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ECOLOGY AND ENVIRONMENT

Drinking Water Supply: Needs and Challenges

Lecture 1

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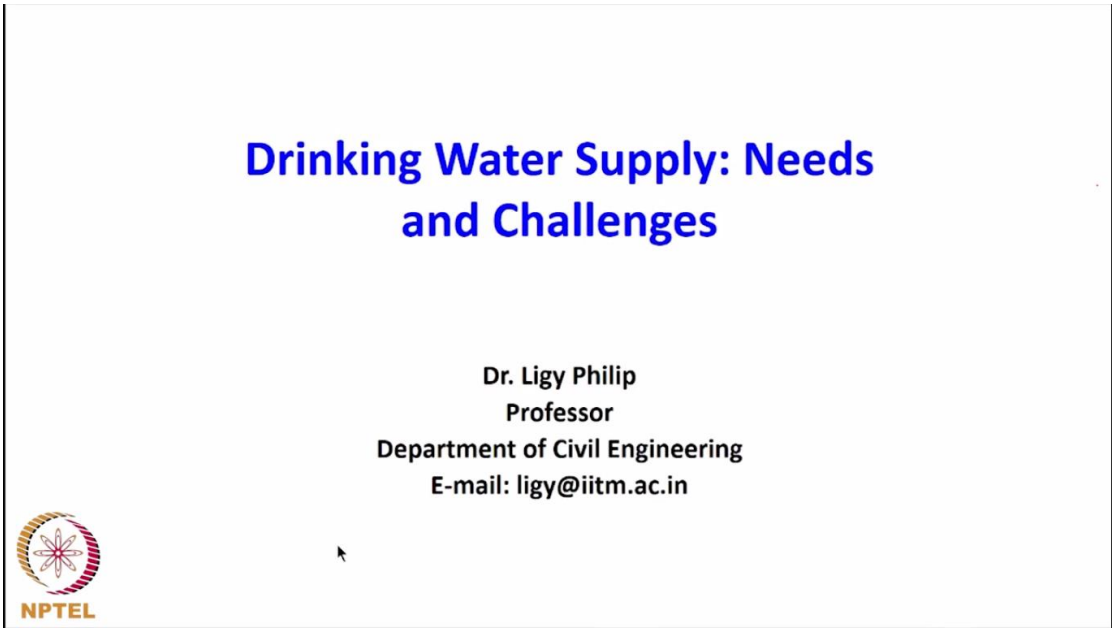
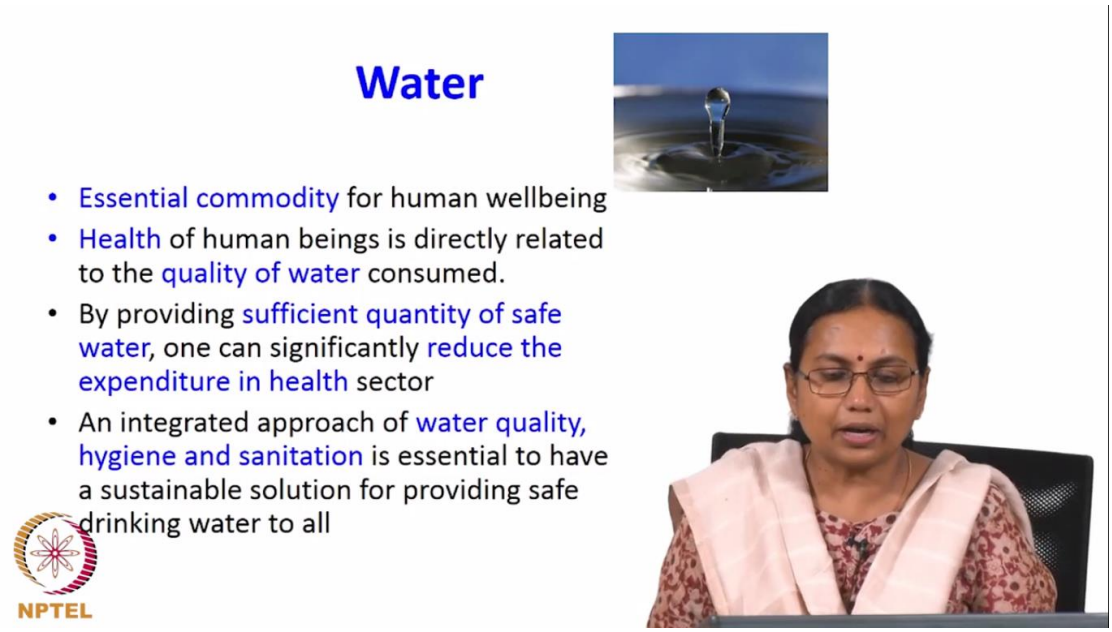


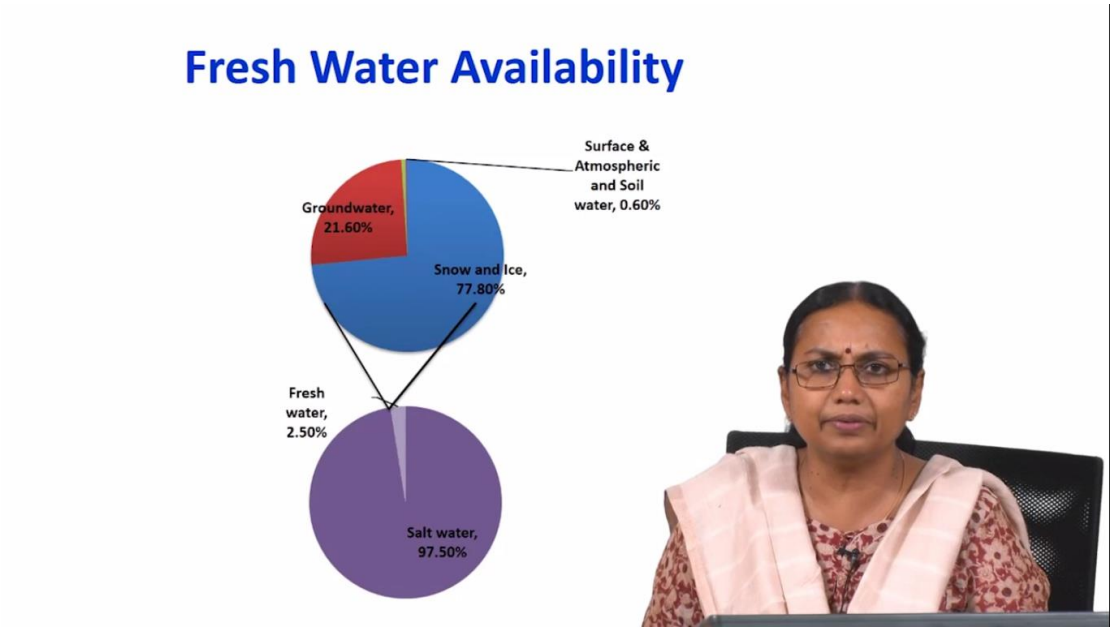
Welcome to all, to this lecture. Today we will talk about drinking water supply, its needs, and challenges. When we talk about water, everybody is very familiar with water. And as we all know it is an essential commodity for human well-being.



And the health of human beings is directly related to the quality of water consumed, okay. Most of you must have experienced when you drink some water which is contaminated, instantaneously or within a few hours you will be getting stomach upset and all the things. So, many times it is very clearly shown that the health of human beings is directly related to the quality of water. So, by providing a sufficient quantity of safe water, one can significantly reduce the expenditure in the health sector.

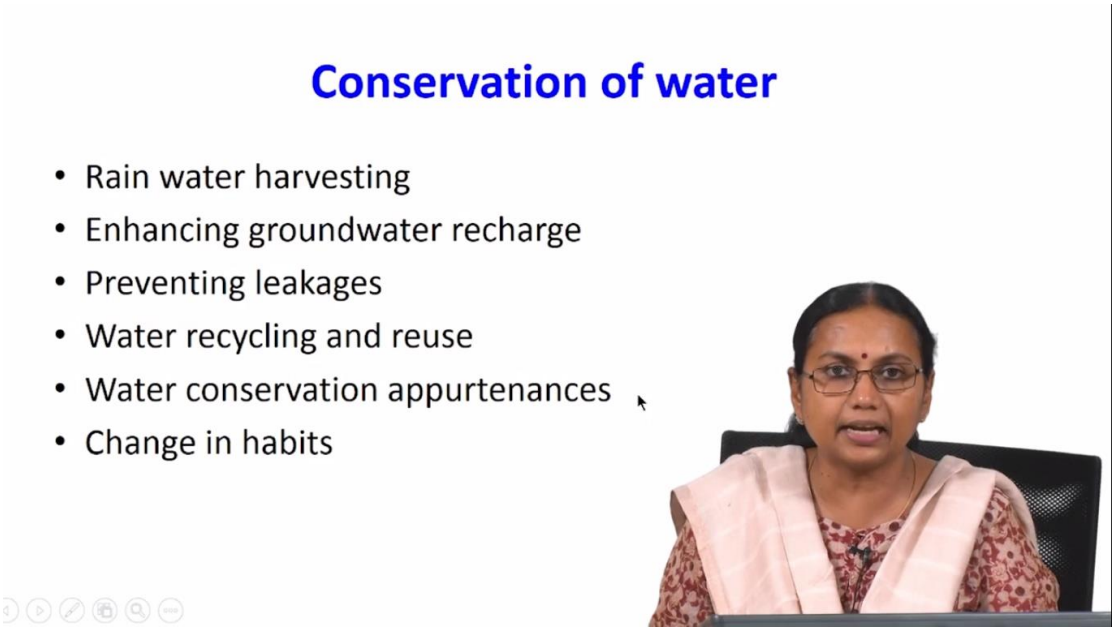
And people have shown that if you put around 10 dollars or 10 rupees in providing good quality water and good hygienic conditions, your expenditure in the health sector can be reduced around 80 rupees can be reduced in the health sector.

So, that that is the relationship between good quality of water and health. An integrated approach of water quality, hygiene and sanitation is essential to have a sustainable solution for providing safe drinking water for all. If you provide only good water supply system and we are not bothered about your wastewater or solid waste or your other sanitation conditions, then you will not be able to provide good quality of water to all. This shows the relationship between water quality, hygiene, and sanitation.



So now, when we talk about water quality or water requirement, we should know what is the water available to us, okay. This shows us very clearly the freshwater availability. You can all see that the freshwater availability is very limited. See around 77.8% of the total water available on earth is in the form of snow and ice. And around 21.6% is existing as groundwater. And surface water, atmospheric water, and soil water constitute around 0.6%.

So, when we talk about fresh water, only availability is 2.5% of the total water in our earth. And in that one around 97.5% is salt water. Yes. Total available water around 97.5% is salt water. So, fresh water is less than 2.5%. So, we cannot assume that water is an endless resource, okay. It is - its availability is very very restricted, and we are seeing the reports that many of the countries will be sooner becoming water-stressed countries. And recently there was some paper article telling that in India by 2020 more than 20 cities will become dry because of over-exploitation of water resources.



So, it is very essential to conserve or augment the available water. So, how can we do the conservation of water? There are various methods, okay. Rainwater harvesting is one of the very proven methods of augmenting the available water resources. And enhancing groundwater recharge. Instead of allowing our rainwater to flow to the sea if we can enhance the groundwater recharge this one will be enhancing our available water sources, and it will be very helpful for us in the future. Then another one is preventing leakages. This one I will discuss in detail little later. If we are not maintaining our water distribution system properly, around 50% of the water will be getting lost in the water supply system because of the leakages and other means. And a well-maintained water supply system, the leakage loss will be around 15% to 20%. And another way of conserving water or augmenting water is water recycling and reuse. Many of the industries are practicing this one; we call them Zero Liquid Discharge industries. What they are doing is, whatever the wastewater they are generating, they are treating it into a very good quality and reusing it in the industry itself.

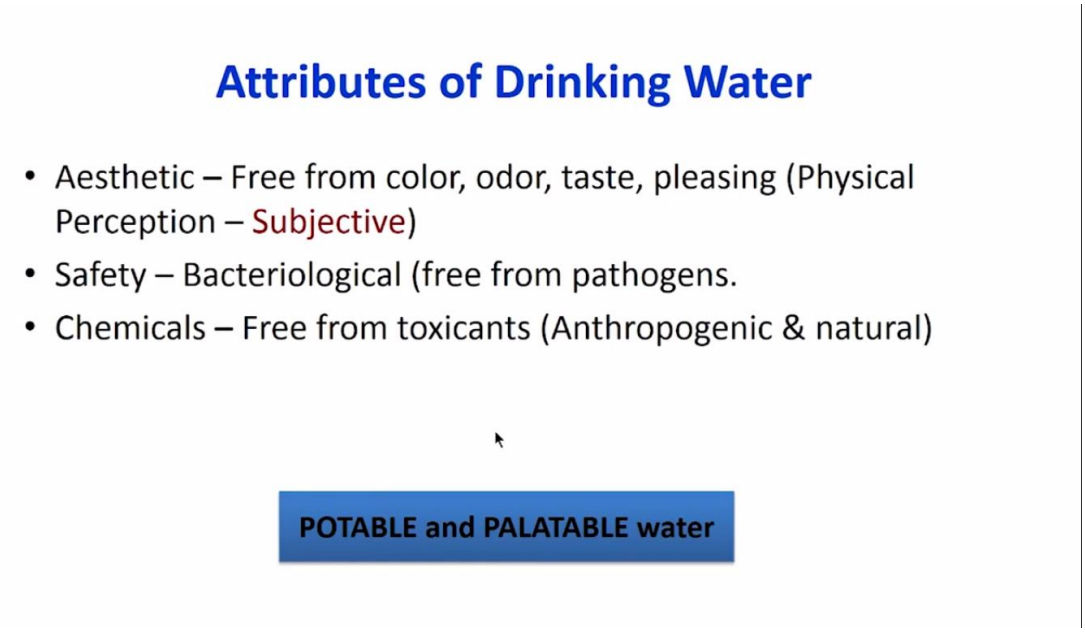
So that their water consumption is almost negligible, or the fresh water consumption is always almost negligible. So, nowadays domestic wastewater also many cities are reusing for augmenting their water supply. For example, Israel is using around 80% of its wastewater for domestic purposes after properly treating it. And many other countries like Singapore and even in India, Chennai we are using some extent of the treated wastewater for augmenting the water supply. So, water, wastewater recycling, and reuse is also a method of conservation of water.

Another thing is we can use water conservation appurtenances, for example, you think about toilet flushing. Each time when you go to a toilet you will be using around 10

liters of water to flush the toilet, but if you can reduce that one to 5 liters or two liters as per the requirement then you will be able to change the – you will be able to reduce the water consumption. So that is why use water conservation appurtenances.

Another example is using sensors in taps. Because many people have the tendency to keep the tap open when you do the hand washing or brushing the teeth etc. So, a lot of water will be wasted during those processes, but if you put a sensor whenever we need the water, then only the water will be coming. So, there are many many examples, so one have to think about this conservation of water.

Then another one is change in habits. By changing the habits, we will be able to save a lot of water or conserve a lot of water. So, now so we have talked about what is water availability, etc. When it comes to drinking water in developing countries, many of us are having a problem taking the water from the tap. We all are bothered about the quality of water.



So, what are the attributes of drinking water? When we talk about drinking water the most important things are one is aesthetic. Another one is safety, okay. The water whatever we are supposed to drink should be meeting or having both these attributes. For example, aesthetic means it should be free from color, odor, taste and it should be pleasing that means physical perception. And we know that any physical perception is subjective, but the water should be pleasing to the people who is going to use it. That is one thing. And another one is safety. Even if the water looks very clean, if it is not safe, that is not good because it will be leading to many other problems.

So, when we talk about drinking water, the most important water quality parameter or most important parameter is the water should be free from bacteriological contamination or free from pathogens because the pathogens can cause diseases immediately. So, the water should be always free from pathogens, and the next one is, it should be free from all toxicants or all toxic chemicals. This can be either Anthropogenic origin or natural origin because sometimes you can see that the groundwater will be having a lot of fluoride, arsenic, etc. So many times, these are coming from the natural minerals present in that area. And many waters or water sources are contaminated with heavy metals, and many of these heavy metals are coming due to Anthropogenic activities or due to industrial activities, and when these industries discharge their wastewater without any treatment, this wastewater will find its way to the existing water bodies either surface water or groundwater.

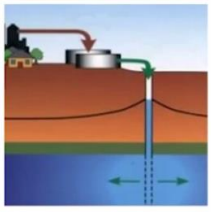
So, whenever we talk about drinking water the water should be portable, and palatable. That means it should be pleasing and it should be safe for the people whoever is consuming the water.

Now, when we have to supply the water, we have to bother about two aspects, one is the quality of the water another one is the quantity of the water. Because we have to supply a sufficient quantity of good quality water to have healthy people. So, first, we will look into water or the sources of water because we have to get enough water from various sources and we have to give sufficient treatment to meet the requirements. So that is what we have to do.

Quantity and Source of water

1) Ground water

(Fe, Mn, F^-, As, NO_3^- etc..)



2) Surface water

Pathogens, organic inorganic pollutants, turbidity

Contd....

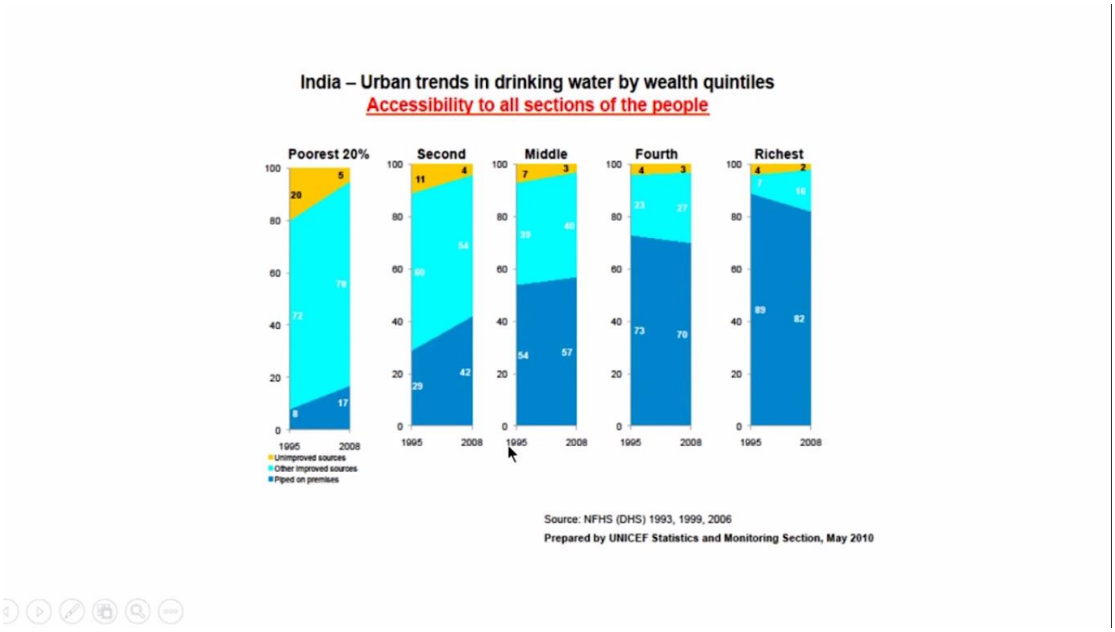
So, when we talk about drinking water or water supply, there are various sources. For example, one source is groundwater, and another one is surface water. Or we can say lake water, we can say recycled wastewater, etc. etc. So, when we talk about these various sources, we should have some idea about the nature of that water. For example, groundwater, most of the time we think that the water is coming from deep into the ground, so the water will be clean because no waste whatever is there in the surface will be reaching the ground. But many times, it may not be the right thing to think because groundwater it is in contact with the natural minerals whatever is present in that area. So, many times the groundwater can have various metals and non-metals like iron, manganese, fluoride, arsenic, nitrate, etc. And nowadays we have seen in India many of our groundwater sources are having bacteriological contamination also. The reason is whatever the wastewater the domestic wastewater we are discharging without treatment it is getting pulled somewhere, or it is getting into the surface water, and slowly it is percolating into the ground, and the groundwater is getting contaminated. So, thinking that the groundwater is extracted from deep aquifers and they are free, it may not be true all the time. So, we have to be careful about the quality before using it as a source.

If the quality is not meeting the required standards, then we have to give sufficient treatment to improve the quality.

So, now we will see the surface water. All of you have seen rivers and lakes, etc. So many of the rivers are river waters are contaminated with various pollutants including pathogens, organic and inorganic pollutants and many times they will be having turbidity, etc. So, surface water also if you want to supply it as a source of drinking water, we have to give sufficient treatment.

Similarly, when we talk about river water or lake water, you will be having, sometimes if the river is stagnant and it is receiving either partially treated, or untreated wastewater or the rivers will be receiving the runoff from agricultural fields. So, a lot of nutrients will be getting into the rivers. So as a result, they will be having algae growth. When the algae growth is there, there will be taste and odor. And as we have seen earlier pathogens maybe there and other organic and inorganic pollutants maybe there. And you will be having turbidity etc. So, we have to look into the quality of water before we use them as drinking water.

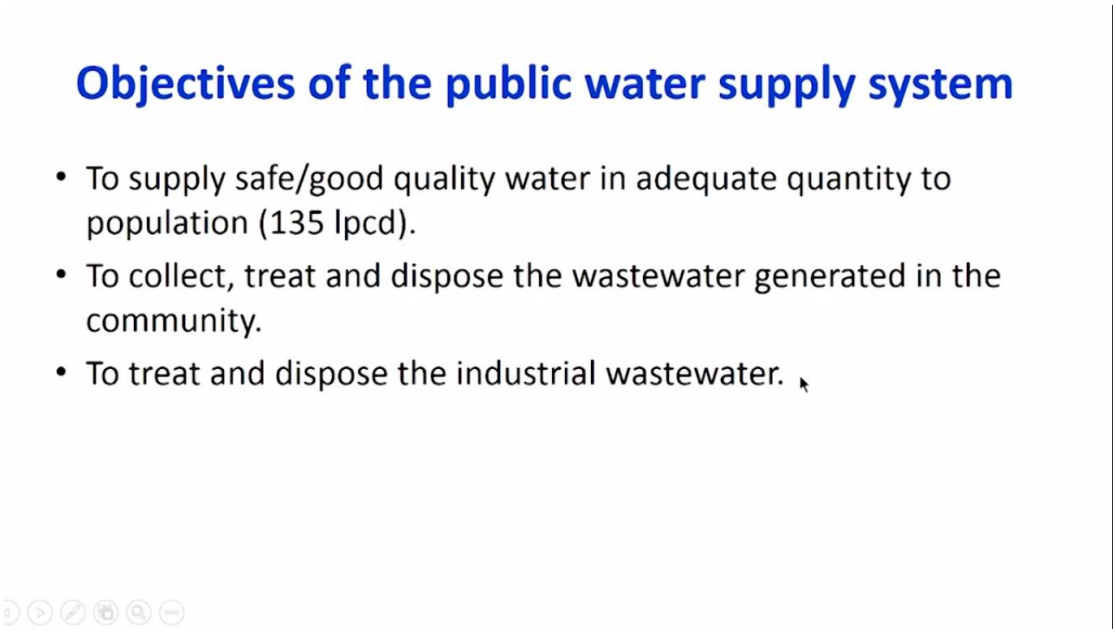
Then another source is sea water, okay. Because you know that many of the cities in the tropical or other regions where you have water scarcity they use the sea water as a source of water supply. And we know that seawater is having a very high concentration of dissolved salts around 35 grams per liter. That is too high a concentration. If you want to use this sea water, we have to give appropriate treatment like reverse osmosis or other treatment to remove the dissolved salts before supplying to the people. And as I mentioned earlier, another source is treated wastewater because wastewater contains around 99 more than 99% water and remaining is organic matter and some amount of microorganism. So, if you can remove the organic matter and microorganisms and other pollutants, you will be getting a good quality water. So, the only thing is we have to make sure that you are giving appropriate treatment. And this treated wastewater is a very reliable source of water supply because whatever the water you are supplying, about 80% will be coming as wastewater. So, if you can treat and re-use it, 80% of your water supply is met from the treated wastewater. So, this is another important source.



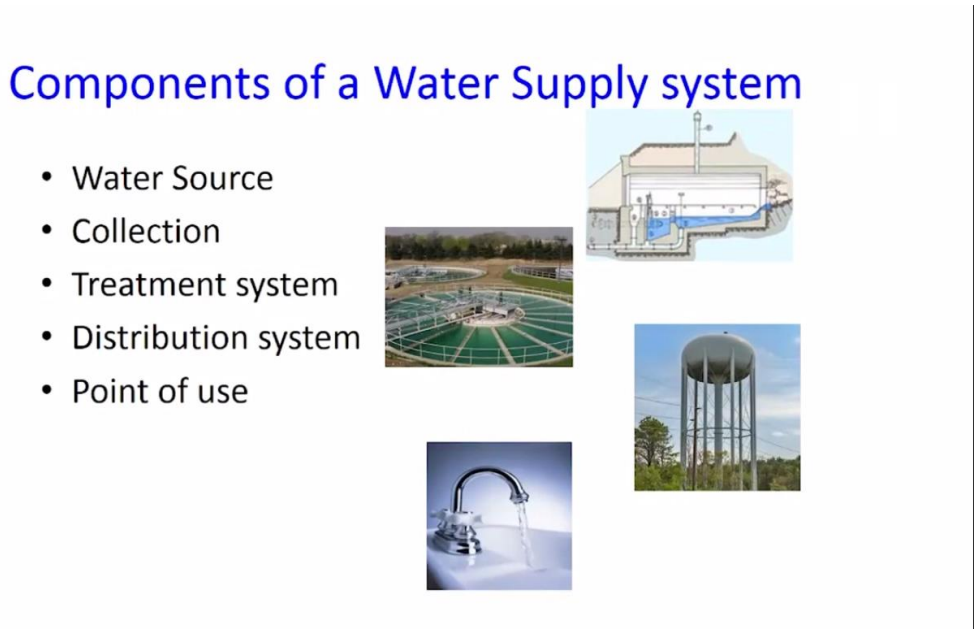
So now we will see, in India what is the urban trends in drinking water. And definitely the classification is based upon the well quantities, accessibility to all sections of the people. So, if you see the poorest people in 1995 only 8% of the people getting pipe water on premises, and by 2008 it become 17% and other improved sources that means other sources; wells or what are other thing which is of good quality around. The total is around 80% in 1995 and it become 95% in 2008. And unimproved sources that means the quality is not yet assured, so it was 20% and by 2008 it become only 5% people are not having either pipe water supply or other improved sources water supply; who is not accessible to that water.

And next section if you take it, from 20 it become 11 and 4. You can see that as the income or as the wealth increases your accessibility to good quality water is improving. And when we see the middle class around 54% were having pipe water supply in 1995 and by 2008 it was 57%, significant improvement compared to the poorest. It was 17%.

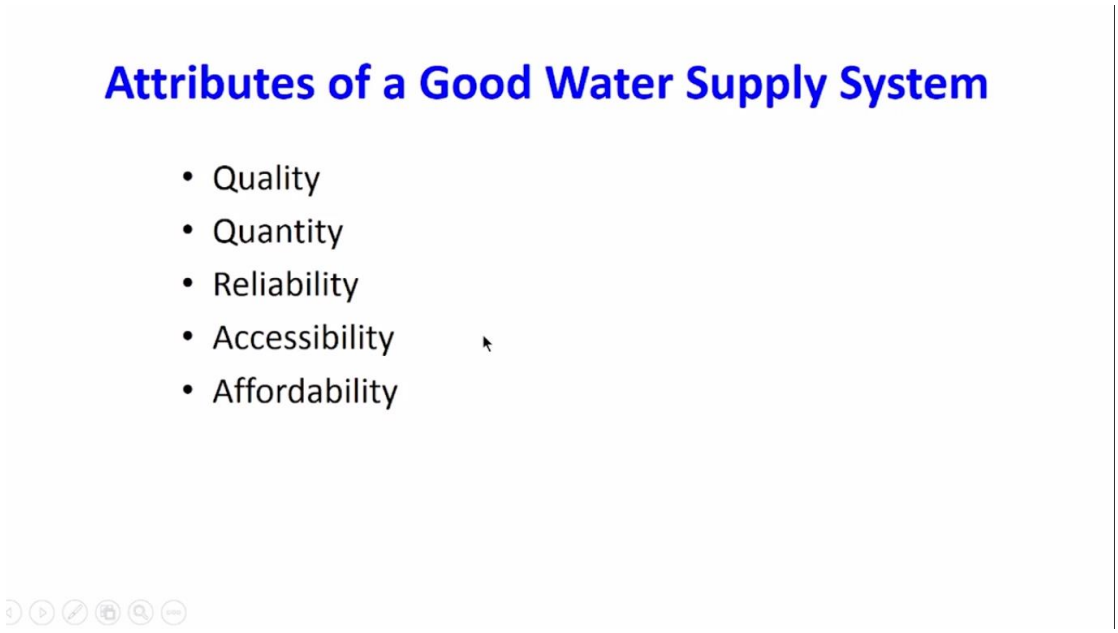
And if you see an unimproved sources, it was 7% in 1995, and late 3% was lacking. Improved or pipe water supply by 2008. And as the wealth increases again the gap is decreasing instead of 7 it it is reduce to 4, and this is remaining 3 again. And the richest people, richest and next to that or upper middle class the gap is not very significant, but here you can see that pipe water supply has increased significantly. Now but what we are - what I am trying to tell is, this is the chart prepared by the UNICEF Statistics and Monitoring Section in 2010 what I am trying to tell is, as affordability is increasing the quality of water supplied is improving in India.



Now we will see, what are the objectives of a public water supply system, because any city or any town you go there is a public water supply system. So, what is the mandate of this public water supply system? So, to supply safe and good quality water in adequate quantity to the population. That is the major objective of any public water supply system. What is this adequate quantity? The government of India has come up with a number around 135 liters per capita per day, but there are some gradations, if it is a peri-urban area it can be 70 to 100 liters and all the things. But on an average one has to supply 135 liters per capita per day. So, this is the quantity one has to supply. So, and the public water supply system also have to do the collection, treatment, and disposal of the wastewater generated in the community. The public water supply system is not only for supplying adequate quantity of good quality of water, whatever is the water supply, naturally, the wastewater will be generated. So, it is the duty of the public water supply engineers or public water supply firm to collect the wastewater generated and not only collect to treat and dispose the industrial wastewater. That is also coming under their purview. The reason why these two are integrated with the water supply system is we have seen earlier unless you treat the wastewater and provide a hygienic environment you will not be able to provide safe and good quality water because all these untreated wastewaters will be spoiling your water sources. So, that is the reason the objectives of a public water supply system is not only supply water, whatever is the wastewater generated collect them properly and treat them as per the standards.



Now, when we talk about this water supply system, there are various components, you will be having a water source, and from there you have a collection system. It is lake, or a reservoir from that one you have the water collection system. So, water is collected from the reservoir and after that one, water is getting treated in a centralized treatment system or decentralized treatment system, or sometimes the treatment can happen end of the pipe. Then what we do the treatment is happening somewhere, and the people are staying all around the city or the town or the village, so you have to have a distribution system. The water should be, sufficient quantity of water should be supplied to the people. Then you have a point of use. So, your water supply system consists of all these five components that means source, collection, treatment, distribution, and the point of use.

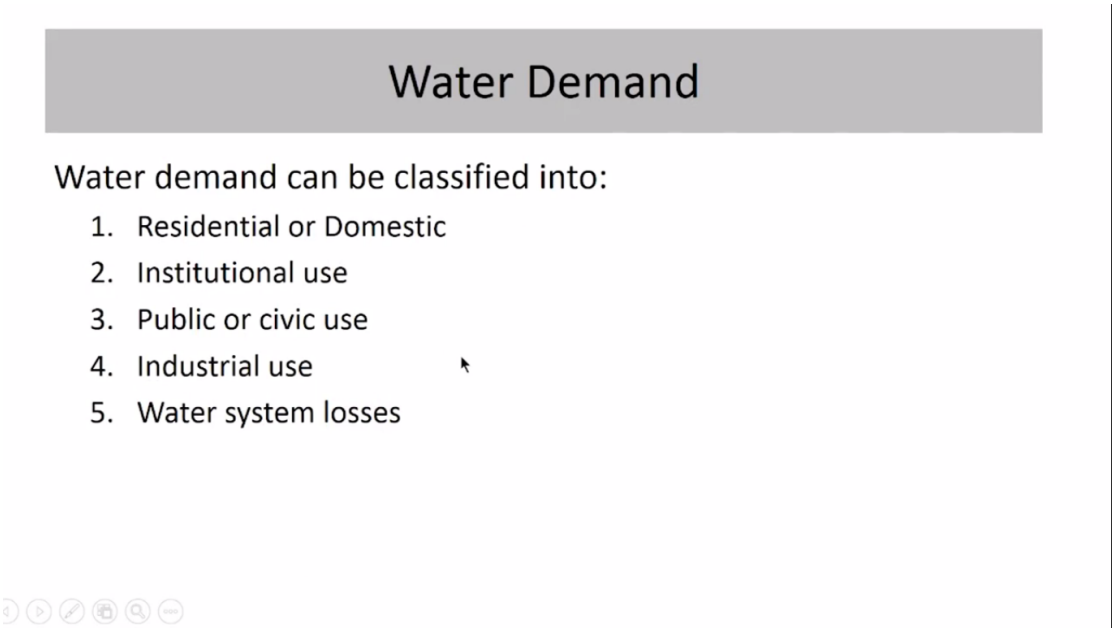


Then when we talk about the water supply system what are all the attributes of a good water supply system. There are five major attributes. They are, one is quality; the supplied water should be of very good quality as per the standards the water should be meeting the standards. That is one important one important thing. Another one is quantity. The water supply system should be able to provide sufficient quantity of water because if the system is providing very good quality but if each household is getting only 10 liters or 20 liters of water that is not a good water supply system because each person needs around 135 liters per day of water. So, the water supply system should be able to provide enough quantity of water.

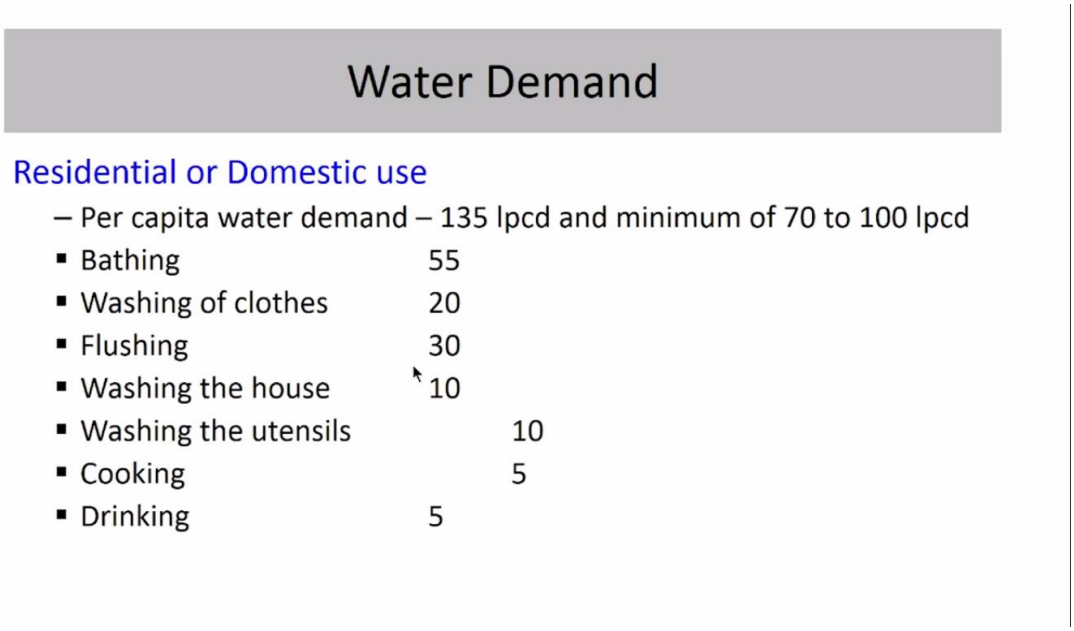
Then the next attribute is reliability, if some system provides good quality and sufficient quantity for some days and all of a sudden there is a breakdown or the water is not coming. So, that system is not a good system because reliability should be there. The system should be able to provide the water. The system should be reliable. And fourth one is accessibility, if you have a water supply system and the pipelines are maybe say 20 meters away, or 500 meters away from your household it is not a good water supply system because the people have to walk around - people have to walk a long distance to get the water. So, that is not a good water supply system. The water supply should be accessible to the people.

And even if all these attributes are met, like quality, quantity, reliability and accessibility and the price of water is very very high and many people will not be able to afford that one. So, such a water supply system is also not good. So, the water supply system should be affordable, accessible, reliable and it should be providing sufficient quantity of good quality of water then only we can call it as a good water

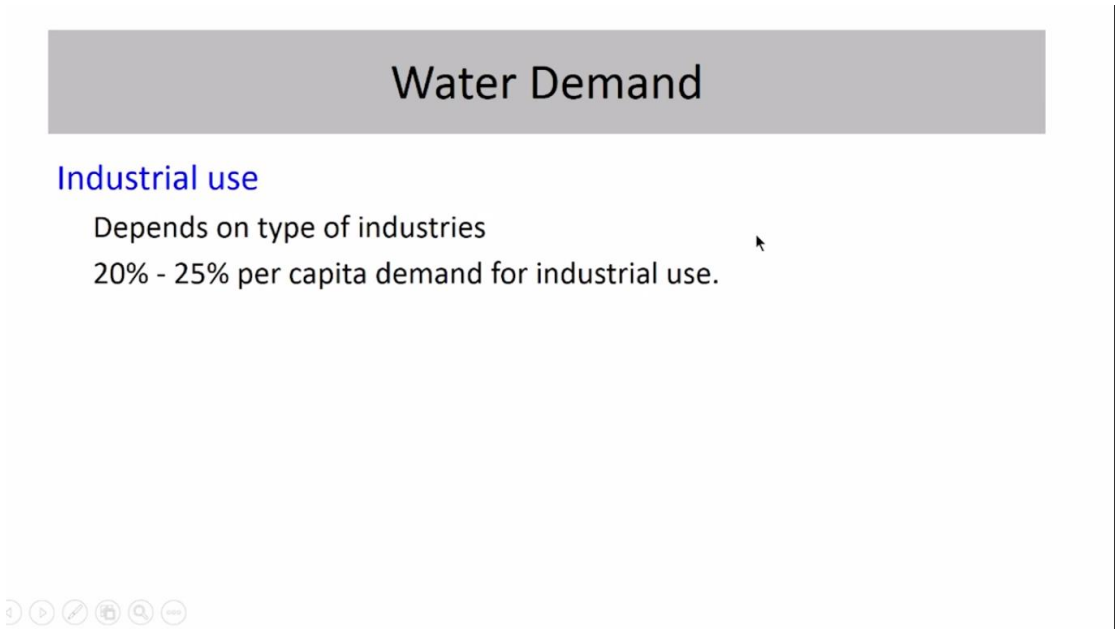
supply system. If your water supply system is meeting all these things, people will not be having any inhibition to use the supplied water through the pipes or taps. Otherwise, people will go for their own treatment units, or they will be going after bottled water, etc. So, we have to ensure that all these attributes are met by the water supply system.



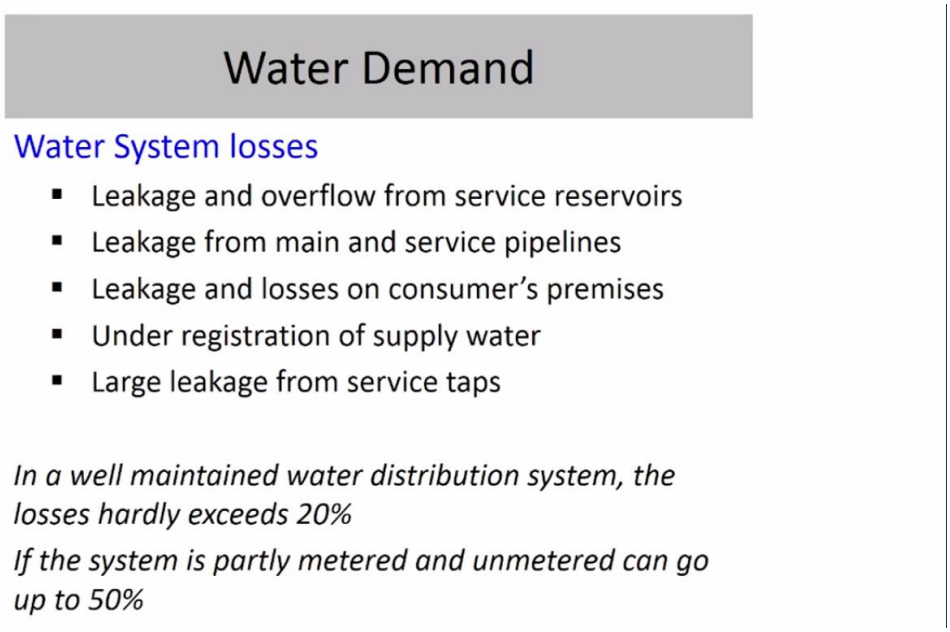
Then we have seen that the water required per person is around 135 liters per day. So, when we decide the water supply system what are all the other needs we have to take into account. One is the residential or domestic water demand. So, that is if you know the population and what is the water needed by a person, we will be getting the water demand, domestic water demand. Then we have to have water for the institutional purpose, we have to have water for public or civic use that means watering the gardens or cleaning the roads, etc. Then we should supply enough water for industrial use and the water supply system should be able to take care of the system losses. So, when we calculate the water demand, we have to consider all these aspects.



So, here I have given the approximate division of water used per person per day. We use around 55 liters of water per day for bathing, and again this will be varying from place to place and depending upon the climatic conditions. And washing of clothes around 20 liters. Flushing around 30 liters. Washing the house around 10 liters. Washing the utensils around 10 liters. Cooking five and drinking five. So, this is the way we are dividing the 135 liters per capita per day. And I have mentioned earlier the minimum supply should around 70 to 100 liters per capita per day in places where they can they have accessibility to other water sources for some other purposes like bathing and washing the clothes, etc., then the water supply can be in the order of 70 to 100 lpcd.



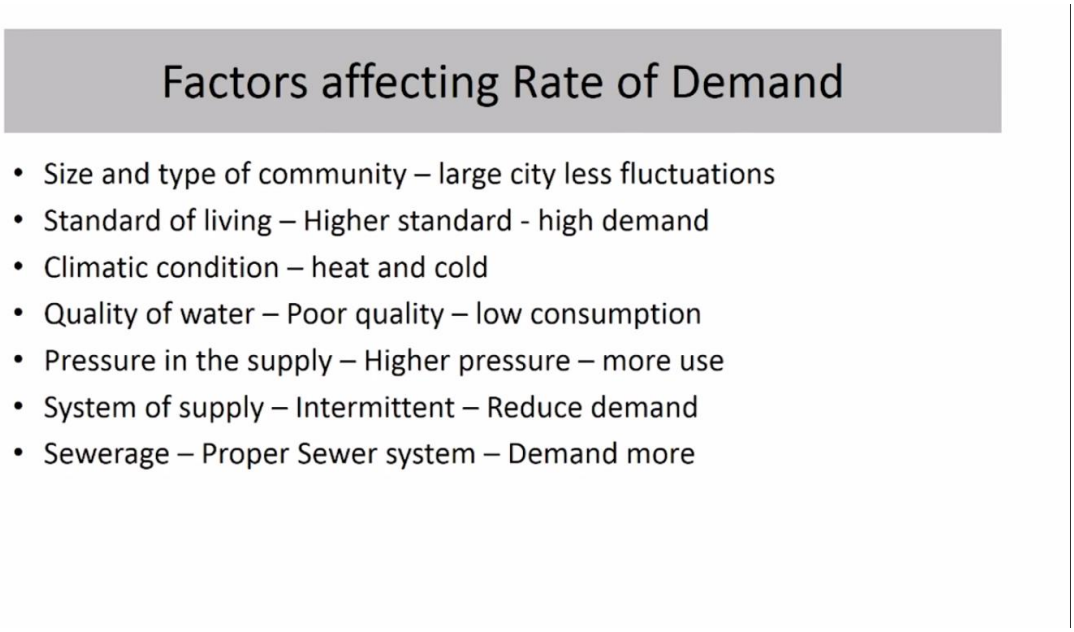
So, if you want to expand on the water demand, when we talk about industrial use it depends upon the type of industries. Around 20-25% of per capita demand is used for industrial use. This is the thumb rule for industrial use.



And water demand also should take care of the water system losses. What are the system losses? We can see that there can be leakage and overflow from service reservoirs, many times it can happen. Leakage from main and service pipelines.

Leakage and losses on consumer's premises. So, this also can happen. So, all these things will be increasing the water demand.

As I mentioned earlier, in a well-maintained water distribution system, the losses hardly exceeds 20%. It is around 10 to 20%, but if the system is partially metered and unmetered, the losses can go up to 50%, because whatever the losses we have mentioned, it can go up to 50%. So, when we design a system or something, we have to look into all these aspects.



And we will look into what are the factors affecting the rate of demand. It will be depending upon the size and type of the community, large city, less fluctuations, and smaller habitat the fluctuations will be more. And the standard of living, if a higher standard of living high demand because they will be having a lot of lawns and water demand for flush etc. will be very high. Then climatic conditions, if you are, if you are in the tropical region or if it is a hot area the water demand will be high, but in cold regions, it will be less. Then the quality of water, good quality more use. The pressure of the water supply system, higher pressure more use. And the system of supply, if you are supplying intermittent, then the demand will be reduced. And whether you have a proper sewerage system or not, if you have a proper sewerage system the demand will be more.

So, I will stop this lecture here. We will see the remaining part in the next lecture.

Thank you very much.