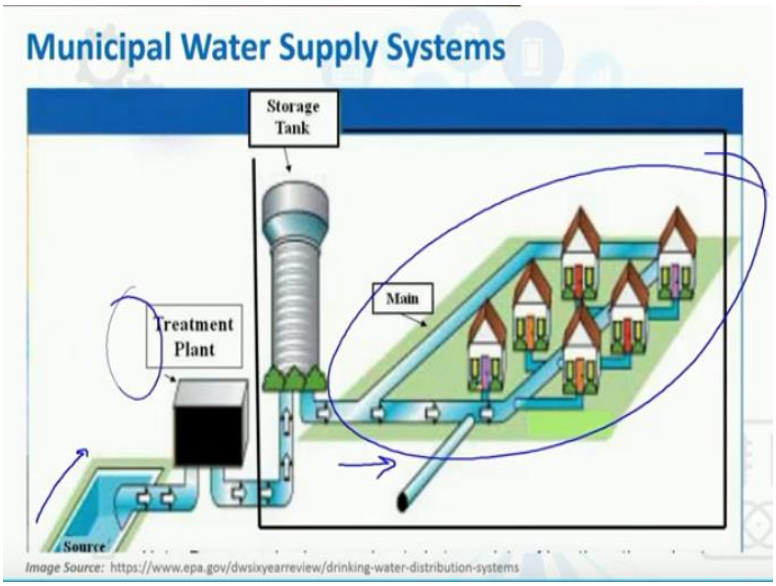

So to begin with when we talk about municipal water supply systems, it essentially consist of a source, water from the source from where we abstract the water. Then there has to be a transportation system to bring the water to the treatment plant. So if say this is our source, we pump the water from the source and bring it to the treatment plant.

So water is brought to the treatment plant, then water is purified or treated at the treatment plant and from this point forwards water is again put through a distribution system, there would be storage tank, intermediate storage tank, overhead reservoir and various other setups in the distribution system. But eventually the purpose of distribution system is to distribute water to make it available for the consumers.

So eventually the water abstracted from the source, processed, put through a distribution system and then it is distributed to the consumers. Now in this process, the first thing that we have to figure out that actually the water which is being distributed is for the purpose of meeting the requirement of this section of the society of the consumer base.

So how much water is to be supplied to them will be the deciding factor on what amount of water is to be withdrawn, what kind of facility is to be set up and what kind of distribution network would be required.

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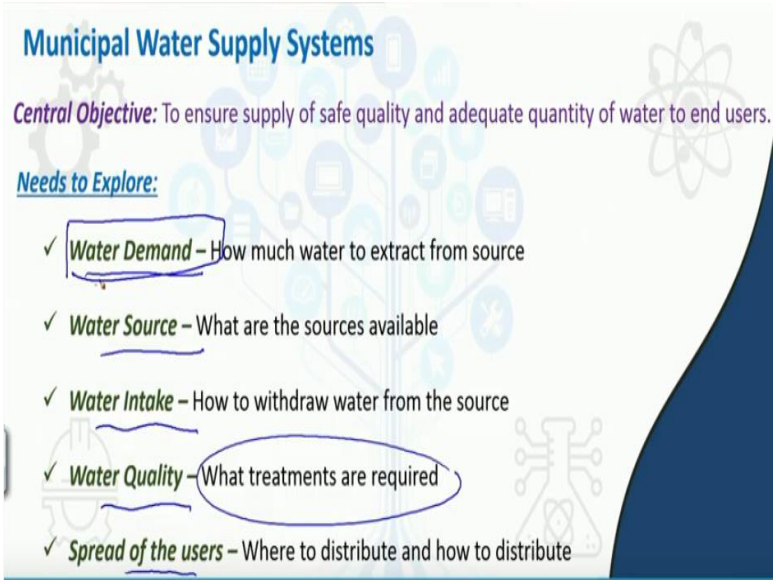

So the very basic of putting a water supply system is depends actually depends on the demand. If we see the central objective of these systems, it is actually to ensure safe quality and adequate quantity of water to the end user. Now for the purpose of setting up a municipal treatment system or a municipal distribution system rather what we need to know, what we need to explode is how much is the water demand.

So basically how much water to be extracted from the source, then what is the, where is the water source, what kind of setup we put in for abstracting the water which is our water intake. Then we have to figure out what is the existing quality and what quality is to be supplied. So that will govern on what degree of treatment is needed and the last is the spread of the user.

So where we need to distribute and how to distribute this water. So these are some of the things that needs to be figured out when we try to set up a municipal water supply system. And as you see the first thing to establish or first and foremost thing to explore is the demand. So how much water is to be extracted from the source will depend on the demand of the water.

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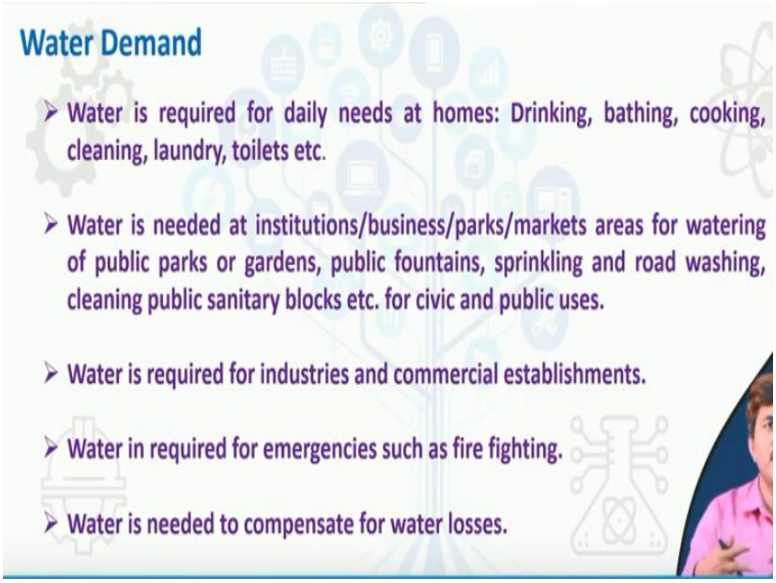

How much demand is being posed from the society or from the city or from the town where we want to set up the system. So water demand is essentially the water which is needed for daily needs at home which is drinking, bathing, cooking, cleaning, laundry, toilets etc. Then water that is needed at institution, business, park, market areas all those places.

Water which is required by the industrial and commercial establishment. Water which is required for firefighting. Water which is needed to compensate water losses.

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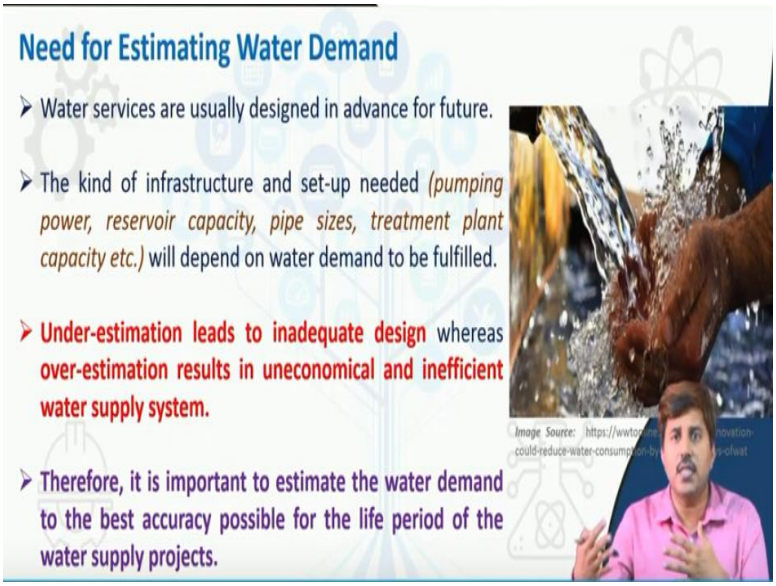

So these are typical categories for the water demand, we will come back to this, but before that, why we should think of estimating the water demand. What is the importance of water demand or why we need to estimate the water demand is

basically when as we were just discussing, our overall idea is to supply consumer the sufficient quantity of water.

Now when we talk this sufficient quantity, what is this sufficient quantity? Without knowing how much water a consumer needs, what kind of demand is being posed from the consumer end, how we are going to set up our system? So water services needs this information at the very first stage. Now although this information is needed at the very first stage, but this information, getting this information is not easy. Why?

Because water services are typically designed for future. So it is not that if I am planning a water supply system in a particular city on say 2019 or 2020, so it is not going to work just for one day. This is a huge infrastructure cost and when I am putting that much of cost, the typically these systems is designed for minimum of say 20 years, generally 30 year, 40 year, 50 years that kind of period is considered as design period.

So if I am say, setting a plan for next 30 years, which should work for the next 30 years, so I have to first estimate what is going to be the requirement during this period. If I say the requirement of today is let us say the population of city today is for say 10 million people, but it is not going to remain the same in the next 30 years. Because next 30 years, the population might get doubled or 1.5 fold 1.8 fold.

So if say we are designing a setup for 10 million people based on today's population, and we want our system to last for 30 years, then when the population shoots up after say 10, 15 or 20 years the population becomes instead of 10 million there are 15 million people, how our system is going to fulfill their needs. So the system is conceptualized based on the time period it has to serve.

So what is the design period or what is the time period that our system has to serve and this time period could be 20 year, 25 years, 30 year or generally higher. So when we go for setting up a water utility or setting up a water services, we have to think of what total requirement or what is going to be the total demand for the water towards the end of the design period.

So if our design period is say 20 years, so how many people are going to live at that time and what kind of total requirement would be there at after 20 years, that we need to estimate today. Then only we will be able to set up a system because let us say for 10 million people, we figured out the requirement is say 15 million liters per day or say whatever is requirement okay for 10 million people, let us say we decided the requirement is 150 million liters per day.

Now this 150 million liters per day requirement, which is as of this date will not be the same in future. So we have to estimate the requirement from future as well. Why it is important, why it is important to estimate the requirement from future because the kind of infrastructure and setup that we will provide will depend on this particular demand. We have to know what is the total requirement.

Based on that we will set up our pumping power because if say from a reservoir you have to withdraw the water at a rate of say hundred meter cube per second or 10 meter cube per second or one meter cube per second, the pumping requirements are going to be different. So what kind of pumping requirement would be there? What would be the reservoir capacities? What would be the pipe sizes?

What is going to be the capacity of the treatment plant that we propose or that we plan. This all eventually depends on the demand of water, what is going to be the demand. So it is, that is why it is very crucial to estimate the demand or rather the future demand which is to be served within the design period to the maximum level of accuracy which is possible.

However, this accuracy cannot be hundred percent, we will discuss on that because the requirement for the water from one individual human being or a kind of setup or establishment is never the same, it varies, it fluctuates and we will talk about that in the later lectures in this week. Now if we choose a demand which is less than the actual demand means, we are basically kind of doing underestimation of the demand.

So this will lead to inadequate design. Inadequate design means if we design a system for 100 million liters per day and the requirement is say 150 million liters per day, how we are going to supply that? We have a setup which is able which can be utilized

or can be used to supply 100 million liters per day of water but if our requirement is higher, so how we are going to use that setup.

So that basically it will fail in the design scale itself because it is designed for a lesser capacity. Whereas if we overestimate the demand, so say if we estimate the demand as 200 million liters per day where actual requirement is 150 million liters per day, that means we are laying a pipe size, we are fixing our reservoirs, we are putting a treatment systems for a amount which is actually not required.

So instead of 200, instead of 150 we are putting a system for 200 million liters per day. So that means the system is uneconomical and then further can actually also fail technically on the hydraulic grounds. So it is not advisable to estimate the demand less or more than the actual demand. We should be as close to the actual demand as possible so that we can get a good robust system in practice.

So as a result it is kind of important to estimate the demand to the best possible accuracy for the period of the water supply project okay. If our water supply project is for 20 years, so what kind of demands we are expecting in the next 20 years has to be estimated as of today because the design is being done now.

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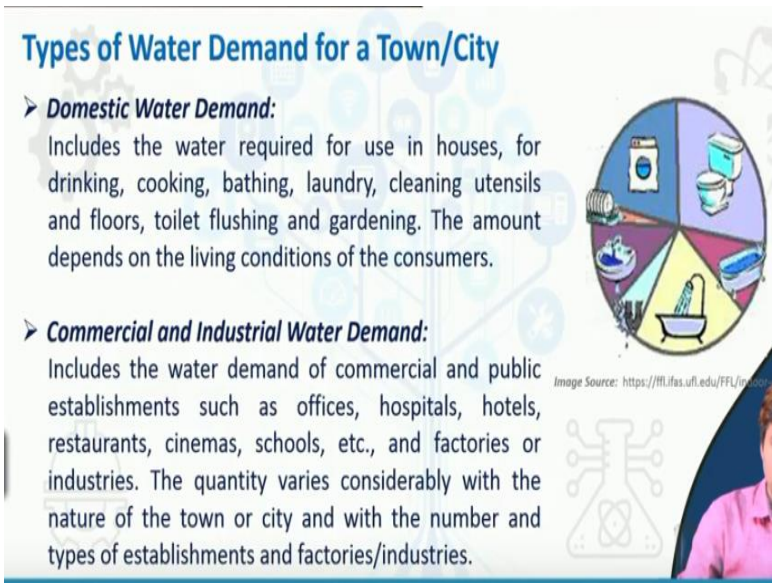

So that is about the importance of estimating the demand. Now, as we were earlier also talking about so there are different types of water demand for a town or city when we plan the total water requirement for a town or city or a region we have to consider

different types of demand. These demands actually may be categorized in five major classes.

So one is the domestic water demand which includes the water for the uses in houses. It is a domestic demand, so water typically uses in houses. These houses not necessarily means within the house itself, within the boundary means small gardening or kind of car washing, outside or washing all these also will be included in this demand.

But the major demand comes from the bathing, cooking, drinking, laundry, cleaning utensils and floors, then toilet flushing, gardening. So all these will lead to certain requirement of the water and that water is typically considered as a component of domestic water demand. This amount will depend on the living condition of the consumers. So it varies from family to family.

Even in a family it can vary from person to person, but generally if we take family as a one unit or household as a one unit, so one house requiring certain water it is not necessarily that same the another house or the adjacent house will also require the same amount of water, okay it could be different. So that is the domestic water demand which is used for the domestic purposes.

Then there is we have commercial or industrial water demand. This is typically for commercial establishment or public establishment like offices, hospitals, hotels, restaurants, then school, cinema, all those places. Apart from that, there would be certain demand might come from the factories or industries in the town and city. So that also may be considered, okay.

Many places the industrial demand is considered separately. So you will like the utilities have a separate line for withdrawing water and supplying water for industrial purpose, particularly more so in the industrial towns where the major demand is from the industrial sector and not from the domestic sector.

However, in general, the residential towns or cities or establishment, the institutional or commercial demand or industrial demand is just taken as a per capita number and

the estimates are done based on that. At times it is quite low, at times it is reasonably high. Then the quantity of this also will vary on the nature of the town and city, how developed the city is, what kind of offices, schools, factories, industries or various establishment it houses. So the industrial demand will eventually depend on that.

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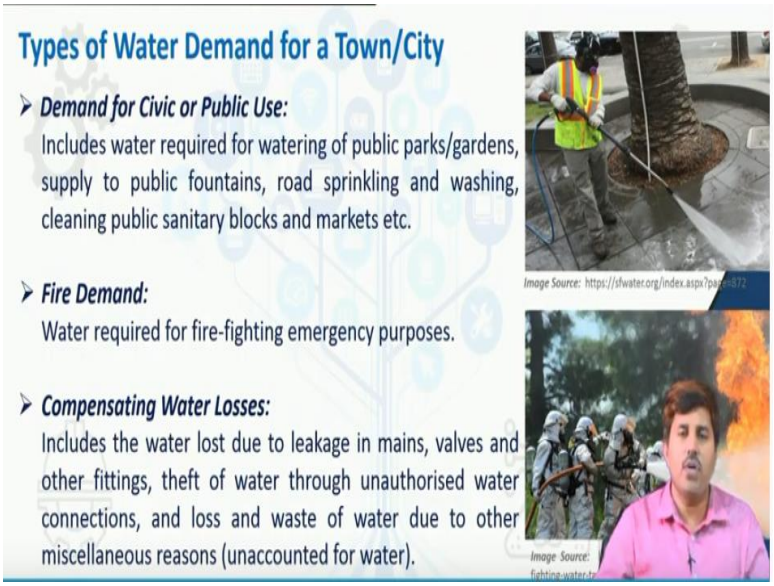

Then there is a demand for civic or public uses. So that means the water which is required for washing say roads, washing public areas, then for gardening, watering public parks, then supply to the public fountains, road sprinkling, cleaning of the public sanitary blocks, so all those general civic or public uses which is being taken care usually by the municipality or the development authorities within city, they also need certain demand.

So the demand coming from these portion or these uses is considered as under the demand for civic or public uses. Then there is a fire demand which is actually the demand for meeting firefighting. So if there is a fire breaks up, then what is going to be the requirement of water for settling that fire. So it is kind of emergency demand. It is not always there but provision is kept because such kind of emergencies or accident may happen anytime.

And the utility or the system has to be well equipped with dealing these kind of thing. So what kind of, what requirement of water might come from such incidents will also be considered while estimating the total demand of the water. So that is under fire demand. And lastly, there is actually certain demand for compensating water losses

because we discussed this earlier week also that when we withdraw x amount of water say from a source, we are not able to use the full x amount of water.

We never generally, it is technically not possible in fact, to make whole of the x amount of water available to the consumer, the best utilities have very little losses. So like some of the order of less than 10%. So at least from x more than 0.9 x water will be available to the consumer end but there are places particularly cities in India go see water losses as high as 30%, 40% or even 50%.

So if 40% is loss, that means when you are withdrawing x amount of water you are actually providing just 0.6 x water for the uses. So if your demand is say hundred units, you withdraw hundred units, then you will be able to supply just 60, 70 units. So it is still not meeting the demand. So there has to be provision for compensating those water losses.

So essentially, if your requirement is hundred units, the water which is pumped is almost 150 units, so that after that if even if say 50 units or certain units get lost, the society can still get hundred units of the water. So this is actually for compensating water losses and this loss could be due to the leakages in the mains, walls, other fittings. There are theft cases also of water or unauthorized water consumption.

So there could be variety of reasons for water losses, and we need to keep provision for compensating these losses as well.

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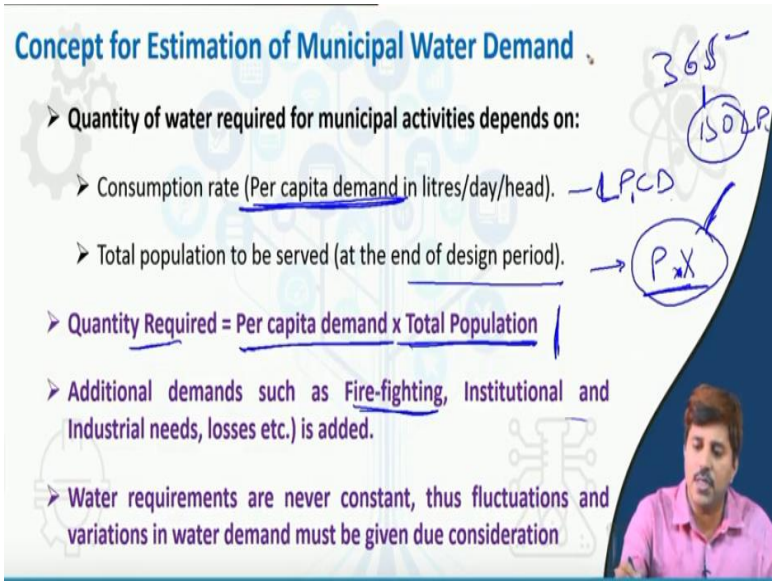

Now when we talk about the estimation of the municipal water demand, the concept that is used for estimation of the municipal water demand is fairly simple. We try to estimate the consumption rate first okay or estimate means in fact there is no specific approach or methodology to estimate. It is just based on the experience, based on the statistics available.

An average number is taken as a consumption rate which is per capita demand. So what is the requirement of water per person in a liters per day per capita or liters per day per head. So the typical unit used for this is LPCD, which stands for liters per capita per day, okay. So how many liters of water is used per person or per capita per day, that is what is consumption rate.

Now this consumption rate is usually taken from the standard guidelines, because it is very difficult to figure out how much water a person would require. And more so ever, when we talk about the municipal consumption rate, the guidelines generally give an average consumption rate which does not only considers the in house requirement, but it considers the outhouse requirement as well.

Like as we were just discussing, there would be institutional and those kind of demand. So many times this consumption rate incorporates that as well, okay. So what is the consumption rate means what is the amount of water which would be required on average by one person, so that is the consumption rate or per capita demand what we typically call.

So we take a per capita demand what so ever number we consider, and we multiply it with the total population. Now the total population has to be considered towards the end of the design period, not the population for the today. So when we talk about the total population, we essentially mean that population towards the end of the design period.

So what is the number, this total population exactly gives us the number of people to be served. So if I have say P number of people to be served and each person requires say X amount of water, X amount of water per day that means X liter per person per day. So my total requirement is going to be P into X. So this becomes my total requirement.

So the quantity of water required typically for municipal activities is considered by multiplying the per capita demand with the total population that is to be served. So this way we estimate the quantity required. Now of course, we can have additional, we can include additional demands if we have those kind of information generally firefighting demand is often included anyway.

But other demands like institutional, industrial needs or water losses etc. can also be added to this demand in addition to the per capita requirement based total quantity. Then generally what is found that this water requirement are never constant, okay even if you because the X number that you take is actually a number, average number, but there is fluctuations.

Now fluctuation in a sense that let us say I use x amount of water in a day, average x amount of water in a day. Now this average is estimated over a period of year. So there are 365 days okay and say I, my average comes out to be 150 liters per capita per day, okay. So if I am using 150 liters per capita per day, so my that 150 number comes actually that my total requirement annual requirement is 365 into my annual requirement is 365 into what so ever amount I am using on this, okay.

If this is my total requirement, and I am say this number is my average annual consumption and I divide it by 365, so I get average per day consumption, which will

come as 150. But the fact is, I am not going to use 150 liters of water each day. Someday I might be using 250. Someday I might be using just 75. Someday I might be using say 175, someday I might be using 100.

So there is going to be a large fluctuation in this per capita demand. And this large fraction is not from person to person but for a person or for a household also as like it is common that say the requirement of water in summer would be high. People might take bath twice or thrice in a day, whereas requirement in winter would be less people will take bath maybe once a time, okay.

And the amount of water used for bath may also be less, okay in places. In developed countries where you have warm water facility it is generally seen that actually requirement in winter increases particularly for bathing purpose, because they waste lot of water for in the wait of hot water and then when hot water comes so it is not no more cold. So that is quite comfortable and people can take bath for longer periods.

So that is like how the system can vary from place to place or from season to season, okay. Within a season if you have some festivals going on the overall requirement of water on that day would be much higher okay as opposed to some other day. Some days I might be out of my home. So there is absolutely no requirement as per means per se.

But so that way there is a possibility of good amount of fluctuation or variations in this per capita demand and that needs to be considered when we go for setting up systems okay, because this water requirements are never constant and fluctuation and variation in demand is to be given the due consideration when we go for planning or setting up or designing the water supply infrastructure.

So how that is accounted or what these fluctuations lead to we will be discussing in the another class probably this week, okay. So for today we will close it here and in the next class, then we will talk about how we estimate because here we were saying that the estimation of per capita demand is vital in order to get the total quantity required.

So we will discuss that how we should have an estimation of the per capita demand, what are the various recommendations to estimate that and what kind of fluctuations in those numbers are available that are given by the different agencies for estimating the per capita demand. So see you in the next class and thank you for joining.