Rural water Resources Management
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Centre of Technology Alternatives for Rural Areas
Indian Institute of Technology, Bombay
Week 12-Lecture 02
Rural Water Databses – Soil Moisture

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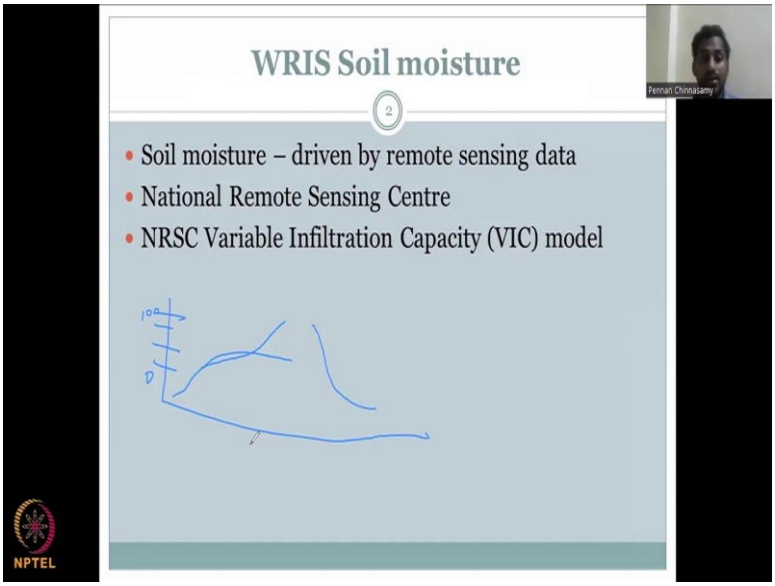

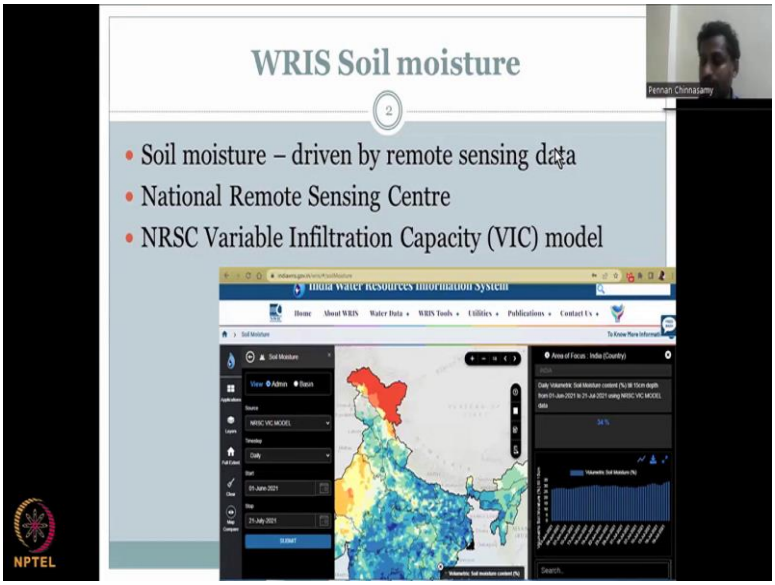

Hello everyone, welcome to NPTEL course on Rural Water Resource Management, this is week 12 lecture 2. In this series of lectures in week 12, we are looking at the final data that is needed for putting a water budget for water resource management. Along this course, we looked at different water data that is needed, why it is needed? We looked at conservation techniques, and we also looked at important aspects of water management. Now, we will look at why this is important in terms of water management and rural livelihood sustainability options.

In the last lecture we look at the hydro metrological data that included your rainfall and other aspects groundwater levels etc. In this week, we will be looking at the other aspects of the groundwater and rural water hydrology and the most important is your soil moisture driven by remote sensing data. Why is it driven by remote sensing data?

There are estimates that we will look at. So, normally you will have to have soil moisture measured at different depths and we understood that, in the soil class we understood that there is a particular volume of water that needs to be present inside the pore spaces of the soil for plant to grow. So, which means you have a depth of soil and the volume of the water changes.

So, it increases with depth, if you go from 0 to 100 or is it decreasing the depth if we go from 0 to 100 centimeters, all these are both are possible in a soil profile. So, there is a need of putting meters at regular intervals and measuring soil moisture. However, it has become very expensive and it is not especially representing the poll area. And for that reason, there has been an introduction of using remote sensing for soil moisture, which is driving these estimates for soil moisture. Basically, remote sensing is the process of collecting data from an object without touching it.

So here we go, we are not going to go under the ground, and however, the satellite or the remote sensing object can penetrate through the soil and estimate properties of the soil water column. It is driven by radar principle, but let us not get into the depth of the how the data is collected. Right now, it has been well used worldwide for assessing the soil moisture in the soil profile.

Now, if we know the soil moisture and the soil profile, we are at a very healthy stage to irrigate or not irrigate, take decisions basically. And that is where this WRIS soil moisture data housed in the WRIS website can have. There are multiple other ways that you could get this data, satellite driven data, observation data, etc. However, there is no one single database that stores all the data.

And for that reason, we are keeping this as an option for water management. So, where we can go to this database update, so I am only going through the database within the WRIS website, but as I said, there are multiple other resources that can be the same data or even better resolution temporal extra. Right now, the one we have is pretty good enough and from there, we can take a lot of understanding. We will go through the data profile right now.

So, it is led by the NRSC to the ISRO. So ISRO has multiple application centers for satellite remote sensing application, the SAC, NRSC and RRSC where NRSC, stands for National Remote Sensing center, SAC stands for Space Application Ccenter and RRSC stands for Regional Remote Sensing Center.

So, these are centers within ISRO where they take remote sensing data, they apply it to the ground and get estimates of properties, parameters, etc. There has to be some validation which they should have done in the modeling stage or data acquisition stage. So, the NRSC has used a variable integration capacity model, VIC in short.

So, what it does is it takes satellite data it is like a model like a box you can assume, it takes the satellite data, different hyperspectral images and also the data from radar and then estimates the soil moisture property and gives it as an output. This is how the soil moisture profile looks like in the WRIS website. So, we will get through it and see how this website is done.

Sometimes there are some changes, so, you will not see that entire website similarly, for example, last days I was trying to get this website but there was some issues luckily it is working now, so, I will be happy to show it live in class. So, that you can also estimate these properties at district level and also sometimes block level.

What you can see here is at every district you have some soil moisture values and soil moisture can be from anywhere from 0 to 100 percent which is the pore space; the pore space that we discussed in the soil can be filled with air or water. If it is 100 percent water then it is saturation. If it is 0 percent water then it is unsaturated totally unsaturated.

If it is in between we will still call it unsaturated depending on the percentage. So, there are some percentages that the plant likes depending on the soil. For example, if it is 100 percent water then the plant will suffocate it cannot breathe your so much water same like us, we like water to drink, but if we are putting a swimming pool, we can survive for some time, but then after that we need to come out. So, similar things where if it is too much water, it cannot breathe, the plant cannot breathe and the roots will decay and suffocate. So, it is necessary to understand if you have to drain the soil or water the soil and this dataset helps you in managing that.

Now, if you have this information, you can plan ahead on your irrigation schedule or if you need to buy groundwater as in pump water out and then put it or how much water is needed

for your crops, because you have the current soil moisture and you have to increase it by a percentage for your plant to grow. So, with this, let me open the webpage so that we could look at it, it is the WRIS website.

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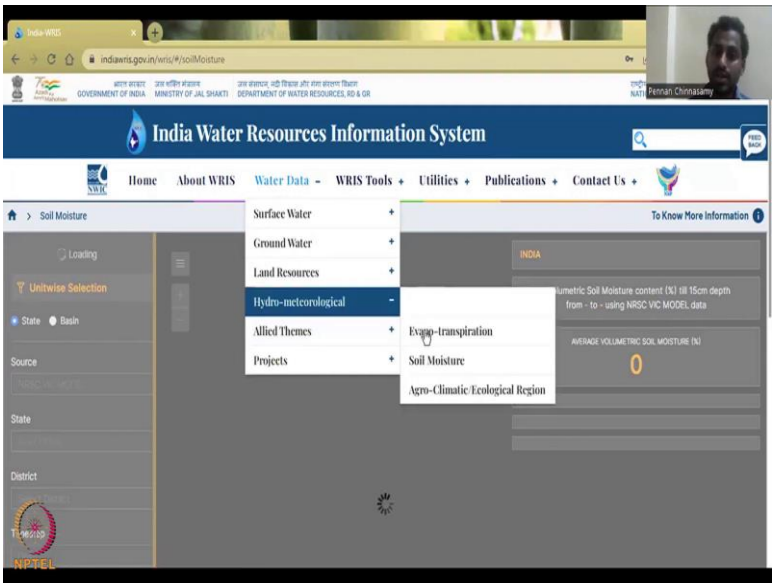

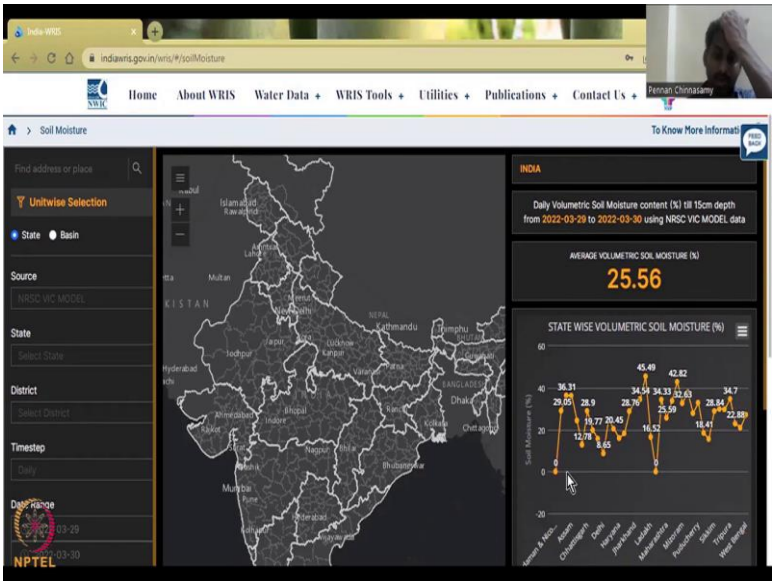

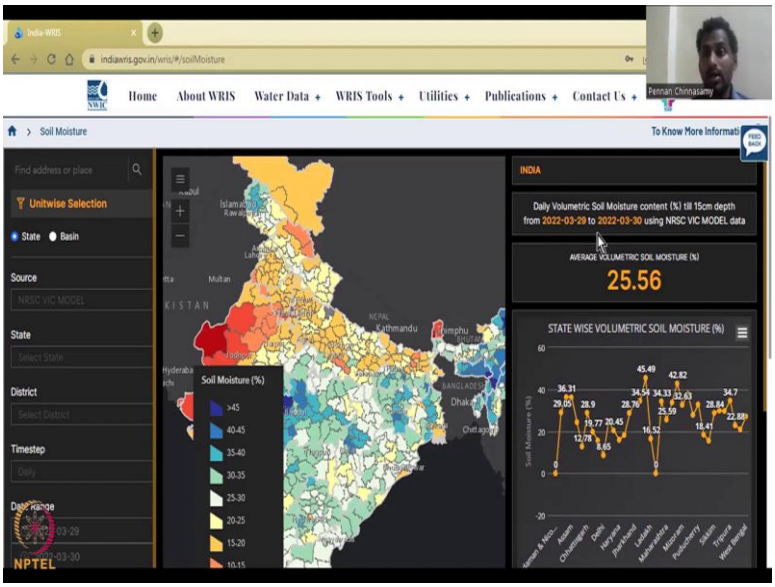
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INDIA
Daily Volumetric Soil Moisture content (%) till 15cm depth
from 2022-03-29 to 2022-03-30 using NRSC VIC MODEL data
AVERAGE VOLUMETRIC SOIL MOISTURE (%)
25.56
STATE WISE VOLUMETRIC SOIL MOISTURE (%)
Soil Moisture (%)
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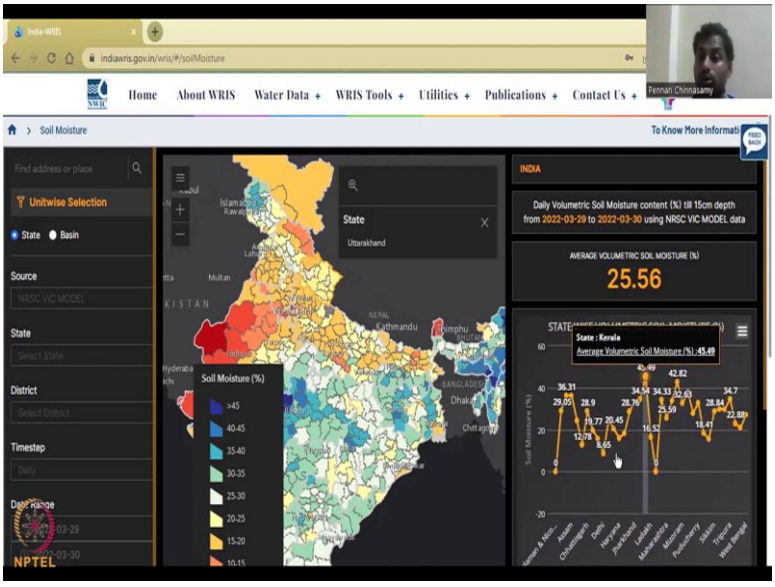
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INDIA
Daily Volumetric Soil Moisture content (%) till 15cm depth
from 2022-03-29 to 2022-03-30 using NRSC VIC MODEL data
AVERAGE VOLUMETRIC SOIL MOISTURE (%)
25.56
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Average Volumetric Soil Moisture (%) :45.49
Soil Moisture (%)
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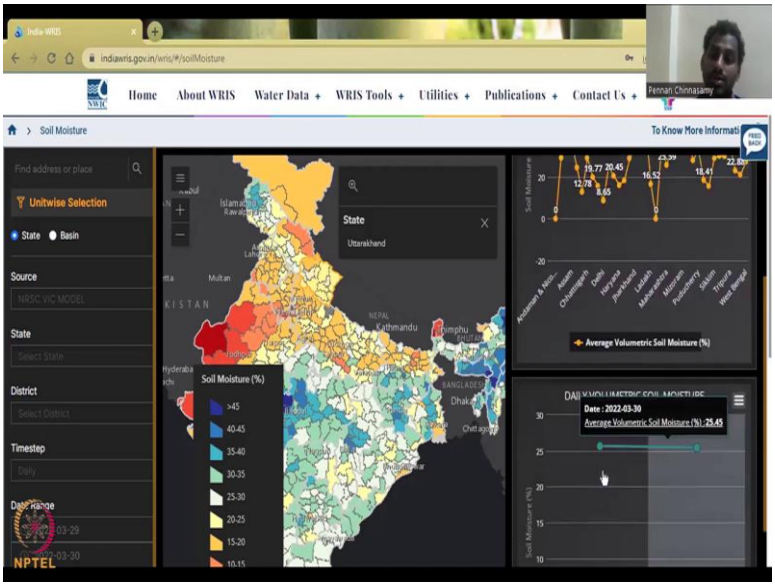
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Average Volumetric Soil Moisture (%)
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Average Volumetric Soil Moisture (%) :25.45
Soil Moisture (%)
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And as I said it is somewhat a little slow today, but let us hopes it works to gather data. So, how I went here is I went to home then water data and under the water data you go to hydro metrological, we already saw rainfall, we will see evapo-transpiration in the next class and then we can go to soil moisture.

When you click soil moisture this page will come up. Normally the India map as I showed in my presentation should have the data already there, for some reason, the data is like for example, it is black in color, but trusts me it is not. It is still populating you can see slowly it is populating and here you could see the value, soil moisture values going up and down correct. And you could see that this is for all the states in together. So, the x-axis is your soil sample location, which are your states whereas your y-axis has soil moisture.

So, you have soil moisture and then these states and then the average of that is taken as volumetric soil moisture which is 25.56 percent. If you ask as a hydrologist is it high, no it is not, because right now we are in the March period look at the date is 2022 3 29 up to 2022 03 30. So, just one week before this class recording this data has come.

So, the data comes and then they build these models. So, the satellite data is taken in and other parameters are taken in, they run these models then they populate it on the website. So, technically a week they take for this and that is where it is kind of we can say near real time, because if you know the soil moisture week before then you could definitely do some irrigation planning to save water.

So, you could see here the legend is a high soil moisture percentage, higher than 45 as blue as the color suggests, and because blue is water and we have higher water in high pore spaces, and then we have the red color too. So, it is alarming, it is dangerous kind of soil moisture in the low phases. So, here we have on the right-hand side, you can see that it is done for India.

The whole data you see here this average volumetric soil moisture and it is taken as a daily volumetric soil moisture content till 15 centimeters step, so, it does not go beyond 15 centimeters. Why is the magic number 15 is because that is where most of the agricultural plants have root depth, if you have this is the 15 centimeters root depth and then some route go down then you need better estimates, but if your plant is only taking water on the 15 centimeters, then this data is enough.

So, the water should be anywhere drained and also soil moisture held in the soil within this 15 centimeters. So, when you apply water, water moves down the soil profile in the 18

centimeters, it gets relocated, and then the plants can take either. If it is a well drained soil like gravelly soil, then water will just flush through and so soil moisture is not going to be kept. We saw these concepts in soil retention specifically. So, coming back for this date, you could see that the soil moisture is around 25.56 for the entire country and just here within this range, I could see that Kerala has high soil moisture content 45.49 percent.

And because it is on the west ghat region, Kerala is blessed with a good soil moisture and soil formation properties also, lot of organic matter, a lot of degrading weathering of soil is happening and those would have fresh soil with a lot of water holding capacity. So, let me see if the other states in the region, so I am just going to pull down there is no other states given but you could see it here coming down. So, this is the daily volumetric content a soil moisture as a number, the percentage 25.56, 25.45, the average is that. So, this for the entire India, of the two days it is taken an average is taken.

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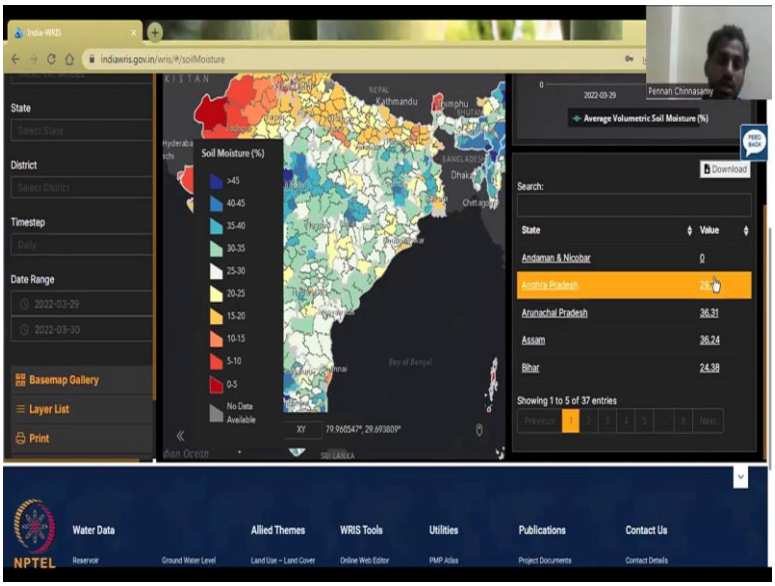

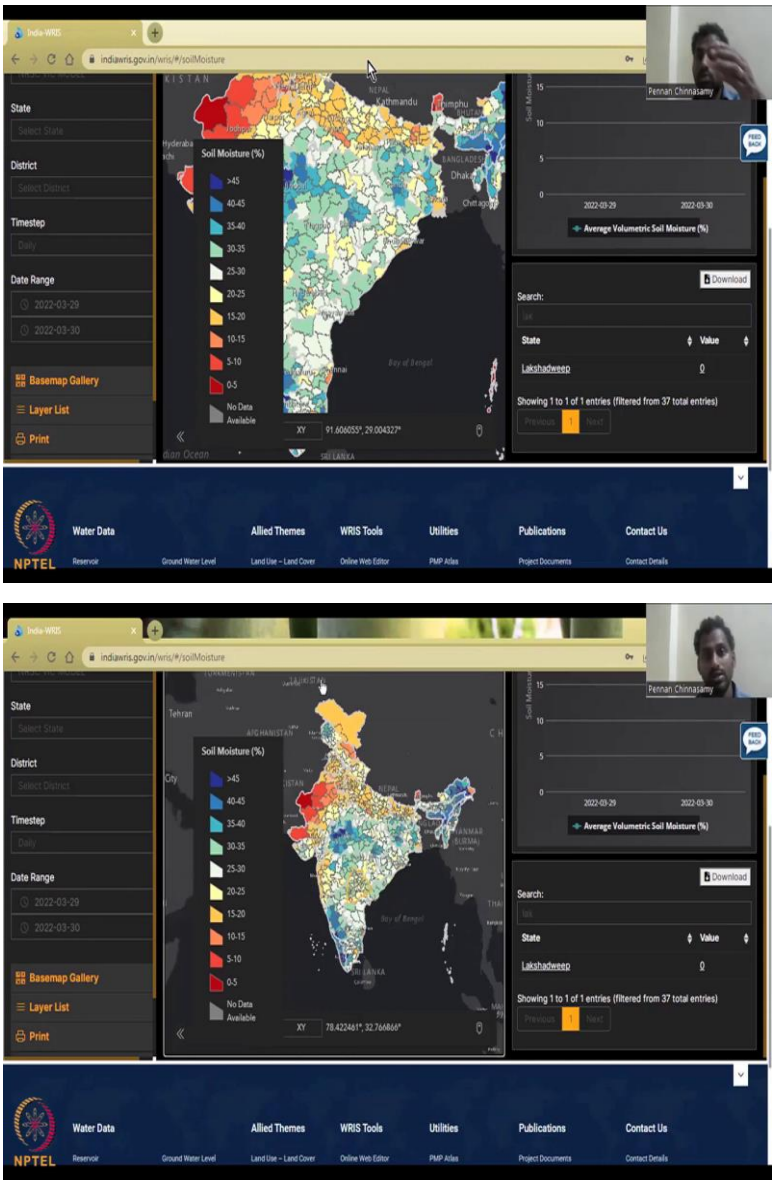

Then you have the other states, when you see 0, it does not mean that there is 0 soil moisture, maybe there is no data because Andaman and Nicobar might have some data, but it is not given. So please understand that these are satellite driven products. So, sometimes the satellite the resolution is small, as in it does not take the entire pixel. So, at the end of the day, you will not have data for Andaman.

So, Andaman areas and Lakshwadeep areas, you might have to go and put the physical sensors. Let me try here Laskshwadeep, and you can see that Lakshwadeep is also 0 as we thought because the satellite data is too big to capture the Andaman has to be small, so that you can capture the data otherwise, you cannot it is like searching for sand particles using your just plain eye say you cannot do it, you have to zoom in. And for that zooming in like a microscope, you need a better higher resolution satellite.

But for the entire India, it is still good, you can see that the entire India's map. I am going to zoom out so that we could see it clearly, and you could see that as I said here along the western ghat region, this part along the concurrent region there is good soil moisture, central India has some good soil moisture and always the North East has good soil moisture, because of the high-altitude rainfall situations.

Whereas, the western regions have really drastic in polar patterns and right now the summer is kicking in. And a lot of groundwater is used because of that. So, if you look at it, soil moisture, have good correlations with your groundwater, because if your soil moisture goes down, people use groundwater to put water into the system.

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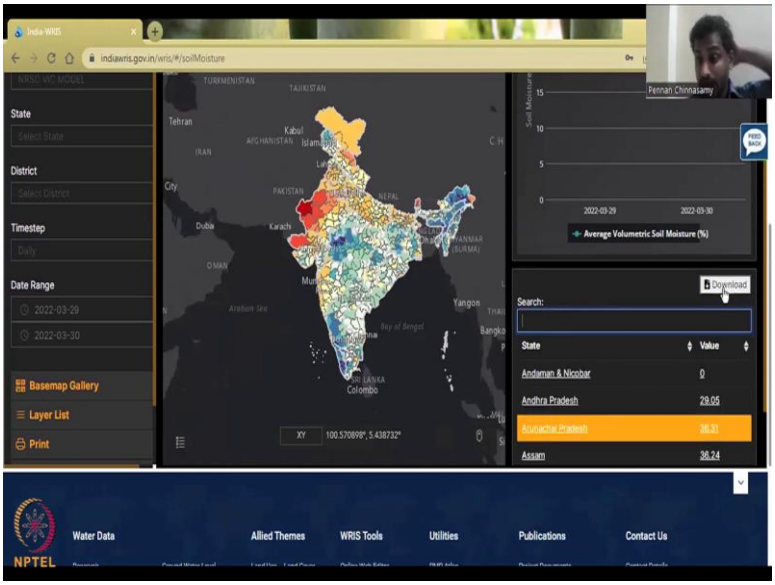

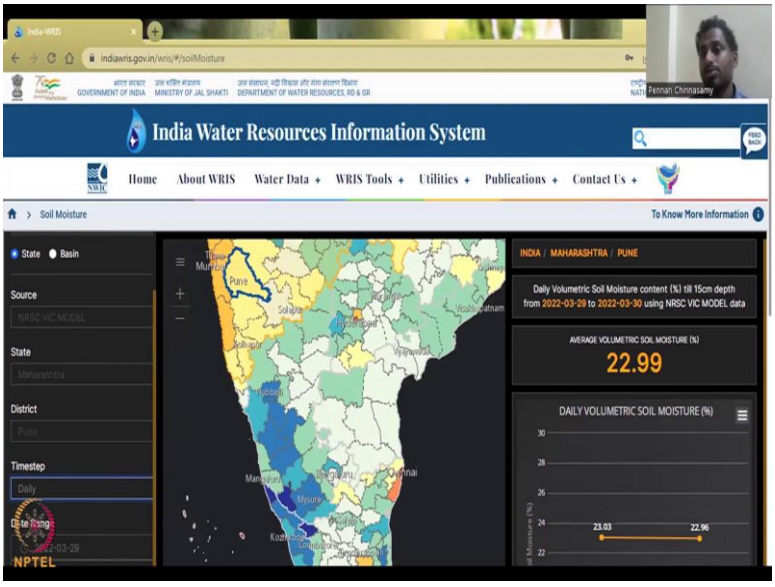

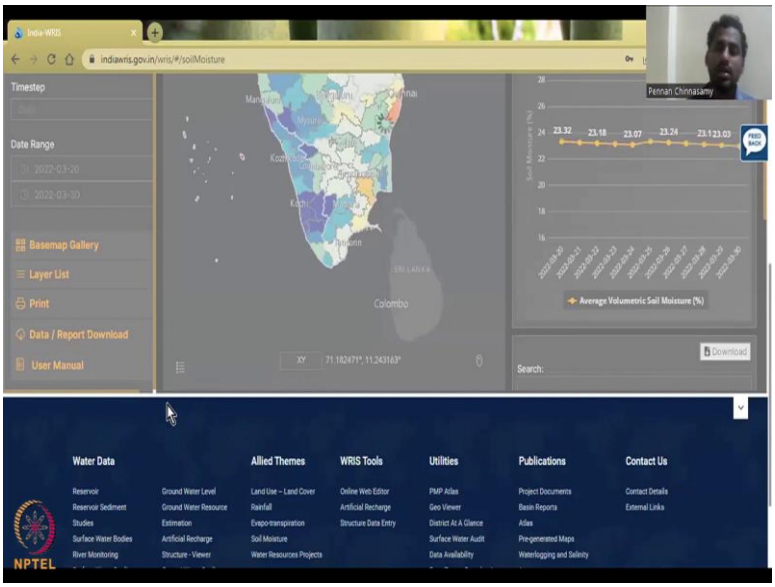
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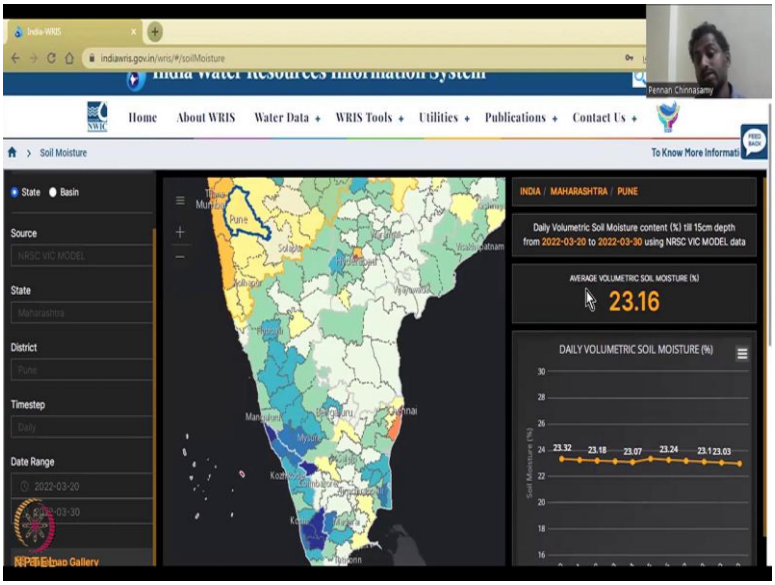
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Daily Volumetric Soil Moisture content (%) till 15cm depth from 2022-03-20 to 2022-03-30 using NRSC VIC MODEL data
AVERAGE VOLUMETRIC SOIL MOISTURE (%)
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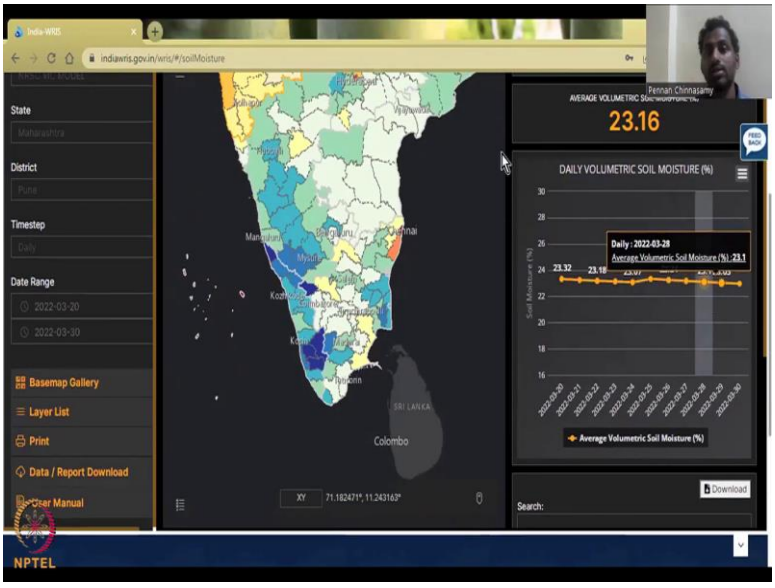
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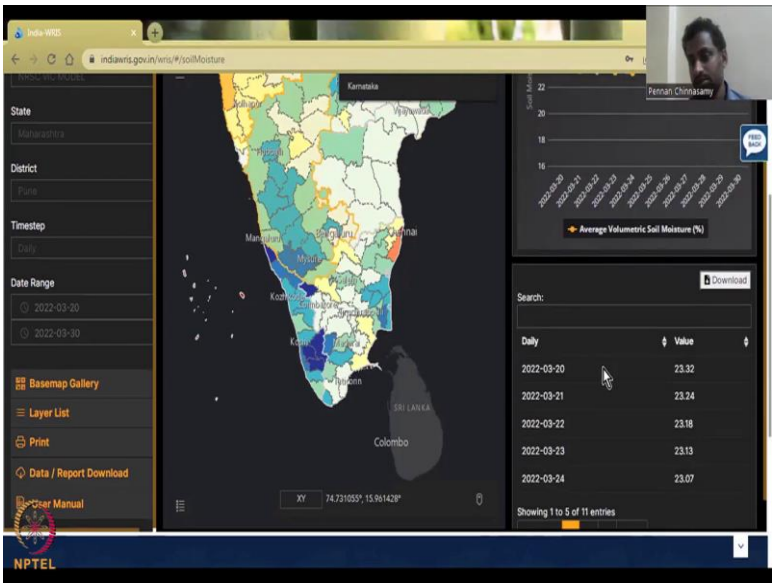

So, we are going to look at the, I am just going to remove the access for now, and then let us take one step ahead on looking at, what does it mean? So, you have the India data, you have the statewise data, and the average data as a point data, you can download. You can also have all the states here, so I am just going to pick it up, you can download all the states data for that particular average. So, this is the average data for those particular dates, the two dates we have. And you can also download these metrics as per statewise metrics.

So, now what I am going to do is I am going to show you on the left side what we have. On the left side, we have a unit wise section. So, which means, do you want it as a basin or a state as again, the basin can be your water basin, the river basins into the Ganges, the Indus, the Kaveri basin, etc. but since all these administrations are done using state boundaries, we will keep it as a state boundary. And then as I said, there is one model that drives the satellite data, and that is the NRSC VIC model. So, NRSC is the data provider, the person who is doing sampling and all those things whereas your VIC is the model so you put NRSC because it is driving the VIC model.

Then I am going to select a state, let us say Maharashtra there is a reason we do Maharashtra because there is a lot of sugarcane which grows here and sugarcane is more than a year crop. So, it needs water throughout, so when you see soil moisture going down, then it is alarming that you have to go back and water the crop.

So, that is what we have this Maharashtra state selectod. So, Maharashtra state is selected you could see that it is now showing up and then I am coming down to the district. Sometimes you do get the district but sometimes you do not but let us take Jalgoan, slowly slowly, you

will see these names populate. So, India, Maharashtra, Jalgoan or also Pune we can take city, because it has a lot of dams.

So, which means like if the soil moisture is lower than the person sitting on the dams can reduce the water, so we have Pune and then we have daily temps, yes monthly does not make sense, yearly is also not that helpful for farmers for people to manage water and wastewater will need daily. So just because of the time it takes for the data to come in, I am just going to do a couple of days in last week of March. Let us see until when we do have data, so take from 20 until April there is no data.

So, let us take the last data in March, which 30, as I said still one-week data is okay. You can see that as we will click it it is populating here, but just the analysis is running behind to do some measurement. These 10 days of data daily volumetric soil moisture content in 15 centimeters you could see, and then the average volumetric soil moisture is 23.16 percent which is very less, we need more water for the crops. You can see that right next to that is Thane and Mumbai regions with has higher soil moisture. That is because of also the climatic factors around that area, but most importantly, Pune has a lot of agricultural activities compared to Thane and Mumbai. So, there is a lot of water demand for the crops.

So, you could see here now it has populated with the 3.16 and I am coming down to show the daily changes in the values and you will see there is a steady decline of the soil moisture and that is correct because of the summer is peaking also, so March end slowly the summer is coming out and then you will see the temperatures rising certainly in the data which dries evaporation transpiration, and then the soil moisture is lost.

And then let us come down, you can see the date wise what is the value so that you can download an excel sheet. That has 11 entries including the date so it is 11 days we have modeled and then we could see how the soil moisture has changed, you can download this as a chart, print chart, download as image CSV, CSV will give you the data in excel format, also you can download and then use it. Here there is no station, so it is like the other data that we use, we do not have a station name, and we have a district. So, we can say for district, we have this data.

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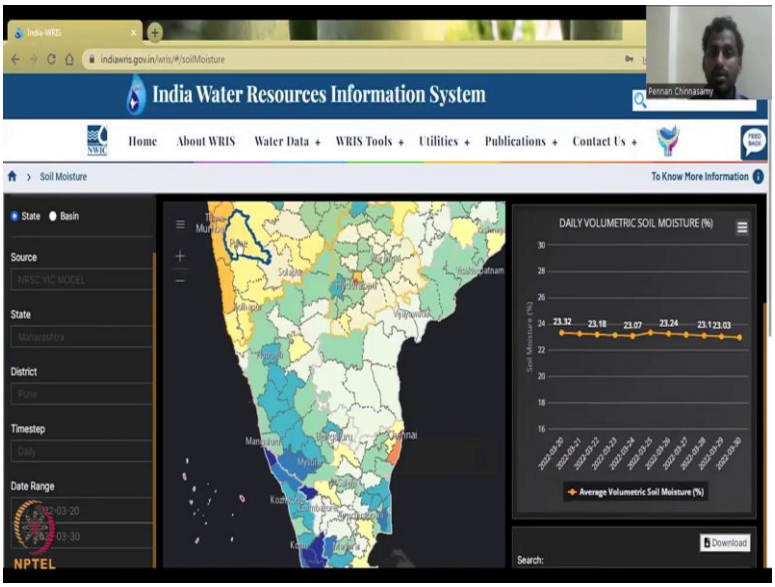

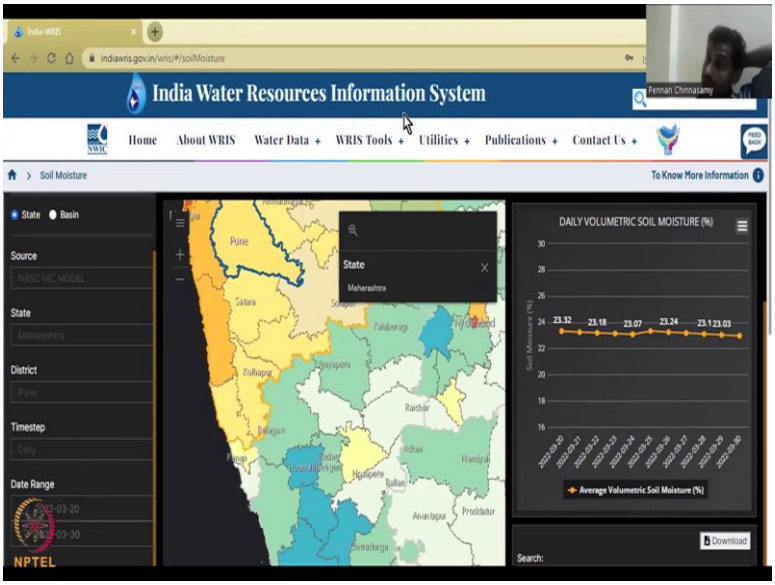

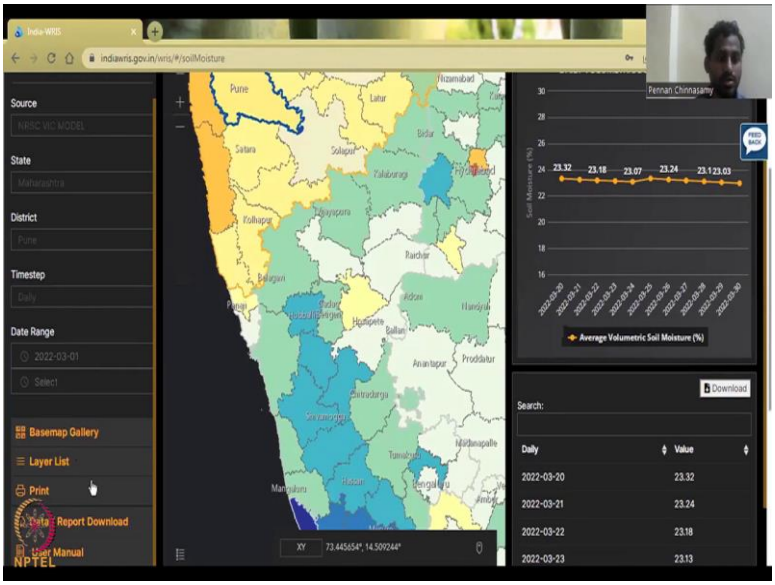

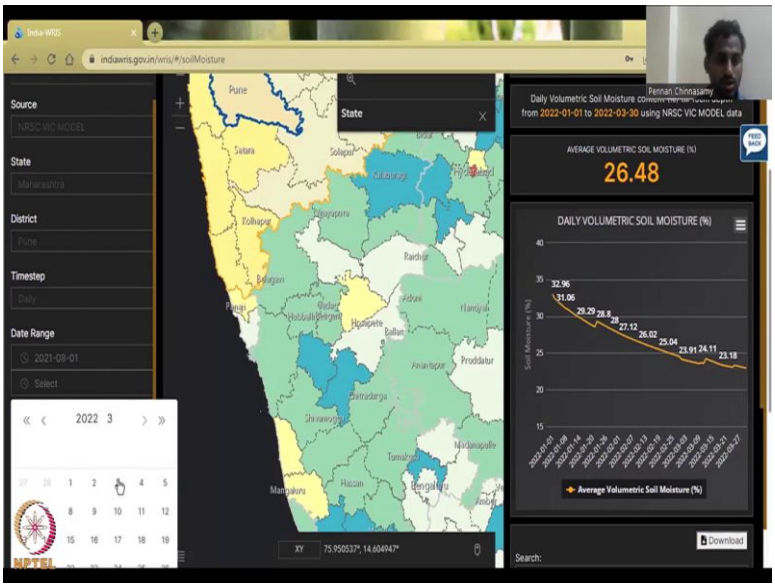
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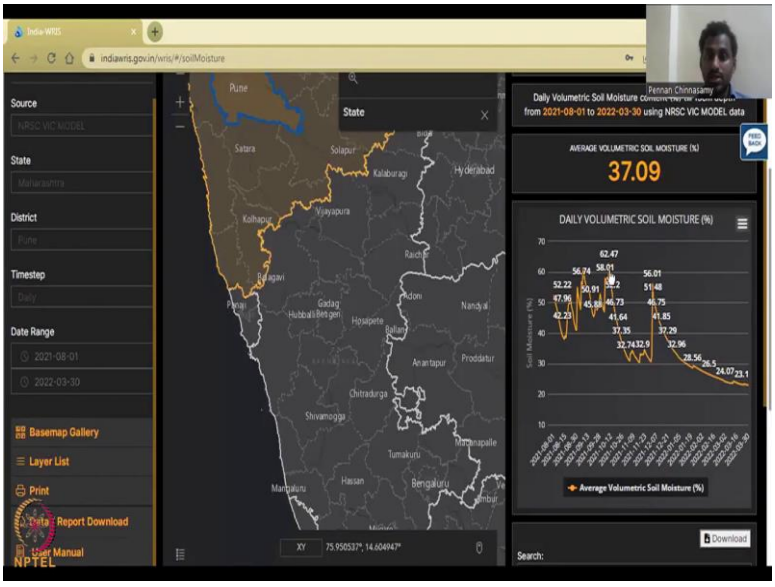
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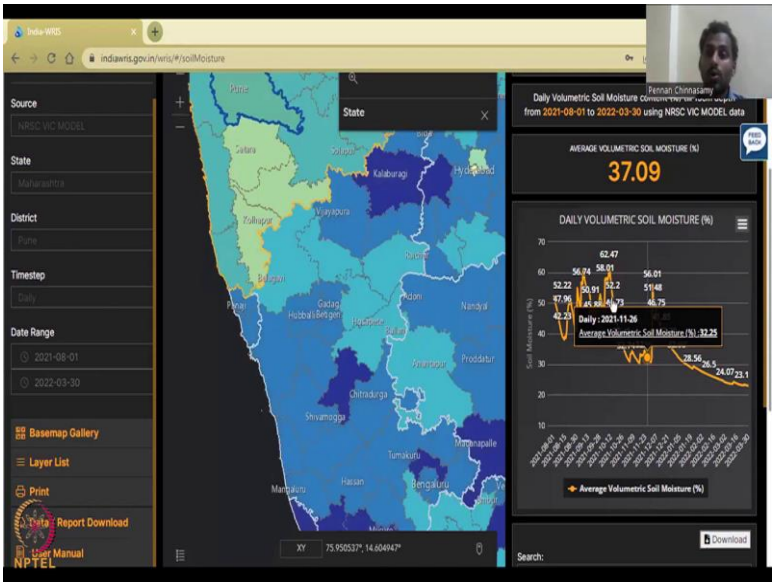
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AVERAGE VOLUMETRIC SOIL MOISTURE (%)
37.09
DAILY VOLUMETRIC SOIL MOISTURE (%)
Daily : 2021-11-26
Average Volumetric Soil Moisture (%) : 32.25
Soil Moisture (%)
Average Volumetric Soil Moisture (%)
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XY
75.950537°, 14.604947°
NPTEL

And if you look at Pune, here, there is no finer resolution in Pune, so you can only have it until Pune; there is no block in Pune that has data. So, you have to be careful saying that I can I do the village level analysis using this? No, you cannot. So, within Pune if one part of Pune has a lot of agricultural activity, and then there is a Pune city. So, are you going to say that the water consumption is the same on both sides? No, it is not.

So, this is kind of an average, this is sometimes a limitation of using remote sensing data, but it is the best data we have for now, and a lot of advisories on on water management, are being given using this data. So, it does work, but as I said, it does, we have to take it cautiously because of the spatial resolution. But temporarily, it is one of the best every day you get data, so every day satellites are taking images, it runs these models, which are based on temperature, rainfall and other attributes, and then you get the output as net soil moisture.

So just while we are here, I am just going to try if we could get a higher data resolution on this model, I am just going to go from 1 to 13 of March. So, because I know for sure the March period the temperature has picked up quite drastically, out be quite much also picks up slightly and then just keeps on going down because of the rising temperature and if you do February, you can clearly see that the February is cooler and you have more soil moisture and then it starts to come down.

So, soil moisture is a very important property for crop management. To do that, once I can check, Jan for sure was very cold cold weather was there it was beautifully how from the soil moisture was 35 it has come down to 23 we have lost more than 12 percent soil moisture, and this is not purely because of the crops it is the changing climate also.

And if you go to the rainfall season, you will see around 100 percent or 80 percent soil moisture, because the rainfall was getting the volume, let me show you that. So, for example, we had good rainfall in August just click August to show you the data. So, from August now, this is seasonal, because see how it goes up and down and up and down is because of the rainfall coming.

And also, because all the crops because in the Kharif season, that is the rainfall season, there is plant sowing and harvesting going on new crops putting being put, and that is where you see this up and down motion. Soil Moisture is taken up, and then rainfall happens it recharges. Soil moisture is taken up, then the rainfall happened reach up, and there is a sudden dip.

This dip is because of the plants plants, the Kharif plant just takes the water and then it just keeps on depleting. Once it depletes you can also see a crisis suddenly because of some rainfall, one or two rainfall events or irrigation, those kinds of things, and then it keeps on declining. So, if you progress in March, April, May, you will see it is still going down to very, very dry conditions.

And this is how you could get some data for your location and also get an average. See average does not make sense here because for the overall period, how do you prepare for it, you have 62 which is almost double the average and then you have 23 which is very low compared to the average. So, average does not make a lot of sense but it does help you to understand the range of which the soil moisture can go up.

I hope this class you could download these data for your village level analysis water for soil and other aspects. This is not only for agriculture because it also supports the recharge process for groundwater, drinking wate, etc. With this I would like to conclude today's lecture on soil moisture data collection. Thank you.