Water and Waste Water Treatment
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Lecture - 02
Life Expectancy and Real World Scenario

Hello, everyone, welcome to the latest lecture session. Let us get this started by looking at what we discussed in the previous session. In the previous session I was trying to take us through, why it is that this course is relevant to humanity at large and then in general Indians. The relevance was that, we are going to look at how to save lives or prevent unnecessary deaths.

And in that context, we looked at people first did not know that pathogens existed, and that we can act as carriers of diseases or say the doctors could act as carriers of diseases, and that the disease does not transmit from or through air or can, transmit through air. However one of the major routes of transmission is by contaminated water, and this contaminated water will look clear. But, we do know now that we can look at or visualize these microbes only under a microscope.

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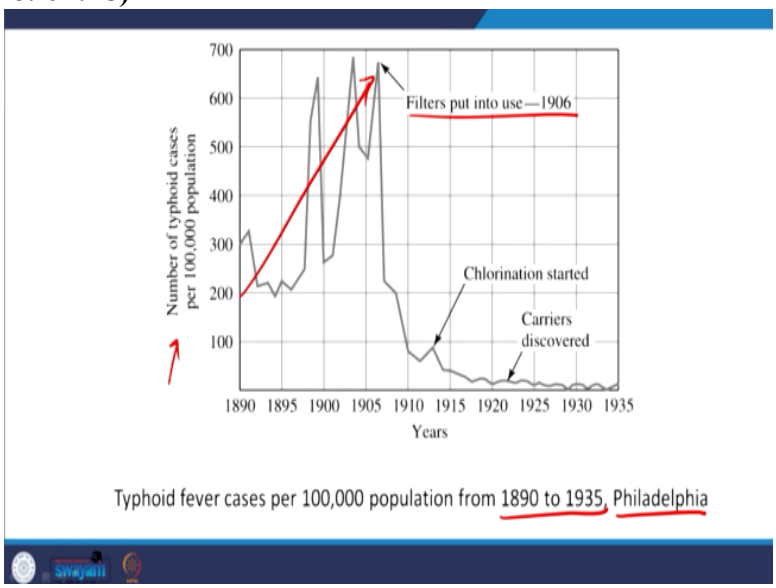

And we started looking at some data, where we have numbers of typhoid cases per one lakh population, this is Philadelphia, 1890 to 1935. We saw with increasing urbanization increasing numbers of cases of typhoid, and then based on trial and error, people figured out that filters or sand filtration could lead to lesser number of cases, they started using filters and you see that Philadelphia great drop, and then again.

By trial and error, people understood that chlorination was leading to what do we say a lesser number of typhoid cases, and thus number of deaths. After chlorination, exponential decrease that is something that you can see out here what do you expect now lesser number of typhoid is water communicated disease.

Most of these diseases, cholera, typhoid, and those that typically end up in diarrhoeal, let us see what happens. Now, typically, you have these particular pathogens, and if I have it, and my faeces contaminates the drinking water of that locality, , now all the people in that area are going to be affected by the disease that I had. In London, particular child's diaper was washed and into that cesspit or a septic tank, and that particular water was contaminating that area, and that is how it is transmitted.

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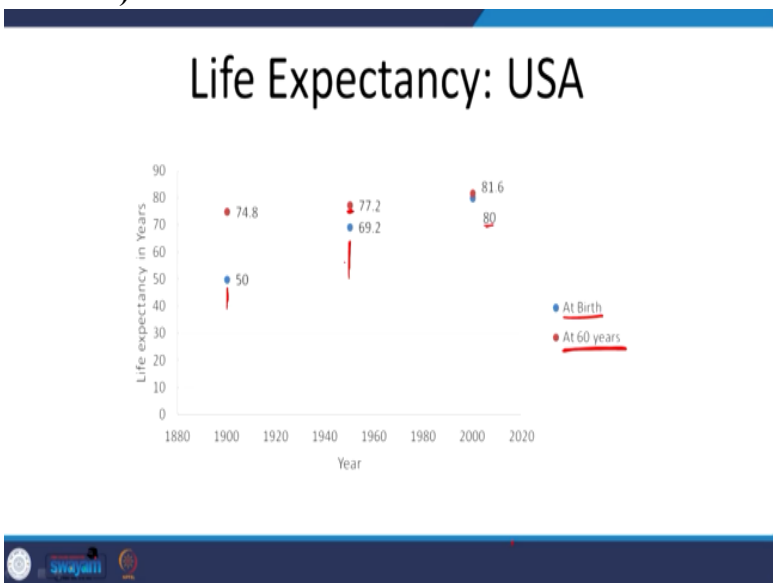

Again, people first we are not willing to take that at face value, because the thought of drinking water that is been contaminated by human faeces was too harsh for people. That is something that we see even now, but we will look at that again. Here with this advancement, sand filtration, and disinfection by chlorination.

Cl_2 or HOCl you know we say that it is supposed to lead to lesser number of diseases that are borne by water, and thus he mortality should decrease. Here we have life expectancy, this is in the USA. It is at birth, meaning at birth, the infant, how many years can he or she be expected to live? This is in blue and then we have another metric. At 60 years, how long is it supposed to is he or she, typically going to live?

But here I tried to what do we say tweak the data so that I can compare it, for example, at birth in the year 1900, 50 was the average life expectancy at birth rates, but at 60 years, so 60 - 74. It was supposed to be 14. But for comparison, I increased it by 60 years. At 60 years, the life expectancy was 14 years, or the person would have would be expected to live to 74 or 75 years . Why is this gap here?

It means that , there are a lot of people dying or not people infants or children dying during their nascent stages of life, why is that again, typically due to these particular diseases that we are experiencing in India right now. That is why we see this considerable difference, in the year 1900. But again, the difference was almost 25.

By 1950 the difference came down considerably, as in life expectancy at 60 years also increased, but only slightly, because medical advancements at that time was not very great with respect to the elderly population. But with the advent of disinfection, and sand filtration and different levels of sanitation, we see that the life expectancy at birth jumped from 50 to almost 70. That is an increase of 20 years in life expectancy.

But still, there was some what do we say there was still some difference between the life expectancy at birth 70, and life expectancy at 60 years. The person at 60 can be reasonably expected to live for 17 more years or reach the age of 77. But as you see, advancements were decreasing the particular what do we say difference here, and then by 2000 or early 2000, we see that there is considerably or relatively some increase.

And the expectancy at 60 years, but now, the expectancy at birth, which is 80 is almost the same as the expectancy at 60 years. What does that tell you that? Over time, especially with the first half century of the 20th century, meaning 1900 to 1950. They were able to bring down the death rate among children, what was the major reason? It was due to sanitation.

And what is the disinfected water that is the primary reason that drove this particular life expectancy. Life expectancy, leads to relatively more thriving economy, otherwise when you have sick populace, typically the economy is does not do as well.

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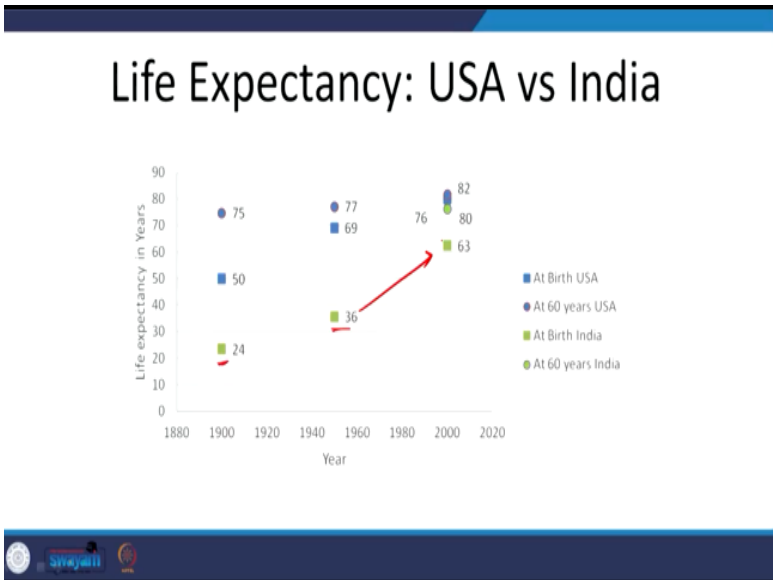

Let us look at it now, by comparing the data from India to so, here we have or I have the data from both USA and India, and I tried to see to it that USA, blue colored India green colored data sets, and then at birth, the square shaped region, and circle is the one at 60 years. As you see in India in 1900, our life expectancy at birth was abysmally low 24. While in the US, which was already a relatively developed country, by that time, it was 50.

All the people who keep talking about all the good that the British have done inspite of the facts or data this is one more set of data out here. Second, life expectancy was remarkably low and by the year 1950, it increased slightly, but not drastically, you can see the difference in slope here. You can see that difference here, for example, here it is 20 points, or 20 years.

And here, it is what is it from an abysmally low value, it is still to a low value, 12 years increase, and I did not find or could not find the data for life expectancy in India at 60 years, for the years 1900 and 1950. But since then, after independence, we had a considerable what do we see increase in life expectancy at birth. That is because , people now think about themselves.

And we had relatively good administrations over the year, considering different aspects, that we were at war, and we were facing food shortages, and so on and so forth. We see that, it is almost 30 increase, or 27 years increase within this 50 year period. That is remarkable increase and we see that in 2000 though we still have a considerable gap between the life expectancy at birth in India at 26, and at 60 years, which is 76.

We still have what are that 13 years difference. We still need to catch up, but we are on the right track. But the aspect that we need to note is that, diarrheal diseases are such they can be eliminated relatively easily but lack of awareness and sources of energy. Why sources of energy? Why do I say so? Because if you boil the water, for the right amount of time, I think 1 and 1/2 minute at the boiling temperature around 100 degrees centigrade, you are going to kill most of these pathogens.

But you need energy to boil them and people need time and the resources. Lack of good sources of drinking water, lack of awareness and lack of sanitation, as in hygiene, feces, if you do not wash it properly you have the diseases on our particular hands, and we act as carriers either we eat, or we help in transmission.

That is the reason why we always need to wash before we eat, , hold the utensils and such, something that we see out here, as in we were pretty poor at one point in time, and also, that was the reason why, our grandmothers, great grandmothers, our great grandfathers, they used to try to have large family, life expectancy was very low.

Earlier, you would have heard of, people giving birth to 10, 12 children but only 4 or 3 survived. But again, slowly, but surely, as the life expectancy increased, the number of what do we say children that were being produced by a particular couple, kept on decreasing, and now it is at replacement levels of 2.1 or 2.2.

But again, because of this increase in life expectancy, we saw a boom, and population or explosive population growth around this particular period. But again, that is due to the increased life expectancy, everything cannot be ascribed to only good water or sanitation and hygiene, people were what do we say suffering from famines and such that was cut down upon relatively better food was made accessible, and that also leads to what is it higher life expectancy.

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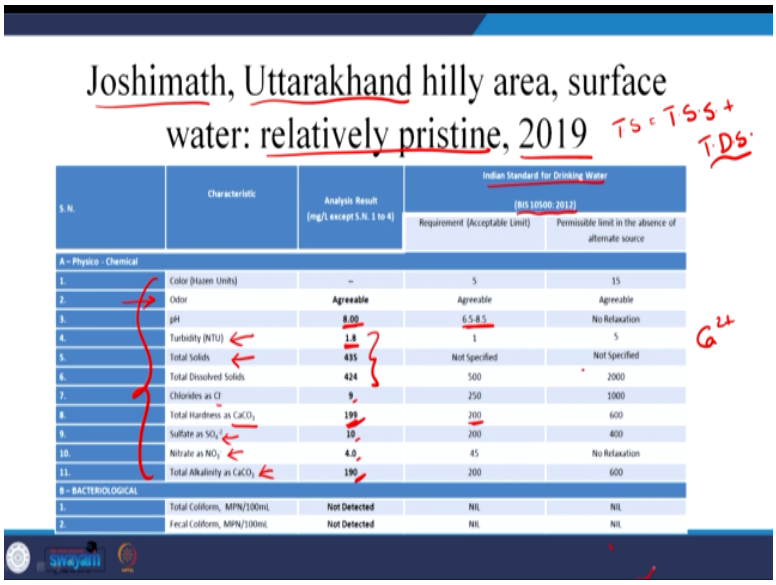

S. N.	Characteristic	Analysis Result (mg/L except S.N. 1 to 4)	Indian Standard for Drinking Water (BIS 10500: 2012)	
			Requirement (Acceptable Limit)	Permissible limit in the absence of alternate source
A – Physico - Chemical				
1.	Color (Hazen Units)	–	5	15
2.	Odor	Agreeable	Agreeable	Agreeable
3.	pH	8.00	6.5-8.5	No Relaxation
4.	Turbidity (NTU)	1.8	1	5
5.	Total Solids	435	Not Specified	Not Specified
6.	Total Dissolved Solids	424	500	2000
7.	Chlorides as Cl	9	250	1000
8.	Total Hardness as $CaCO_3$	199	200	600
9.	Sulfate as SO_4^{2-}	10	200	400
10.	Nitrate as NO_3	4.0	45	No Relaxation
11.	Total Alkalinity as $CaCO_3$	190	200	600
B – BACTERIOLOGICAL				
1.	Total Coliform, MPN/100mL	Not Detected	NIL	NIL
2.	Fecal Coliform, MPN/100mL	Not Detected	NIL	NIL

Here I have some sets of data that I want to share with the people here. We have this water quality report or water quality analysis report, from Joshimath, Uttarakhand, that is where Roorkee is, lower reaches of Himalayas, we have the surface water is relatively pristine, the data report was from 2019. Here we have the different units typically for which we are typically concerned, at least with respect to drinking water. What do we have?

Odor agreeable, pH 8 you know, because it is the mountain ranges, that is why it is relatively higher. It is within the acceptable limit turbidity, meaning it will give you an idea about how many suspended particles there are, for example, if I take some mud and put it in a glass, and I am going to put some mud in it, with turbidity, or the suspended matter some of it will settle down, some of it will be suspended,

I can measure that by turbidity that gives you an idea about this suspended matter, and total solids total solids meaning is equal to total suspended solids, which we just discussed about and also total dissolved solids. As when I say dissolved solids, it is explained self-explanatory.

If I take water in a glass, and I put in either salt, let us a spoonful of salt and the salt is not going to settle down, it is going to dissolve same case with sugar, or some such compounds they dissolve. At a certain threshold, that is with respect to the solubility product. TDS total solids and total dissolved solids, there will be some errors that is why you see some variation.

Chlorides we are concerned hardness in the units of calcium carbonate, sulphate, nitrate, and alkalinity, this is what we are typically concerned with, and typically as you see, almost all of

the parameters are relatively low, or pretty good. Hardness , with respect to deposits, or the water would have what do we say come across, or come in contact with calcium, or lime deposits. That is why it seems like hardness is almost at the limit. But other than that, you see that it is pretty good .

That is something that you have and here we have the Indian standards for drinking water that is something we will look at later BIS 10,000 or 10500, and again, one aspect I would like to point out is that acceptable limit is out here and permissible limit in the absence of alternate sources is also mentioned.

One aspect I would like to point out is that total dissolved solids, we allow it to be as high as 500 that should not create issues too high and you are going to have digestive tract related issues and such. Which is what most people are drinking now because most of the relatively affluent families are using reverse osmosis based their water treatment units and there the TDS is going to be very low 10 or so, and if you are not having recycled are such are bypassed, your drinking water that is very low in dissolved salts or dissolved solids which are actually beneficial to health. You need chlorides, sulphates and so on and so forth at some levels in our body, but we are you know depriving of our body by , spending money.

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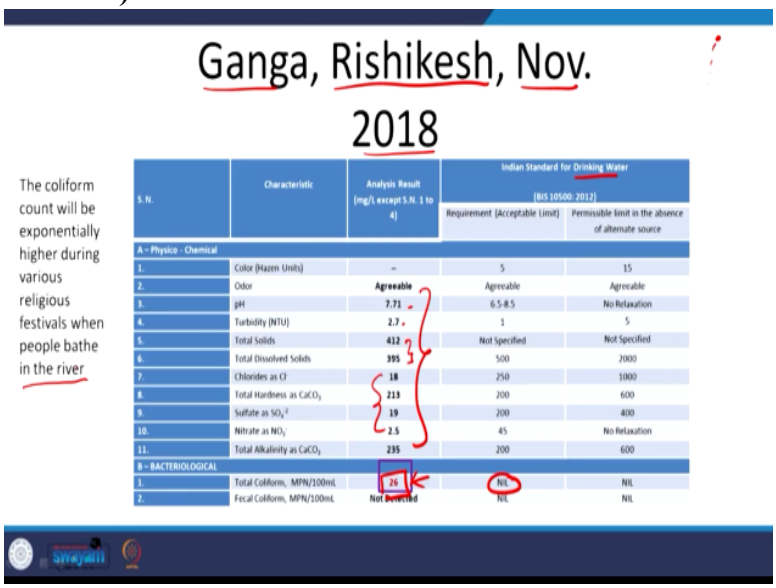

And then Joshimath is somewhere out here, further downstream, we have Rishikesh, but still relatively pristine. We are now looking at Ganga surface water body the data is from November 2018. What do we see again, pH relatively less turbidity, slightly higher compared to Joshimath

total solids again, in the same range total solids and dissolved solids. Other 2 are in the same, what do we say range more or less.

But one aspect that pops up here is that we see that what is this now total coliform? Which gives us an idea about contamination by fecal matter, human faeces, is not 0. But what is the requirement with respect to drinking water? It has to be 0, but it is 26. Why is that? and what does that indicate? Why if that you could have sewage from Rishikesh flowing into Ganga.

Also, you have people taking a bath in Ganga, because it is considered pure and that it is going to wash away the sins. People take holy dip in Ganga in Rishikesh. That could be the reason how we have contamination of the relevant water there with faecal matter, but this is one way, where transmission of the relevant pathogen takes place. This water is not fit for drinking, but all the other parameters are fine, but thus water is not fit for drinking because of the pathogen count.

The coliform count will be exponentially high, during religious festivals when people bathe in the river, for example, we have different Kumbh mela and such, and once a year, we have different religious processions out here where people come take a dip in Ganga, take the water and go back home, and during that time, I am sure you know, you are going to have remarkably higher coliform levels there.

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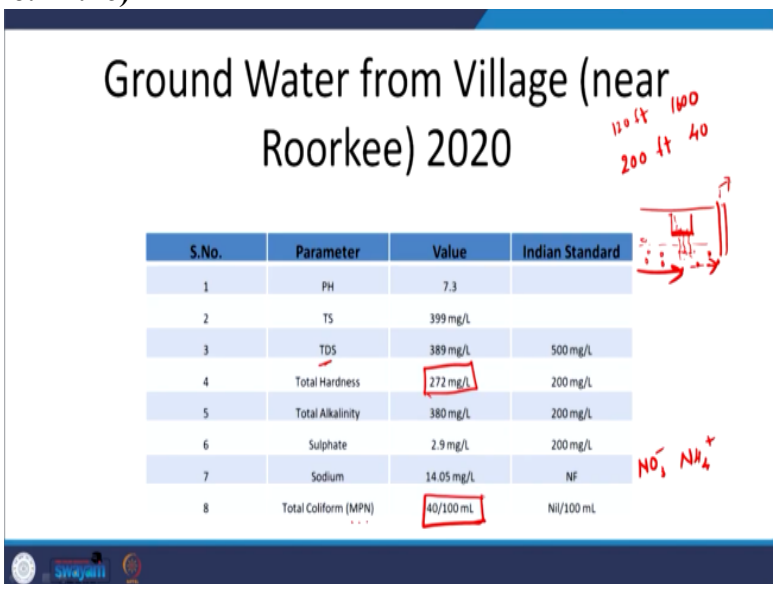

And I wanted to compare that to groundwater from a village near Roorkee, and again, the data is from a month ago, October or I think September 2020 . Why are we looking at this data?

Because typically, in India, where a lot of people use groundwater and they think that it is pretty, clean, because it looks clear smells fine . Let us look at this out here so parameters total solids, total dissolved solids high but not very high, hardness is high.

Yes, that was an issue that was leading to considerable digestive tract related issues and some joint related pains to the local population of that village, and alkalinity is high but typically, that is not a great issue. Sulphate and sodium is also relatively what do we say low, and then with respect to coliform though, keep in mind this is groundwater and I think they were pumping the water up from 120 feet .

And another one we are going to look at is from 200 feet, the coliform value is 1600 this is called most probable number 1600 per 100 ml sample and what is the standard for drinking water it is supposed to be 0 and how is this occurring? Now, before we go further discussing the relevant reason let me also look at the second sample which was collected from 200 feet. pH, TS, TDS is fine TDS slightly high, but hardness is still high as you can see others are okay, alkalinity is not a great issue in general.

But again, we see that coliform contamination at relatively shallow depths greater contamination as high as 1600, and at relatively greater depths we see relatively less contamination 40 again, MPN stands for most probable number per 100 ml sample it is again, how is it being contaminated this many groundwater being contaminated with human faeces are such how, because we are going to have at least in the villages.

And most of the even the urban areas, you are going to have septic tanks that are nothing but crude pits, septic tank are supposed to have some certain design, we maybe we might look at it during the course of this class. But again, in these villages, or in most of our areas, people with you know half knowledge which is pretty dangerous, are going to build these septic tanks and they have no what do you say impermeable layer or such at the bottom, or maybe even the sides so you have all this sewage be from the homes accumulating there.

And that is going to leach into the ground loop. For example, you have septic tanks out here, and I would have loved to have nitrate and NO_3^{-1}, Impermeable layer, this contaminated or the sewage is going to go out here, and if the groundwater table is out here as in, if the porous layer is out here that is where you will have the groundwater.

And the sewage is going to go down and contaminate this groundwater, and people are and if the groundwater is in this flowing in this direction, now you have human faeces, contaminated groundwater being pumped up, and then being consumed by the local population. In this context, I want to discuss one aspect that the relevant project assistant raised. He mentioned that he saw a particular documentary where he was the person who collected the sample and got it analyzed in our labs.

And when he was looking at the data, he was wondering about why this is an issue. The reason why he was what do we say confused was that he saw a particular documentary, and where a person living near Varanasi or such was fine when drinking the water from the river or from the vicinity of that particular river, Ganga but a foreigner who came and drank that water immediately fell ill.

And our project assistant thinks that, we are, if not a better race, we are, a healthier race, and thinks, why are we concerned about this coliforms or such, but as we just looked at the data, shows us that you know there are a lot of deaths with respect to the age group 0 to 5 and 5 to 14 due to diarrheal diseases, typically due to contamination of water by human faeces.

Let us say if I survive, say, or if my child or your child or your friends survive during that period, and then make it to the next stage, maybe they will not be affected by that particular what do we say pathogen or such, but typically, you will keep having episodes from time to time, but here, it is not a we cannot make such simplistic what do we say comparisons based on one particular observation.

Because we know from the data that a lot of the susceptible population is still dying susceptible, meaning the ones that are still at to develop their own immune systems. We have children dying out there and lakhs every year and again, why is that because of diarrheal disease. It is not as if Indians by themselves are, remarkably better of race or such.

We are experiencing different issues or health issues every time. That is what we have out here and the western population they are not experiencing or used to these pathogens anymore. When they come in contact with these pathogens, they might be relatively more susceptible. But please note that the chances of them coming in contact with this pathogens are almost nil

because of sanitation, and clean and disinfected drinking water. That is something to keep in mind.

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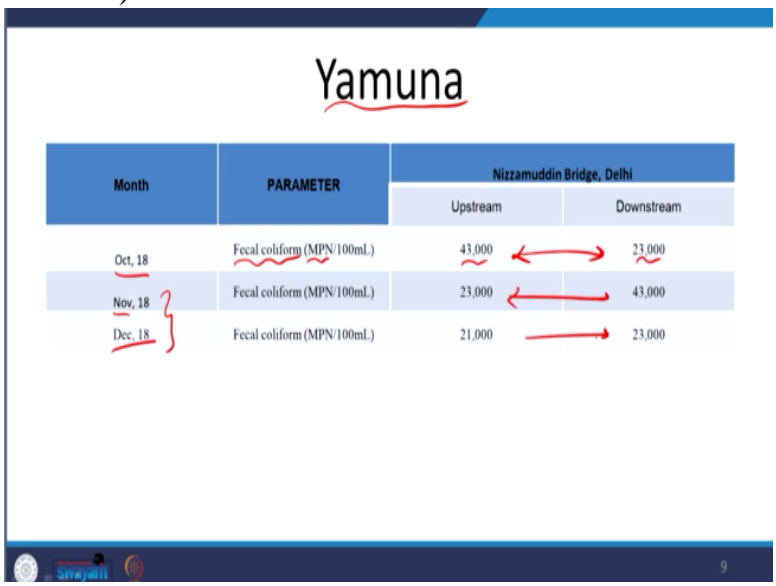

And let us move on to Yamuna though, why Yamuna it comes through the National Capital Region Delhi, you it starts at around Dakpatthar then flows through Haryana and then Delhi and Delhi again, what is it one crore or one half crore population NCR region. Let us look at what we have, we have samples collected in October, November and December.

And this is the winter period out here at least from November, winter period, faecal coliform, which gives us an idea about the contamination or level of contamination of the water sample by human faeces, faecal coliform this live in the guts or the intestines of warm bodied animals. We have an Nazimuddin bridge where, typically we have it is a lot of pollutants accumulating out there and both upstream and downstream.

Anyway, we see that the coliform count is remarkably high, and that tells you about the level of either partially treated or untreated sewage coming into Yamuna. Why is this an issue? You have contamination of the groundwater, you have people depend upon it for either daily activity if not drinking water, or if not for source of drinking water.

You as a water or wastewater treatment expert will now be able to better explain or when you at least you know you take up your job as any other you know, either civil engineer or any other job, you will at least be aware and be able to take part and hopefully arriving at the right decision. That is the reason for offering this course.

And with that, I will end today's session and the next session we will look at the outline and see what it is that we are going to discuss. But in general, as I mentioned, we are going to look at wastewater treatment and water treatment, I thank you for your patience.