Groundwater Hydrology and Management
Professor Pennan Chinnasamy
Indian Institute of Technology, Bombay
Lecture:02
Groundwater Data- Artificial recharge structure

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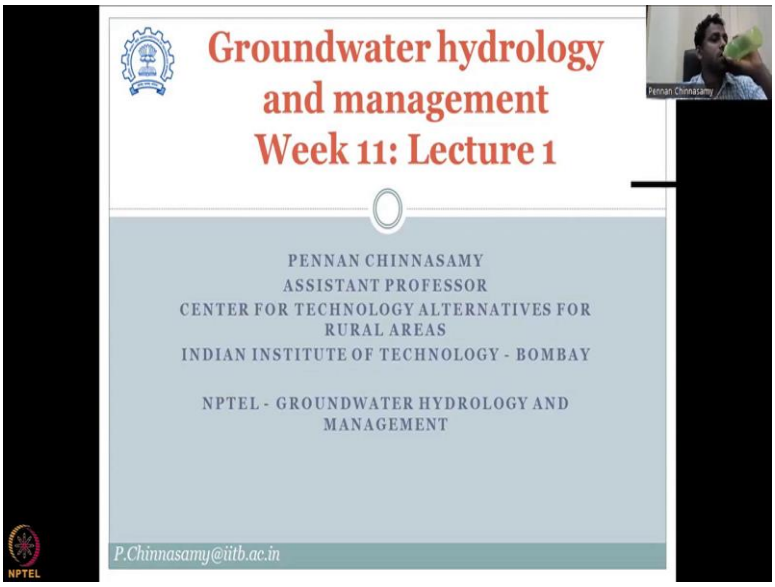

Hello everyone, welcome to NPTEL course on Groundwater hydrology and management. This is week 11 lecture 1. The past weeks, we have been looking at building and understanding for the data. We have identified what are the key data that is needed for Groundwater management. And we have looked at many data sources that can be used for Groundwater management. Since the data sources are vast, we will be continuing for some more time in this week on data sources.

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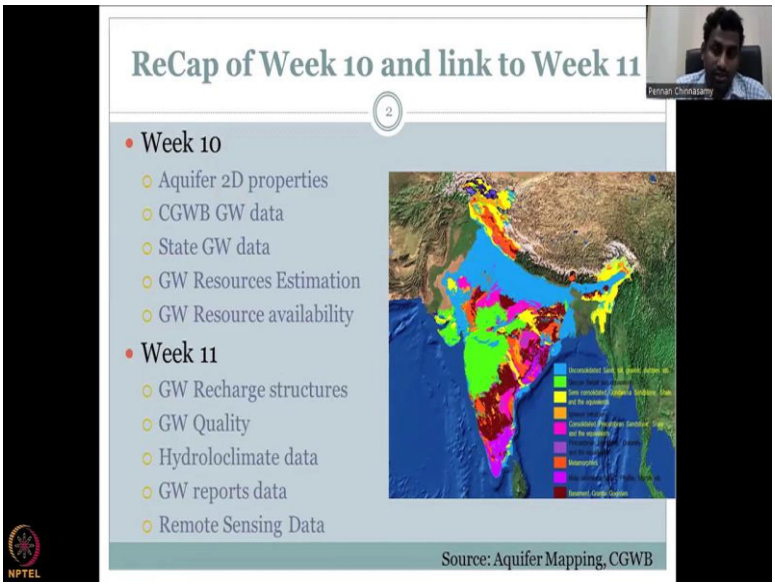

Let us do a quick recap of what we did in week 10, and then how it is linked to week 11. In week 10, we looked at the aquifer 2D properties, this included aquifer thickness, aquifer type as a 2d on the top, spread area, aquifer material and depth. So, all these are 2d, you could incorporate them as a 3d model. Because your surface area spread is one dimensional, your depth x and y is 2 dimensional. So, you can have 3 dimensions just taking a 2d data you have to mix all these into a hydrological model, especially a groundwater model to create a conceptual 3d model. We will look at that in week 12, a very short introduction on conceptual models.

Then we looked at CGWB data to understand the groundwater level data which they collect across India, around 15,000 wells they collect and they monitor it at every 4 months interval. Some of the data we have for the past 20 years, and it is the one of the most important data available in India for groundwater. Then we looked at state groundwater resources also the same WRIS website.

We also looked at groundwater resource estimation where groundwater budget is made, I would recommend that if you are starting a study, you should take this groundwater resource estimation and do budgets to create a need statement. For example, if you are doing work in Maharashtra weather bar region, you could look at the groundwater estimation data, the water budgets and propose that this is how much water is being pumped, this is how much water is recharging. So, we need to put excess amount of structures etcetera. Or we should capture more rainfall into the groundwater.

Then, the last we saw was groundwater resource availability. This is kind of a physical format of how much water is available, the test done by CGWB. It is not done all throughout India, there are some grids and I have shown you how to identify these grids, make maps and jpeg images for your report. It has very important information like aquifer type, aquifer material, the depth, the pumping rate, what rate the water is coming, or water yeild rate, recharge rates, and some remarks like if the water is good quality, is it sustainable to use the system etcetera.

Then we also looked at different districts and how water can be stored in these districts. In week 11 what we are going to do, So, we will build good data about the aquifer. In week 11 what we want to do is look at the recharge structures that have been put down by the government and other NGO agencies and how they are performing in a very mapped environment GIS environment using the same WRIS website. Then we look at the last groundwater data, specifically the groundwater data which is quality. I will explain why quality is very important for understanding these aquifers because you might have a good aquifer system, but if the water quality is not good, then the use of that water is not available.

It is available physically water is available physically but you cannot use it. You cannot use it for domestic industry, agriculture or livestock, wearing any other use. It is just a water that cannot be used for much. It is like your salt water in the seas you have most of the water is the seas and oceans but it is salty. You cannot grow crops you cannot do industry applications or domestic applications without investing a lot of money and energy.

Then we look at hydroclimate data, some groundwater reports data and remote sensing data in this week. The hydroclimate data would also have some reports and remote sensing data that I will cover mostly based on the time. Why do you need hydroclimate data? Is to establish a water budget from which you can estimate the net recharge into the groundwater resources. If you do not know how much water is coming, it is going to be very difficult to capture it and recharge it in the groundwater aquifer.

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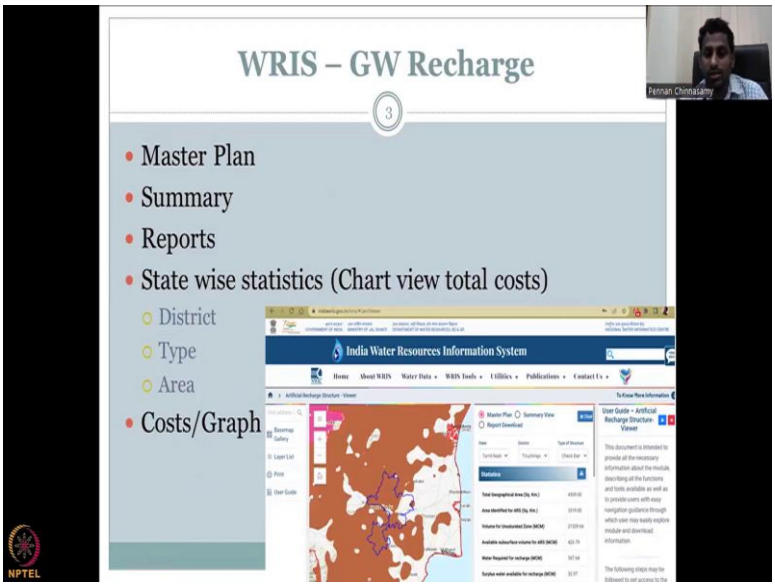

So, let us go ahead, the WRIS groundwater recharge structures data is given in this website. It can be divided into masterplan, summary, reports, website is given here, it is the same WRIS, will show you lightly how we would go into the website for this and then the data is kept at statewise statistics which you could see on your screen and a chart view of total costs that have been spent. Also you can zoom down to a particular district here we have zoomed down to Tiruchirappalli in Tamil Nadu you can look at what type of data structures have been built the area across it and costs and some analytics using graphs.

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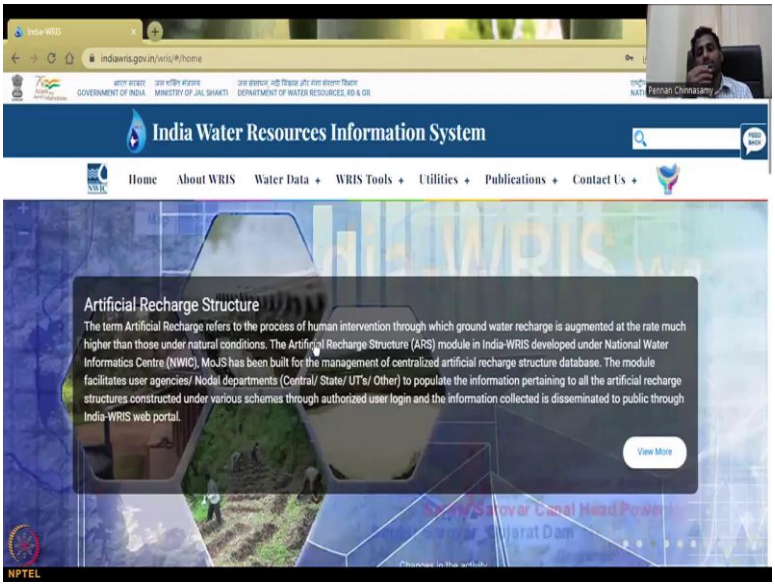

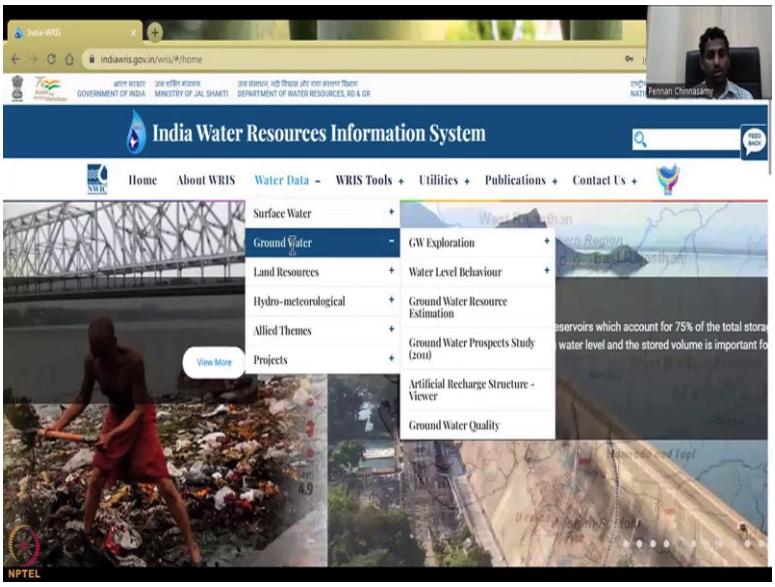

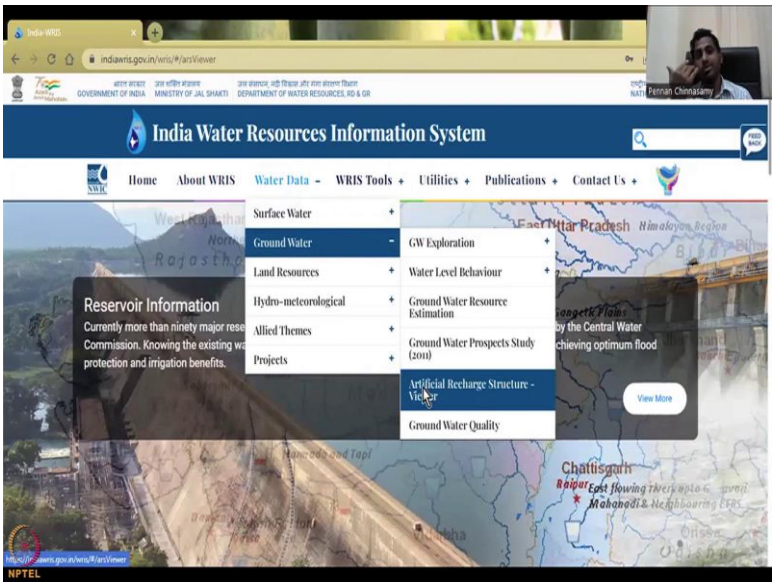

So, let me pull out the website So, that we could start looking at the groundwater recharge structures, So, here it is, we have a WRIS home, go to water data, I am not clicking anything, you just hover move the mouse on top of water data, do not click then come down do not click, go to your right, come down to artificial recharge structures and then click.

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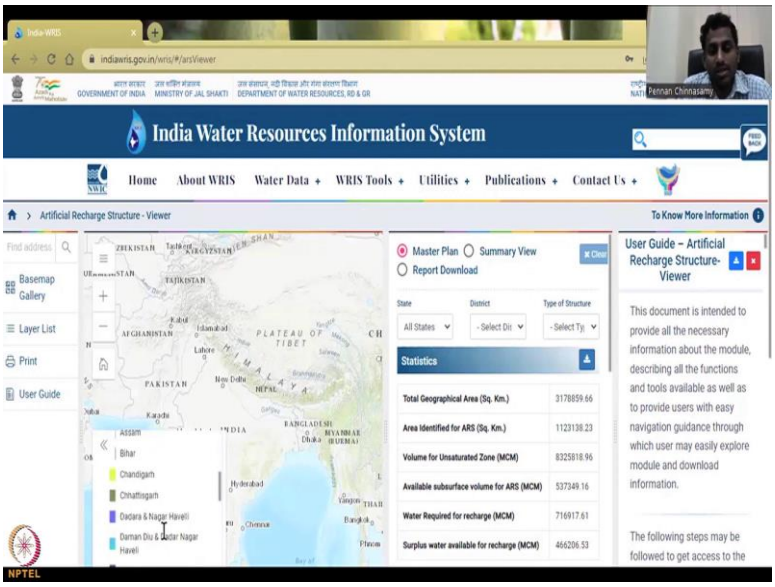

Once you click it the map populates depending on your internet speed, so, it is loaded for me you have the map of India with some boundaries and state colors etcetera the state colors will come as soon as we start populating it. So, I at an India level again the manual on how to do these how to use the website everything is given on the right, I will go through with you on how to read the data with this exercise.

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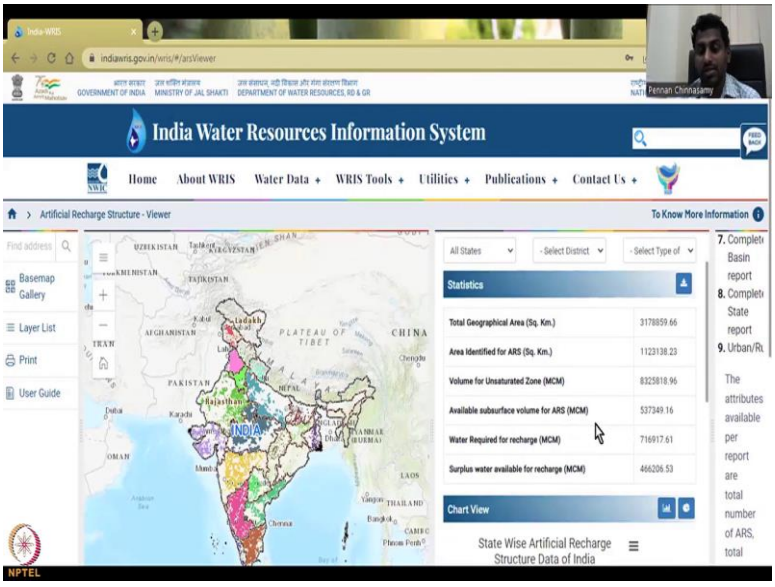

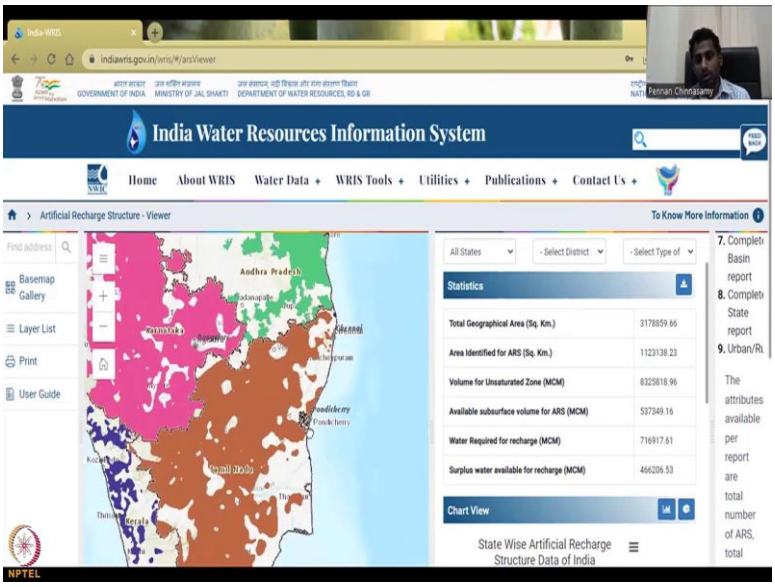
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Karnataka
Kerala
Tamil Nadu
Pondicherry
All States
- Select District
- Select Type of
Statistics
Total Geographical Area (Sq. Km.) 3178859.66
Area Identified for ARS (Sq. Km.) 1123138.23
Volume for Unsaturated Zone (MCM) 8325818.96
Available subsurface volume for ARS (MCM) 537349.16
Water Required for recharge (MCM) 716917.61
Surplus water available for recharge (MCM) 466206.53
Chart View
State Wise Artificial Recharge Structure Data of India
7. Complete Basin report
8. Complete State report
9. Urban/Ru
The attributes available per report are total number of ARS, total
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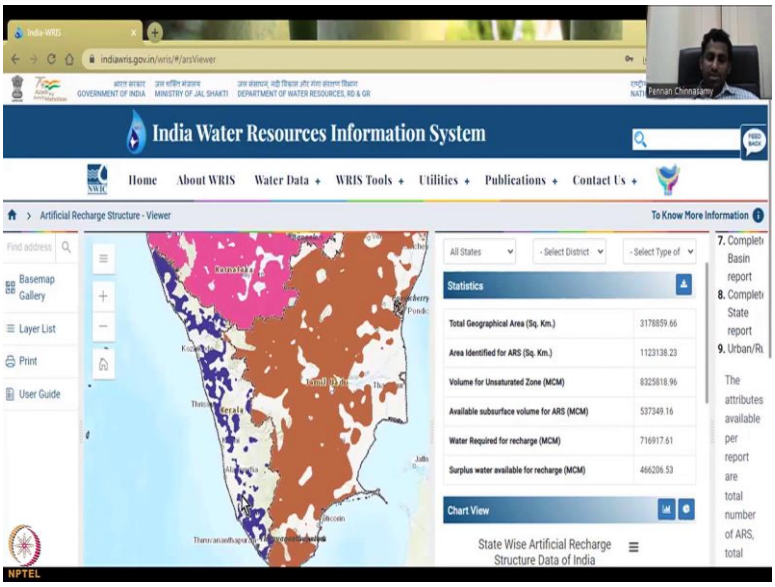
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Kerala
Tamil Nadu
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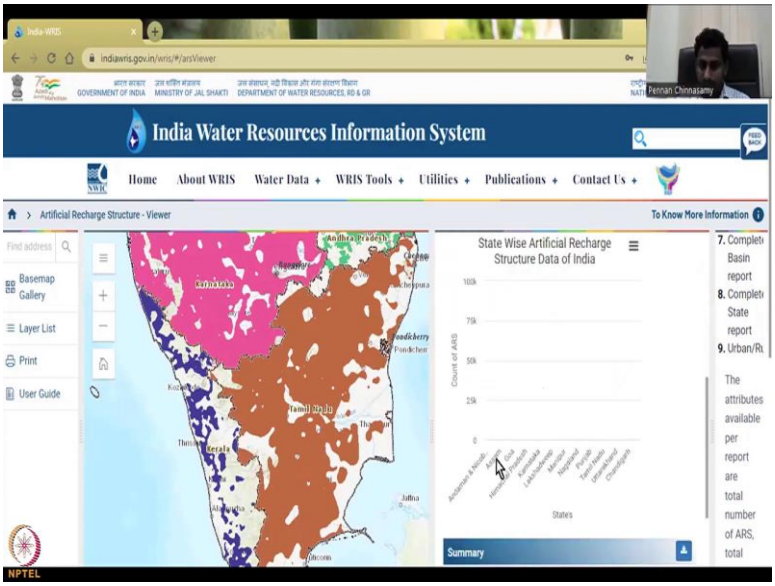
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Karnataka
Kerala
Tamil Nadu
Pondicherry
State Wise Artificial Recharge Structure Data of India
Count of ARS
States
Summary
7. Complete Basin report
8. Complete State report
9. Urban/Ru
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So, I am just going to move to the side. So, the master plan for entire India the statistics is total area is this much whereas your identified area for artificial recharge structures, ARS is around 11 is in the units, square kilometers. So, almost 1 3rd is okay for groundwater recharge structures, volume for unsaturated zone, then you can also estimate the volume million cubic meters, you can see that they have already captured water in a conceptual model.

And say that unsaturated zone or which is your unconfined aquifer can store a lot of volume of water which can be used for your future demands. So, this is how you should look at it, you can pull the map and then you can zoom in, zoom out. Especially for where you want to look at and the coloring gives you where the ARS can be made.

The artificial recharge structures can be made. It is a potential mapping. And also some data is there on where these are located and how much cost has been put. So, you can see that, why Kanchipuram does not have an ARS, why maybe there was not enough budgets or they did not need it because they were near the other water priority areas So, they did not need it. Similarly, in Kerala, you can see a lot of pockets which do not have any structures. So, coming down, this graph is not populating now, So, some issue is there on the website. However, if you want to look at the statistics as a graph, I would recommend clicking the pie chart.

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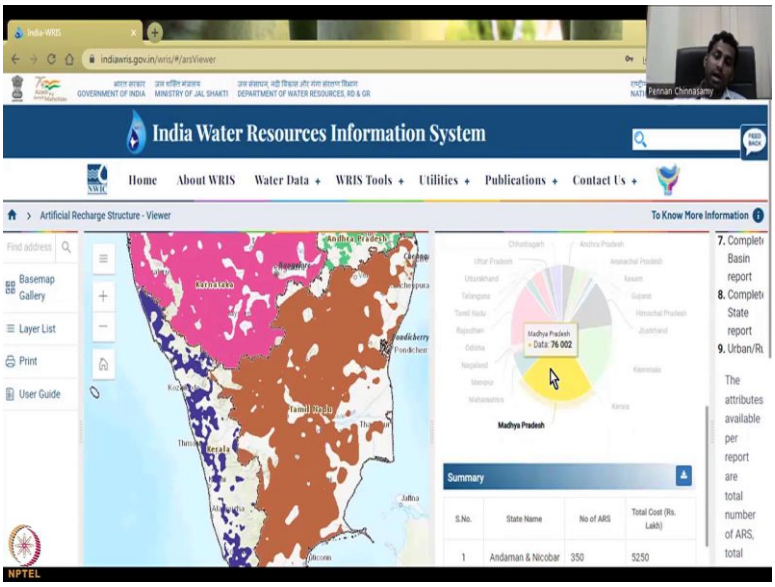
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Madhya Pradesh
Data: 76 002
Summary
S.No.
State Name
No of ARS
Total Cost (Rs. Lakh)
1
Andaman & Nicobar
350
5250
7. Complete Basin report
8. Complete State report
9. Urban/Ru
The attributes available per report are total number of ARS, total
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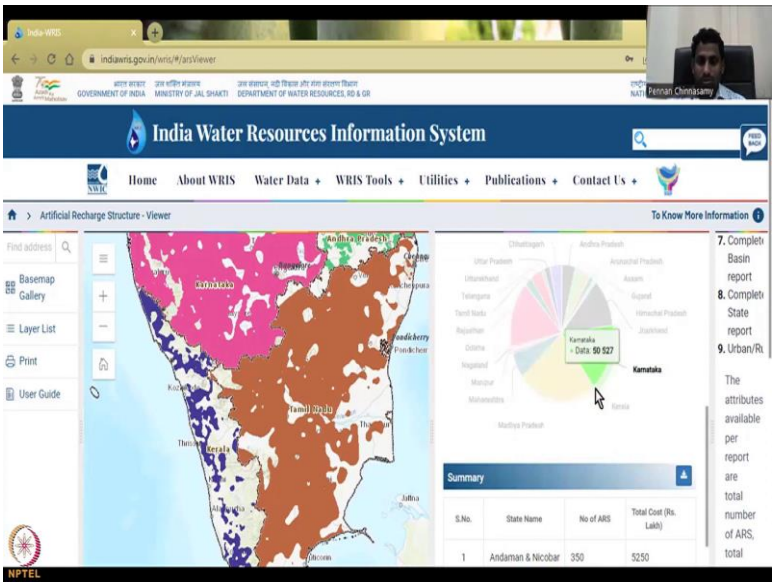
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Summary
S.No.
State Name
No of ARS
Total Cost (Rs. Lakh)
1
Andaman & Nicobar
350
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7. Complete Basin report
8. Complete State report
9. Urban/Ru
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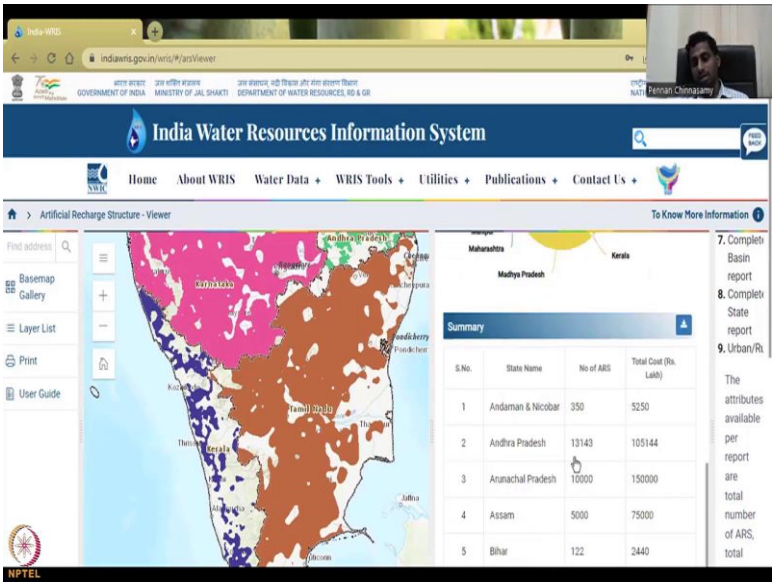
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Kerala
Madhya Pradesh
Summary
S.No.
State Name
No of ARS
Total Cost (Rs. Lakh)
1
Andaman & Nicobar
350
5250
2
Andhra Pradesh
13143
105144
3
Arunachal Pradesh
10000
150000
4
Assam
5000
75000
5
Bihar
122
2440
7. Complete Basin report
8. Complete State report
9. Urban/Ru
The attributes available per report are total number of ARS, total
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So, when you do a pie chart beautifully the graph comes out you could see that it is coming and when you hover your mouse it will tell you which state has good volumes of these structures. This is a number how many in number are present. So, you can see Madhya Pradesh has put a lot, Kerela is very small 1000 around, Karnataka has the next highest 50,000 whereas Madhya Pradesh has 76,000, Rajasthan all these dry belt and areas where there are a lot of agriculture happening you could see a lot of these number of recharge structures. Then you can see in lakhs where and how much it is being put down.

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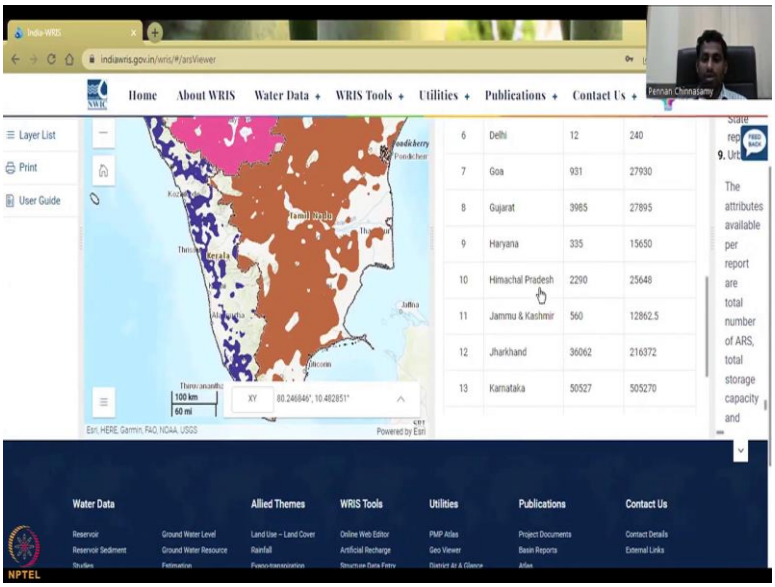

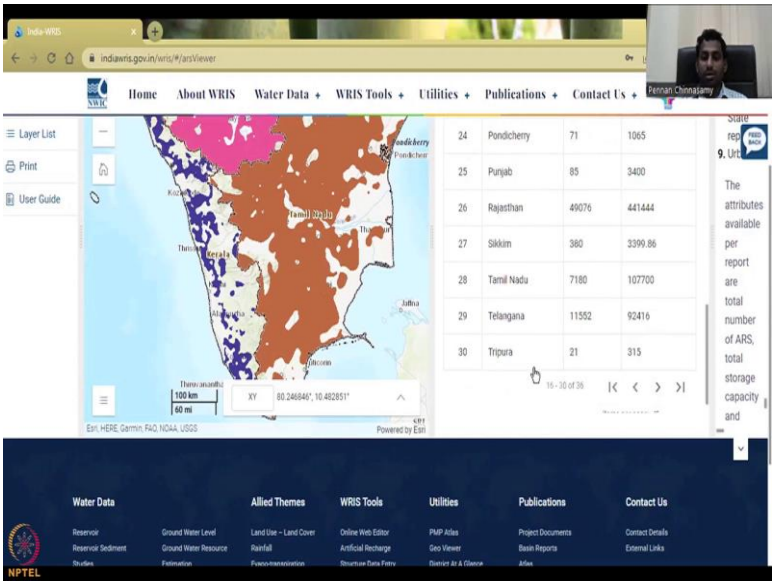

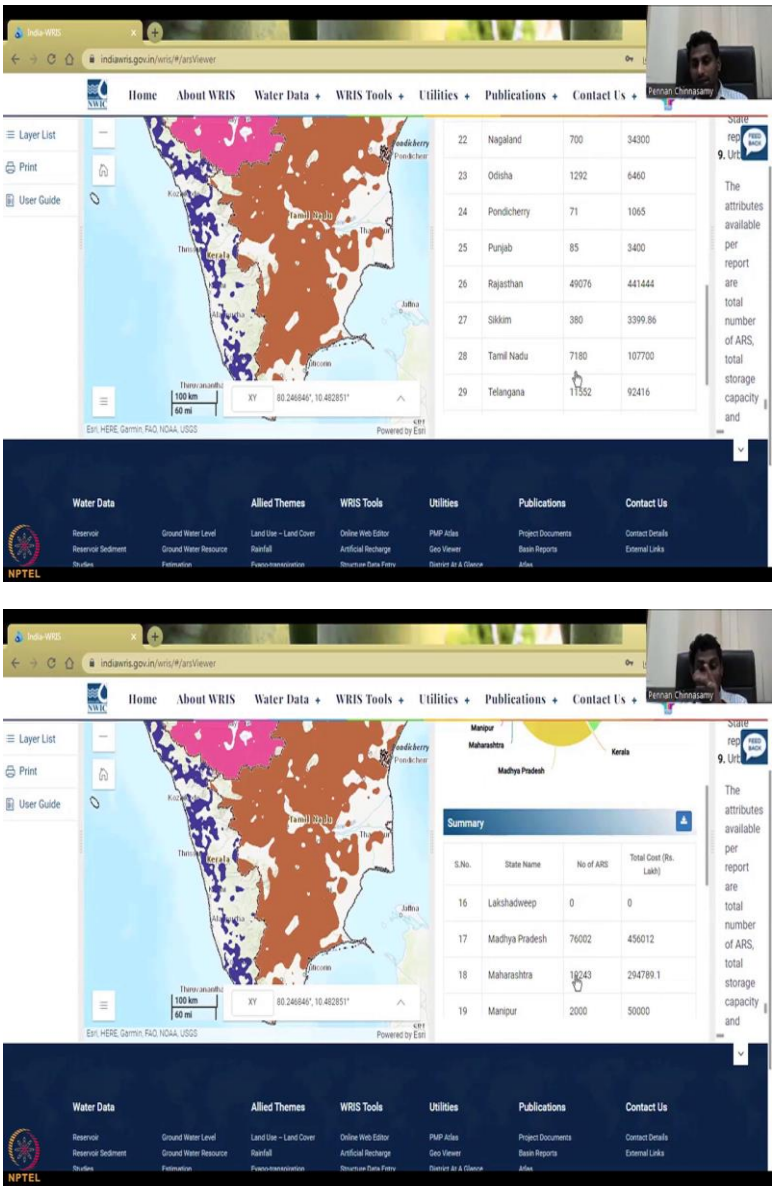

If you come down further you could go to the particular state you want to look at. So, I am for example, until 15 you have and then Tamil Nadu is there 7180 in lakhs, this is in lakhs. So, you have around a lot of money in took 1000s of crores, it is it is not a very small amount they put down for these structures.

Let us say Manipur, you are talking about 500 crores, it is very small state money pool. So, that is what these structures cost and maintenance and all these things are built in.

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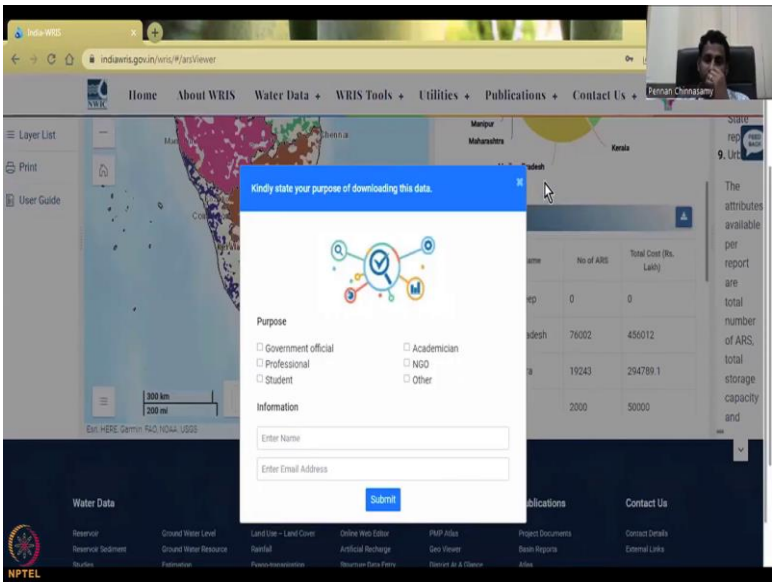

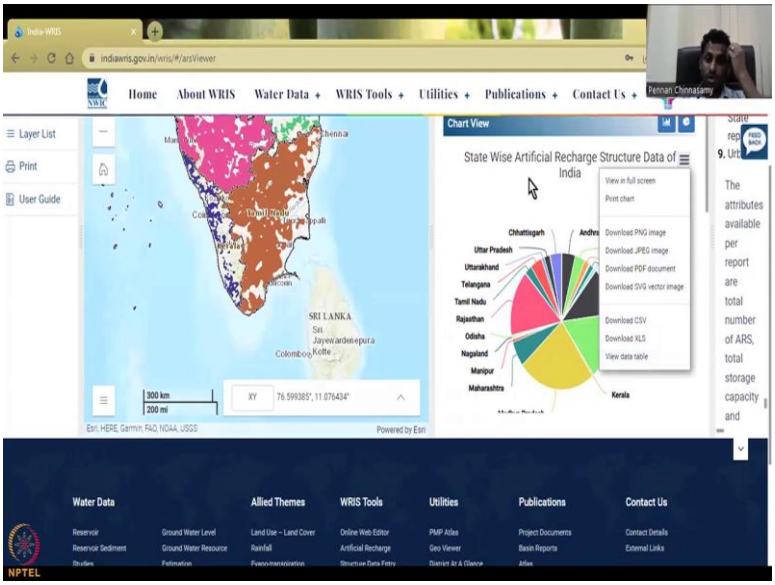

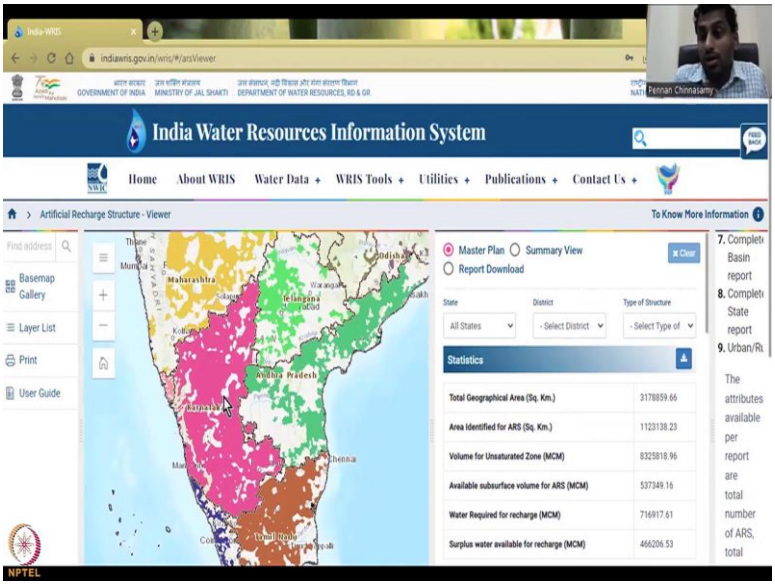

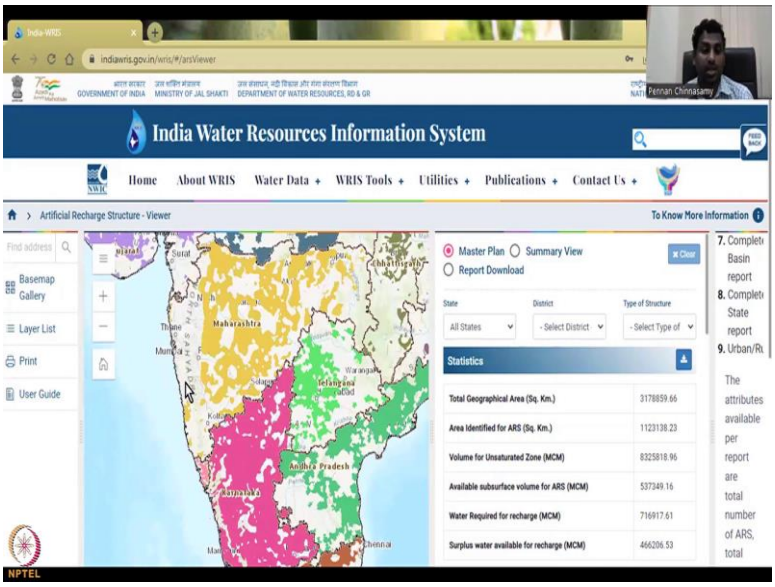

So, let us see how to get this data you can download this data as a statistics just as an Excel sheet it will come like how you looking at it, it will come as an Excel sheet. And these graphs also you can download if needed as a JPEG image, Excel sheet, and then change the graph if you want. This data on the whole of India, how much volume etcetera can also be taken out and download it.

Now, we would like to see mostly the entire India first. So, this is what you get for the entire India, the total spread of area and how much of that has been identified for artificial recharge structures. Artificial recharge, because why is go back to your class notes. Artificial because it the groundwater takes a long time to recharge. And by natural recharge systems, it does not move fast into the groundwater. So, you eventually lose all the water, whatever water you are capturing, if you do not use it properly, you lose the water.

And that is what is happening in this areas that rainfall is concentrated and if you do not capture the rainfall in these structures, it will just go fast into the ocean and seas and get wasted. At least not used for animal agriculture or human consumption. So, the idea is to promote artificial recharge structures through the initiation of these kinds of activities. So, the mapping has been done, remember, we had this natural water resource assessment data, the previous classes, using that they have identified the area where you could make these artificial recharge structures.

And based on that now we are going to look at particular states and how they have performed. Just a quick update here on Maharashtra, you could see that on this side you do not need much recharge structures, So, much rainfall is there. And also it is the Western gulf.

So, you do not capture much of rainfall because the slope is too high. However, on this side, which is the rain shadow side of the Western Gulf, tremendous groundwater depletion has happened, very less water resources are there and that is why you see a good map of areas suitable for groundwater recharge.

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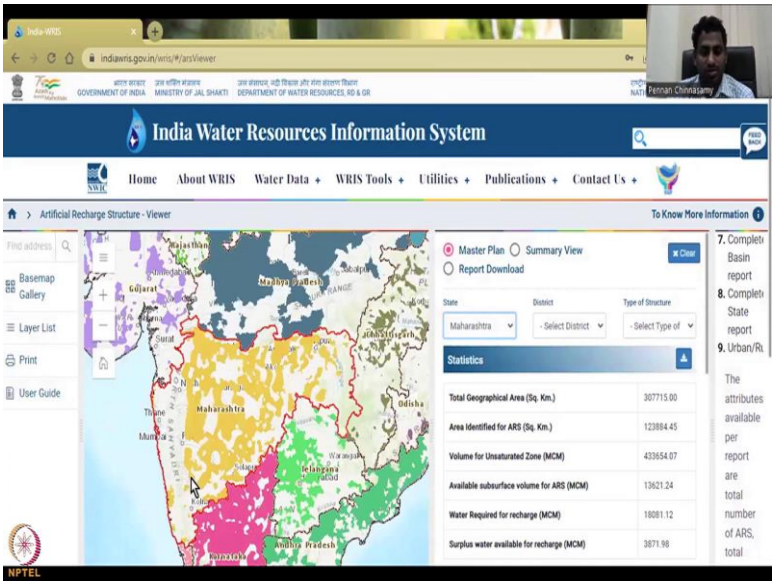

Now let us take one state for example, I will say Maharashtra. When you click Maharashtra in the state here you could see then the map would zoom into Maharashtra state and then you can pick as a district. So, you can see the red color happening, but once this is picked this area, total area everything has changed to Maharashtra statistics. Initially it was India statistics now it has Maharashtra statistics.

So, you can see that more than 1 3rd of the area is mapped for artificial recharge structures, a very good volume can be captured as per this data, water required for recharge is around 18 billion cubic meters all these are per annum. So, every year how much happens? And then so, how much is available when they do a surface water for recharge. So, what is the difference between these two, all these have been done like a water budget to estimate you can put these structures but is there water available? So, what it says is volume for unsaturated zone is around, I will not tell the numbers is too large, let us say 43 units, and then we have available subsurface volume for ARS. The ARS is Artificial recharge structures is around 13 billion cubic meters out of which you have water required for to populate to recharge this, you need around 18 billion cubic meters of water.

And still there is surplus water, they are saying, how they arrive at this, you can go to the user guide, and then download all the method they use for this data.

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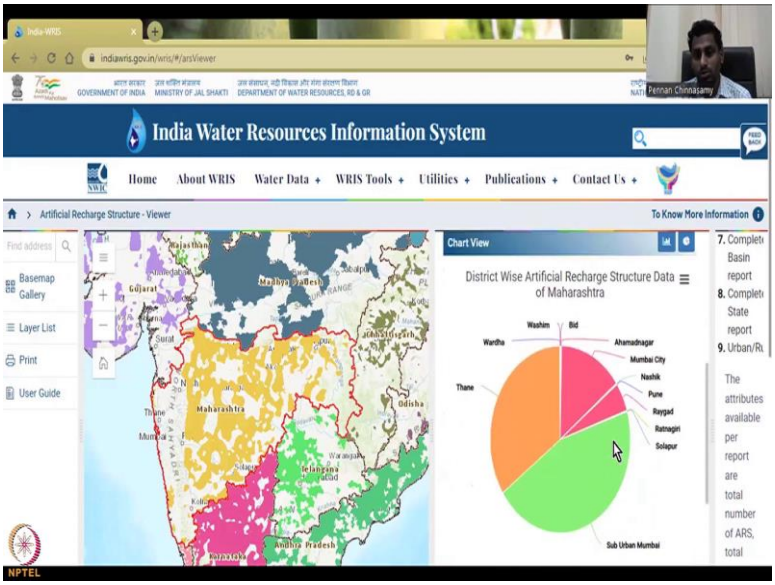

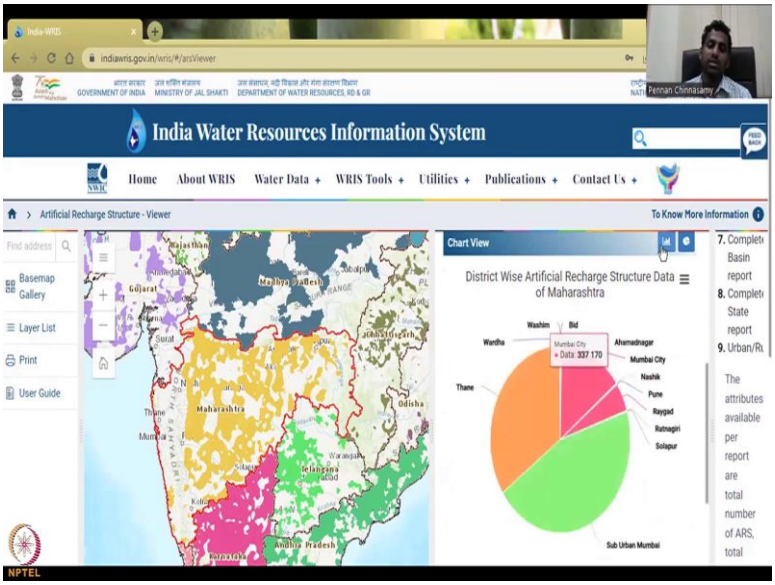

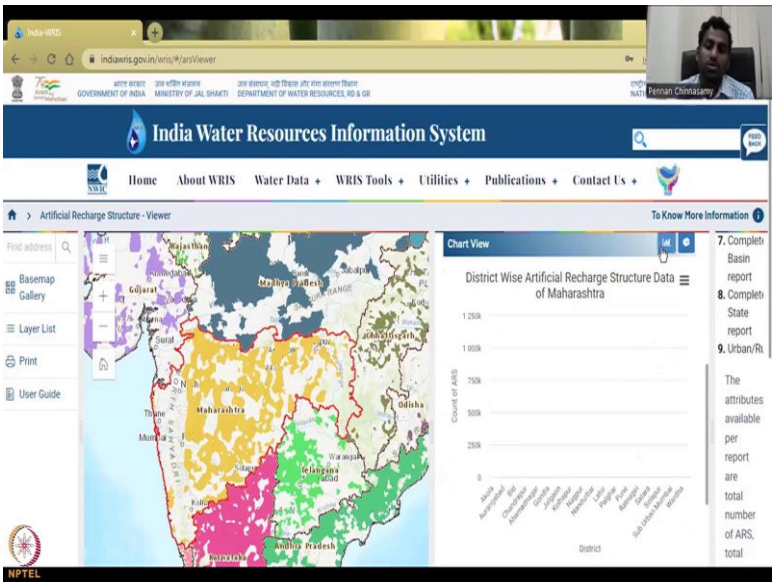
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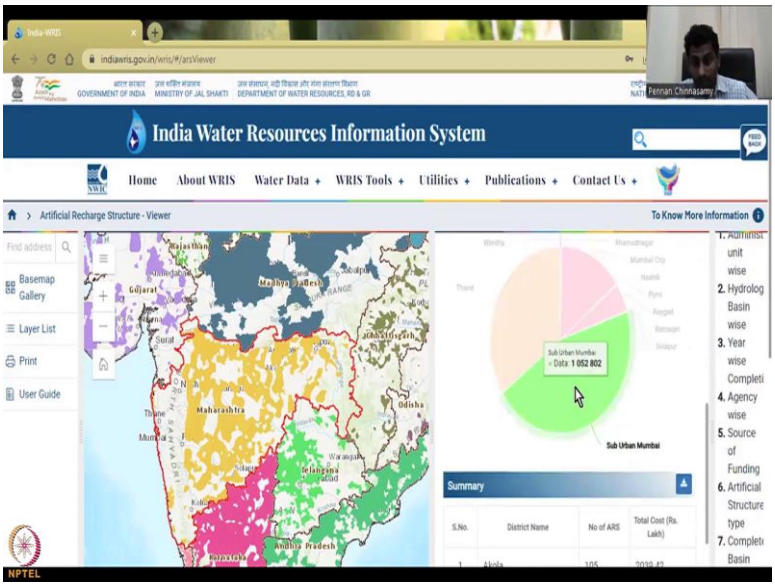
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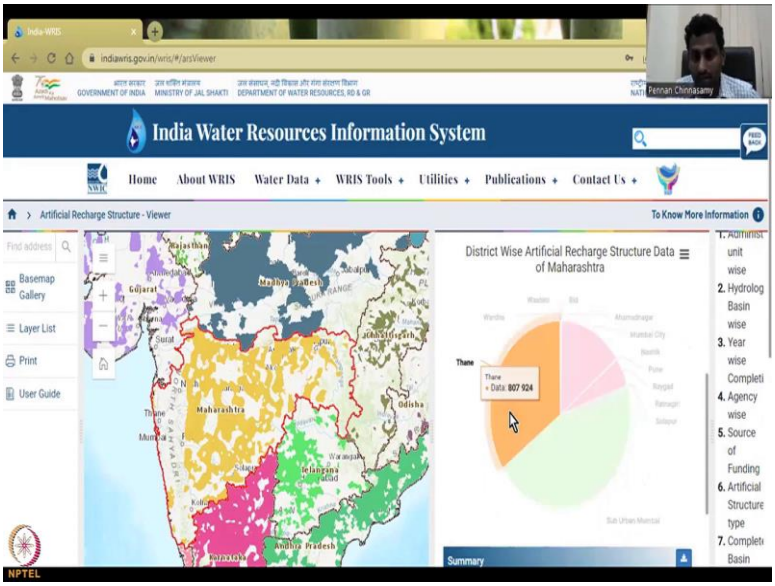
S.No.
District Name
No of ARS
Total Cost (Rs. Lakh)
1. Administ unit wise
2. Hydrolog Basin wise
3. Year wise Completi
4. Agency wise
5. Source of Funding
6. Artificial Structure type
7. Complete Basin
NPTEL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Thane
Data: 807 924
Summary
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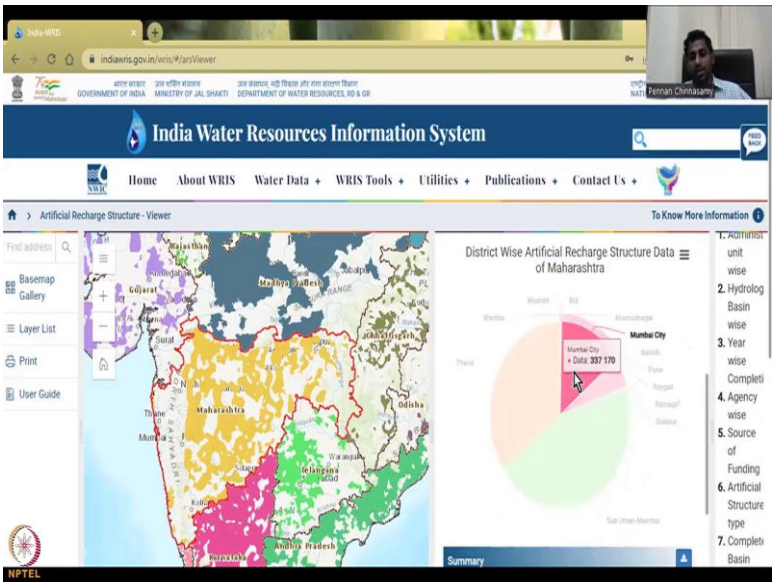
4. Agency wise
5. Source of Funding
6. Artificial Structure type
7. Complete Basin
NPTEL

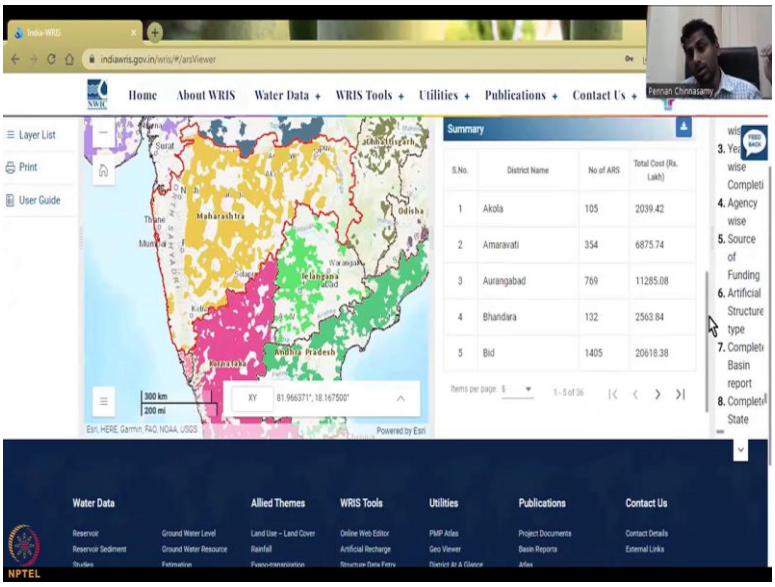


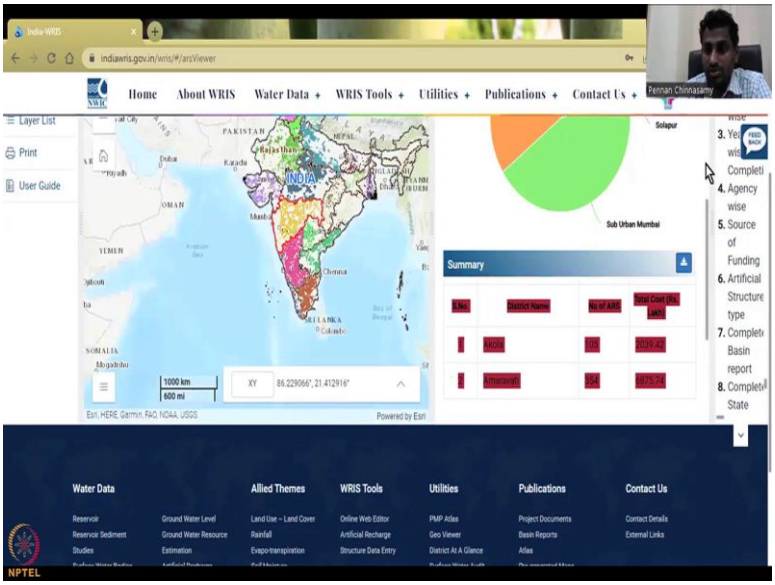
I am going to come down to, where in Maharashtra they did, you can see now it automatically populates the Maharashtra data, I am going to just click the graph to see if it is working, it is not. So, do not worry about it, it is the count of ARS, the count is not zero, there put a lot of money. So, here it is the count.

So, sometimes as I said, the websites do have some hardware software issues, So, please excuse them. And then you could see how and where these structures have been put. So, a total number of structures, you can come down on this list to get the total number, but most of it is in suburban Mumbai, and then Thane, and then Mumbai city, etcetera, etcetera.

See, this is not only for rural water, because this website has all the data that can be housed. And most of it is Solapur, Thane, where is the agricultural districts, and that is where you see a lot of water structures that have been promised and put. Let us take one for example. Let us take Thane and Sub urban movement also you will see a lot of agricultural activity.

(Refer Slide Time: 18:08)

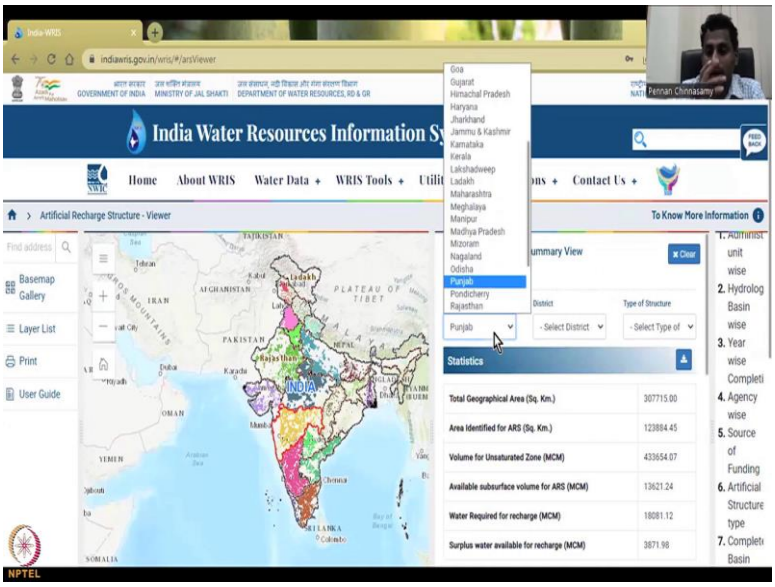


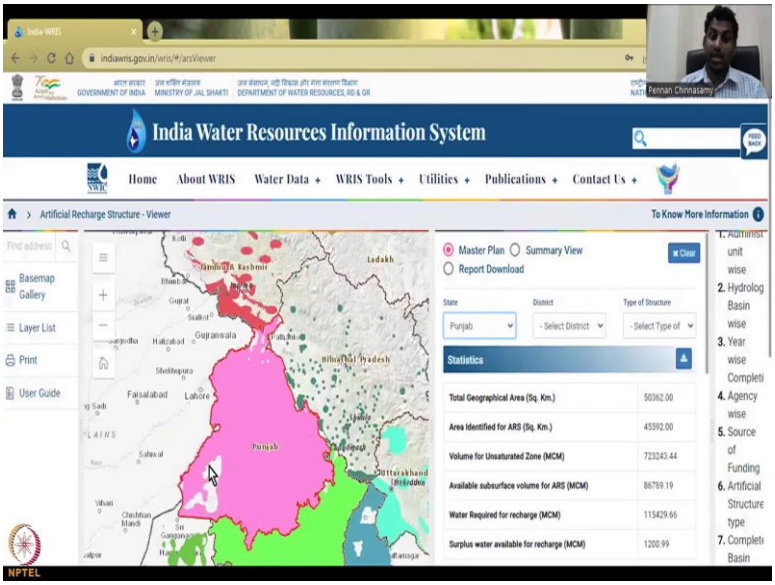


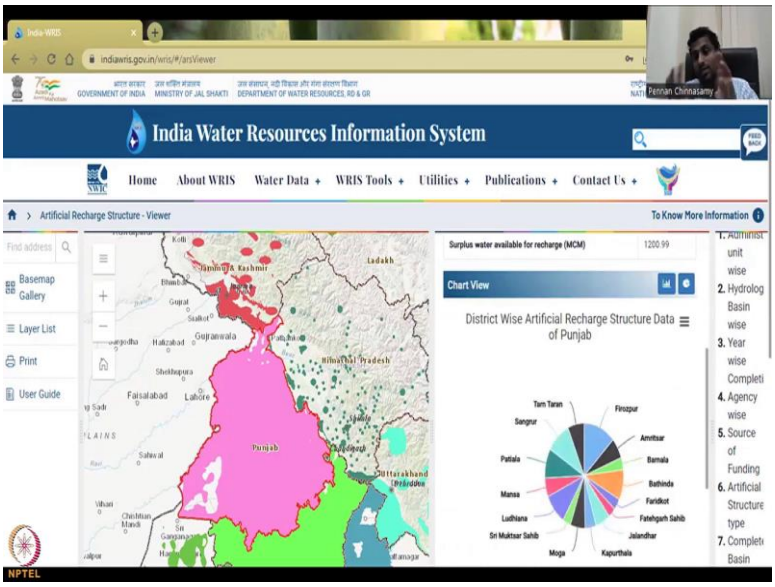
So, IIT Bombay where I am in, is also kind of suburban Mumbai, but just within a kilometer So, you get a lot of agricultural activity in small small pockets.

So, I am going to come down to a particular data, let us say Amaravati, number of ARS 354. So, 350 structures have been built at a whopping cost of 68 crores, So, 354 at 68 crores has been built and maintained in the Amravati district. So, like this, you could actually go down to see where the recharge structures money has been put. And if you want to map them, there is one website in the given, ISRO where you can go down and map exact locations of these.

(Refer Slide Time: 19:07)





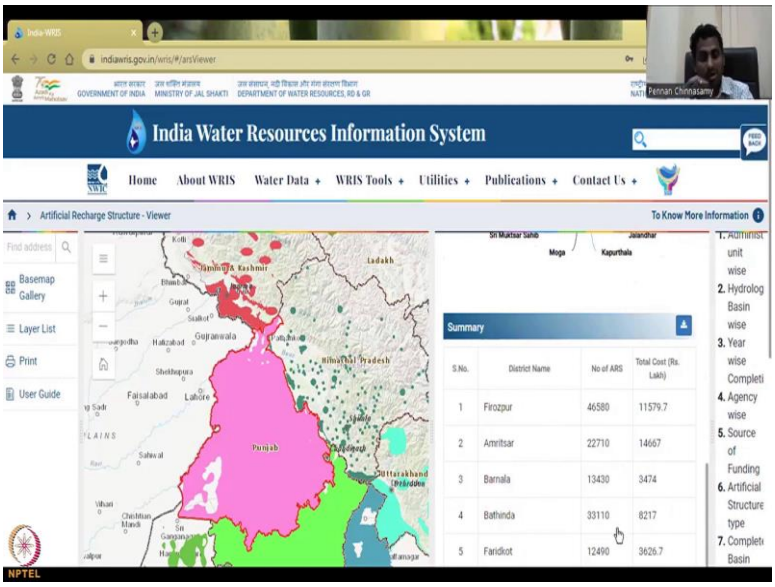


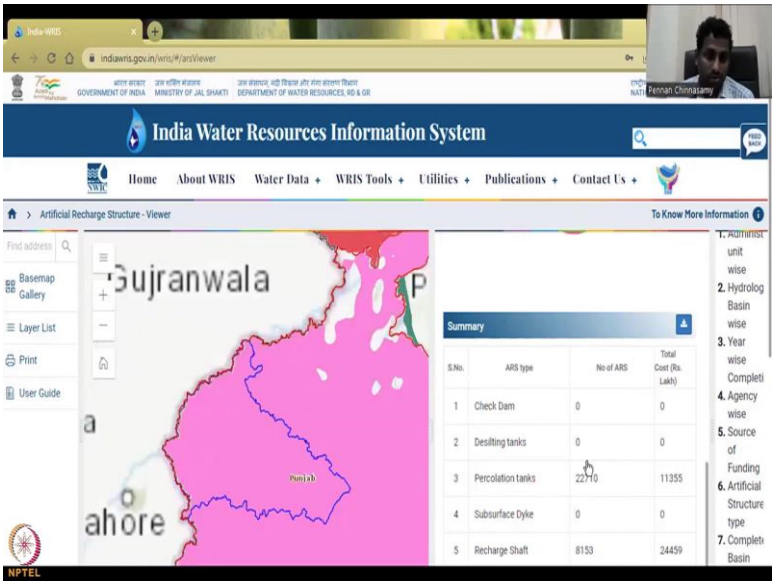
I will just like to do one more, because Rajastan or Punjab, let us say Punjab is kind of highly groundwater depleted as per the groundwater data. So, you could see that entire area is mapped for ARS, because it is, it was initially very fertile land. It was all the five water bodies coming together. That is what Punjab was named after. And then you could see that the fertility is gone because tremendous activity agriculture activity has been happening and the water resources also are diminishing.

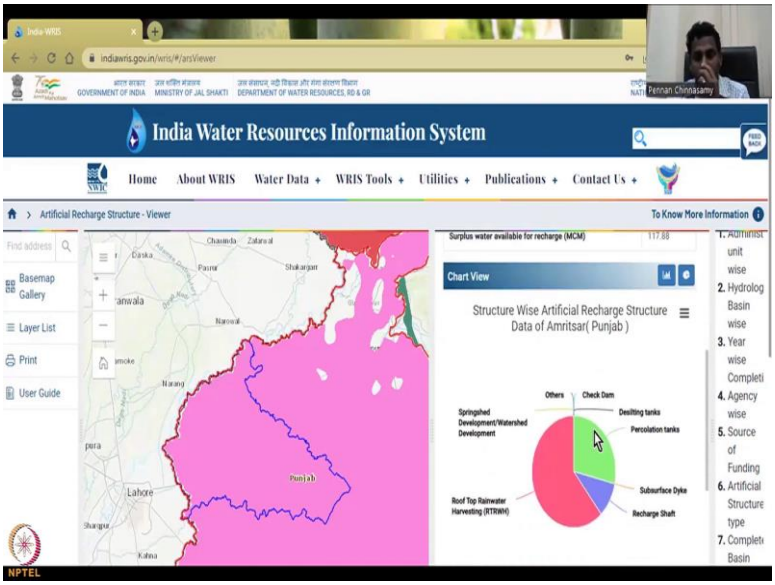
So, in Punjab, you could see that that is why one of the reasons they did extra work on it to see how much area is there for groundwater recharge and you could see that almost entire area is mapped. Out of the 50 or 45, almost 90 to 92 percent, 95 percent is going to be having these structures. Then the volume was assessed and then how much rainfall coming in how much rainfall goes into the aquifer, all these has been mapped, is it going or not is not the question because here it is just a potential mapping for these recharged structures and sources.

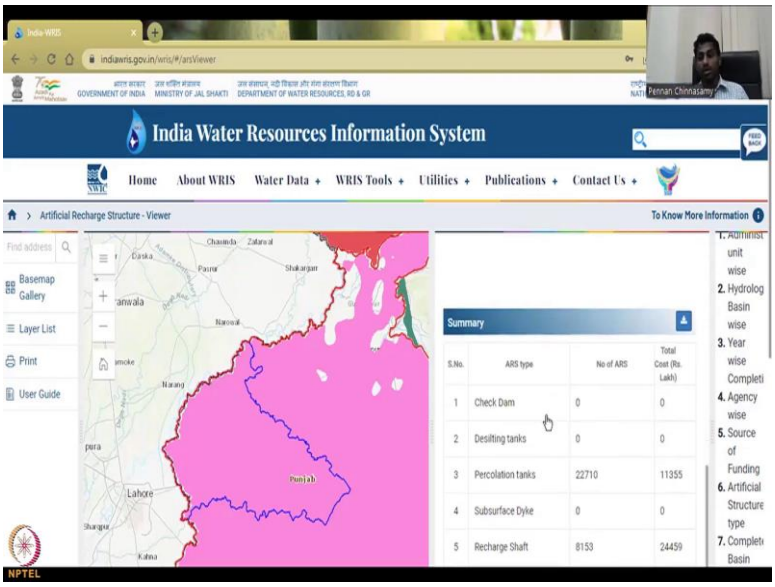
So, you could see that almost all districts, the wheel is more distributed, it is not like concentrated on one district, you could see that the money has been spent across all those districts.

(Refer Slide Time: 20:40)





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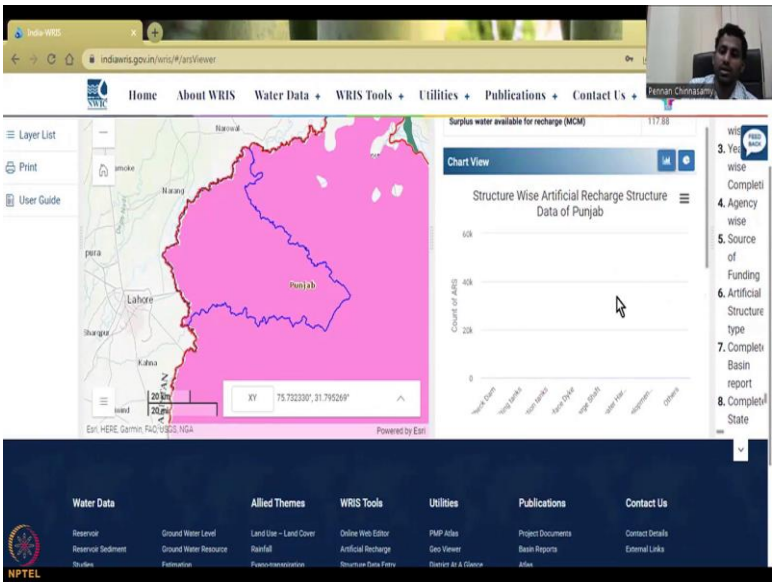
S.No.
ARS type
No of ARS
Total Cost (Rs. Lakh)
1 Check Dam 0 0
2 Desilting tanks 0 0
3 Percolation tanks 22710 11355
4 Subsurface Dyke 0 0
5 Recharge Shaft 8153 24459
1. Administ unit wise
2. Hydrolog Basin wise
3. Year wise Completi
4. Agency wise
5. Source of Funding
6. Artificial Structure type
7. Complete Basin
Lahore
Punjab
NPTEL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Surplus water available for recharge (MCM) 117.88
Chart View
Structure Wise Artificial Recharge Structure Data of Punjab
Count of ARS
60k
40k
20k
0
Lahore
Punjab
XY 75.732330°, 31.795269°
Esri, HERE, Garmin, FAO, USGS, NGA
Powered by Esri
1. Administ unit wise
2. Hydrolog Basin wise
3. Year wise Completi
4. Agency wise
5. Source of Funding
6. Artificial Structure type
7. Complete Basin report
8. Complete State
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Reservoir
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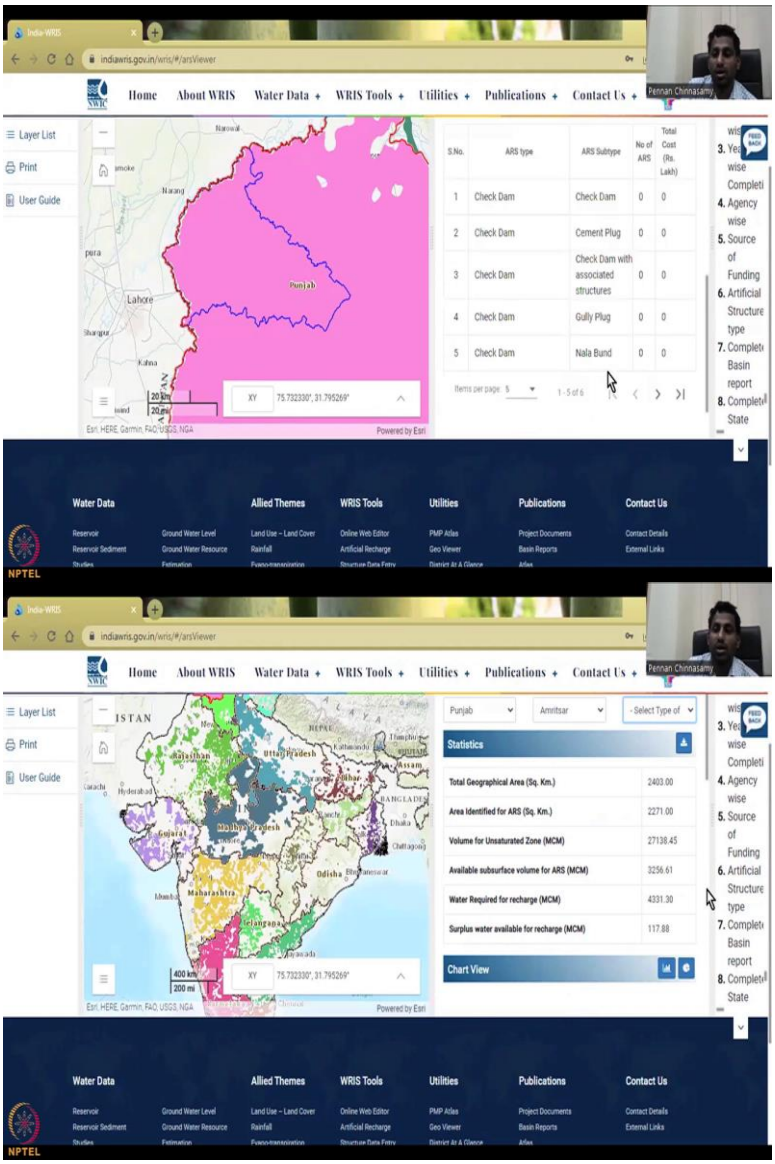


And you could see that the number is also given here. The number and the cost might differ based on the size of the district and you could also go to a particular district. So, now, what I am going to do is I am clicking Amritsar in the district. So, Punjab I click, then I have clicked Amritsar, I can check anything I would like. But let us click Amritsar. See once you click it goes, the map goes to that area, but since Amritsar is pretty big, we will have more options.

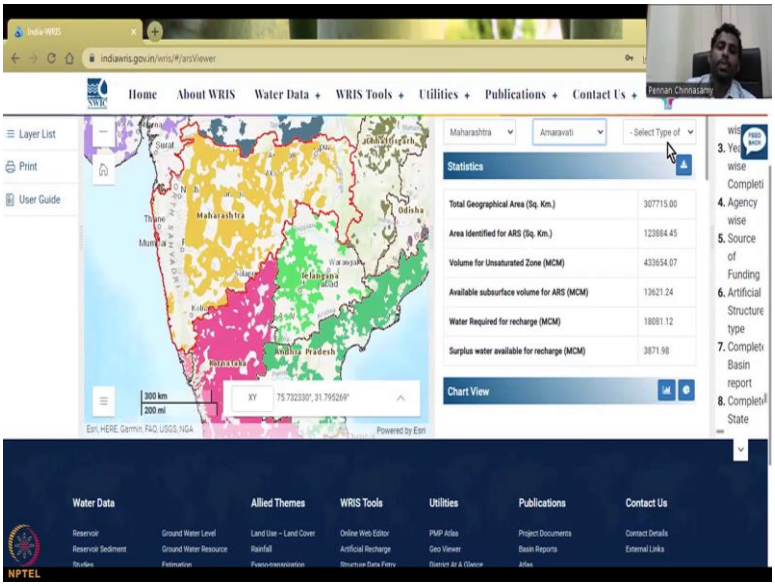
So, I am going to go to Amritsar. So, we are here in Amritsar. So, the red was Punjab this selection, then the selection is Amritsar, the blue line, which is the district then you can actually select what type of structure you want to see the performance and analytics. Here it is a total statistics, which is the same, but now it is at a district level. Initially it was national level, then we went to state level.

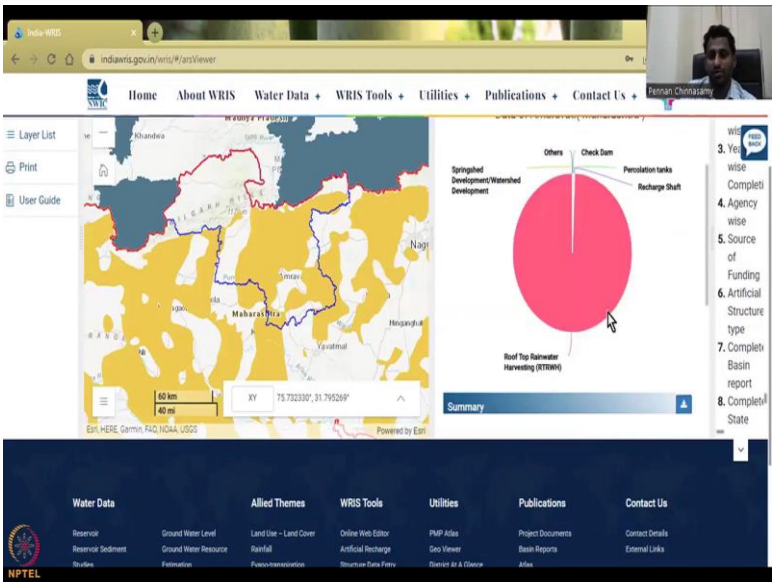
Now district level, if you come down. Now you could see the type of structures initially it was number, how many are there, per district here, you are going to see type within the district how many So, you could see rainwater harvesting is really high, check dams, desilting tanks, percolation tanks, subsurface Dyke, Recharge shaft. I am happy that most of these were already discussed in the class. So, you have now an understanding of what is a check dam, what is a rainwater harvesting? What is the percolation tank, recharge shaft, everything has been covered in the class.

You could come down and see there is not much check dams. Almost 0 because maybe there is not a flowing river, they wanted but a lot of percolation tanks to recharge groundwater and recharge shaft has been built. So, this is how you could view the data, let me click on the see the graph line graph is not working, the column graph is not working, but this is working just fine. So, this is going per district. Now let us select a check dam. So, now what is going to happen is this data is the same for the district does not change.

So, the check dam will be now populated here were number of check dams in Punjab, and it is not coming. It is not coming, that is fine. So, I would say that you could, leave this part open, which is select type of structure, then what would happen is all the structures in that particular district is going remapped. I think that would be enough, that is a pretty good data, you can download it as an Excel, etcetera.

(Refer Slide Time: 23:37)

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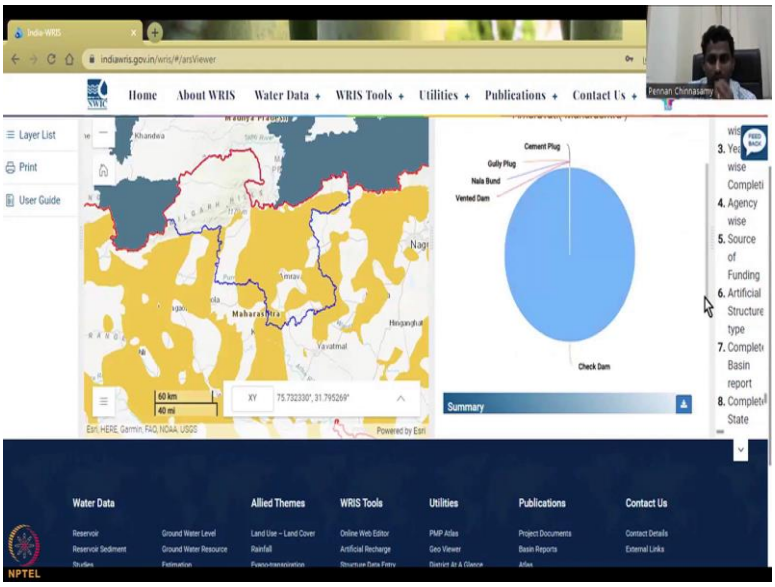
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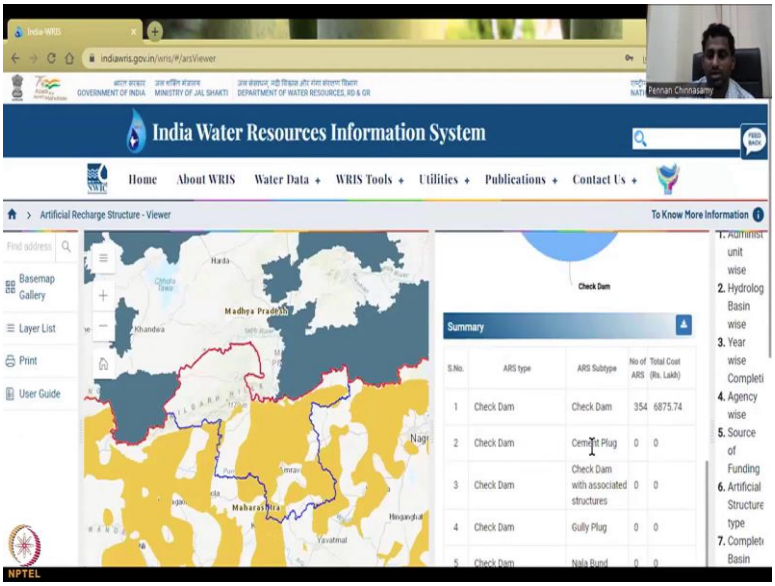
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S.No.
ARS type
ARS Subtype
No of ARS
Total Cost (Rs. Lakh)
1 Check Dam Check Dam 354 6875.74
2 Check Dam Cement Plug 0 0
3 Check Dam Check Dam with associated structures 0 0
4 Check Dam Gully Plug 0 0
5 Check Dam Nala Bund 0 0
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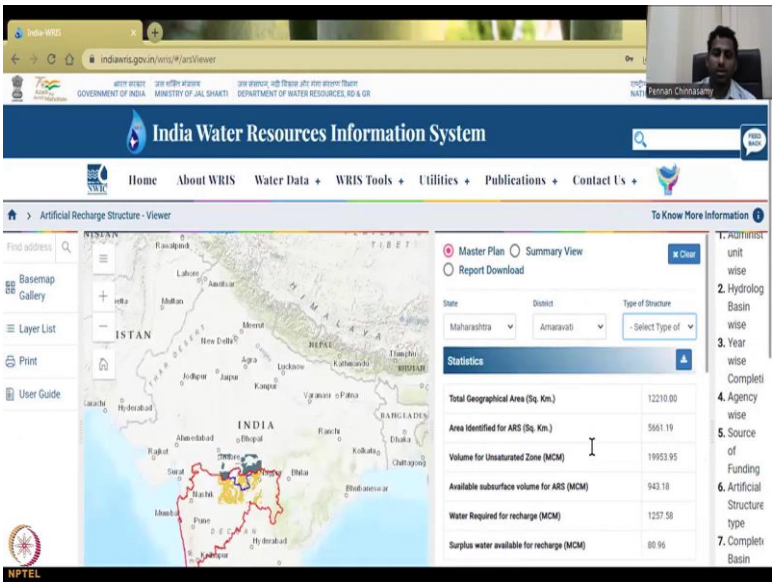
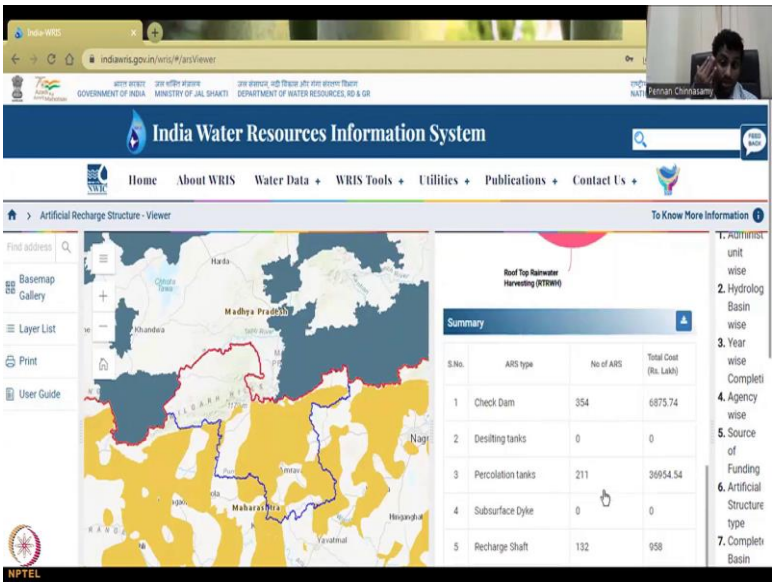


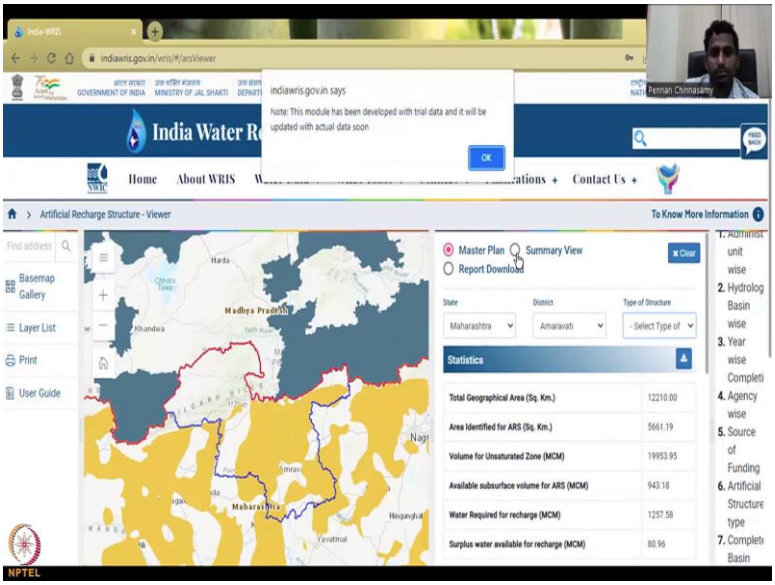


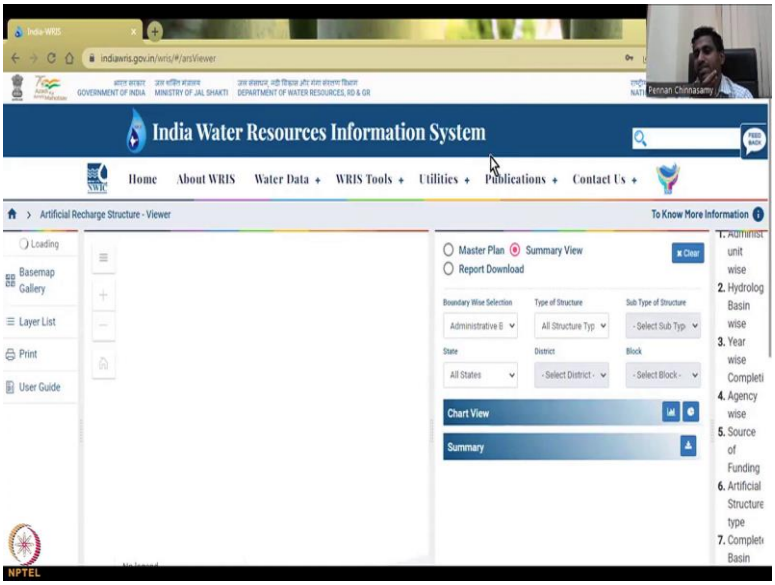
So, let us try quickly check another district in Maharashtra to see the structures are working, let us say Amravati and it might work one day, it might not work the other day. So, do not think that it did not work today, it will not work tomorrow or something. Keep checking if you want a data and if we say the data is there, I would recommend you to check the data of, So, here just because we click Check dam, only the check dam data is given here, you see that 354, that is where I am trying to say, do not click that just keep it open to all structures, select type of structures then it will go back to India, go back to Maharashtra and then it will come zoom to Amaravati.

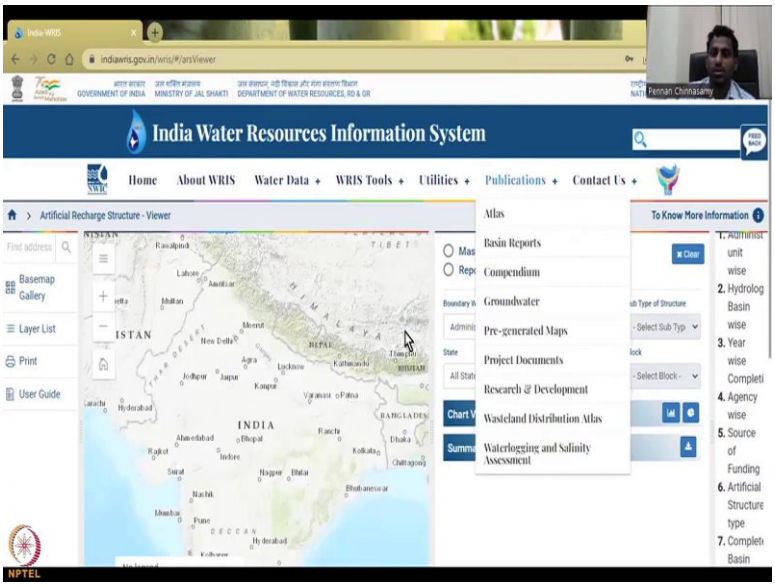
So, automatically it does it and then the types all the types are being mapped here. So, rainwater harvesting is a 354 check dams, you see the number did not change, and the

budgets are given here. The budgets are very important to understand how the government has spent money on these structures.

(Refer Slide Time: 24:38)



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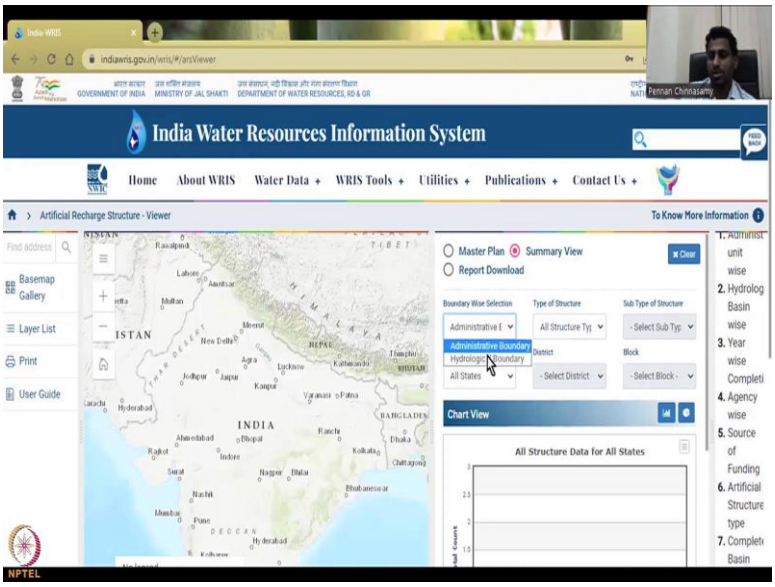
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Select District
Select Block
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All Structure Data for All States
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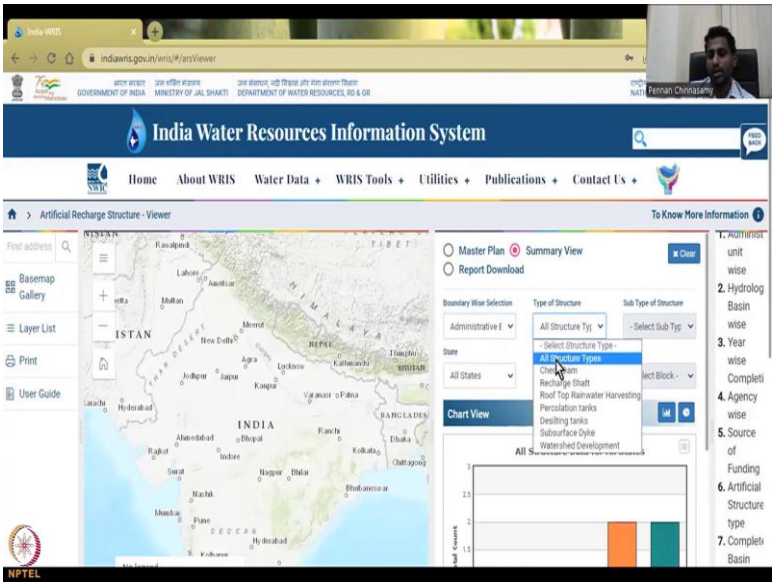
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Watershed Development
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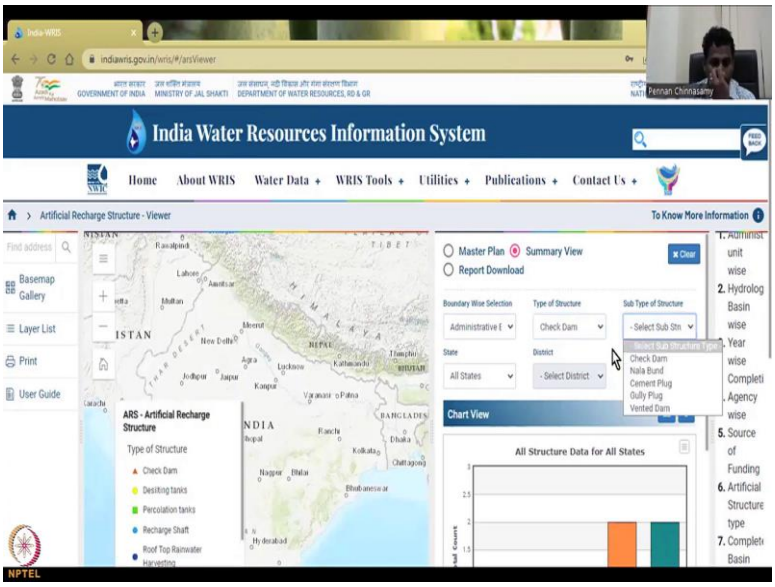
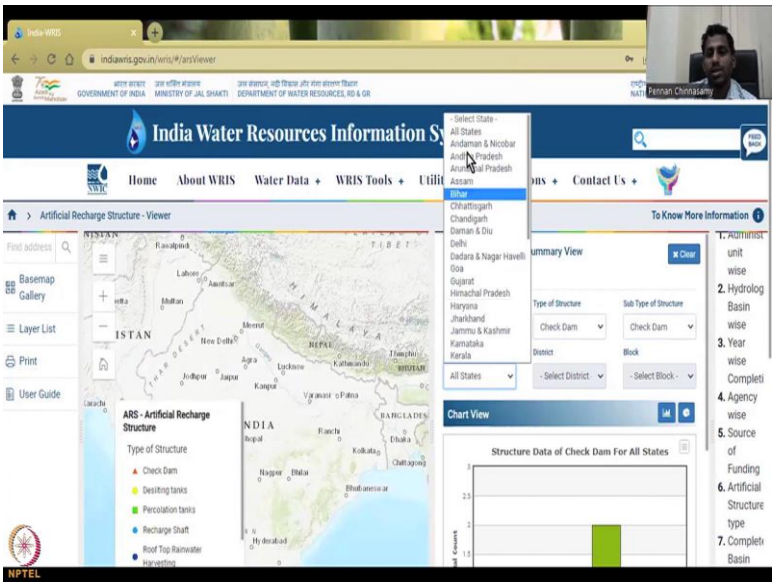
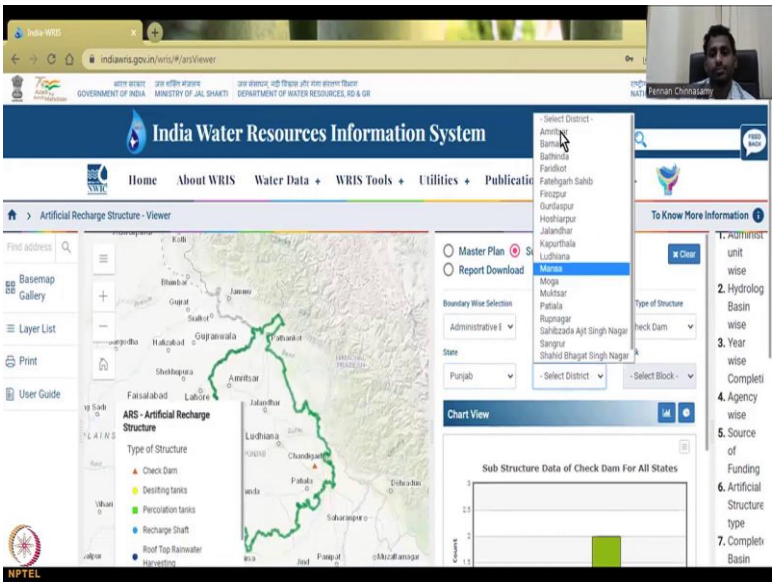
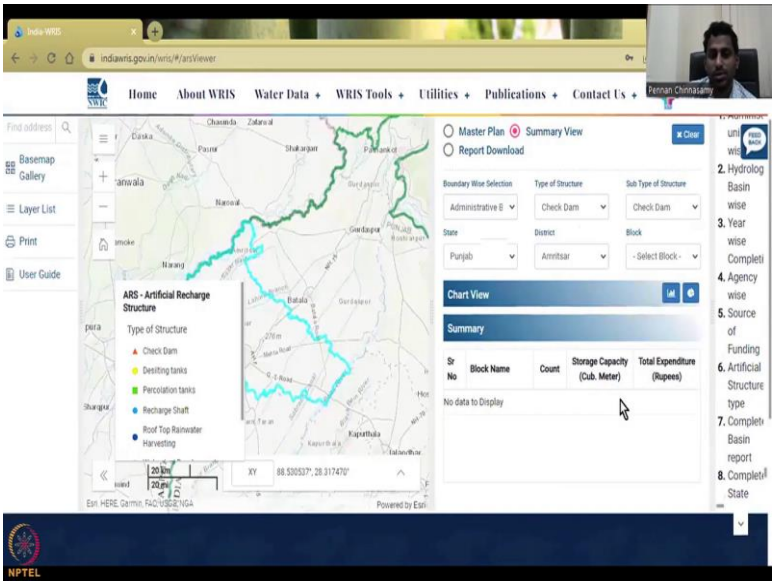


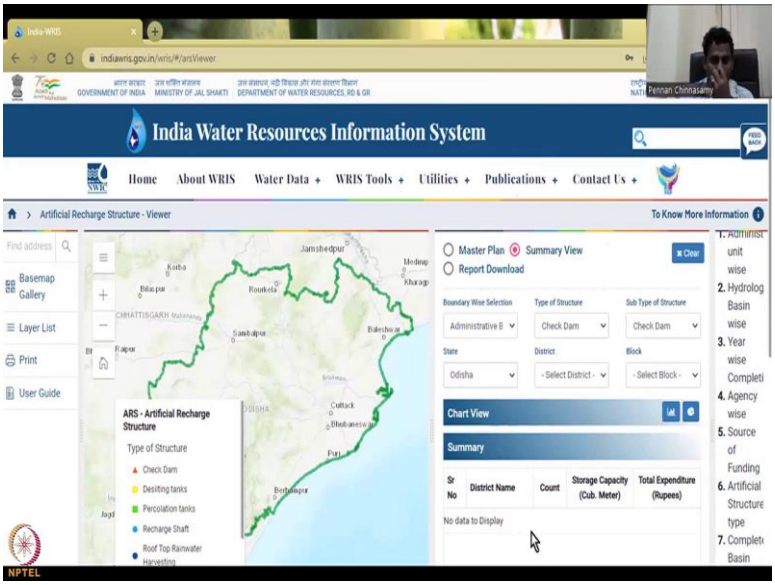


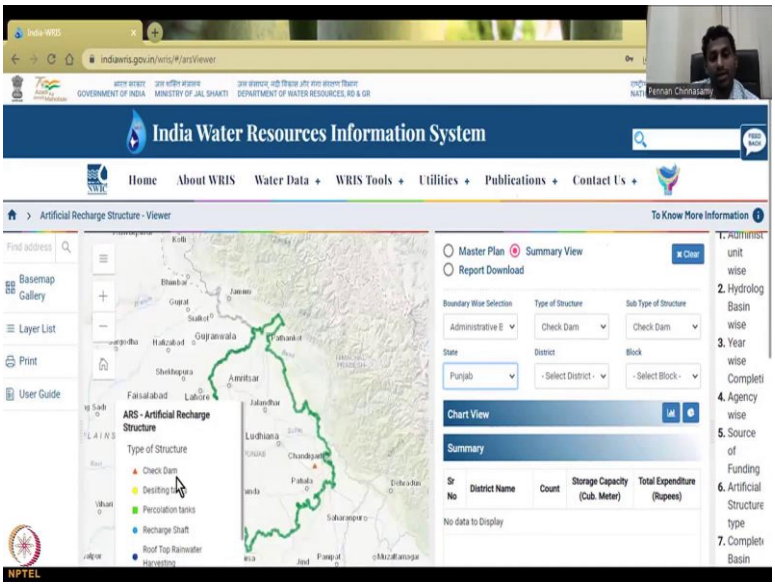
So, you can also do a summary view. See now when I click the summary view, it says it is developed, this website, this web page has been developed using a model module data, trial data. So, actual data will come soon, but now you could see what are they working on if you click okay. You See some summaries about these structures, some boundary, administrative or hydrology. And then type of structures, check dam, sub structure, check dam, you can select Punjab and then we went to Amritsar.

(Refer Slide Time: 25:23)





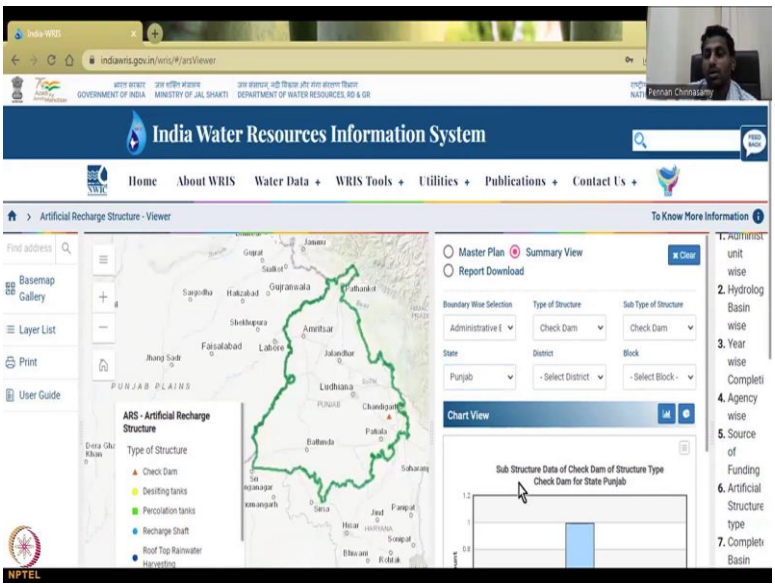


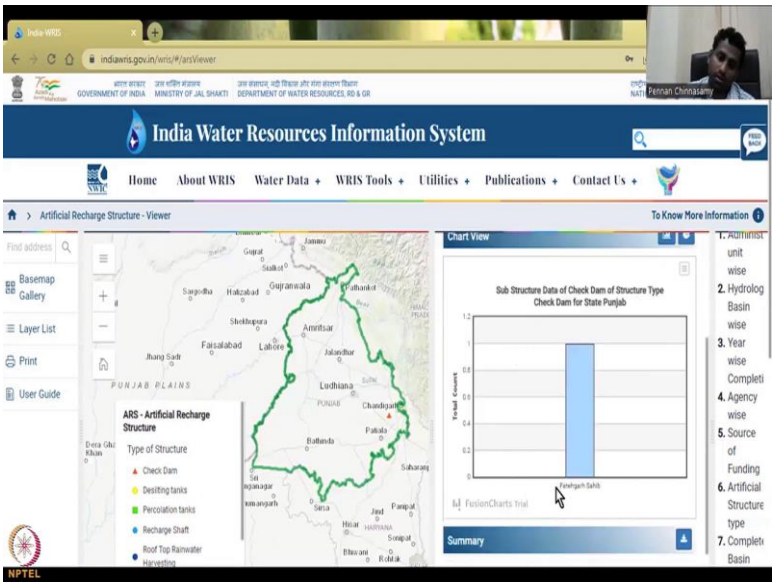


You can also go for blocks, at a block level where the data is available. Now it is not coming but it is okay, so, as it was saying it is still a trial data, no data to display, but we could keep all the districts just to say let us say Odhisa and it is no data to display. So, it is here not fully operational.

I will go back to Punjab and then show you that they have made a legend you can see the legend has been made and if how you come down and up is, just move your mouse to that table and then scroll up-down, then this automatically starts to work, the slider.

(Refer Slide Time: 26:19)

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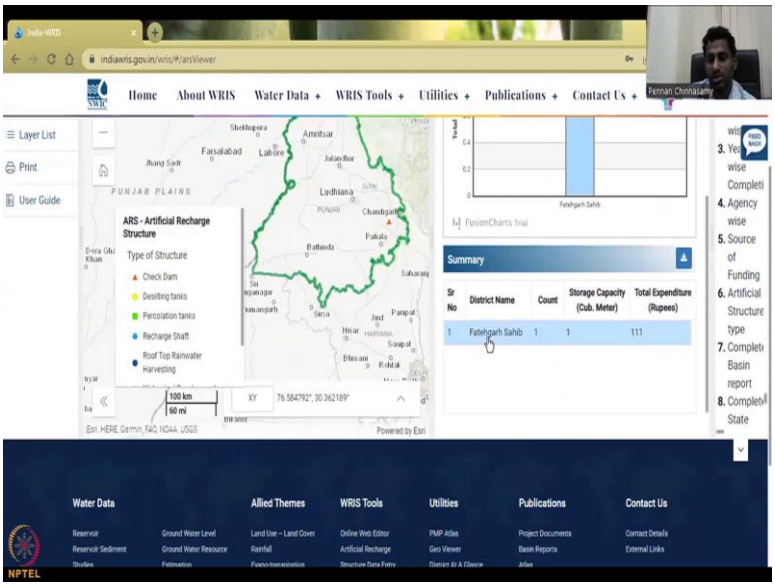
Roof Top Rainwater Harvesting
Chart View
Sub Structure Data of Check Dam of Structure Type
Check Dam for State Punjab
Total Count
Fatehgarh Sahib
FusionCharts Trial
Summary
1. Administ unit wise
2. Hydrolog Basin wise
3. Year wise Completi
4. Agency wise
5. Source of Funding
6. Artificial Structure type
7. Completi Basin
NPTEL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ARS - Artificial Recharge Structure
Type of Structure
Check Dam
Desilting tanks
Percolation tanks
Recharge Shaft
Roof Top Rainwater Harvesting
FusionCharts Trial
Summary
Sr No
District Name
Count
Storage Capacity (Cub. Meter)
Total Expenditure (Rupees)
1
Fatehgarh Sahib
1
1
111
Esri, HERE, Garmin, FAO, NOAA, USGS
Powered by Esri
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Ground Water Resource
Land Use – Land Cover
Rainfall
Online Web Editor
Artificial Recharge
PMP Atlas
Geo Viewer
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Basin Reports
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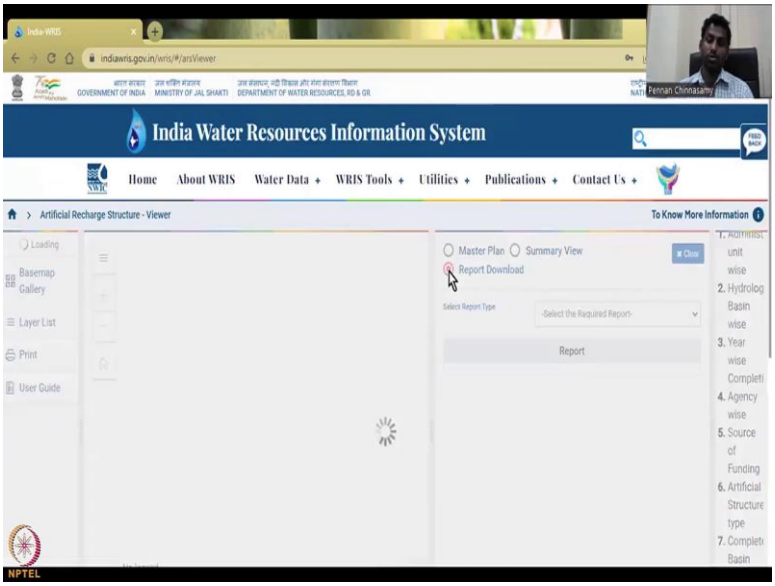
External Links
1. Administ unit wise
2. Hydrolog Basin wise
3. Year wise Completi
4. Agency wise
5. Source of Funding
6. Artificial Structure type
7. Completi Basin report
8. Completi State
NPTEL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-Select the Required Report-
Report
1. Administ unit wise
2. Hydrolog Basin wise
3. Year wise Completi
4. Agency wise
5. Source of Funding
6. Artificial Structure type
7. Completi Basin
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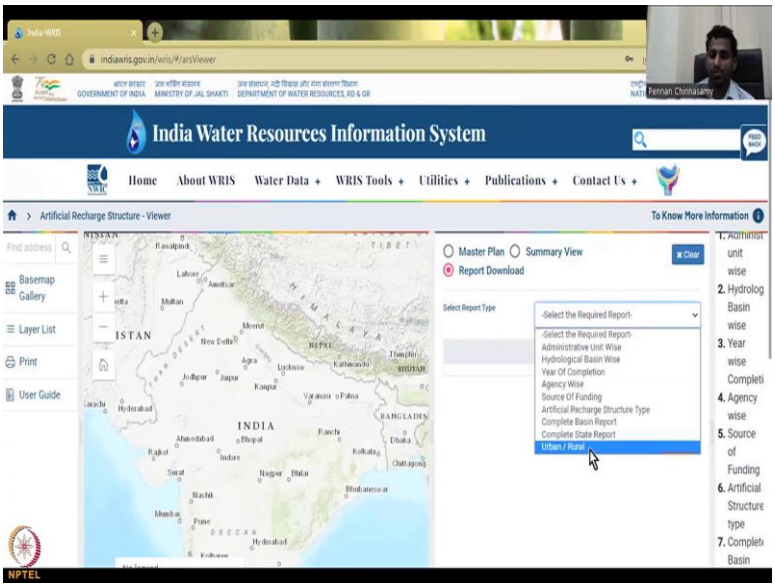
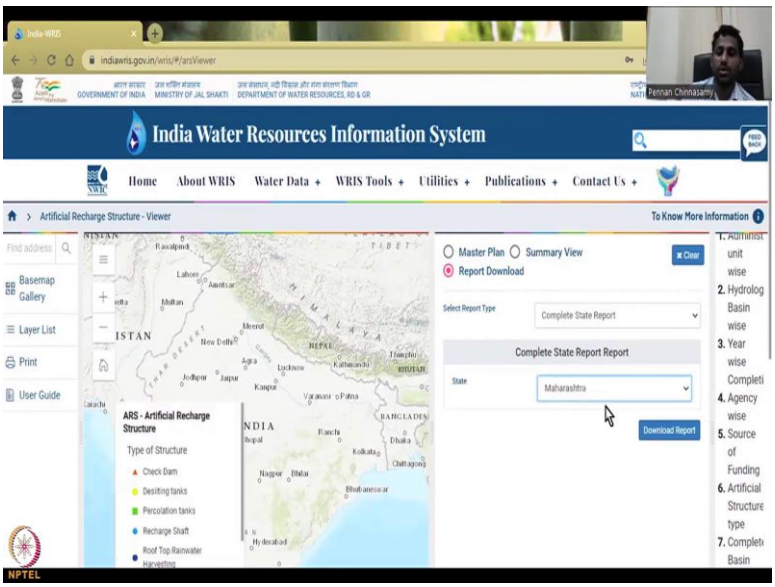
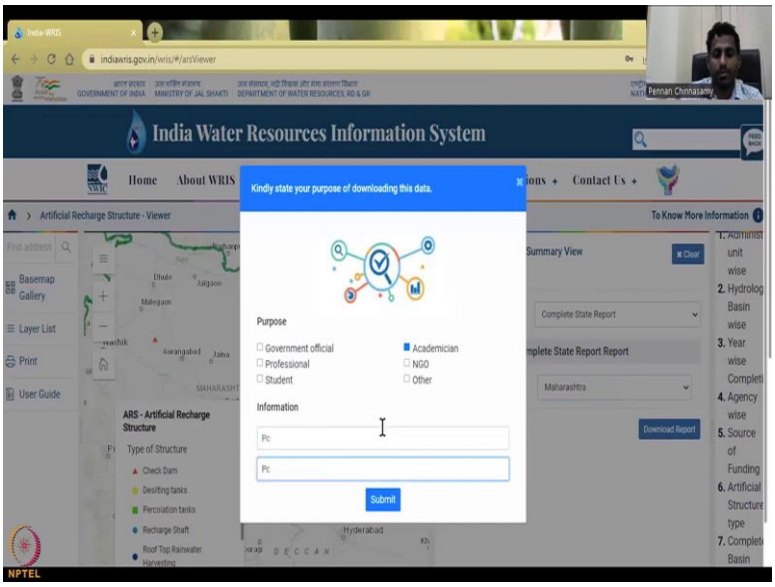
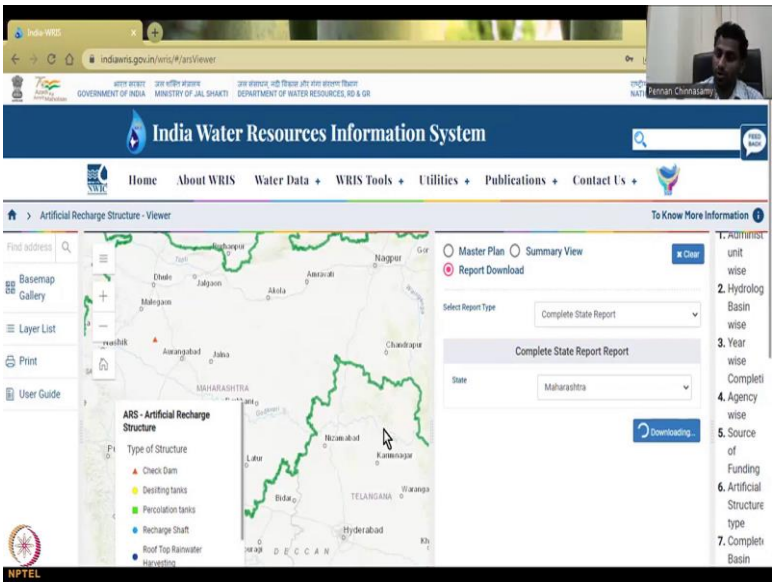
If it is too in front of your image, you can just move it like this to see it. So, now what I am going to say is you can see that the total count at this particular area is number of sub structures and the type of structure in Punjab is around one. So, all this is trial data. The district name is Fatehgarh Sahib and all these are trial data expenses. You see 1 1 1 all this are trial but again, what I am trying to say is do not ignore it, maybe go back every week or a month and this data will also be populated soon. Again, you can also download reports which is also still working on trial data.

(Refer Slide Time: 27:05)









And you could select what type of report you want, Year of completion of artificial structure, Administrative unit wise, Basin wise, etcetera, etcetera. You could say complete state, which state you want, you can say Maharashtra, and download the report. The report come as a PDF as you would like to see. Academician, the report will not have much information because they are still using trial data, they want to first see if the system works.

So, I would recommend you to go ahead and look at these structures where they have been populated and also is it useful for your research in terms of understanding the groundwater etcetera. So, with this I would like to conclude today's lecture. I will see you in the next class. Thank you.