Remote Sensing and GIS for Rural Development
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Week - 5
Lecture no. 04
Raster Data Tools: Raster Calculator and Raster Align

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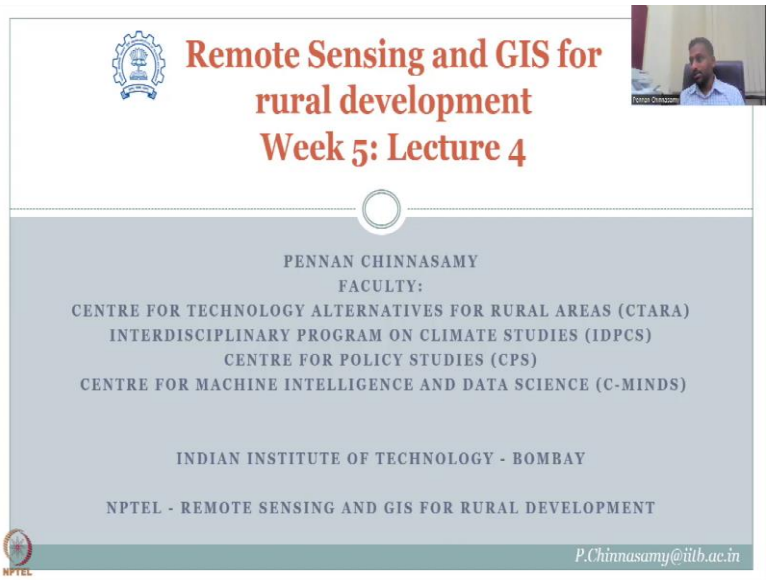

Hello everyone, welcome to NPTEL course on Remote Sensing and GIS for Rural Development. This is week 4, lecture sorry, week 5, lecture 4. In this week, we are going to look at Raster data sets and in the past lectures we have looked at the different types of data and how raster is different from vector and where raster data can be used for rural development.

In addition, we also looked at the aspects where raster data can be used and a lot of errors and issues that can creep into the raster data sets. These can be effectively removed through the system by using GIS tools and algorithms to filter the data. Given that let us look at some tools for raster analysis in today's lecture.

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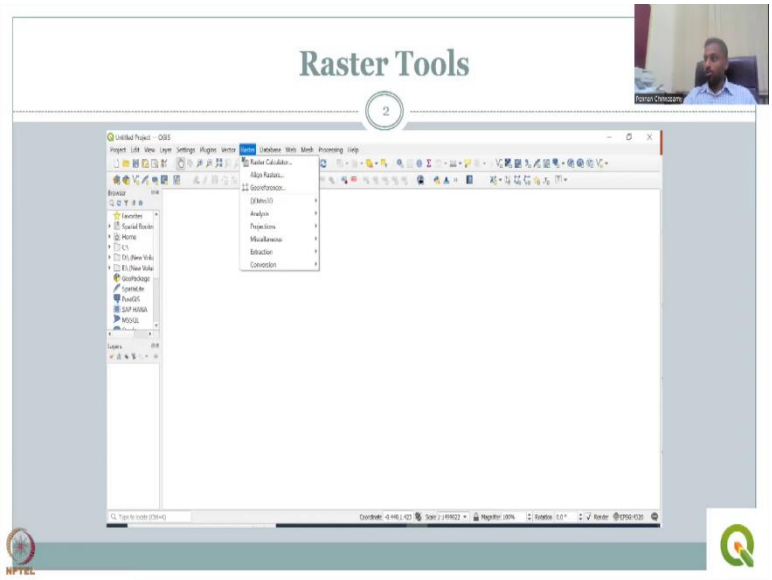

So, as we have seen in the GIS portal, and the GIS dashboard, there are a lot of datasets available, which are raster that can be used for learning. But most importantly, there are set of raster tools that are always on the toolbar. This is what we will look first in today's lecture. We also looked at how do you understand the tool by using the help bar. We will also showcase each tool which is dominant for Rural Development cases of the tools that are listed today.

So, if you see here in the raster window, you do see that there are a lot of tools. And in the tools we have multiple analysis tools, projection tools, miscellaneous tools, but not all are priority level high in rural development. We will only focus on certain tools that will be used in the following case studies. Let us look at some of the tools today.

But before that, please spend some time using the software. Going through the help command as I showed you in the previous lecture and studying about each tool. Normally one tool can be discussed in one lecture, but we will go through four tools because I have given you how to read and assess these tool sets. The first tool we will be looking at is the raster calculator. Before that, I will again show you how to look at the toolbar.

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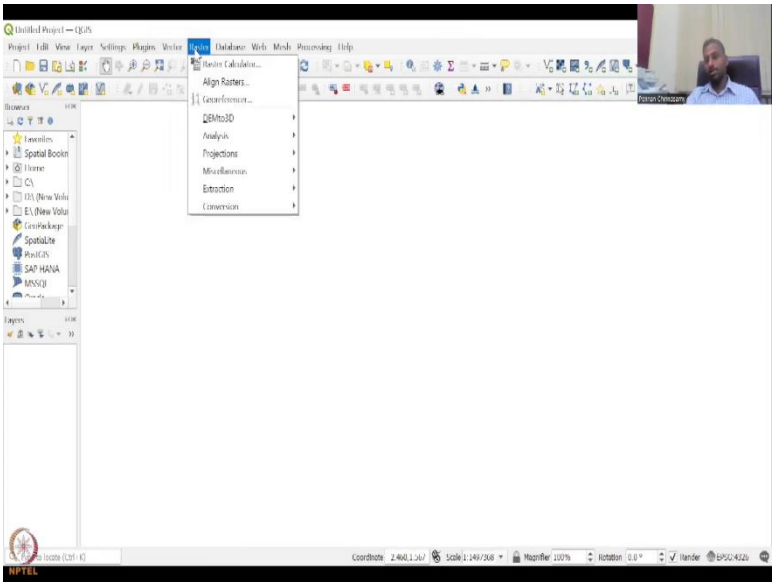

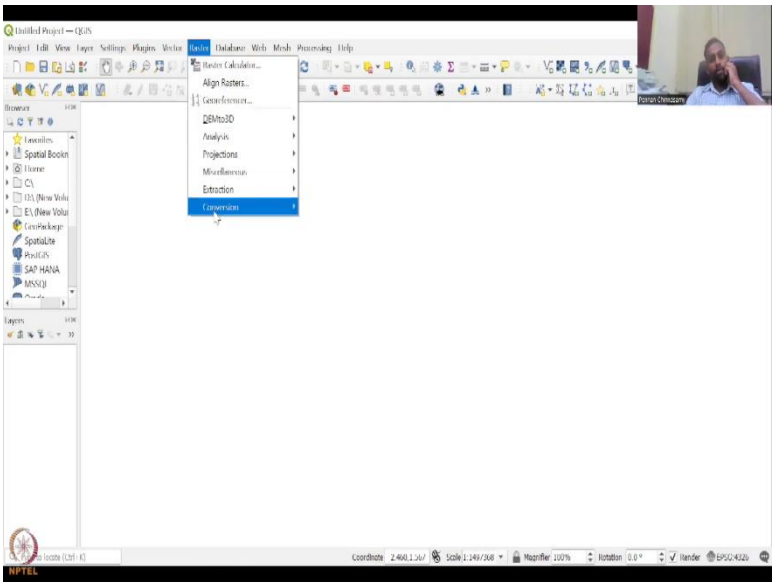

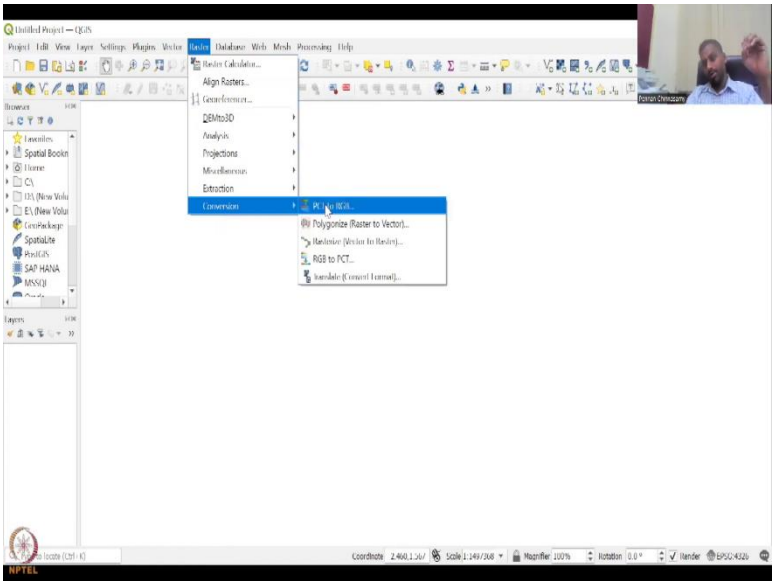

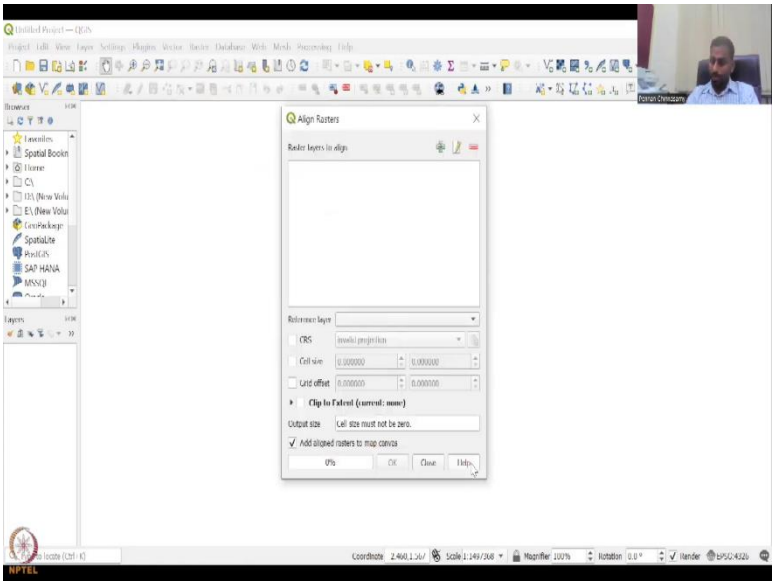

So, you have the GIS open blank window, an empty project. And in that project, you have raster just click on the raster tool bar on the top. And then if you had come down you have multiple data sets and these data sets are important for tool sets. These tool sets are important for our particular Rural Development cases of which we will look at some specific cases in the later sections.

Here what you see here is as an example, we can click one and then the help command I have shown how to use the help command. So, this is where you will be losing there is a database manager if you have a database and then there are a lot of datasets that you use you add using the add raster layer button. So the add raster layer button is also on the toolbar.

It is below the main toolbar and it can add raster and mesh layer or even create new raster sets. What we will be doing now is let us go one by one in today's lecture and see some of the data sets, tool sets that we will be using. So, let us go back to the presentation window that we have wherein we have the PowerPoint presentation.

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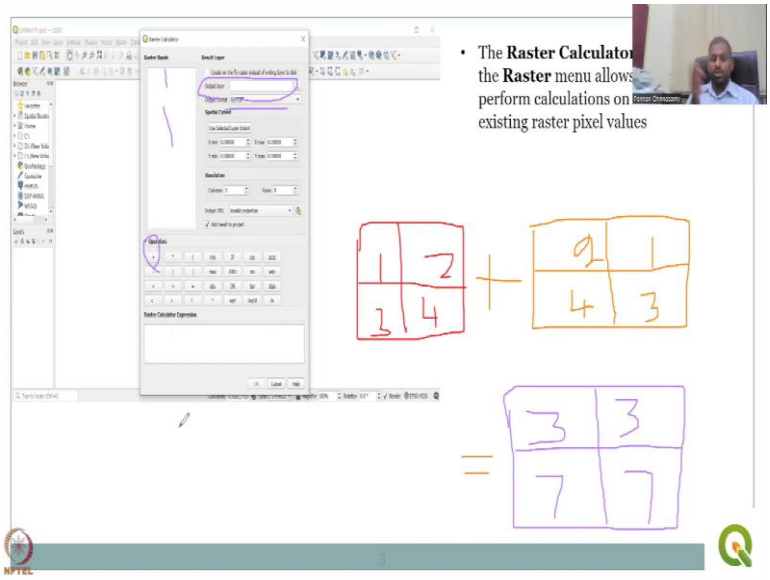

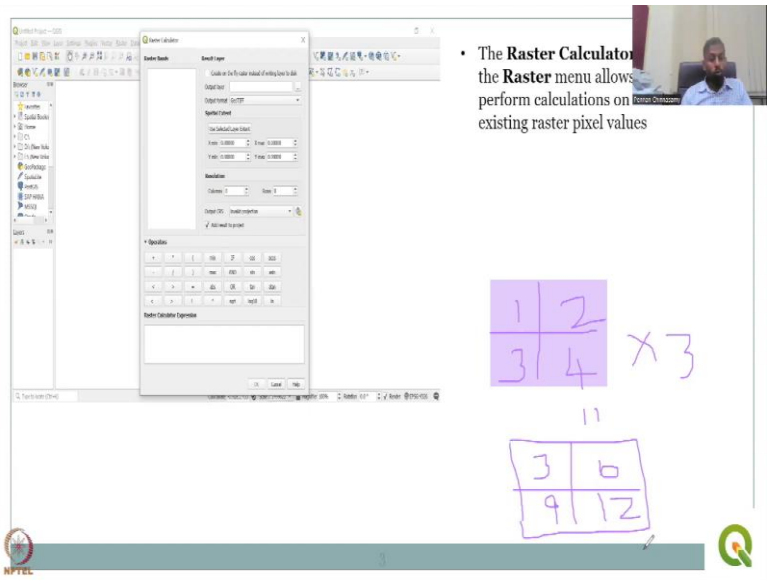

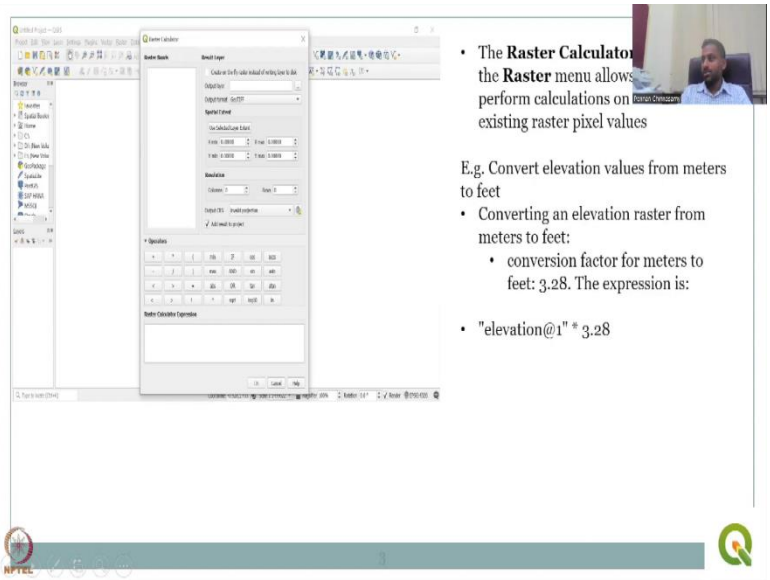

The first data tool set is the raster calculator as the name suggests, this is a calculator that is used to calculate using raster as a object. So, in a normal calculator what do you use, you use numbers. So, 5 plus 4 is equal to 9, here 5 is an object, 4 as an object, plus is an operator you use the operator and then you make the result. In a raster calculator instead of numbers you use the raster itself.

So, a raster plus b raster is equal to c raster the plus is the operator as you could see here there is a column of operators pointer. So, you can see that there is a lot of operators and you have the bands that can come in here you can add subtract each band as needed. I will not show examples because that takes time to run and stuff we will just introduce the tools we will have hands on tool display in the following lectures.

So, what does this tool do? So, before that a small hint for those who are learning software's you can use a book or a tutorial to learn software by keying in specific steps. You can also learn it by just playing with the software like just adding two layers, subtracting two layers etcetera. These are not coded heavily you already have the codes embedded in the system, all you have to do is bring the objects use the operators and then get the output the output can be stored in the computer or you could store it as a fly data on your model.

So, let us look at the first aspect the raster calculator it is in the raster menu as you could see and allows you to perform calculations on the basis of existing raster pixel values. So, when I said a plus b is equal to c, let us draw this function. So a raster is having 4 pixels, let us say values are 1, 2, 3 and 4, whereas your b raster can have I have to change the colour. So Let us change it to orange assuming these are all equal size, and this is 2, 1, 4 and 3 any values can be there, but just we are using it and the operator is plus.

So, now what will happen is the resultant pixel value would be only calculated based on the same pixel location for example, 1 and 2 are in the same location. So, 1 plus 2 is 3. So, this will take 3, 2 plus 1 is 3, 3 plus 4 is 7 and 4 plus 3 is 7. So, now we have added two layers based on the numbers that are interchanged and but in a pixel which is same as the other pixels. So two layers are there this pixel and this pixel at the same location, but different values and the values we are adding.

So, the resultant is what comes here in the output layer and the format is geotiff. So, the two layers can come here and you have an operator which is plus the operators can be complex by

using a equation such as a plus b plus c is equal to d. So, we do not have to keep it simple we can also make it complex by putting in brackets divisions, multiplications, anything.

So, please understand that depending on the model and the data set that you use, you can have it much complex or very simple and also the excel, the value of the pixel need not be just multiplied with another pixel. You can have one common value denominator applied across. So, for example, in the previous model you had let me draw it again a different example in this box you have 1, 2, 3, 4. So, in this raster you had 4 pixels values 1, 2, 3, 4. Now, this can also be multiplied by a common denominator which is 3, any value can be used. So, just example I am giving, so the resultant would be 3 times 1 is 3, 2 times 3 is 6, 3 times 3 is 9, 4 times 3 is 12.

So, now, you could see that a simple raster calculator can be used to multiply raster between the raster or just one common value and multiply the raster well this will be important that is in rural development cases we will discuss that in the case study scenario. So, moving on, these are just the introduction of the raster tools then we have an example given in the manual itself convert elevation values from meters to feet, we know that from meters to feet, we need to multiply it by 3.28.

So, the equation that comes in the Raster Calculator equation box is elevation which is the raster band times 3.28. So elevation add 1 is the raster name the name of the raster that times 3.28 gives you the meters to feet conversion. So, this is very important for doing multiple values and changing the values into different aspects because what happens is normally we get data in a particular unit as I said in the initial part of the Rural Development cases, we will get in a different unit however, we will have to make it in a same scenario and that same scenario is only possible if we use excuse me, if we use a particular unit.

So, the unit is important and we will have to apply the same unit across we cannot we cannot have multiple different units and then crash the model you need to have the unit and that normalization happens by multiplying a common value to convert one unit to the other all units can be made as the same unit by using arithmetic operations.

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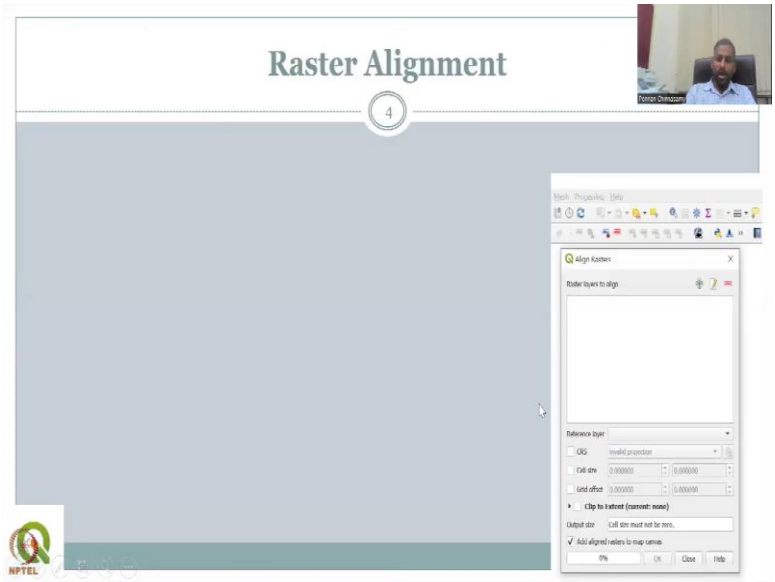

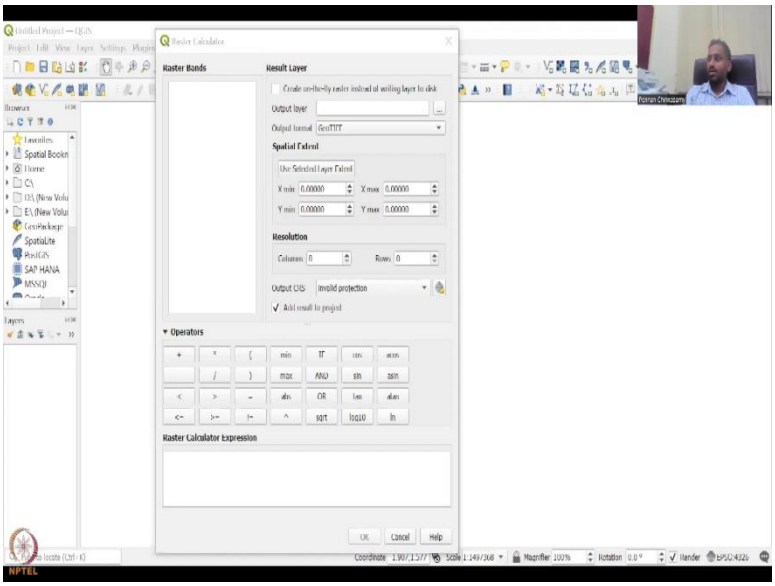

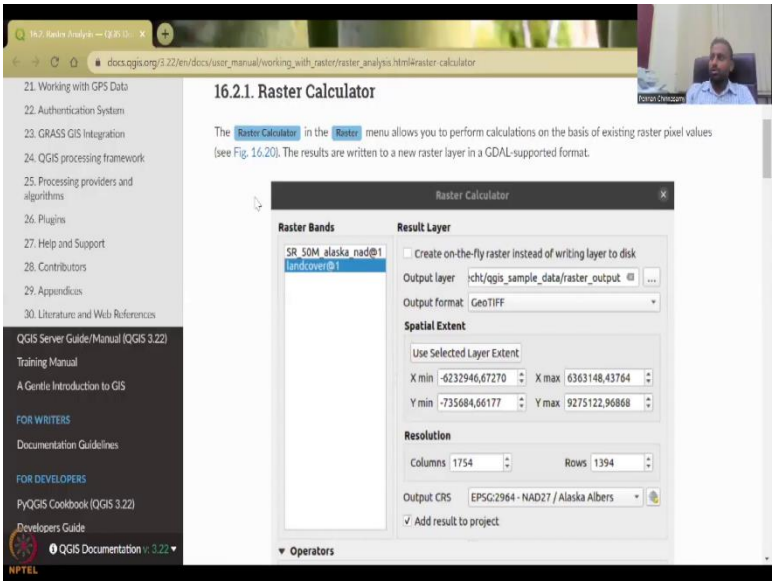

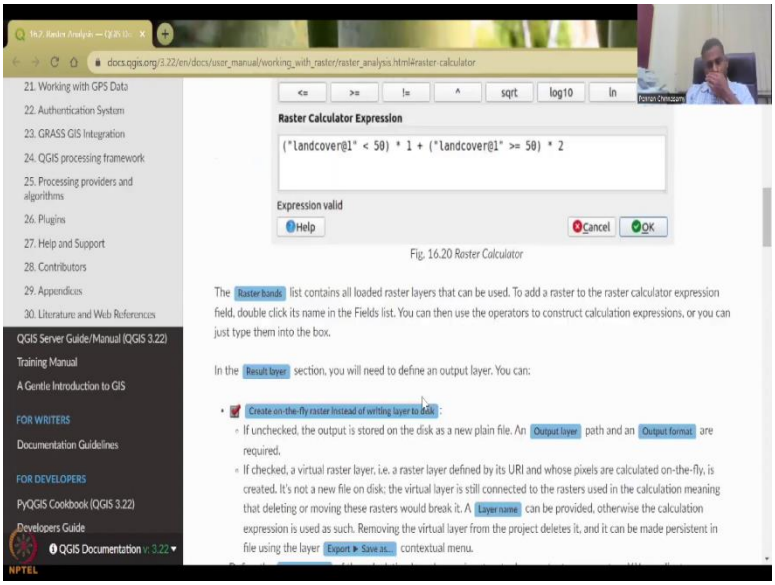

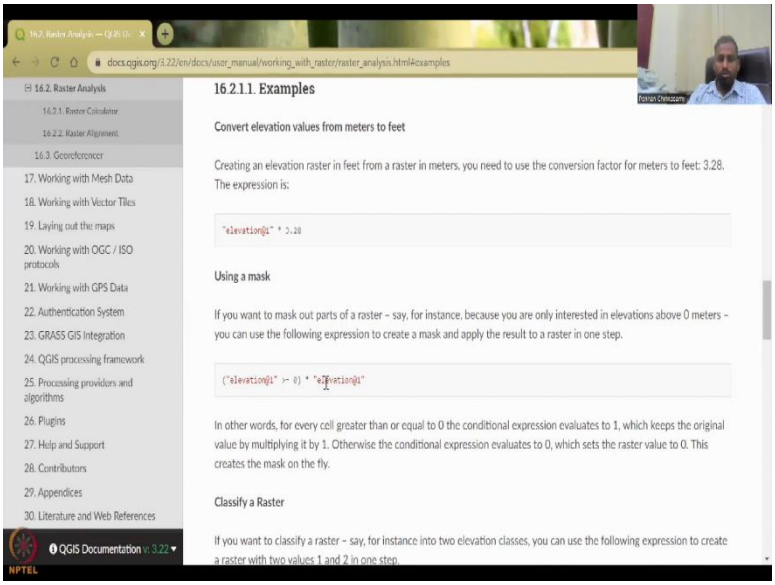

So, moving on, we will now look at how the tool is in the GIS portal. Let me open it. So we are here in the GIS portal, we can definitely open the raster calculator. As I said, the raster bands, the input bands would come here, you can create on the fly of the raster, or you can do output layer where you want to store all these were discussed in the previous class. And if you need a help just click the help bar it will go into a new tab which will open now see where it is opening and I have to share.

So now you could see that the raster calculator help tool has come up and you can use it along where you will have to so they also give you some data to play with and examples using a mask how you can do classifying a raster the multiple aspects, algorithms that you can use and the forum will help you definitely for understanding where the raster is. So moving on. Let us go back to our presentation.

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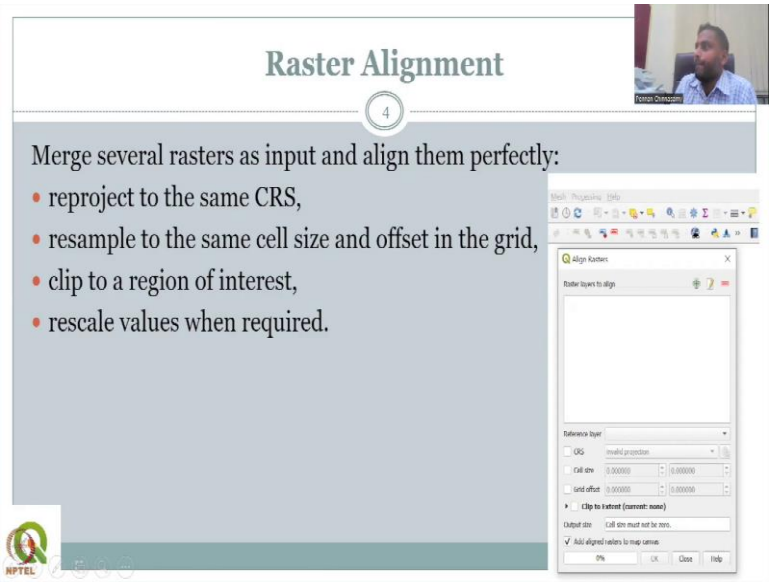

So the next tool we will be looking at today is the raster alignment. What is special about this so you could see that it looks like raster layers to align. So, you may have different raster's present in the data format or for your rural development, the objective let us say you are doing a agricultural based assessment, you need rainfall, soil type, crop type, groundwater levels, etcetera as raster.

So, all need to be aligned. So what it mean aligned is you each one could be in a different projection. So let us first define what we are going to do in the raster alignment, merge several rasters as input and align them perfectly. So one raster could be here, one raster could be here because this is using a different coordinate system and reference system and if you bring it together, this is this for example, if for this, this is a 0 for this raster, this is a 0.

We are going to merge the 0 together and then align them so that all raster's can be used for the same location. Reproject to the same coordinate reference system CRS because as I said, a satellite can take in a different coordinate system, it need not coincide with the same coordinate system that this satellite is using. Then resample to the same cell size and offset in the grid, each raster has a pixel value there is a value but I also said there is a spatial resolution.

For example, this raster one has a cell size of 100 by 100 kilometre like this, whereas the landsat data can have 30 by 30-meter resolution, how do you merge them? How do you bring them to the same panel? That is by doing resampling? Resample is a good tool for rural

development where you have multiple datasets in different cell size, but you can bring them to a same level, same cell size by using the align tool.

So you could see here, there is a button called CRS, what do you want to do with the layer that is what it is asking let me bring my pointer. So it says you put all the input layers here, then what you do is you can create a reference layer or you can say that bring them all to the same CRS wherein they are scattered now bring them all to the same coordinate reference system so that they can align each other.

For example, Chennai here in one coordinate system is far away, or compared to another coordinate system, or the size of Chennai is different here and there because of the coordinate reference system. However, we know in reality, there is only one Chennai location. So for that Chennai location, you are going to bring all the layers together so that they merge, once they merge, you can do calculations on them.

So the raster calculator can come after you align the raster. So the first part here is you will be looking at resample to the sample, same size, cell size and offset in the grid. So here is where you have the cell size and grid offset. So the cell size is very important. You can give numeric value for the cell size for the x and y so that you have the same cell size across.

You can also do a clip to a region of interest. Let us say for example, you are downloading data that the data I download is for the India scale. You cannot download the India's scale or use the India study scale for a small district, Let us say Pune. So for Pune, you need to remove all the other data which is too heavy on the system and on the database and only use the Pune district data.

So for that you need to clip, clip is a tool that will go to see where you have the entire data set, but you only take one data set that you want for the region and the others are thrown away. Those are discarded because we do not want to use them we do not want to use them. So just use a clip to a region of interest. Rescale values when required, as we showed in the previous example, suppose one is in a in a different unit and the other is in a different unit you can rescale.

So you know how this the cell size can be changed. If the cell size can be changed. You can also scale up and down the values when required. So kind of multiplying with one on the other. So let us look at how this tool is on the platform.

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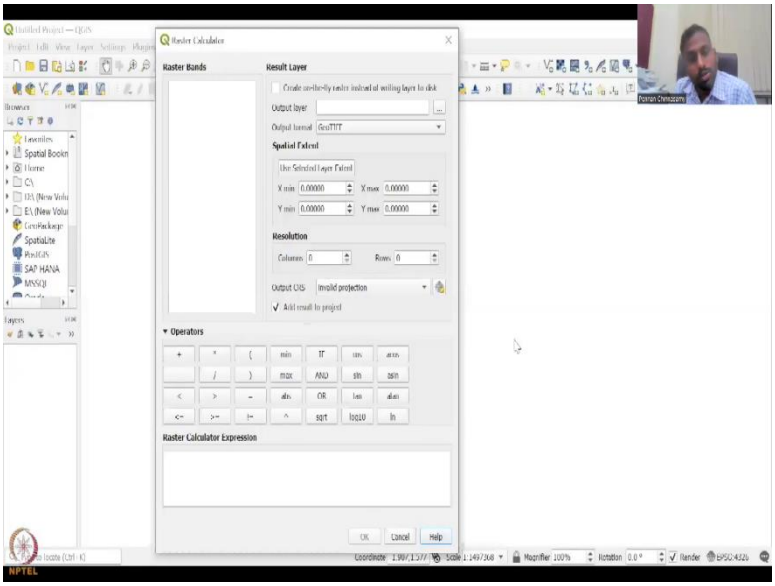

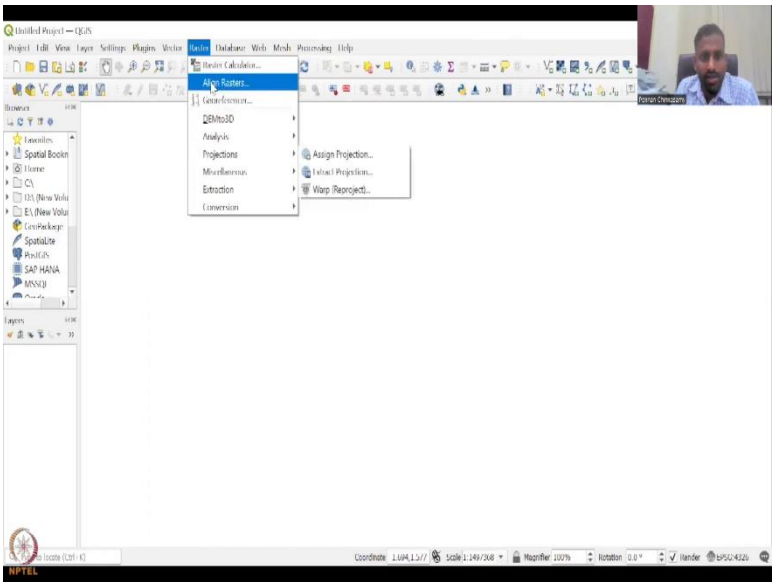

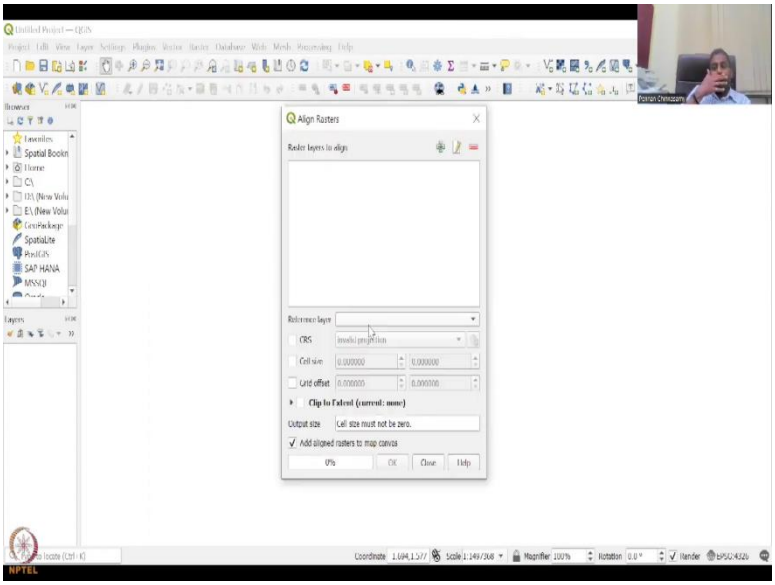

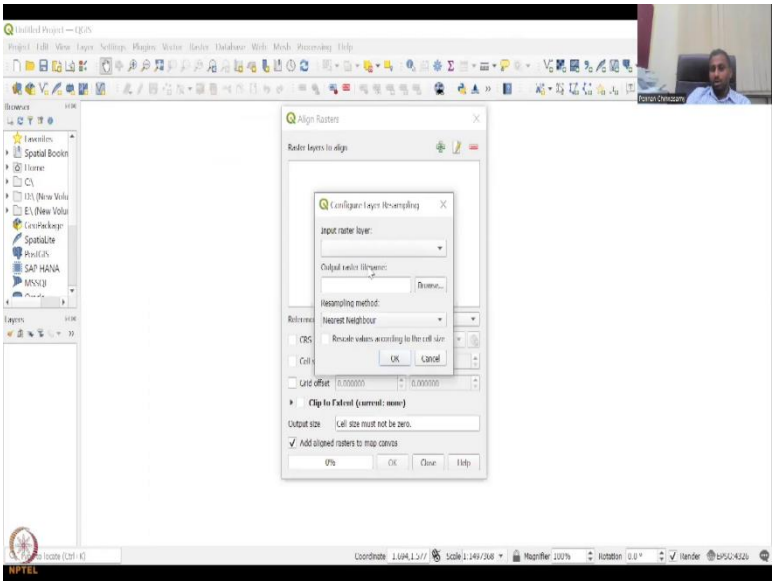

So you can see here, I am going to close this, use raster, and where do you find it, it is here, you do not have a thumbnail, like you have a raster calculator and geo referencer, but we will use it. geo referencer is very important. We will use it extensively in one week, I will show you why it is very important for rural development. Especially the maps are outdated, we will update those maps.

So, aligned raster is this you can add data supplied the data based on your interest, since we do not have any layers here, it is not showing as positive. But once you add it, then it will auto populate with the raster image. So, what happens here is you have an opportunity to look at different datasets and make them in a same singular fashion.

This is important, because sometimes what happens is, we tend to have only one estimate of the data. We do not use multiple datasets, or we do not see multiple data sets for a single property, let us say groundwater, we only look at groundwater. However, we know that groundwater can be a function of rainfall land view crop type, etcetera. So in that case, what we have to do is we will have to merge some understanding from the other data sets so that we have an overall picture. So, let us see, in general terms, how a data set can look like in real time world.

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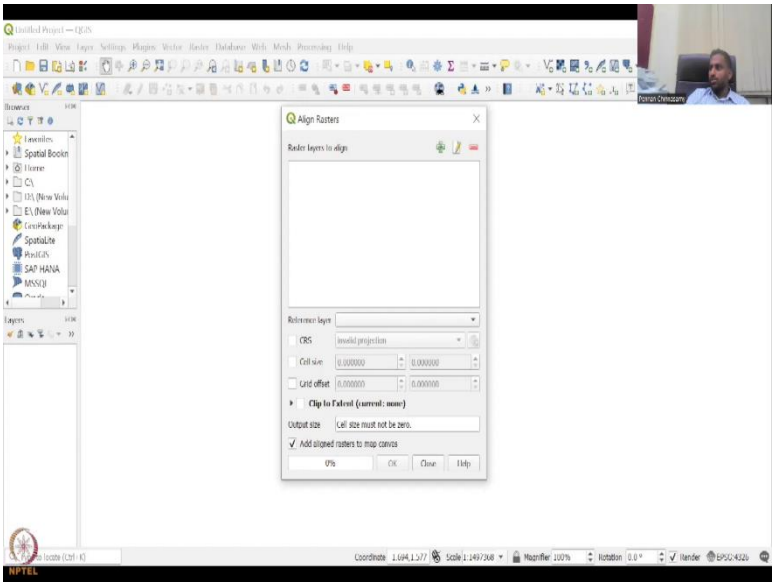

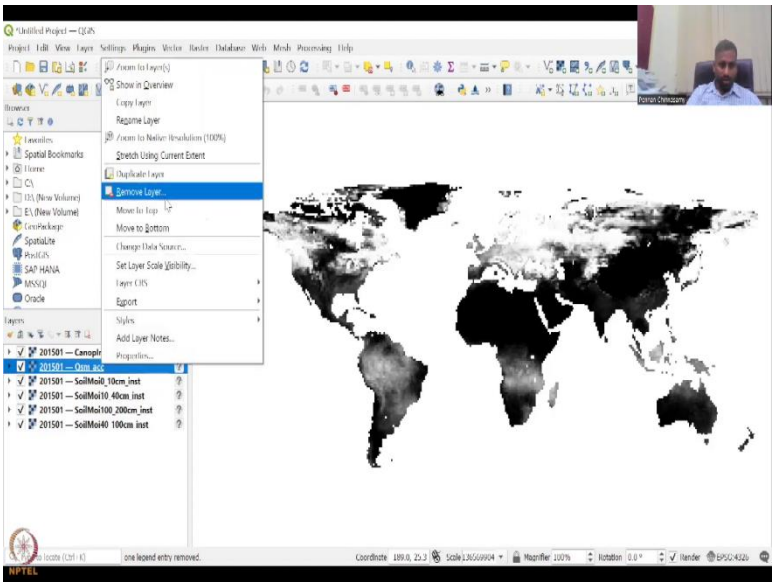

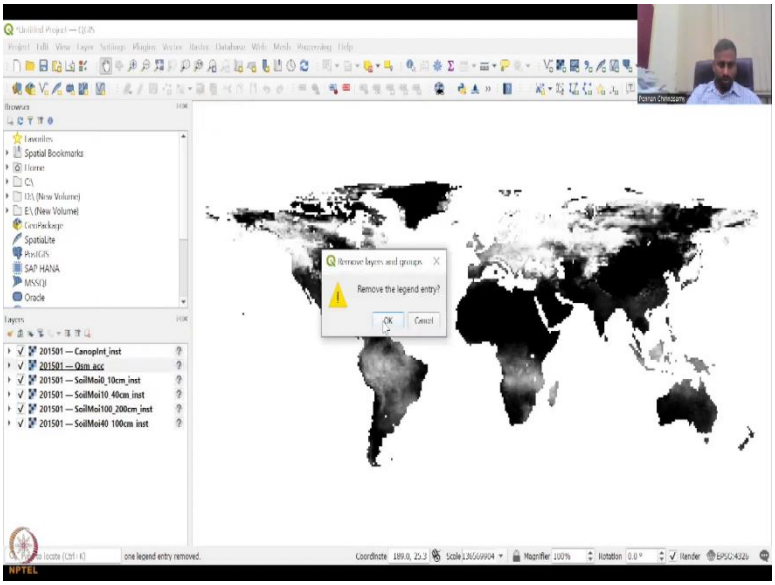

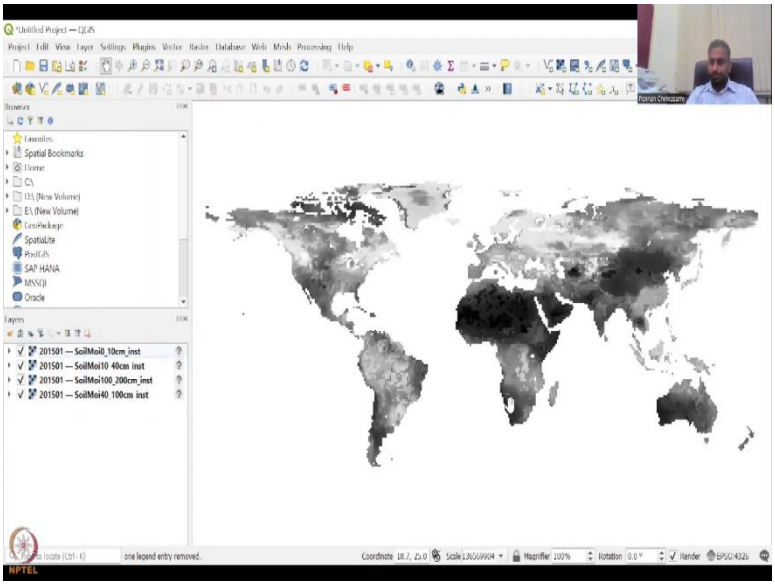
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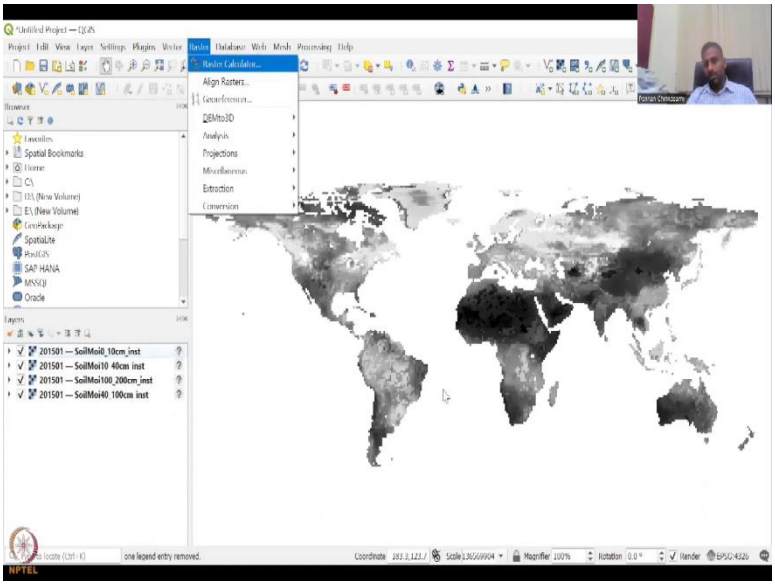
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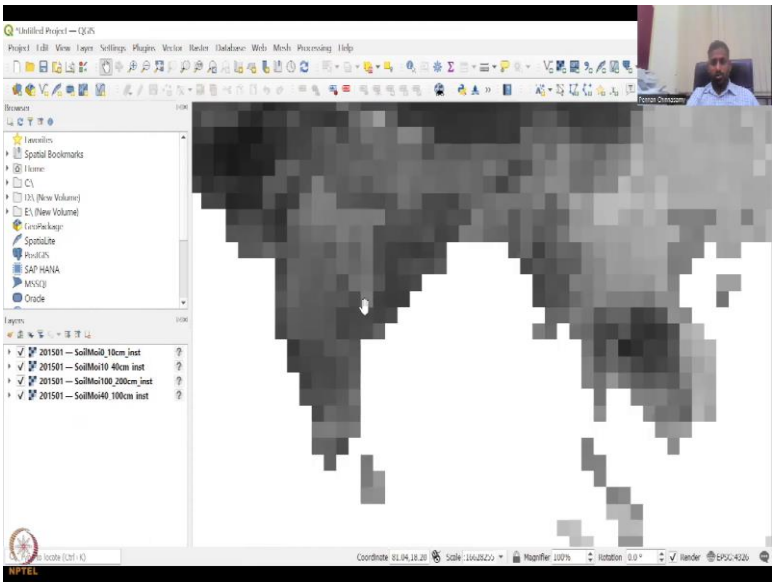
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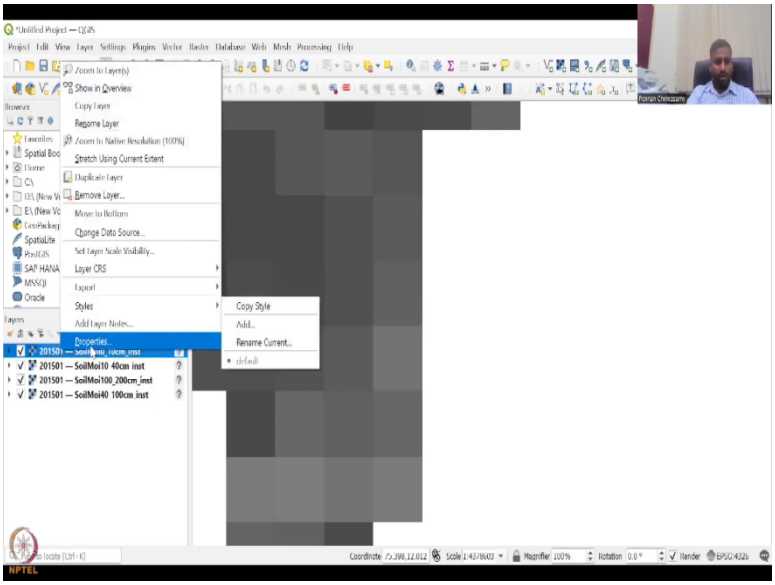
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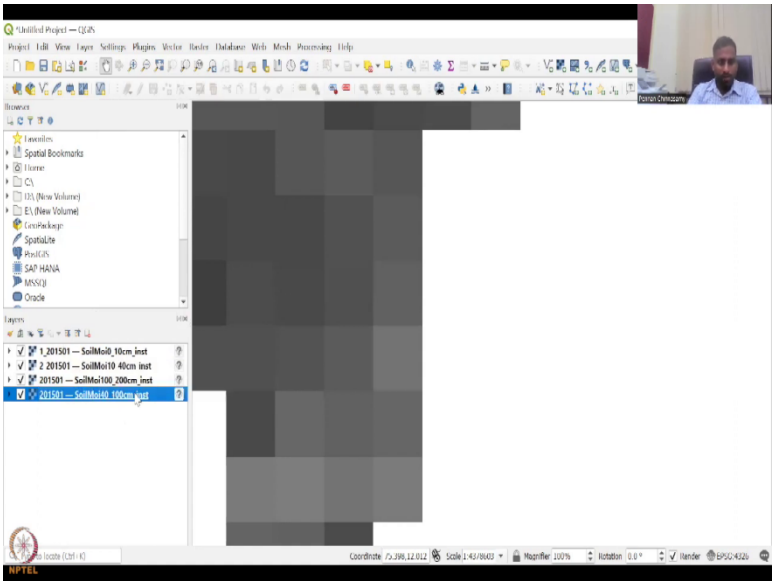
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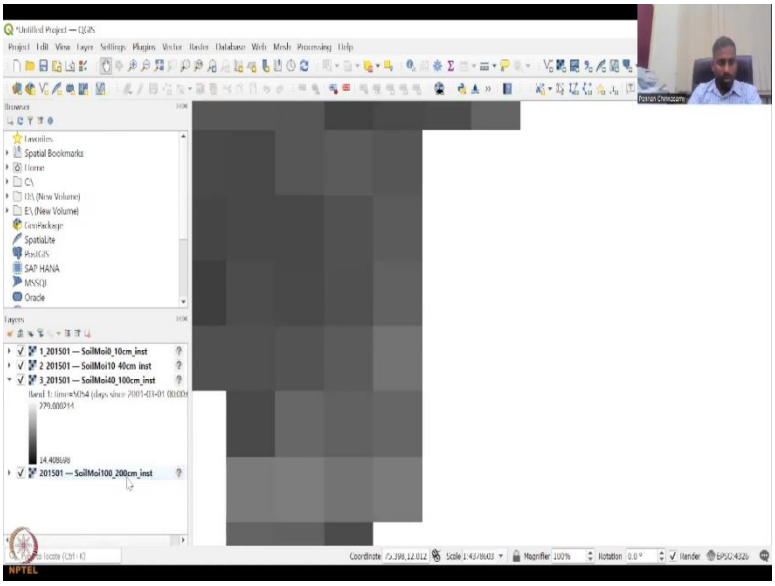
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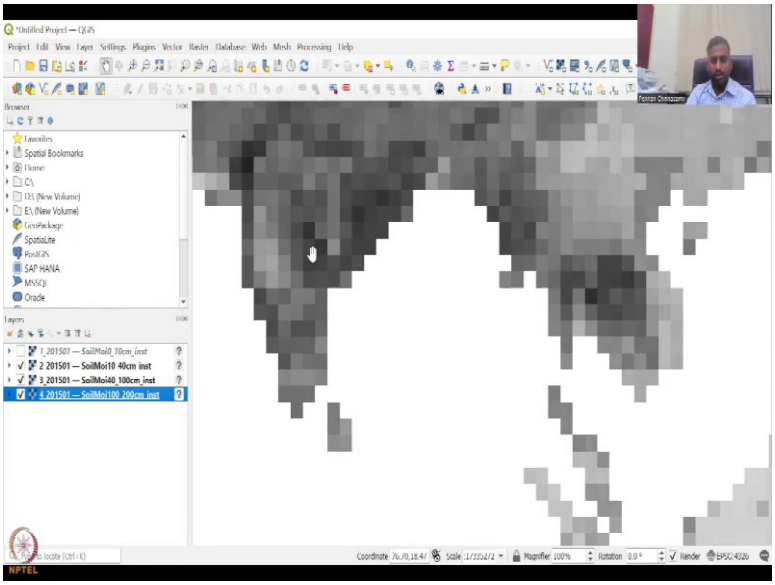
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3_201501 — SoilMoi40_100cm_inst
4 201501 — SoilMoi100 200cm inst
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Rotation 0.0 °
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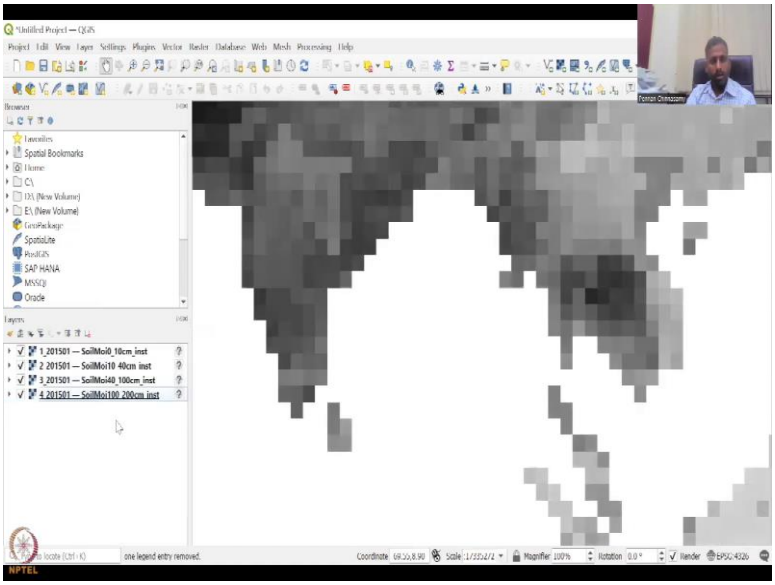
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Magnifier 100%
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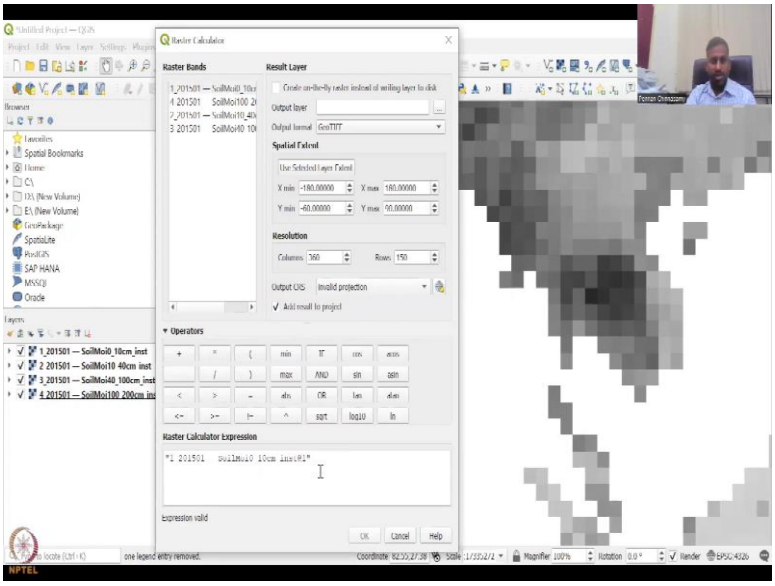
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Raster Calculator
Raster Bands
1_201501 — SoilMoi0_10cr
4 201501 SoilMoi100 2(
2_201501 — SoilMoi10_40
3 201501 SoilMoi40 10(
Result Layer
Create on-the-fly raster instead of writing layer to disk
Output layer
Output format GeoTIFF
Spatial Extent
Use Selected Layer Extent
X min -180.00000
X max 180.00000
Y min -60.00000
Y max 90.00000
Resolution
Columns 360
Rows 150
Output CRS Invalid projection
Add result to project
Operators
+ * (min IF cos acos
/) max AND sin asin
< > - abs OR tan atan
<= >= != ^ sqrt log10 ln
Raster Calculator Expression
"1 201501 SoilMoi0 10cm inst@1"
Expression valid
OK Cancel Help
Layers
1_201501 — SoilMoi0_10cm_inst
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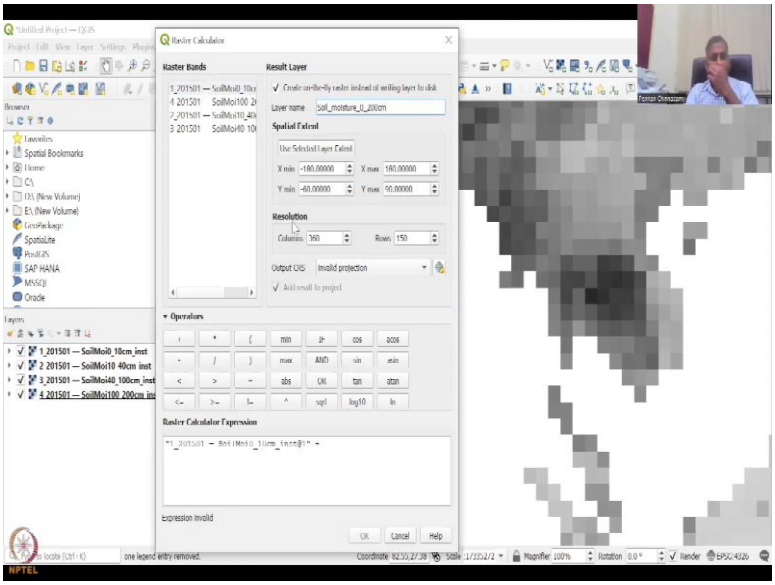
Raster Calculator
Raster Bands
Result Layer
Layer name
Soil_moisture_0_200cm
Spatial Extent
Resolution
Operators
Raster Calculator Expression
Expression invalid
OK
Cancel
Help
Browser
Layers
1_201501 — SoilMoi0_10cm_inst
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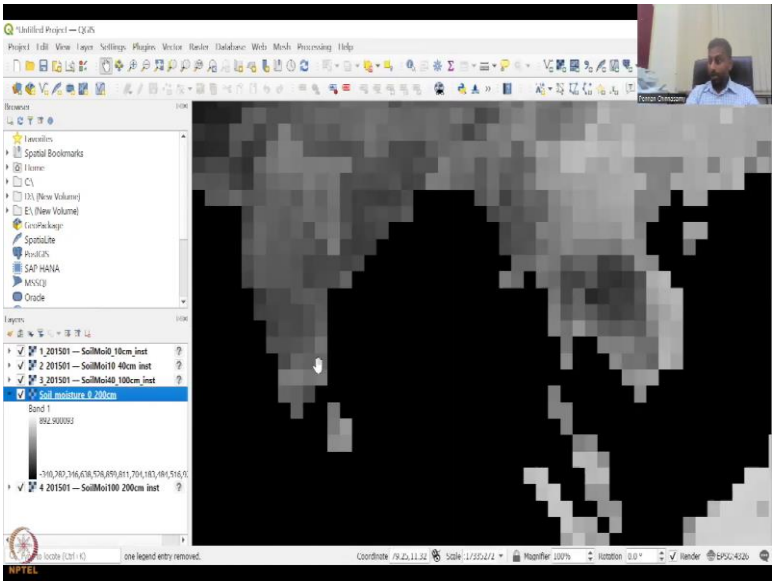
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Soil_moisture_0_200cm
Band 1
892.900093
4_201501 — SoilMoi100_200cm_inst
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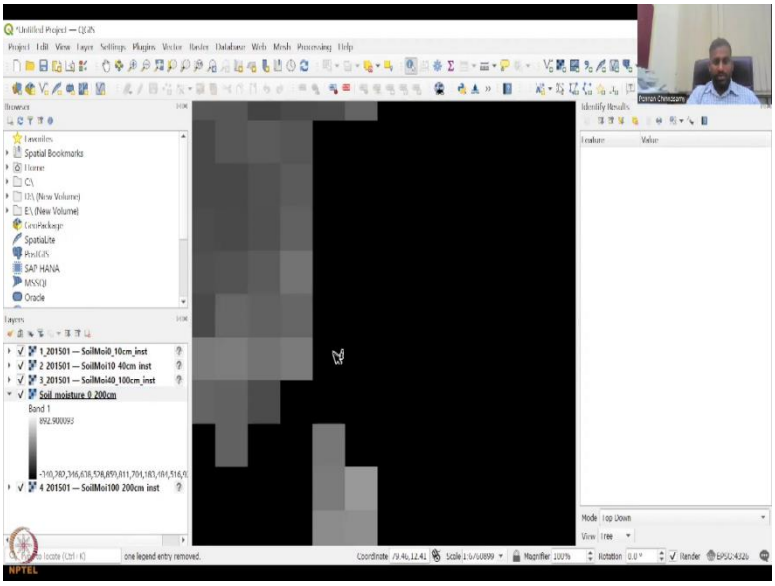
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3_201501 — SoilMoi40_100cm_inst
Soil_moisture_0_200cm
Band 1
892.900093
4_201501 — SoilMoi100_200cm_inst
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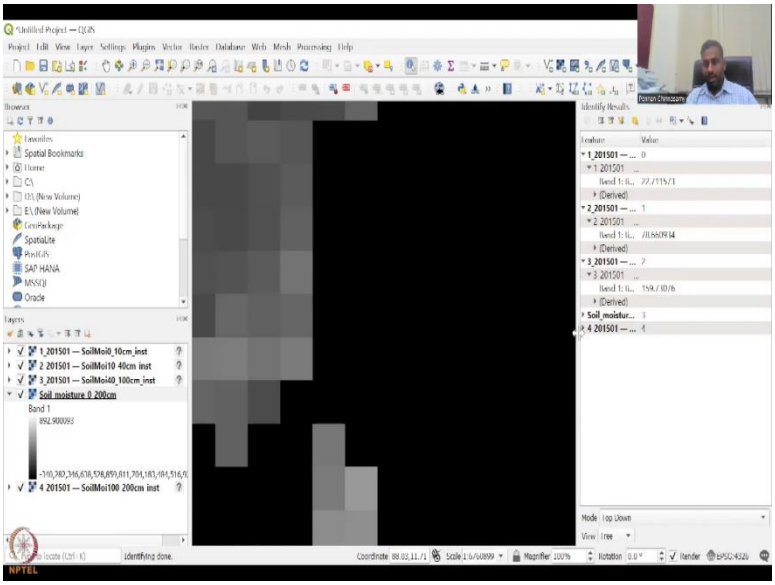
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MSSQL
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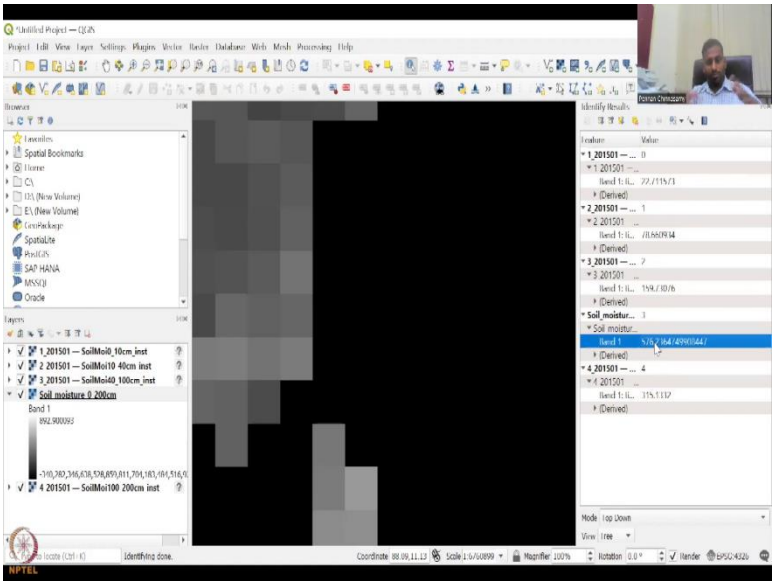
2_201501 — SoilMoi10 40cm inst
3_201501 — SoilMoi40_100cm_inst
Soil moisture 0 200cm
Band 1
892.9000693
-510,280,346,638,926,859,811,704,183,491,516,9
4_201501 — SoilMoi100 200cm inst
Identify Results
Feature
Value
1_201501 — ... 0
1_201501 ...
Band 1: IL... 22.7115173
(Derived)
2_201501 — ... 1
2_201501 ...
Band 1: IL... 70.5607814
(Derived)
3_201501 — ... 2
3_201501 ...
Band 1: IL... 159.7187076
(Derived)
Soil_moistur... 3
4_201501 — ... 4
Mode Top Down
View Tree
Identifying done.
Coordinate 88.02,11.71
Scale 1:9,150899
Magnifier 100%
Rotation 0.0 °
Render
EPSG:4326
NPTEL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3_201501 — SoilMoi40_100cm_inst
Soil moisture 0 200cm
Band 1
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-510,280,346,638,926,859,811,704,183,491,516,9
4_201501 — SoilMoi100 200cm inst
Identify Results
Feature
Value
1_201501 — ... 0
1_201501 ...
Band 1: IL... 22.7115173
(Derived)
2_201501 — ... 1
2_201501 ...
Band 1: IL... 70.5607814
(Derived)
3_201501 — ... 2
3_201501 ...
Band 1: IL... 159.7187076
(Derived)
Soil_moistur... 3
Soil moistur...
Band 1
(Derived)
4_201501 — ... 4
4_201501 ...
Band 1: IL... 315.1137
(Derived)
Mode Top Down
View Tree
Identifying done.
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Scale 1:9,150899
Magnifier 100%
Rotation 0.0 °
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EPSG:4326
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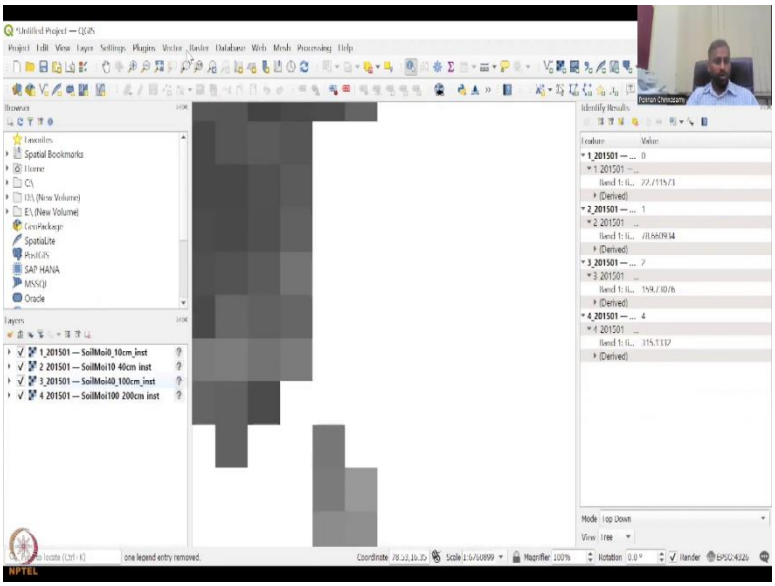
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4_201501 — SoilMoi100 200cm inst
Identify Results
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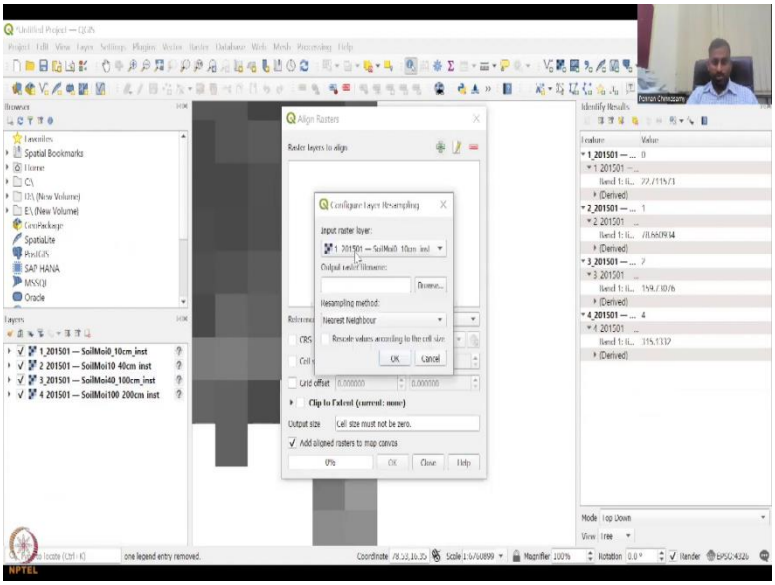
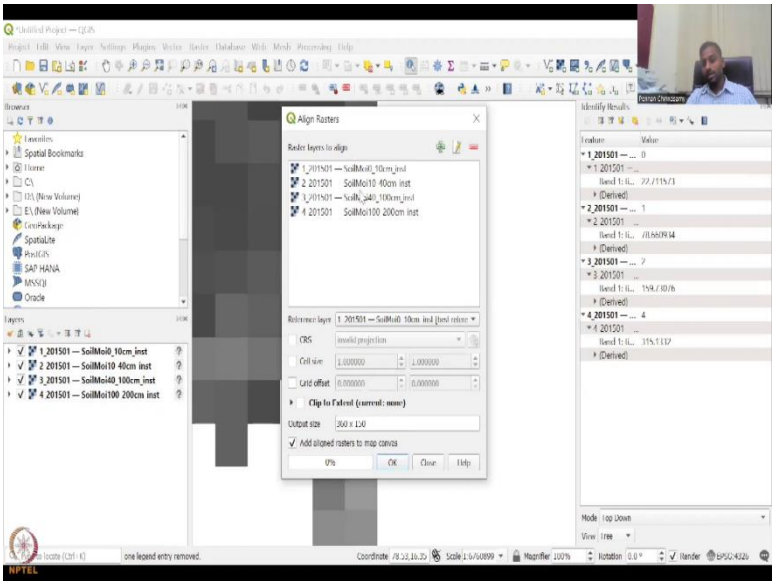
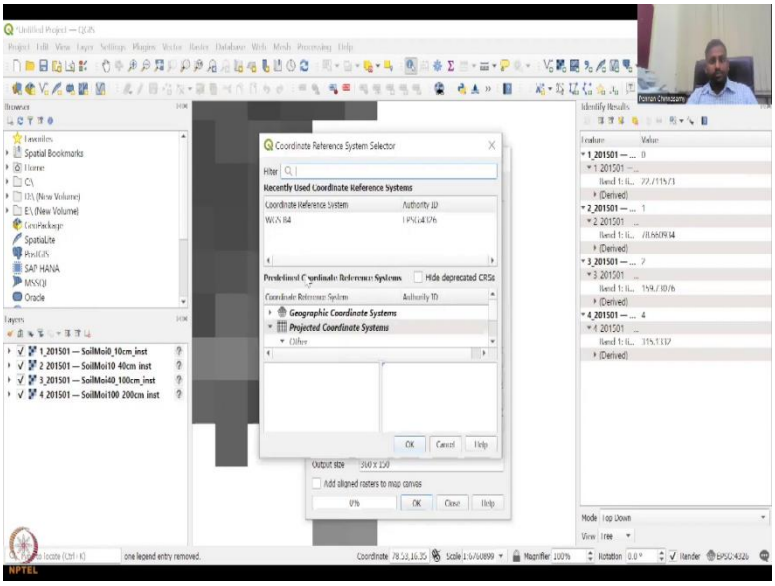
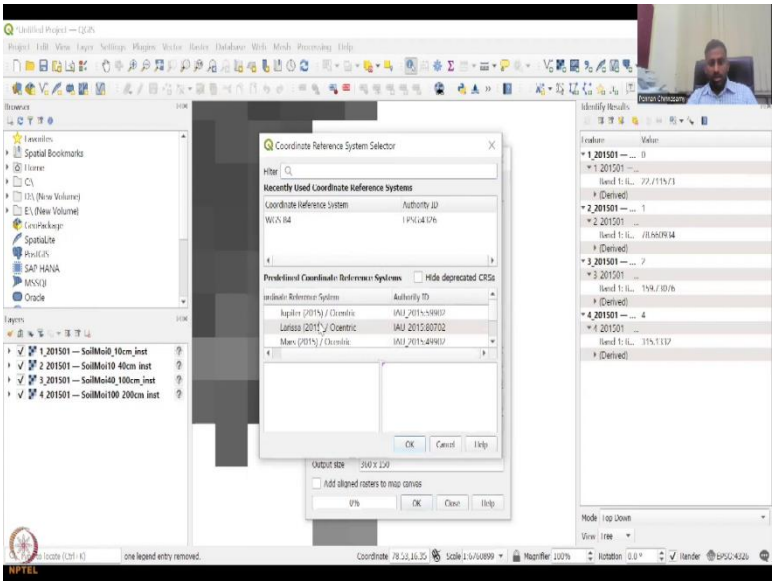
Value
1_201501 — ... 0
1_201501 ...
Band 1: IL... 22.7115173
(Derived)
2_201501 — ... 1
2_201501 ...
Band 1: IL... 70.5607814
(Derived)
3_201501 — ... 2
3_201501 ...
Band 1: IL... 159.7187076
(Derived)
4_201501 — ... 4
4_201501 ...
Band 1: IL... 315.1137
(Derived)
Mode Top Down
View Tree
one legend entry removed.
Coordinate 78.12,10.25
Scale 1:9,150899
Magnifier 100%
Rotation 0.0 °
Render
EPSG:4326
NPTEL


Align Rasters
Configure Layer Resampling
Resampling method:
Nearest Neighbour
Output size
Cell size must not be zero.
Add aligned rasters to map canvas
NPTEL


Align Rasters
Output size
360 x 150
Add aligned rasters to map canvas
NPTEL


Coordinate Reference System Selector
Recently Used Coordinate Reference Systems
Predefined Coordinate Reference Systems
Geographic Coordinate Systems
Projected Coordinate Systems
Add aligned rasters to map canvas
NPTEL


Coordinate Reference System Selector
Recently Used Coordinate Reference Systems
Predefined Coordinate Reference Systems
Hide deprecated CRSs
OK
Cancel
Help
Add aligned rasters to map canvas
Close
1_201501 — SoilMoi0_10cm_inst
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3_201501 — SoilMoi40_100cm_inst
4_201501 — SoilMoi100 200cm inst
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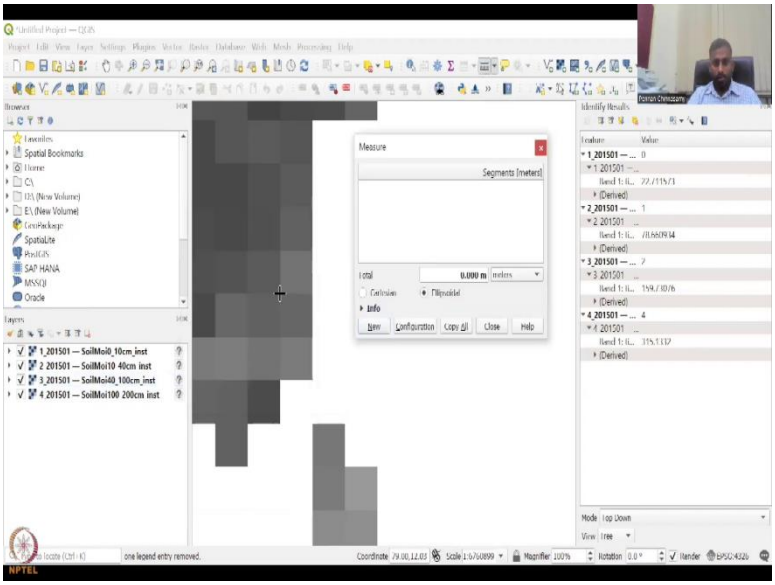
Measure
Segments (meters)
Total
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Cartesian
Ellipsoidal
Info
New
Configuration
Copy All
Close
Help
1_201501 — SoilMoi0_10cm_inst
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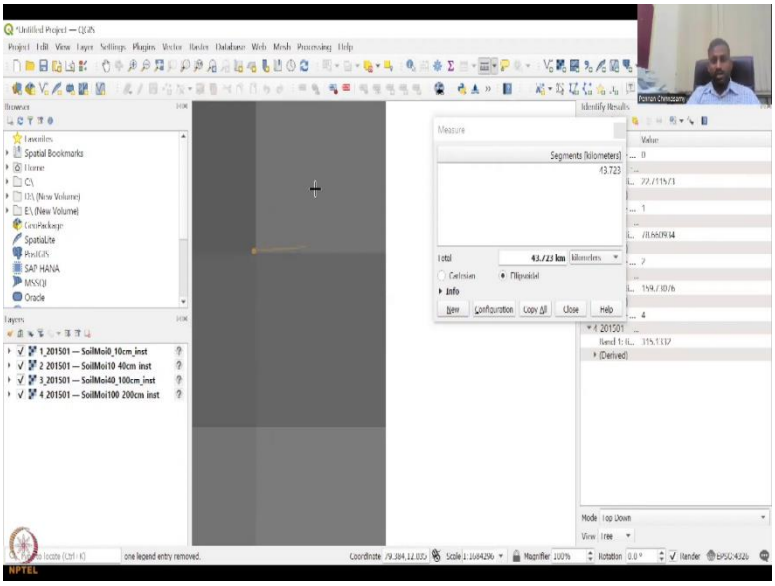
Measure
Segments (kilometers)
43.723
Total
43.723 km
kilometers
Cartesian
Ellipsoidal
Info
New
Configuration
Copy All
Close
Help
1_201501 — SoilMoi0_10cm_inst
2_201501 — SoilMoi10 40cm inst
3_201501 — SoilMoi40_100cm_inst
4_201501 — SoilMoi100 200cm inst
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NPTEL

So, I am going to share the screen with some data that I have downloaded. You can see here there are there is a data set for, I just added these data. So you have time bands, we can remove that right click remove a layer. And then you have soil moisture. So basically what layers I have added, I have added soil moisture from 0 to 10 centimetres, 10 to 40 centimetres, 100 to 200 centimetres, and then there is another is 4200. So, 4200 comes here.

So basically from 0 to 200 centimetres, you can assess the soil moisture, why is this important? When you are growing crops you need to understand how much water is there in the soil, if the soil level is less water level is less you will have to supply more water. So, it is very important for agricultural water management to rural infrastructures to know what is the status of soil moisture.

So, we will also remove the other layers for now, let us just keep these layers. And as I said, let us first look at this a calculator. I am going to say that I am going to add, I need the net soil moisture which is available across the region let us zoom in so I want to zoom in to Tamil Nadu region. You can re-label it as 0, 1, 2, 3. But yes, let us do that.

So that we can have quickly one. 1 underscore 0 to 10. And then we have 10 to 40. Then we have 10 to 40 and then we have 4200. And then let us pull it up 1, 2, 3 and then 4 just for additions I am going to show. So, now all these layers are there. As anyone who knows GIS have been using you know that the top layer is what is visible.

If you remove it, the colouring changes if you remove it again, again and again. So all the maps are gone. So, I can have all the layers turned on. And I have clicked the raster calculator. For the first example, let us 1, 2, 3, 4 is there so I am going to click 1. So, 1, if I double click, it populates the raster calculation expression, then I said I am going to add, I am going to add to the layer.

So, the output layer is going to be called soil moisture. Always use underscores for names. Space is not a good way of naming in GIS, 0 to 400 centimetres, 400 centimetres. Use Selected Layer extends. So this is the whole globe so let us use the whole globe. You could see I am only focusing here, but we can remove that later. So, number 1, plus 0 to 10 plus 10 to 20, 10 to 40. So I am going to click and double click it comes.

So if you double click the equation already comes the variable comes in with the double quotations and stuff. So that name has been this way you see the whole name. Otherwise, you

can just have a simple name for it. Then you are going to add again. So you are going to add, you can put 3 and then you went to add again and say 4.

So, now you have 1, 2, 3, 4 plus, is the expression valid? Yes, it says the expression is valid, the total soil moisture is 0 to 200 centimetres, and projection, do not worry about it. Now, you can keep the one which is there on the projection, say ok, and it is populated. So how do we know how we have done, we can use this click button, the identified button, and you can click one pixel, just one pixel. And that one pixel I clicked has a value.

So that value is going to be extracted now in the right hand corner, if you click the right hand corner, you can see the values of band 1, which is what it is it says 22 point. So the decimals just leave it for now. It is a long number. So, 1, 2, 3 you have band is 159. And then 4 is 300. So 315, we are just going to an average 315. Or we can use the calculator also, looks like my calculator is not coming on the screen, but I will keep it on the side.

So I am just going to add 22 plus the next value is 78 plus 159 plus 315. Neglecting the decimals for now, for time consideration. So is around 574, around 574 is the total. So what are we getting here. So this same pixel should have the same number. So exactly 574, 575, 576 is because of the decimals. So, you see how we have summed 4 raster's into 1 and now we have labelled it as 0 to 400 centimetres.

So, that is how you will be using the raster calculator. You can multiply, subtract, add, add variables, etcetera. So, you can see visibly 22.7, 78.6, 159.7, 315.1 add all of that is 576. Good. So let me remove the total moisture now. I do not want it so let me remove it. So, this is one tool that we have seen today.

The other tool is the align raster's. And then as I said, you could align all of them into the same. Now if you click the plus button, you will see that okay, this can come you want to rescale the values or just add the values, we just add. So there you go, you got added. So just click on add, I want a second. So just input layer, because input is already here. You can just click input layer number 2, it will input number 3, let us go on do that for all the four. And then further.

So, now raster layers to align, eventually all are aligned in the same coordinate size. And the cell size is also going to be the same. How do you know, you can use a scale. So, the scale

two is there just click. Let us say okay, or add a line passes to the canvas. So if it is already aligned, it cannot be aligned again.

So, cell size is also the same, but we are going to change the cell size to now is 1.00. So let us say I want to change it to 0.5 also can be done 0.5. So this is how you could click what you want to change. Or let us say, I am going to change all of them to a different coordinate system. So, you can say, different coordinate systems there are multiple coordinate systems, let, us say Larissa, and say okay.

So all of these are going to be aligned to a different coordinate system add aligned assets to the map canvas, because we have already settled them in our database when not copied it is not going to do. So, this is how you would use align last raster's, you would bring it to the map, and then you would align them or change the cell size, etcetera.

How do you know the cell size, as I said, you can use the scale button here, click 1, click 2 you have in meters the value, as I said it is 1, 1 degree. So, 1 degree, approximately 100 kilometres. So, let us first set it in kilometres, you can zoom in to see the pixel. So this is the pixel and it is approximately 100 we have to zoom and click on the correct box. Since I am not doing that you have 110, but it is 100. So, all pixels are 100 by 100 kilometres. So with this, I will go back to the slides on doing the projection.

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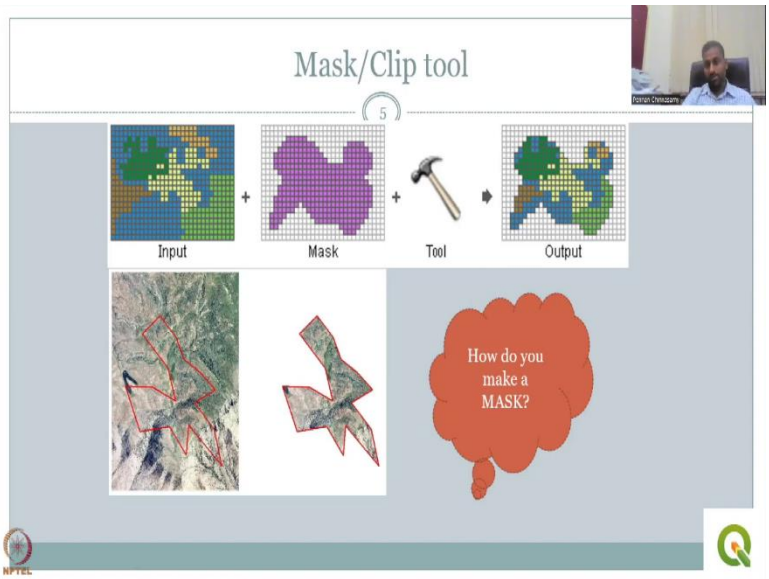

So, we will, we will do the last tool for today, the mask tool. So what is the mask tool, the mask tool is you have an input. So I have showed you in the QGIS layer, the whole globe is

there, but I am going to only focus on India, how do I take only India by using a mask tool, the mask tool will do a clip function.

So, you have a whole layer and then only a small cutter you will use and take it out. And that shape that shape you want is the mask. So you have the input layer A plus the mask layer, which is only B it could be the mask could be raster, it could be a shape file or anything. And then the tool what the tool will do, it will take only the output under the mask and bring it out, thereby reducing the size of the data and the complexities associated. Let us look at an example.

This whole raster is there. But I just want to look at this raster. So I am going to apply a shape file, that the mask shape file is red in colour, it could be a raster or it could be a vector here it is a vector it is a shape file it is a polygon. So the polygon is applied on the top extracted and put out. So, then you have the output.

So, how do you make a mask, that is a vector shape file that you can use and the vector shape files, you can create a new shape file to extract the region that you want. So normally, I would create a new shape file and then draw on the shape file to so that I could make a mask and then take it up it is like making a cookie. So you roll a dough, the dough is the input layer and then you have a cup to cut and take out the shape you want. So the cutting shape is done in a vector shape file database.

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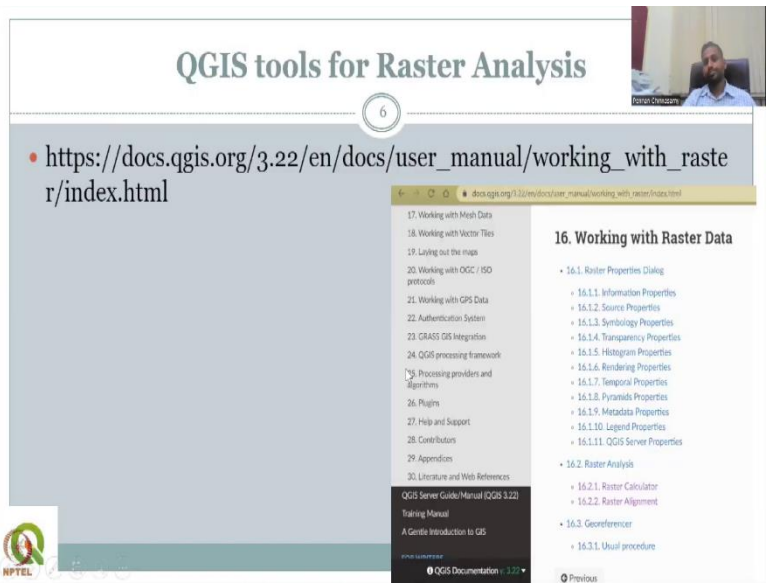

So, I would like you to go ahead and read some more of the documents on using the manual for raster analysis. We will look at this in the next lecture. With this I would conclude today's lecture. Thank you.