**Remote Sensing and GIS for Rural Development**
**Professor Pennan Chinnasamy**
**Centre for Technology Alternatives for Rural Areas (CTARA),**
**Indian Institute of Technology, Bombay**
**Week 8**
**Lecture 38**
**Analyzing Bhuvan LULC data (Part 1)**

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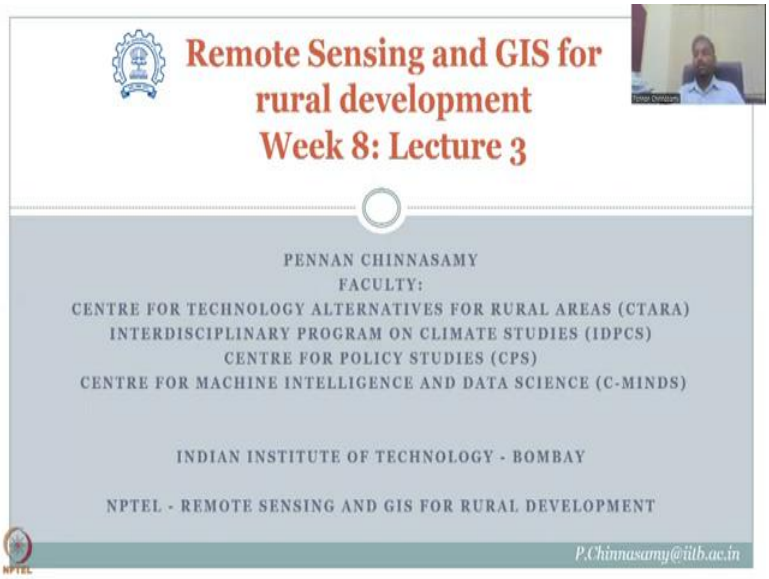


Hello everyone. Welcome to Remote Sensing and GIS for Rural Development, NPTEL lecture this is week 8 lecture 3. In this week we have been looking at land use land cover. How it is related to rural development and what are the data needs for doing a good land use land cover map. We have defined what is land use land cover, specifically what is land use and what is land cover. Then we merged it into one word as LULC and then we added a change word, so LULC is there and then LULC change between 2 time periods.

We also noted that there is lot of data issues in mapping LULC and for that we are going to devote the next 2 lectures on data sources, data access and how you could bring data from multiple sources into resource matter.

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So, let us start with the first example, we have ISRO's resources for LULC and as you could see there is a very detailed Bhuvan portal looking at the land use land cover with multiple attributes, roads, houses, buildings, airports, infrastructure, etc. And there is also another portal within the Bhuvan which showcases the agricultural rural aspect.

As I said we cannot neglect rural and urban as separate entities. The demand in urban is taken up by rural areas and when the urban system increases the rural regions fill the page or they are impacted, for them to flourish and sustainably develop the urban systems also have to be checked.

So, we will now look at multiple resources as I said there are multiple hierarchies in ISRO, that is ISRO, there this is SAC state space Application centres and then there is NRSC National Remote Sensing Center and then there is subdivisions. Just for the state there are multiple ISRO products, ISRO works with multiple software agencies to collect data and map it. And there is the ready-made Bhuvan data which is sometimes made with ISRO data and other satellite data like NASA, etc. and some products are given. So, we are going to look at the access to these data but first let us look at the tutorial on how to access it.

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For this we will go to this website. So, allow me to share the screen on the Bhuvan wiki page, where how you can access thematic maps, how you can go into learning to use these different data sets will be showcased. So, now I am opening the data set page.

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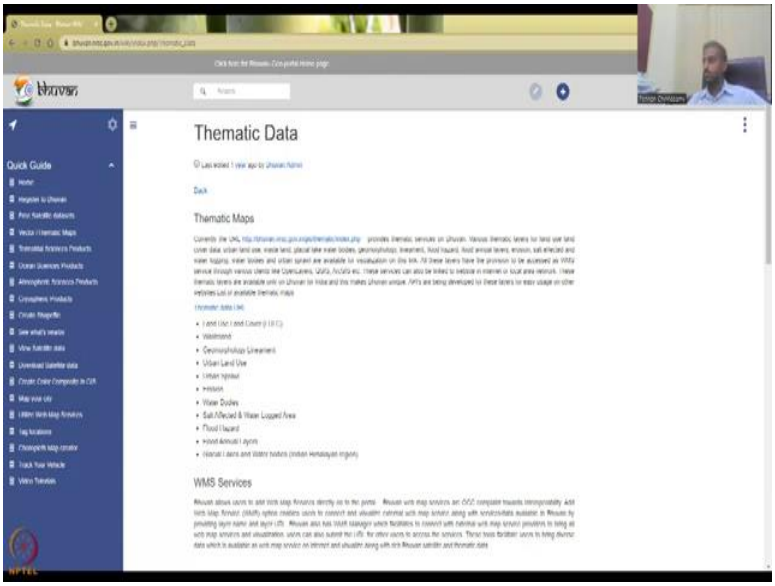

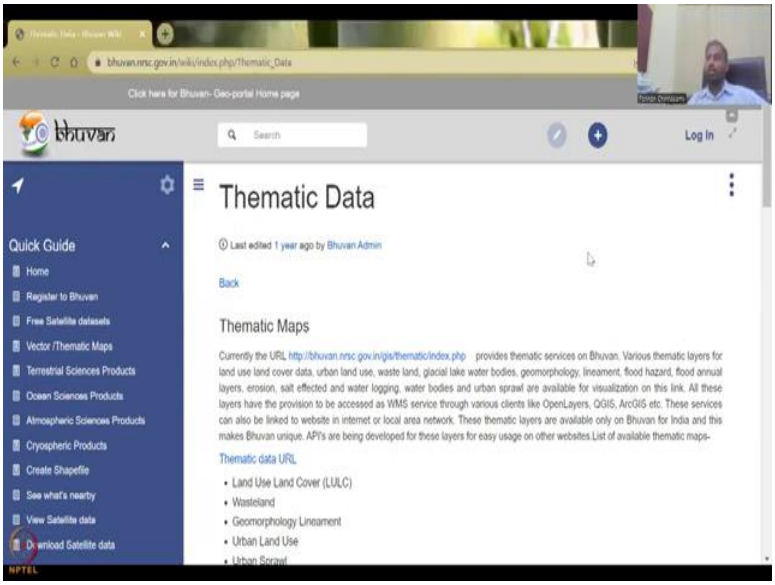
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Thematic Maps
Currently the URL http://bhuvan.nrsc.gov.in/gis/thematic/index.php provides thematic services on Bhuvan. Various thematic layers for land use land cover data, urban land use, waste land, glacial lake water bodies, geomorphology, lineament, flood hazard, flood annual layers, erosion, salt effected and water logging, water bodies and urban sprawl are available for visualization on this link. All these layers have the provision to be accessed as WMS service through various clients like OpenLayers, QGIS, ArcGIS etc. These services can also be linked to website in internet or local area network. These thematic layers are available only on Bhuvan for India and this makes Bhuvan unique. API's are being developed for these layers for easy usage on other websites.List of available thematic maps-
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Wasteland
Geomorphology Lineament
Urban Land Use
Urban Sprawl
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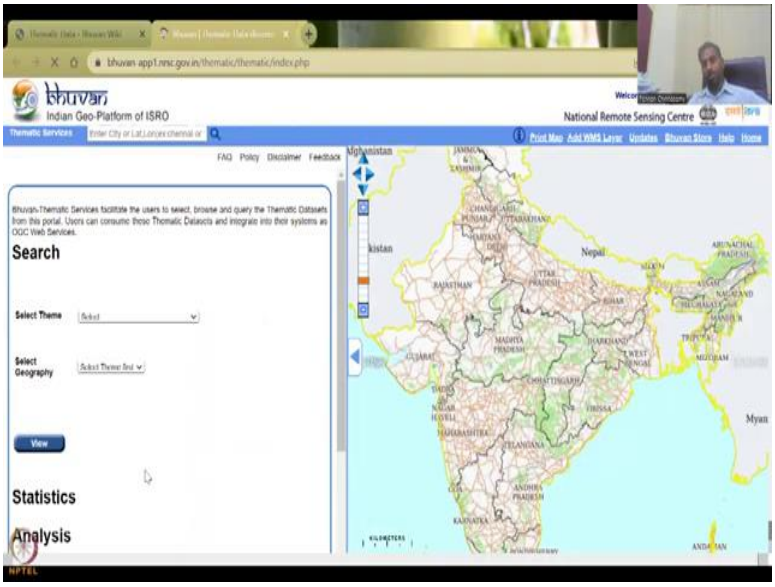
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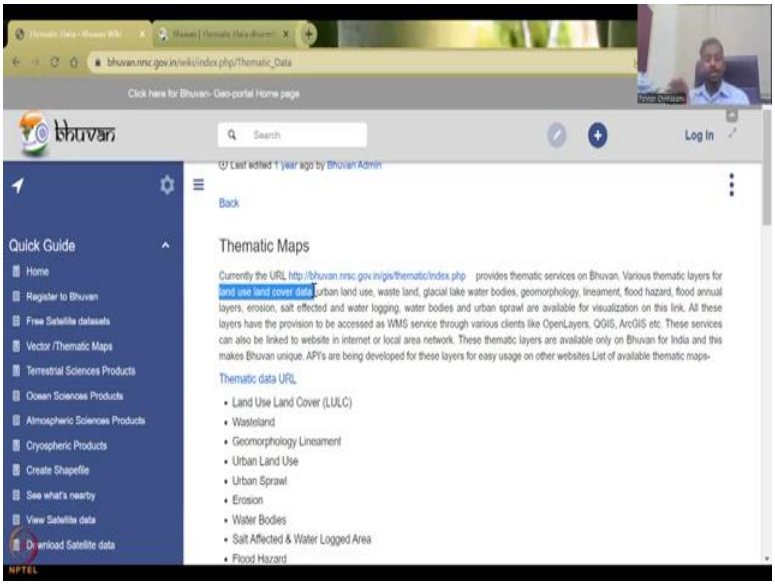
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Erosion
Water Bodies
Salt Affected & Water Logged Area
Flood Hazard
NPTEL

So, the link I have clicked and this comes up and what you could see is it is like a book with a user guide on thematic maps. So, you can click on the thematic data URL which opens out a specific portal which we will come after this, going through this tutorial part. So, it tells about the URL is this and you can have multiple mapping systems, it is provided in Bhuvan, it can be used for liniments, flood hazard, flood annual erosions, etc.

Our need is this part you can see that land use land cover data is the first very very dominant part in rural development, urban development etc and that is why I am using it here in this lecture series as one week. We may spill over in the next week where we may have a hands-on tutorial on using downloaded data for land use land cover.

You can open and access these layers using WMS service through various clients like open layers, QGIS, ArcGIS, WMS service you can just Google it through YouTube and it will open out ISRO's web page on how to use the WMS service. Again it is apart from the lecture content we are not here to give one specific data set and how it interacts in GIS, so that is what the WMS is.

We will just focus on the data access, data download which we will do in the hands-on session. We will use NASA's data because it is more appropriate and more relevant in terms of time and space and you will find that even the Bhuvan data houses NASA data, it is not made with ISRO's data we will find it pretty soon.

So, these services are linked to this website, it is good to use the best service available, it is free, open source. So, what NASA's data does is it mixes with the slow data and comes as a bigger product. So, it is always good to use the best service available. Yes, we are here to use more Indian products but we should also understand that we should use the best service available for the Indian public so that they manage the land and other resources well.

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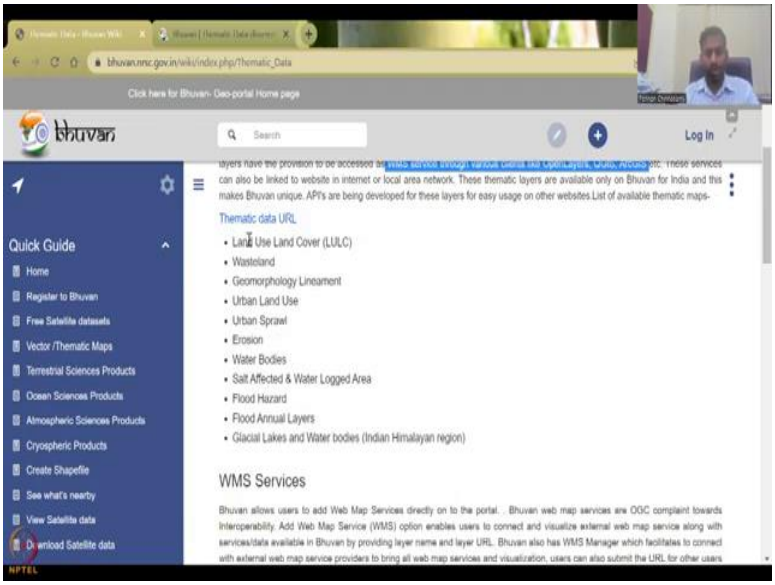


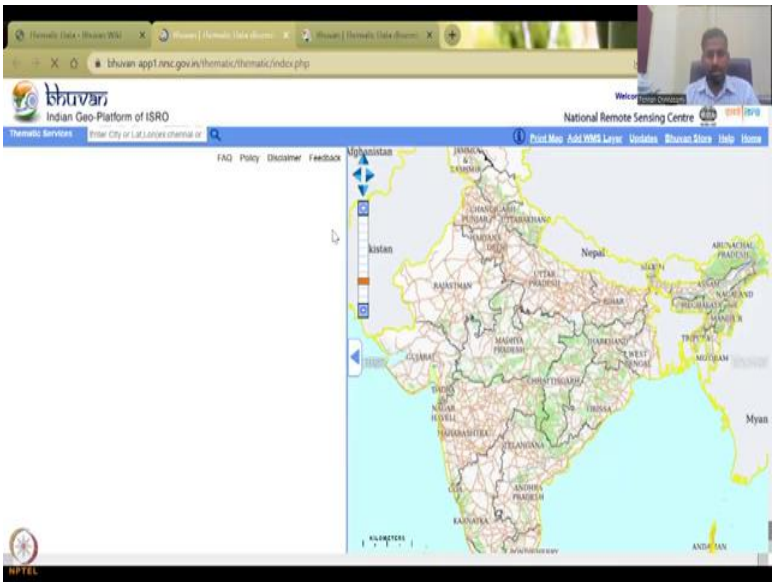


So, coming back we will look into what the data are there, there is land use land cover. If you click this it is going to be the same thematic region just 2 links given for same part. So, WMS service is there.

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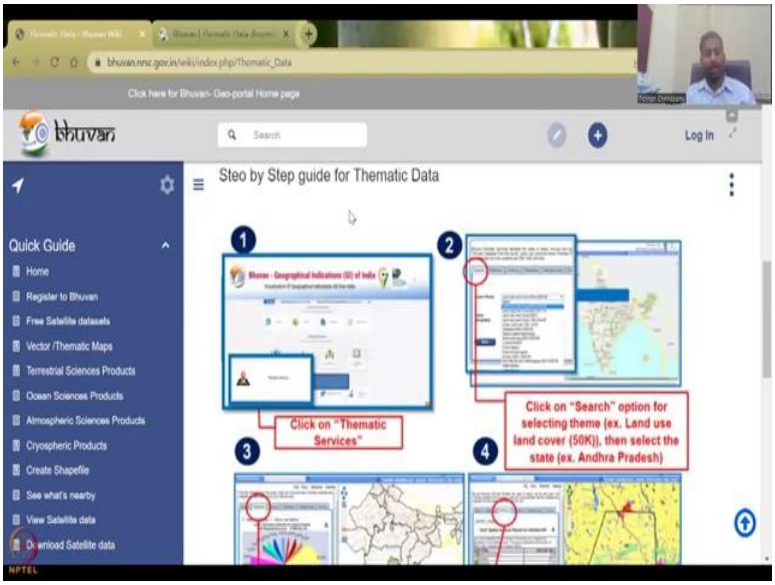


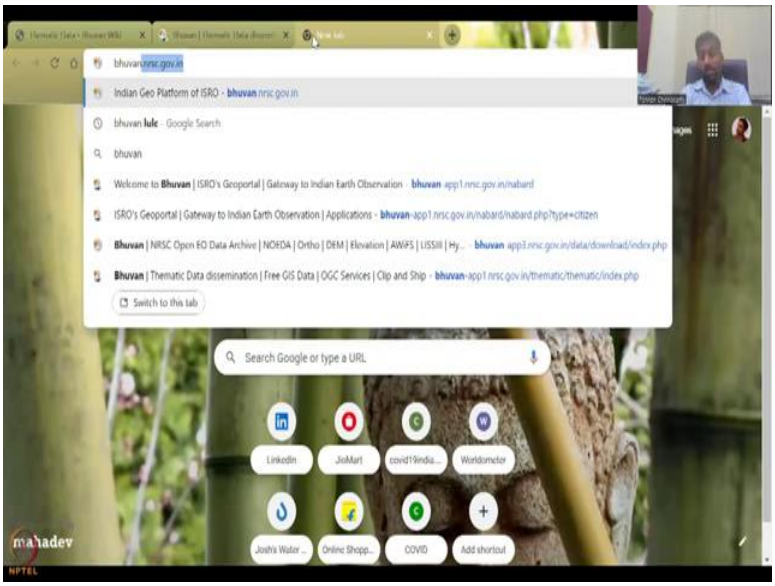


And then there is a step to step guide on how to download the data if you just go to the Bhuvan geographical indications GIS India or just the Bhuvan website you can also click on thematic services. I have given the link but let us search it for ourselves so that in the due course of time if the link does not work you can just go ahead.

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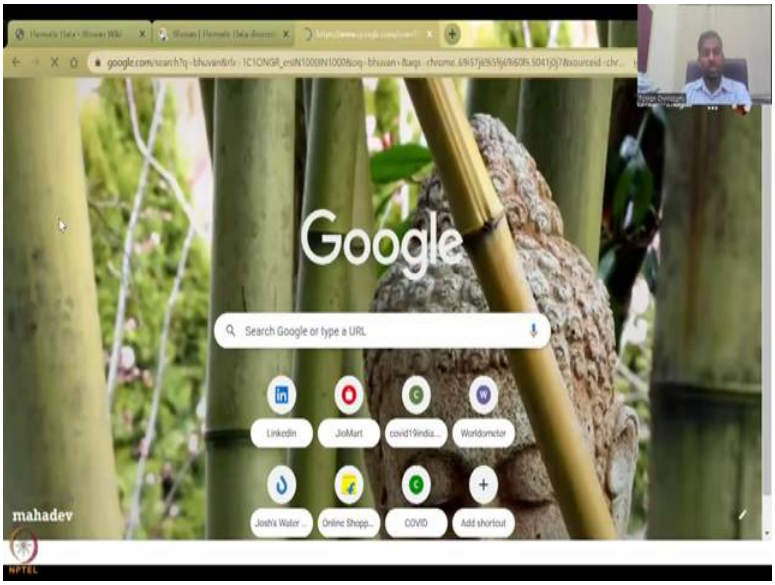


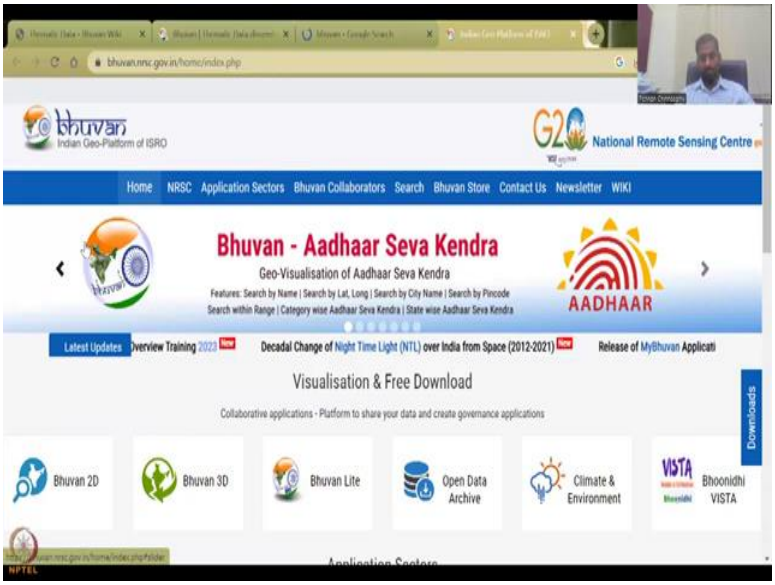


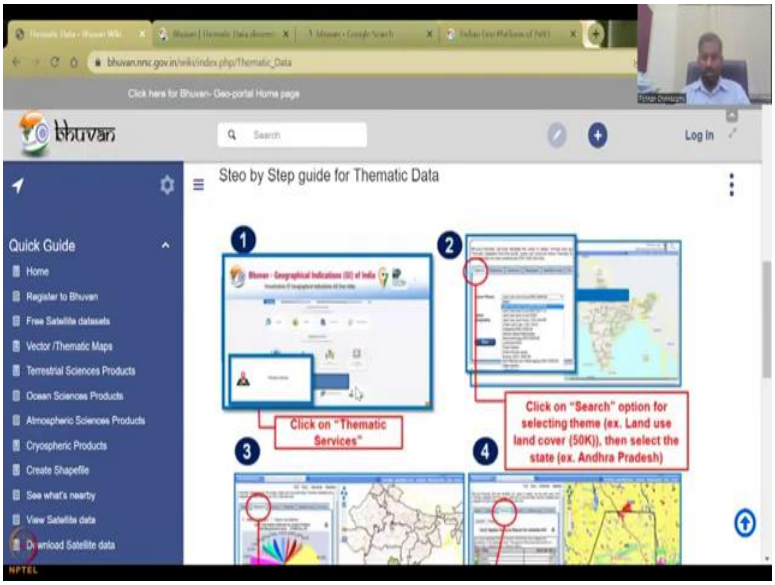

So, just type Bhuvan the first thing which comes on Bhuvan is this. The web page opens as entire data fee. So, if you look at this Wikipedia page this page is different than the current page. Why? Because the page has been updated, the schema is same but it has been updated with new buttons.

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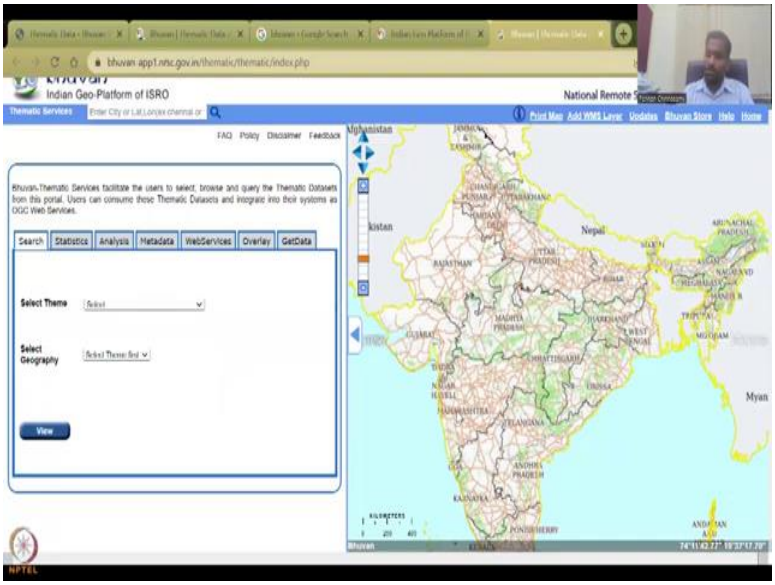


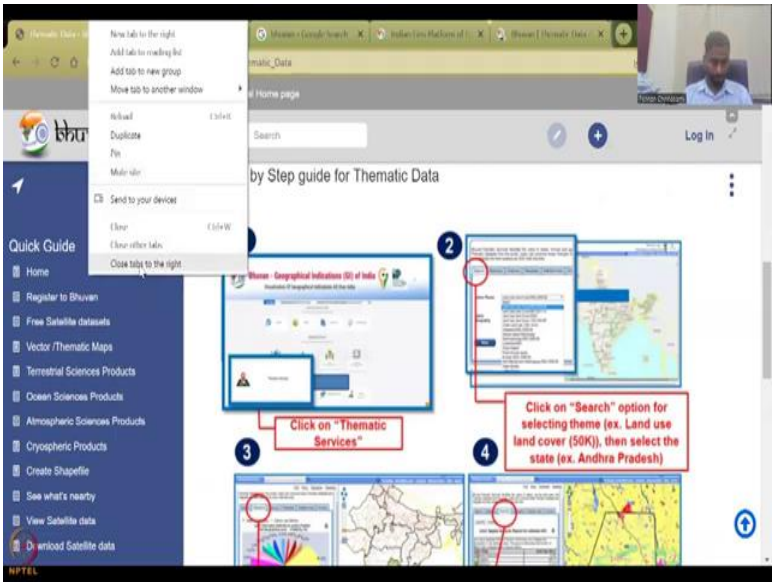


So, you can see all these different layers and if you come down you can see that there is thematic layers here it is. So, you click thematic layers and this webpage comes up. So, even if the link does not work all the methodologies I have shown will bring you to the same web page where you have the thematic layers I am just going to close all the other layers and just maybe open one layer just for our sake and let us see how it does.

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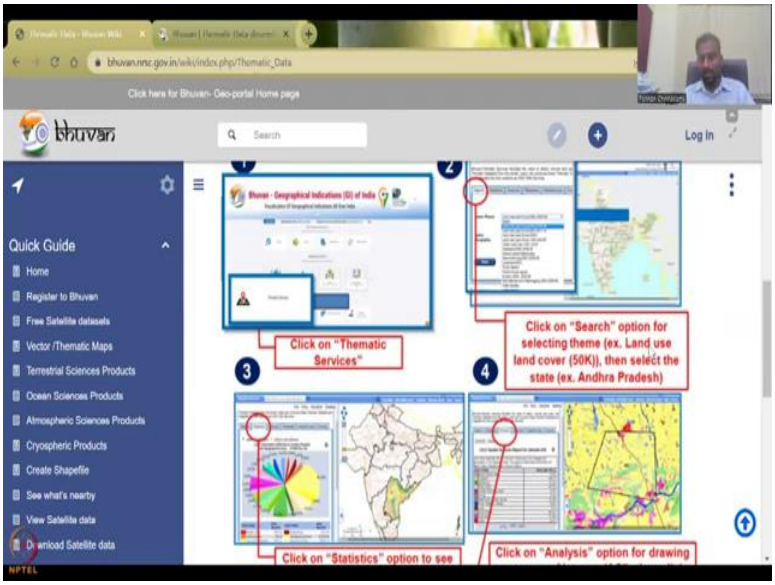


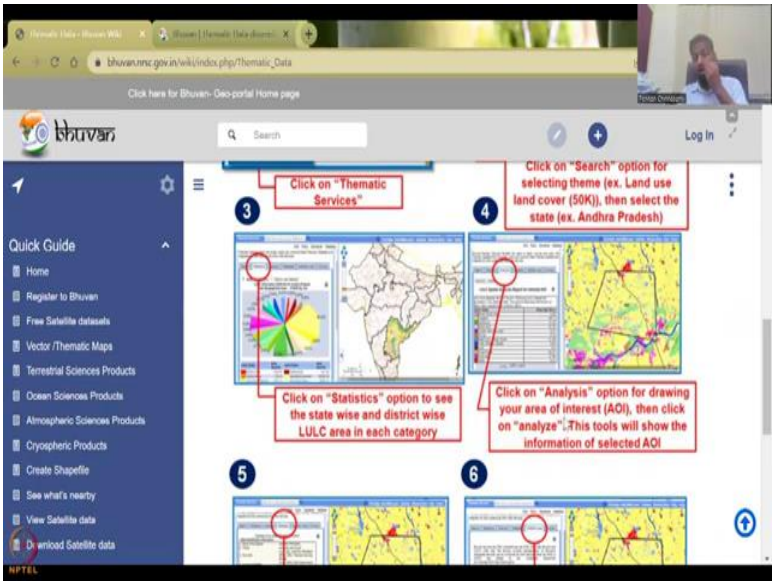


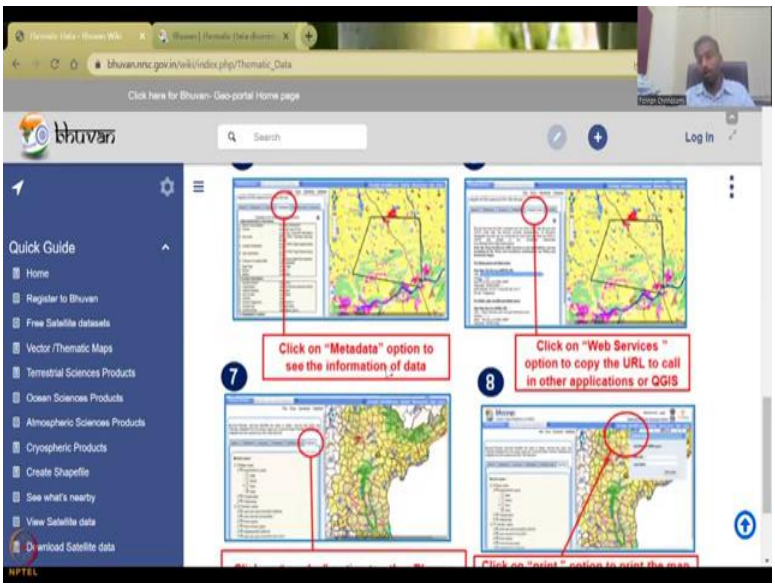

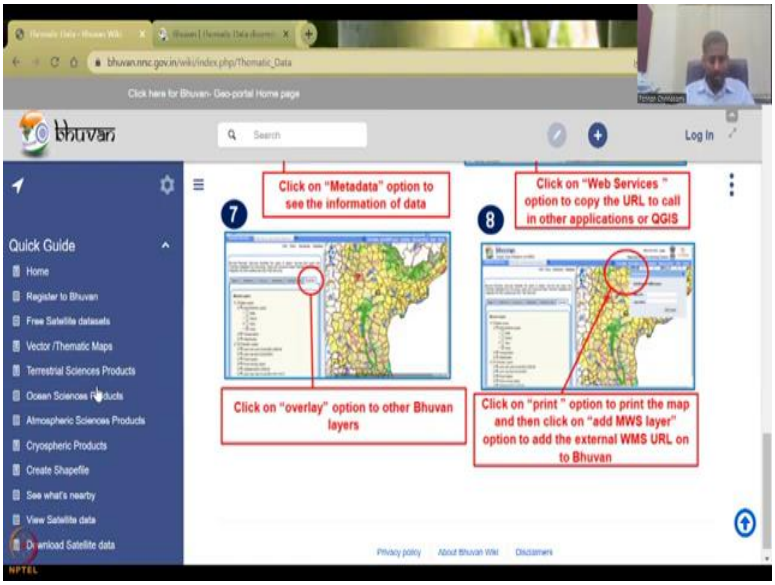


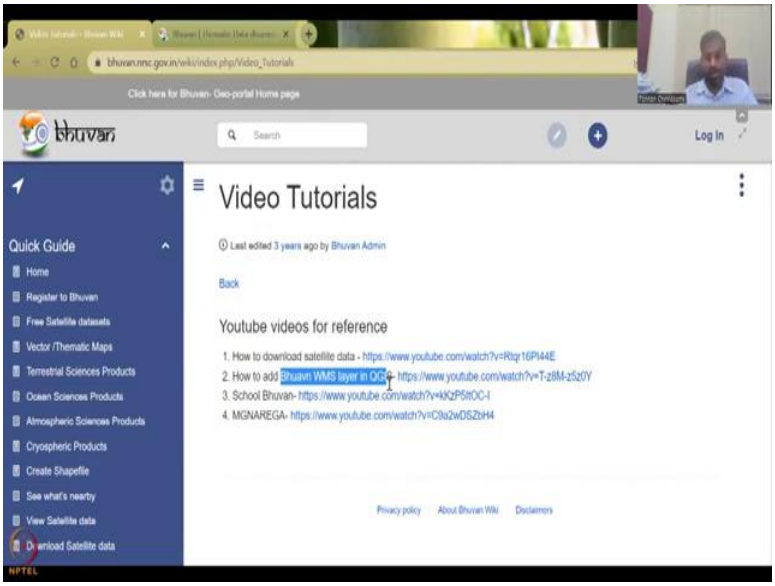


So, we open a thematic layer and then you can search option to select the theme what type of data you want and then you can do some statistics based approach to see how the data differs for a particular region. Click on statistics option to see the land use land cover in each category you can also click on analysis option for drawing an area of interest and then doing a quick analysis.

All these data can be downloaded as an image or as a table CSV file with the result. So, you do not have to do this in GIS so whatever I am going to show took nearly a master's thesis to do but now with just a click of a button you will be doing this in the class. So, I will be showing all these resources on how to use it click on the metadata option to read the data about the data and then the web service URL so that you can call this into GIS platform like QGIS.

You can just click copy this open in QGIS it will quickly open. Overlay option to put other data within the Bhuvan surface into your own surface and then print option to print the map which you see. So, we are going to see these things and so before that there is lot of other tags that you can see.

Video tutorials as I said if you click on the video tutorials link you could see how to download the satellite data, how to add Bhuvan WMS layer in QGIS. You can see here that specifically QGIS is given because it is open source and everyone should have access. So, what we use in this current lecture is also QGIS.

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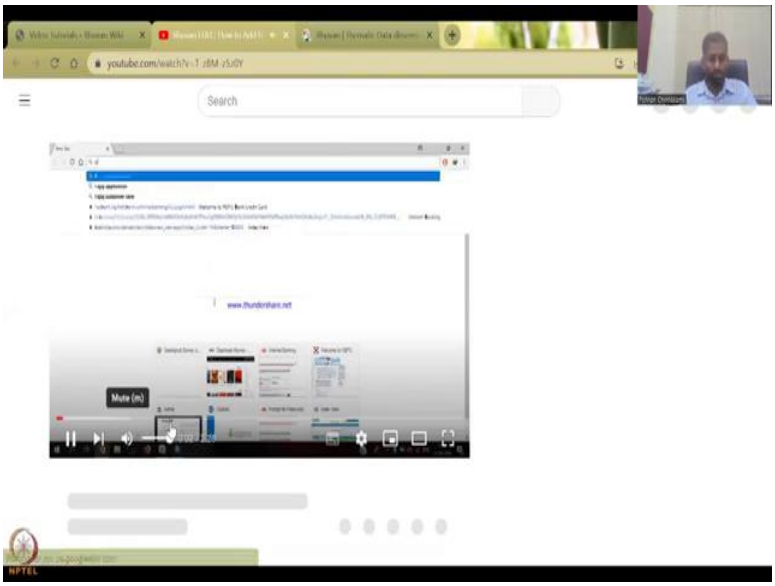


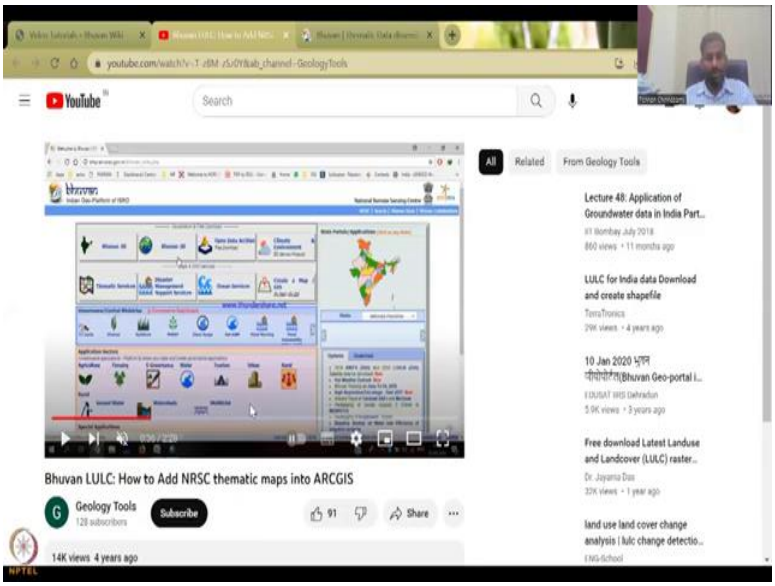

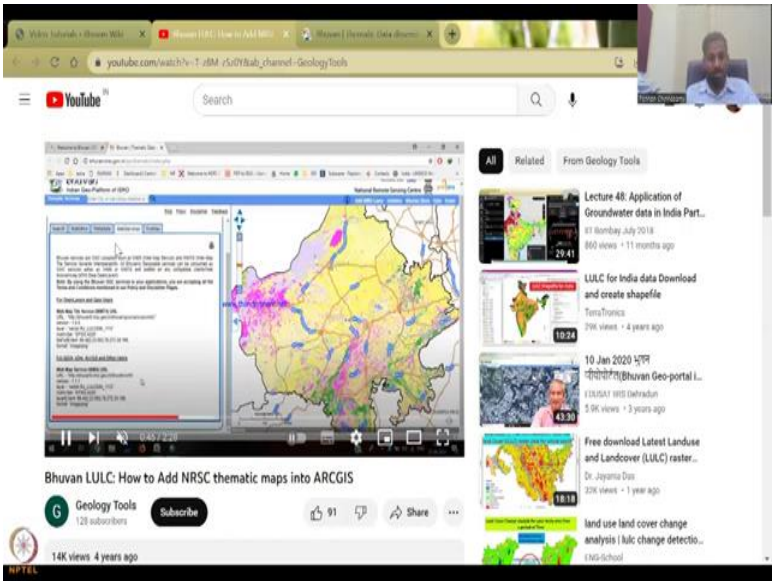
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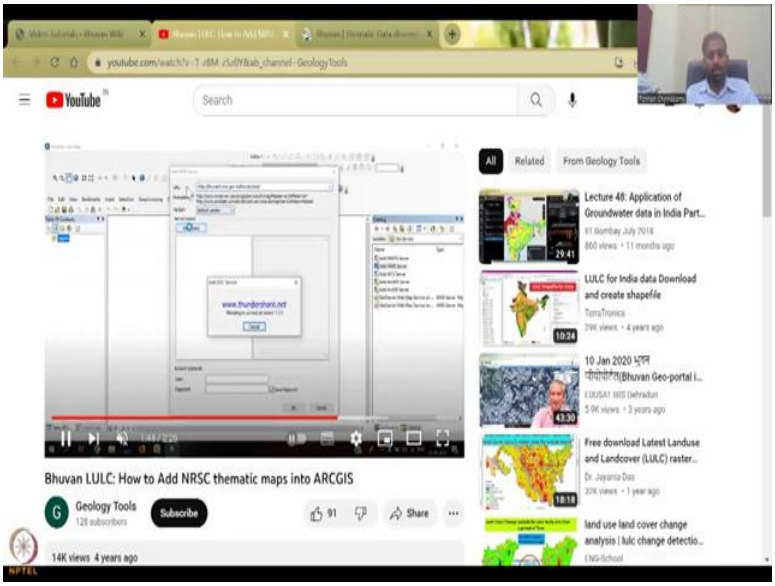
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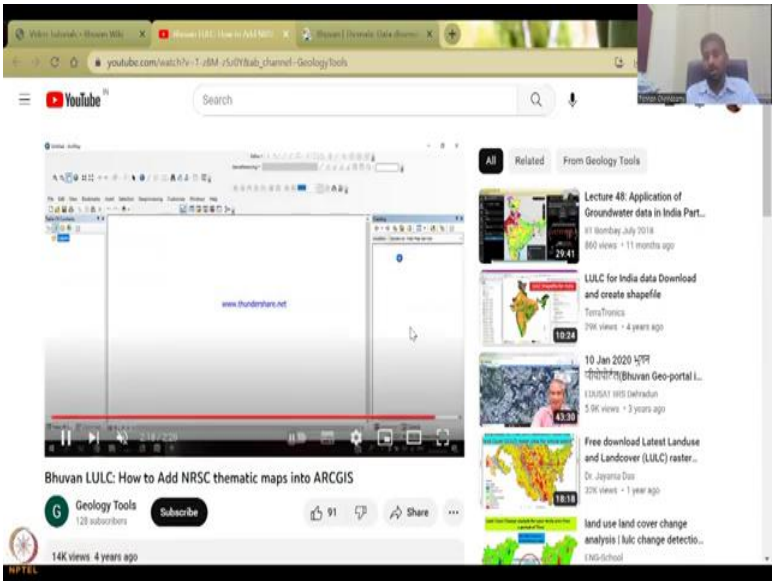
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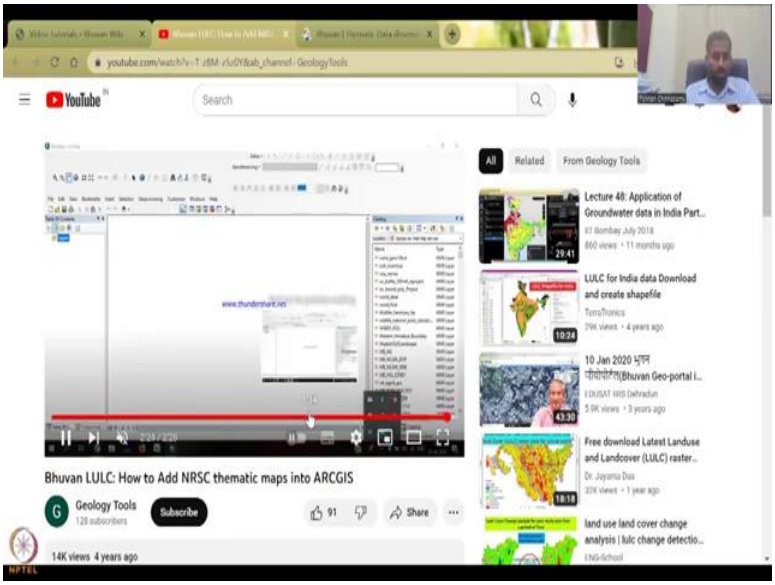


So, we are using what all industries use, we are using what all people use for the software QGIS open source so you can go through this lecture which has been given in the ISRO platform as I said some day some lectures are already linked to the lectures within the QGIS platform in ISRO, I think that we can use so here you can see that web service is given you can open it, it will directly open in your QGIS web service location.

You will generate it, you will go here and then you will put it into your QGIS software and then it says add WMS service you put in the layers it will just open out and come up in QGIS software. I do not want to redo this entire exercise but it works and you can see clearly that they are showing how the layer works. So, here it is getting populated and you can visualize it.

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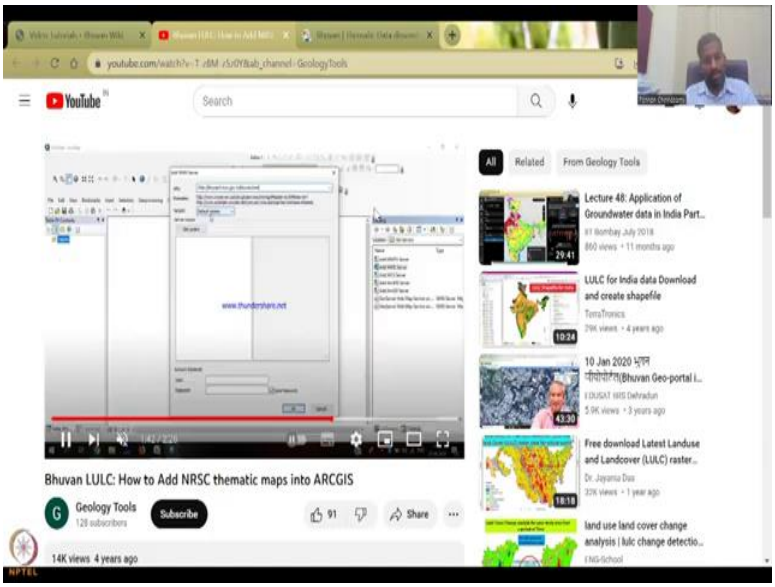

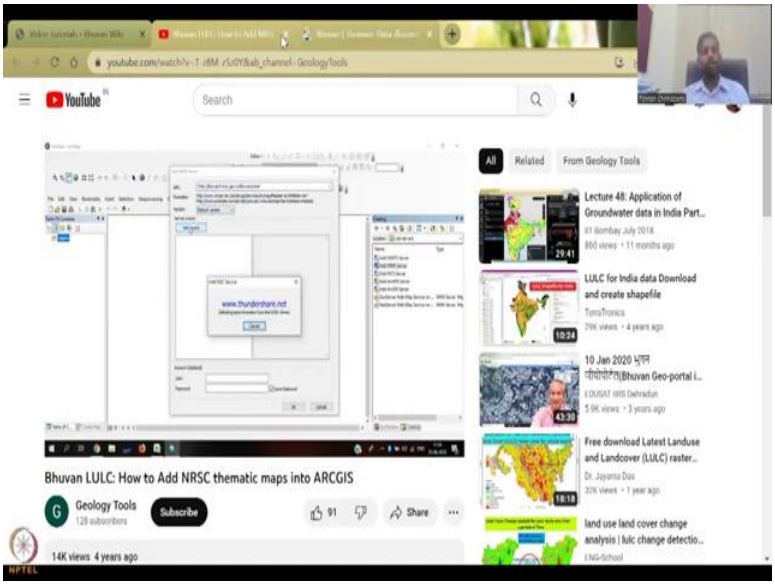
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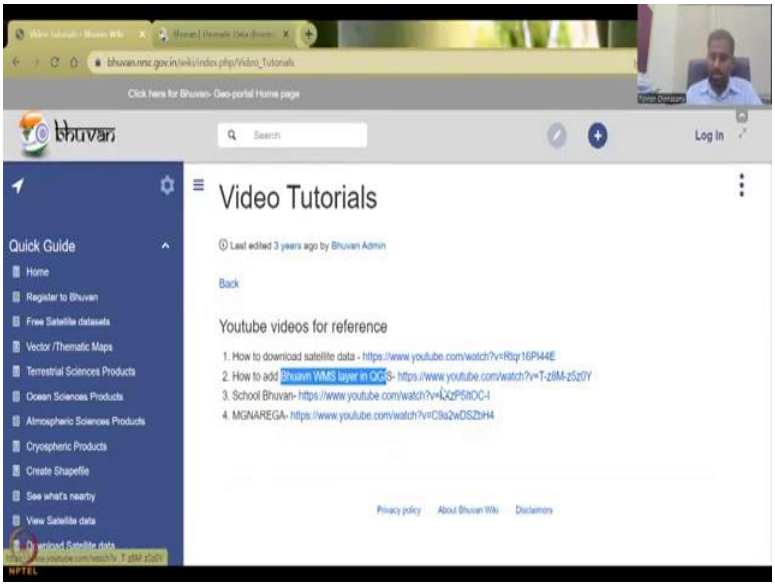
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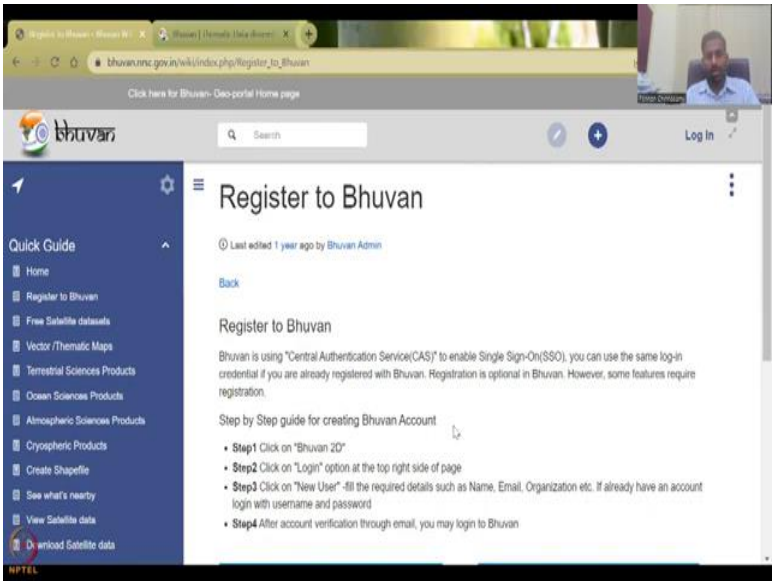
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Step by Step guide for creating Bhuvan Account
Step1 Click on "Bhuvan 2D"
Step2 Click on "Login" option at the top right side of page
Step3 Click on "New User" -fill the required details such as Name, Email, Organization etc. If already have an account login with username and password
Step4 After account verification through email, you may login to Bhuvan
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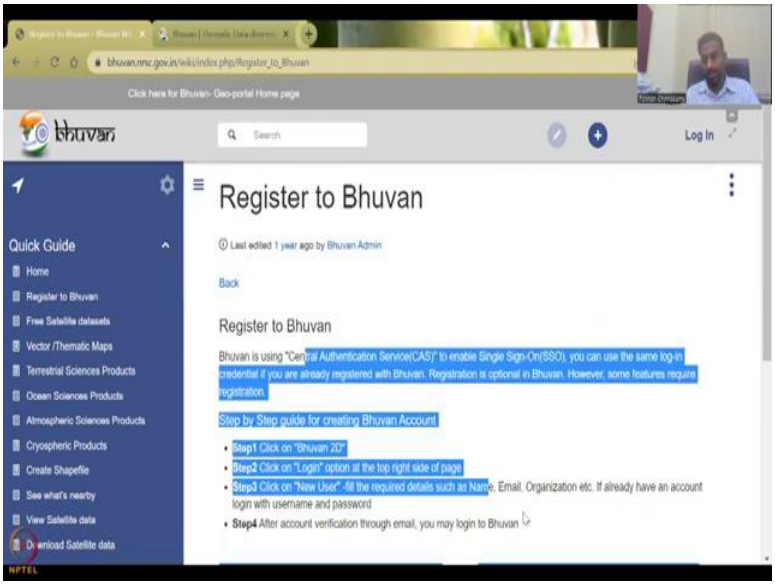
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Step2 Click on "Login" option at the top right side of page
Step3 Click on "New User" -fill the required details such as Name, Email, Organization etc. If already have an account login with username and password
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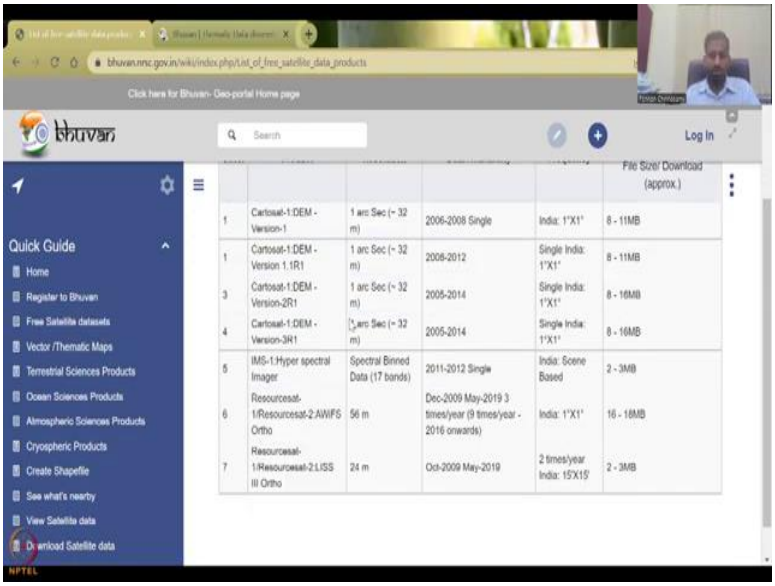
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6 Resourcesat-1/Resourcesat-2:AWiFS Ortho 56 m Dec-2009 May-2019 3 times/year (9 times/year - 2016 onwards) India: 1°X1° 16 - 18MB
7 Resourcesat-1/Resourcesat-2:LISS III Ortho 24 m Oct-2009 May-2019 2 times/year India: 15'X15' 2 - 3MB
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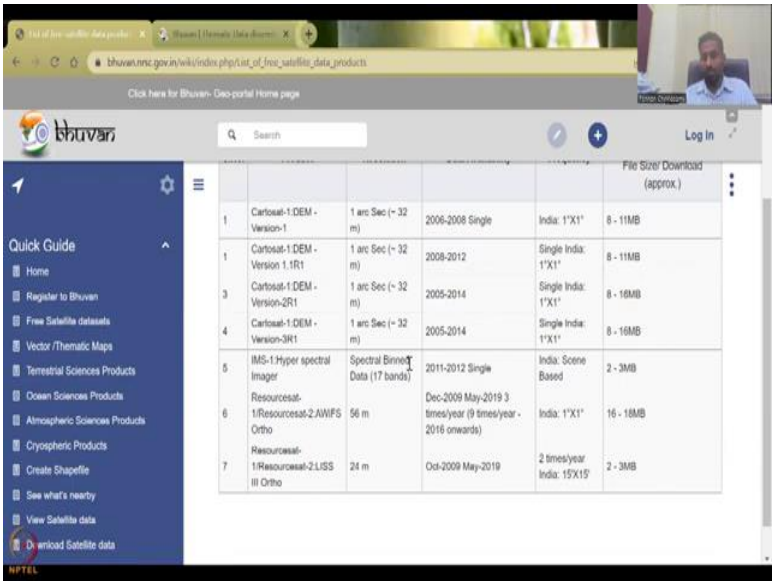
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They have used here ARCGIS in this example, so this is an ARCGIS, QGIS is used much much better because it is free and open source. So, I will come back even though it says add in QGIS you will see that it is ARCGIS the link they have given but it is fine we will do a quick analysis using QGIS in this lecture series.

So, all the other tutorials and other things are there you can see how you can register on this portal. You can say for example here so you can see how you can register and what data is needed, it is secure as per their comments you can have an account. Then there is free satellite data as I said the DEM that we had in the lecture 7 we had around one hour second approximately equal to 32 meters per pixel so that is within the equatorial region we said 30 degrees, 30 meters etc so that is almost the same.

And then we have Carter DEM, Cartosat 1 DEM version 1.1 R1 which is also a very good in Indian regions, then the version 2, version 3 and then there is a IMS hyper spectral image 17 bands for high perspective image which is more on land use land cover and others, other resources.

Here we have the resource set which is also giving you the land use land cover if you remember that in the previous lecture we had this is being used for LULC preparation maps by the ISRO agency and that is at 56 meters. So, now here is the question if you have an open source data which is a 30 by 30 meter resolution which is good enough for an Indian region you will definitely use it.

The ortho is also good, list 3 this is a 24 meters but the data is only available until May 2019. And it comes twice, 2 times a year at 15 minutes so you have all these data which is freely given, last updated one year ago. So, now let us come back to the thematic slides where we are going to cover what we are going to cover.

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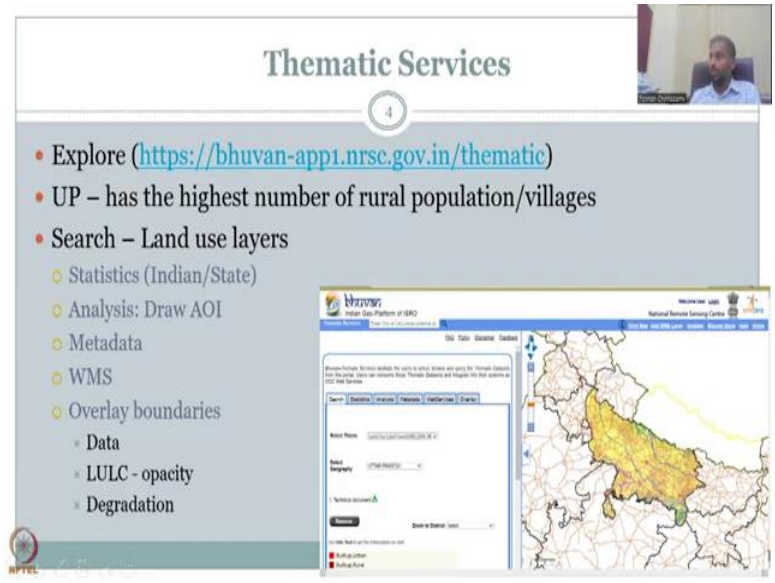


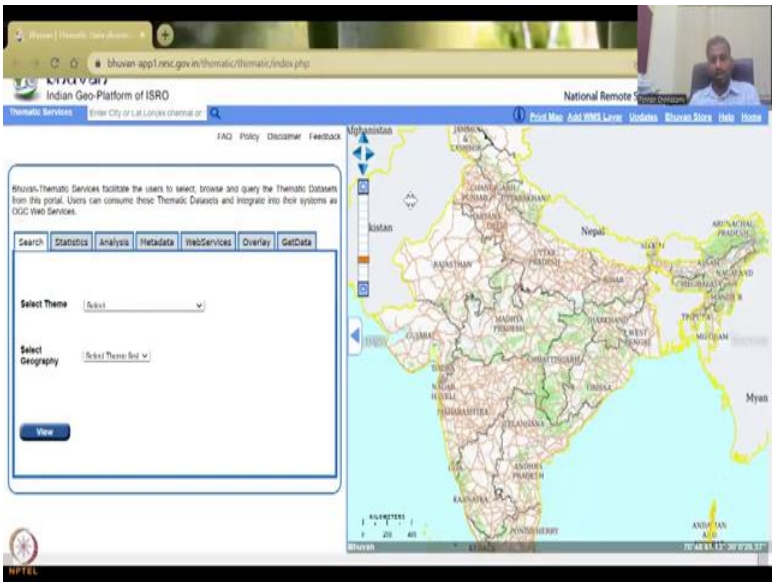


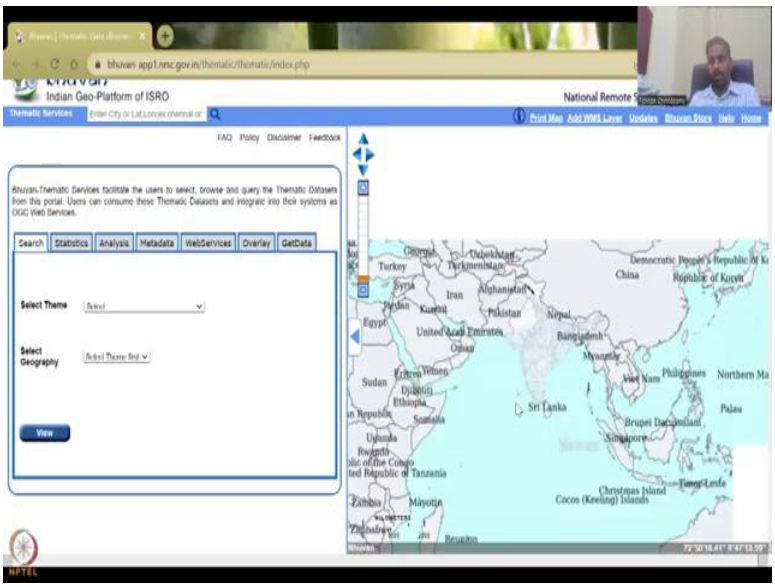

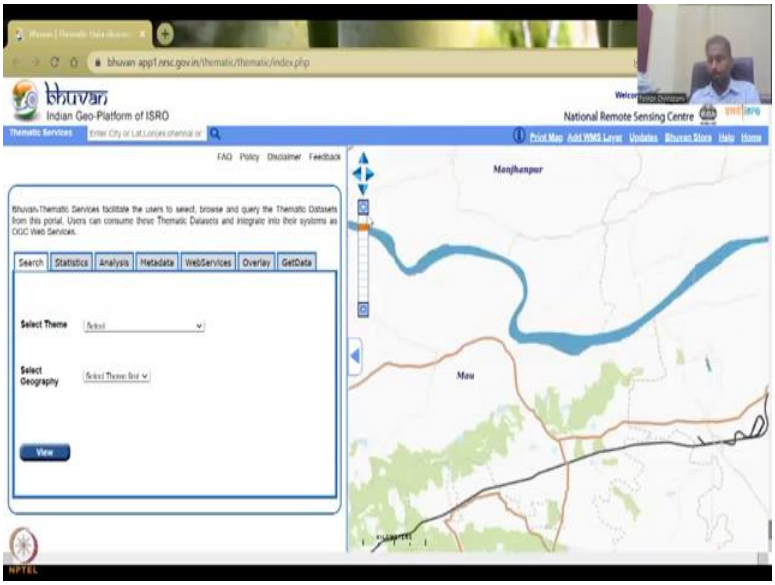


So, the tutorial has been explained, let me yes the slide has come up the tutorial has been explained we hope that the tutorial is helpful for you. Now, we are going to look at what the thematic area is going to cover. I am going to select UP as the region Uttar Pradesh. Why? Because UP has the highest number of villages so this link will take us to the webpage for the thematic services which is also the same which was given in the Wiki page.

But what we will be doing is we will see take case study as UP as an example. Why UP? Because UP has the highest number of rural population and villages again this course is for rural development so let us take a rural entity as our data set for the tutorial. Then we will be doing these steps. We hope we could cover most of it in one lecture but we can also trickle this to the next lecture which is the fourth lecture of the eighth week.

And because this is very important to understand each and every tab and how it works. So, I will patiently go through this quickly I will explain in detail how this can be helpful, downloading you can just look at the YouTube tutorials from ISRO's webpage on downloading.

But manuring and linking this to rural development is the goal of this course. So, as we suggested let us go back to this slide. So, the thematic area is going to be showcased, it is going to share, so I can close this and now the thematic area has come. You could see the boundaries are clear, entire India is there and we can go zoom in to this a particular level. So, let us look into all these links.

So, you can print the map add a WMS layer updates some things and then login I will not log in for now if needed we can log in when we download the data.

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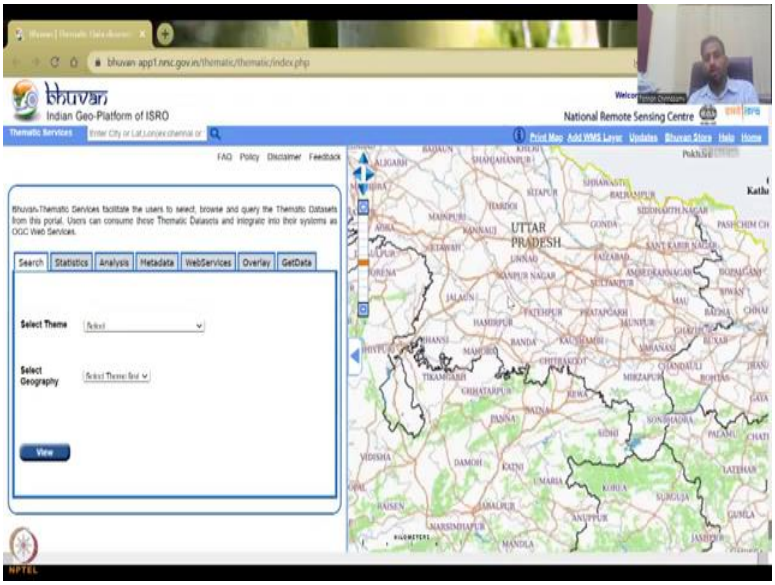


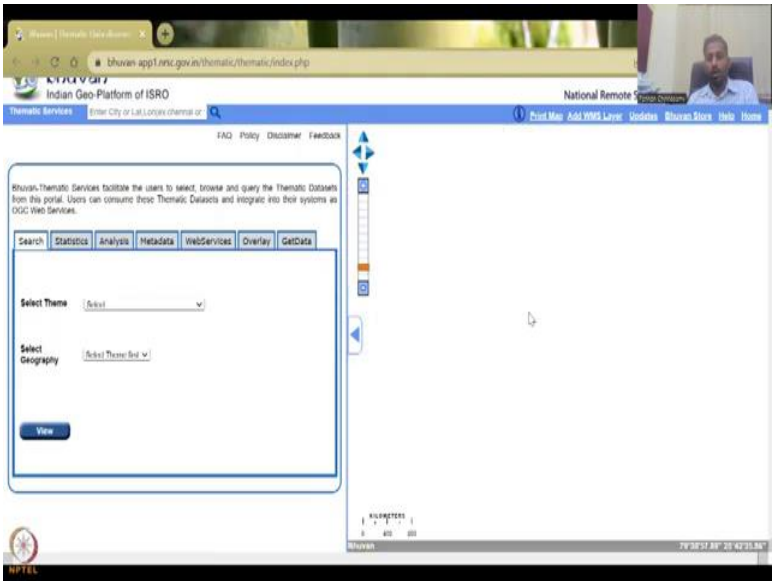


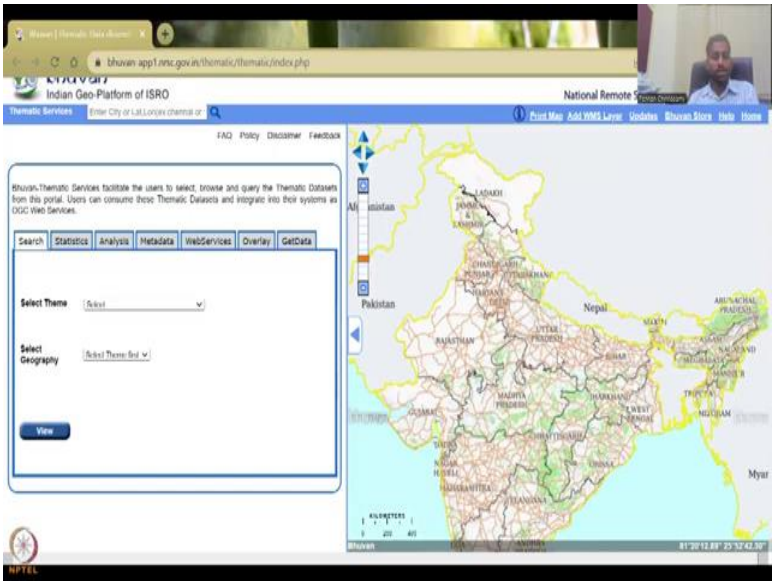

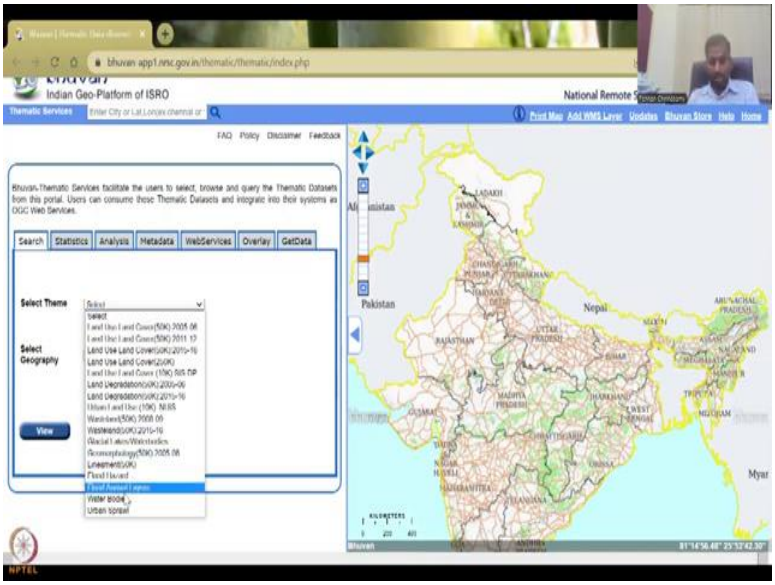
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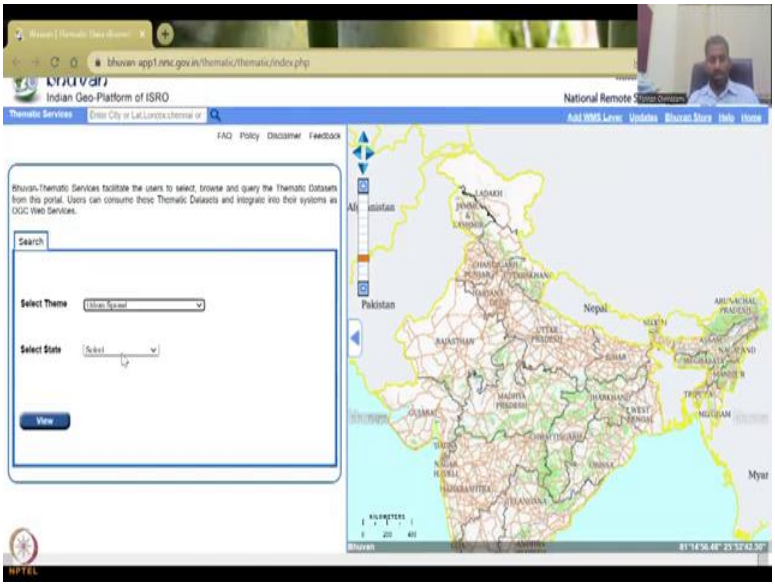
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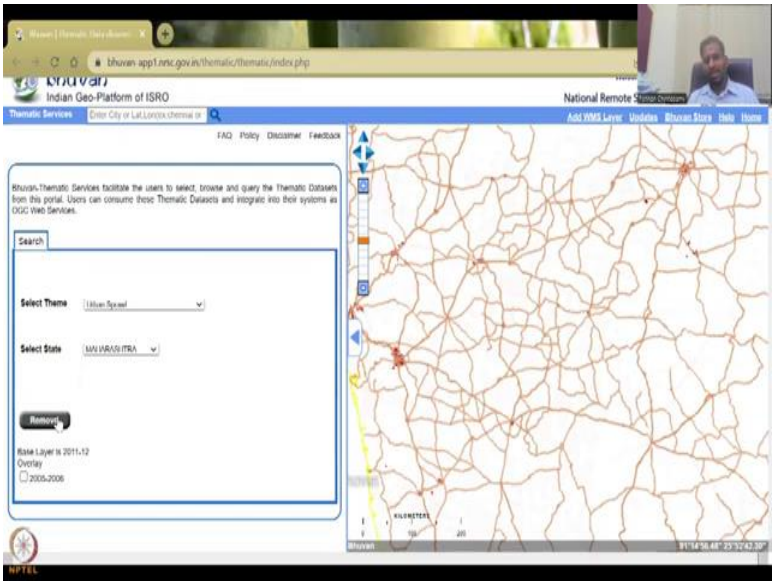
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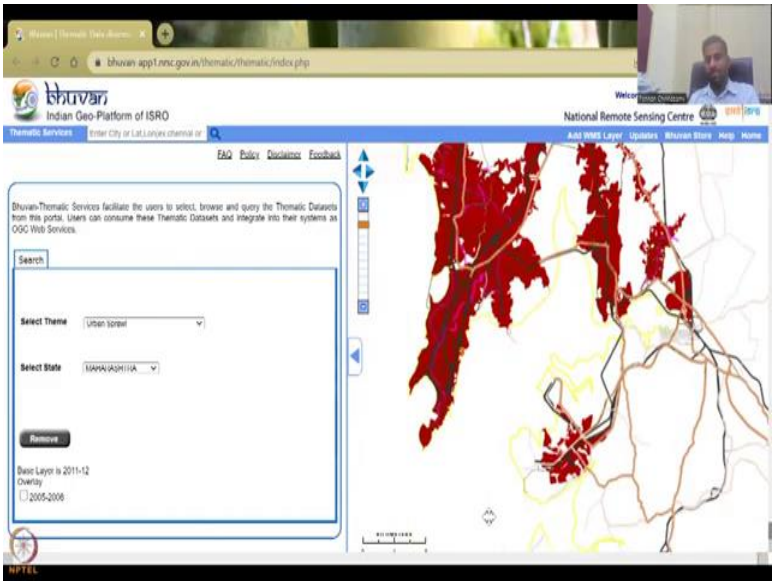
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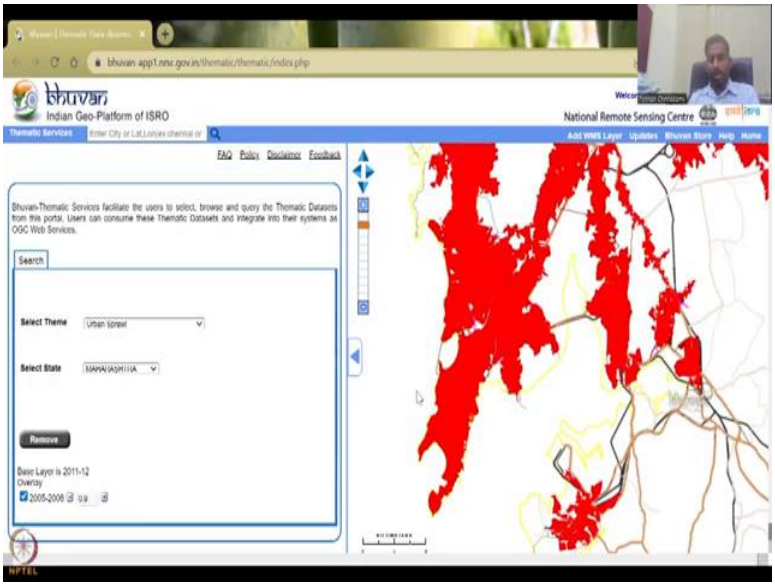
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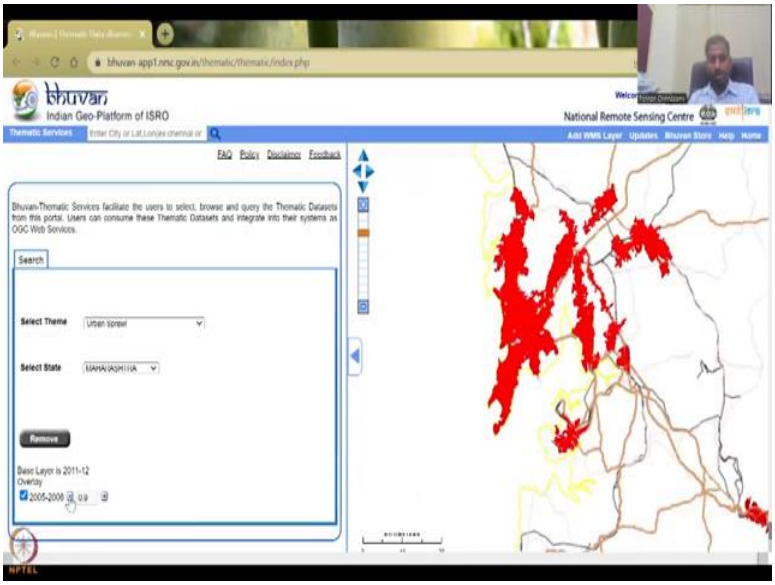
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So, normally you can keep it here so that we can see the entire resolution of India I can double click to zoom in. We will keep it like this so that we all can see what region that we are going to work on. So, in the search box the first is select team. If you click this there is multiple thematic layers that have been made of this yes urban sprawl, what is urban sprawl means how does the urban area increase.

Let us just click one urban sprawl and then select some stage, not all states are there let us say Maharashtra and then view, this kind of a land use land cover but basically base layer is 2011-12 so this is 2011-12 you can see how Mumbai region is the red color means the urban area but if you overlay this with 2005, 2006 you could see that I am zooming out so some layers are coming out as paved which means there has been initially the area was here but now it is expanded here in 2012.

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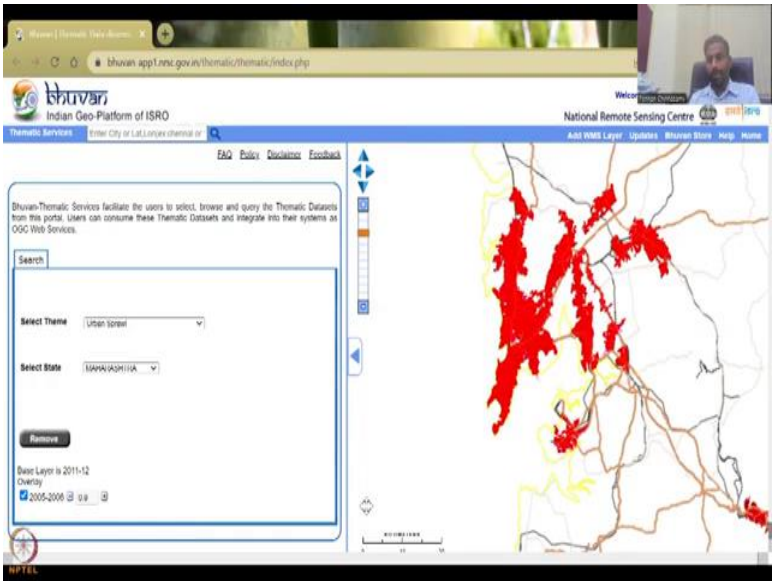

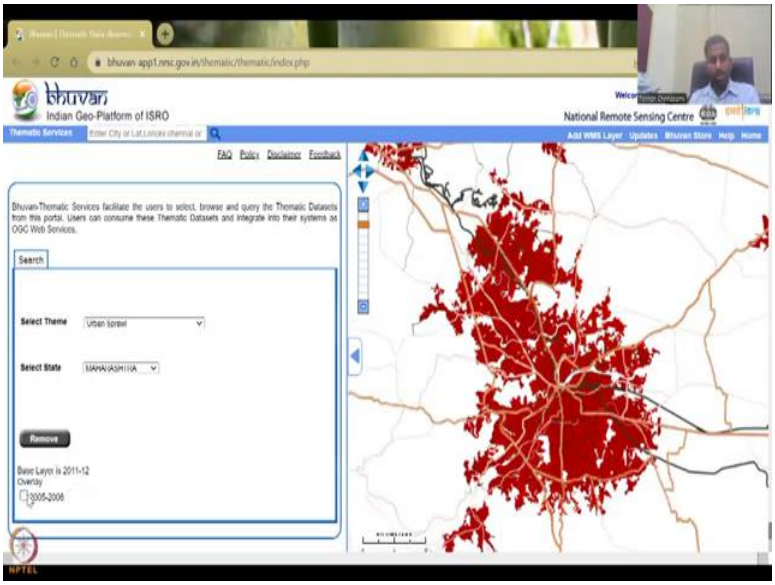


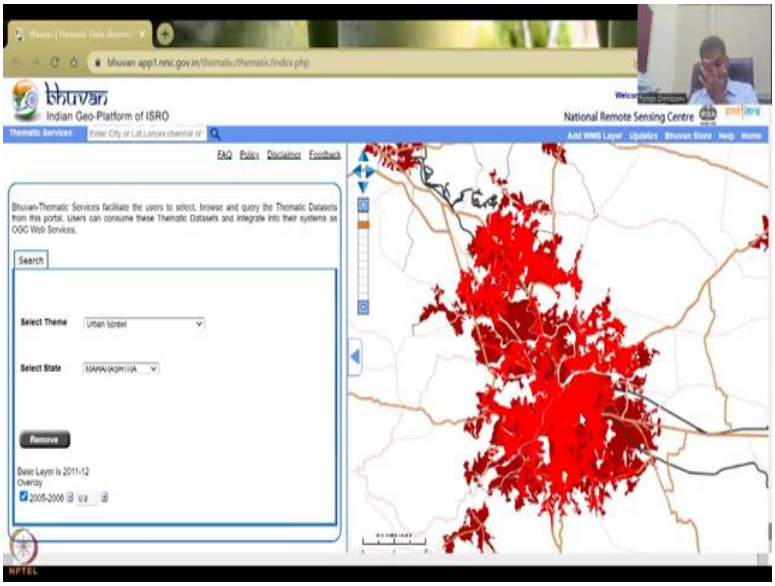


So, now if you increase this and then move it across you could see that here this example is good you could see that initially in 2011, 2012 this is the urban sprawl and if you click this part then you can see that the light red is 2005, 2006 but now it has increased when urban area increases as I said it consumes rural or peri rural, peri urban regions, it consumes the resources that were promised for rural regions and there is an imbalance. So, to document that it is important to do land use land cover.

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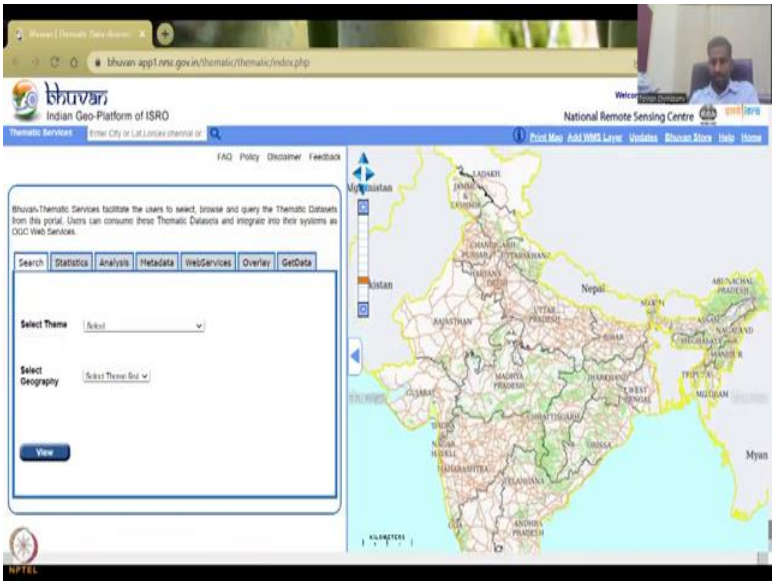


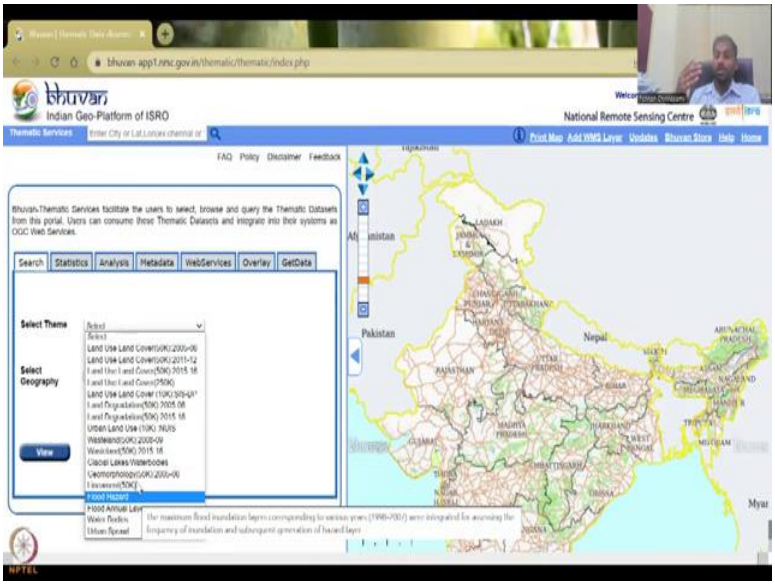


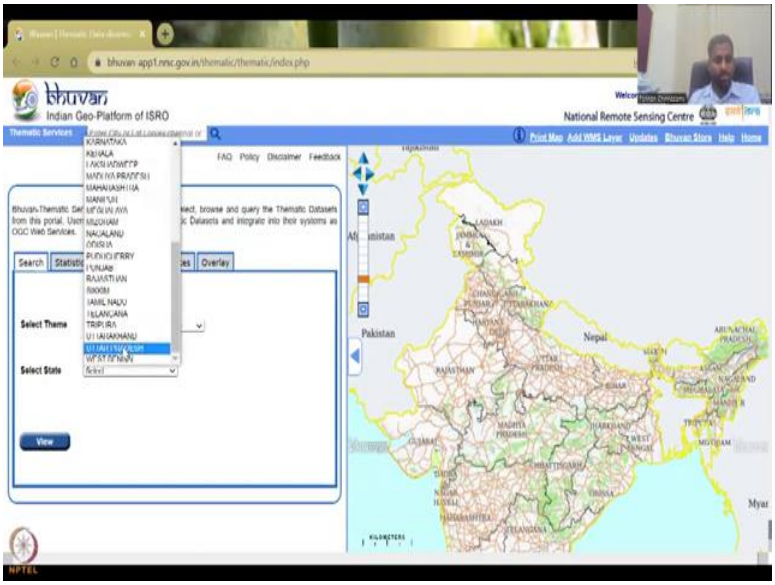

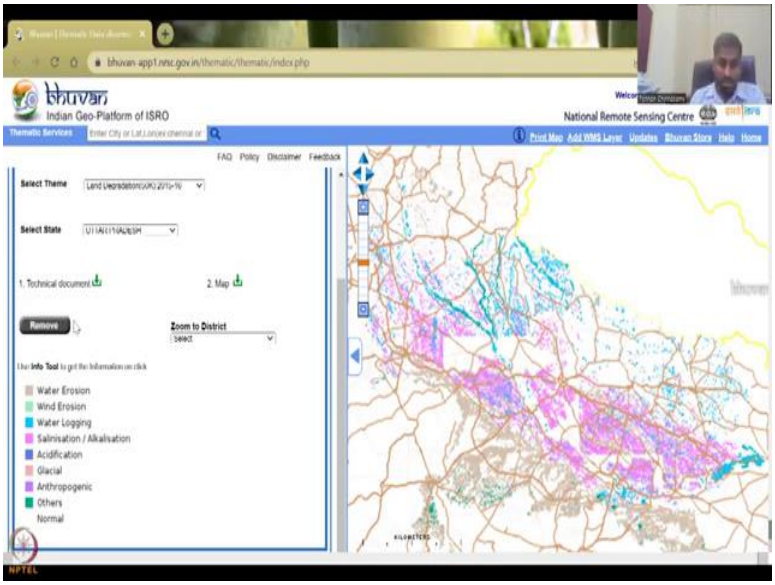
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Wind Erosion
Water Logging
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Glacial
Anthropogenic
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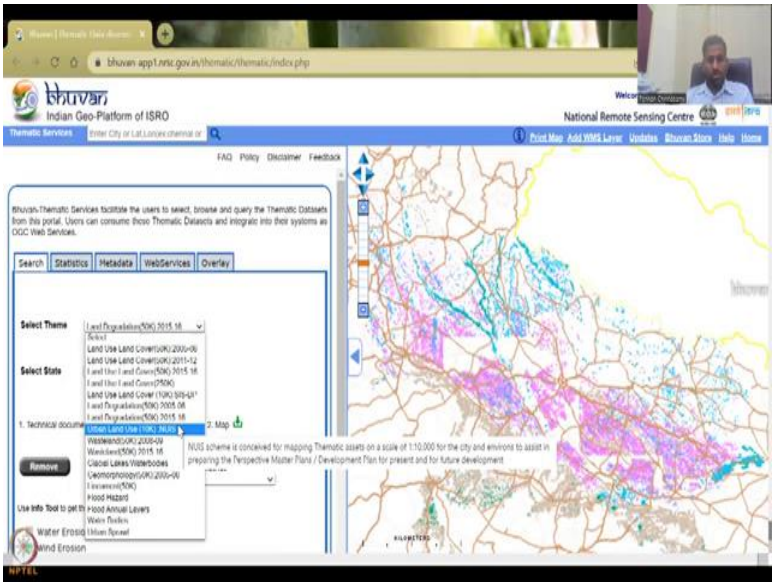
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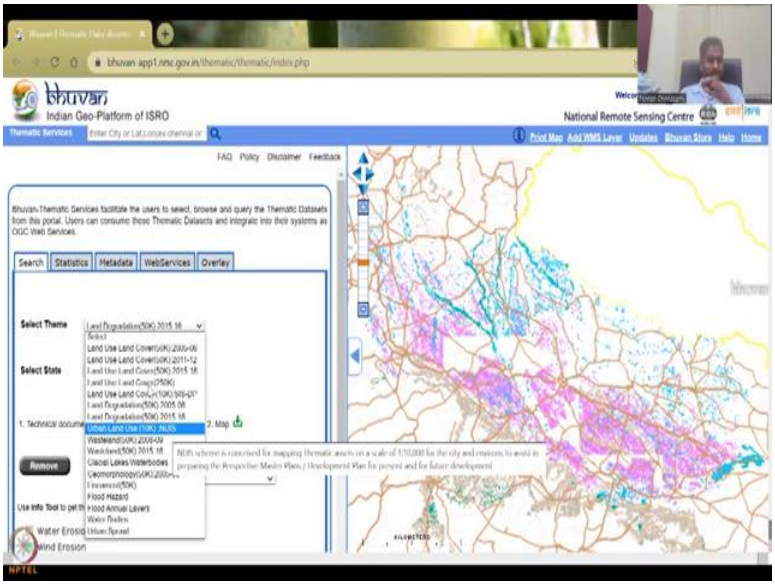
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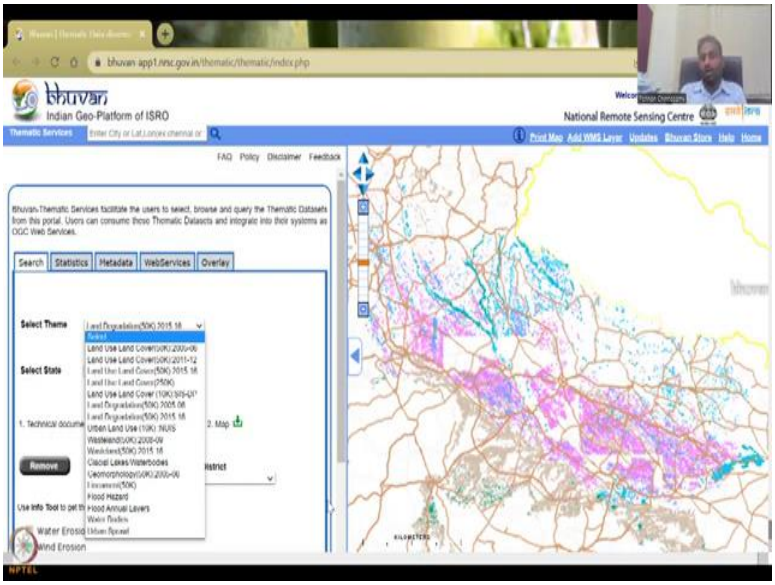


So, let us go back to our initial theme that we wanted to work on so I am just going to refresh it, we have the India slide again you go here so there is water bodies again part of your land use land cover, flood, annual flood hazard these are just basic flood analysis for a particular year, it is not full in term.

Lenient is a geological fractures and lines where they are present in India it basically maps the earthquake prone zones. Geomorphology is as a name suggests lot of geology and the morphology of the rivers. Glacial lakes where water bodies, again water bodies, wasteland where land has not been cultivated a kind of barren land, urban land use, etc.

Land degradation where how and how far the land has been degraded let us look at 2015, just quickly you could see only some states are there but we can see Uttar Pradesh and you can see here as the legend is here. So, legend is this the color and what the color represents you see that water erosion happens a lot, water logging happens a lot because the ganges flows through this region. Less glacial and some data is not complete so you can see here there is data gaps and stuff.

But the methodology if you look at the technical document which is the same that you can apply for using any other data. So, we try to do a quick analysis of a NASA data for you so that you can download and do this exercise on your own. As I said there is land degradation but our course for this this week is land use land cover so you could see that there is a 50k, 50000, so 1 is to 50000 that is how you should say.

So, one unit on the map is equal to 50000 units on the ground, so 1 centimeter is equals to 50000 centimeters likewise 1 feet is equal to 50000 feet. So, there is a very fine resolution is

1 to 50000 and then we have a 250k so 1 is a 250k which is not as fine resolution as the previous one there is a 10k which is the highest but it is urban not rural areas. So, when you do land use land cover it is entire.

So, they have done 3 years we have 2005-2006, 2011-2012, 2015-2016. So, 3 years have been mapped but still as I said 2016 is the latest data available today's date is 23 March and there is a 7 year gap so how come how can we use a 7 year data for a current scenario is not clear but for sure you can use the previous and then map the current to see how it works, we will be showcasing that part how do you current, take a current data and then do a quick land use land cover.

However, this requires lot of manpower, time and cost we will do the basic requirement which is free and quick, it is not as good as these maps that have been populated and that is why it takes time. So, but 7 years is too long to take maybe a year time should have been taken to take the ground points across India because all the institutes can cover there is a tremendous locations of the ISROs database centers across India they can pitch in the data and I can work on this.

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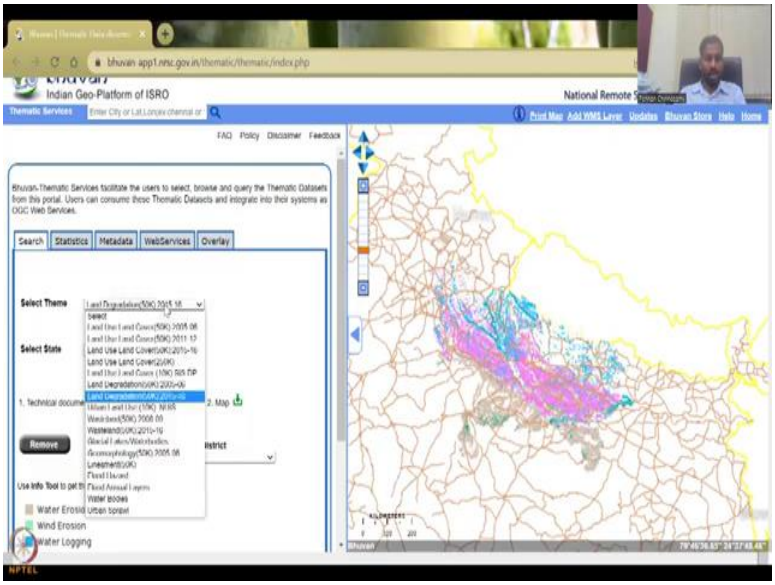

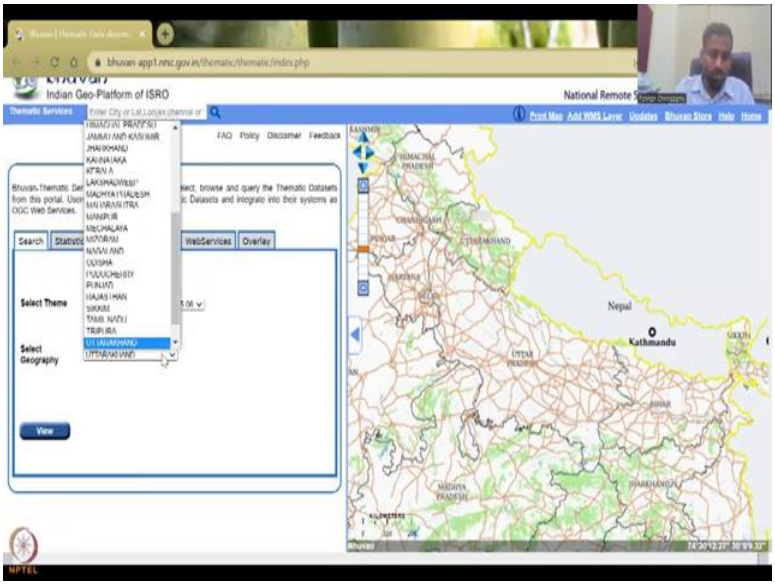
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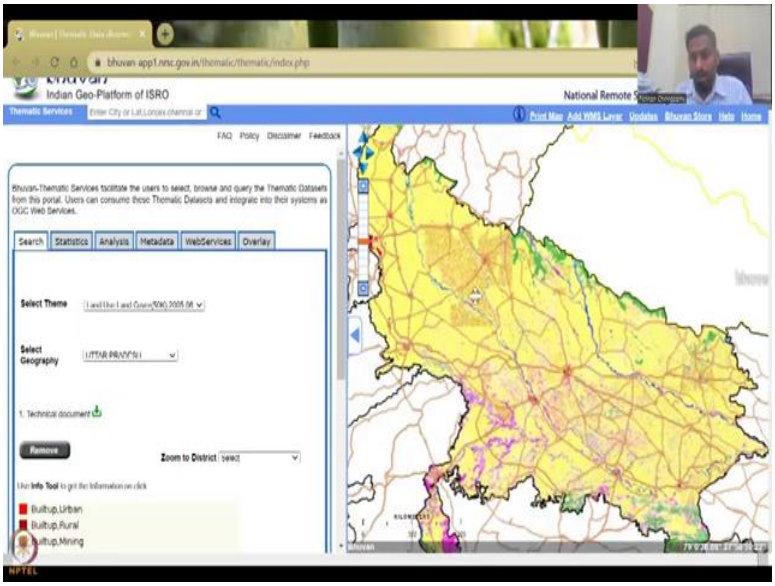
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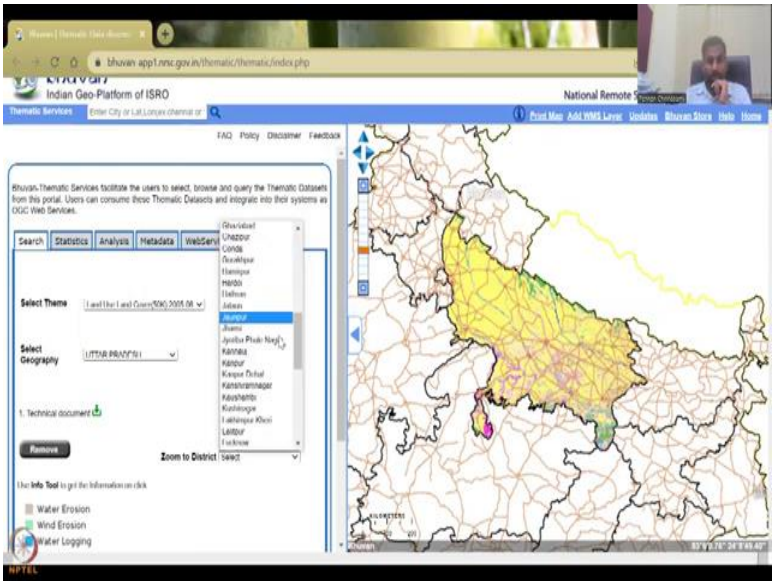
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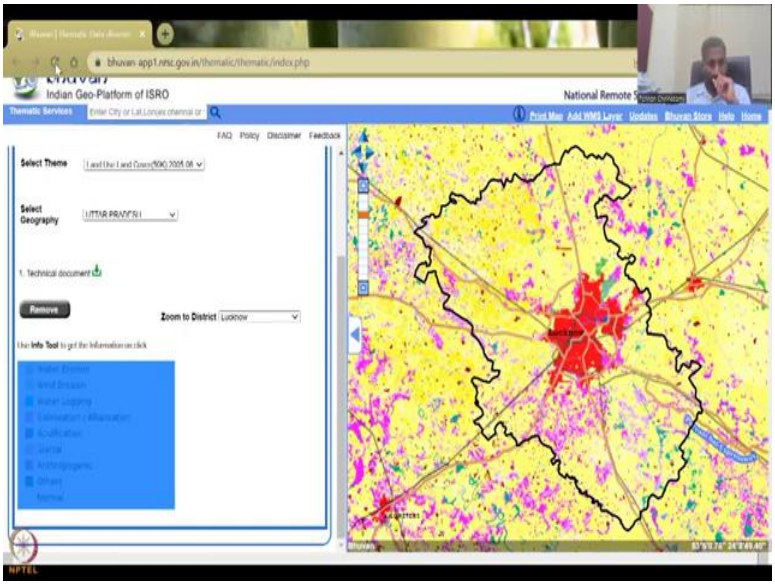
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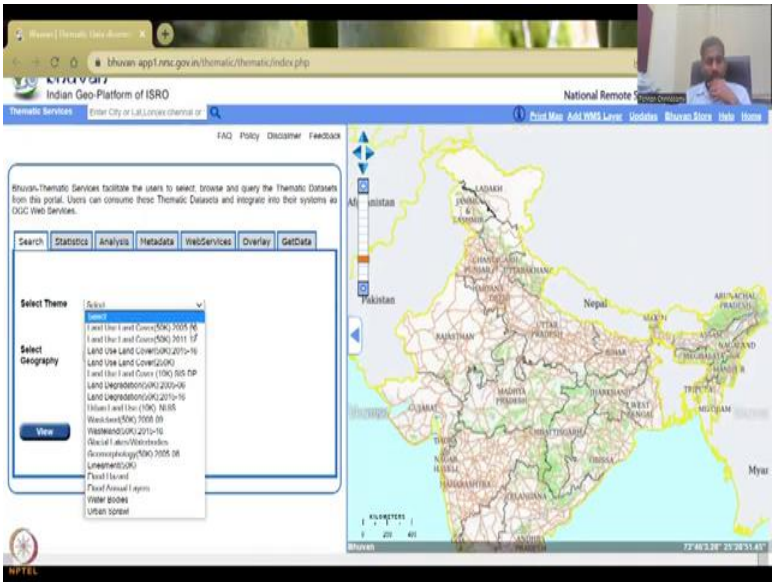
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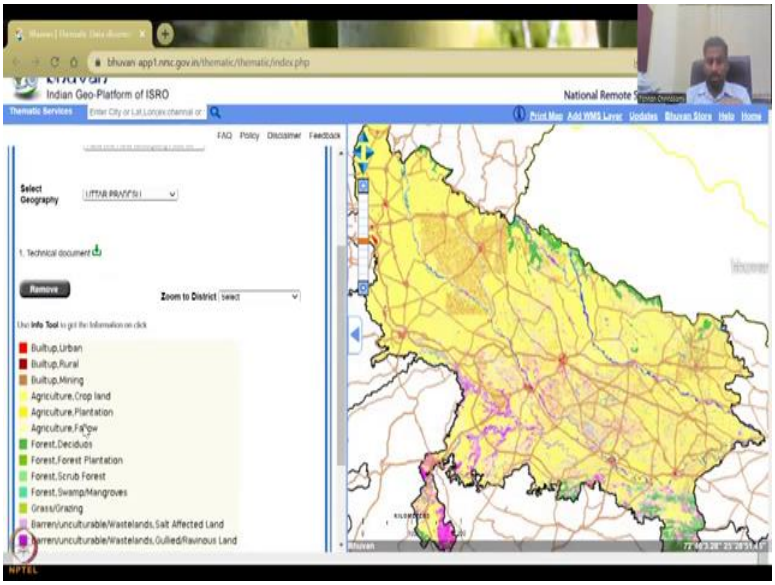
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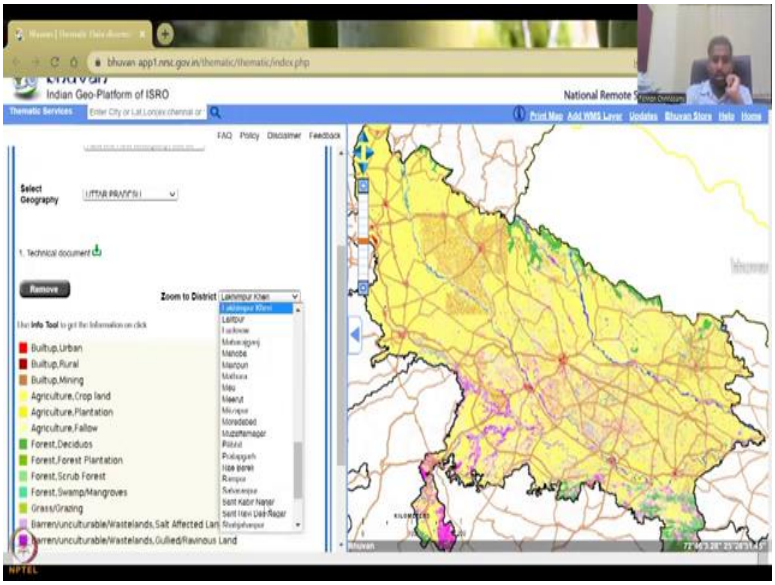
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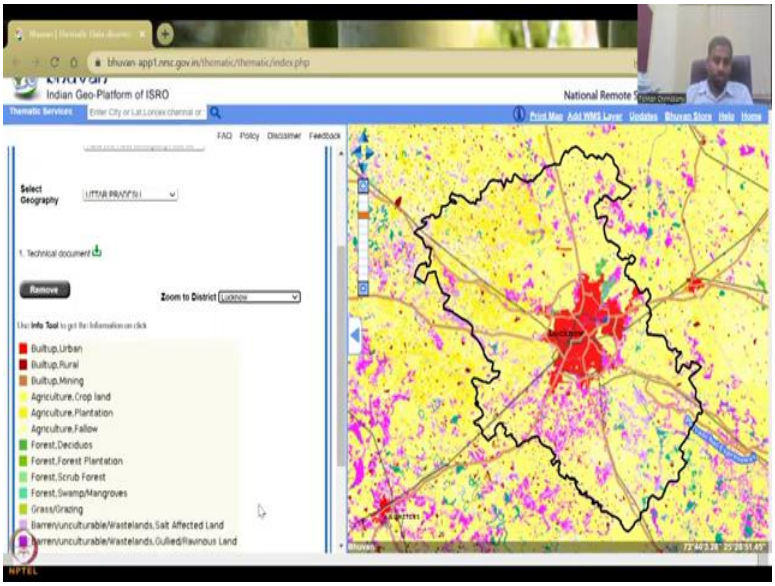
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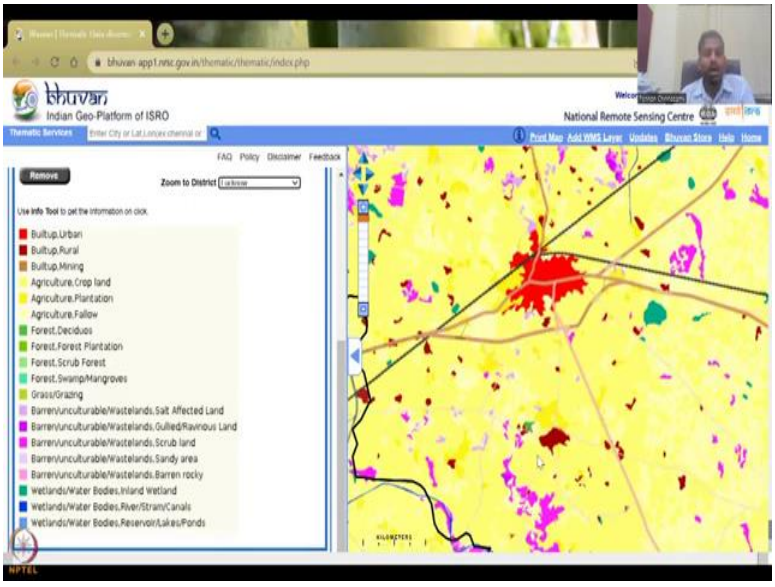
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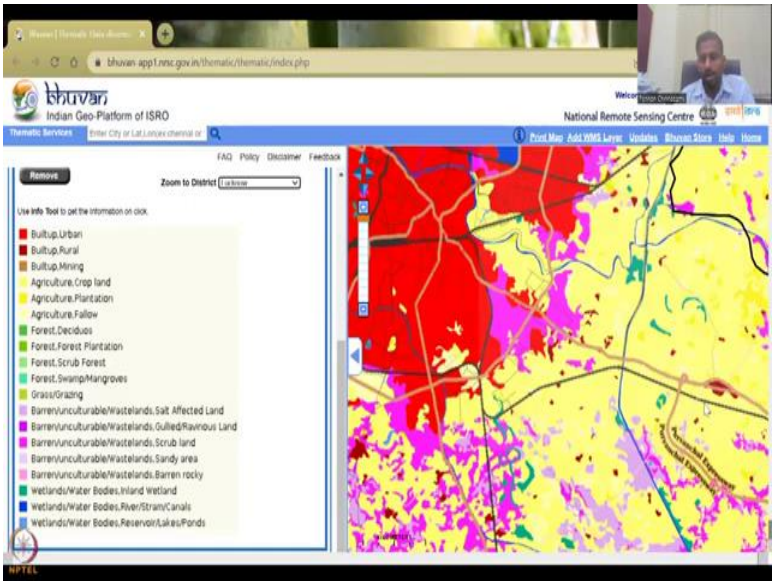
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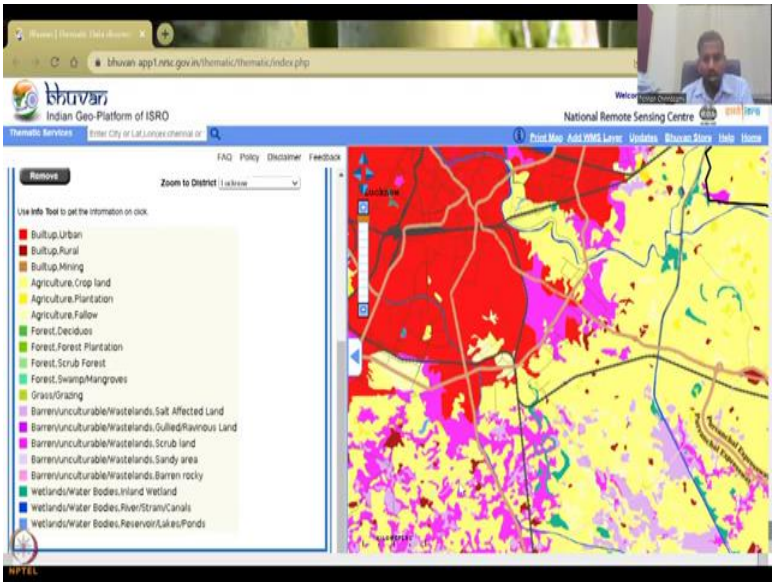
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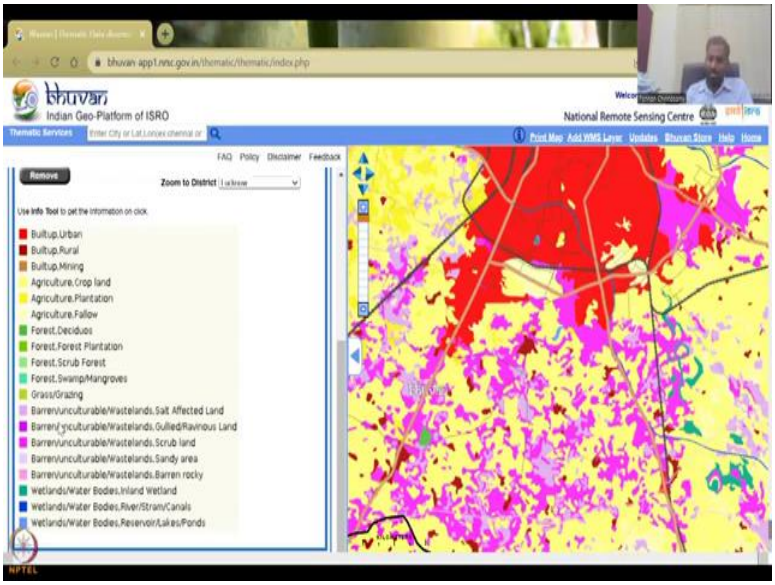
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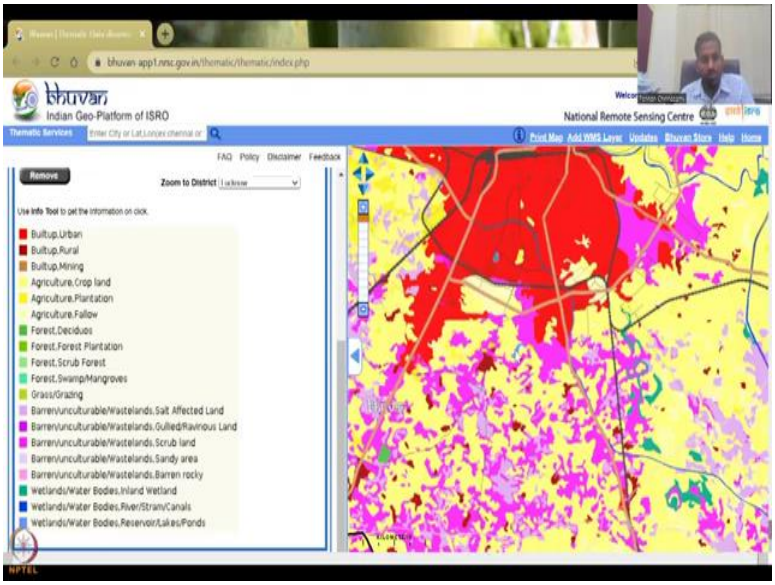


So, let us go back to what we want to see. So, I have looked into the Uttar Pradesh and you could see that the boundaries are very accurate in these maps because these are as per the government rules and laws, we should also use these boundaries. So, the first we are going to see is the land use land cover let us say 2005-2006.

As I said I am going to check UP, so Uttar Pradesh and click view. So, beautifully the map comes up you can see that, try to minimize it a little bit so that you can see the entire UP and there are lot of base layers. You can zoom into a one particular location I have been to Lucknow as I said the last week I was there for a particular conference, so I am just going to do that.

You could see here that it does not populate the current legend, the legend is stuck so you will have to refresh it so this happens so do not get concerned it is just the map did not update so do not worry about it. Again click, UP, then view, beautiful. Now the legend has been updated. You can see that agriculture cropland is what we want to see and as I said let us look at Lucknow, Lucknow still is major hub but still you can see lot of agriculture crop land, agriculture cropland is given as yellow and you could see the different classes.

So, now come back to the lesson that we have seen, the classification is this is the classification, the pixel has been classified each pixel inside each pixel each grid what is the dominant land use land cover, if it is 50 percent urban, 50 percent rural it is sticky but never it comes like that, it will be not a straight 50 percent, it will be like 50.12 percent and 49.88 percent that is your rural.

So, now you have a slight improvement or slight benefit for the urban so the data goes for urban and the pixel is covered with red. But if the agriculture is there for example 60 percent and 40 percent or even 51 percent, 49 percent, 51 percent rural, 49 percent urban then it becomes yellow.

So, now you could see that a built up urban is red, built up rural is darker red which is on this part so this part is darker red you can see that that is a rural area but built up and then I am just little bit outside Lucknow, but here is Lucknow all these areas. The red part is the city in 2005-2006, built up mining is not there, agriculture land, crop land, plantations all these are plantations and agriculture land, there is fellow land, forest residues, there is not much forest here but there is lot of pink color and what does pink color give, it is barren land, wasteland culture or scrub land, etc. It is type of barren lands it is lot of barren land type are there. There are small wetlands here so some part of the land has lot of wetlands and then water bodies blue color for water bodies.

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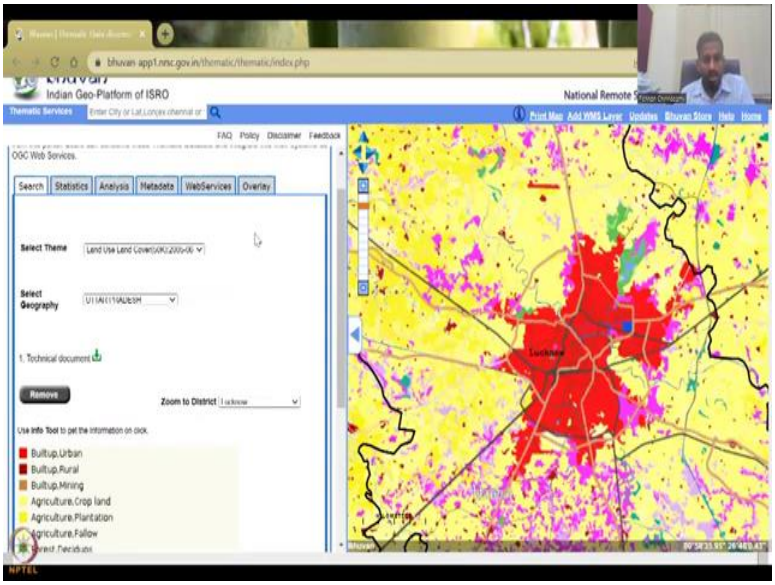

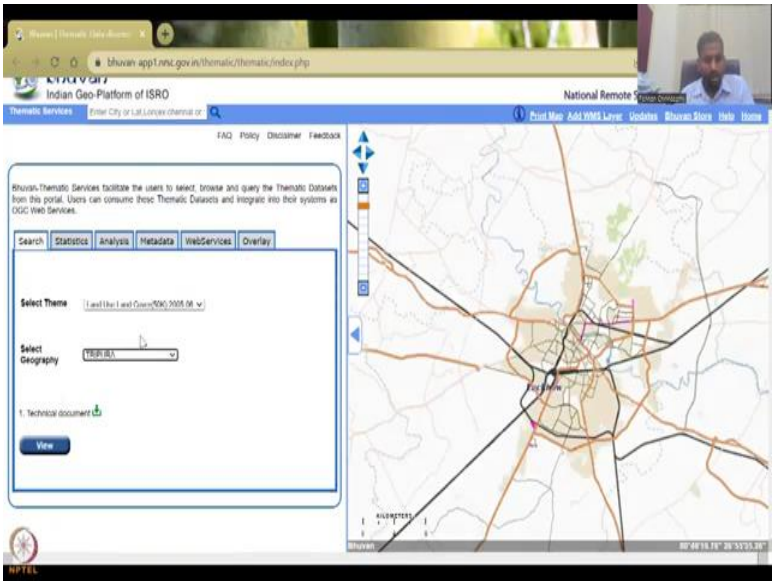
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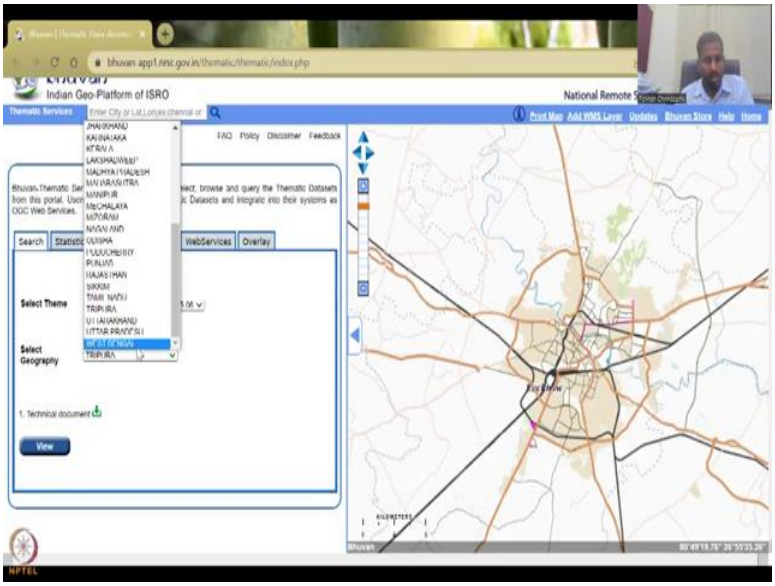
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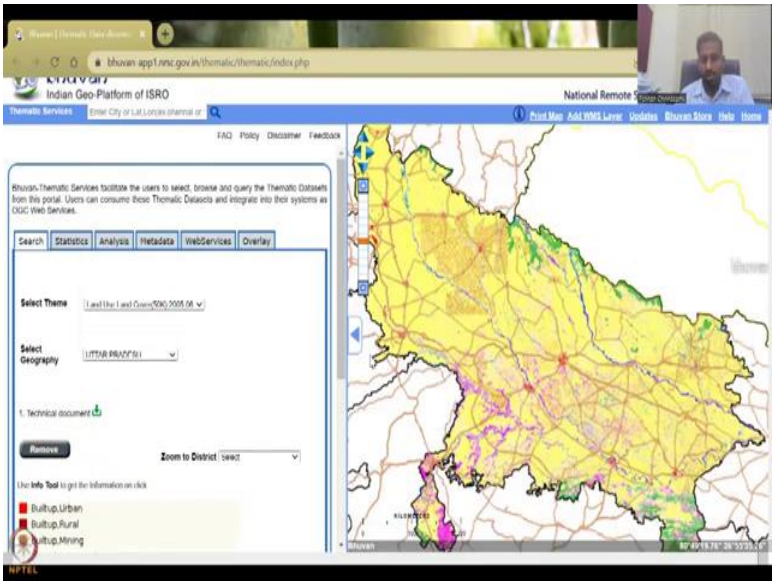
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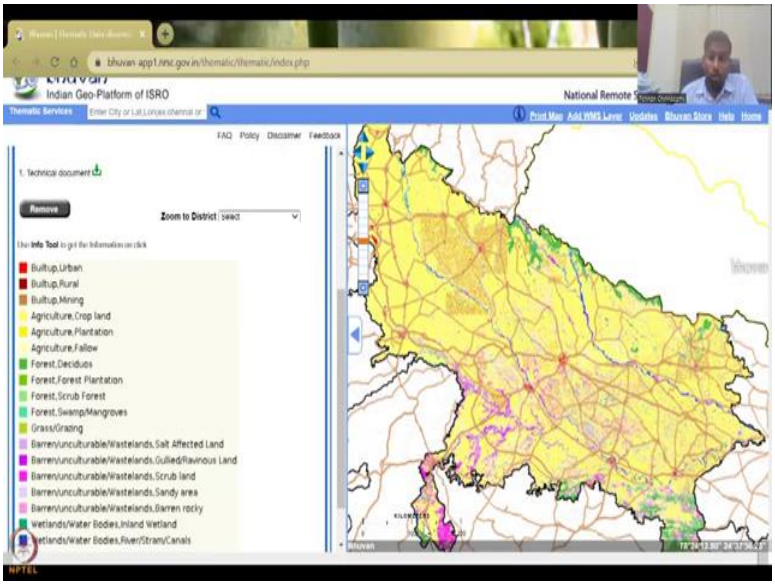
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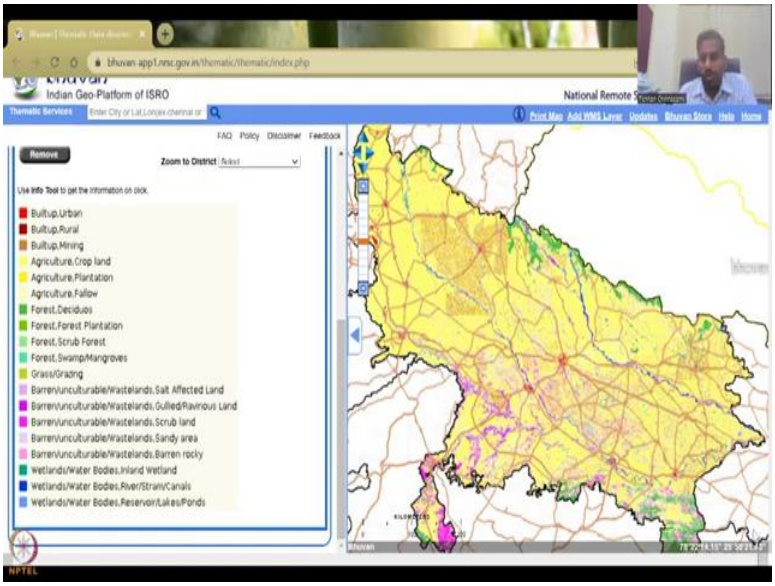
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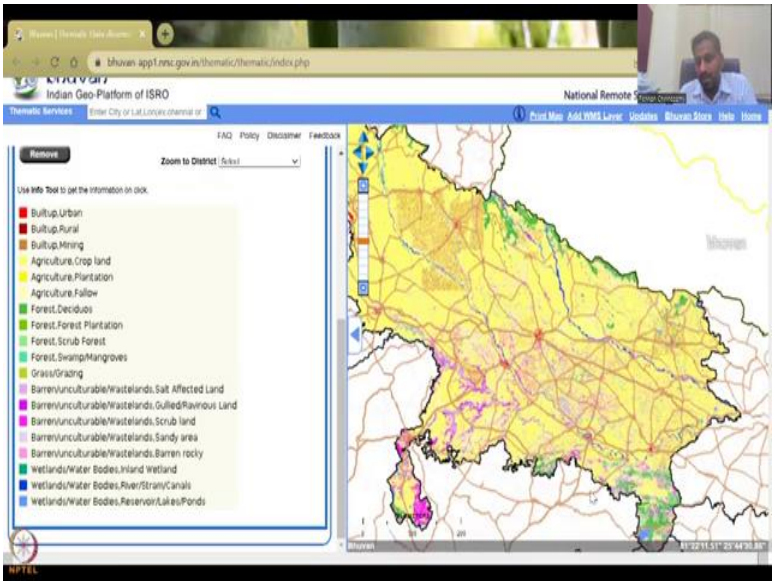
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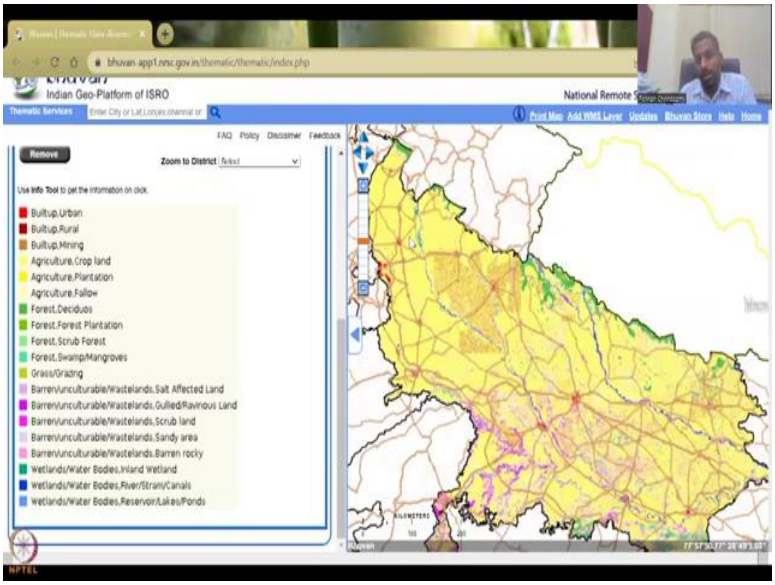
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Builtup,Rural
Builtup,Mining
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Agriculture,Plantation
Agriculture,Fallow
Forest,Deciduos
Forest,Forest Plantation
Forest,Scrub Forest
Forest,Swamp/Mangroves
Grass/Grazing
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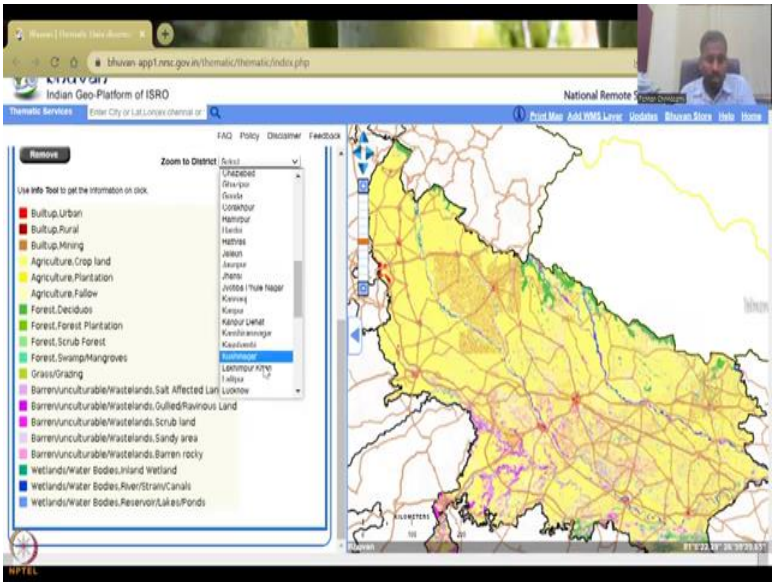
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Kushinagar
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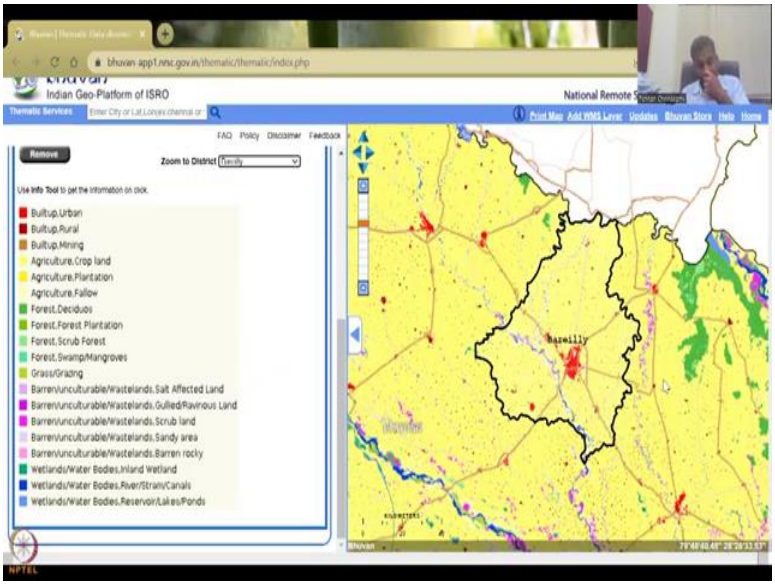
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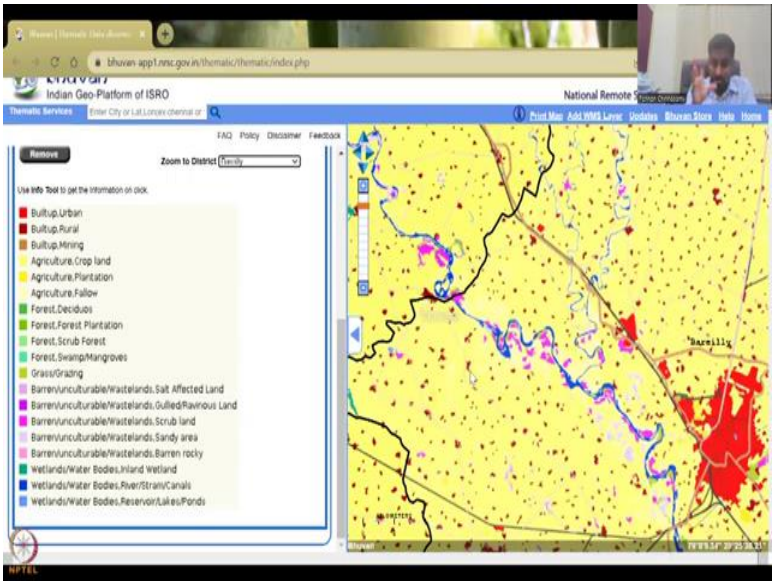
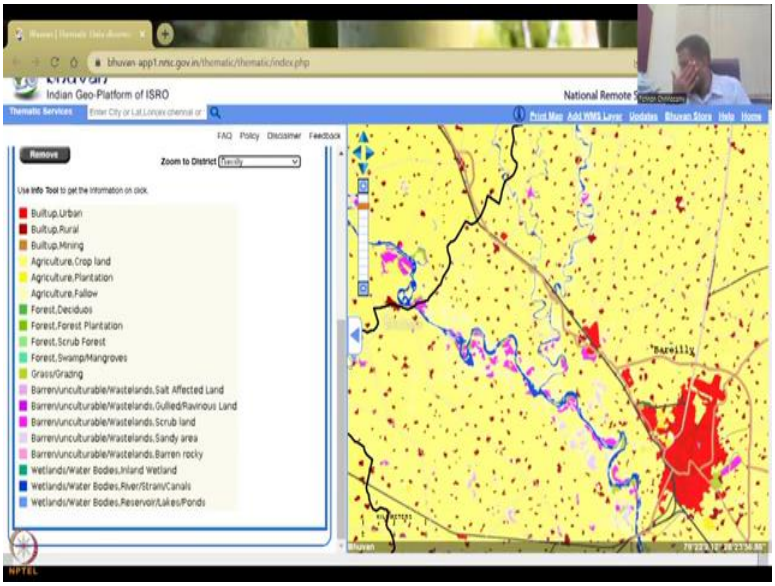
Wetlands/Water Bodies,Reservoir/Lakes/Ponds
Bareilly
NPTEL




So, the basics have been mapped and as I said you can you can go as the district boundary or you can just say select and then remove it gets removed you can just go back up and down and then say database view now it views it gets loading, you can see that this is the overall. And in the overall you will see forest on the top the Himalayan regions, the ganges flowing which is building water bodies and in the lower part you will see lot of barren wasteland, etc land has not been used well along the ganges, along the river channels these are prime land for agriculture you see lot of agriculture activities.

So, on a whole you do see that these lands have more agriculture it relates to the statistics I just shared as per census data UP has the highest number of rural population and villagers. So, definitely there will be lot of agricultural activities. And so we also have lot of wasteland and barren land and then some forests in the bottom, forest on the top and lot of urbanization these hot spots, so these are hot spots let us take some other Bareilly can be taken. I have

worked in Bareilly, so let us zoom in and you could see some city and then most of it is the ganges region, along the ganges there has been lot of waste shrublands, barren, unculturable wasteland, etc. etc.

The colors are not as perfect but you see lot of red dots the red dots the maroon kind of red is the built up rural areas lot of rural areas and then this is the Bareilly city very very nice posh city, very small but still not as big as Lucknow but still is good.

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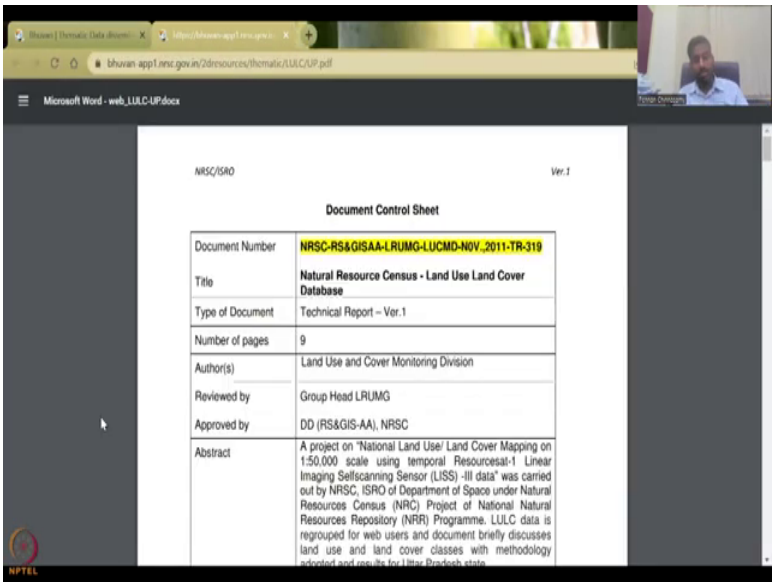


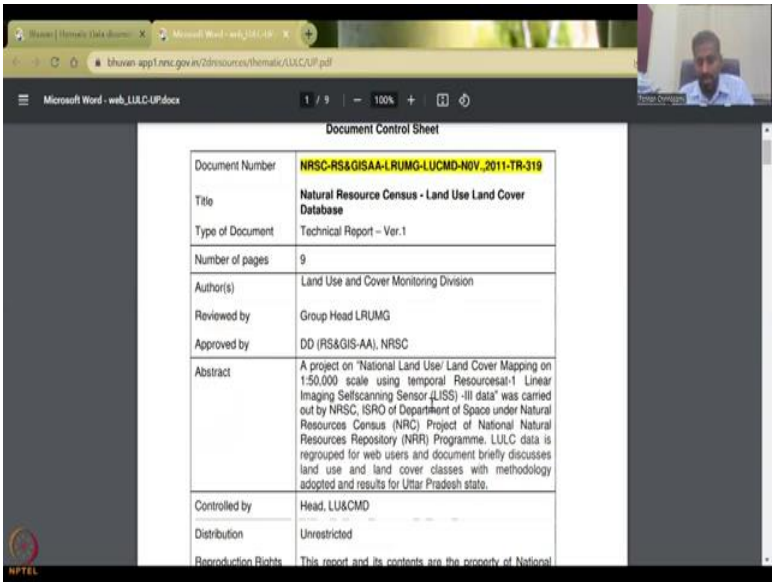


So, this is how you will access the land use land cover, you can look at the technical document as promised let us go and see what is the data source that has been used, you see that a projection of land use land cover 1 is to 50,000 scale. Metadata is always important it is

your duty to read through these before using the data because anyone can question you what is the source of the data.

You can say ISRO is a source but still ISRO is what is the question and this is the list 3 data, linear, imaging, self-scanning sensor 3, it has good high resolution compared to the previous ones.

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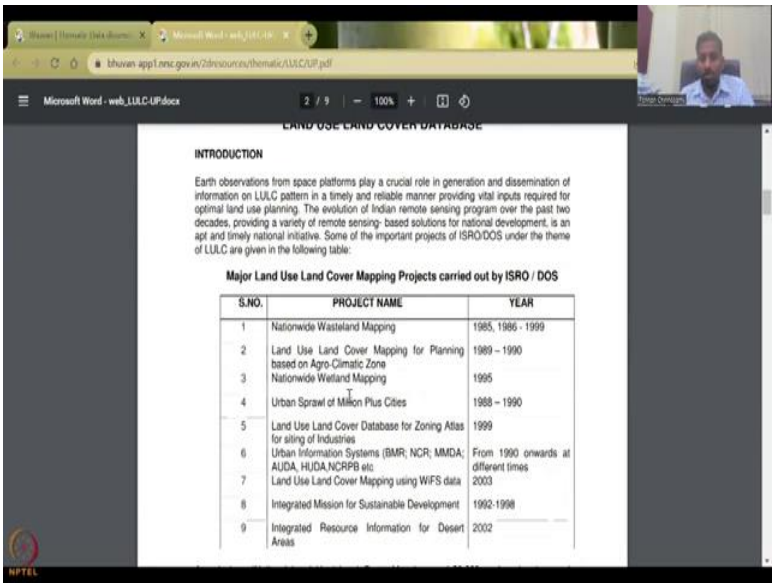


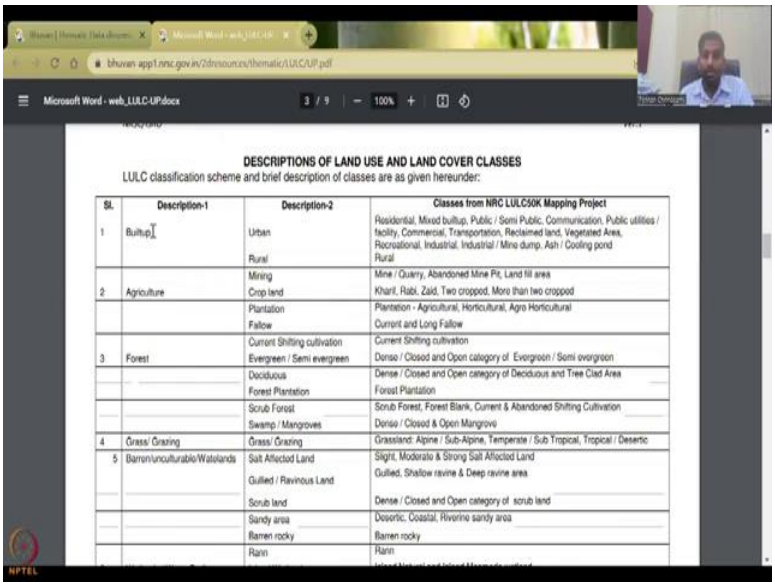

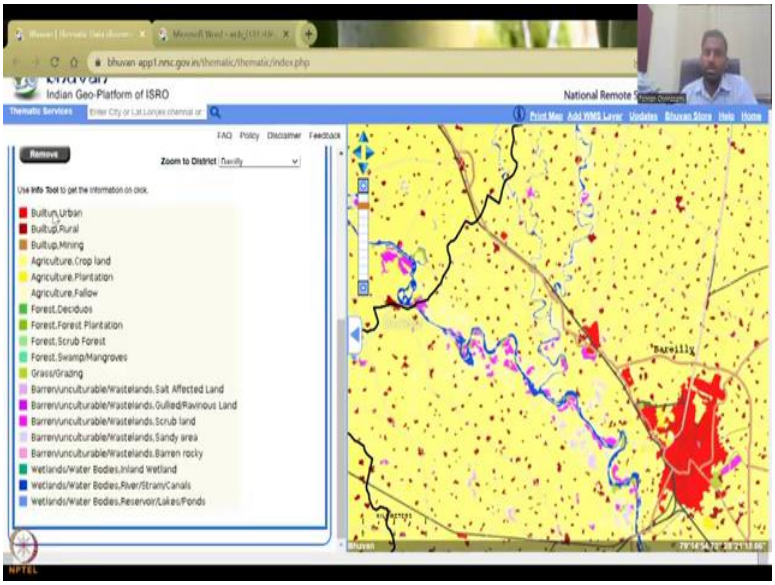
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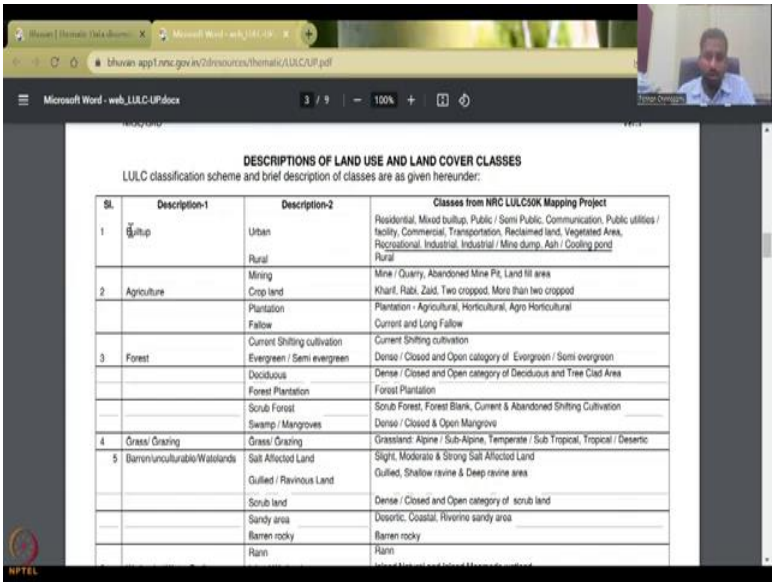
Bareilly
NPTEL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DESCRIPTIONS OF LAND USE AND LAND COVER CLASSES
LULC classification scheme and brief description of classes are as given hereunder:
Sl.
Description-1
Description-2
Classes from NRC LULC50K Mapping Project
1
Builtup
Urban
Residential, Mixed builtup, Public / Semi Public, Communication, Public utilities / facility, Commercial, Transportation, Reclaimed land, Vegetated Area, Recreational, Industrial, Industrial / Mine dump, Ash / Cooling pond
Rural
Rural
Mining
Mine / Quarry, Abandoned Mine Pit, Land fill area
2
Agriculture
Crop land
Kharif, Rabi, Zaid, Two cropped, More than two cropped
Plantation
Plantation - Agricultural, Horticultural, Agro Horticultural
Fallow
Current and Long Fallow
3
Forest
Current Shifting cultivation
Current Shifting cultivation
Evergreen / Semi evergreen
Dense / Closed and Open category of Evergreen / Semi evergreen
Deciduous
Dense / Closed and Open category of Deciduous and Tree Clad Area
Forest Plantation
Forest Plantation
Scrub Forest
Scrub Forest, Forest Blank, Current & Abandoned Shifting Cultivation
Swamp / Mangroves
Dense / Closed & Open Mangrove
4
Grass/ Grazing
Grass/ Grazing
Grassland: Alpine / Sub-Alpine, Temperate / Sub Tropical, Tropical / Desertic
5
Barren/unculturable/Watelands
Salt Affected Land
Slight, Moderate & Strong Salt Affected Land
Gullied / Ravinous Land
Gullied, Shallow ravine & Deep ravine area
Scrub land
Dense / Closed and Open category of scrub land
Sandy area
Desertic, Coastal, Riverine sandy area
Barren rocky
Barren rocky
Rann
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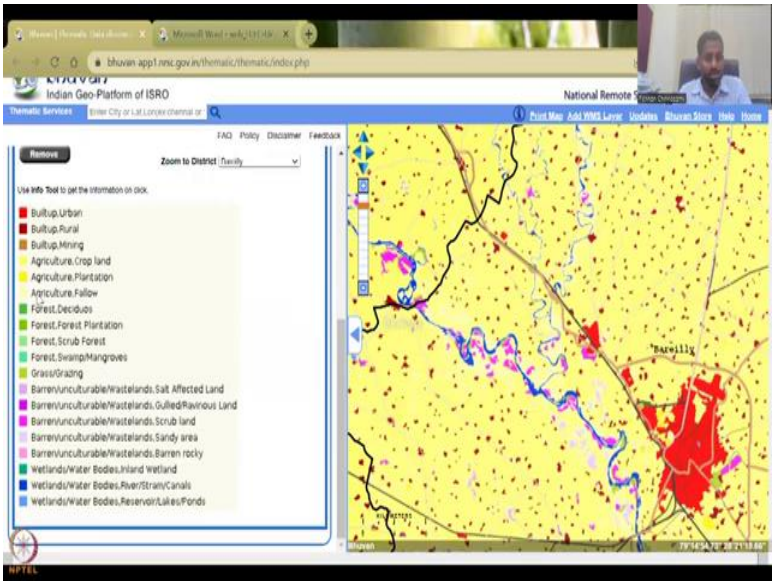
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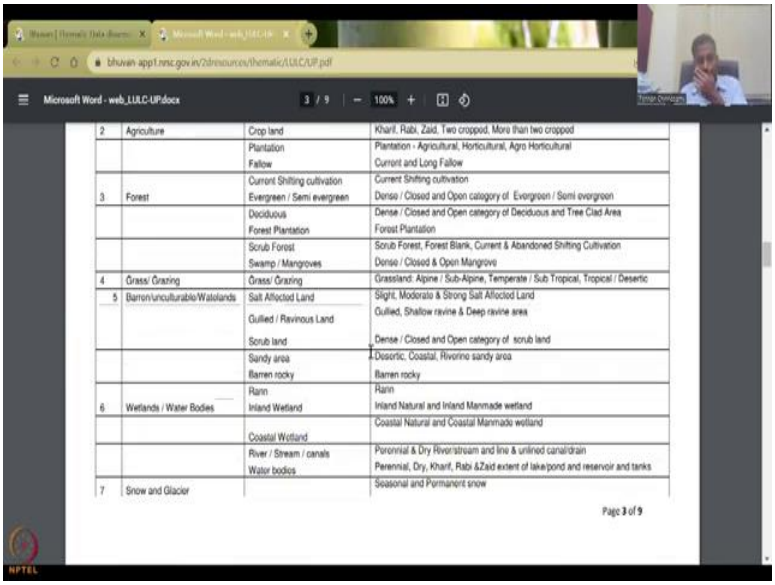


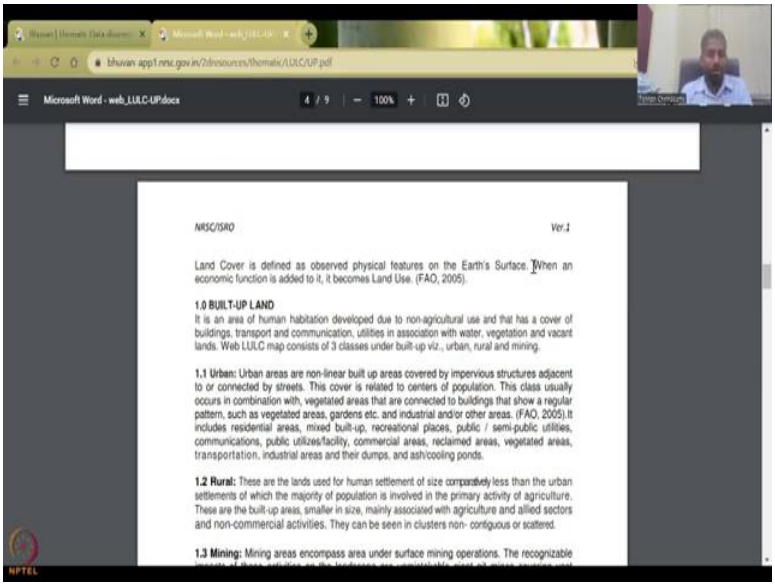


You can see that it has mapped all these different water bodies and land use land cover. And they give you what does it mean so as I said in here you say the 2 legends are here and what the, what constants when they say what is built up urban you can come here and say what is built up urban is a mix of public, public, semi-public communication centers, industries, recreational, ash dump, reclaimed land vegetated area.

For example, reclaim land is what the Bandra-Kurla complex is in Mumbai, it is a beautiful land but it is all reclaimed from the ocean they have put in lot of soil and gravel to claim the land. So, that is all called as built up area and then within the built up there is rural, just rural area, within the rural region, if it is built up it is called built up rural and then build up mining.

So, we do not have any mining but we have 3 buildups and that is what you see here built up and then three descriptions. Then you have agriculture cropland it constitutes kharif, rabi, zaid 2 crop seasons or more than 2 crop plantation includes plantation which is rubber, tea, etc or even banana and then you have agricultural horticultural etc all these come under plantation.

Fallow current and long fallow, current shifting cultivation, all comes under agriculture. So, you can see here there is agriculture crop, agriculture plantation, agriculture fallow. There is a comma so there is a first description and then the second description and it is separated by a comma.

And then there is grass, grazing, baron, I would recommend you to go through these. And as I said it uses the FAO scenarios and we have used the same description in our class, you would have seen that land cover is defined as observed physical features on the Earth's surface I have added bio because there is lot of bio also in it, which is forest cover, crop cover all these things.

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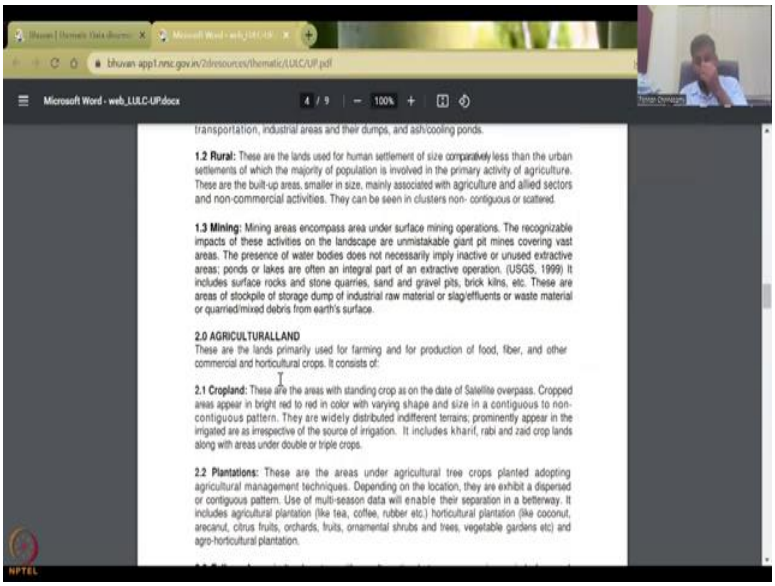
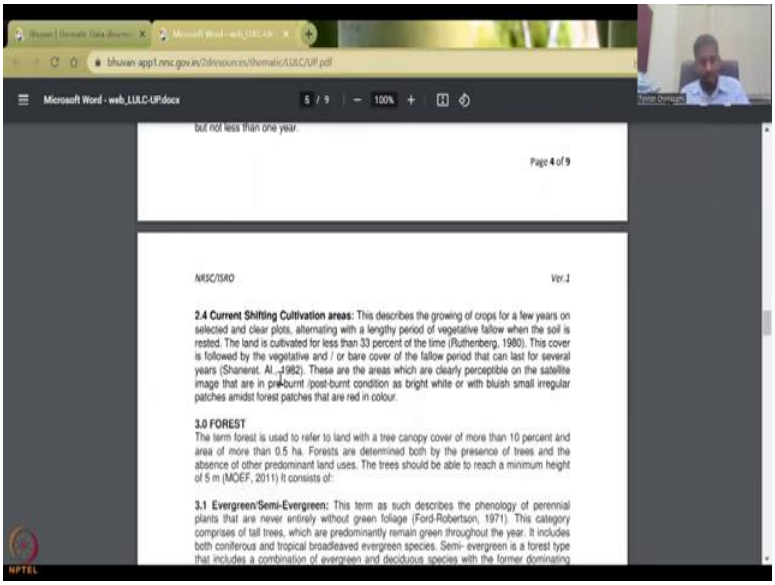





but not less than one year.



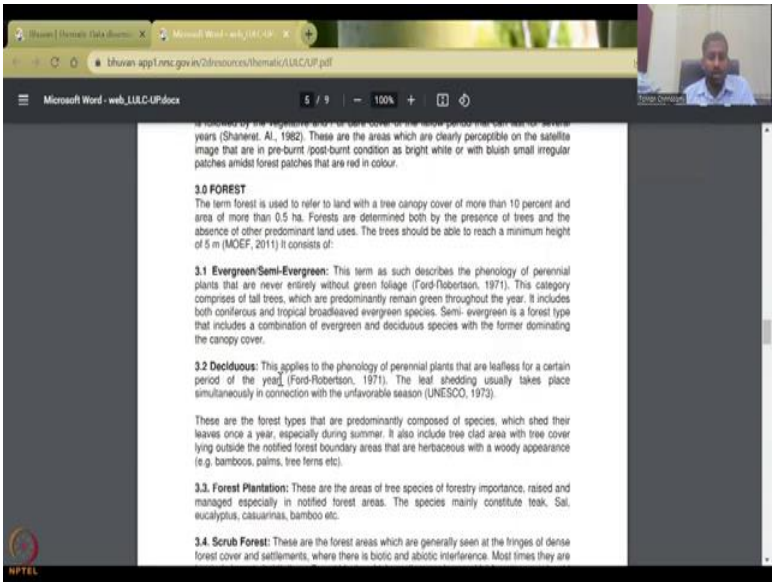


**2.4 Current Shifting Cultivation areas:** This describes the growing of crops for a few years on selected and clear plots, alternating with a lengthy period of vegetative fallow when the soil is rested. The land is cultivated for less than 33 percent of the time (Ruthenberg, 1980). This cover is followed by the vegetative and / or bare cover of the fallow period that can last for several years (Shanerat. Al.,1982). These are the areas which are clearly perceptible on the satellite image that are in pre-burnt /post-burnt condition as bright white or with bluish small irregular patches amidst forest patches that are red in colour.

**3.0 FOREST**

The term forest is used to refer to land with a tree canopy cover of more than 10 percent and area of more than 0.5 ha. Forests are determined both by the presence of trees and the absence of other predominant land uses. The trees should be able to reach a minimum height of 5 m (MOEF, 2011) It consists of:

**3.1 Evergreen/Semi-Evergreen:** This term as such describes the phenology of perennial plants that are never entirely without green foliage (Ford-Robertson, 1971). This category comprises of tall trees, which are predominantly remain green throughout the year. It includes both coniferous and tropical broadleaved evergreen species. Semi- evergreen is a forest type that includes a combination of evergreen and deciduous species with the former dominating

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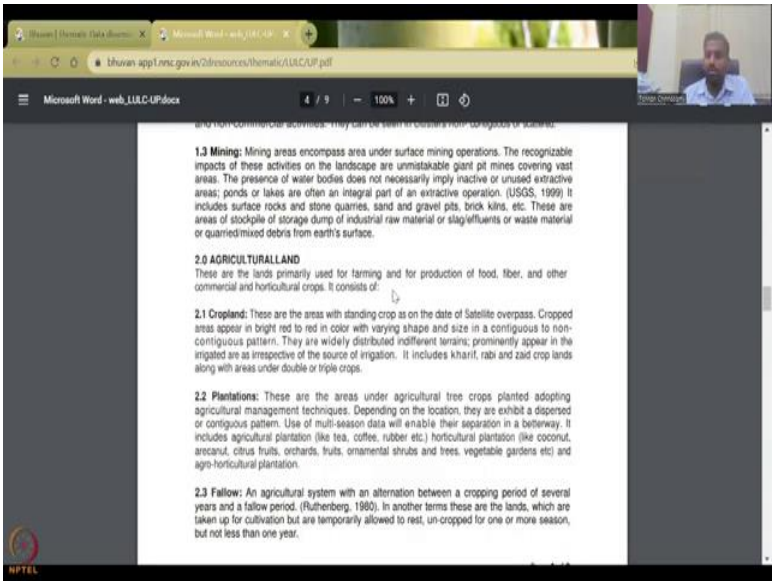
**3.2 Deciduous:** This applies to the phenology of perennial plants that are leafless for a certain period of the year (Ford-Robertson, 1971). The leaf shedding usually takes place simultaneously in connection with the unfavorable season (UNESCO, 1973).

These are the forest types that are predominantly composed of species, which shed their leaves once a year, especially during summer. It also include tree clad area with tree cover lying outside the notified forest boundary areas that are herbaceous with a woody appearance (e.g. bamboos, palms, tree ferns etc).

**3.3. Forest Plantation:** These are the areas of tree species of forestry importance, raised and managed especially in notified forest areas. The species mainly constitute teak, Sal, eucalyptus, casuarinas, bamboo etc.

**3.4. Scrub Forest:** These are the forest areas which are generally seen at the fringes of dense forest cover and settlements, where there is biotic and abiotic interference. Most times they are




**1.3 Mining:** Mining areas encompass area under surface mining operations. The recognizable impacts of these activities on the landscape are unmistakable giant pit mines covering vast areas. The presence of water bodies does not necessarily imply inactive or unused extractive areas; ponds or lakes are often an integral part of an extractive operation. (USGS, 1999) It includes surface rocks and stone quarries, sand and gravel pits, brick kilns, etc. These are areas of stockpile of storage dump of industrial raw material or slag/effluents or waste material or quarried/mixed debris from earth's surface.

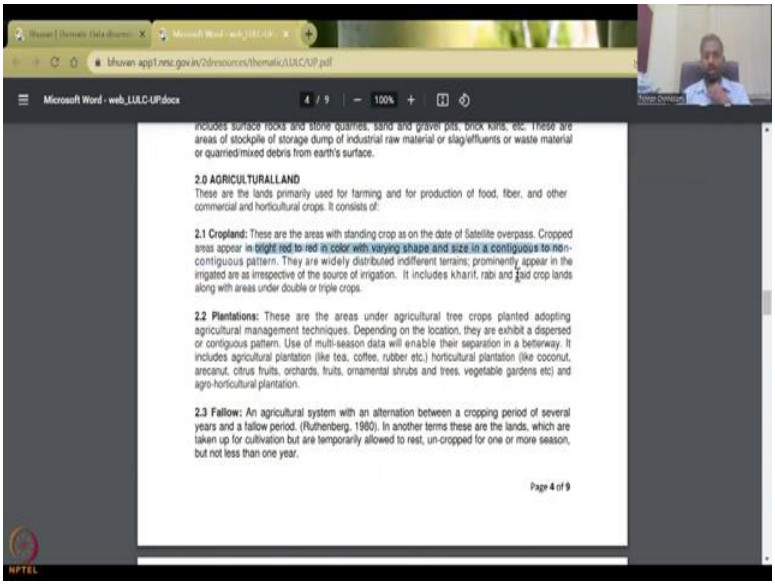
**2.0 AGRICULTURAL LAND**

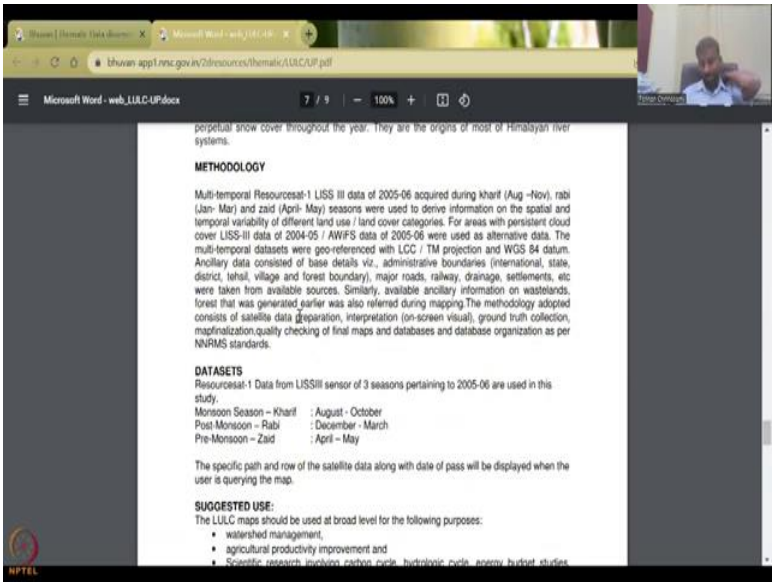
These are the lands primarily used for farming and for production of food, fiber, and other commercial and horticultural crops. It consists of:

**2.1 Cropland:** These are the areas with standing crop as on the date of Satellite overpass. Cropped areas appear in bright red to red in color with varying shape and size in a contiguous to non-contiguous pattern. They are widely distributed indifferent terrains; prominently appear in the irrigated are as irrespective of the source of irrigation. It includes kharif, rabi and zaid crop lands along with areas under double or triple crops.

**2.2 Plantations:** These are the areas under agricultural tree crops planted adopting agricultural management techniques. Depending on the location, they are exhibit a dispersed or contiguous pattern. Use of multi-season data will enable their separation in a betterway. It includes agricultural plantation (like tea, coffee, rubber etc.) horticultural plantation (like coconut, arecanut, citrus fruits, orchards, fruits, ornamental shrubs and trees, vegetable gardens etc) and agro-horticultural plantation.

**2.3 Fallow:** An agricultural system with an alternation between a cropping period of several years and a fallow period. (Ruthenberg, 1980). In another terms these are the lands, which are taken up for cultivation but are temporarily allowed to rest, un-cropped for one or more season, but not less than one year.




And they are given detailed description of each bullet point what it means what is fallow, what is forest. So, let us look at agriculture for example, we have agriculture, these are the land primarily used for farming, production of food, fiber and other commercial horticulture crops in India it constitutes of cropland plantations and fallow, cropland areas appear bright red in the red spectrum, they are widely received distributed in different terrains prominently appear in the irrigated and non-irrigated areas.

It includes kharifs, rabis, zaid crops, zaid is mostly the winter crops along with areas under double or triple crops. So, this is the definition of agriculture cropland. So, then you have solved infected, barren land, etc. What is the year when we downloaded we did notice that it was 2005-2006. So, now it says resource at data from list 3 sensor of 3 sensors pertaining to 2005-2006 I use, 3 seasons are monsoon, rabi and zaid, kharif is the times August to October is your kharif the rainy season.

Rabi is your December to March which is mostly your winter crops and your pre summer crops, Zaid is your pick summer crops in this in some regions it is called the winter crop, here they have used it as the summer crop.

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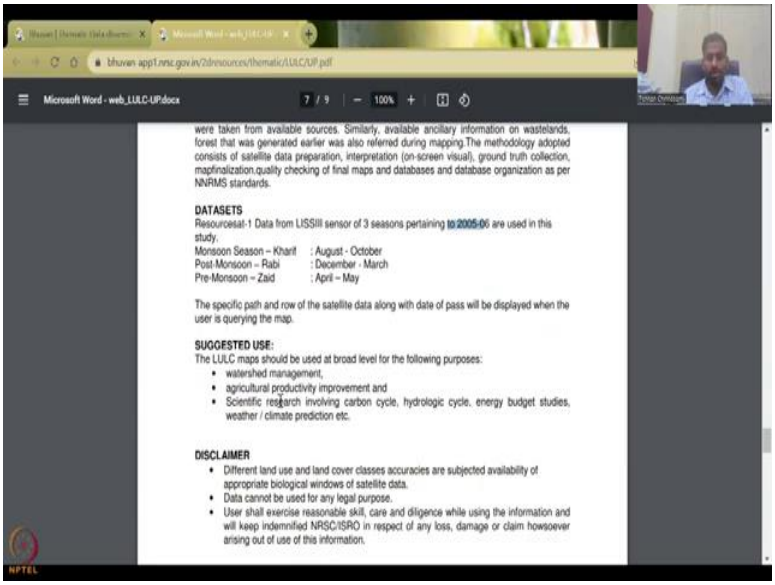


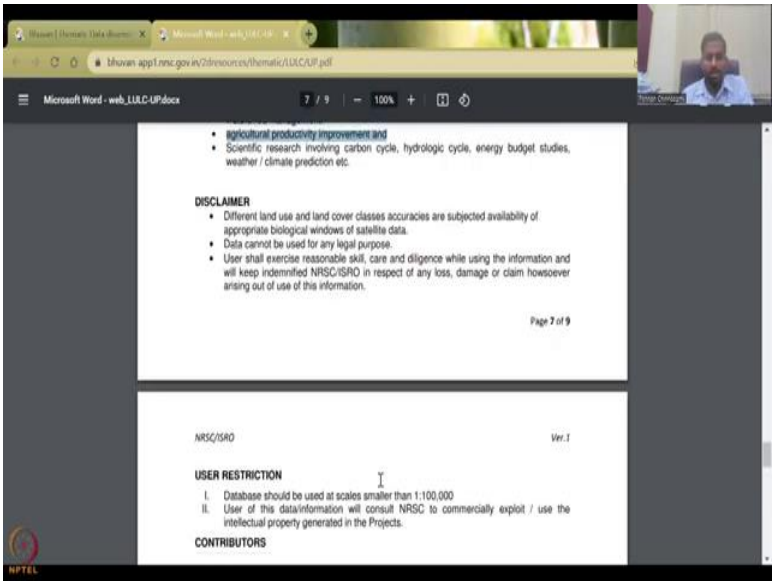

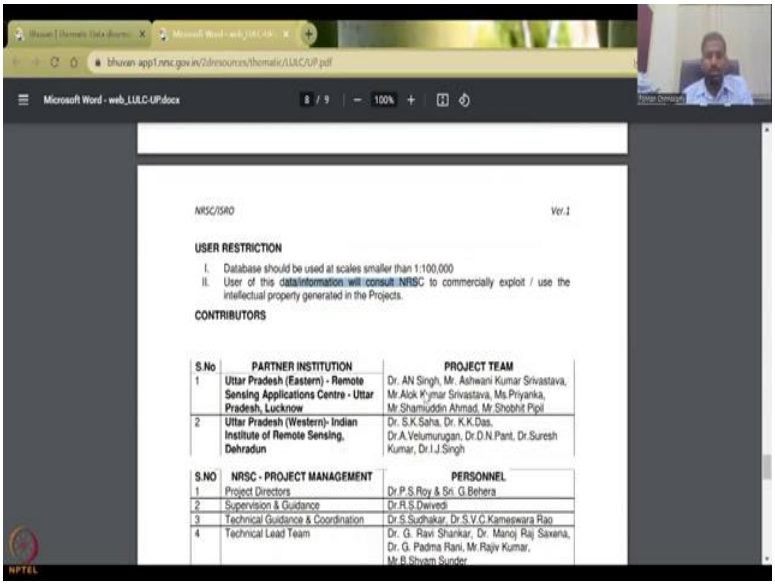


So, as I said use you can use it for watershed management, agriculture productivity and improvement which is what the rural development scenario we are looking at. How do you increase agriculture productivity, how do you map regions where agriculture productivity is needed. And then your energy budget, hydrological budgets etc. There is some disclaimer and then data etc.

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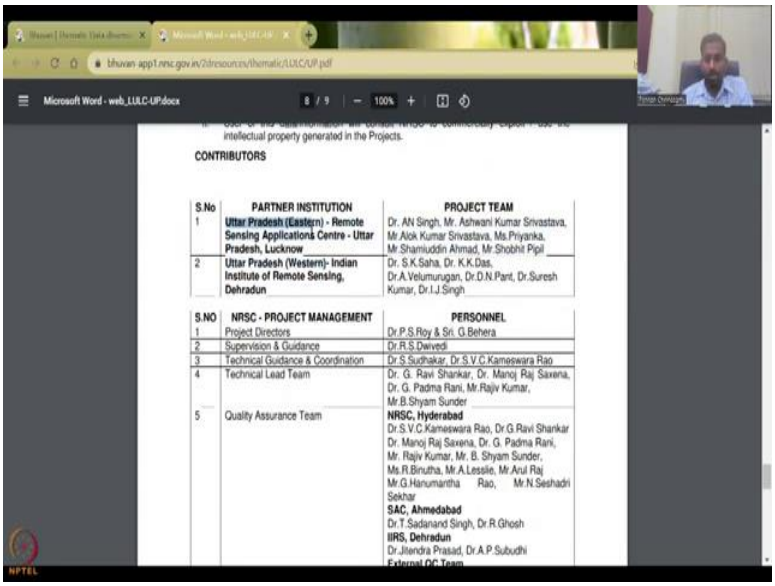

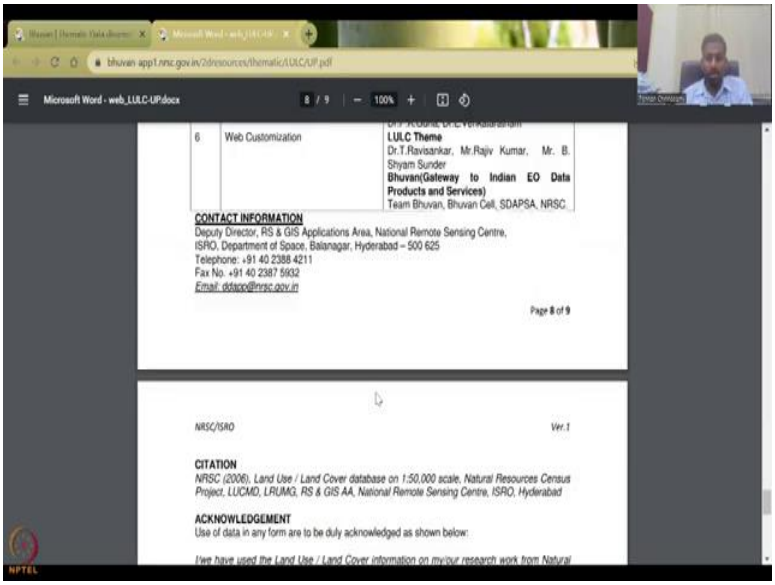


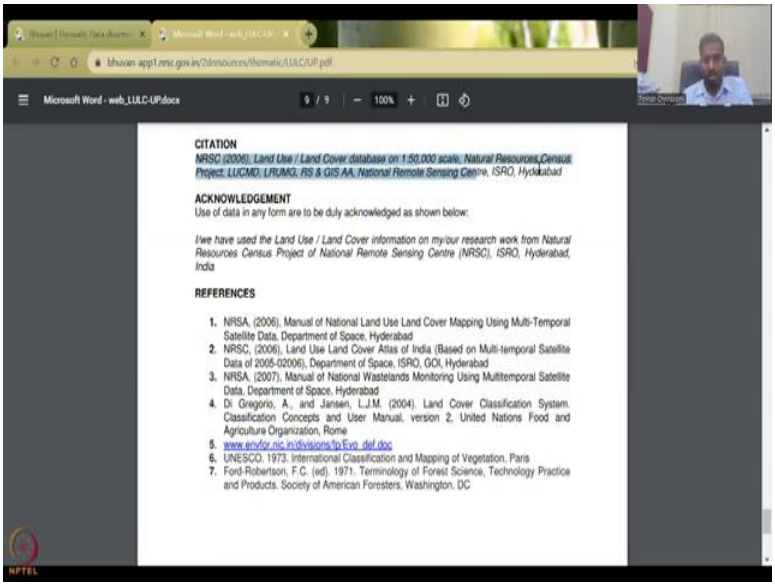


Partner institutions as I said they work with other regions so UP looks like UP, space center was very very helpful and then so maybe UP is a good section to look at and then the project director's personal etc. Citations if you use the data you could cite this NRSC ISRO is also pretty good to site. They have their own citations of what is land is land classification, they use the manners on FAO so good thing that we are also using the FAO citations in our lecture series so we are currently on track and we use these technologies also.

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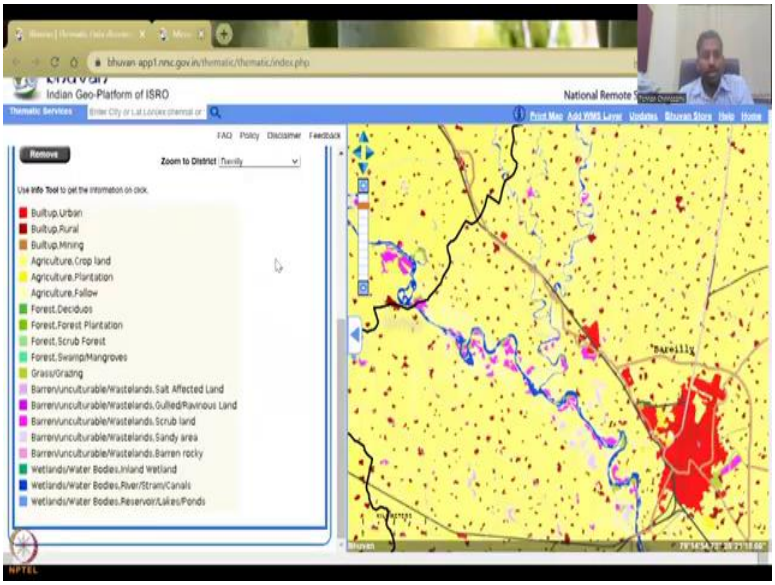


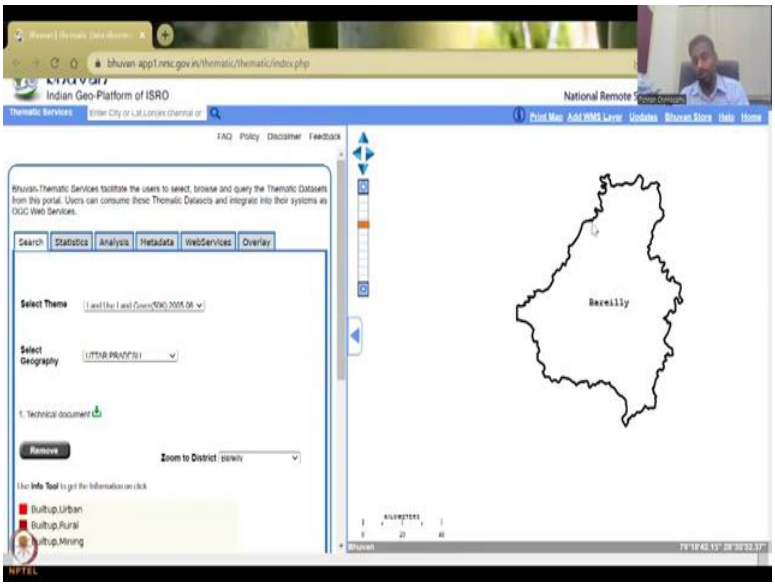


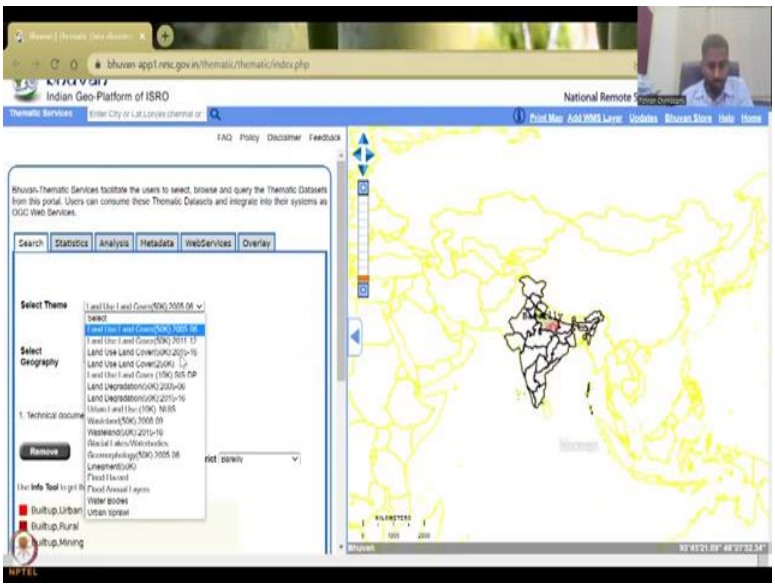

So, with this I think the metadata is clear you can zoom out, zoom in using your mouse and you can use different locations also.

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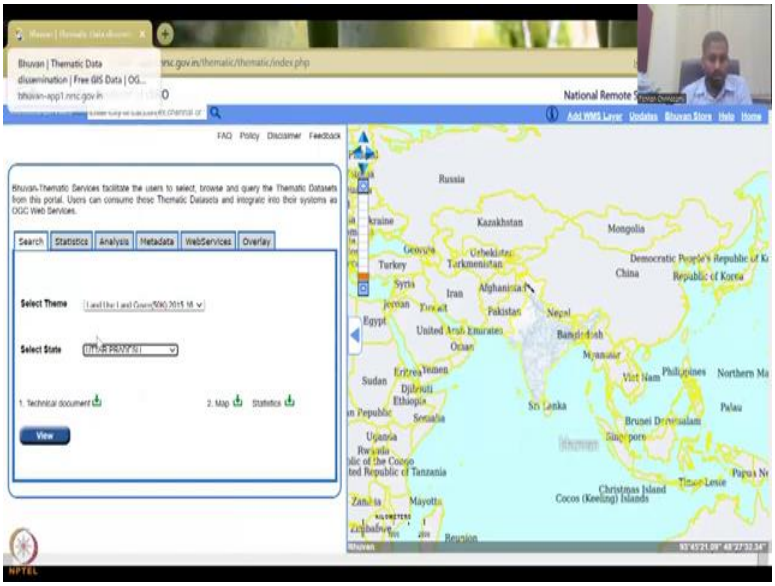
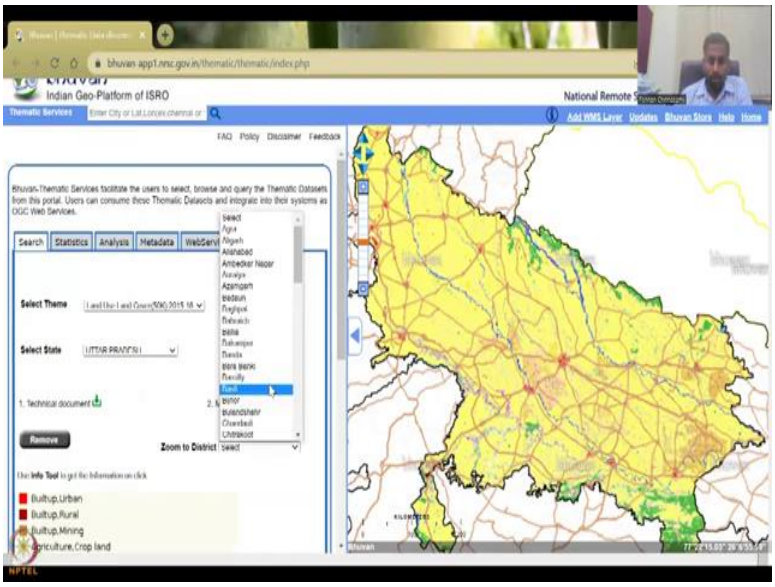
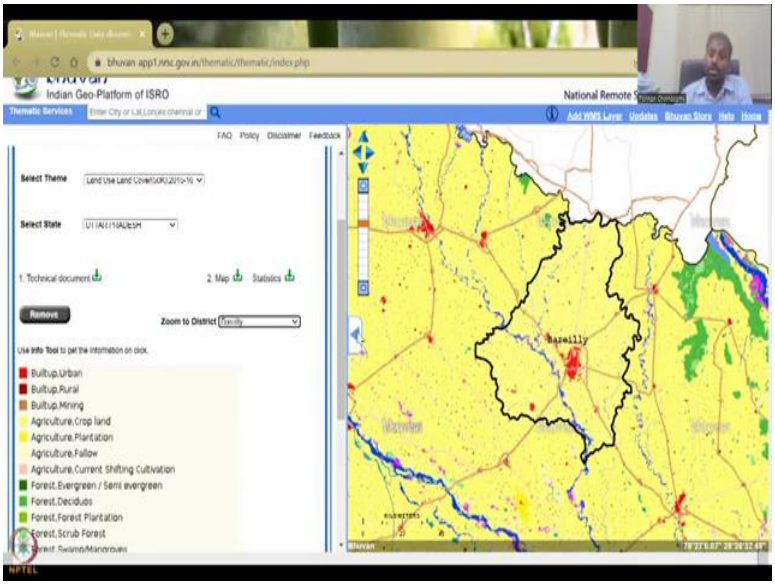
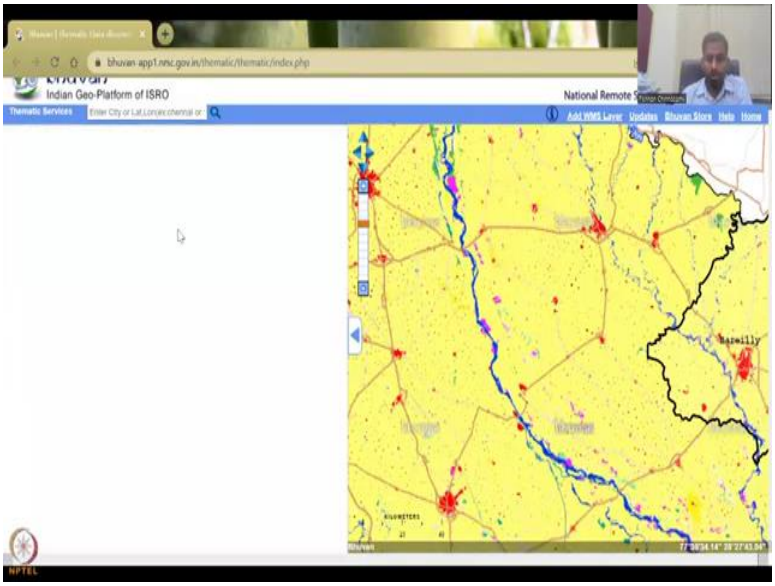


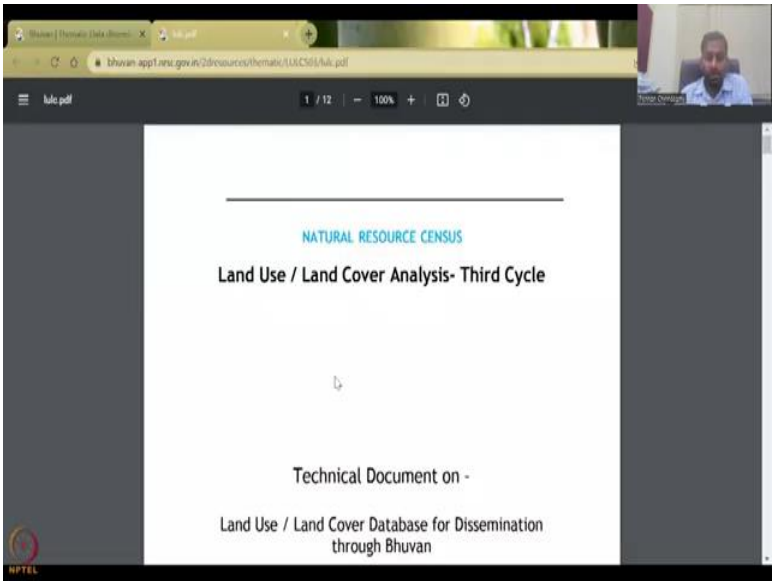



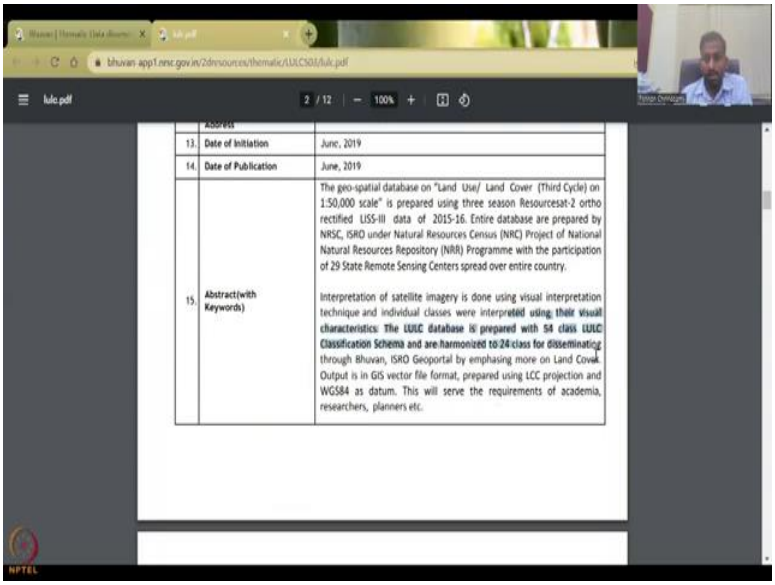


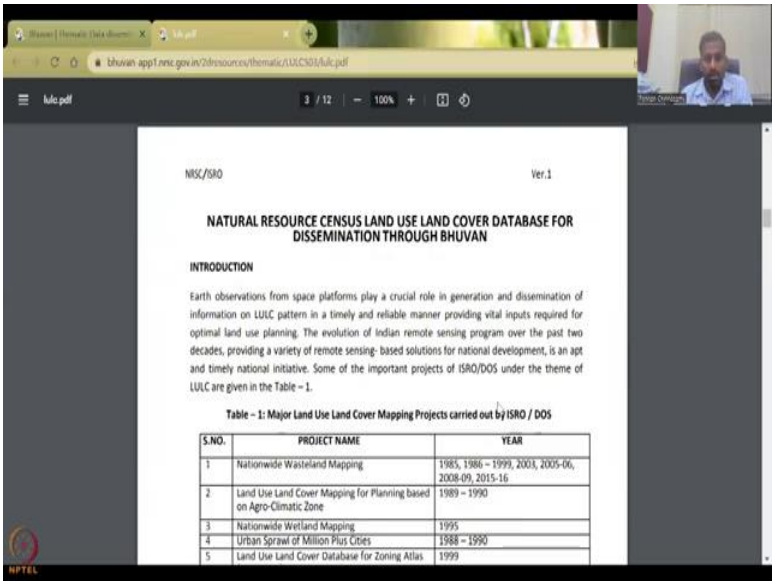



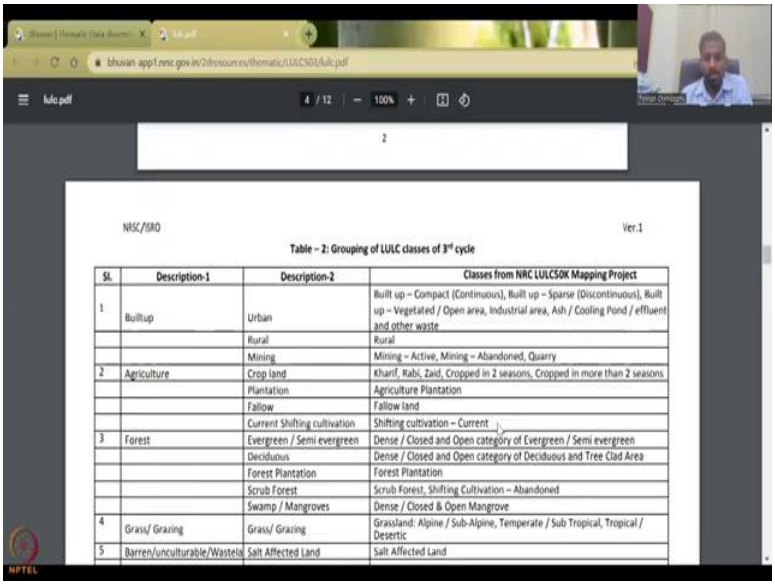

So, let us look at 10 years difference so I am just going to UP and then let us say view. So, just for 2015-2016 we have a map and statistics you can download both or read both we use Bareilly, so let go to Bareilly again and Bareilly comes up. You can see the same legend is used however the data is different because we had 2 different, yes, you can move the screen up and down if you do not want to see this part but then you can also use it.

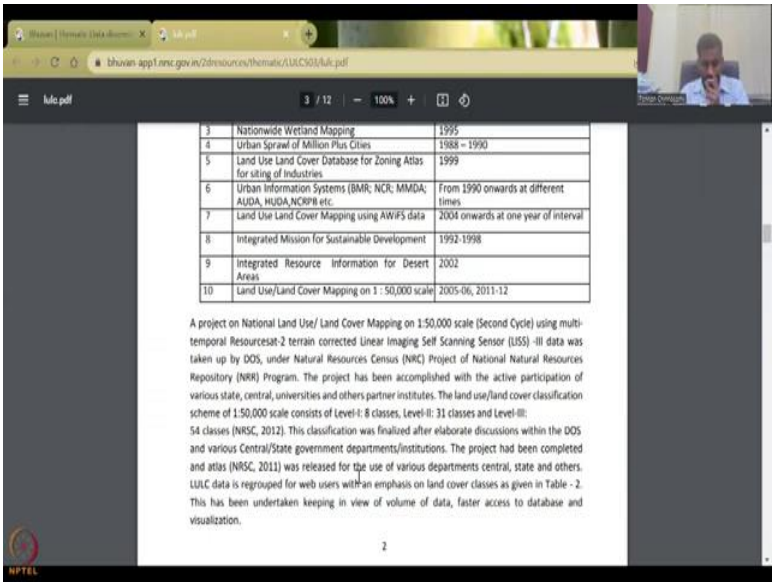
(Refer Slide Time: 33:04)






So, the technical document for 2015-2016 is they have used let us see what data they have used, they have used ISRO's data cycle, 54 classes of land use land cover has been done. The years that have been used, what are the legends etc etc. So, we can also see that it has used the resource center project land use land cover, it is using a multi resource at linear self scanning this 3 etc etc. And they also use other ISRO satellite data products.

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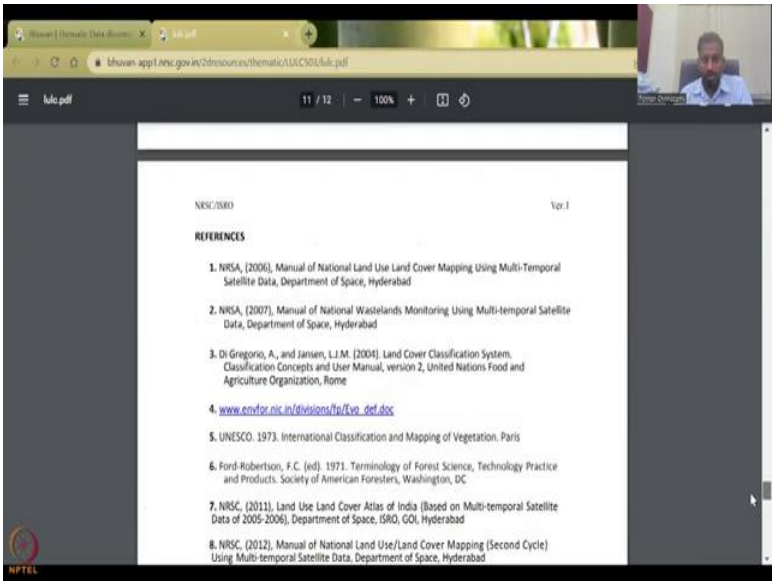
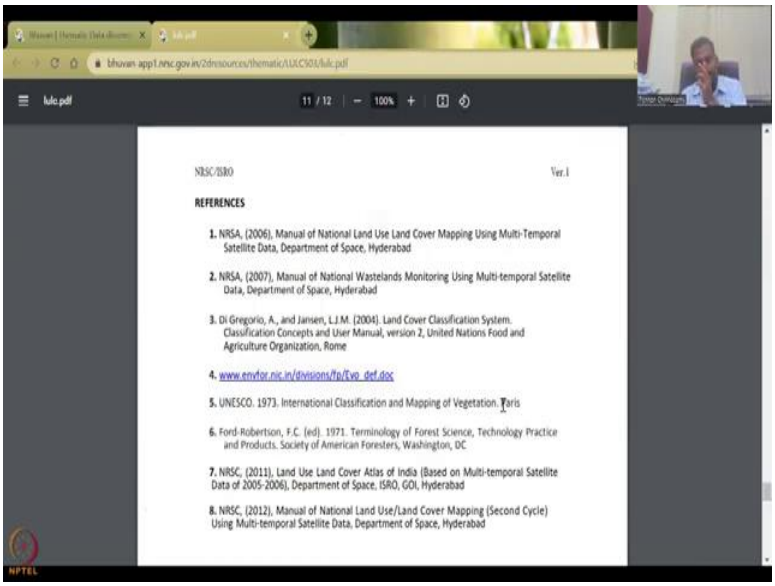
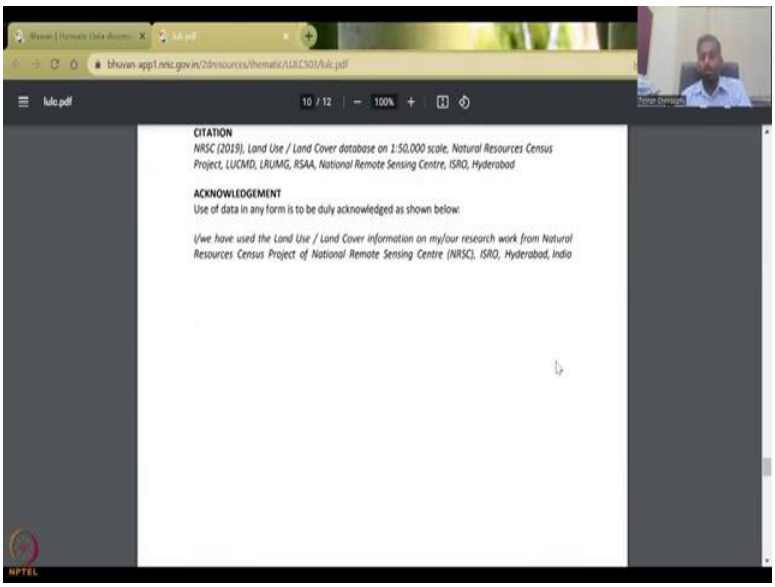
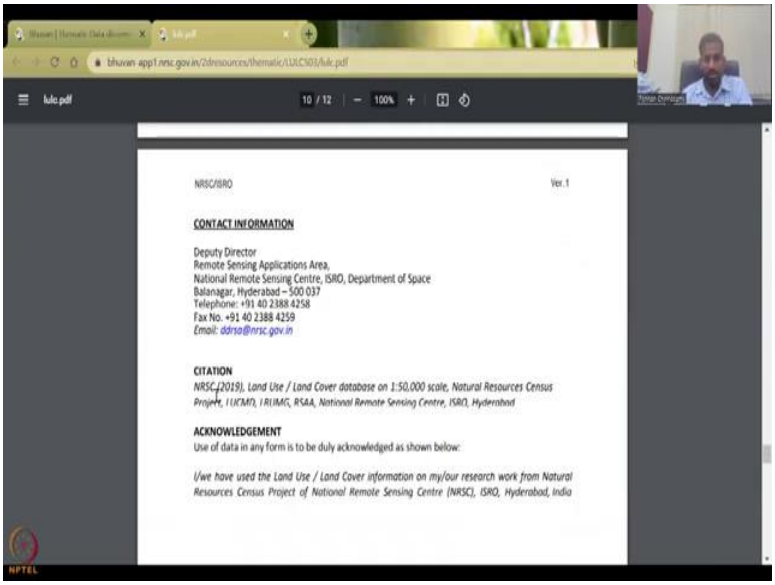


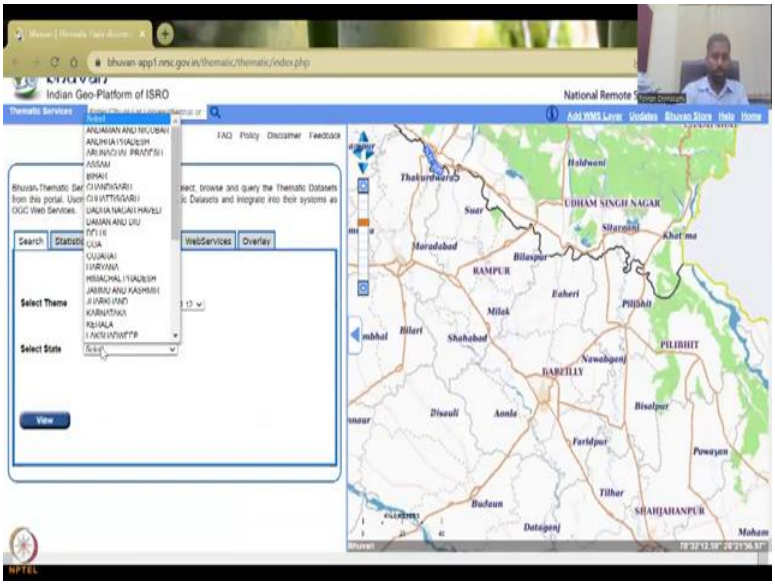



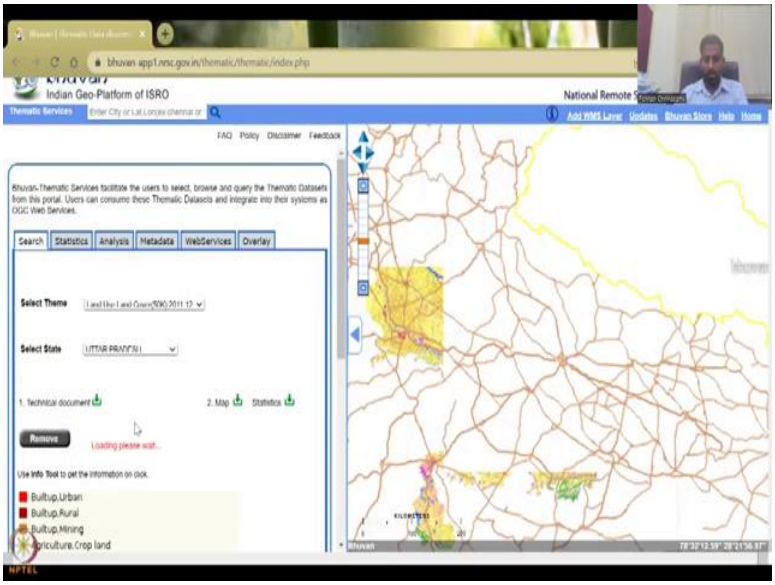






And the same documentation has been given here they are given different updated data products and the previous citations have been used this is a 2019 citation so it is approximately 3 years old but the data was for 2015-2016.

(Refer Slide Time: 34:13)

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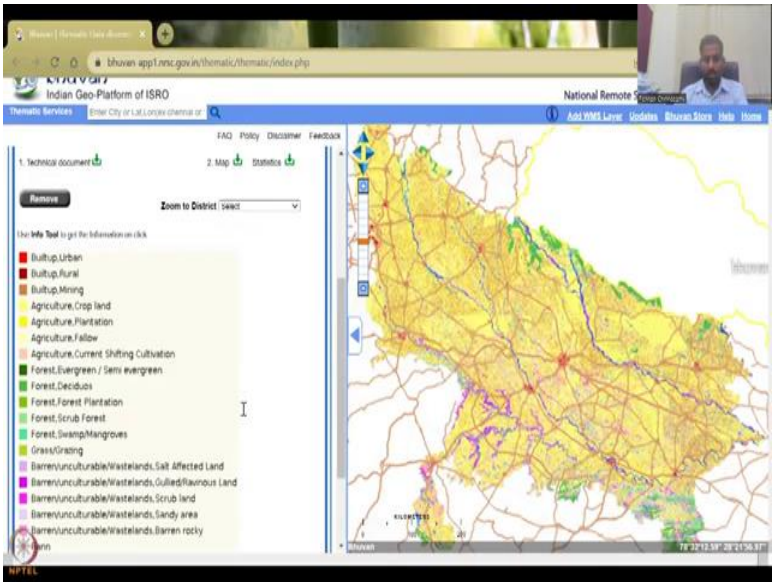
Indian Geo-Platform of ISRO
National Remote
Thematic Services
Add WMS Layer
Updates
Bhuvan Store
Help
Home
FAQ
Policy
Disclaimer
Feedback
Bhuvan-Thematic Services facilitate the users to select, browse and query the Thematic Datasets from this portal. Users can consume these Thematic Datasets and integrate into their systems as OGC Web Services.
Search
Statistics
Analysis
Metadata
WebServices
Overlay
Select Theme
Select State
1. Technical document
2. Map
Statistics
Remove
Loading please wait...
Use Info Tool to get the information on click.
Builtup,Urban
Builtup,Rural
Builtup,Mining
Agriculture,Crop land
NPTEL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Indian Geo-Platform of ISRO
Thematic Services
Add WMS Layer
Updates
Bhuvan Store
Help
Home
FAQ
Policy
Disclaimer
Feedback
1. Technical document
2. Map
Statistics
Remove
Zoom to District
Select
Use Info Tool to get the information on click
Builtup,Urban
Builtup,Rural
Builtup,Mining
Agriculture,Crop land
Agriculture,Plantation
Agriculture,Fallow
Agriculture,Current Shifting Cultivation
Forest,Evergreen / Semi evergreen
Forest,Deciduos
Forest,Forest Plantation
Forest,Scrub Forest
Forest,Swamp/Mangroves
Grass/Grazing
Barren/unculturable/Wastelands,Salt Affected Land
Barren/unculturable/Wastelands,Gullied/Ravinous Land
Barren/unculturable/Wastelands,Scrub land
Barren/unculturable/Wastelands,Sandy area
Barren/unculturable/Wastelands,Barren rocky
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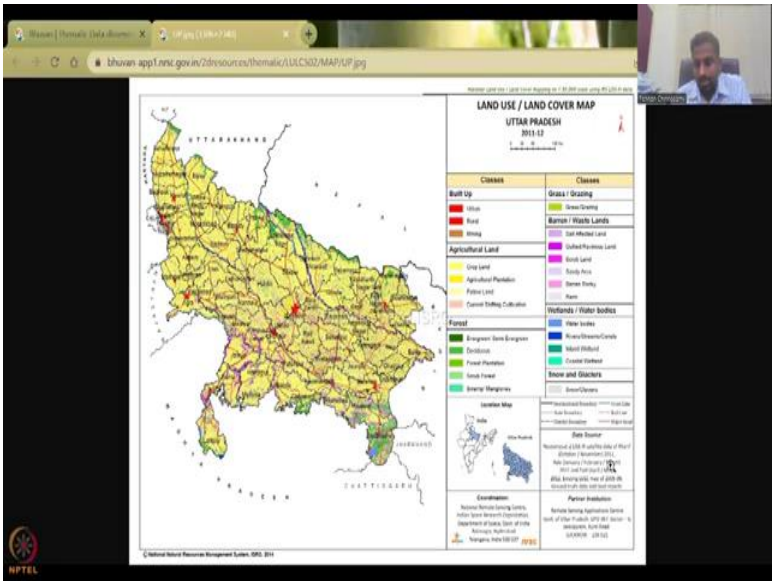
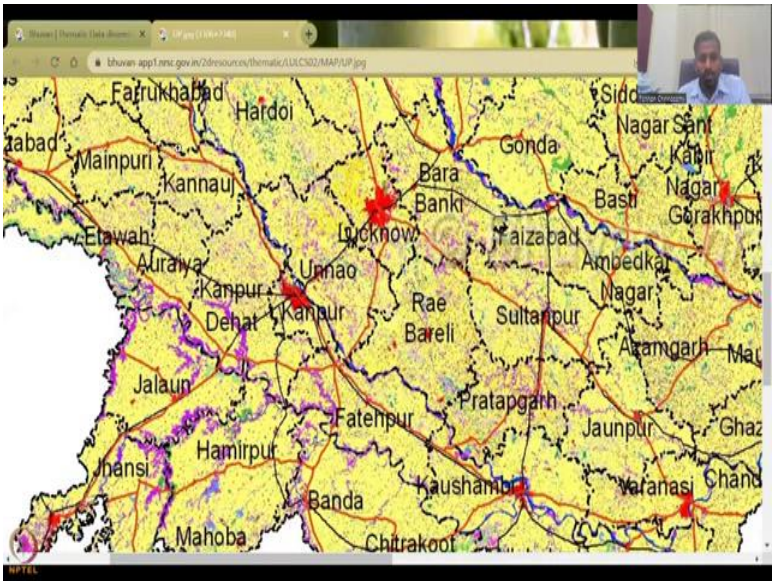
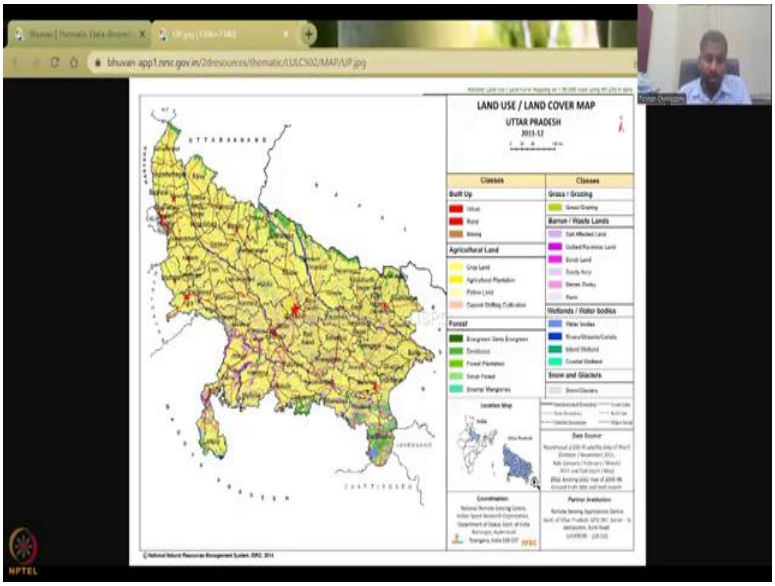

bhuvan app1.nrsc.gov.in/2dinsources/thematic/LULC502/MAP/UP.jpg
LAND USE / LAND COVER MAP
UTTAR PRADESH
2011-12
Classes
Built Up
Agricultural Land
Forest
Grass / Grazing
Barren / Wastes Lands
Wetlands / Water bodies
Snow and Glaciers
UTTARAKHAND
CHATTISGARH
NPTEL




So, let us stop here we have looked at, let us look one more quickly and select UP, view, technical document is the same and then we have map, map you can download the map if you click the map quickly the map comes up with all the land use land cover and data source resource set so this is the metadata of the data they have taken 3 seasons 11, 2012, so 2011 to 2012 was used to make this map and they published it in 2016-2017.

So, you can zoom in and zoom out and then use this for your studies you can geo-reference this map because you know where Bareilly is, you can click a point in Bareilly, the center of Bareilly take the GCPs the ground control points and then use it in your studying area. For some reason statistics also can be looked at.

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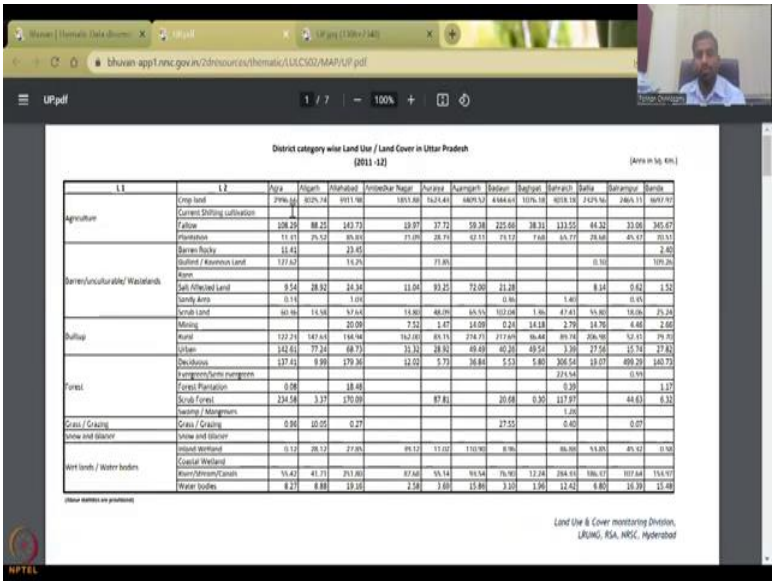


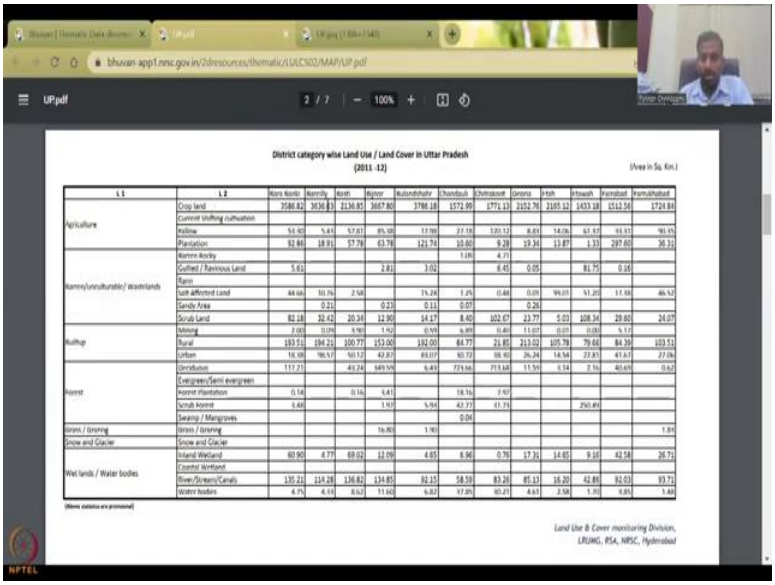


So, basically gives you the statistics of the percentage of land cover land use etc how much land is in cropland, total land area and square kilometers has been given in statistics. Comparisons is not done yet but we can definitely do it in the next lecture series.

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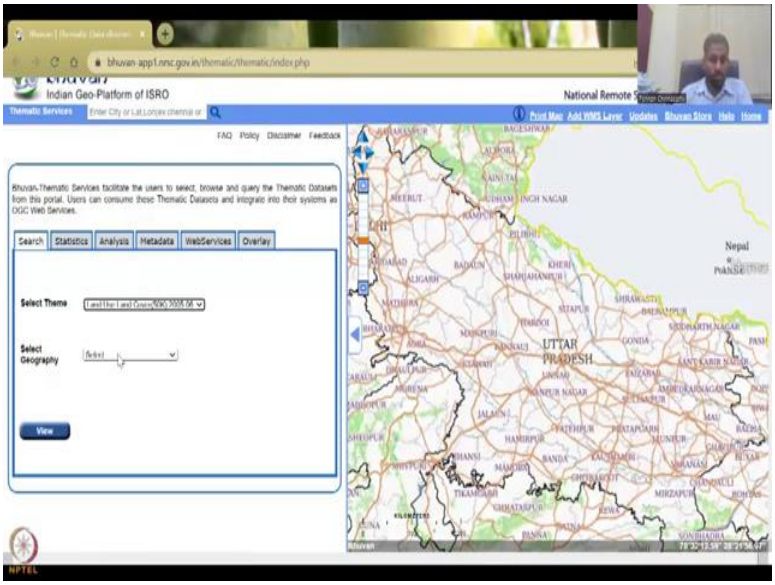


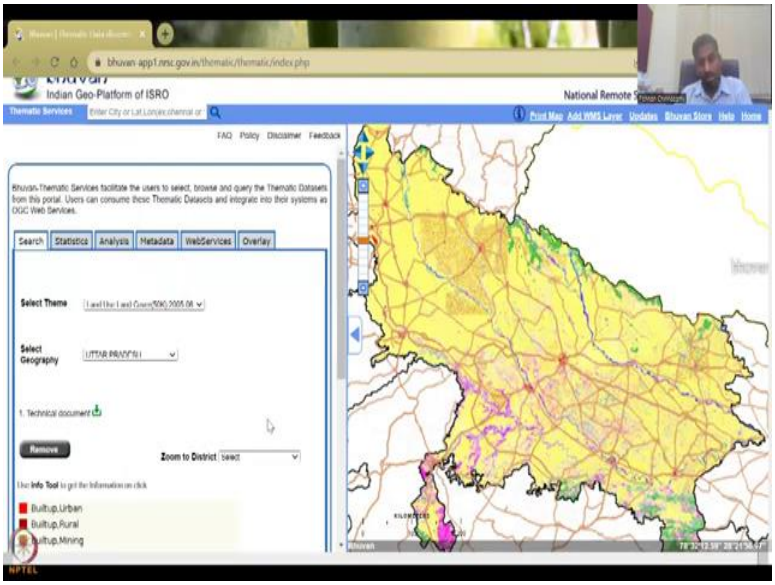


So, let us look at in detail the next ones as I said in 2005-2006 if you go to Uttar Pradesh you do not see the map and statistics it is not readily available you will have to download and put it in the map but there are other regions you have. So, with this I stop here, I will see you in the next lecture. Thank you.