Rural Water Resources Management
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Week 01-Lecture 03
Introduction to Hydrological Cycle

Hello everyone, welcome to Rural Water Resource Management course, week 1 lecture 3, where we would be discussing about in the first week importance of water resource management in India, and also some of the hydrological components we will be introducing in the lecture.

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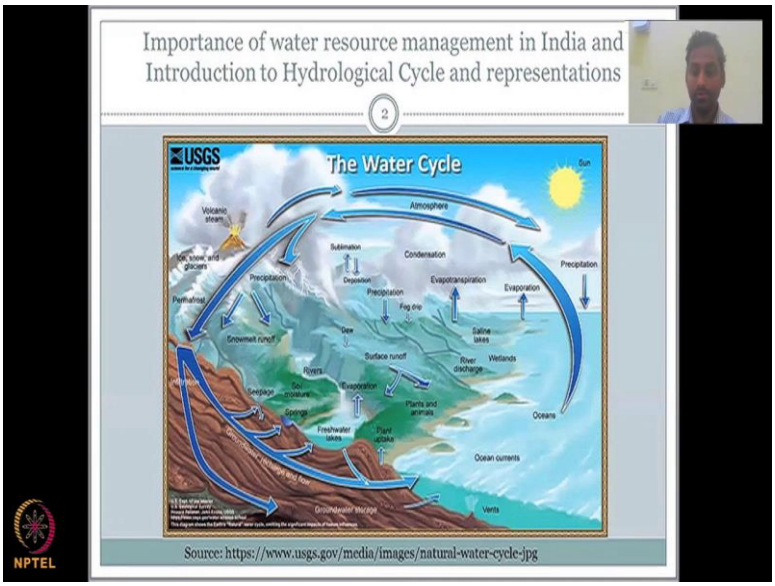

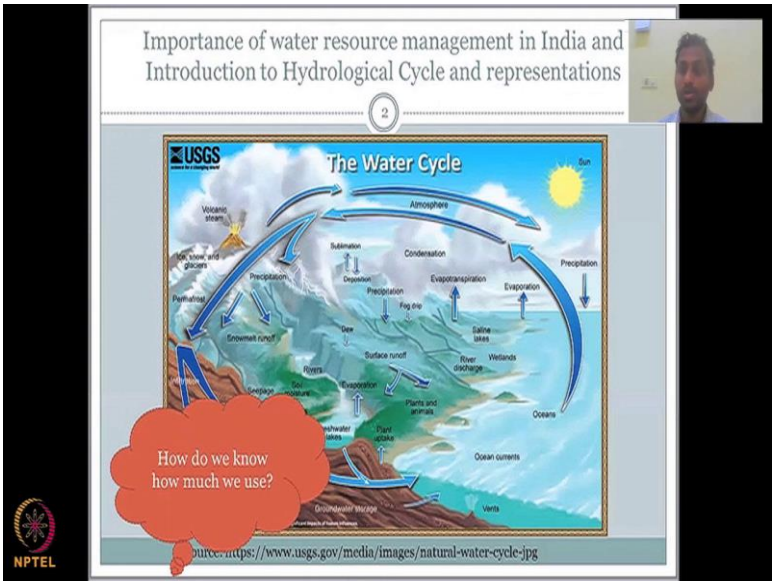

Before we start, I hope you had a chance to look at the units and how it has been used in Indian contexts. So, please go ahead and check what are the different water units because that

would be applied here in due course. So, let us look at the water cycle. And we would be, today we would be looking at per capita water use which is how much water at a domestic level we use and how much we consume in terms of relative terms of the total water available.

So, in the water cycle for rural water management, I know I said again, that there will be less emphasis on snow, snowmelt etc., but how much precipitation as rainfall occurs, which is used for the rainfall crop season and also the non-monsoon season. So, there are two important seasons monsoon and non-monsoon. So, during the monsoon, we use the precipitation water and whereas, in the non-monsoon season, we use water from storage units like dams, lakes, rivers, etc. and also from groundwater aquifers.

So, in today's lecture, we would be looking at what is the consumption in India? How do you define how much water is available? And how much of that water is segregated in different units? How do we know how much we use? First, we need to start with how much we have, and as a percentage, how much do we use.

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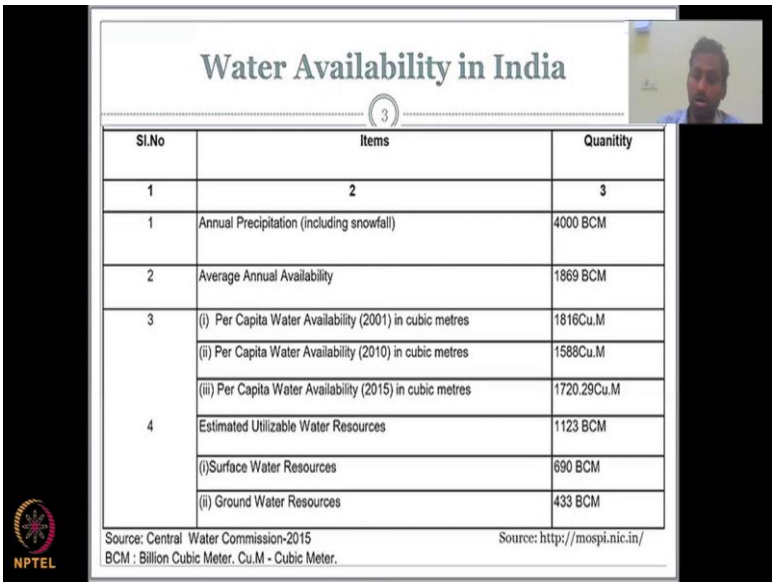

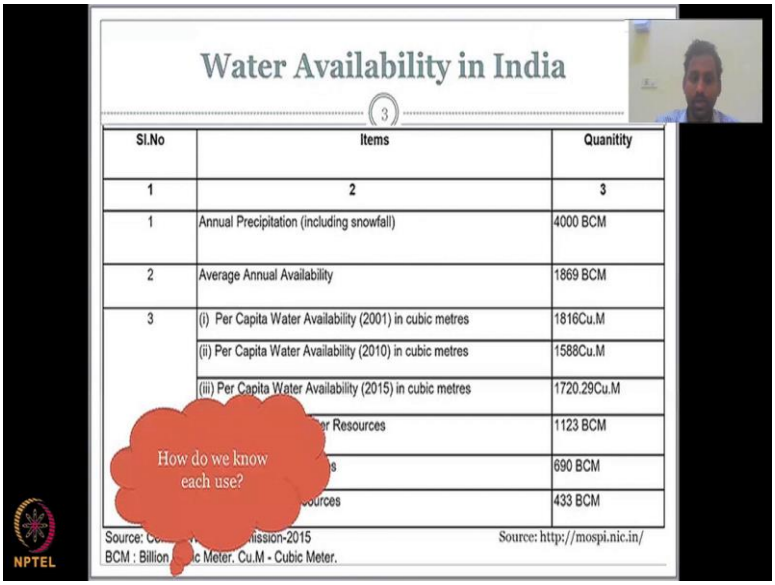

When it comes through this kind of estimates, there are you would come across different sources. So, right now, I am being using the Central Water Commission report, 2015. But you would also see Ministry of Irrigation, Water Resource Development and different, different commissions, Central Groundwater Board.

So, the different agencies that quantify water differently, the idea is they would have better data on specific units, for example, Central Water Commission would look more into the discharge units whereas IMD, which is more concentrated on weather forecasts, weather parameters, they would have better estimates of rainfall, those kinds of things. So, we would touch upon this in later part of the course, where we discuss the different agencies, how you can get data for your analysis etc.

So, let us look at water availability in India. And again, I have cited my sources, please use this source or different sources when you want to look at different components. The annual precipitation is approximately, all these are approximate numbers around 4000 BCM and BCM is billion cubic meters. So, cubic meters is meters times 3 dimensions.

So, we have meters, meter square as an area, so meter cube, cubic meters as a volume and billion. So, we cannot put that as a number. So, we just use BCM and MCM would stand Million Cubic Meters. So, at an annual average for India, we have around 4000 Billion Cubic Meters from precipitation, including snowfall, because India is a beautiful unique country, you have, in the since you have Great Himalayas, you have rainforest, everything, every different type of geological environmental setting is available.

So, if you look at precipitation and the different types, we do have snowfall, we do have just rainfall, etc. So, if you total it, it is around 4000 billion cubic meters. And the average annual availability is only 1869 billion cubic meters, which is 1869 billion cubic meters, you would see a big difference, almost 40 to 50 percent is lost.

Why is because not all rainfall is readily capturable or available for use. As I said snowfall might be locked in icecaps, so, yes snowfall is happening, but some of snowfall still remains on the Himalayas. So, that those water we have to neglect, we cannot take it as an available water. So, approximately around 40-45 percent is available and then we go to per capita water availability different estimates.

So, if you look at 2001, it was estimated as 1816 cubic meters of per capita available water. So, per capita is how much water we have per person is the per capita in cubic meters. So, in 2001 it was 1816 cubic meters; in 2010 it was 1588 came down which means the country was stressed for water to give the public, so there was a little bit decrease in amount of water available per person.

And then we have per capita water availability in cubic meters in 2015 was 1720. So, think about these numbers. So, these are annual numbers, all these are annual numbers, you could see that it fluctuates, it fluctuates depending on the precipitation, depending on how much water is available. So, not all the precipitation is available.

So, some water is locked and some water is readily available for human use and that is what the per capita tells us, every country would have its, rate we will go through that in the next couple of slides. So, estimated utilizable water resources is around 1023 billion cubic meters. So, of the 1869 billion cubic meters remember the units, the per capita is in cubic meters, not billion, because it is per person per use per year and the annual availability in billion.

So, of the available water 1023 billion cubic meters is utilizable readily and some are going in as recharge. So, you cannot use them, it is freshwater which goes into recharge, etc. So, of the utilizable, surface water resources is 690 billion cubic meters. Surface water resources include rivers, dams, lakes, ponds, storage units like tanks, etc.

Whereas groundwater resources is around 433 billion cubic meters, so you would see a slightly higher surface volume compared to the groundwater volume and that is because you have big rivers in India and a lot of structures in India compared to the groundwater

resources. And some of the groundwater when it goes into the aquifers is lost because it goes down into deeper aquifers, which is not readily available.

So, how do we know each use? So, now we have known what is the input to the system, which is your precipitation and where is segregated. Yes, surface water and groundwater. But how do we know, how we use each one of them?

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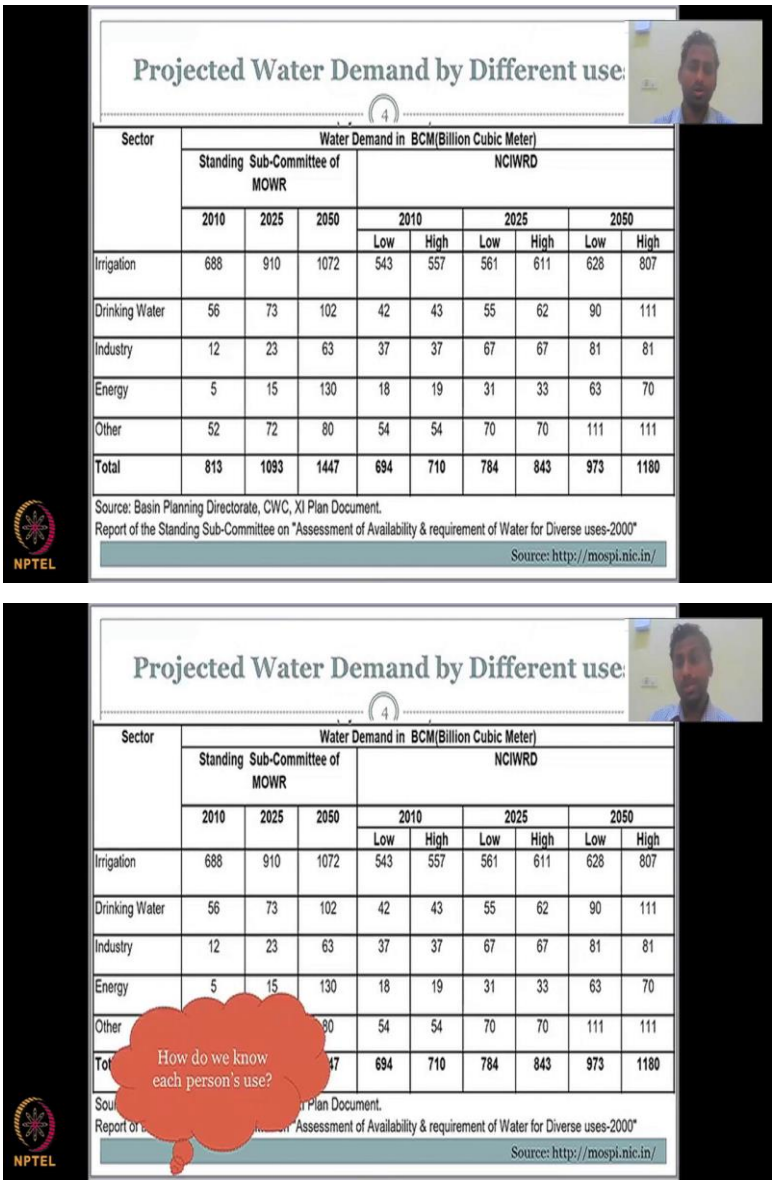

So, let us take some of the sectors that use water, air consumption compared to the other sectors. Most important, as I said is India is an agrarian nation, so we still have most of the water used for irrigation, followed by industry and drinking water. So, domestic consumption is still high, because of the population we have. So, irrigation water, agriculture waters is the top, followed by drinking water and then we have energy and industry combined together as

industry use and other uses around which would be your domestic supply in terms of washing, cleaning, those kind of things and other uses, forests, etc.

So, if you look at the sector irrigation as per the standing subcommittee of the Ministry of Water Resources, we had around it we have three estimates 2010, 2025 and 2050. And then you have another estimate from National Committee on Integrated Water Resource Development. So, there are a couple of different committees, there are a couple of different government agencies that do these estimations differently. And as I said they have different data sources, it is not the same always and that is why you see a difference in the estimates.

So, if you look at 2010, 2025, 2050; 2010 is gone. So, we could start with 2025, which is near 2021 right now 2022. And 2050 is a hypothetical estimate. So, look at irrigation, it has increased from 688, 910, 1072 billion cubic meters. And if you look at irrigation, let us just look at the high, so these are the low and high and then you can take an average.

So, low, how much low they will use minimum use and the maximum use. So, we will just take the high columns just to compare. So, you will see that 557, 611, 807; so, it is increasing. So, both the estimates are telling that the irrigation water consumption would increase by 2050.

The drinking water consumption also is steadily increasing 56, 73, 102; 43, 62, 111, which also tells us that the domestic consumption of water is also increasing, it could be because of the population increase, it could be because of better lifestyle people do have better access, so the drinking access and water is increasing.

Then you have industry sector which is booming in India, so 12, 23, 63; so see the jump between the years and then 37, 67, 81. So, there is no high low for industry, because it is a standard rate, they, so they just put that rate. Energy, how much water is used in the energy sector, it could be cooling your thermal power plants, it could be your hydropower, all the energy components.

So, you see that it is steadily increasing because both irrigation is increasing, the consumption of energy is going to increase in the future. So, all the estimates show that it is going to increase 19, 33, 70. So, we do need more water for energy. In other allied sectors also would increase 80, 70, 111. So, what this shows us is just let us look at the totals. So, you will see the totals that from 813, it increases 193 billion cubic meters and then 1447 billion cubic meters.

Let us just focus on Ministry of Water Resources, you could see that it is tremendously increasing and precipitation, annual precipitation is going to be the same. So, what does that mean? If your input into a system is going to be almost the same, to be honest, it is decreasing. So, still, let us say it is the same, but your consumption is going very, very high.

So, which means there is going to be tremendous stress on the water resources and this is where we need to have a better water management plan. When you come to the differences of sectors, you could see that, you could do a lot of interventions in drinking water industry, energy, but it will be miniscule, very small compared to your total. Why? Because the total is driven by irrigation water demand. So, of 1447, 1000 liters, 1000 billion cubic meters is used for irrigation.

So, you need to conserve water more in the irrigation sector and then irrigation is in the rural regions. So, that is why this course is focusing mostly on rural water resource management. Feel free to look at the sources and how they estimated, but basically, they know how much area they have, what type of crops they have. So, that is how they estimate these volumes in the industries etc.

How do they know what industries come? They have a trajectory. So, we have car industries in 10 years, we would have another one more car industry, something like that, but irrigation is almost on the ballpark, which is the biggest user of water. So, as I said they estimated by looking at what area we have and what type of crops we have, but how do we understand how much water we consume? This is a very important parameter for the National Rural Drinking Water Program.

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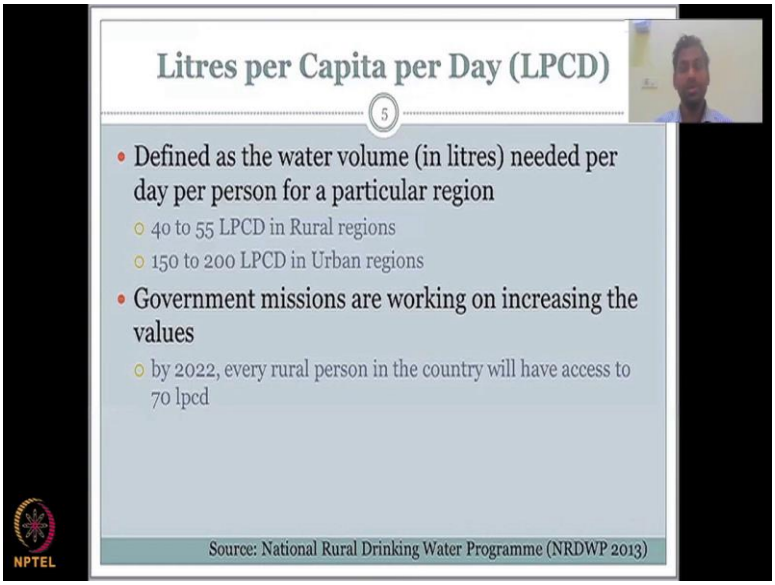

So, they have estimates, it is called liters per capita per day, you can convert it into per year also. So, it is defined as the water volume in liters needed per day per person for a particular region. But what types of regions? Most importantly rural regions and urban regions. And rural gets anywhere from 40 to 70 to 55, LPCD; on paper, it is around 55. But the actual rates might be different.

And then for urban regions, it is anywhere from 150 to 200, LPCD, urban regions get more water, it is not that they are going to drink more water. But because of their lifestyle, because of the sanitation systems they have, for example, drainage; they need to supply that much water to push the drainage. So, they have flush toilets, they would have more access to water for cleaning.

So, those kinds of things are expected higher in an urban region. And that is why you would see a higher water use rate in urban regions. Let us just focus on the rural, so the government missions are working tremendously hard on increasing these values, because there is a big disparity, you have 55 liters per day per person in a village, where it is almost four times; four times that in an urban setting. So, the liters they drink, it is almost 8 liters per day.

So, it is not a big consumption difference as drinking but the water they use for cleansing, toilets and then other recreational activities, washing the cars, etc., is high in urban beaches. And because of that, the pressure on water resource management is high. So, there has to be some, you know, normalization of these rates. So, the government missions are working hard to increase the standard of rural livelihoods, rural people by giving them more access to

water. And they promised to give around 70 liters per capita per day according to the National Rural Drinking Water Programs.

There are multiple programs and multiple subsections in the programs, which aim to give depending on the location, because you cannot give 70, expect to give 70 liters per day in a desert region, it is so costly. So, in other rural regions, like for example, Northeast where there is good rainfall, you would expect higher LPCD. So, but across India, at least the bare minimum, the Indian government wants to give 70 liters per day.

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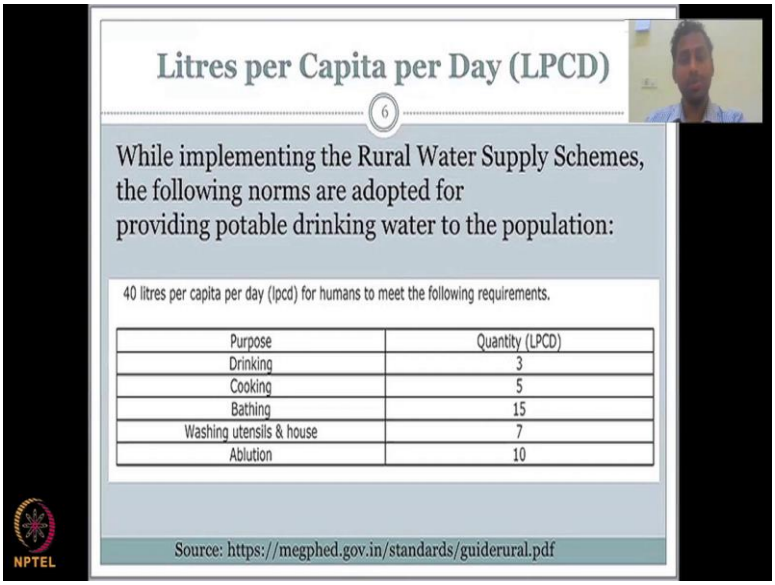

While implementing rural water schemes, the following norms are adopted for providing potable drinking water to the population is good quality drinking water and water use, so in freshwater. So, what are the norms at least again, this goes to the minimum so 40 liters I mentioned in the previous slide. So, at least 14 liters and how is that 40 liters broken up? So, for drinking it is at least 3 liters per day per person and study say around 6 to 8 liters, so okay it is still good.

Cooking around 5 liters, bathing 15 liters, washing utensils and house is around 7 liters This is the interior of the house and cooking vessels you wash and ablution is washing yourself in terms of clothes, cleaning, etc., is around 10 liters. So, you see that there is considerable water use in different sections when they propose this, 40 liters per day. So, this is how the 40 liters a day assign a number, this is how they give where would you put the water.

Here you do not see any car washing or gardens because that is more in the urban city. So, that is where you know the higher quality of life, demands are higher water availability or supply. So, here the 40 liters per day is set. And this is how it is being broken up.

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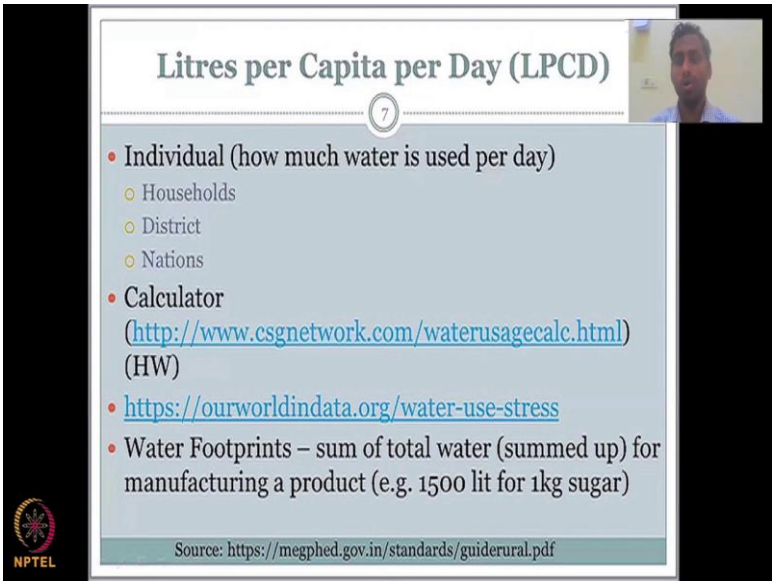

Let us look into more definitions, individuals how much water is used per day, you can calculate it at a household level. So, in a house if there are 4 people, how much water do they use per day and those averages can be used to calculate the district average and the district average is used to calculate the nation's average. So, this is how you get a norm of how much water is being used at a district, state, national level.

There are multiple calculators, so those who are interested after this lecture can use it. I want to see how much water I use, because for meters, for a city, you do have a meter at home. And every day, I do not know how many of you look at it, you could look at how many units you used per day, maybe you used your AC, maybe you used to watch TV the whole day for cricket match. So, you could go back and see how much units you can use.

But for water it is not like that, because metering is still a very new concept in conservation of water in India. So, metering is very less as especially in rural areas. So, what you could do is you could use these kinds of calculators, so if you just go and click there, you go to a calculator supplied by some open source people.

They would give you, they will ask you to put in how much water did you drink today? How many vessels did you clean? And those kinds of questions, how many times did you take bath, just one time, two times etc.? So, these kinds of data you could put into these

calculators and get back the total water used per day. And in that if you divide by the number of household people, you will get the liters per capita per day, then you go back to these calculations, household, district, nations etc.

So, what is the water footprint? Now, you know how much people use but what is a water footprint is the sum of total water of all the components that are used for manufacturing a product. So, if you take sugar cane or sugar, for example, for making 1 kilogram of sugar, how much water do I use? It is astonishing that you use 1500 liters for 1 kilogram of sugar. That is, so where is the summing comes?

When I say sum, it is the total water used from the cropping stage, how much water you applied for a crop to the processing stage where you convert sugar cane into sugar and then cleaning stage. So, all this water, how much water you used for irrigation, how much water you used for taking the molasses and sugar out of the sugarcane and then converting and washing the sugar into the table format you get at home? So, it is around 1500 liters for 1 kilogram of sugar. So, it is a tremendously water consuming product.

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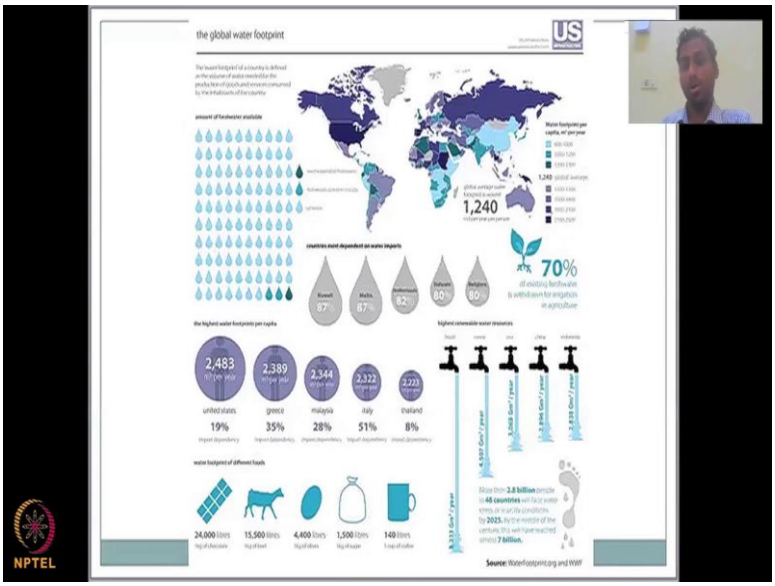

Let us look at now we know the rates, what LPCDs we have. And we also know how much the, what is the water footprint, which means how much water does a product take. So, let us look at the world averages, if you look at the world, India is around 600 to 1000 cubic meters per year and, the boundaries are not the proprietary of the author, which is me, these maps are made by international agencies, which also give funds to India like wwf and programs, not funds but programs to India. So, it is not the view of the authors.

Because it is a small map, some boundaries might have been changed. So, if you look at the water consumption per capita per day per year, you see India's around 600 to 1000 or 1000, 1200. And that is the same numbers we looked at in the previous government of India slides. But if you look at the developed nations like US, Europe, etc., you get around 2000, 2100.

So, the world average is 1240 and we are below the average; 1000, 1200. So, India water consumption domestic water consumption is below the world average that could be because of the higher population we have because we are very high on the population and also the low number of precipitation volumes that we get compared to other places. So, we still need to improve. So, where we need to improve is better water conservation technologies, better use of water.

So, the other thing that is more important is renewable water resources. India does not have that many renewable water resources, whereas Brazil, Russia have a lot of water resources, even though they have a higher per capita per year, they do have higher renewable resources. And countries that are most dependent on water inputs, these countries mostly the Middle West, Middle East countries, and if you look at the highest water footprint per capita, per capita rates, look at the US 2483-meter cube per year per person.

They do have some inputs, but still they have a very high quality of life and living standards. So, they have a lot of water consumption. And Malaysia is also, in the Asian countries Malaysia is ranking top 2344-meter cube per year per person. And 28 percent is dependent on other countries, but still they do have good rate for.

So, on the whole, this graph tells you that India's water per person is pretty low compared to the global average of 1240. And when you compare to developed nations, it is almost double, the developed nations have double the water per person, whereas compared to India. So that is the water, that you have for drinking that is the water you have for cleaning yourself, sanitation.

So, when you want to improve the lifestyle, the livelihoods and cleanliness, you need to give more water. So, that is where this number comes. And we also looked at water footprints. And water footprints of different food products as I said sugar takes 1500 liters, but also chocolate, eggs, olives, everything takes a lot of water.

So, even for a cup of coffee, one cup of coffee, which is around 200 milliliters, you would take 140 liters of water and that includes your sugar, the water that comes from your cow like

the milk and everything else that goes to the coffee beans etc. So, please understand that what you consume is also, there is a water footprint on it that each product and if you go to this website, you can get much more details on other products like bread, wheat, rice, how much they consume per kilogram.

So, this is where we need to conserve the water because most of these products are made, are developed in the rural region. And we need to improve that and already our water per capita is pretty low, so we need to improve that.

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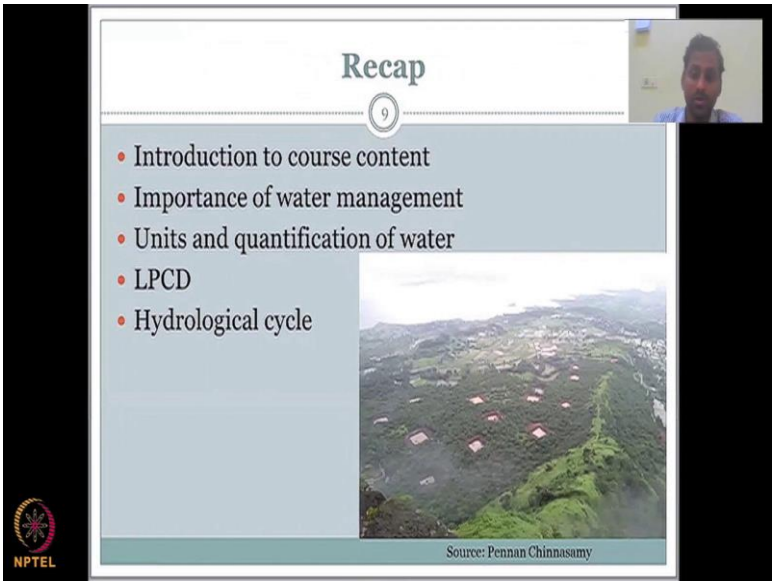

So, how do you do it? By better water management. So, that is where the introduction of the course content has come. And we have stressed on the fact that there is a need for water management. The first week is to get all of you sensitized, why do we need this water management and especially for rural resources, rural regions?

We also looked at the units very, very carefully that you need to look at units before you jump into conservation and liters per capita per day per year or for per unit. So, we have looked at how much liters per capita per person is being consumed at a daily rate which is around 40 to 70 percent in a rural village and per year is around 1000 which is much, much lesser compared to that of a developed nation.

We looked into some components of hydrological cycle today. And we would jump into more or more focused discussions on rural water management stream. The next weeks may be looking at these hydrological cycle components with a rural focus. I would like to conclude today's lecture and hope to see you in the next lecture. Thank you. Bye-bye.