Remote Sensing and GIS for Rural Development
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Week - 13
Lecture no. 13
Intro to Remote Sensing Data for Rural Development: Soil and Climate

Hello everyone, welcome to Remote Sensing and GIS for Rural Development, NPTEL course, this is week 3, lecture 3. In this week, we have been looking at the remote sensing data that can be used for rural development. We have identified three special focuses, water, soil and climate.

In the first part of the lecture series, we are going to look at the available data for mapping using Indian Government Data Archives. In that sense, we have been looking at the Bhuvan series. In the last class, we looked at Bhuvan water data.

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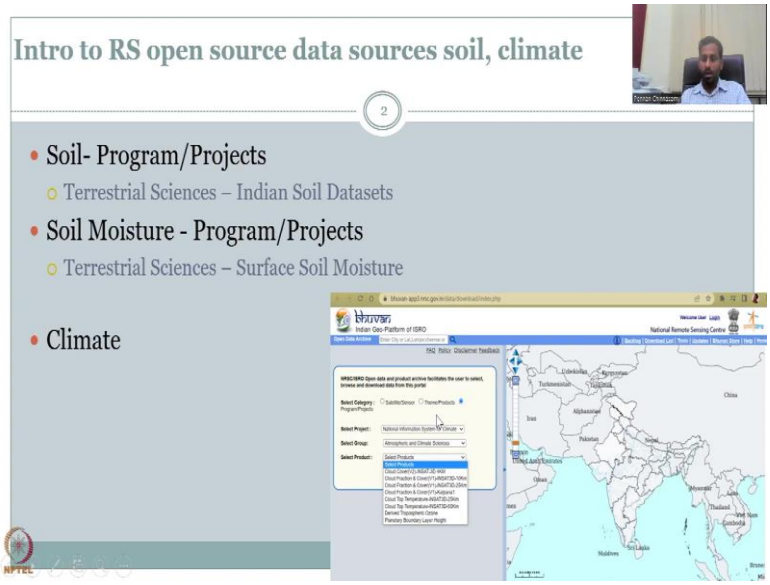

In today's lecture, we will look at soil and climate data that is stored in the Bhuvan portal. So, this is the hierarchy that we will follow. We will first share the soil and program projects and from there the program projects will identify the terrestrial sciences and an Indian soil database. There is also a soil erosion data we will look into that. So, if soil is in order, you would know that it is not feasible to have rural development initiatives and that is why we need to be accustomed and informative about the soil health. Before going into soil health, it is been interested and immediate trust in the need to identify the soil type.

I have seen in many projects; they start to build infrastructures without understanding the soil quality. If you do not understand the soil quality, it will be eroded and washed away thereby reducing the lifetime of the investment of the Rural Development Project. In that note, we have looked into the Indian soil databases which has been archived in the Bhuvan portal. We will also look at the soil moisture data that has been stored in the database. And provided time, we will also be looking at the climate variables.

So, this is how it looks like. You will click the theme products after the theme products we have programs and projects. We will click that and then in that you have climate under the atmospheric and climate sciences. You could see you have cloud cover cloud fraction, planetary boundary layers et cetera et cetera. This is not as much as we would require. So, for that, I will definitely give another link of database. Please understand that not all the data that is stored in Bhuvan is driven by Indian satellite data.

There are some satellites like for example models Landsat are being used in the evaluation of these studies and data. However, in the Bhuvan portal, it has been stored only for the Indian region. So, it is easier for you to download and access. So, without further delay, let me share the screen for the Bhuvan portal.

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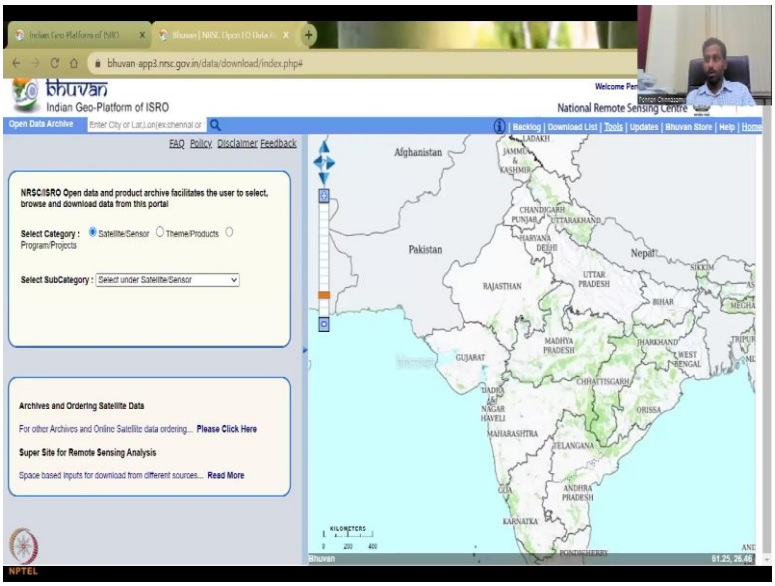
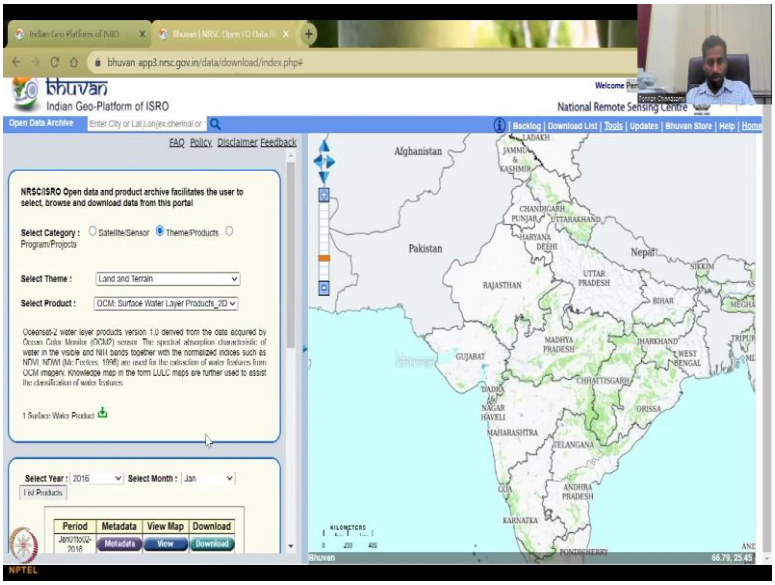
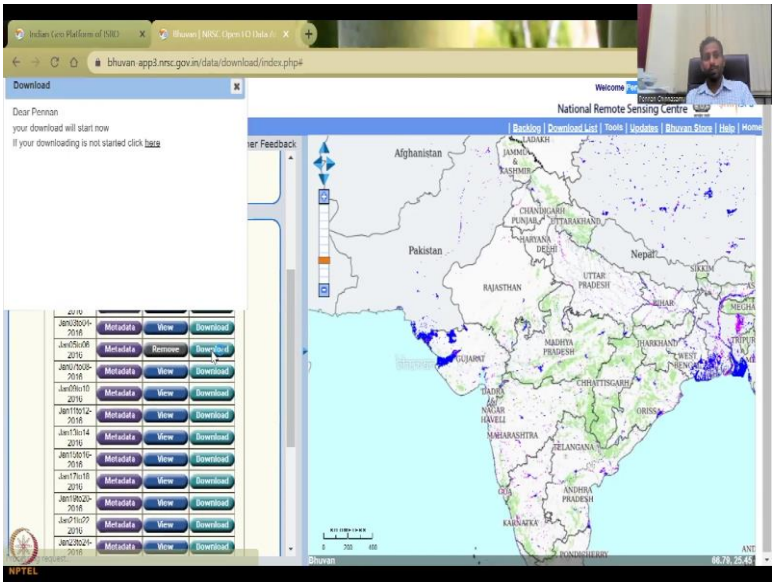



bhuvan
Indian Geo-Platform of ISRO
National Remote Sensing Centre
Open Data Archive
FAQ Policy Disclaimer Feedback
NRSC/ISRO Open data and product archive facilitates the user to select, browse and download data from this portal
Select Category : Satellite/Sensor Theme/Products Program/Projects
Select Theme : Land and Terrain
Select Product : OCM: Surface Water Layer Products_2D
Oceansat-2 water layer products version 1.0 derived from the data acquired by Ocean Color Monitor (OCM2) sensor. The spectral absorption characteristic of water in the visible and NIR bands together with the normalized indices such as NDWI, NDWI (Mc Feeters, 1996) are used for the extraction of water features from OCM imagery. Knowledge map in the form LULC maps are further used to assist the classification of water features.
1 Surface Water Product
Select Year : 2016 Select Month : Jan
List Products
Period Metadata View Map Download
Afghanistan
Pakistan
Nepal
NPTEL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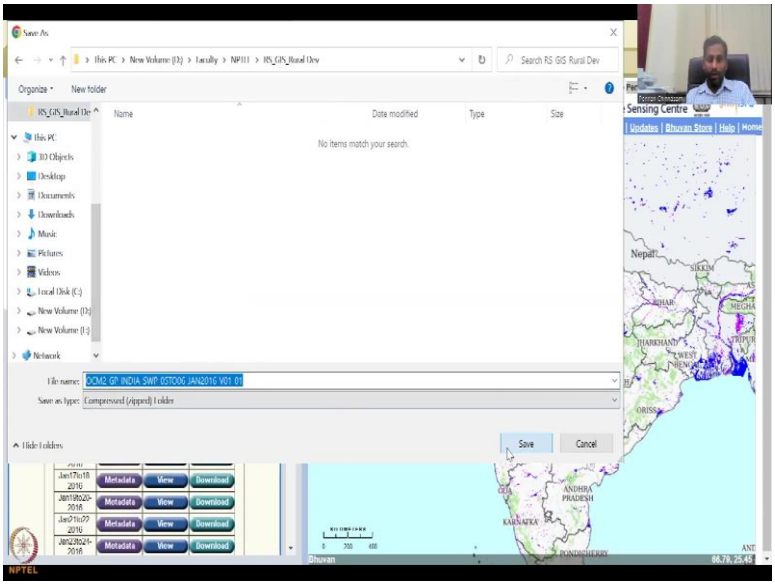
Save As
Organize New folder
Name Date modified Type Size
No items match your search.
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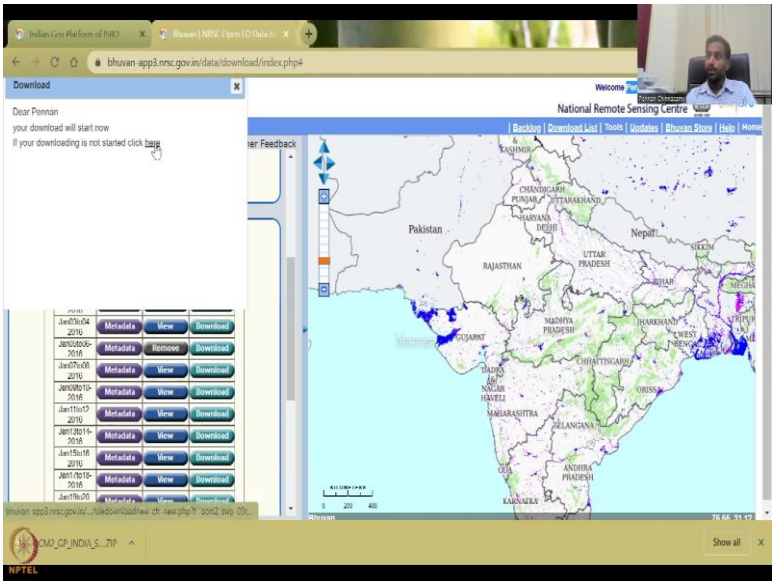

So, I hope that one portal is now visible. And we could see that initially I had clicked on the Open Data Archive. And as promised, I have logged in. You can see my name is coming and you can see logout. So, in the login section, it is important to have that further data download. Let us do quickly the product that we did last time. We did water layer and then we want to pick a 2016.

Let us say Jan. Lists products, we have a Jan Fifth, we have this data and then we click Download. So, it says Dear pendant it has been downloaded here it is. So, you could see that it is downloaded as a zip folder. You download as a zip folder. And then you could open it and look at it. So, yes, it will not be visible on your screen because of all the data that I have kept it separately but the point is you can download as a zip folder and then put it on a desktop or download section and then you can use it from there.

So, moving on, we will look into the data that has been downloaded. So, dear pendant your download will start now. If download does not, start click here, I have clicked and then the data has come.

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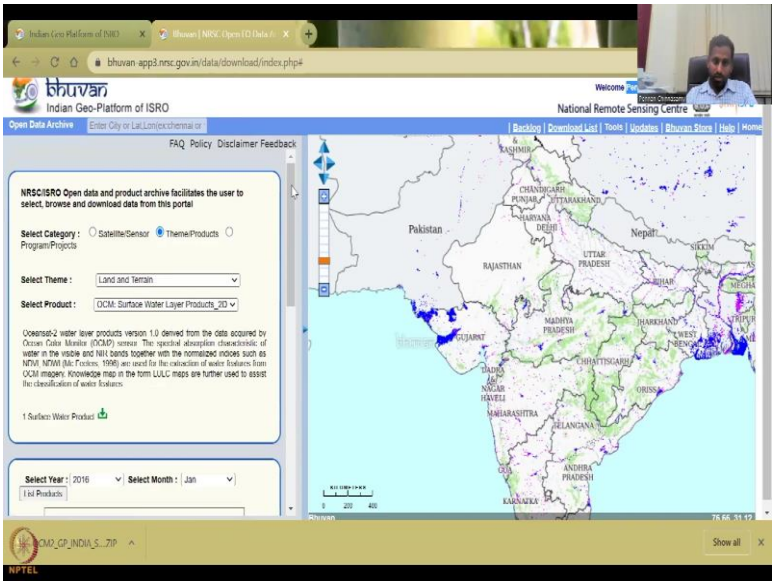

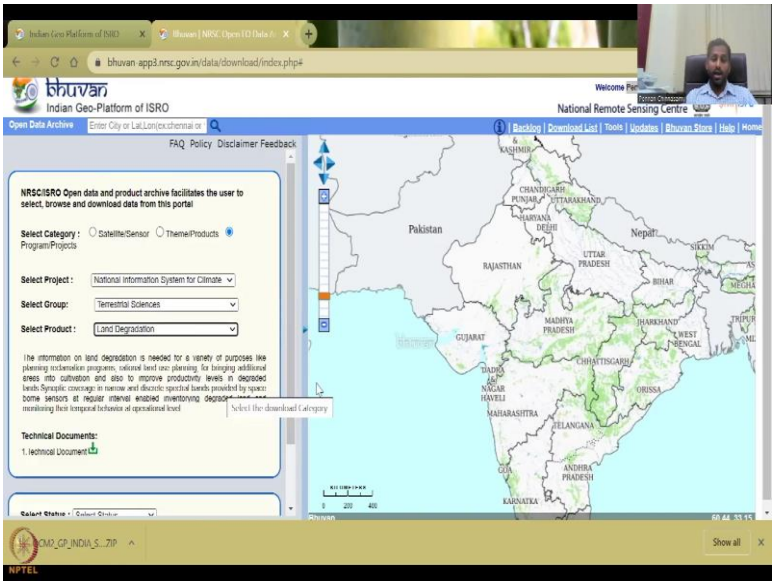

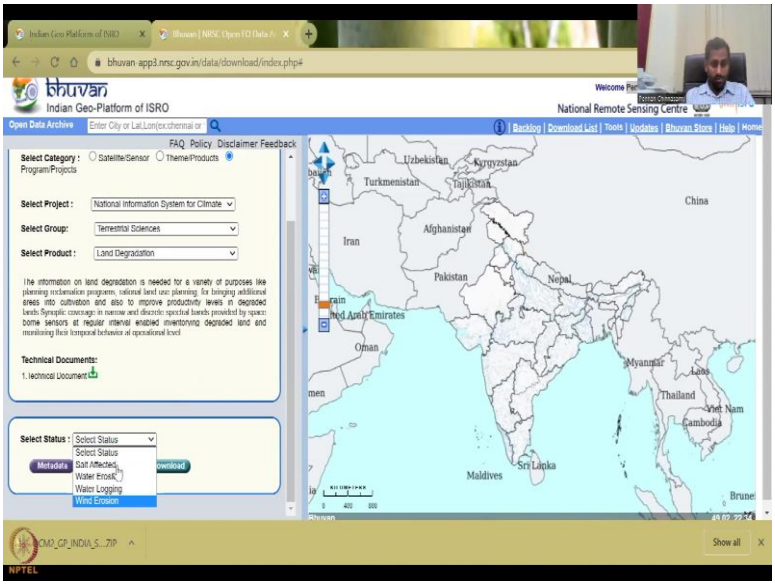

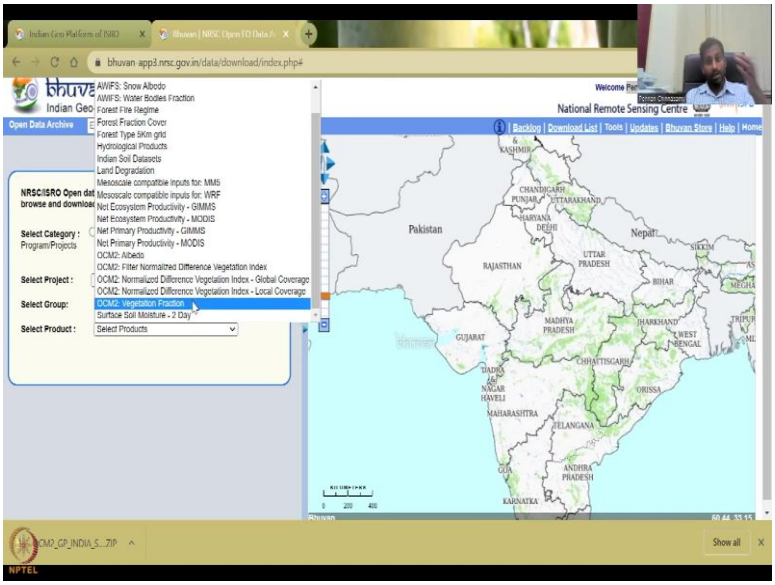

So, it comes as a zip folder you have downloaded. Once you have downloaded you can answer and then use it in the GIS software. We will wait for the hands-on section where we will go through GIS and then go through the download option again. Here this sections is this lecture week is for you to identify that these sources are available and request you to go and check these sources for your study areas.

So, now, let us go back to the slide where we said we will look into the soil data for which we will click the program and projects, under program and projects we go to the National Permission System for Climate and Environment. And then we go to terrestrial sciences because it is on the land and then we go here. Here you will see lots of direct datasets for soil and then indirect datasets.

So, for example forest cover will tell you that the soil under the forest is porous soil. So, this example is modest. Modest is not Indian satellite, it is a NASA satellite, but still they have it here because the length of the data is good approximately 30 years and it has been well researched and used for the Indian regions. So, here we have a database organized by the Indian government, ISRO body and in that we do have foreign data, which is open source, they do not pay for it. So, you can also freely download and use it.

So, there are two things that are directly related to soil, which is the Indian soil database, and then there is this other soil moisture data, the indirect ones would require like land degradation, which would look at the soil eroded, land eroded those kinds of things. So, the technical document would give you the idea of how they arrive at land degradation. So, it is a salt affected soil water erosion waterlogging wind erosion. Wind erosion happens if you see

the sand dunes that are created in the desert, because wind brings and moves them up. So, there are some regions where wind picks up the soil and narrows it, let us see where it is.

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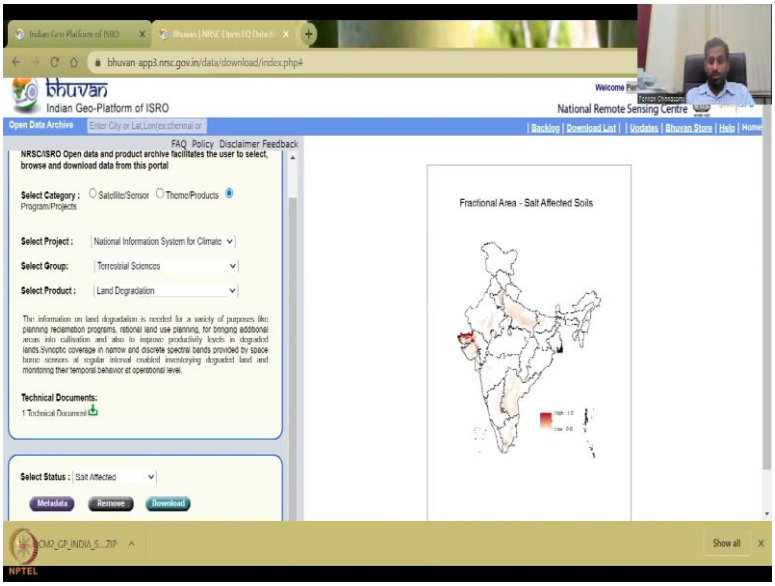

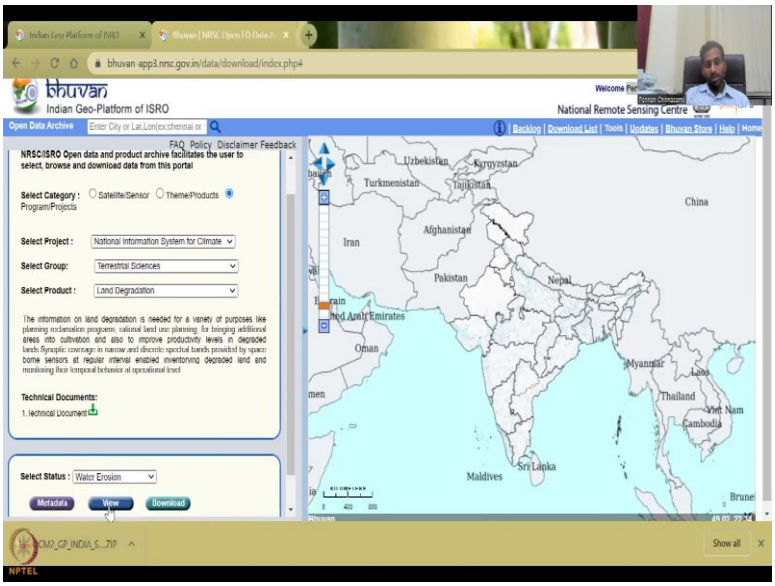

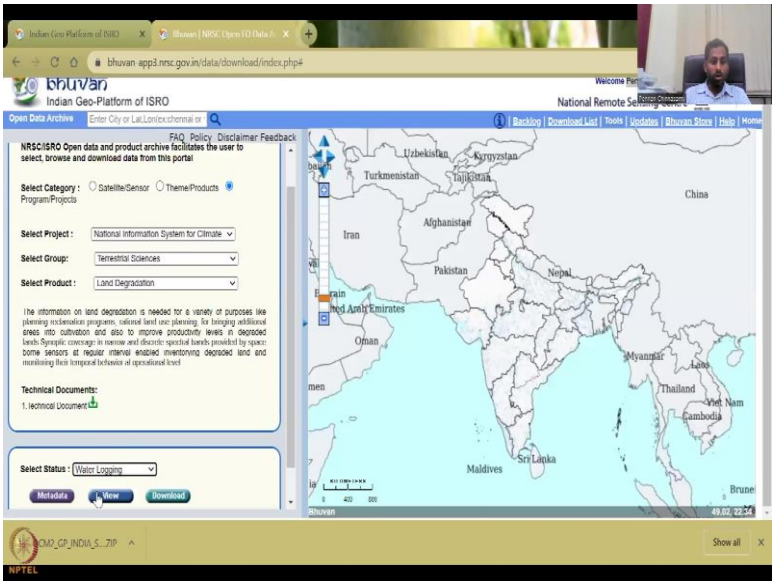

So, you could see mostly on the southern regions of India, erosion, salt affected as the name suggests, mostly it will be in Gujarat because the Kutch area is there where you have white sand and white sand is always laden with salt and also in among the Ganges and other regions, but most highly in the Gujarat, Kutch region. And then the water erosion is mostly because of running water, running waters across India, so, you would see more and more especially on the higher altitude regions. So, you have the western Ghats in Maharashtra region, and then the eastern Ghats that go along in the Tamil Nadu and Andhra border.

You see that the map is not updated in the borders but however, please use this data. For example, here Telangana is not divided yet they should be updating pretty soon.

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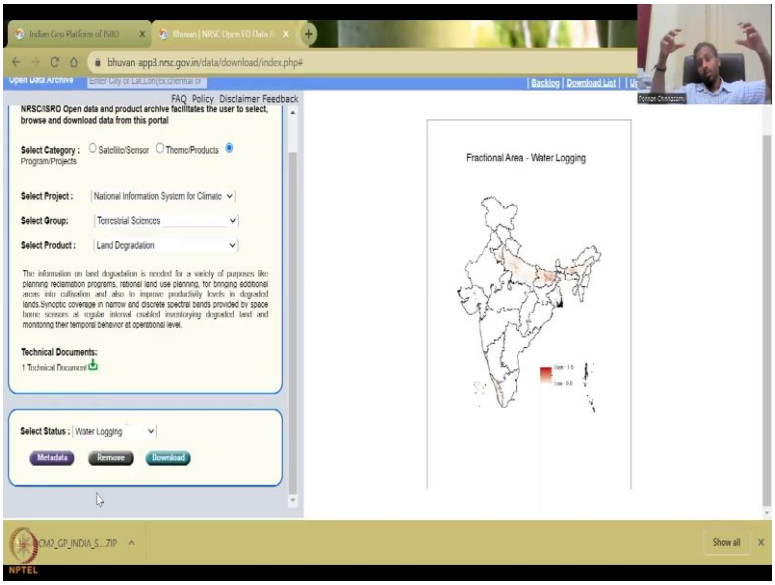

Water logging is the condition when water is too much and it does not go into the soil. So, sometimes it just remains on the soil and impacts the plant growth which again gives less crop yield and then that results in less rural development. So, that is mostly on the Ganges basin model, Brahmaputra basin.

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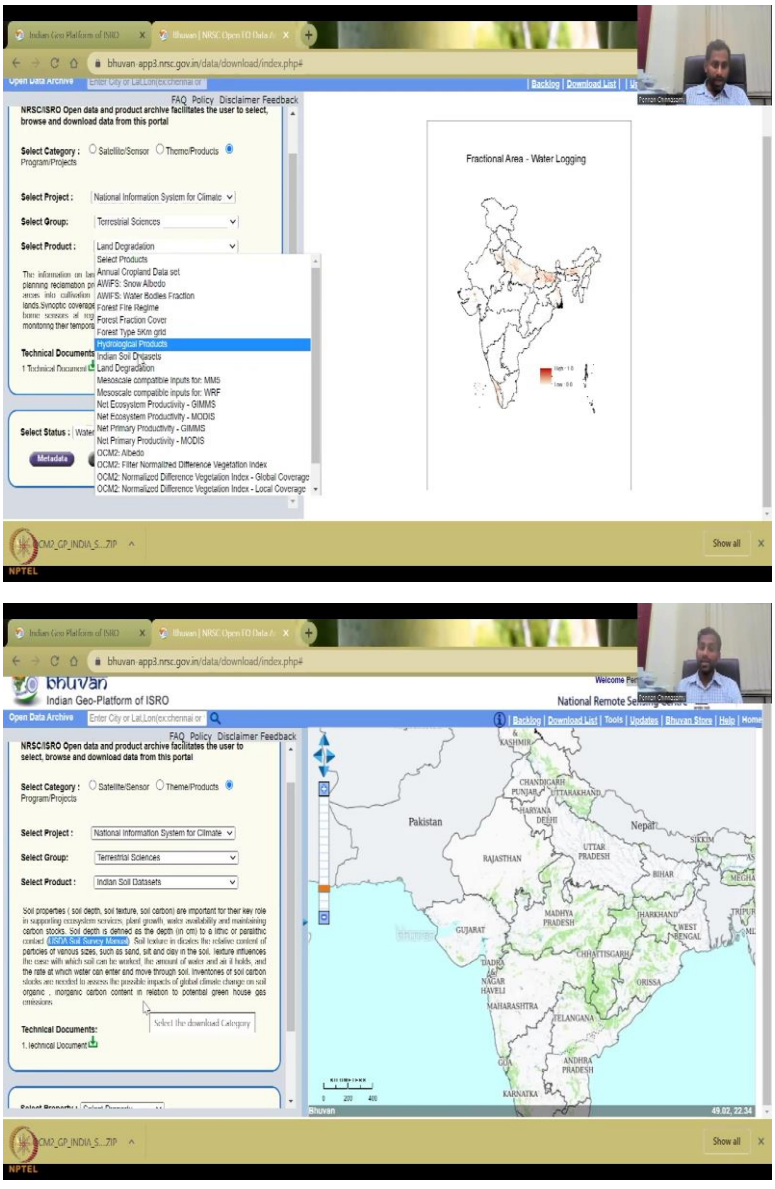

So, let us go back to what we had shown in the slide. We will be looking at the Land Indian Soil Database. So, it says here the soil properties soil type, soil texture, soil carbon. So, those who have taken soil classes would know what is soil texture, what is soil structure. So, these are important parameters that you have to associate with soil. Soil structure is how the molecules arranged which is dynamic in nature because you can compress and you can break

the soil flocculation, dispersion those kinds of things whereas, soil texture is more permanent because it is a mix of sand, silt and clay. It is the percentage of mix of sand, silt and clay.

So, for now, I think the introduction part that is enough so, soil texture are important key role for this and the soil depth is also important to understand what type of soil we have at different depths because plants grow to a particular depth. If we have highly impervious soil impermeable material in the soil then the roots cannot progress down.

So, that is where you need to be careful about having a healthy soil with good porosity permeability to allow the roots to go in. So, you could see that rural development is kind of impacted by these factors. You cannot just build everywhere a structure and in my introduction slides I have clearly shown that lot of times it has backfired and lot of times there is a failure of the project across the world not only here and that is because they did not value the physical setting of the environment, soil, water, air quality those kind of things.

So, you can look at here and it is based on the naming and other things are based on the USDA soil survey. So, still I teach soils in IIT, Bombay and I still use the USDA method because that is the predominant method that is that has come across for soil management and a lot of countries still use it.

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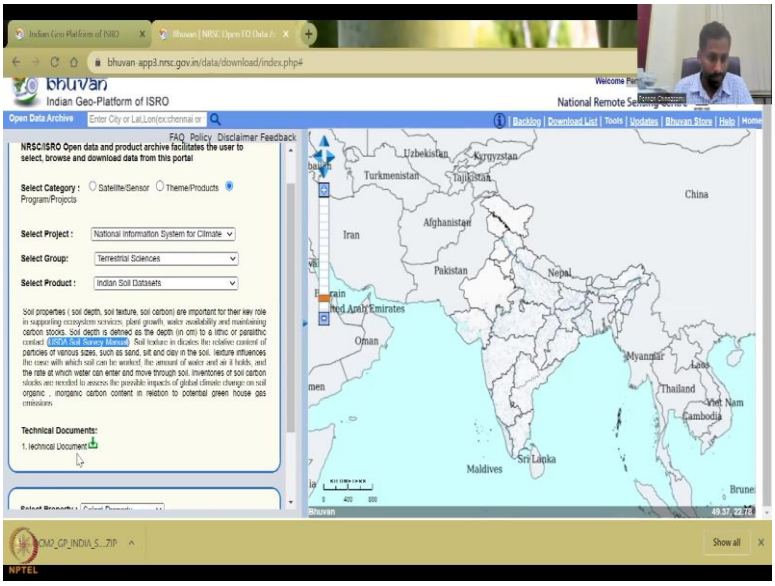

The science is very well validated in the US and backed up by lot of research. So, still we also use some nomenclature definitions from the USDA soil survey and that is why you see the soil survey reported here.

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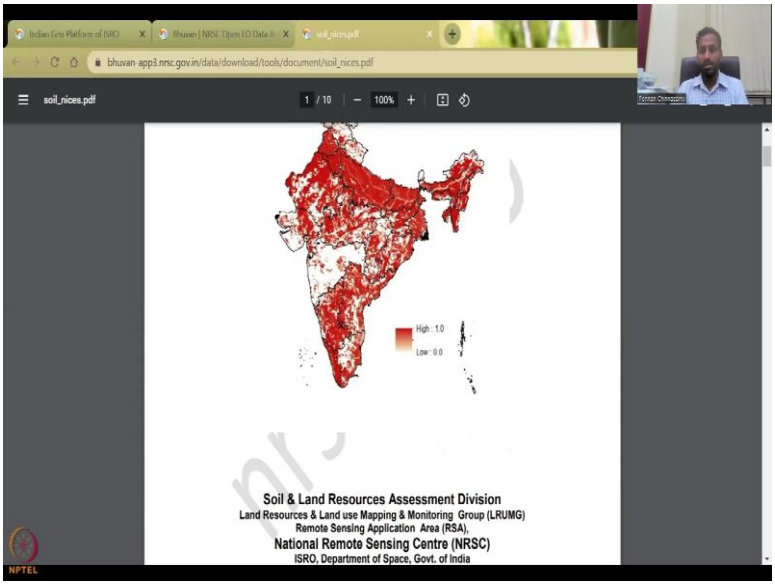

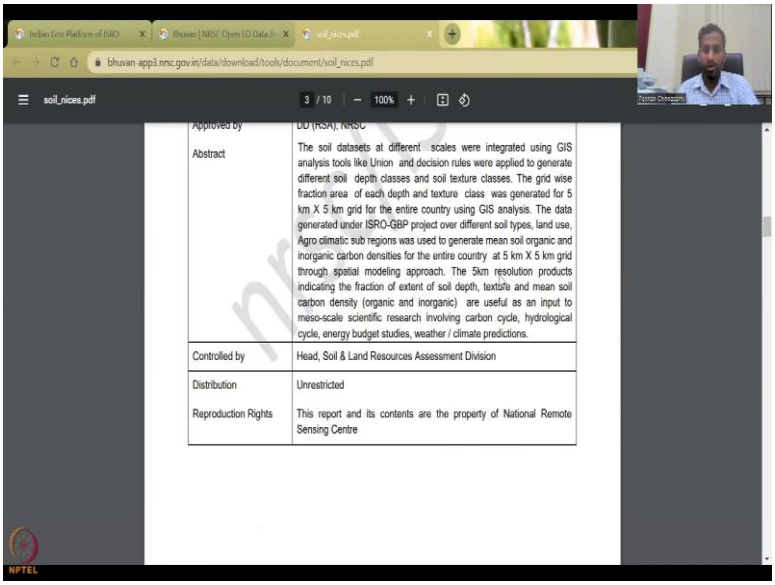

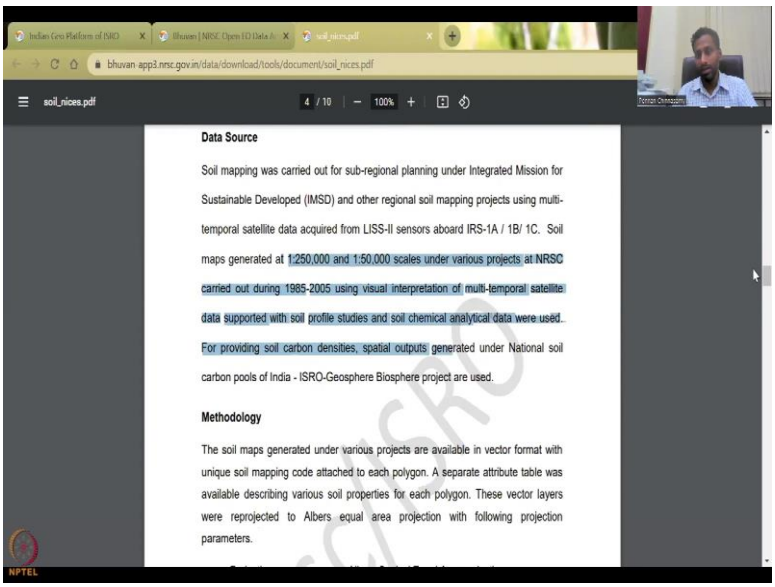

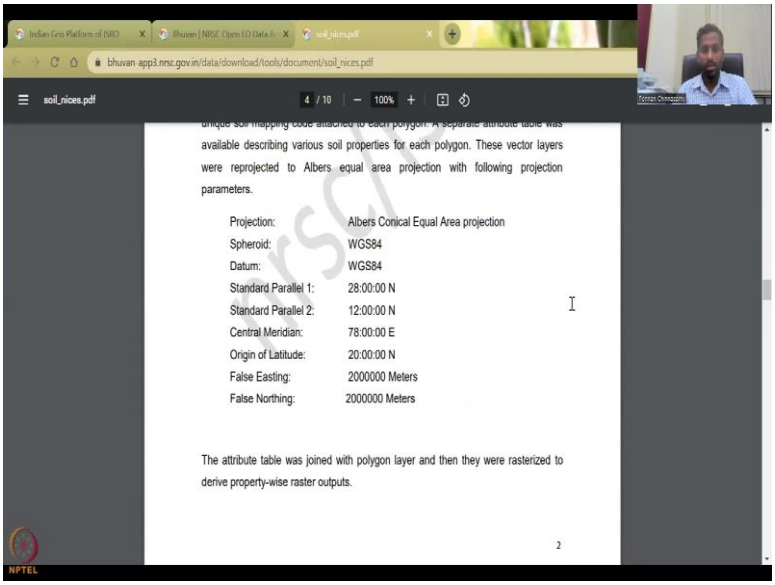

You can see the technical document. So, you could have seen under the bottom of the screen in the previous minute or so, the data has downloaded and kept in the folder and I could just unzip it and use it. So, here is the soil data set document, how it was prepared, what scale of data that they used methodology, all these things.

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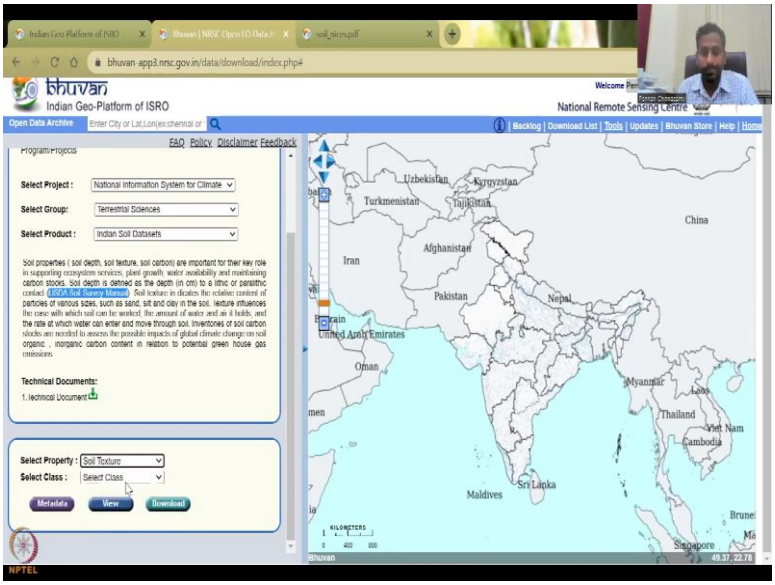

There is some field work that they had to do and that is based on the USDA soil survey. Survey means you go there and take measurements and stuff to validate the model. So, now let us come here as I said you are going to look at the three soil properties soil texture is the percentage of sand, silt and clay in that particular location and depending on the sand, silt and clay there is a name nomenclature given and then there is a soil depth how deep you have soil is not unlimited soil you have.

After some depth it is just unweathered rock and then partially weathered rock which is not conducive for crops or any type of rural development. And then you have the mean soil carbon density which is kind of not related here directly but indirectly it is a measure of the soil fertility also. So, as much as carbon the soil is holding the plants are accessible to it. And then there is much better growth of plants and crops. So, let us look at soil texture.

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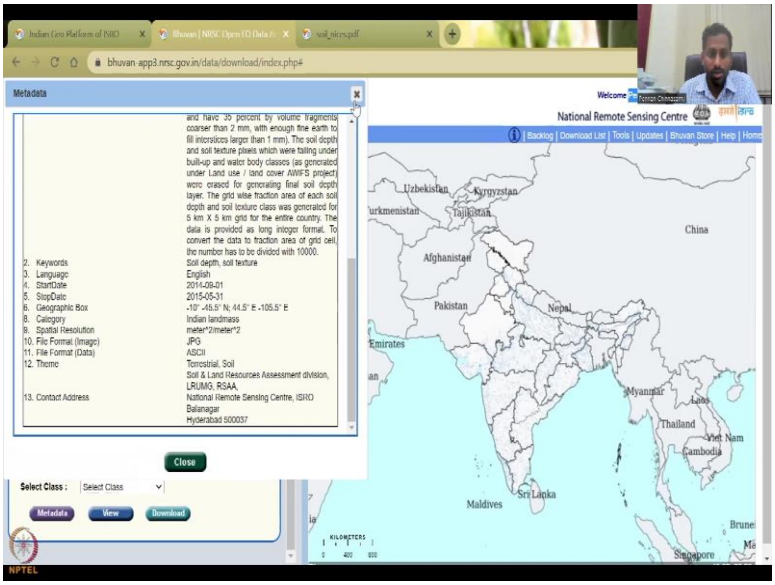

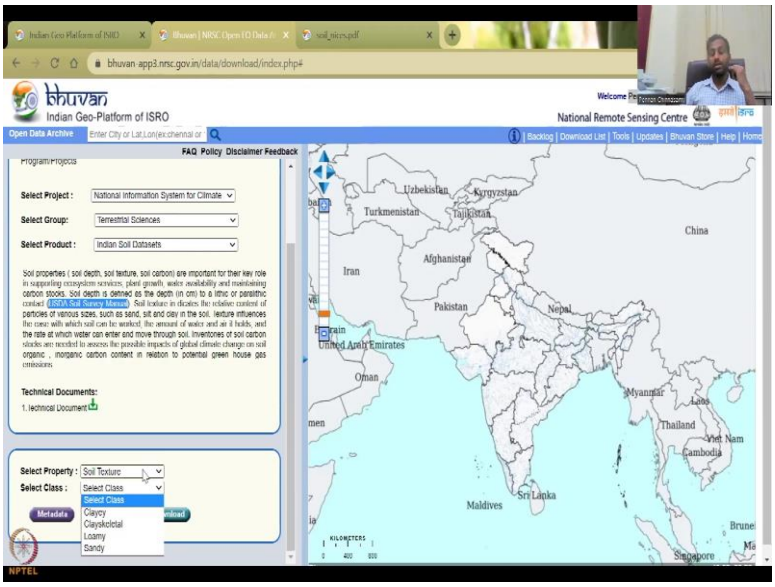

There is a meta data which says the same thing that we pulled out the form. So, I will just look close it. It has been made in Hyderabad. So, let us look at class. So, once you pick texture, the classification is there. As I said there is clay, clay soil which means more clay is there. There is low which is sand, silt and clay together. Clay is skeleton which has dried up a lot of clay and then there is sandy too much of sand. So, let us look at clay soil.

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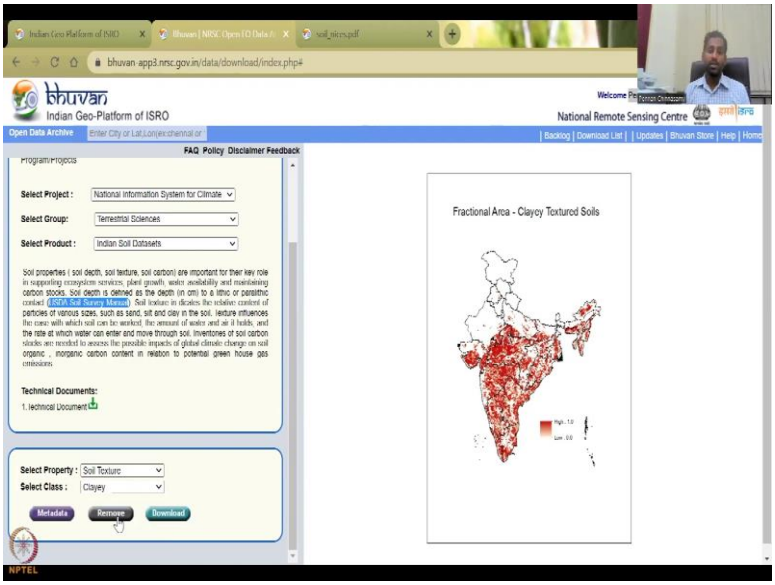

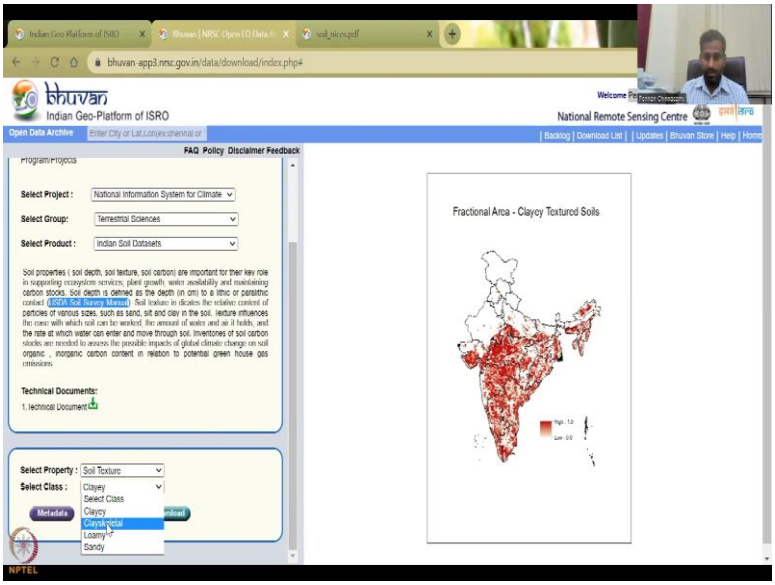

So, for a lot of people who know agricultural background, clay soil is sometimes mostly used for black cotton and those kind of things. So, only certain type of crops can grow in clay soil because it impedes the water movement down. It actually stagnates the water and so, only some crops can grow. You cannot grow all the crops.

So, you could see that mostly central India has a lot of clay texture and then so, you cannot grow certain aspects in the regions where there is forest you will see different types of good healthy soil, much more mixed soil, it is not purely sand or purely clay, it is a mixture. So, then we go to clay skeleton.

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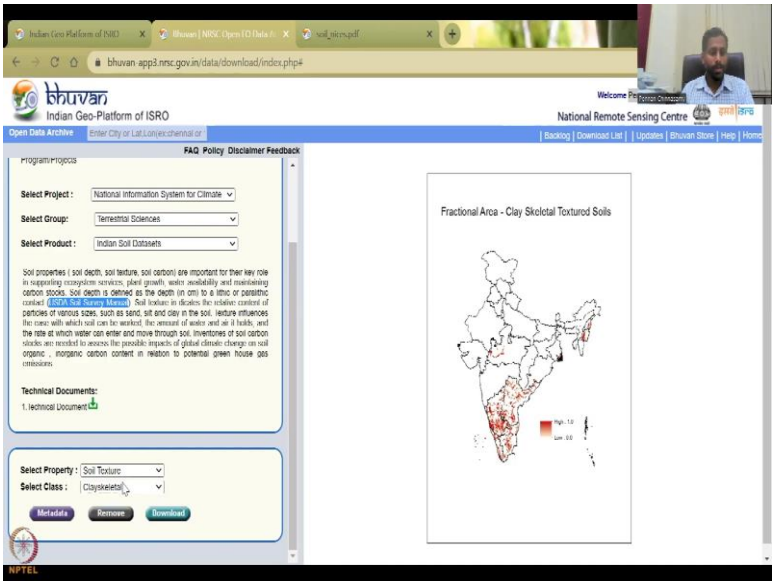

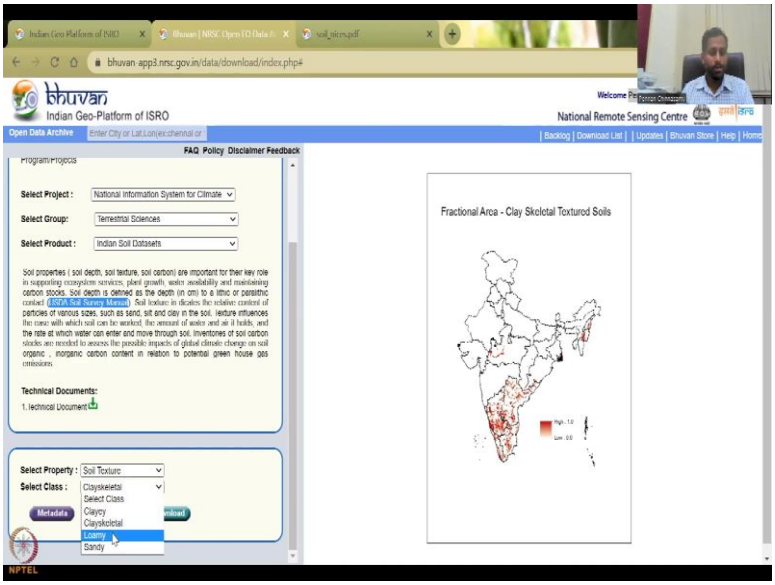

So, clay skeletal is more hardrock kind of area soil, you could see that mostly in the south southern parts of India you have that soil.

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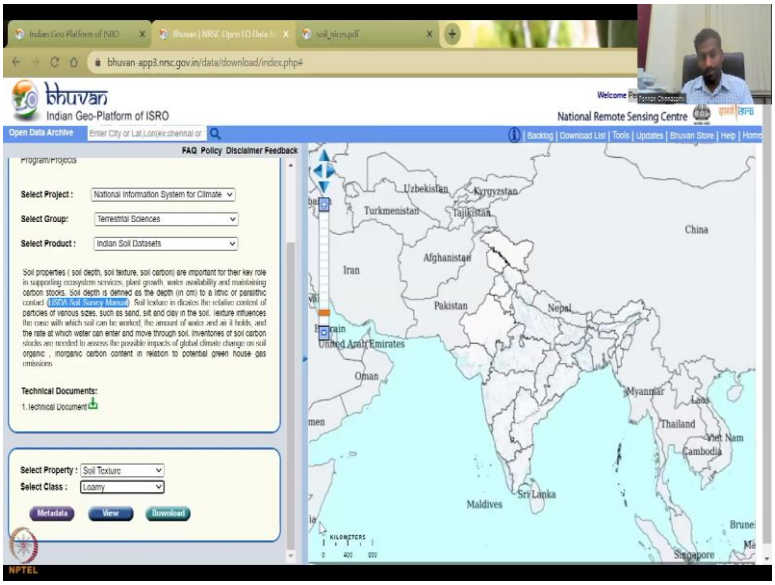

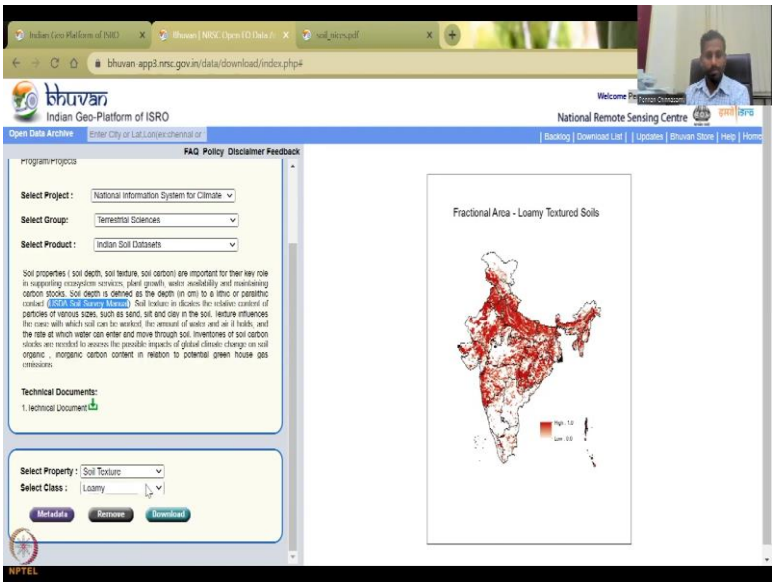

Then you have the loamy. So, the loamy is wood mixture of sand, silt and clay. So, all the other regions, the northern regions that did not come up in the clay pack have a good fraction of loamy textured soils. You can download these maps, these are static maps, which means the properties do not change. So, someone can ask, Sir, why is there no timeframe on it? It is a good question.

But as I said the texture does not change. If it is a clay soil, it is going to be clay soil, it degrades and stuff but it does not change within a timeframe of 10 years or 20 years, even hundreds of years. So, we will have to be using the same data set. So, that is why there is no indication of time and one of the reasons why it is not the boundaries are not fully updated,

the Telangana, Andhra, the borders have not been demarcated here, which is because these maps have been static for a long time.

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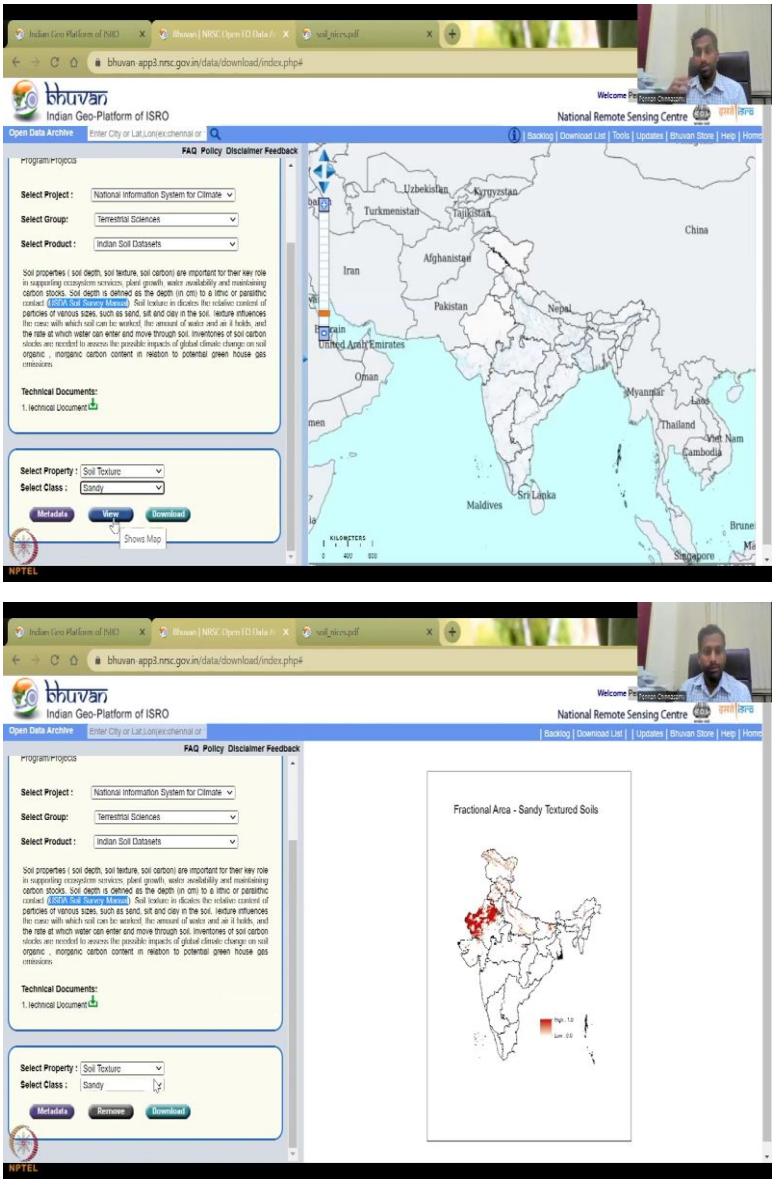

The last is the sandy so just like a quiz I could ask where would you find sandy soil? So, sandy soil is mostly found along the deserts. So, you see it along the deserts and hilly regions have a lot of sandy soil and mostly it is eroded soil that is falling down in the hilly regions. So, desert as the Thar Desert is there you can have a lot of sand in the deserts.

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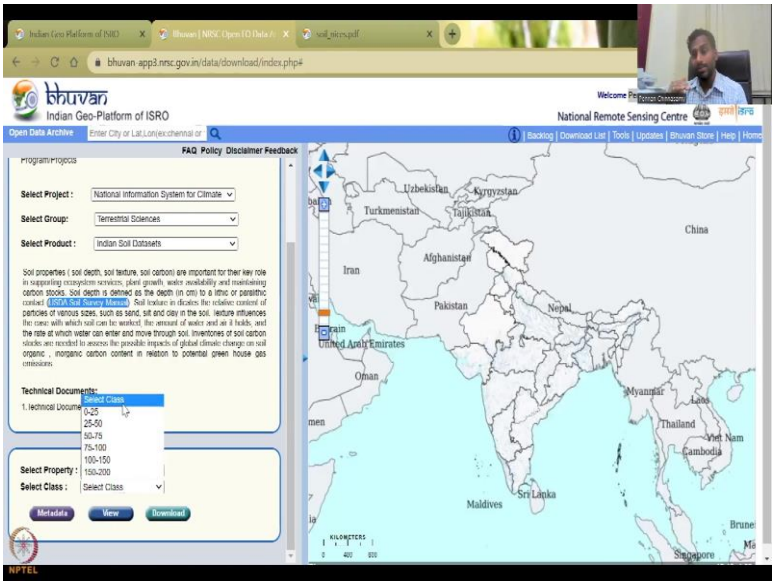

Now let us go to soil depth. So, in the soil depth, you can see like different classes, these are centimeters, because you should know where do you find soil up to 25 centimeters, up to 50 centimeters, 75 centimeters, 100 centimeters, and 200 centimeters, we will come back to this in the soil moisture part. See 200 centimeters is a good depth for the plan to grow. Somewhere you only have soil that very last 0 to 35, 0 to 50 centimeters, that would impede the growth of the plant.

So, as long as the root biomass grows, the plant is also healthy and it grows. So, we should be waiting to let the plant take full control and exhaust the soil that so that it has more potential to take water and nutrients.

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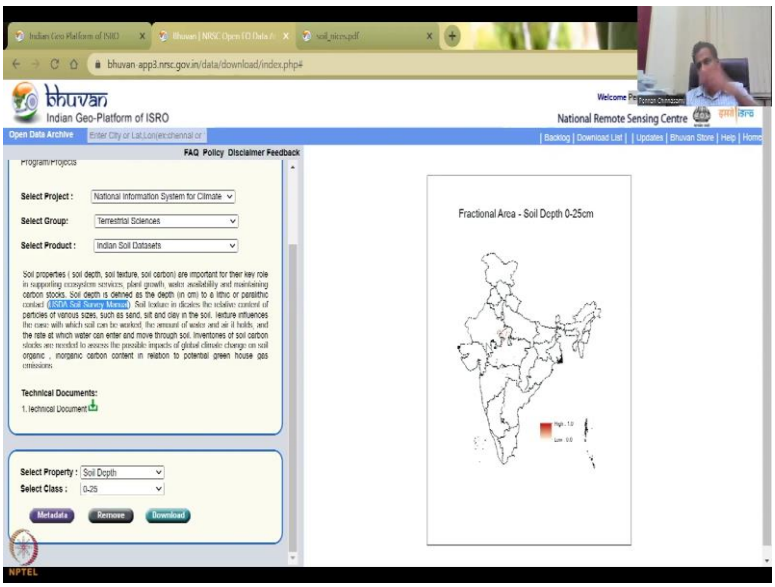

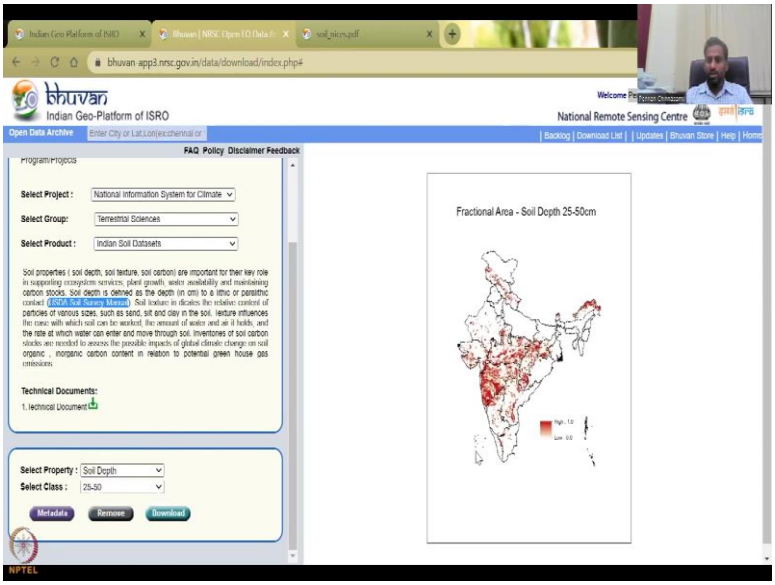

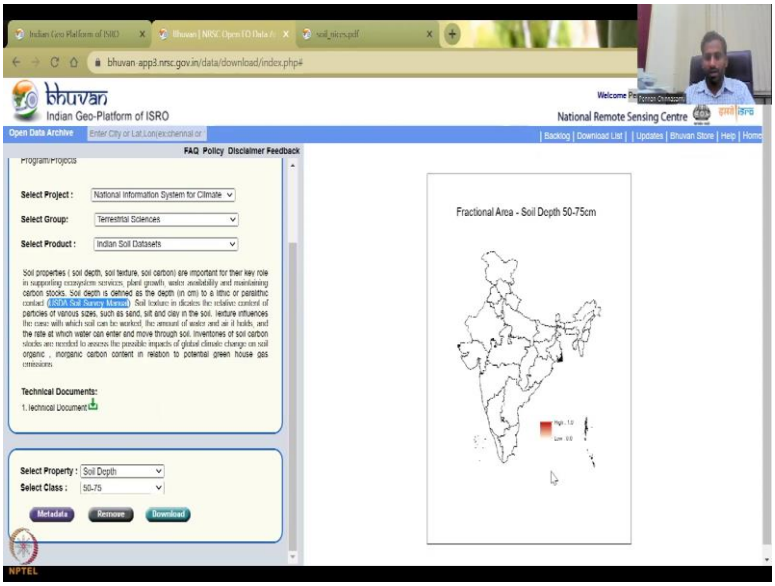

So, let us see each class quickly, you could see that 0 to 25 is very less maybe hilly regions, one or two regions in the central India and then 25 to 50 is mostly prevalent, Maharashtra where I am teaching this lecture from and along the hilly regions also you have 50 centimeters. 50 centimeters still not that good for plant growth. And in the 50 to 75, we do have some relaxations in some areas, but it is not as small to see.

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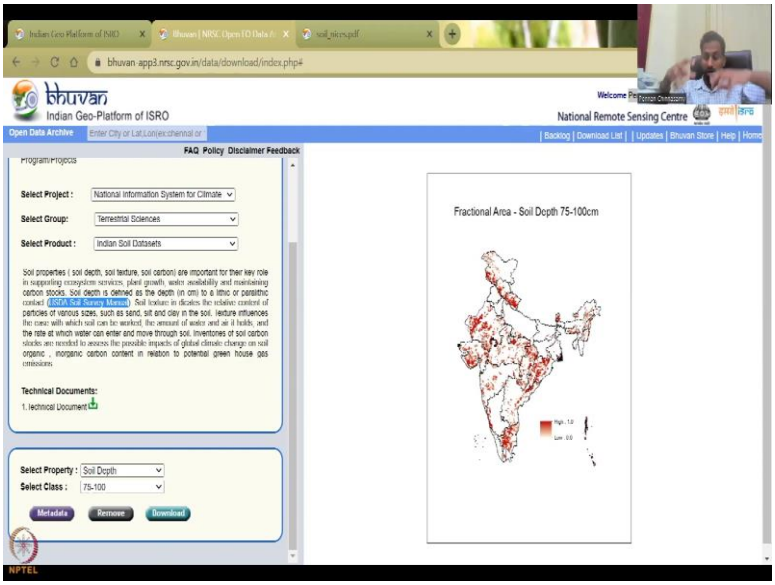

This is a very good growing part, 75 to 100 centimeters, most of the forest are covered here you could see the forest because the root depth goes pretty long, the Himalayan region, Gujarat those kinds of areas, Tamil Nadu and this is also good for growing rice and other crops where water percolation is needed, water needs to flush to the system.

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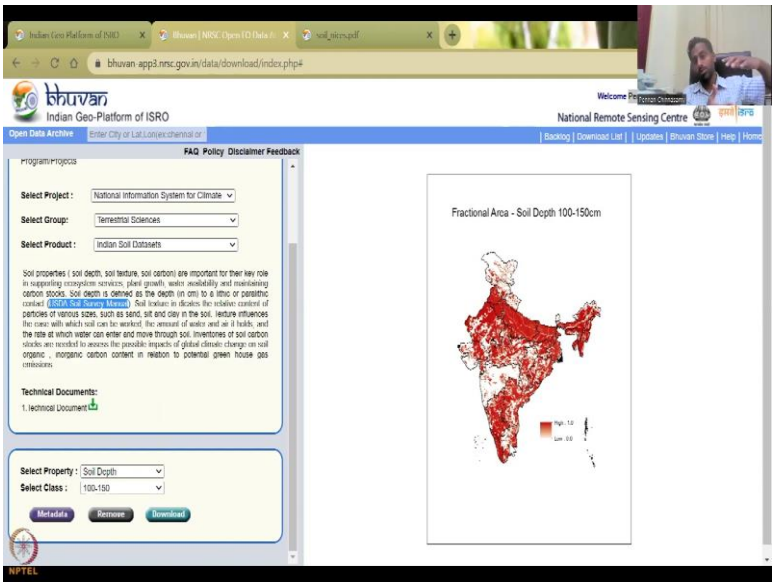

Then we will go to 100 to 150 which is the majority of Indian part. So, you will also have a mixture of 0 to 150 depth soil and then 150 to 200.

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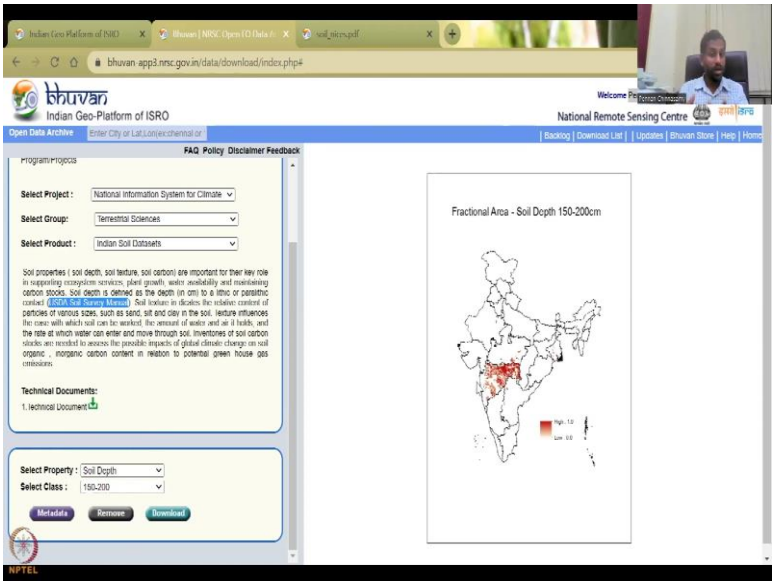

Also, and the last part 180 to 200 centimeters, only here. So, most of Maharashtra has a lot of deep soils. So, the good part about that is yes, it is supposed to plan but then the bad part is water just can percolate to 200 centimeters and then go into the aquifer or different areas. So, it is very, very important to maintain the soil moisture, otherwise, the crops cannot grow. So, those who know Maharashtra, this is the dry part of Maharashtra, whether those kinds of reasons come here, and it is not that conducive for plant growth as witnessed by the Western Gulf side. So, this side the Konkan region of Maharashtra.

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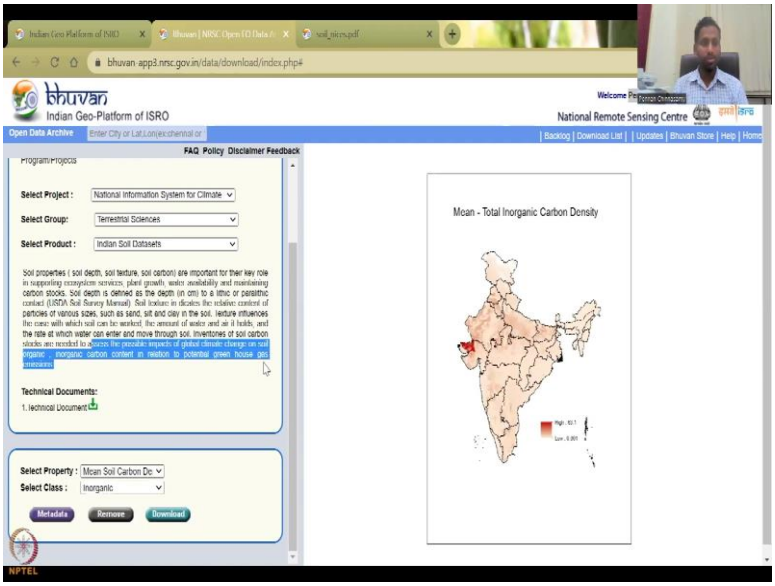

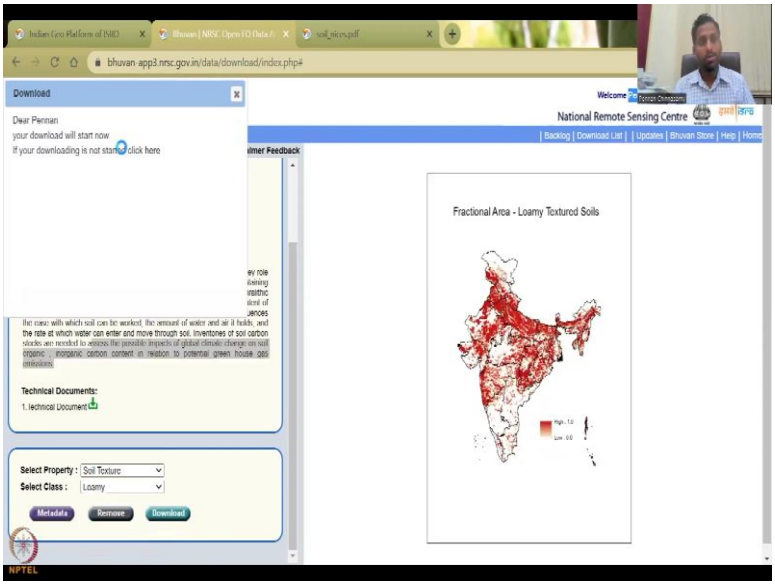
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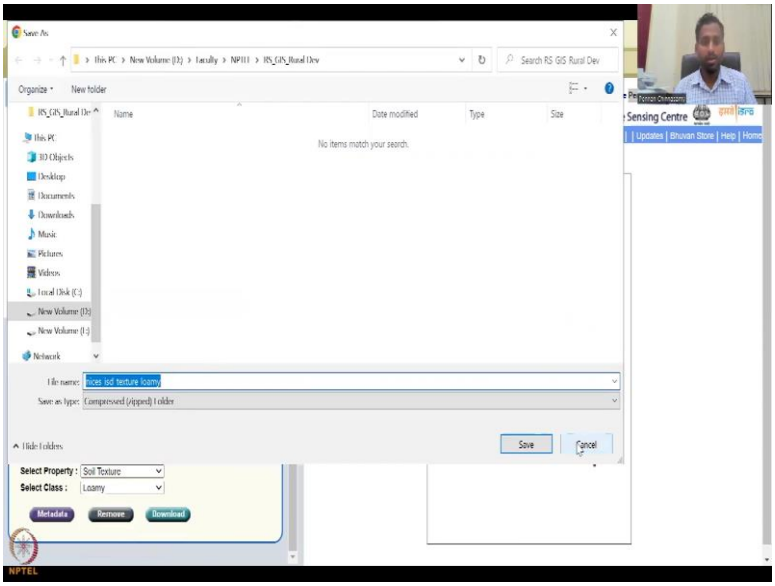
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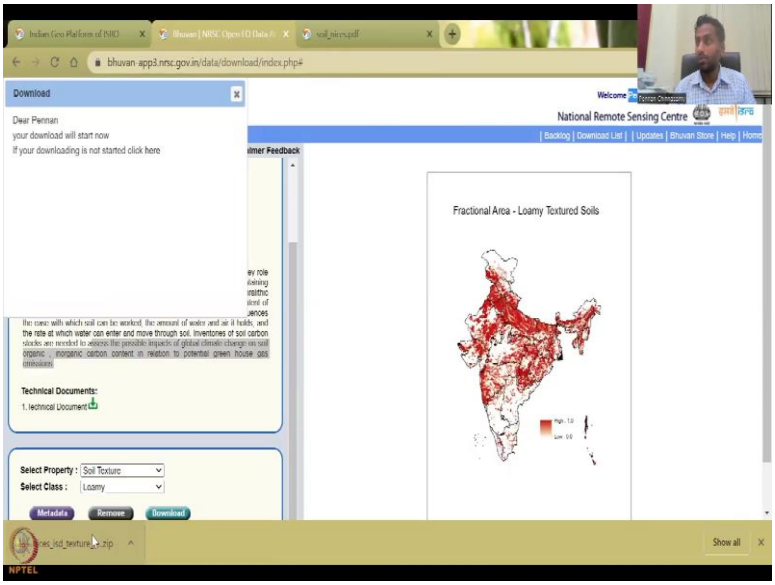
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So, let us now go to the mean soil carbon density again, it is not part of the class, but I will just show you quickly where you find organic carbon density and inorganic carbon density, which is very good for potential greenhouse gas emissions and then that impacts climate change. So, we are not part of this course, but it is there. So, I just showed you. All these can be downloaded as maps. So, for example, you can take this and then lo me view and then download, so it says download open and then it is getting stored. So, I will just save it so that you can see that, it is being saved.

Now, you could see that in my folder it has been saved. You could now import it into QGIS and it will be geo referenced.

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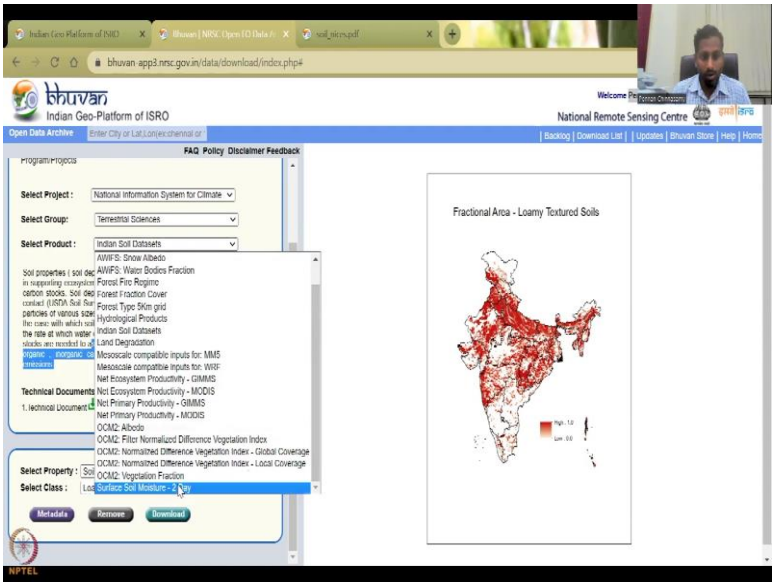

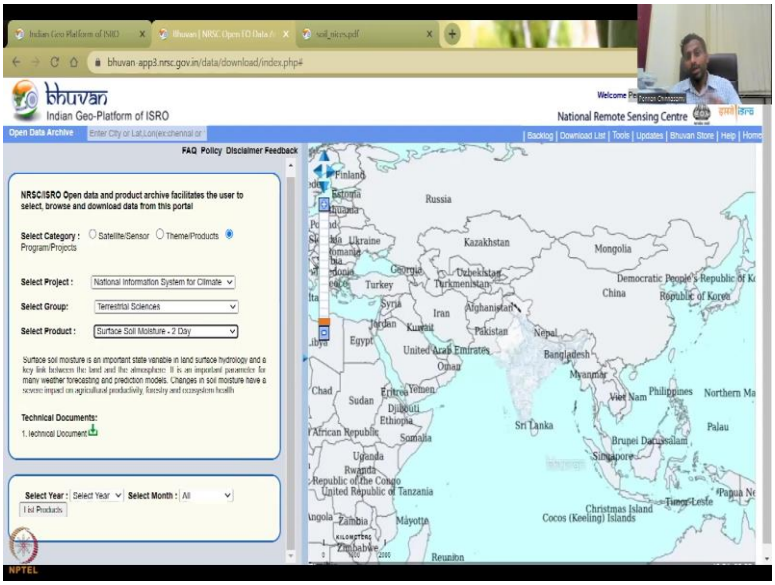

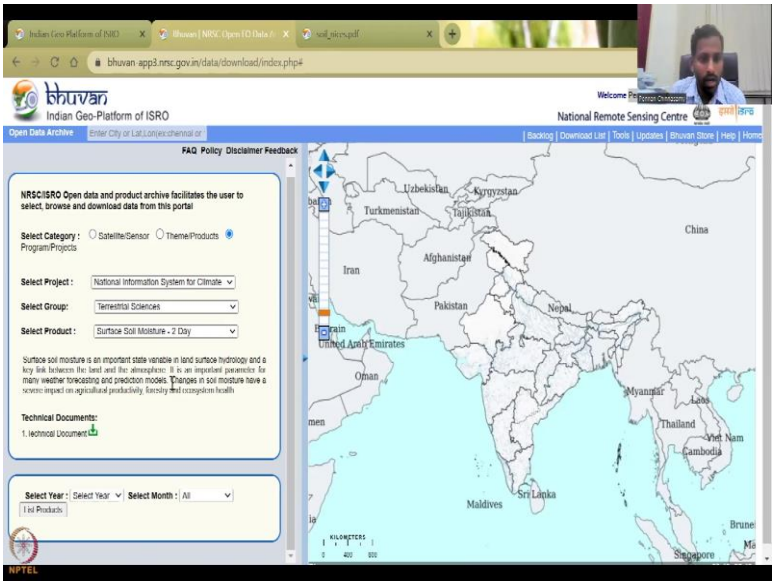

Moving on. Now, we will be looking at the second part of the soil database that I promised it is a soil surface moisture, it is a two-day soil surface moisture, which means every two days we will get the soil moisture condition. Now, if a farmer has access to soil moisture, then he or she will take a decision to either irrigate the land or not irrigate the land because that is the biggest question for a farmer when should I put water into the soil. Most the times the farmer sees, the plant and if it is wilting, turns color then they irrigate. But in most regions also they just blindly irrigate, thereby wasting the water.

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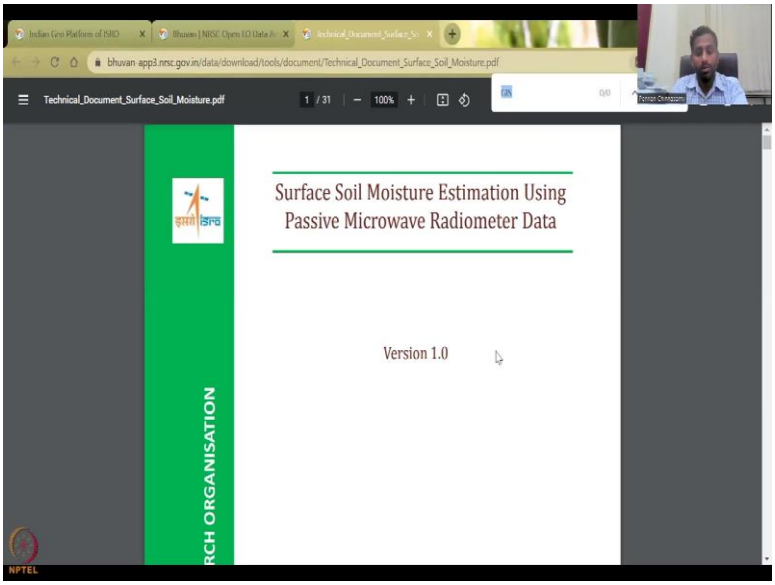

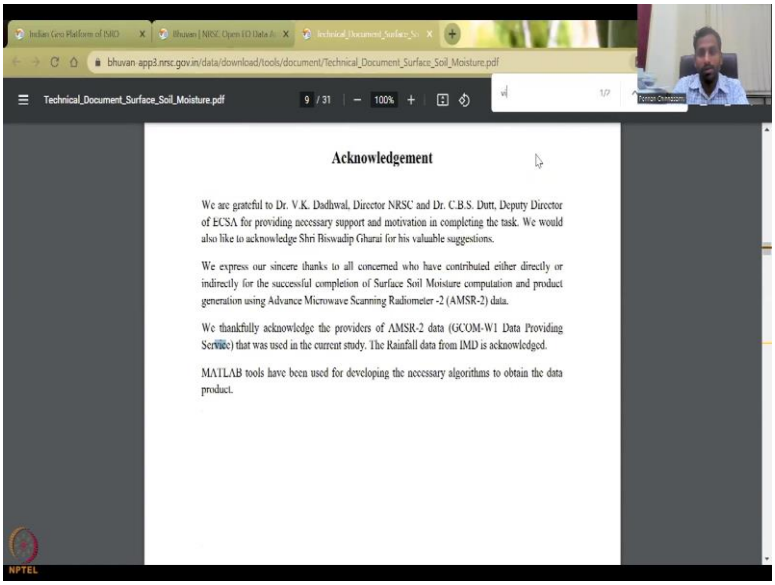

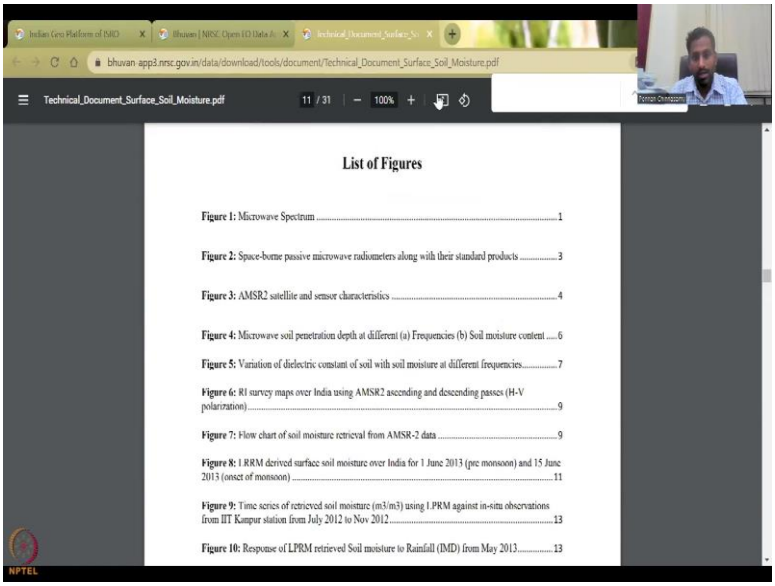

So, we are going to look at this and this is also driven by the DIC model, the technical document will help you to understand this model. It is done by VIC or variable infiltration capacity and also other data that is mixed NDVI and all this stuff.

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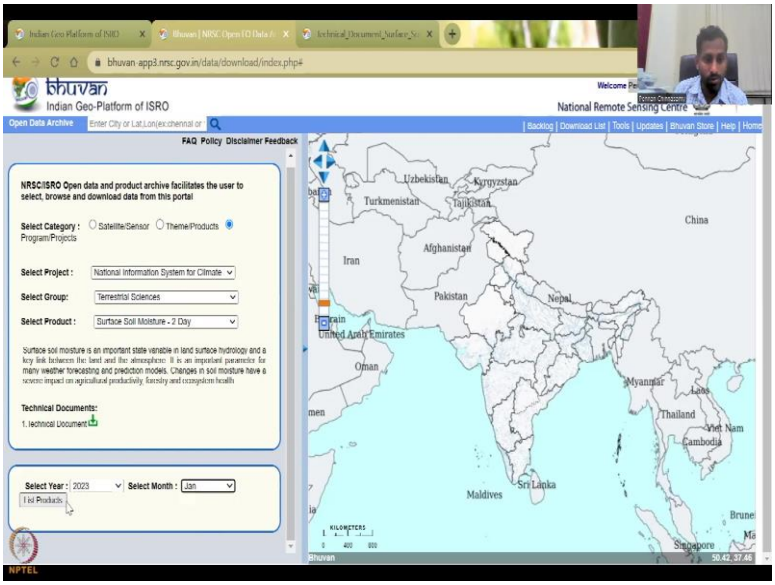

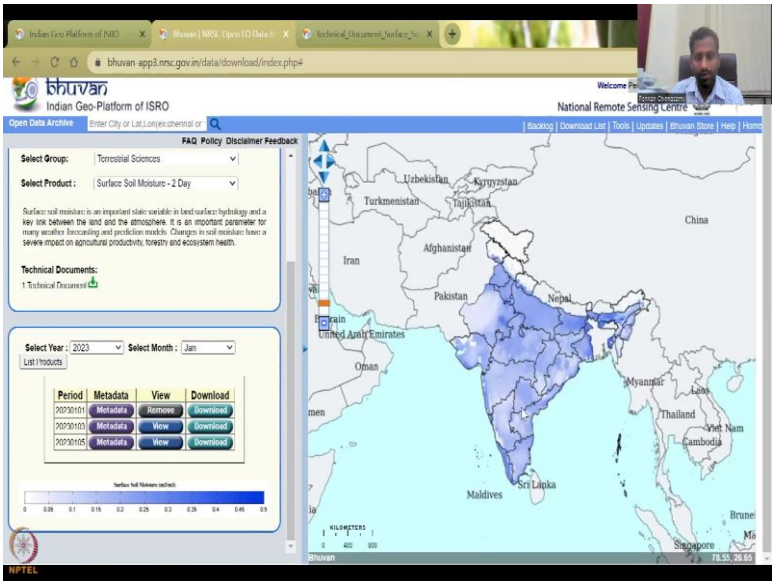

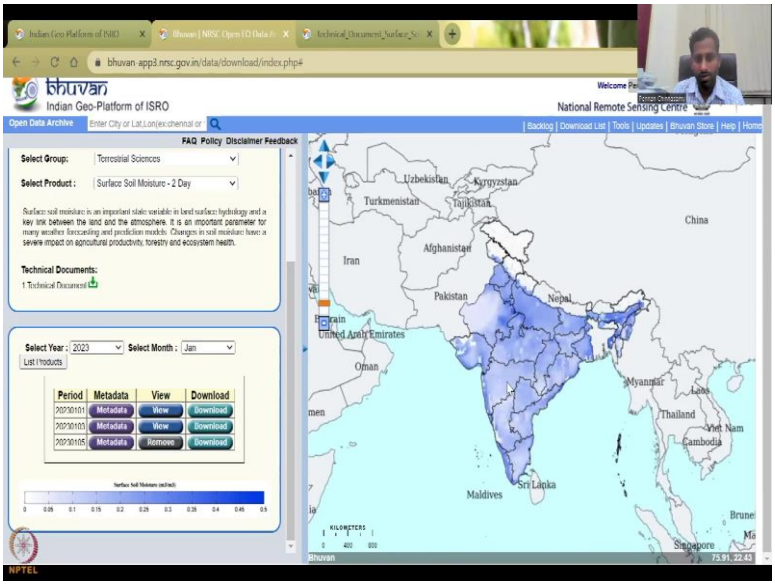

So, coming back, you can have different years and this is the only product I could see which is highly, highly updated. So, 2023 already we have. I am taking this lecture, you would have seen my screen on 10th Jan, so let us see what dates we have. So, we have from the fifth. So, 5 days before what is the soil moisture across India, we can see now. So, let us look at view. And you can see this is no data it is not like so much it is not there. It is not correct to take data from the mountainous regions because soil that is very less so people do not use it in a model. But you could see that across India, the soil health is the water quality capacity is still good.

The unit is meter cube by meter cube and you see 0.5 is the highest and then 0 is very less, so, you have the Western Ghats still having good soil moisture, central India still having good soil moisture, because these are the parts which just influenced were influenced by the monsoon. So, the monsoon entered maybe November or October and or November first week, and then it was not too windy or too hot for the water to evaporate. So, it still outcasts conditions cloudy or most regions are cold.

So, with cold there is not much evaporation, it is already humid, so you do not see the water molecule jumping out of the soil. But you could see now how it changes. So, let us take view between two dates. The first of Jan and the fifth of Jan you could see more water, but let us take just for the case, let us take 2022.

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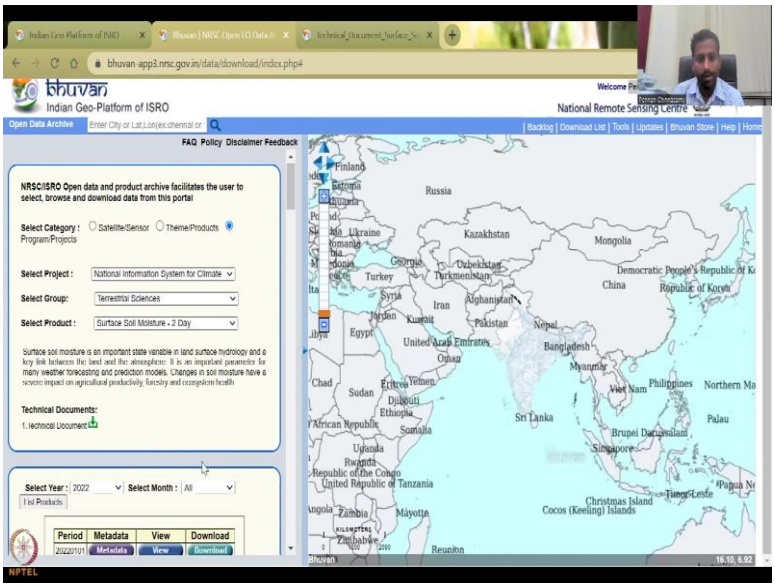

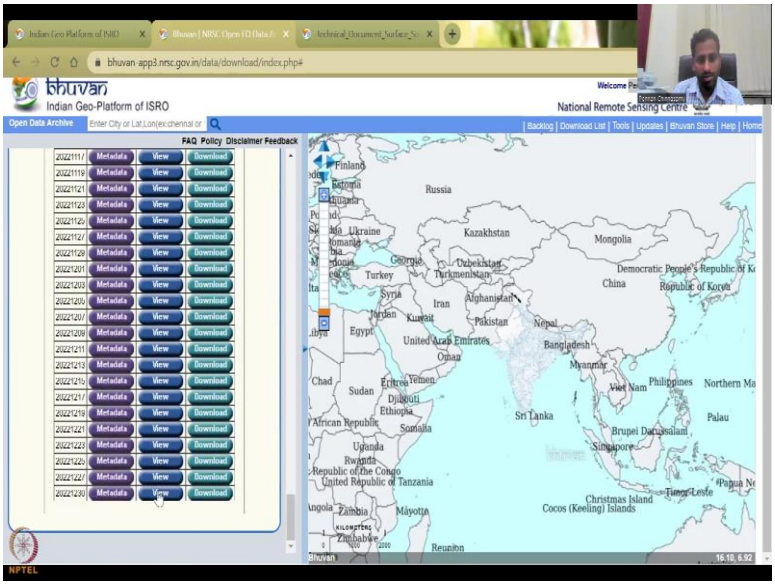

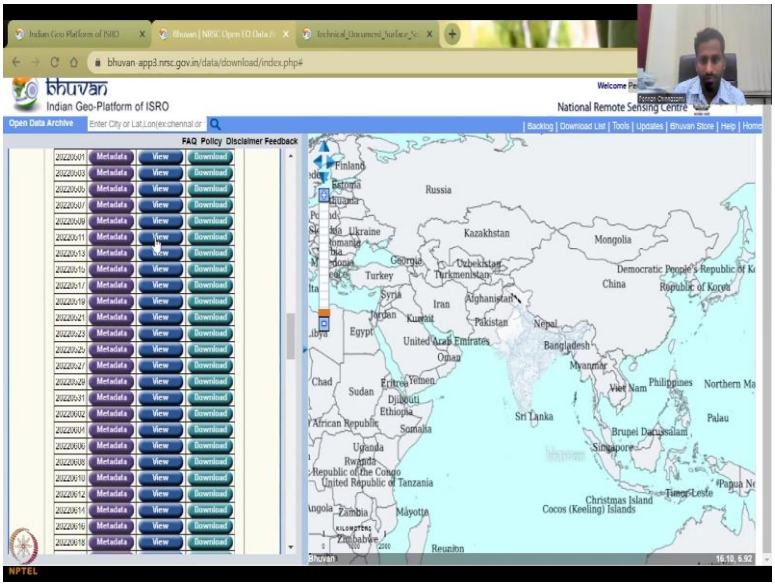

Let us take one date. Let us say list on list all products. And from first Jan up to the 365 days you have it. Let us take a peek month in summer, which that will be made so 2005, 2002 or 5. So, let us start.

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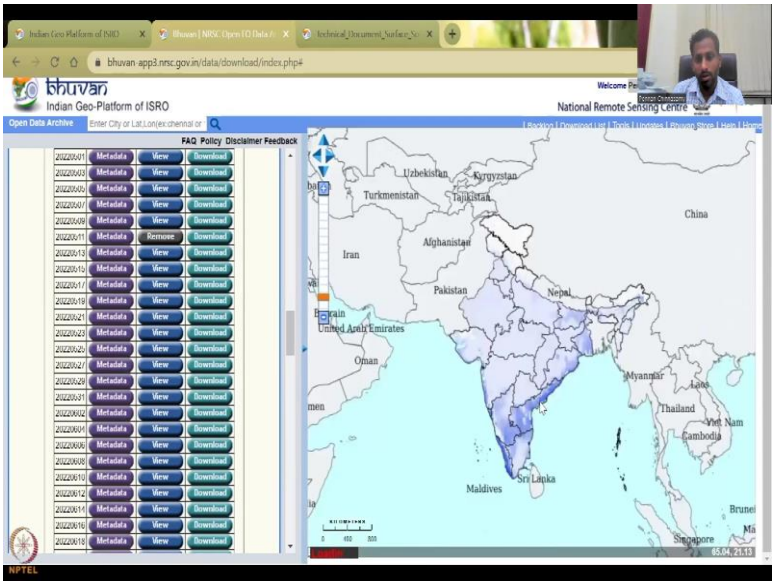

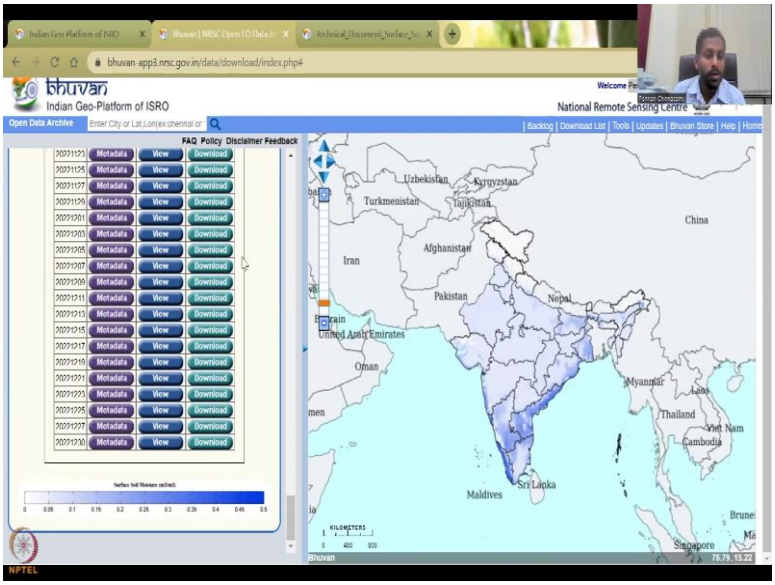

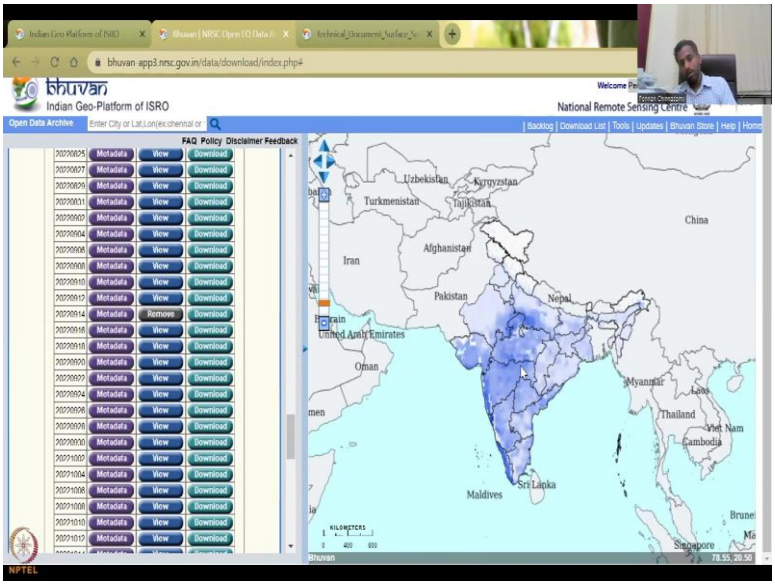

So, now you could see that it is pretty dry across India. There is white color is almost 0, 0.5 whereas only Kerala was influencing some rain so that triggered some soil moisture on the Western Ghats and other some parts of Andhra and Telangana. So, here now you see the division here, the soil database you will see the division. So, that is good.

So, now let us take. So, this is the summer just look at Maharashtra and this region the central region you will see how it changes during the monsoon period, the monsoon started in July so, let us take September, mid-September and you could see how the blue thing comes out. So, this is the soil moisture. So, if a farmer knows it, he or she can now prepare the irrigation schedule as needed. So, there is only one limitation here. Look at the scale.

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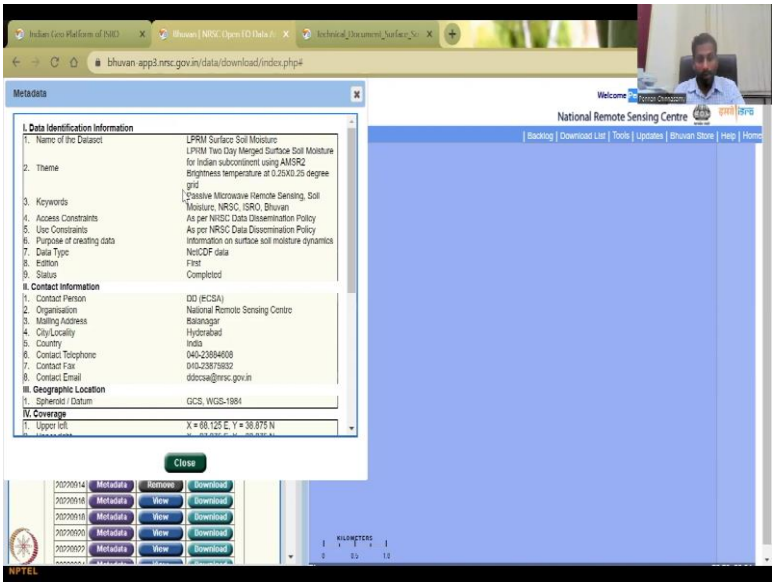

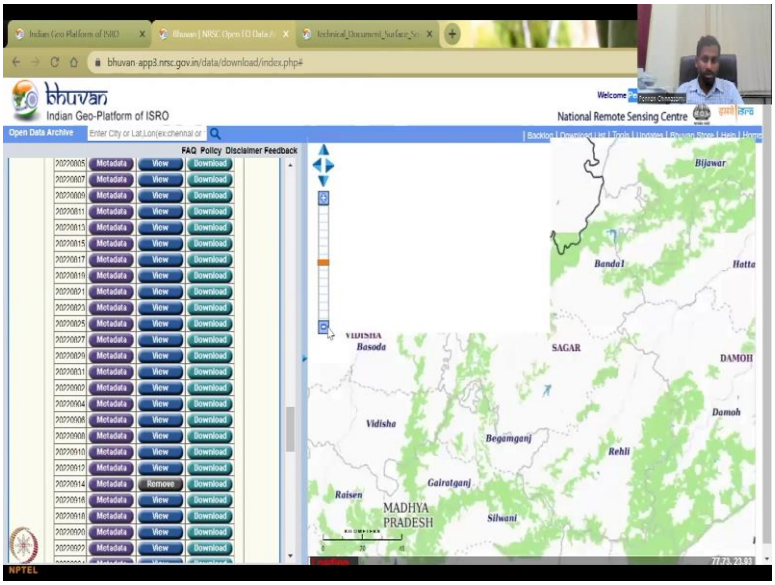

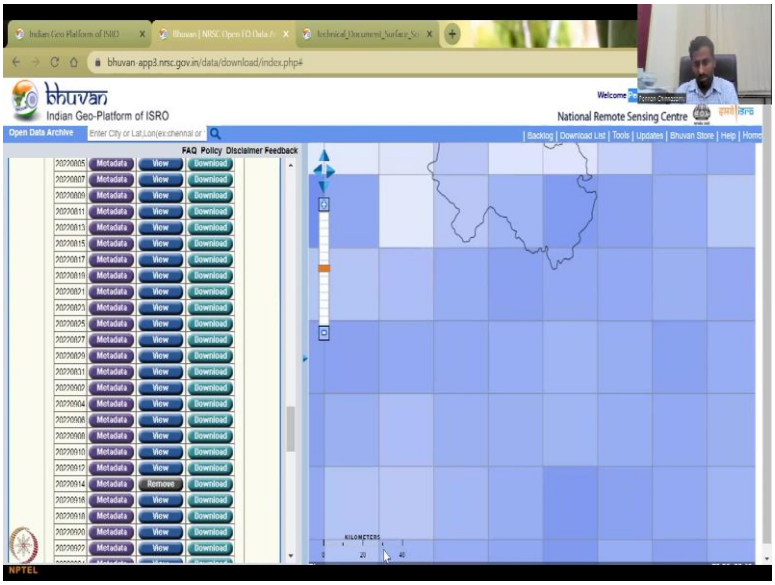

So, if you go in and then see the metadata, so, here the metadata is there, we can come down and then see the resolution if the resolution is not correctly given it says 2 days, 0.25, 0.5 degree grid. So, 1 by 1 degree grid is 100 kilometers by 100 kilometers approximately. So, you have around 25 by 25 kilo meters each grid soil moisture is 25 by 25 kilometers whereas, we know that the land holding size is much much smaller.

A farmer cannot take this data readily to apply for that region. You can do a district analysis, you can do a village analysis, but for a particular rural entity might become difficult. However, the methodology can be used. So, this is the grid, you could see that it is a 25 by 25 kilometer grid, it is pretty, pretty big.

So, you can see this is in kilometers and you could if I move it right there you could see that the box runs almost 30. So, that is 728 kilometers on one side this is a square it should be the same. So, each pixel one value in the pixel is 28 kilometer resolution that is really really difficult to use at a farm scale. However, this is the best data we have for Pan India. So, you can use it for ground truthing your values looking at drought regions, hotspot regions et cetera.

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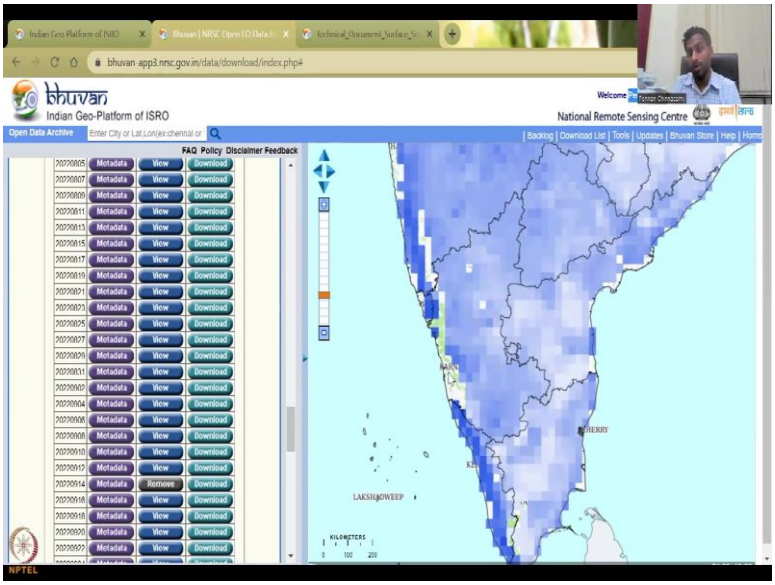

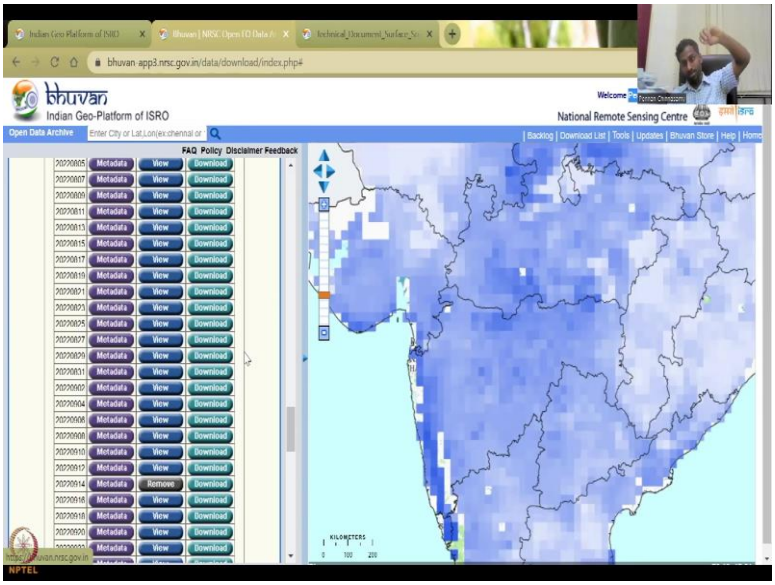

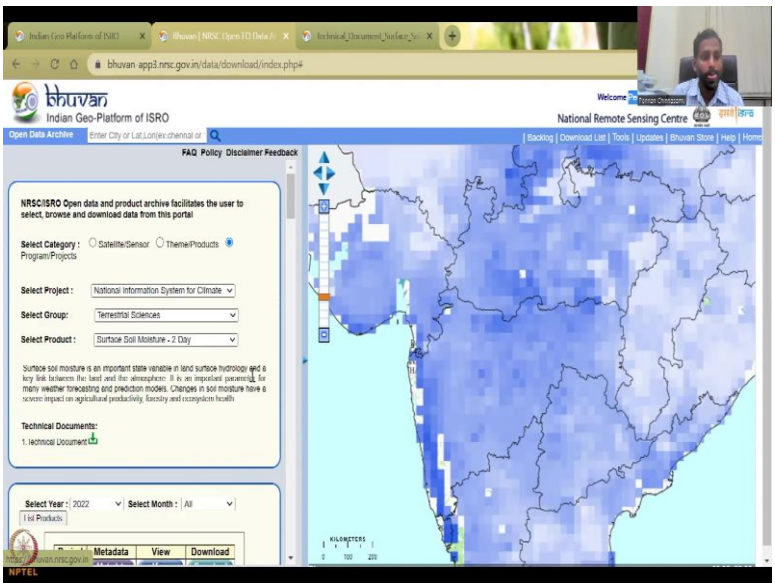

So, for example, in this time period, if you look at certain locations. Let us say and so, you could see that certain locations or let us say Karnataka certain location on the west Ghats were blue which indicates good soil moisture, but across that is called the rain shadow region this region is pretty dry, same in Maharashtra these regions are pretty dry, which is not good for agriculture. So, even though Maharashtra as a state has good rainfall during that period, it is not the full state is enjoying that rainfall, there is good variance. So, here is how you could quickly visualize the data very, very close to the data date that you are analyzing.

So, today is tenth Jan, and you could see that you could look at the data on the fifth of Jan. So, within 5 days the agency has downloaded the data, run the algorithms, cleaned it, rectified it and then put it up for your vision. So, for India scale analysis and district scale analysis is good from there you can drill down to your village level analysis and farm level analysis.

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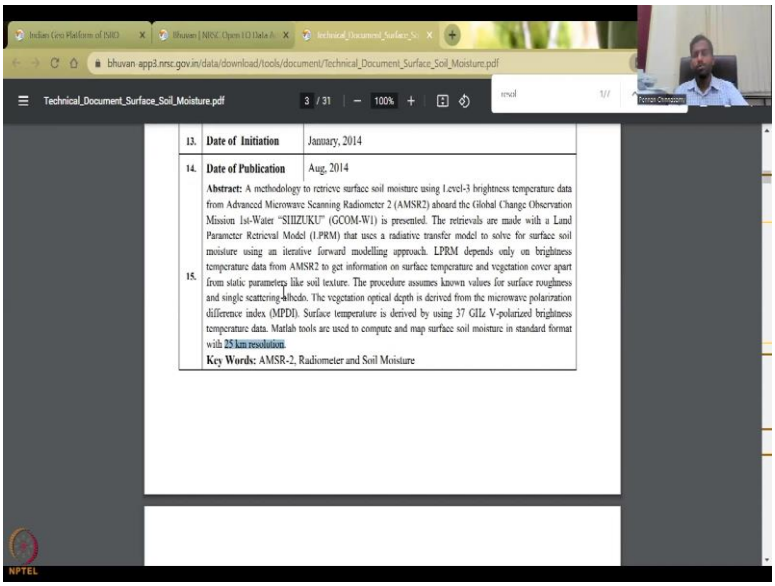

We will again look at a technical document then just search for resolution. So, as I said it is 27 kilometer rain, on the thing it is 25 kilometer. So, they have used a lot of indexes to create it and it is been pretty well cited for research purposes. So, there are some students who want to use it for research, this is a good data set. Those who want to use it for learning exercise also it is good.

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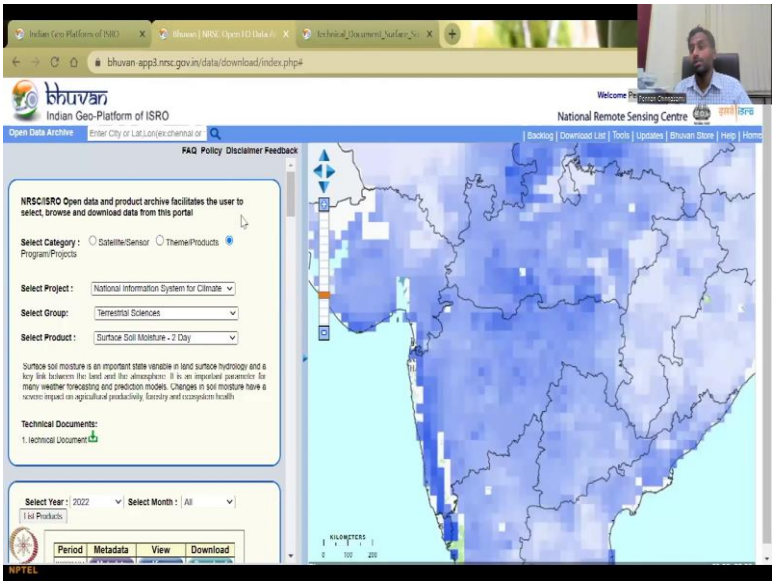

So, the point is we should not tell out that there is no data. When there is no data, there is definitely remote sensing data that can help. Yes, it may not bring to that particular scale like village scale or boundaries that you keep, but somewhere you can get it there and from there you can drill down to your particular area of interest. So, that has wrapped up the soil moisture and soil data exercise. The climate, I will continue in the next class.

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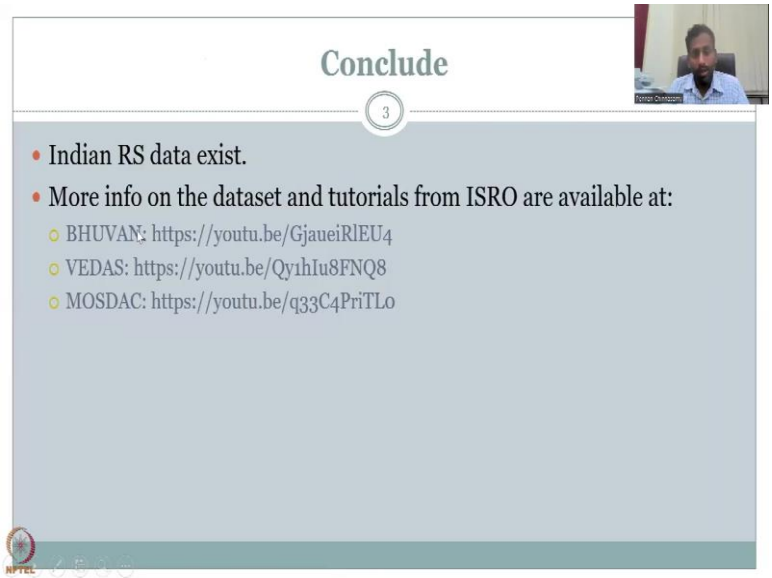

As I said, please do, go ahead and look at the various tutorials that we have. There is lot of data that good data that exists. And actually, because the climate is not much, I will just quickly show the climate data in today's lecture.

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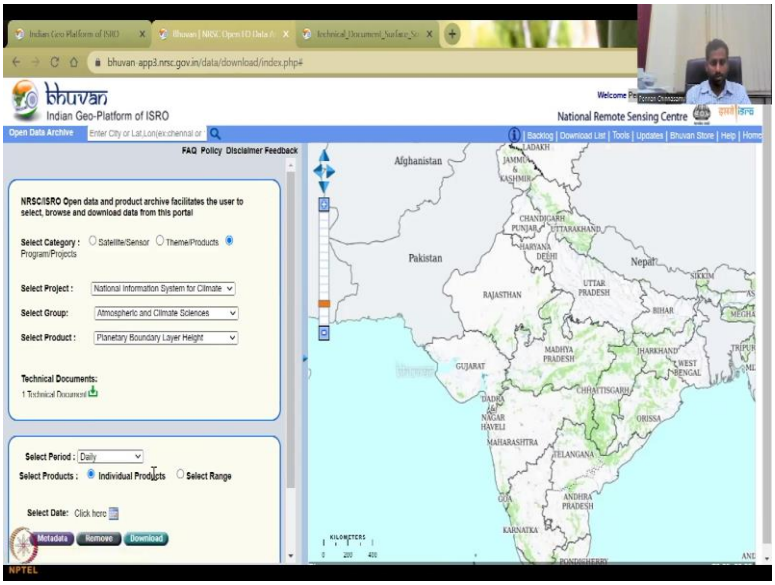

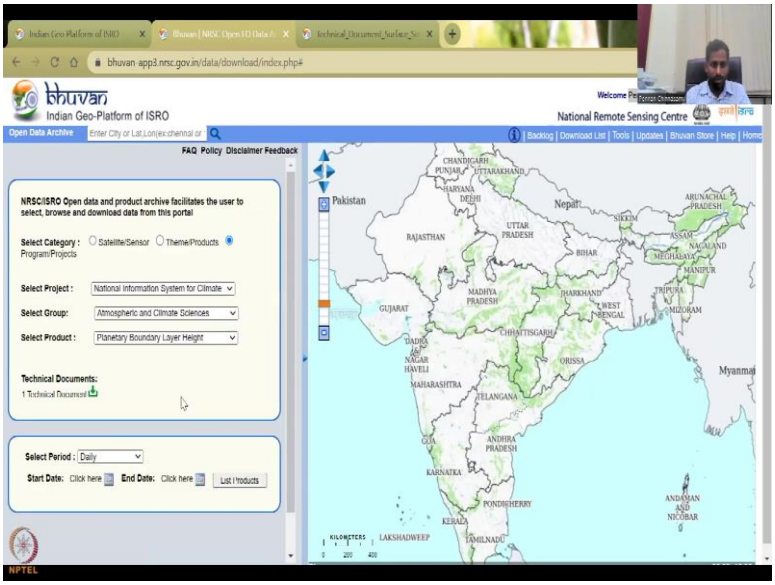

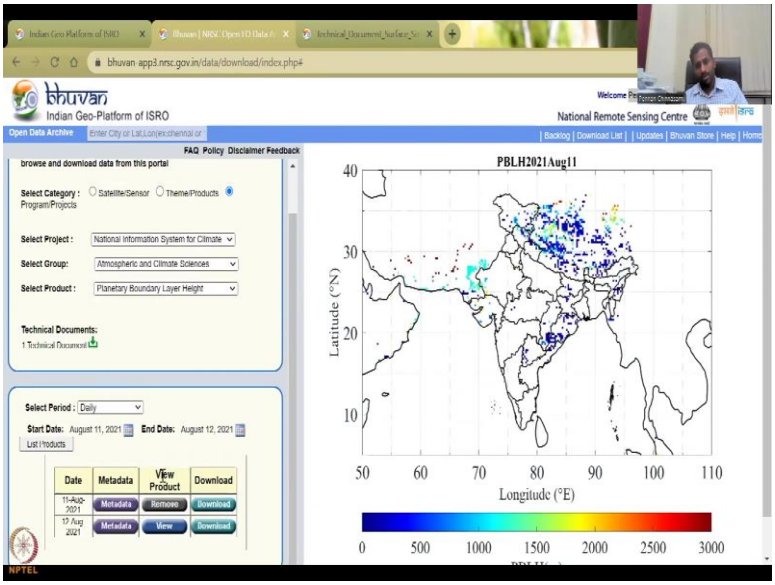

So, let us go back to the Bhuvan portal and the theme products you can see here terrestrial sciences and in here you can have climate products, atmospheric and climate sciences. So, under the same thing program and projects, I clicked national, atmospheric and climate sciences, and you can see here. So, you could see only mostly cloud cover and fraction of cloud cover and the troposphere ozone that boundary levels and all.

The only thing that could be used is some things like the planetary boundary daily, we can use the view button. So, it is not useful for, let me double click the you give a start date, and then an end date. We just give one more date extra products, we view the product and you can see here. So, these are just the planetary boundary layer height, which is not much use for us what the point I am trying to get here is the climate sciences are not that much in depth for rural development.

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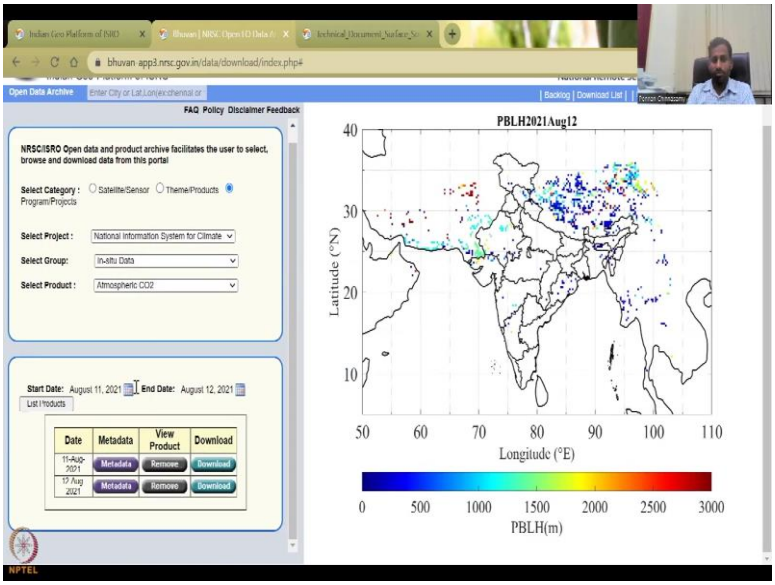

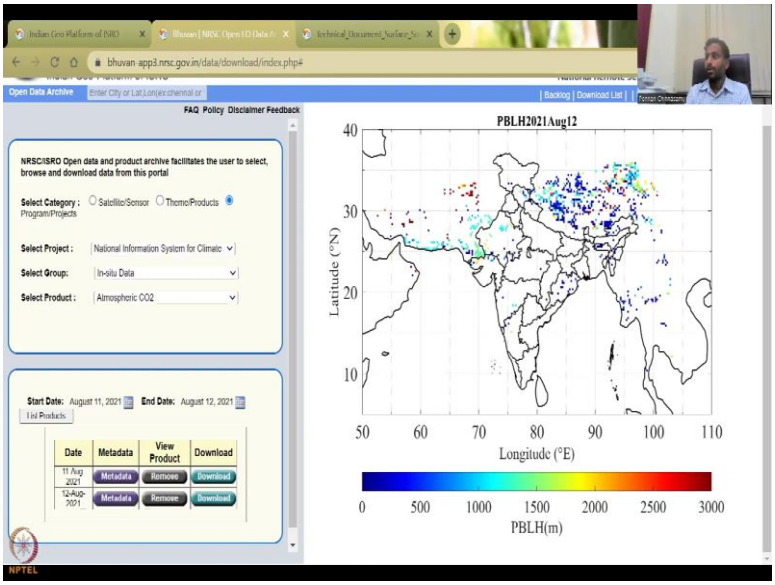

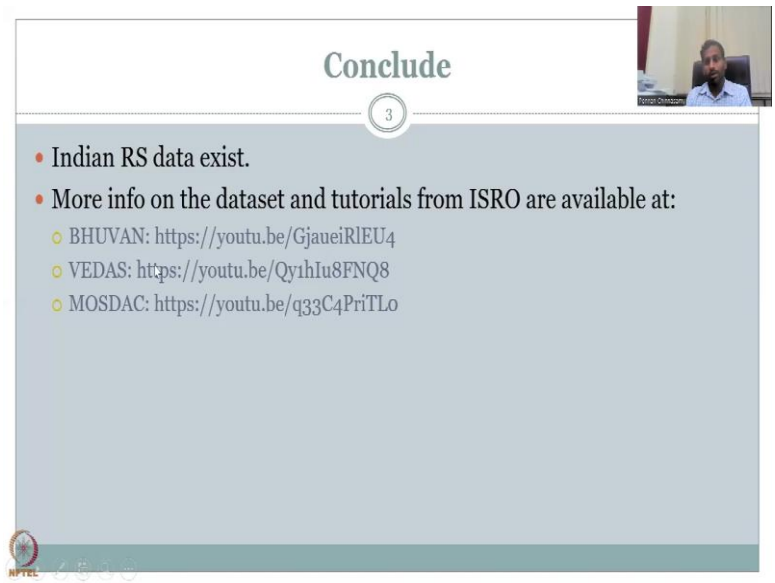

In the institute data you have atmospheric carbon, as I said, this is more on the carbon CO2 carbon dioxide across India, where you get carbon dioxide layer forming those kinds of things. So, with this, I think we have closed the climate data. That is why we will go into the next session we will go into other data sources that are being used in Indian context for data. We will catch up in that part. Please again, go ahead and look at these different, different tutorials to update yourself on using the Bhuvan portal. Thank you.