Groundwater Hydrology and Management
Professor Pennan Chinnasamy
Indian Institute of Technology, Bombay
Lecture:02
Groundwater Quality Data

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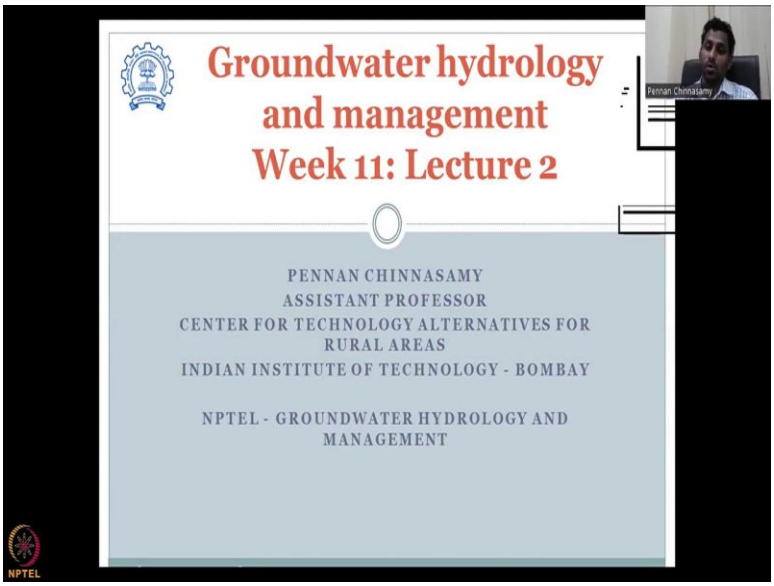

Hello everyone, welcome to Groundwater hydrology and management, NPTEL course, week 11, lecture 2. In this week, we have been looking at data sources for understanding groundwater and properly managing it across India. We looked at the basic concepts and we have been looking at the most important data for groundwater management. And now we are almost at the end looking at groundwater quality.

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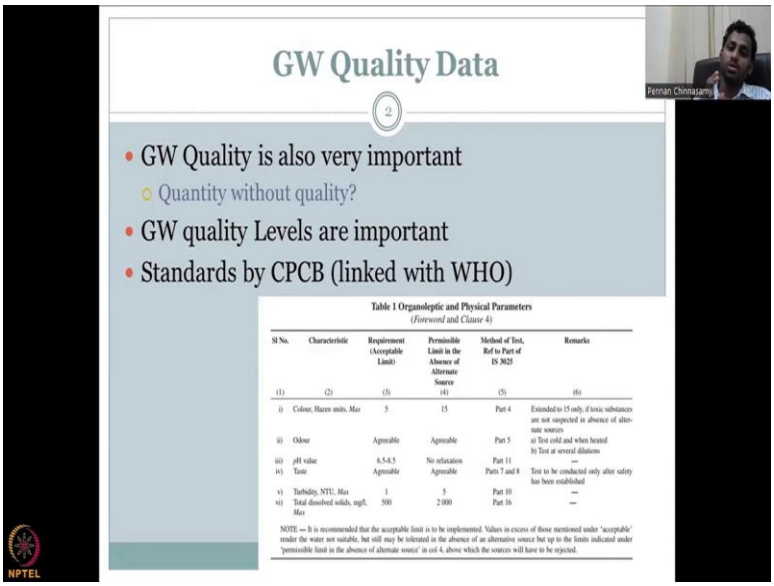

So, what is groundwater quality so important, in groundwater management? Let us first take a step back, because while I was explaining the groundwater, hydrology, the parameters, how it recharges, percolation, etcetera. Since then I used the word groundwater quality. This course is aimed at getting you through the Groundwater management assuming the groundwater quality is good. However, that is not always the case.

Rainwater if it has been collected and filtered and pushed into the groundwater, not much issues will be happening for the quality. However, while the rainwater is collected, and while it is recharging, there are pollutants are also moving along with the water, which can go inside the groundwater and impact the quality. So, it is important to understand why these quality issues are there and what are the data to manage it properly.

For now, the physics, the chemistry will not be taught because we are almost at the end of the NPTEL course, I will talk about why groundwater quality is important. I will show you some slides on the data as per government and then we will jump into particular data across India. So, groundwater quality is also very important as I mentioned, what do you do with quantity without quality? So, this question I always ask students, if you have groundwater and you assume you say that groundwater is present, but if the quality is bad, bad as in not consumable, not potable, cannot be used for industries drinking, bathing and or agriculture.

One example would be a saline aquifer where the water is very salty, it cannot be used for most of anything. See, your aquifer is not like a bottle where water does not go inside the other contaminants etcetera. Other interactions also go and that is why it is important to understand the geology which we have done the past lectures and understand the groundwater quality. So what do you do with quantity without quality? For example, I have 10 million cubic meters of groundwater aquifer recharge and full, but if it is not good, you cannot use it.

It is the same as surface water, you have a dam but if the dam water is polluted, all the fish are dying, lakes if the lakes are polluted, the fish are dying, people do not use the water, the water is black in color those kinds of things. So always remember that when we say improve the quantity, indirectly the quality is also should be good. The quality is not good and you are just recharging, then it is not of good use.

This has happened in many, many cities across India, when they started to do groundwater, rainwater harvesting and recharge activities. They forgot to make sure that the quality is not compromised. The quality is compromised, it is not usable. Why? Studies show that groundwater qualities impact the human health. the industry instruments, the livelihood, options of livestock, and also the agricultural productivity. If you use bad quality groundwater. Your standards are always set by CPCB which is a central pollution control board.

So which is getting references from the WHO standards, World Health Organization standards. So, there are standards for water quality and specific standards for groundwater quality. There is a resource by the ISO the Indian standard organization standards, where it gives you all these data which tells you at what level it is acceptable to use the groundwater. Let us take for example, table 1 in the book by CPCB, you would see that the color Hazen units, Max everything has to be at an acceptable limit of 5, the orders should be agreeable, the pH value should be 6.5 to 8.5 which is neutral almost it should not be too acidic or too base. If it is like that, then you cannot have good water for drinking.

So, then the Taste, Turbidity etcetera, all these are measures, physical measures the turbidity how much sediment is mixed in the total dissolved solids which is measured by milligram per liter, all these are done at a lab scale. So, the physical parameters that I, we were looking at the groundwater aquifer properties, the water level rainfall etcetera are measured by an instrument in

the field. However, groundwater quality mostly you have to take the sample back to the lab analyze it and then give the results. Thereby there is some lag time, a lot of costs involved transportation lab etcetera. That is where you will see less water quality data than water quality data. However, as I was mentioning, it is very important to understand the groundwater quality importance.

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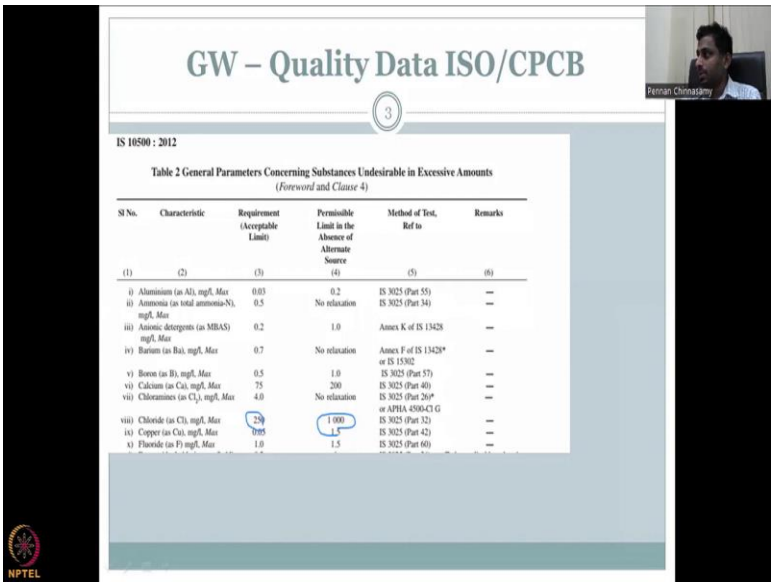

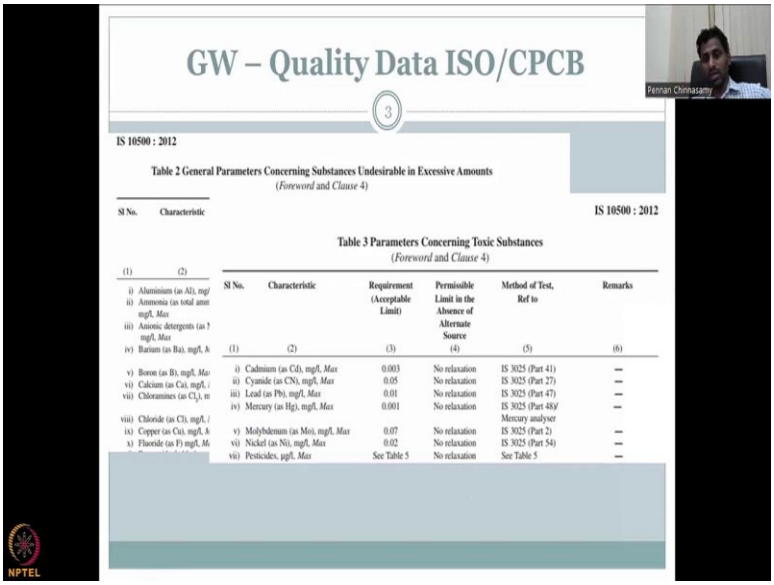

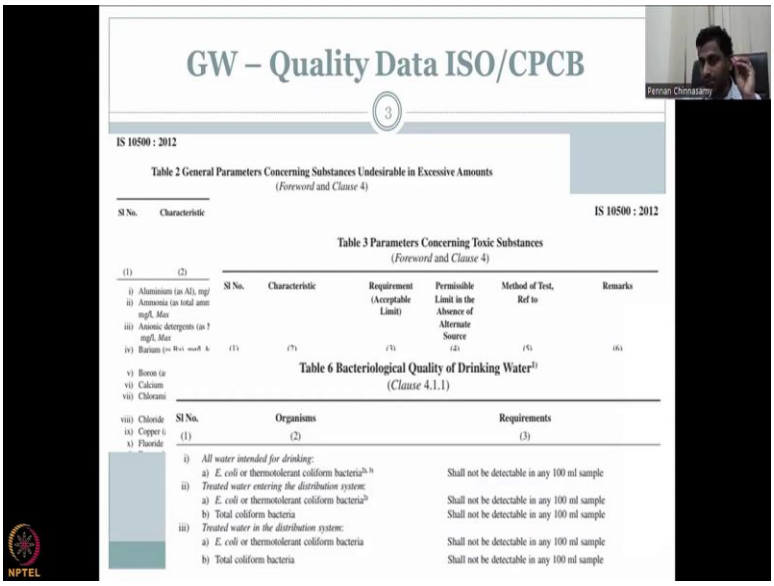

Let us look at some more of the ISO standards. So, the standards are given here 2012, even linked here and the data is taken from CPCB, where you could see that multiple tables are there in this document. What we could see that is that these are the characteristics or the parameter they want to test. Let us take chloride for example, your chloride milligram per liter should be around 250 as an acceptable limit. If there is no other water resource, that is what this is saying. chloride is actually sometimes they added it to clean the water in urban systems, the pipes etcetera, but the pipes get clogged with chlorine or chloride. You smell chlorine water in swimming pool. So all these are not acceptable after a level.

So 250 is the best case here as you see. If you go above 250 then what you should do is for example here if you go about 250 You can go up 1000. So 250 is normally the WHO standard, where all the countries of the world developed, under developed, everyone follow. Let us say European standards are 250 and then Indian standards, what they are saying is upto 1000 it is okay, if you do have any other water resource, like that they have given other relaxations, they are very strict on some parameters, which are very very harmful for human health, like ammonia here, no relaxation is given aluminum they are okay. barium, no relaxation is given. Boron some relaxation etcetera etcetera.

Let us look at fluoride. See fluoride is something which is causing lot of trouble with the groundwater because when you drink it, your bones get dissolved. Think about fluoride in your toothpaste. Why does it make your teeth look bright? Because it cleans part of the top surface out

fluoride, chlorine salt sodium etcetera. But fluoride is mostly used. So what is fluoride do is, it slowly takes a part of your top surface out like it is like acid you use for cleaning the rust.

Some part of the acid also eats the metal. So you have to be very careful, when you drink fluoride enriched water, your bone density will deplete and that is a big big issue in Rajasthan Gujarat belt where geochemically it is mixed in water which is the natural contaminant, the rock releases fluoride, and when people drink it, their bones get really low in density, and as a result, they got more fractures, they fall down there, they cannot do heavy duty work as others can do.

So these are still they are giving some realizations 1.5 as per the test, what tests they should be using etcetera. So like this there are multiple multiple parameters, you should just check CPCB website and say water quality standards, you will get all these water quality parameters and they are very important to understand the quality of the groundwater.

So, one more table I will look at is the concerning toxic substances like cadmium, cyanide, lead, these are mixed in the water because of the industrial pollutants, pesticides is from your fertilizers, so there is no relaxation at all, because these are potentially life threatening chemicals that are mixed in the water. So if you find this cyanide, cadmium, lead, you should not be given any relaxations for groundwater just close it, do not use it. But however, as I said, not a lot of people know how much of these are present. So, they eventually drink it and then go to the doctors, if they have problem then they find out this cyanide pollution in the water.

And then this is the bacterial content. So now we are slowly coming from geogenic to industry, now the bacteria, the bacterial mixes because of a leaky sewage system, open defecation, animals defecating in the wild. So all these have traces of chemicals and biological by bacterial contamination in the water, it is purely for drinking water, but then the water, the wells that you use for drinking should not have a place.

For example, if your groundwater well is right next to a sewer channel, or your polluted waterways like among the Yamuna, then water can move into the groundwater while you pump it, and then you will be drinking it unknowingly. These you cannot see by eyes or by color, these are not physical parameters. So you need to test it.

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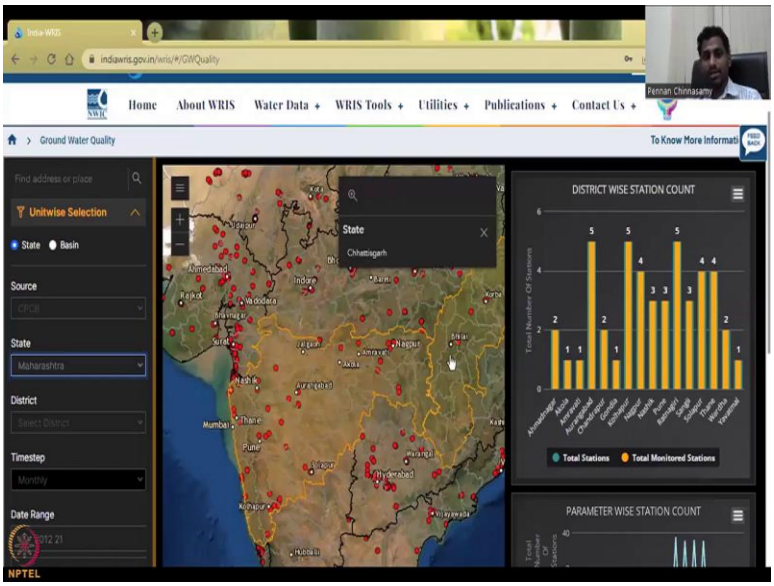

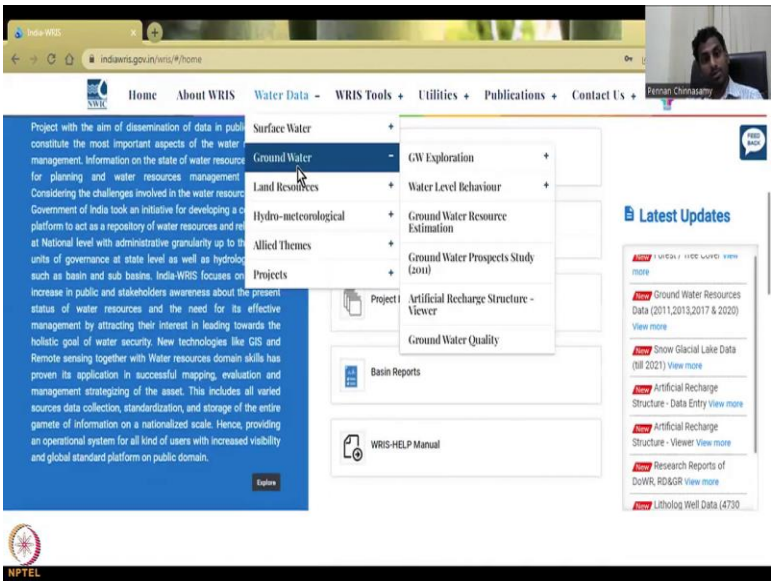

And that is where the data that I am going to show next is going to be having a lot of understanding for groundwater quality. It is taken from the WRIS website, I will walk you through because of the number of data that goes in. It does take some time, but let us see how much it does when we open it. So I will continue the lecture on understanding the water quality parameters. So how do I get here? I go to home, so from the homepage, you go to water data, and still we are the groundwater, this is a groundwater course. So we are only focusing on the groundwater parameters.

And the last parameter is groundwater quality. There are multiple agencies that collect data. One is your major contributor, major role player is the CPCB, central pollution control board. So they

are the agencies that are responsible for collecting these data, they have the labs, and they populate these databases on the WRIS system.

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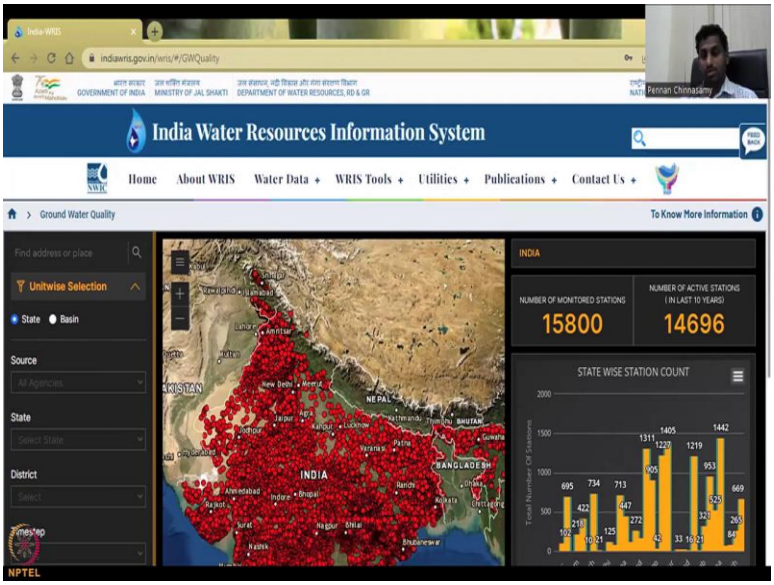

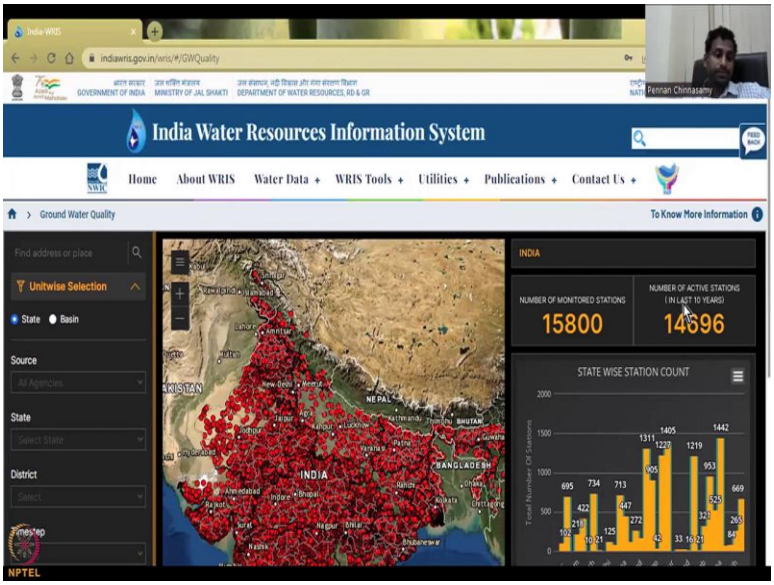

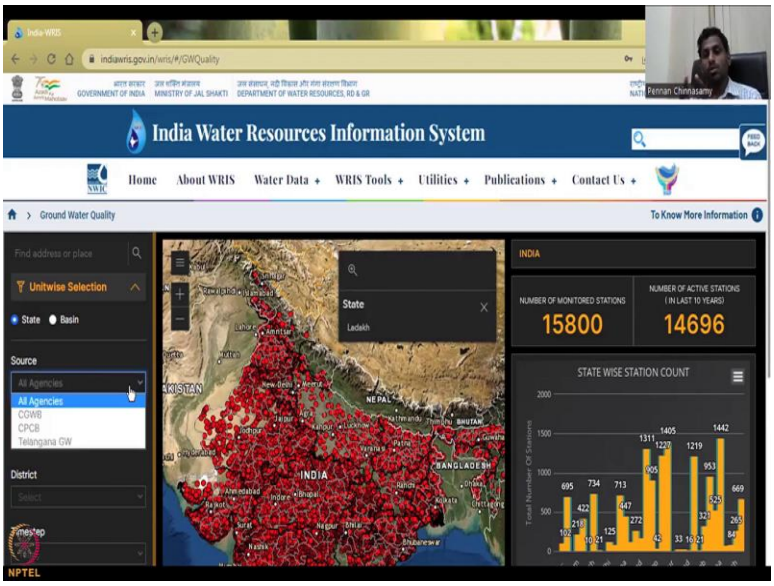

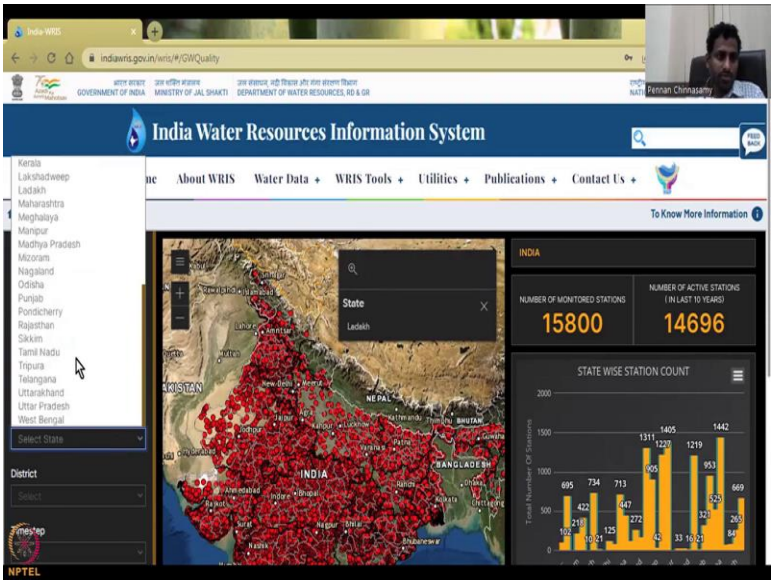

So now you see all the number of monitoring stations across India, in red. around 15,800 stations. However, the active ones are only around 14,600 stations that you see here. Similar to the other website data that we have looked at, you can actually go by state boundaries or basin boundaries, we will go at state boundaries to look at how data is collected, let us say state and then when you look at source, so, here is where I said not many are allowed to even test it because some of these labs need sophisticated instruments, which are only hosted by a government institution.

So for example, CGWB, central groundwater board might have some locations, but eventually they will collect the sample and give it to CPCB because they have better labs. And then the

other Telangana groundwater board, which also collects data so let us look at all just for case, all agencies and select a state I am going to go into Maharashtra why because it may have a lot of sample locations and capturing all of this might take some time.

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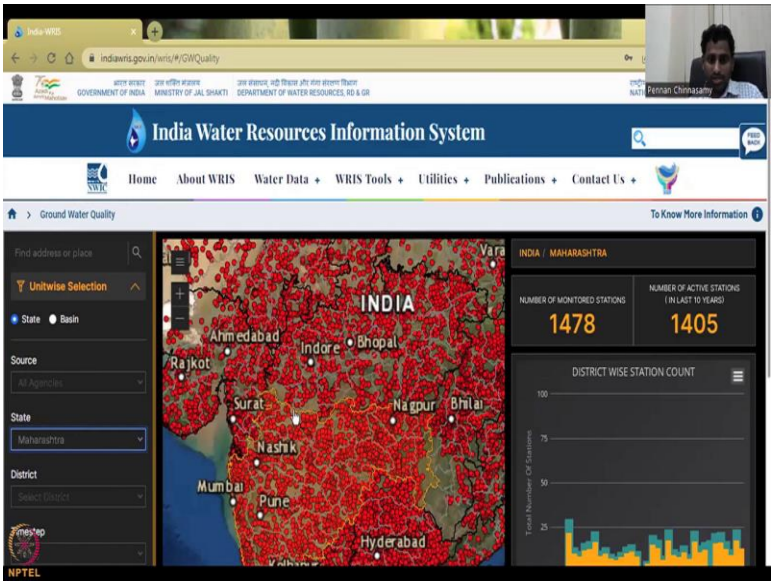

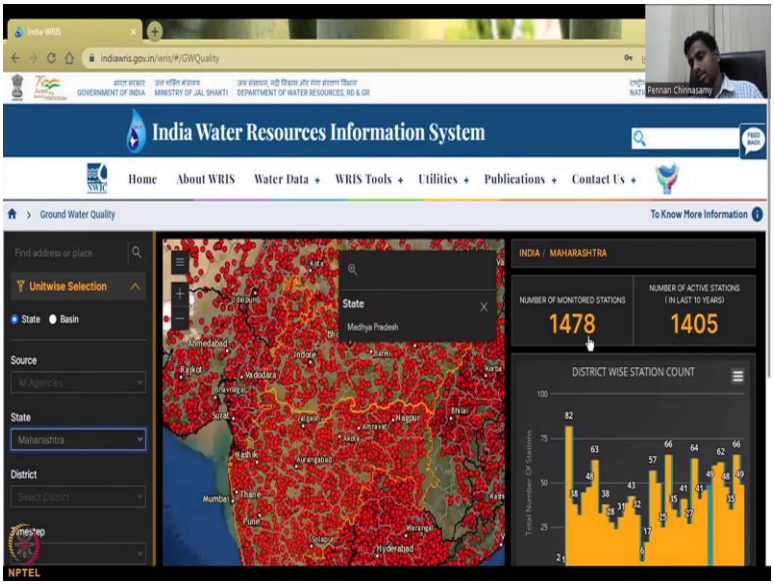

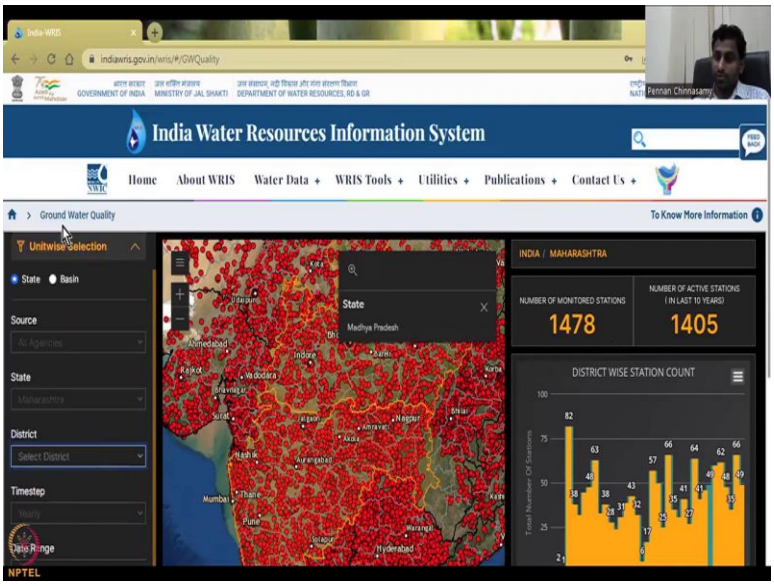

So here we are, Maharashtra is now in yellow. So once this populates then the total number we populate the state, then the total number of your location stations also get adjusted. So here we have 1400 locations. So almost 10 percent are in Maharashtra and around for same number, you could say that is available in your active in the last 10 years. So they are very good in maintaining that the last 10 years how much data is coming, we can select a district.

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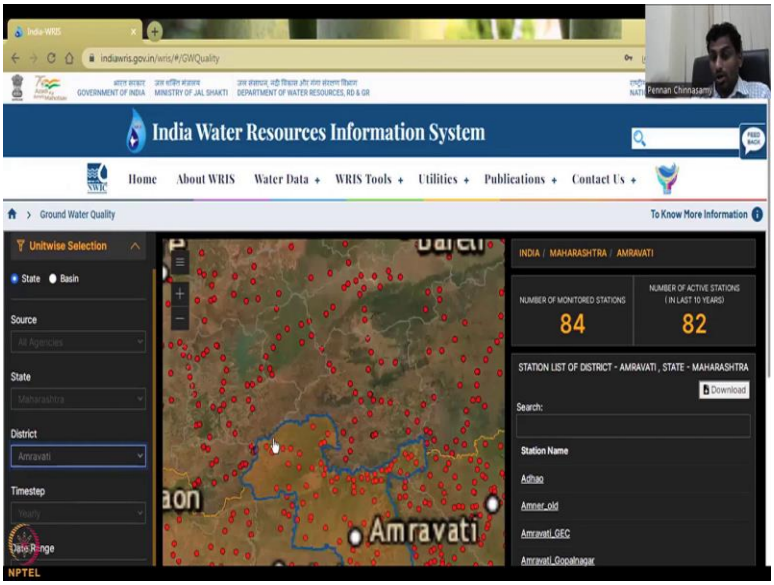

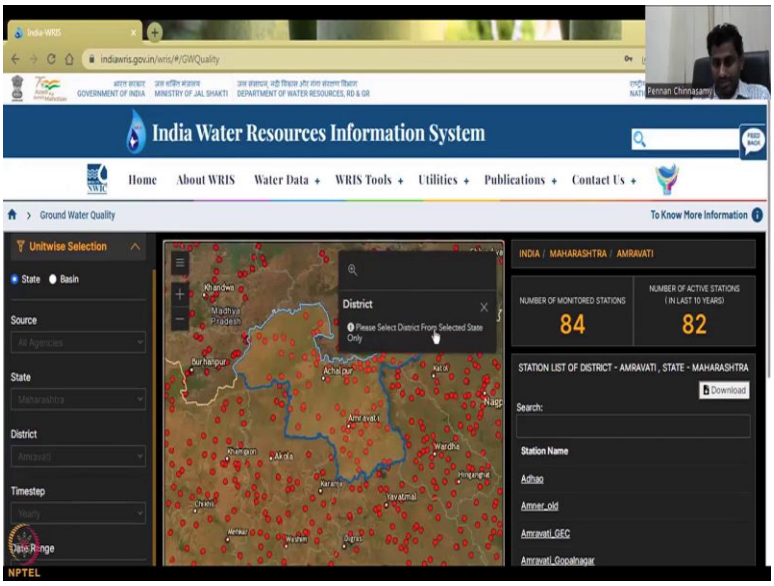
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NUMBER OF MONITORED STATIONS
84
NUMBER OF ACTIVE STATIONS (IN LAST 10 YEARS)
82
STATION LIST OF DISTRICT - AMRAVATI , STATE - MAHARASHTRA
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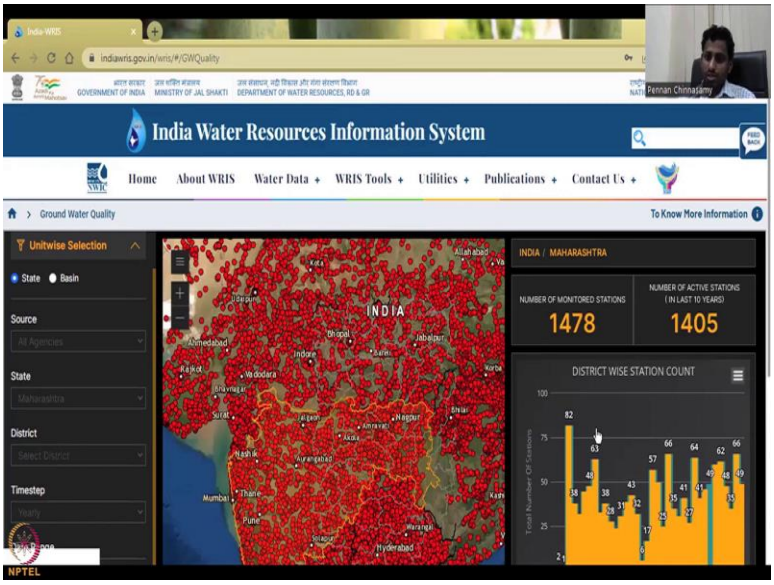
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INDIA / MAHARASHTRA
NUMBER OF MONITORED STATIONS
1478
NUMBER OF ACTIVE STATIONS (IN LAST 10 YEARS)
1405
DISTRICT WISE STATION COUNT
Total Number Of Stations
NPTEL


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INDIA
Ground Water Stations
XY 79.153846°, 21.162396°
NUMBER OF MONITORED STATIONS
1478
1405
DISTRICT WISE STATION COUNT
Total Number Of Stations
Total Stations
Total Monitored Stations
PARAMETER WISE STATION COUNT
Total Number Of Stations
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District
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User Manual
INDIA
Ground Water Stations
XY 79.153846°, 21.162396°
NUMBER OF MONITORED STATIONS
1478
1405
DISTRICT WISE STATION COUNT
District : Amravati
Total Stations : 82 Stations
Total Monitored Stations : 82 Stations
Total Percentage : 100.0%
Total Number Of Stations
Total Stations
Total Monitored Stations
PARAMETER WISE STATION COUNT
Total Number Of Stations
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FEED BACK
NPTEL

So we have been looking at Amaravati for the groundwater levels. So let us take Amravati again. So these are the dots, the dot you see on the map are the number of wells, so all locations where, they take our groundwater sample, it is a groundwater not surface water, not the river water so you do not see a river channel or something. It is the groundwater they take a sample and they analyze the results. So before that, I will just take one step back. So if you want to go one step back, you can just click here, India, Maharashtra.

So you can see here district wise count. So, I am just pulling down this table, you can see number of stations per district. So actually from here, you can see that Aurangabad has the most number of stations, clubbed together, and then you could zoom into that monitored stations and total number of stations. Then you here see, the total number of stations that are monitoring these parameters. So pH is very important.

As I said, it is a physical parameter, you can take an instrument and then put it and measure what the values are. So, the other one you would want to see is your temperature, because too much temperature can lead to chemical reactions, which can release more water or polluted water etcetera. Then you have the electrical conductivity measure, TDS sodium absorption nitrate from your leaching from your fertilizers and other things. So how these are coming the physics, the chemistry, I will not teach because again, as I said, you need at least a half a lecture not a separate corse for groundwater quality and chemistry.

Here we are just going to say that, groundwater quantity is important, we need to recharge, we need to use it sustainably but also the quality has not to be compromised. And for that we are going to look at these stations. So again, we are going to go to Amravati. These numbers might be different when you zoom in more.

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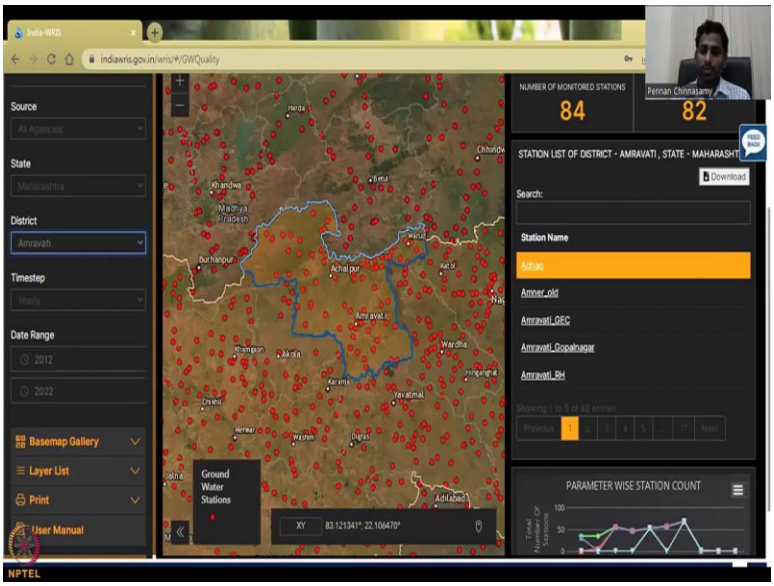

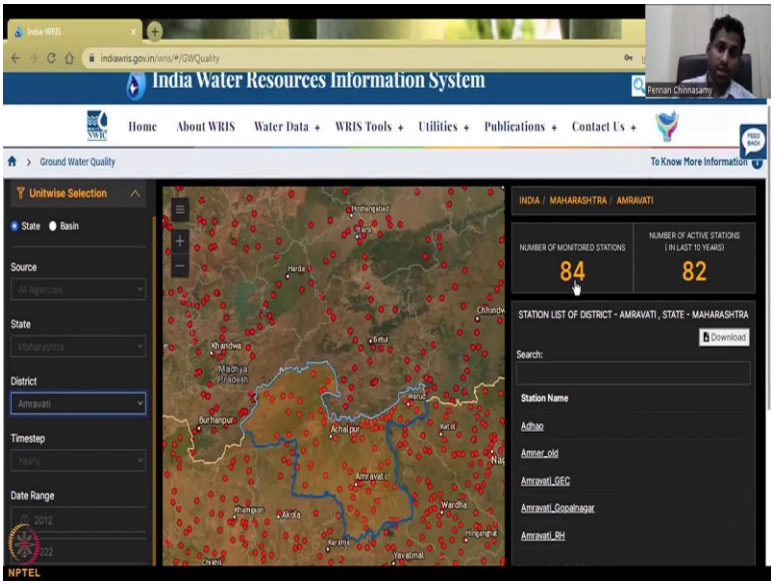

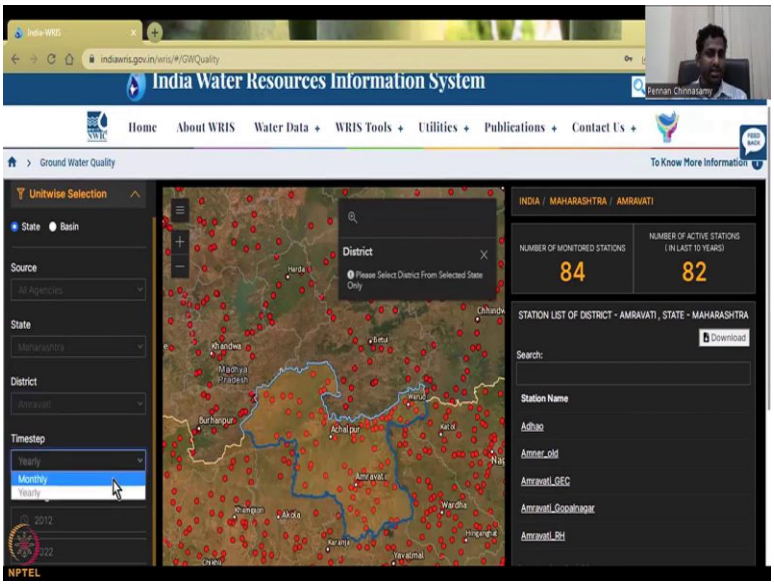
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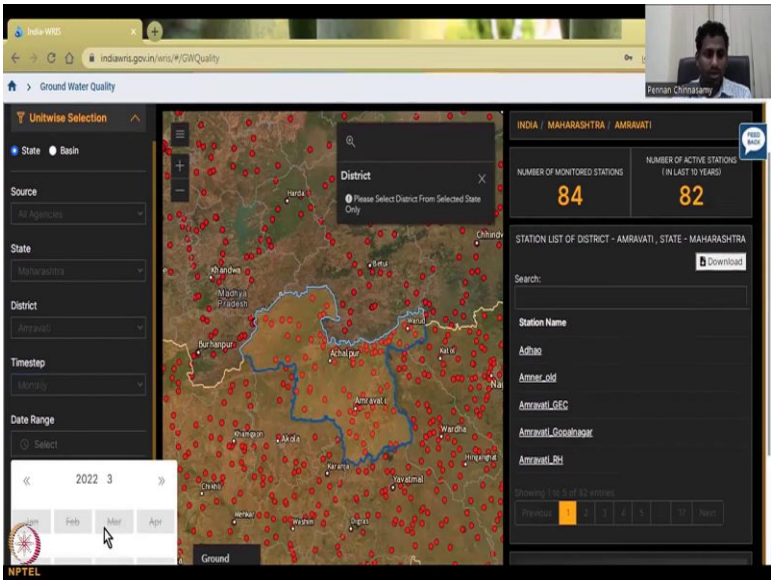
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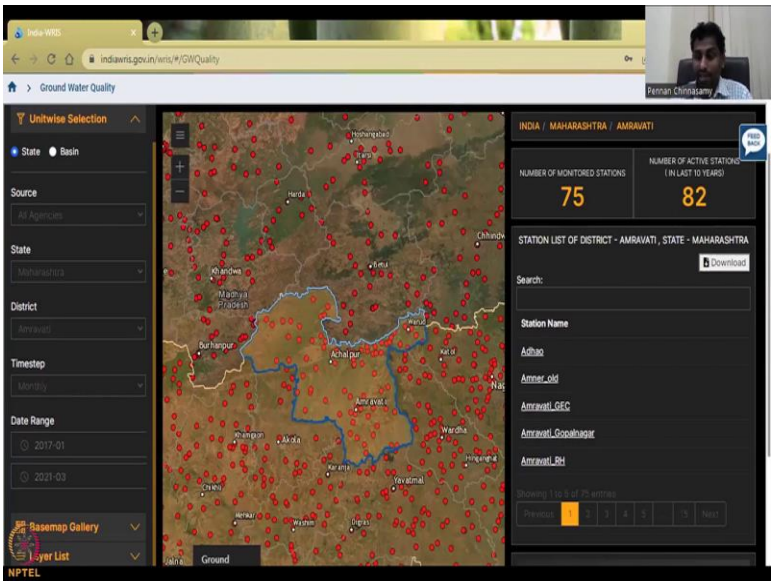

So, in 1000 in 1400 stations across Maharashtra 84 are located in Amaravati. That is what it comes here. And then what do you do is you have yearly or monthly. See most of this data is started yearly, because they would assume that the water quality does not change every month. But let us click monthly just for case if we if you want to see and then we are going to select a date from when to when, you see there is a dash mark, the dash mark means there is no data in that period.

So you cannot collect data. So let us go back to 2018 17 Jan to 2022, there is no data for this year. So now we are in March, but there is no data collected, we can go to the last year March. So there is almost a year lagging in the data. So I have clicked it. And you could see that the same base map, gallery, etcetera.

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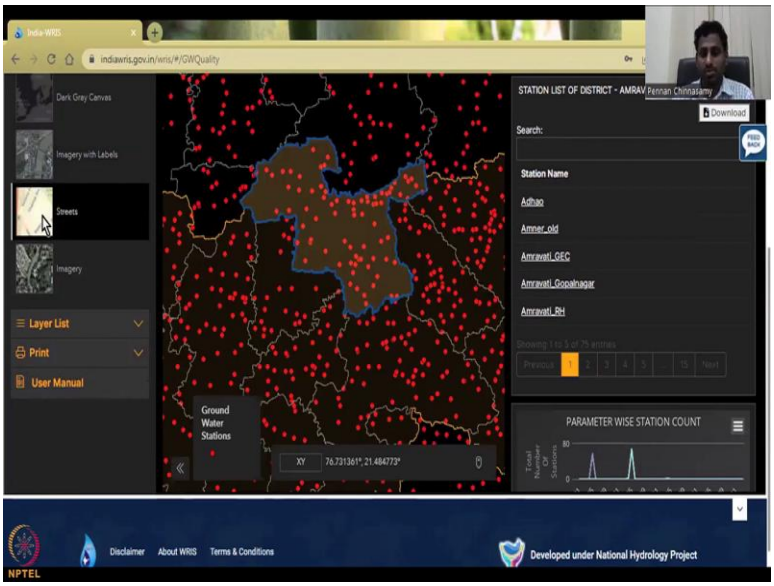

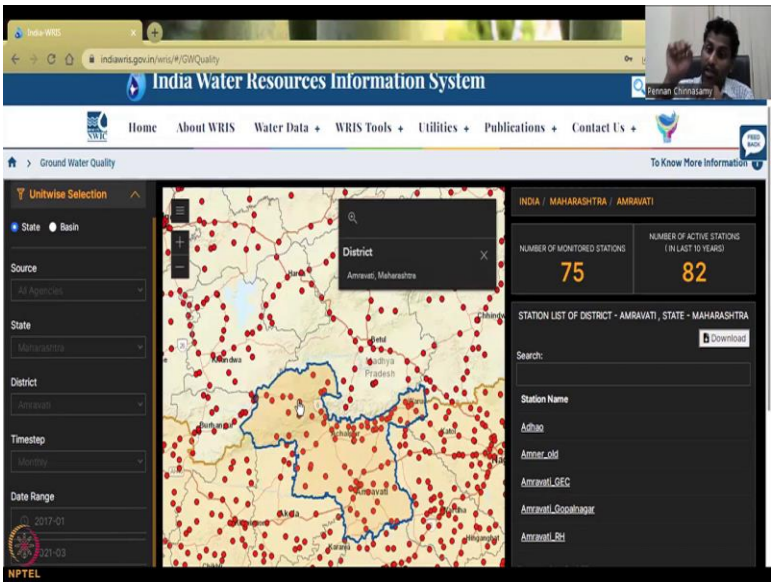

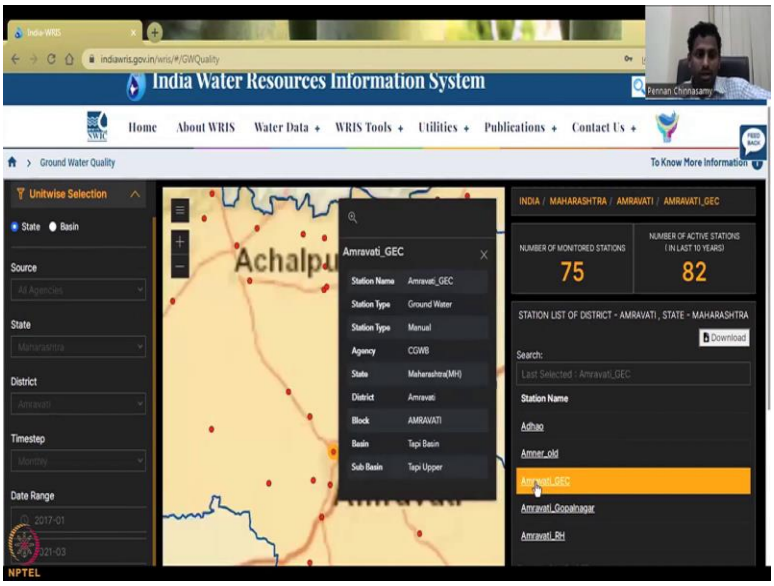

So if you have internet issues, as I said, you can put your street map, I am going to use it just to quickly save the bandwidth for the class and then you have the unit wise selected here. So now you can select each station either by clicking on the dot, if you know, the location or the station name. Let us say Amravati groundwater estimation committee, well I want to do and it zooms into that well you can see that this is the Amravati sea, so I just clicked it and then this has come, so what it tells you is it is the groundwater station.

It is a manual station which means manually they take a sample out not telemetry where you have an instrument which gives the data in regular intervals.

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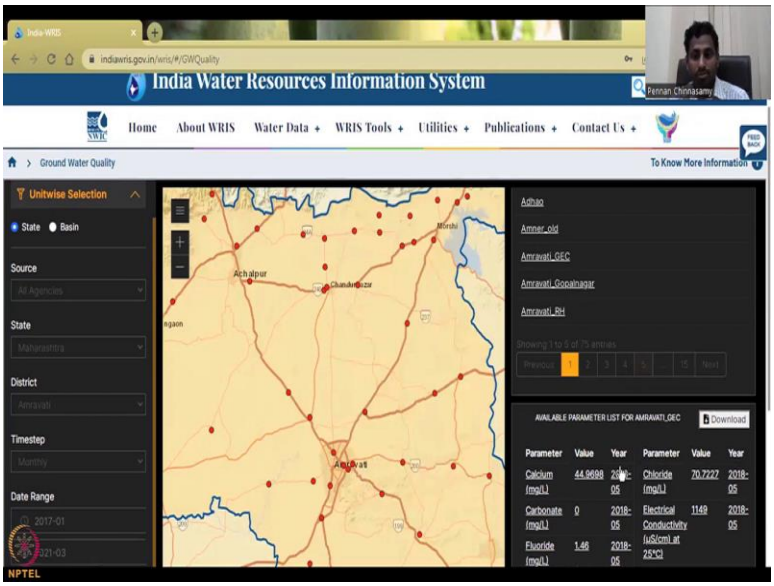

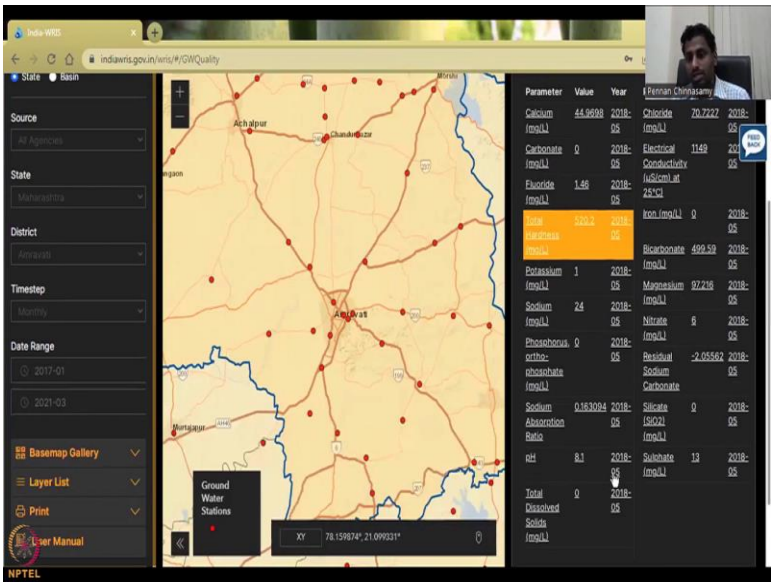

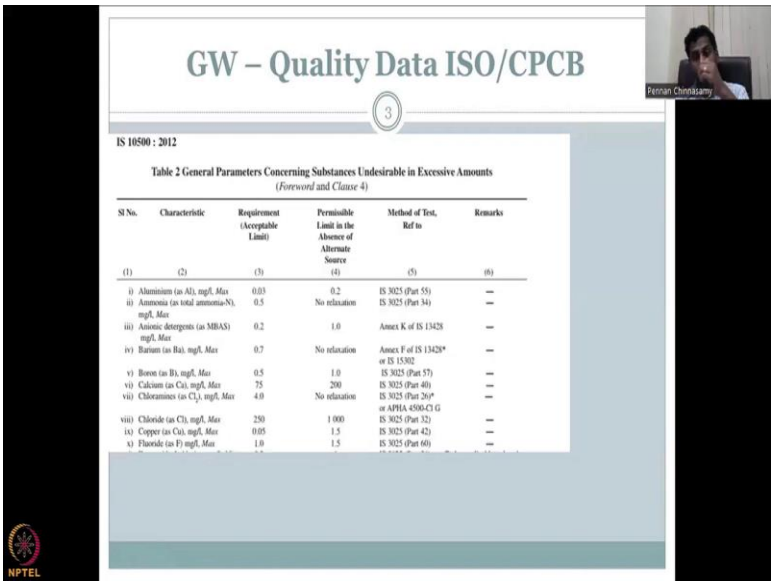
GW – Quality Data ISO/CPCB
3
IS 10500 : 2012
Table 2 General Parameters Concerning Substances Undesirable in Excessive Amounts
(Foreword and Clause 4)
Sl No. | Characteristic | Requirement (Acceptable Limit) | Permissible Limit in the Absence of Alternate Source | Method of Test, Ref to | Remarks
(1) | (2) | (3) | (4) | (5) | (6)
i) Aluminium (as Al), mg/l, Max | 0.03 | 0.2 | IS 3025 (Part 55) | —
ii) Ammonia (as total ammonia-N), mg/l, Max | 0.5 | No relaxation | IS 3025 (Part 34) | —
iii) Anionic detergents (as MBAS) mg/l, Max | 0.2 | 1.0 | Annex K of IS 13428 | —
iv) Barium (as Ba), mg/l, Max | 0.7 | No relaxation | Annex F of IS 13428* or IS 15302 | —
v) Boron (as B), mg/l, Max | 0.5 | 1.0 | IS 3025 (Part 57) | —
vi) Calcium (as Ca), mg/l, Max | 75 | 200 | IS 3025 (Part 40) | —
vii) Chloramines (as Cl2), mg/l, Max | 4.0 | No relaxation | IS 3025 (Part 26)* or APHA 4500-Cl G | —
viii) Chloride (as Cl), mg/l, Max | 250 | 1 000 | IS 3025 (Part 32) | —
ix) Copper (as Cu), mg/l, Max | 0.05 | 1.5 | IS 3025 (Part 42) | —
x) Fluoride (as F) mg/l, Max | 1.0 | 1.5 | IS 3025 (Part 60) | —
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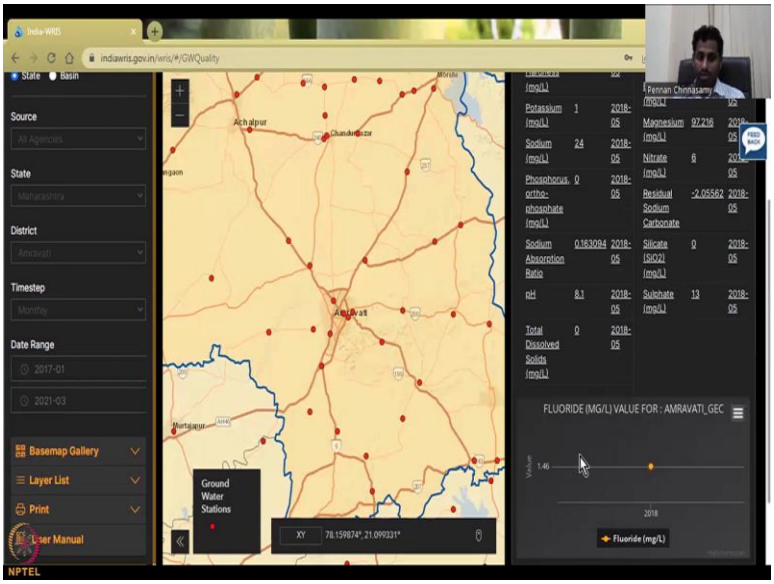
India-WRIS
indiawris.gov.in/wris/#/GWQuality
State
Basin
Source
All Agencies
State
Maharashtra
District
Amravati
Timestep
Monthly
Date Range
2017-01
2021-03
Basemap Gallery
Layer List
Print
User Manual
Achalpur
Chandurbazar
Amravati
Murtajapur
Ground Water Stations
XY
78.159874°, 21.099331°
Potassium (mg/L) 1 2018-05
Sodium (mg/L) 24 2018-05
Phosphorus, ortho-phosphate (mg/L) 0 2018-05
Sodium Absorption Ratio 0.163094 2018-05
pH 8.1 2018-05
Total Dissolved Solids (mg/L) 0 2018-05
Magnesium (mg/L) 97.216
Nitrate (mg/L) 6
Residual Sodium Carbonate -2.05562 2018-05
Silicate (SiO2) (mg/L) 0 2018-05
Sulphate (mg/L) 13 2018-05
FLUORIDE (MG/L) VALUE FOR : AMRAVATI_GEC
Value
1.46
2018
Fluoride (mg/L)
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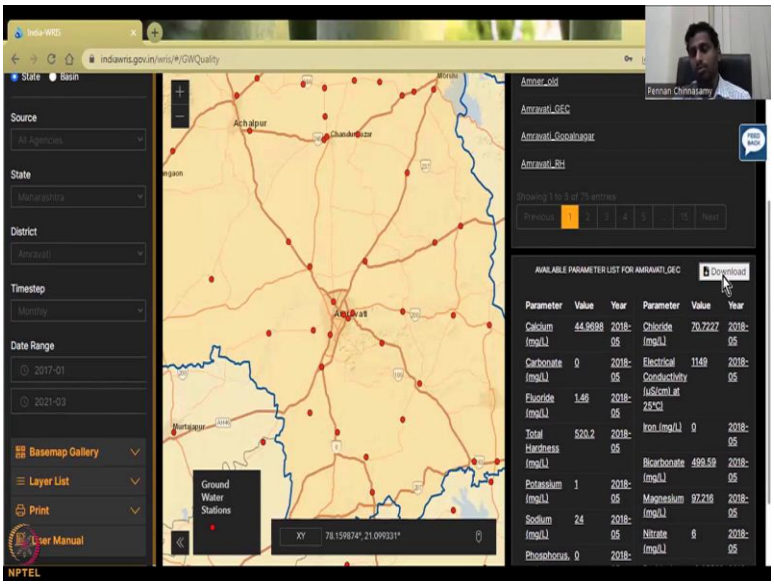

And if you come down for that particular station, you could look at Amravati GEC, what is the data and here, you will not have a graph or a trendline as other data that we see, you will have all the parameters running from 2018 till here. So it looks like one year they have been collecting data. And you can see calcium values are there, and then carbonate, fluoride.

So for example, let us take fluoride 1.46, what was the fluoride estimate that we had, let me go back to that slide, we had around the fluoride estimate we had was 1.5. So basically, you are very close to that region, I will also go and show you the Gujarat, website just so that we can, or Gujarat state or a district in Rajasthan. So we can look at 1.46.

So again, this is kind of very close on the level. So if you click it, you just have one data point you can see and then you will find the data. So like this, you could download the data, I have already taught you how to download just click it, you will get the same model or it will come as an CSV, Excel file, you can download it and then you could also look at other stations if you would like. So, every entry you can go or you can pick and choose based on the location.

So, Achalpur, I would like to click on that particular block for example, and that station has populated saying, Achalpur would be populated down, you can see Tondgaon.

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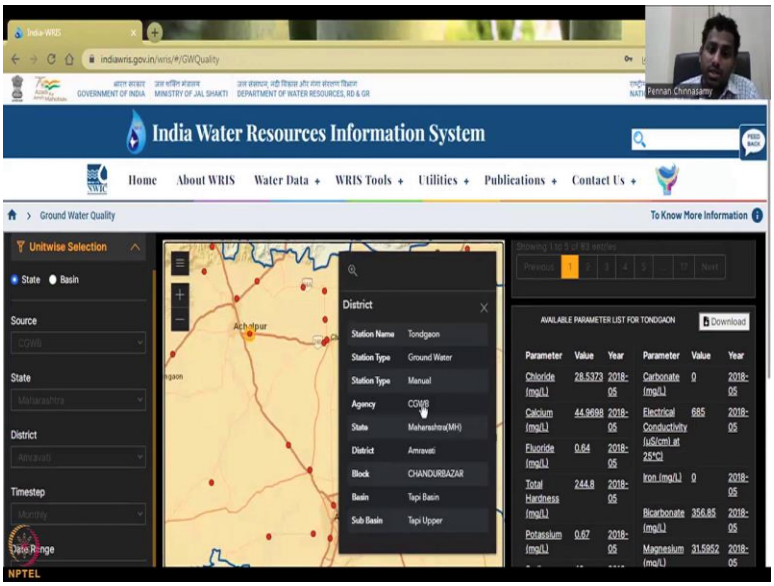
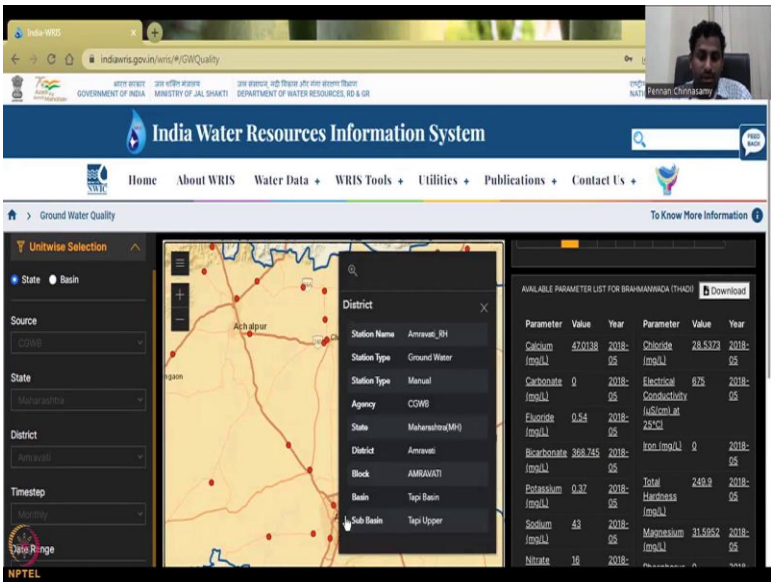
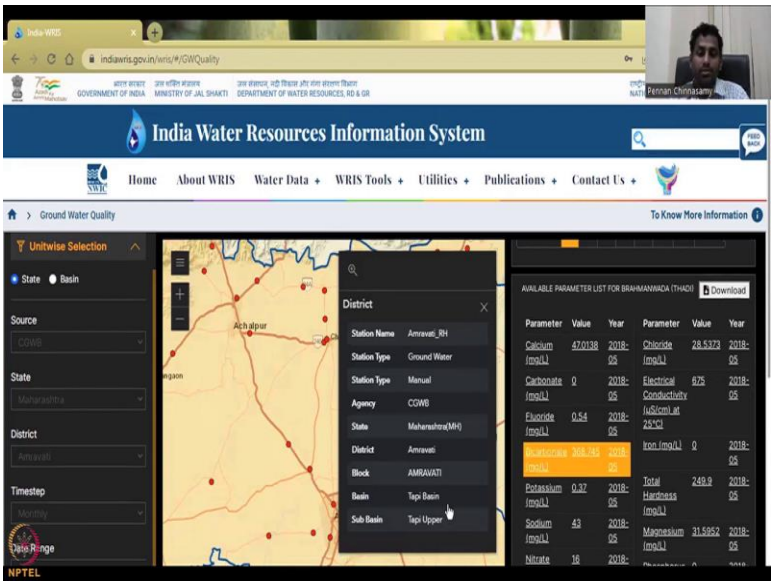






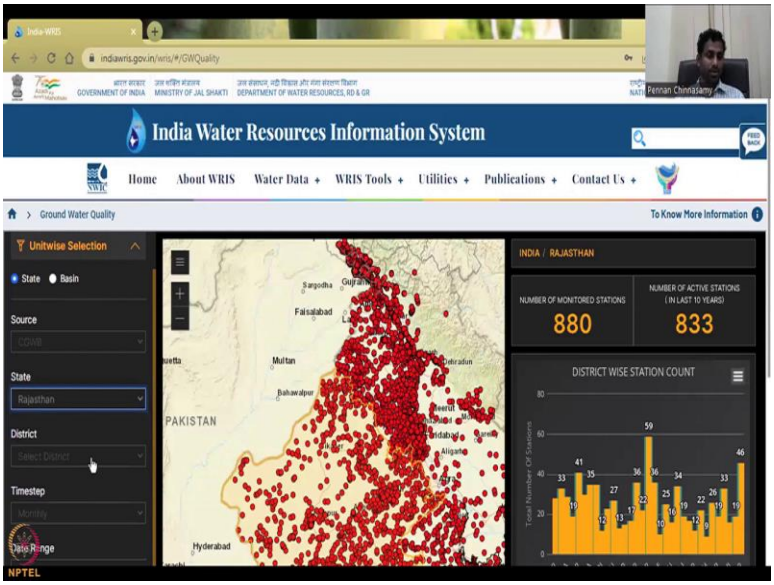
The Tondgaon is the location if you can see here it is that location, the station name is Tondgaon, the location is in that same Achalpur near and it is the Amravati district. So within the district that block I have selected. And you could see that the fluoride has changed 0.64, and the previous data point, we had 1.46, now it is 0.64 like that all these parameters can be checked. So the whole goal of today in this lecture is to show you how you could download this data.

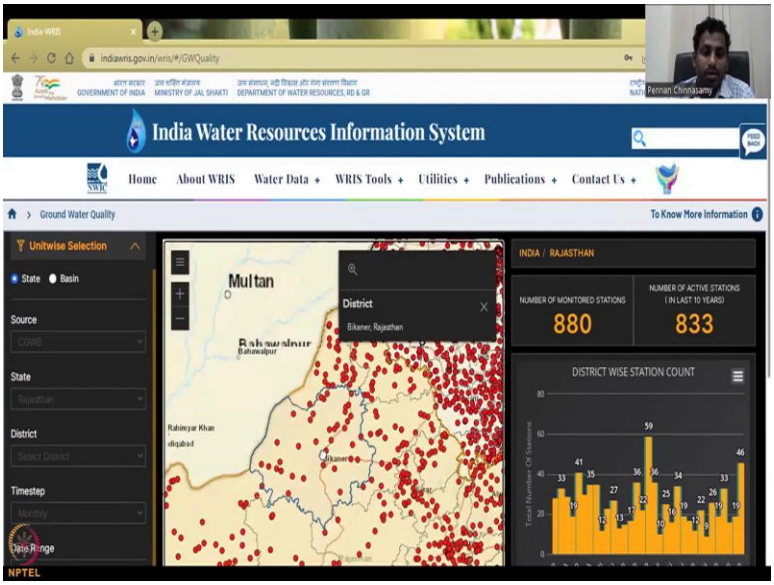
And I have given you water quality standards, please look at the PDF of the slide, the link to the data is given, you could actually go there and read this bulletin and look at the standards how these data look at. For example, if your village or your block has an elevated standard or an elevated level of water quality, you should be telling that there is no point of recharging the groundwater. Because if the groundwater is very bad to start with, then you should not be putting more water inside because it is not going to clean it. You should put it in a different location. Because that as you see the wells between them have different water quality standards.

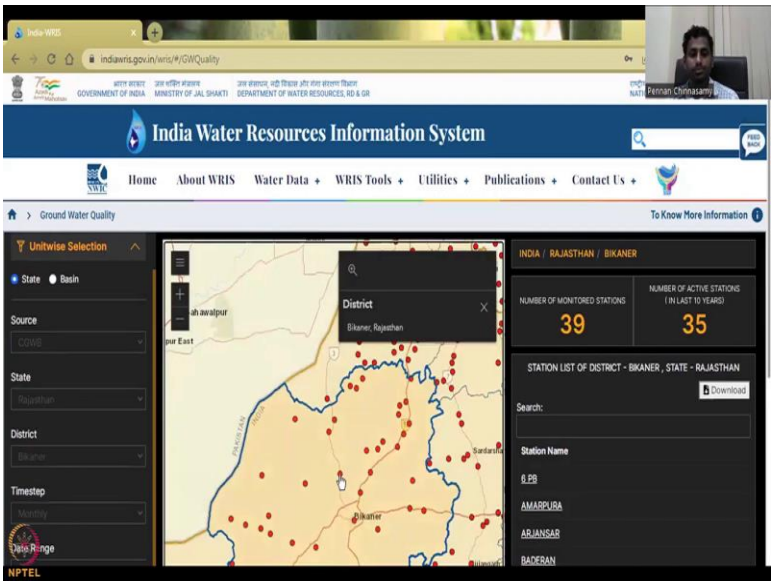
Let us take this well. I have clicked this well, I do not know the name it says Brahmanwada Thadi. Same Amaravati region you can see 0.54 fluoride. I am just going to look at fluoride for now. Whereas in this location Amravati RH, I have clicked it, just take some time. I am going to click another one Amravati GEC, we already see that it is 1.46. So why, where would I recharge more, I will recharge up north in the district. Because those areas were having better water quality. For example here. I am in Hiwarkheda, and there if you see the fluoride, it is only 0.68 compared to 1.5. It is also lower than standard given by WHO.

So you could clearly see now where you could have these data. Normally there should be a submit button and then all this data should come but for some reason it is not showing all the data, it is only showing part of the data. As I promised let us go back to Rajasthan.

(Refer Slide Time: 24:43)



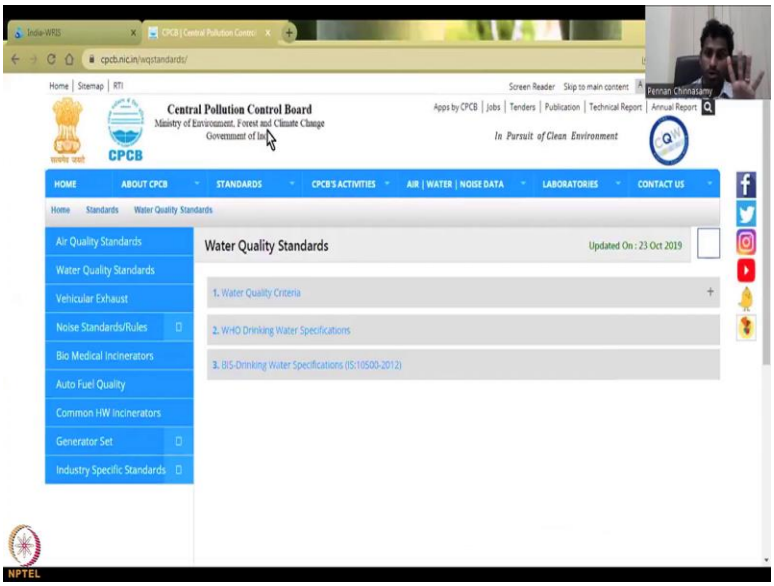


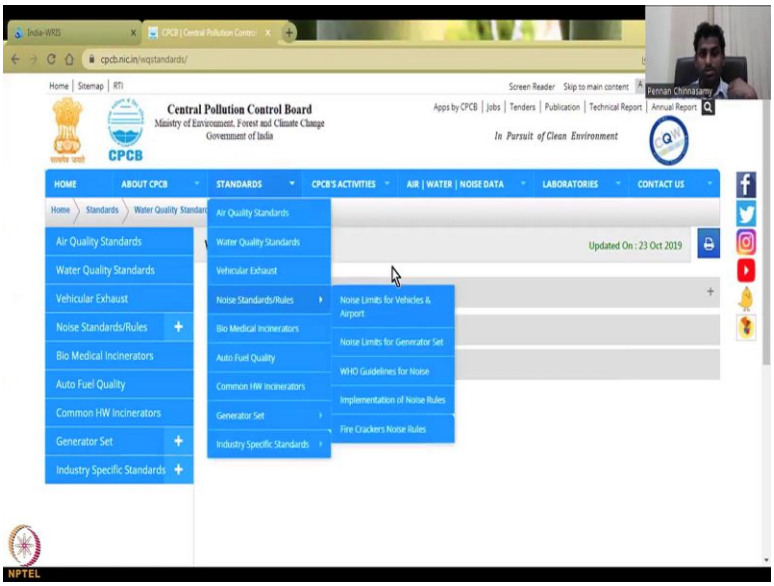


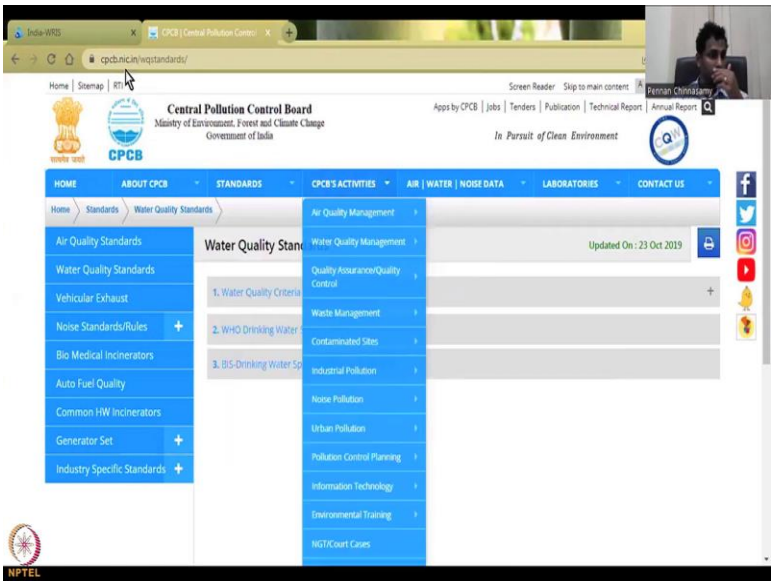
I will click Rajasthan the state and then all the wells in Rajasthan had come up. I do not know where but let us pick one here. I am just going to pick one well, from the map itself. So I am just going to click and the proceeds it is spinning, so it does take, you can zoom in.

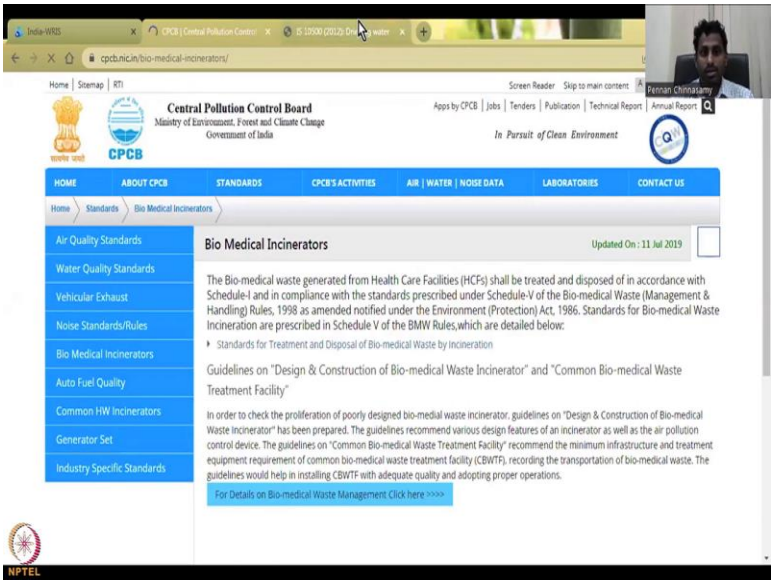
So I am going to Bikaner, Bikaner is the district and then I have clicked on a well, so you can click on a well. So, now the district name has come up, sometimes if you click on a well there is no data. So do not worry about it, it will just be there as a location, but the date will not come. So, now we are here, we have selected a well in Rajasthan, Bikaner, district Amarapura is that Well, station name, sometimes the location has given us the station name, you could see all the parameters here from 2014 per year it comes. And then when you download it, most of the data will be downloaded. Your fluoride is 1.3 again, very, very close to the WH, is above the WHO standard, very close to the ISO standard. So you need to be very careful in putting down this value.

(Refer Slide Time: 26:10)





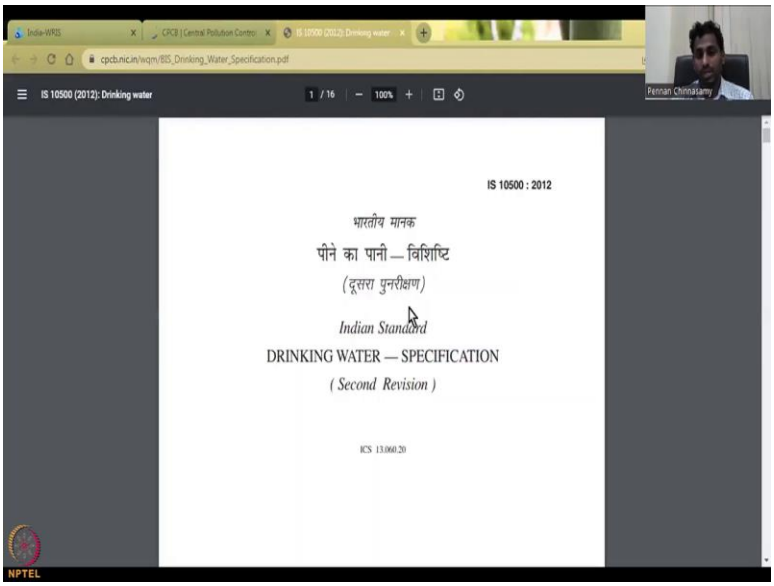


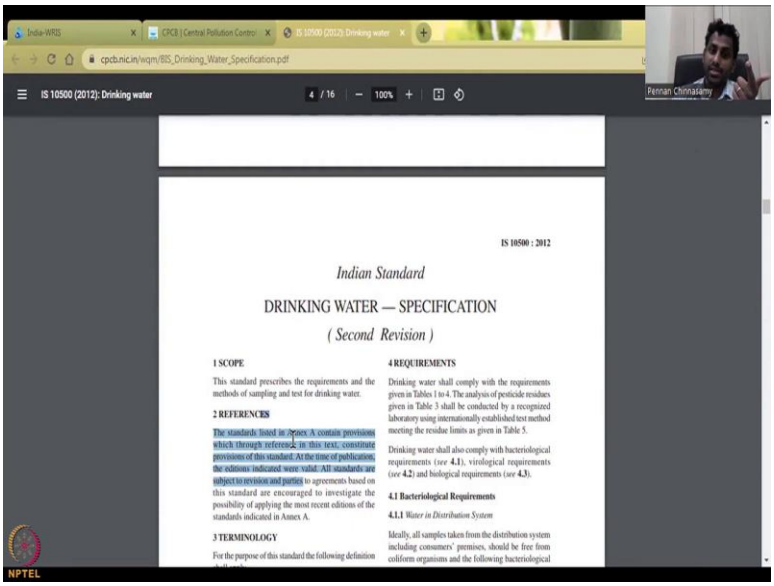


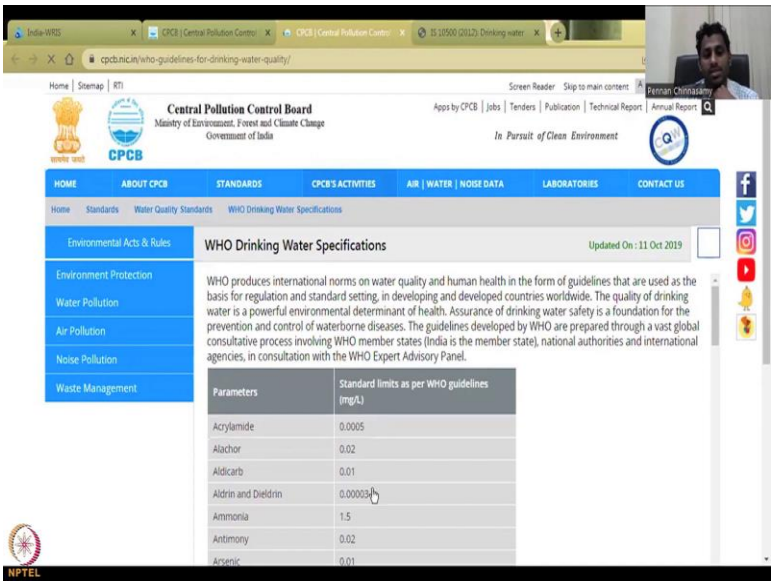
So it is very easy to find the standards, I am going to show you how to do it, because what happens is as your as you search for these kinds of data, sometimes the links do change. So, it is very important for you to understand also googling what are the standards. So, the WQ standards I want to share now. So all I did is CPCB which is a central pollution control board, this is where you collect all the standards for all the water, the groundwater, drinking water, surface water, also the bathing water you should use.

So you can come here cpcb.nic.in WQ standards, WQ is water quality, you can click on the water quality criteria, but this is what we need the BIS standards or the Indian standard report.

(Refer Slide Time: 27:21)






Central Pollution Control Board
Ministry of Environment, Forest and Climate Change
Government of India
In Pursuit of Clean Environment
HOME
ABOUT CPCB
STANDARDS
CPCB'S ACTIVITIES
AIR | WATER | NOISE DATA
LABORATORIES
CONTACT US
Environmental Acts & Rules
Environment Protection
Water Pollution
Air Pollution
Noise Pollution
Waste Management
WHO Drinking Water Specifications
Updated On : 11 Oct 2019
WHO produces international norms on water quality and human health in the form of guidelines that are used as the basis for regulation and standard setting, in developing and developed countries worldwide. The quality of drinking water is a powerful environmental determinant of health. Assurance of drinking water safety is a foundation for the prevention and control of waterborne diseases. The guidelines developed by WHO are prepared through a vast global consultative process involving WHO member states (India is the member state), national authorities and international agencies, in consultation with the WHO Expert Advisory Panel.
Parameters
Standard limits as per WHO guidelines (mg/L)
Acrylamide 0.0005
Alachor 0.02
Aldicarb 0.01
Aldrin and Dieldrin 0.00003
Ammonia 1.5
Antimony 0.02
Arsenic 0.01
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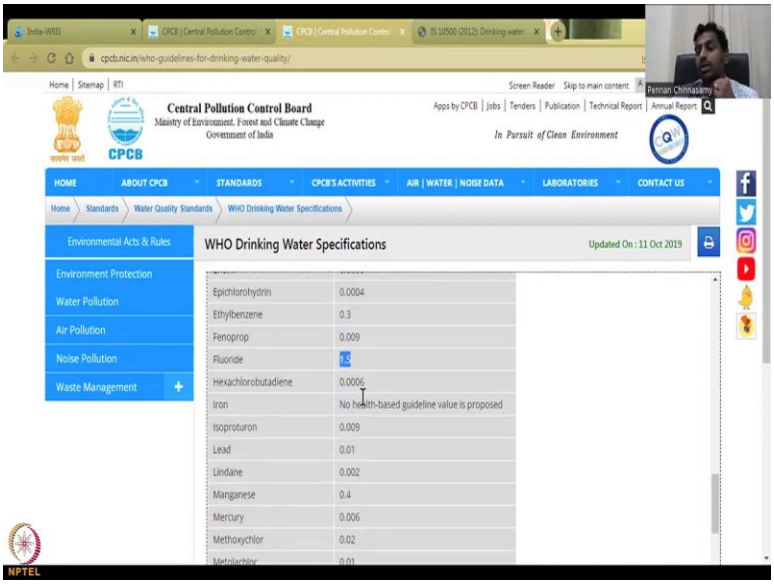
Central Pollution Control Board
Ministry of Environment, Forest and Climate Change
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HOME
ABOUT CPCB
STANDARDS
CPCB'S ACTIVITIES
AIR | WATER | NOISE DATA
LABORATORIES
CONTACT US
Environmental Acts & Rules
Environment Protection
Water Pollution
Air Pollution
Noise Pollution
Waste Management
WHO Drinking Water Specifications
Updated On : 11 Oct 2019
Epichlorohydrin 0.0004
Ethylbenzene 0.3
Fenoprop 0.009
Fluoride 1.5
Hexachlorobutadiene 0.0006
Iron No health-based guideline value is proposed
Isoproturon 0.009
Lead 0.01
Lindane 0.002
Manganese 0.4
Mercury 0.006
Methoxychlor 0.02
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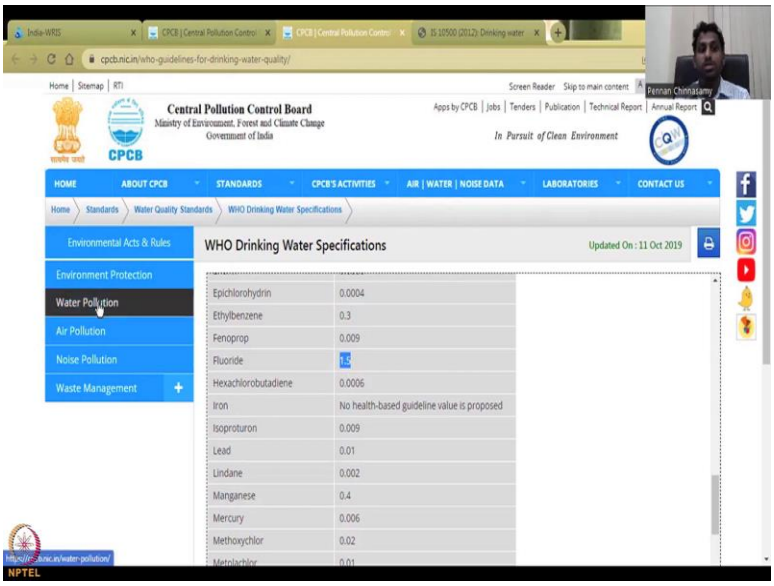

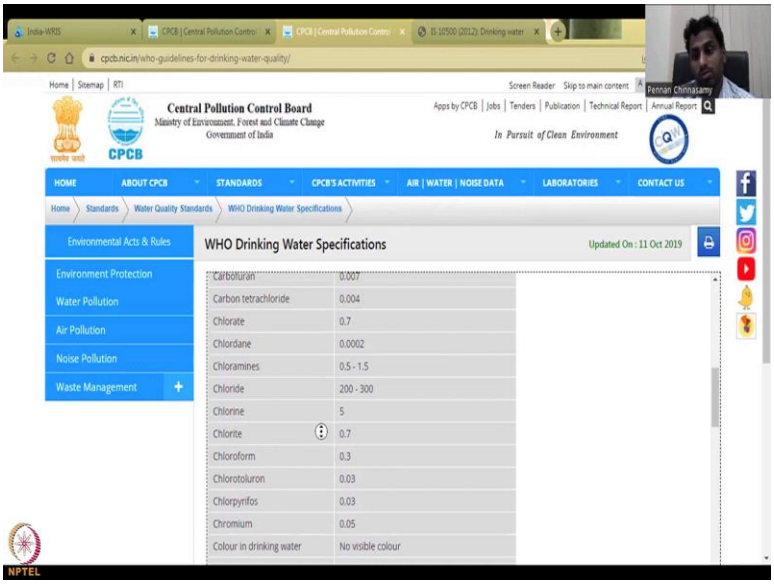

Part of it will be in Hindi, but you can also look at the. So, for example, it starts with different language since NPTEL is a course, across the country, I would show the English version. So all these tables are here. All these tables are here.

As I said there is multiple multiple tables that run into water quality, they would also discuss what and where can you give relaxations? Why do you have to give the relaxations etcetera. And the references are given from where they took the methods and the standards. So again, going back to wq standards, WHO standards are very important. I am just clicking on it. It opens another tab and these are the standards. So these standards are already taken. So for example, the fluoride, we found that it should be around 1.5, so 1 to 1.5 is the WHO standard updated in 2019.

So somewhere that this report needs to be updated because it is 2012, In 2012, the WHO are saying 1, but in 2019, it says 1.5.

So here is where you need to go back and forth between the WHO standard and the Indian standard. First, my recommendation is use the WHO standard for drinking water standards. If it does not meet the quality then please look at ISO. If these two are breaching, for example, your aquifer groundwater is high in fluoride, there is no point in putting in too much of water recharge structures.

Because recharge structures you put money and time and invest in capturing the runoff. So better to take the runoff and put it somewhere else or not in the groundwater. You put it in a storage tank where you can use it like on top of the surface. So not always your groundwater will be the best option. That is all I am trying to say because there is quality standards. This I would like to conclude today's lecture. For those who would like to understand more about the water quality, you can go here and look at water pollution, environmental protection acts, etcetera. Since this course was on the management of groundwater, I just kept 1 lecture for the water quality.

In my previous slides. I have also mentioned that almost everywhere in India, there is groundwater purification systems like your RO, every house almost has a water purifier because your groundwater is slowly getting contaminated, it could be natural contamination like your iron, Mercury lead, most of these are industrial, but your natural could be a fluoride, iron, you have iron here, etcetera. So, there is sometimes you do not know which contaminant it is.

So, your industrial contaminants your human Ecoli, bacterial contaminants would be in a location where industrial or domestic population is there, but mostly other regions you will have groundwater contaminated because of geogenic contamination, for example, arsenic is very bad in the Ganges belt. It is one of the very very important parameter which is causing really bad health hazards in the Ganges belt.

So we need to not use the groundwater, we cannot use the groundwater, there is no purification of Arsenic at a low cost. So it is better to not use that groundwater or put more water into the Arsenic lead in groundwater. So please think on these terms about water as a quantity is important but you should also look at quality and both quantity and quality go together and you

should put these recharge structures that we saw in the last class only in locations where is no potential contaminants. With this we have also closed the WRIS websites, groundwater part. We there is also other data that is needed to create the groundwater budget

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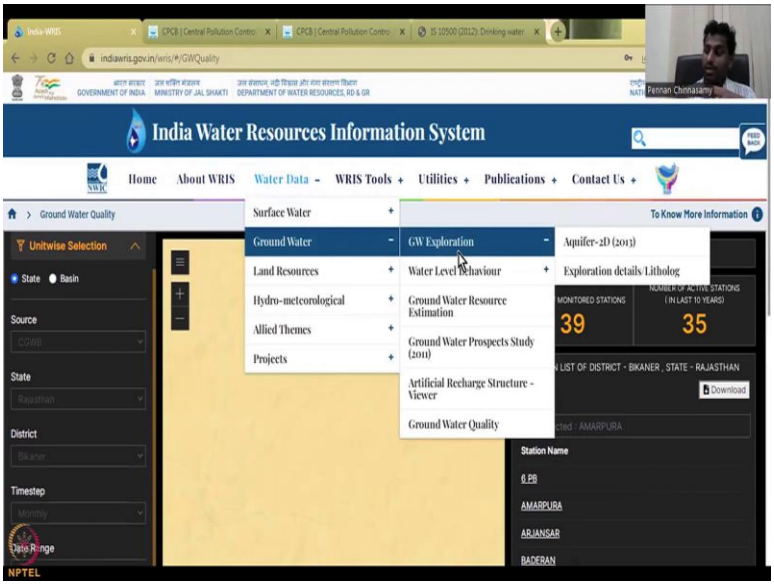

Because what we have here is purely the groundwater data, data all the data we have looked at but there are other data that leads to the groundwater recharge which is going to be taken from your water balance account which will be doing in the next lectures. I will see you in the next lecture. Thank you.