Geographic Information Systems
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Lecture - 51
Data Acquisition and Raster Functions

Namaste, welcome you all to NPTEL online certification course on Geographic Information Systems. I am Chandan M. C. I am a Ph.D. student at Ranbir and Chitra Gupta School of Infrastructure Design and Management, IIT Kharagpur. Today, we will be going to see GIS as a software and in particular, we are going to see how to acquire raster data and how to perform various raster functions.

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In this class, we are going to first understand where can we get the raster data from, how to download raster data and then we will just visualize digital elevation model downloaded from USGS EarthExplorer. Following that, we will also see how to perform terrain analysis, such as slope, aspect, hillshade and contour, etc., and then we will see how a raster calculator works. QGIS has inbuilt raster calculator function.

And then we will also see from available point data set, how can we interpolate and the produce a raster image and lastly, we will also see how to clip a raster for our area of interest or it is also famously known as masking.

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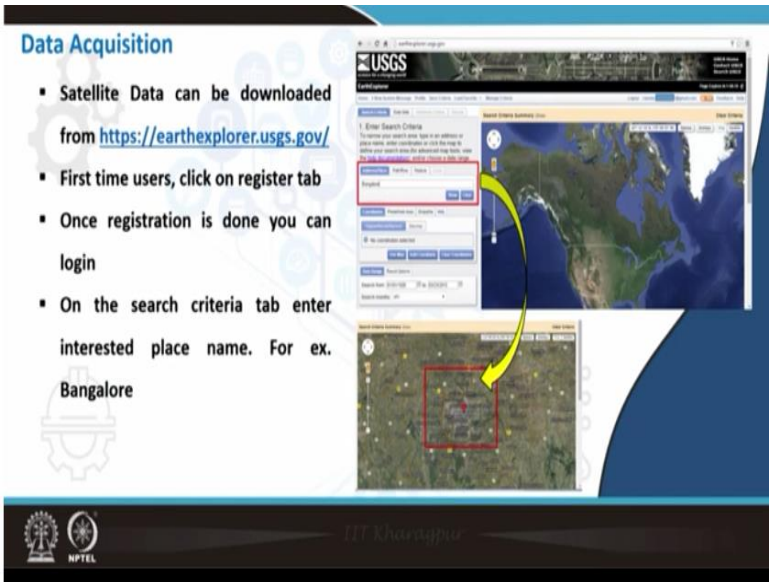

Now when it comes to raster data set, you always have to download anything which is available for free, since larger set of student communities involved in a lot of analysis. We depend on free data sets, which are available. Example for freely available raster data set includes USGS EarthExplorer, wherein it is under the United States Geological Survey and it has a huge repository of satellite imagery.

For example, if you take Landsat; they have Landsat data from 1983 or 85 onwards till date. Similarly, just similar to the USGS, we also have Bhuvan, which will be demonstrated by my colleague Prakash and in Bhuvan, we can also get Indian datasets. First let us see, how USGS EarthExplorer, we can download the datasets from. Before going into USGS, I think you should have registered account in USGS.

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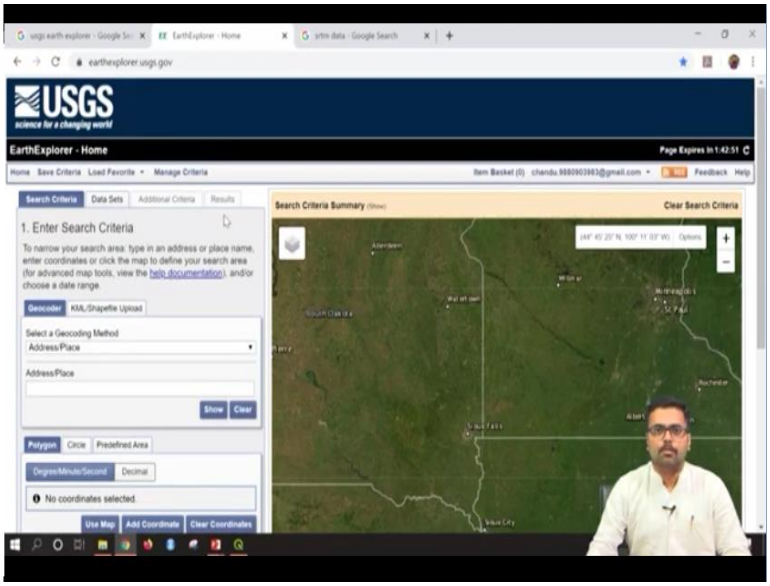

So what you can do is, you can go to Google and here you can search for USGS EarthExplorer. When you search USGS earth explorer, the search result the first search result it will take you to EarthExplorer home. When you click on EarthExplorer home, the window will open something like this. This is nothing but the landing page or home screen of USGS EarthExplorer. Now here, if you have not registered, for example in this window whatever you are seeing, I have been registered. You can also register for this and you will get a one-time password or a verification email. After that, you can directly login to USGS EarthExplorer. So this is the home page.

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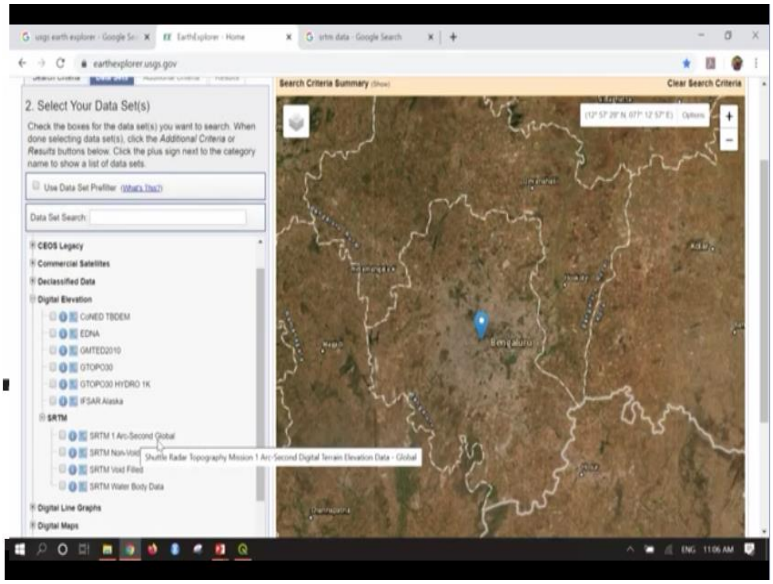

Now the first step is to search a place name. For example, let us say I need data for Bangalore. So I will say Bangalore and then say show. So here you can see it is suggesting address or that

particular place along with the latitude and longitude details. So here if I click on Bengaluru. So it will automatically zoom in to that particular area and now you can see Bengaluru is highlighted. I can just zoom in here. So this is the location Bangalore city.

So now let us say, I need to download SRTM DEM that is nothing but the digital elevation model. So for doing that, first we need to set other details, such as date range. Here what I am going to do is, I will set the date range, as I will set it from the year 2009. For the last 10 years, I am trying to collect the data, January 1st to 2019 January 1st. Once the date range has been selected, then you can click on data sets.

Now suppose let us say you need to do a temporal kind of analysis from 1985 onwards till present. So in that case, what you can do is you can just search the date range as 1985 for Landsat data and present date is 2019. You will get all the data sets ranging from 1985 to 2019. For this particular exercise, I am taking only the last 10 years data sets. Once this is selected, you can click on data sets. So here it will go to the second page.

Here you can see at the top, the first page is criteria and yeah the second page will be your data sets. So here you can select the data sets whatever you need. In this exercise, we are going to select the SRTM digital elevation model. So under the digital elevation, once you click on that, here you can find a lot of datasets. Here you also have SRTM. SRTM stands for shuttle radar topography mission. So it is showing that we have the data set SRTM one arc second global.

That means, they have repository of digital elevation model for the entire globe. The resolution is one arc second. Now let us move to the board and see how does one arc second is translated into meters.

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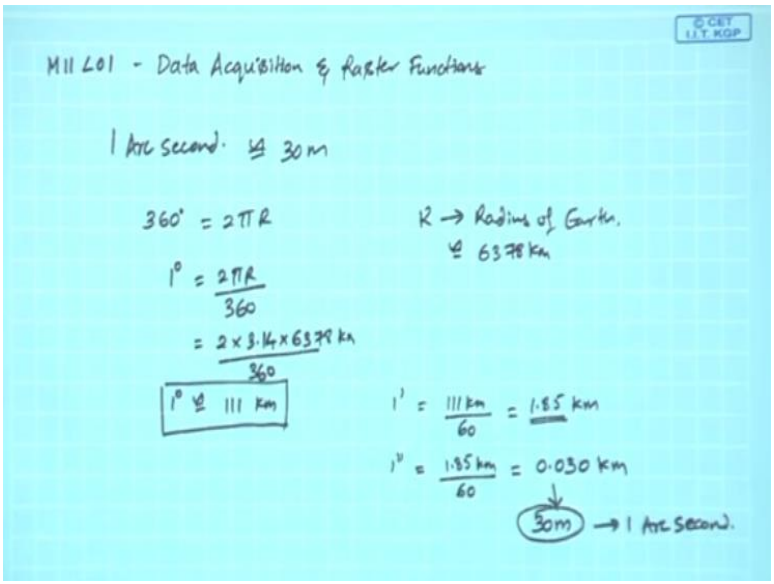

Now if we can go to the board, here we can see, the given data is one arc second okay. This is in seconds, degree minute and second is roughly equal to 30 meters. Now how do I get this? As we all know, earth is a sphere, that is 360 degree that is given by 2 pi R, where R is radius of Earth. As we all know radius of Earth is equivalent to 6378 kilometers okay. Now how do I measure one degree? One degree is equal to 2 pi R divided by 360.

So this is nothing but 2 into 3.14 into radius of Earth is 6378 divided by 360 okay. So please mind, this is in kilometers, that is the radius of Earth. Now the value which I get for 1 degree is roughly equal to 111 kilometers. Now, I have got how much is one degree corresponding to kilometers? Similarly, I can also get how much is one minute that is nothing but one minute is equal to 111 kilometer divided by 60.

So this will give a value of 1.85. This is also in kilometers. Now I know one minute is corresponding to 1.85 kilometers. I will try to convert this into seconds. So one second is equal to 1.85 kilometer divided by 60 again okay. This will give the value of 0.030; this is in terms of kilometer or if you convert this into meters, this will be 30 meters. This is nothing but one arc second okay.

So now whatever we are referring that is the shuttle radar topographic mission, the data is one arc second. Now let us go back to the downloading screen. So here one arc second is 30 meter, I

am going to download the 30 meter data resolution, just we need to check that and come down. If you want to select any other data like, suppose let us say if you want Landsat, you can select that also.

If you want sentinel data which is 10 meter resolution that is also possible or here you also have ISRO resource sat data. If you click on that, you can also see ISRO LISS-3 data is also available. If you check this, you will also find the data here. Now as of now let us select only the SRTM. The next step is to click on results. I am clicking on result.

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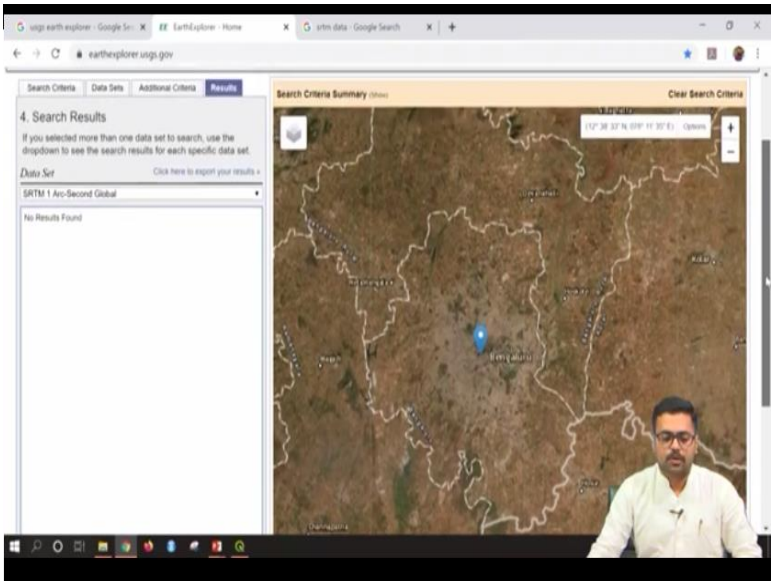

so once you click on result, this will take you to the final page that is nothing but the result page and here the data set selected is SRTM 1 arc second global. It is showing no results found. Let me just go back to the search criteria and verify the search date. It is given from 2009 to 2019 and data sets I have given SRTM one arc second. So I will just increase this particular date range, so that I will get any of the data. I will put 2000 January 1st to 2019 January 1st and then search for the results okay.

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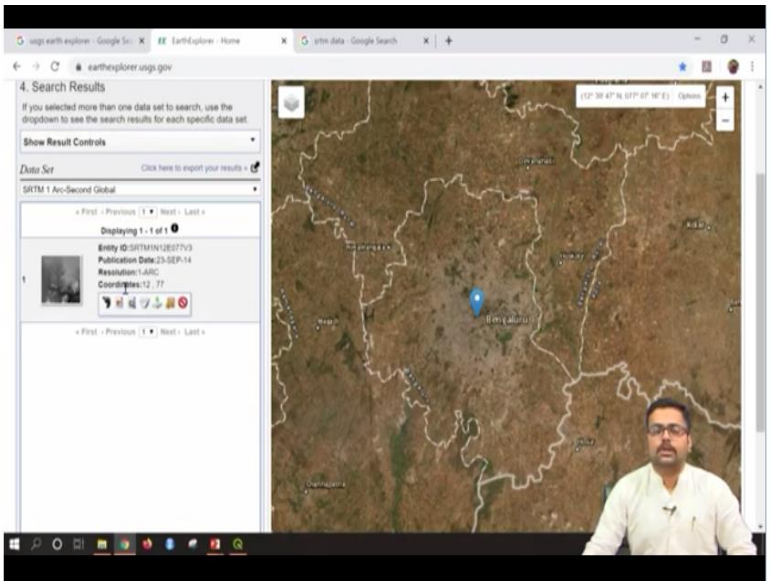

Now I have got one result and if I want to see this, there are a lot of tools here to visualize this. The first one is called as show footprint.

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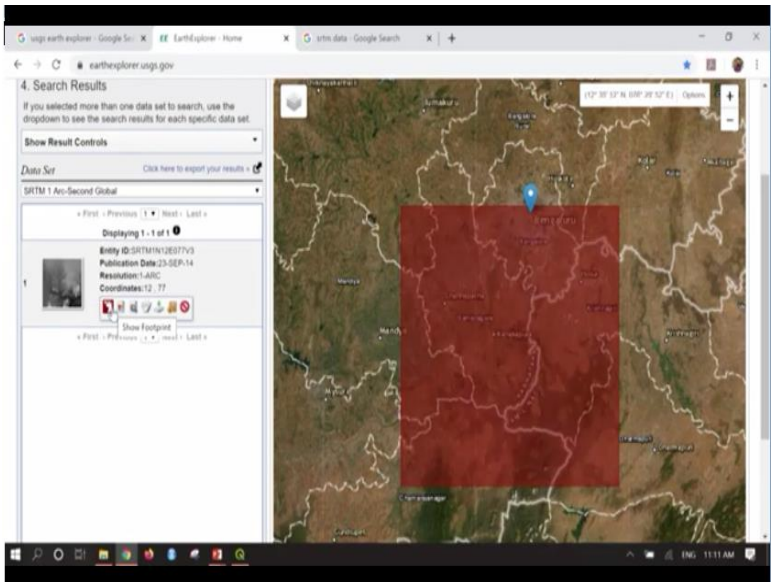

So if I click on this, it will show the footprint, meaning to say what are the extents of the image in which it is covering the digital elevation model. So this particular image will be downloaded. This particular extent will be downloaded. This is called as show footprint and here you can see the publication date is 23 September 2014 okay. So I will just turn the first option off. Next option is show browse overlay. I will click on this.

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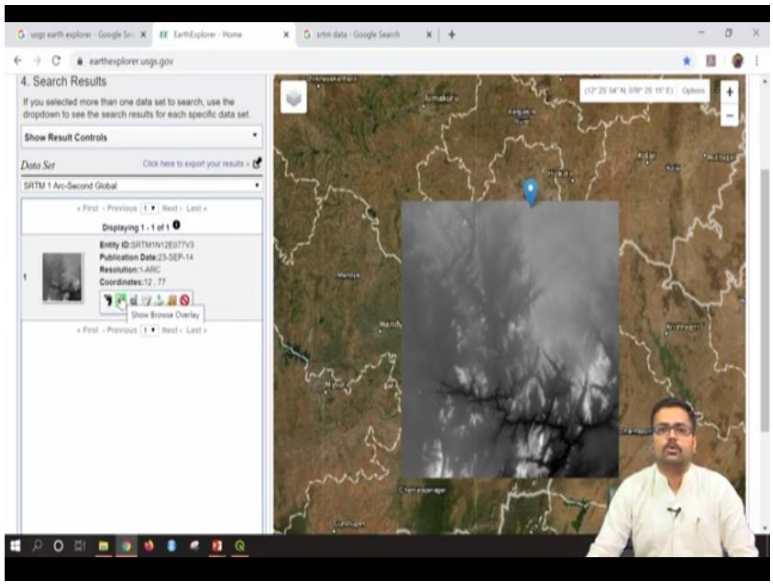

Now you can see the image with the extents is appearing on to the right. That is called as show or browse overlay, that means image is overlaid on the already existing satellite data. The third option is compare browse. We would not go into this. The fourth option is show metadata and browse. This is very, very important when you download a particular satellite data. Suppose for example, let us say if you are trying to download Landsat imagery, you have to make sure that it is free from clouds okay. Clouded data will hamper your analysis.

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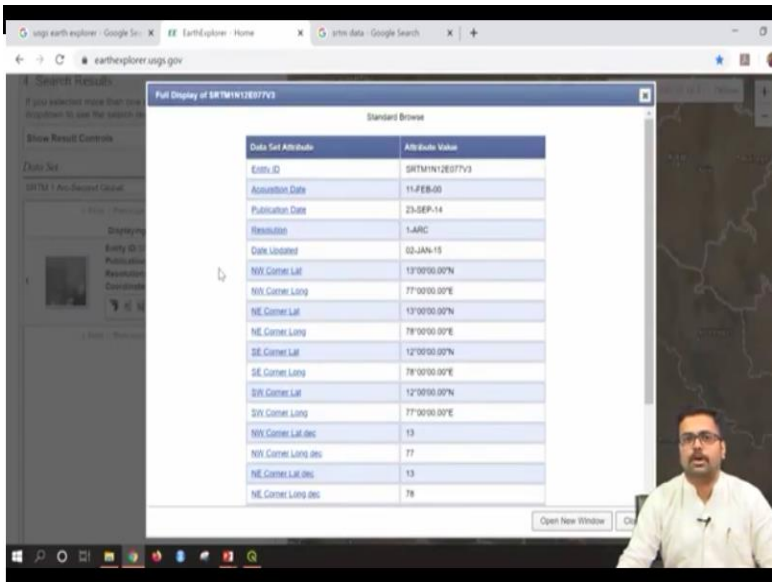

So in metadata, there will be information about clouds, cloud cover and all for Landsat, but since we are referring to SRTM, SRTM is a radar technology. So it can penetrate even through the clouds. So here you can see data acquisition is 11th February 2000, publication date is 2014, that

is after correction, resolution is one arc, which is nothing but 30 meters and then we have corner extents. Please be careful, this image is in terms of latitude and longitude.

It is not in UTM okay. So other details can be seen here. Once you are seeing the details, you can close this. Now the next option would be for downloading the data. Here you can see a tab it is called as download options.

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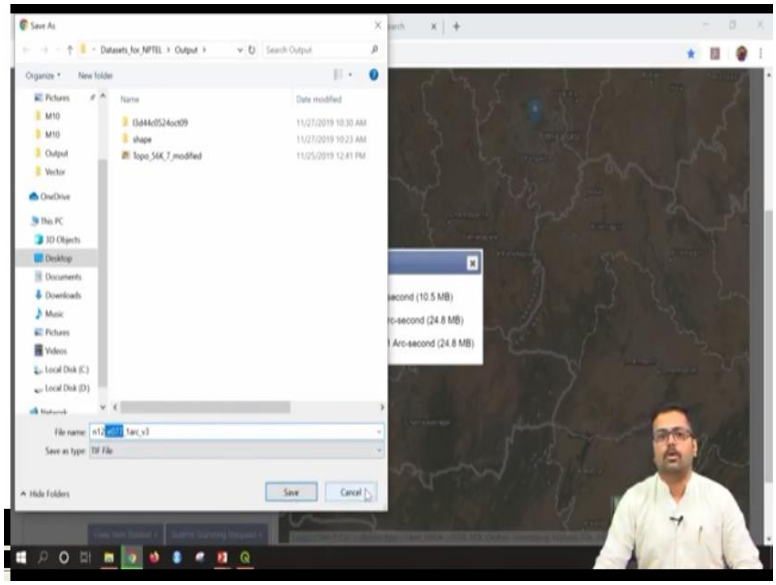

Once you click on that, you will get a lot of download options. Out of this, you have to take Geo TIFF. GeoTIFF is nothing but geo-referenced tagged image file format. That means each and every pixel will have a latitude and longitude information. So I am going to download this, which is of 24.8 MB. If you just press on download you can see to the left it will start downloading. It will ask for a name.

So the name is N12, that is North 12 latitude, E77 is nothing but easting longitude 77, one arc second version 3 and then if you say save, it will download. As of now, I will just cancel this because I have already downloaded this in my local drive. If I go to raster, so here N12 that is North 12, E77 is already downloaded. Like this, we can download the SRTM data set. Similarly, I will quickly show you how to get Landsat data which is from 1985 onwards.

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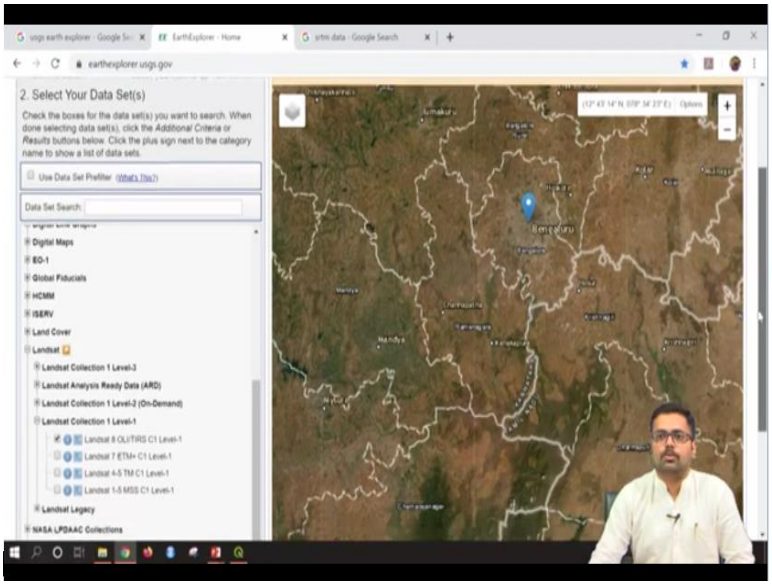

So here you can go to the second tab that is nothing but data sets, just I will uncheck SRTM which I just selected and if I come down, I have Landsat. So as we all know Landsat has data from 1983 or 1985 onwards. So here I can say Landsat collection 1, level 1. So you have 1 to 5 that is multispectral scanner, thematic mapper, Landsat 7, enhanced thematic mapper, Landsat 8, OLI TIRS, that is operational land imager and thermal infrared sensor. So as of now, I will just select this particular Landsat 8 images that is the latest one and let us see, how we can search for Landsat 8 results. I will click on results.

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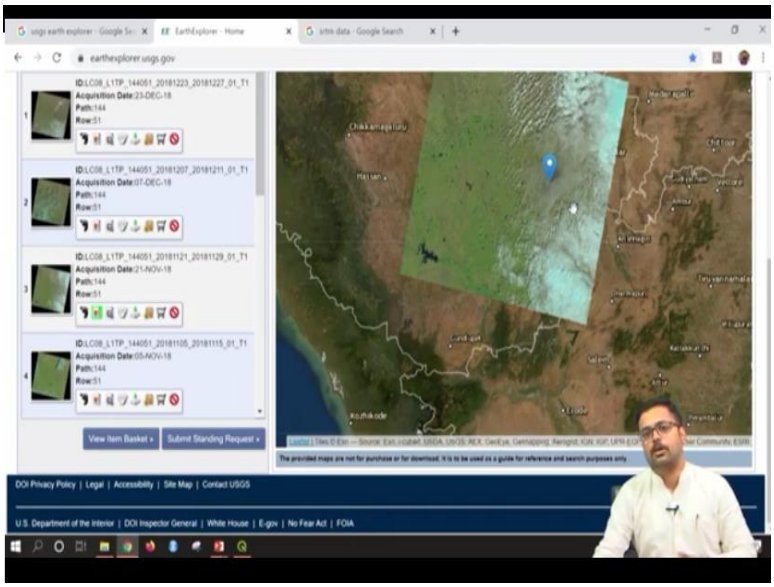

So now you can see a lot of datasets has come, but please be careful Landsat is not a radar satellite image it is optical satellite image meaning to say your data will be only within your

visible spectrum followed by NIR thermal infrared and other bands. So let us say for example, I am trying to acquire 21st November 2018 image, first I will just click on this show footprint to just ensure how much amount of the cities is covering.

So it is more or less covering the entire Bangalore city. Please be careful, this particular image style will be 175 kilometers in width by 175 kilometers in height. So it is a tile of 175 by 175 kilometer and next to this, I have image also if I click on this second tab that is browse overlay, here you can see this particular data has a lot of clouds, that means if you see the northeast part and southeast part, it is completely covered with clouds.

If you do any kind of land-use analysis with this data, all your analysis will be erroneous. So that cannot be right. I will just show you how this transforms. You can go to show metadata and browse.

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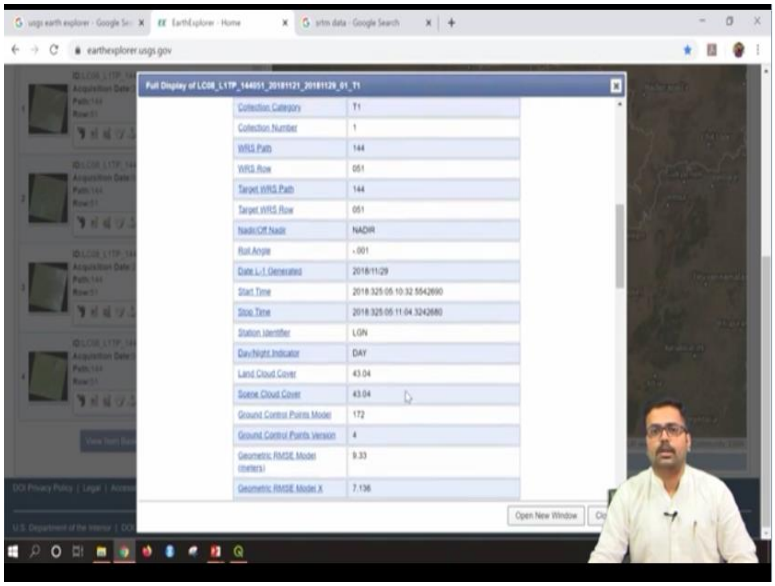

So it opens a new tab. Here if you come down, it gives all the details that is path and row number, whether it is nadir or off-nadir kind of image and if you see here this is very important. Land cloud cover is 43% and the entire scene cloud cover is also 43%. Ideally speaking, when you download a Landsat data, the cloud cover should be less than 1%. This is 43%. It is not at all acceptable. So you can just browse for any other data.

As of now I will close this metadata and once you are satisfied with the cloud cover, then you can directly go to the download options, here you need to take level 1 GeoTIFF. If you are downloading any kind of data from USGS, please make sure that you will download GeoTIFF images. So this is around 961 MB. It has around 11 different satellite bands. This is how you download Landsat data.

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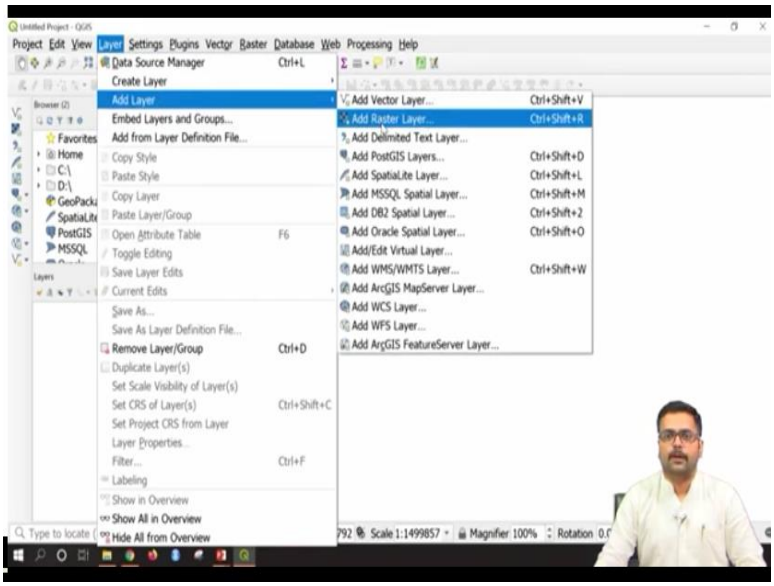

So now let us go back to QGIS and try to bring this particular digital elevation model, which we downloaded. So this is the QGIS home screen and in the previous session, we have already seen how to add a raster layer. I will go to layer from the menu bar, add layer, add raster layer. So here, I can browse to the folder where I have kept the SRTM digital elevation model. It is in the NPTEL, data sets for NPTEL, raster. So this is the one which we need to open.

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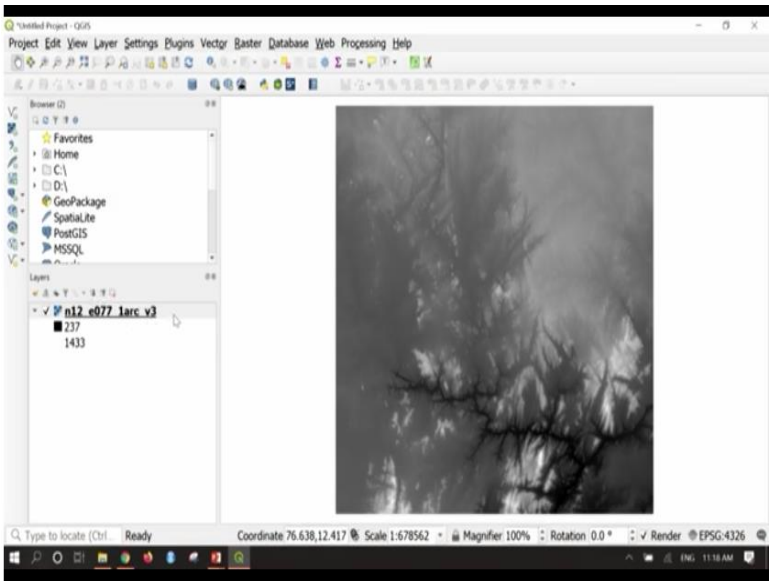

So here I will just say open and then say add. On to the left, you can see the image has been added or the raster has been added.

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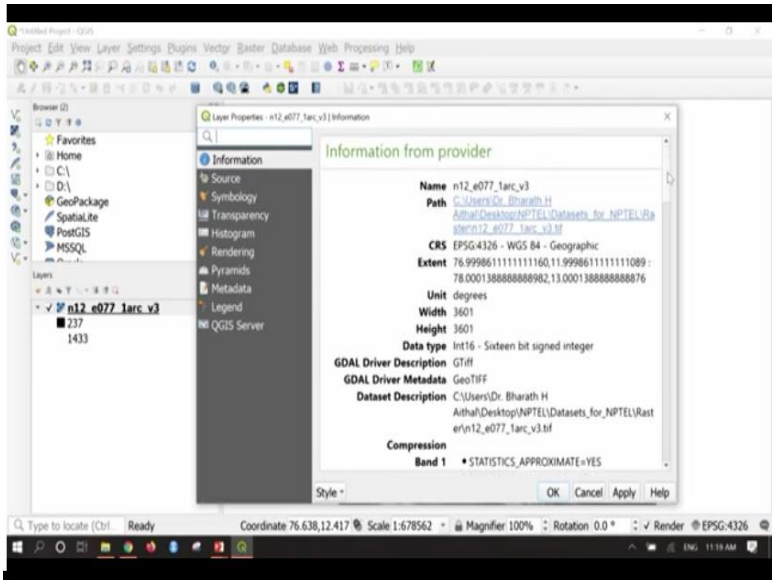

So this is how the raw data, that means raw digital elevation model looks. You can hardly represent any kind of undulations or elevations in this particular image. So before doing any kind of analysis, let us just go through the metadata and see what are its various properties. So here it gives the name, path name, coordinate reference system, that is 4326. So this is in latitude and longitude system; the unit is degrees and number of pixels in width number of pixels in height and other details can be seen. So now after seeing the information I will just close this. First task

is to convert this particular raster image into UTM projection system. So I will go to export and I will click on save as.

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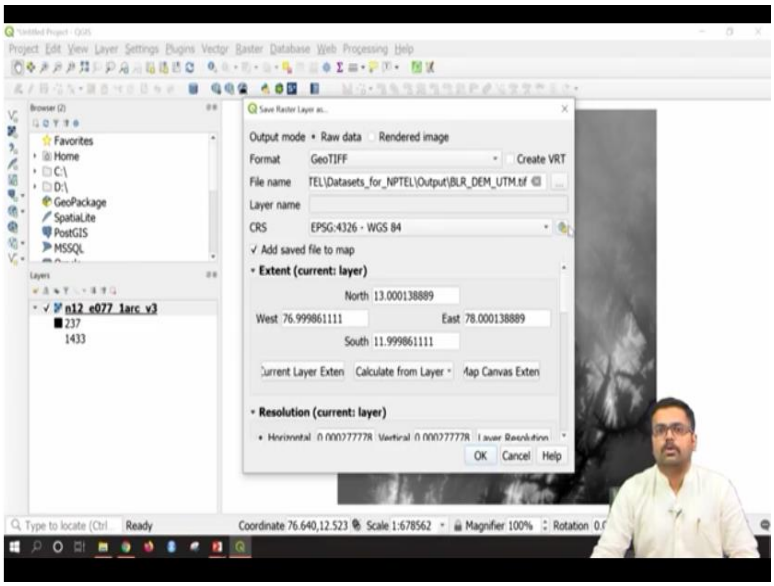

So here you can see one more dialog box has been opened. So format I will retain as GeoTIFF only, layer name I will browse and I will go to NPTEL and here I will go to datasets, output. So here I will just save this as; this is Bengaluru, so BLR underscore DEM underscore UTM. Then say save. So the output I have saved it here and now the very important thing is coordinate reference system. By default, it is in latitude-longitude system.

So I will go to this particular tab, wherein I can select the CRS. I know Bangalore belongs to 43 zone. How I know it belongs to 43 zone? Now let us go back to the board and see how Bangalore belongs to zone number 43 UTM.

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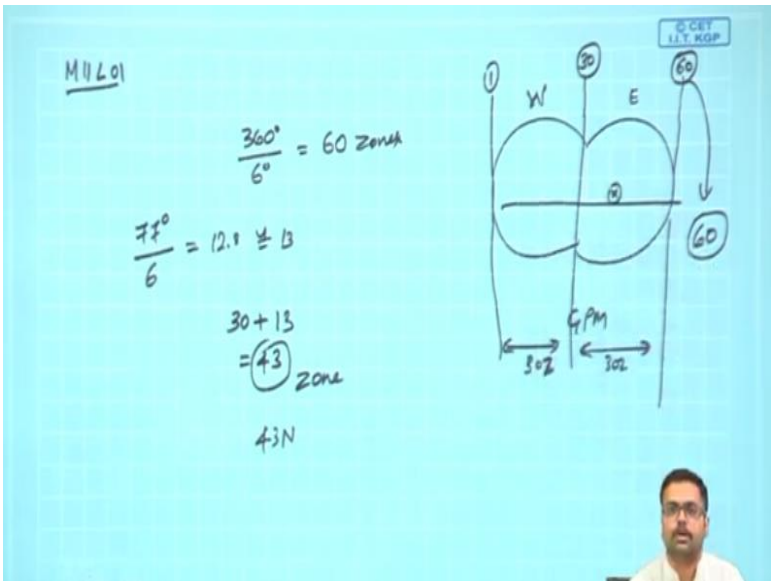

So as you all know, UTM zone is based on the number of zones that is being divided equally. So the entire world is divided that is 360 degree is divided by 6 degree zones each, that is nothing but 60 zones. Now how does this transform? If we see carefully, it will be. So this is the world and this is the Greenwich prime meridian and here this is the Western hemisphere and this is the Eastern hemisphere.

So in both of these, all together we have 60 zones; Western hemisphere 30 zones and eastern hemisphere 30 zones okay. Now the zone number 1 starts from west most end and by the time you reach Greenwich prime meridian the zone number is 30 and by the time you move to the far east, the zone number is 60. This is how 60 zones has been divided around the world. Now let us say Bangalore has longitude of 77 degrees.

So just divided this by 6 because each zone is 6 degree, then once you divided by 6, you will be getting somewhere close to 12.8. Let us say, just round this to next digit, that is 13 okay. Since we already have 30 zones on to the west, Bangalore is somewhere here. So you just need to add 30 zones till the Greenwich prime meridian plus 13 okay. This is nothing but 43. So this is the zone, UTM zone of Bangalore that is 43 North.

North because we are at the northern hemisphere from the equator okay. Now let us go back to our QGIS interface and see how to assign this particular coordinate system. Here if you look at

the coordinate reference system, there are lot of geographic coordinate systems and projected coordinate systems. So since I know it belongs to 43 North, I will just press 43 N. So here you can see, coordinate reference system it is WGS84 UTM zone 43 north and the corresponding code is 32643.

If you are picking any of the UTM codes, the last two digit stands for zone number. So if it is zone number 1, it will be 32601. If it is zone number 30, it will be 32630. Similarly, if it is zone number 43, it will be 32643. Now here you can visually also see, which are the places that are falling under 43rd zone. Once that is selected click on ok.

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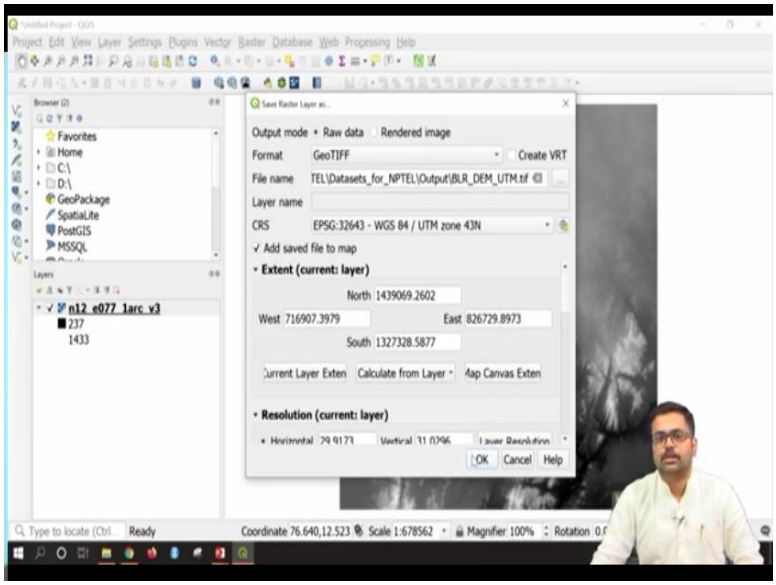

Now you can automatically see all the north, east, south and west coordinates has been assigned in terms of meters. So then just press ok. It will start saving. Now the layer has been successfully exported. You can see here, to the left in the layer panel BLR DEM has come. If you want to inspect, go to properties.

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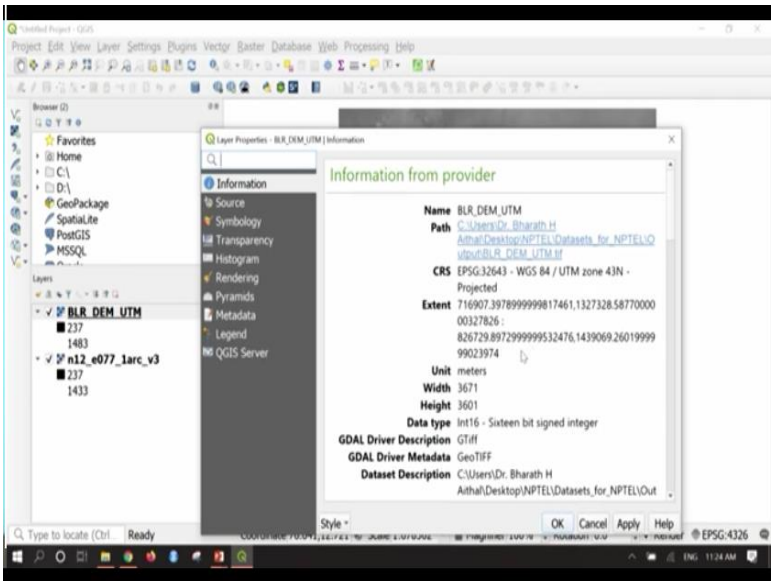

So here you can see it is projected coordinate system 32643 UTM zone 43 and you can see the extent; unit is meters. Please remember earlier which we saw unit was degrees. So this is in terms of meters. Once you are satisfied, you can close this. Now let us try to assign some colors for this particular DEM to understand exactly what it is showing.

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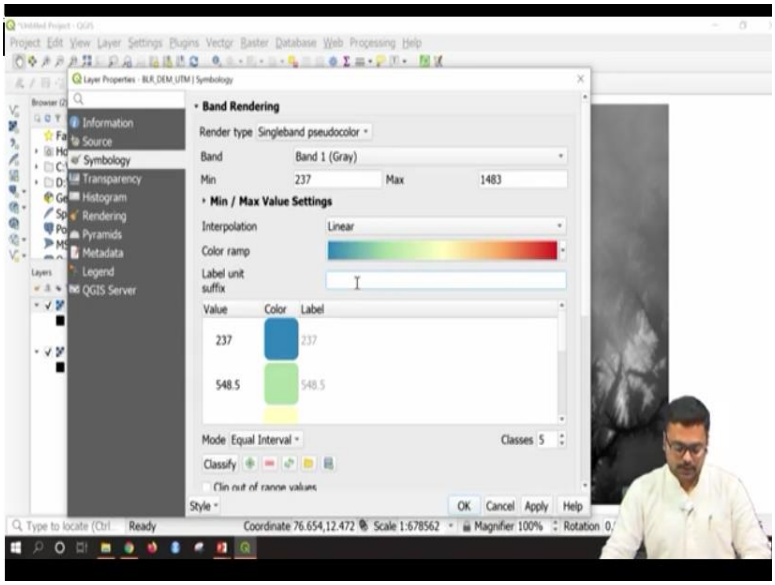

I will right click on this. I will go to properties and in the property tab, as you can see there is something called as symbology. So I will select this by default it a single band grey. So from the drop-down, I will select it as single band pseudocolour. So a lot of colours has been added here. So if you see this properly what we can observe here is by random it is taking some colors. So I

will select the interpolation method as linear and colour ramp I can select it any color you want or I will just say spectral.

So here you are you have an option spectral and from the drop-down, I will say invert color ramp so that blue is for the lesser colour and red is for higher colours and once that is done. So by default, it is taking 5 classes. I will say here equal interval, label suffix, it will be meters, since this is in UTM; it is in meters, equal interval and say classify, then say apply.

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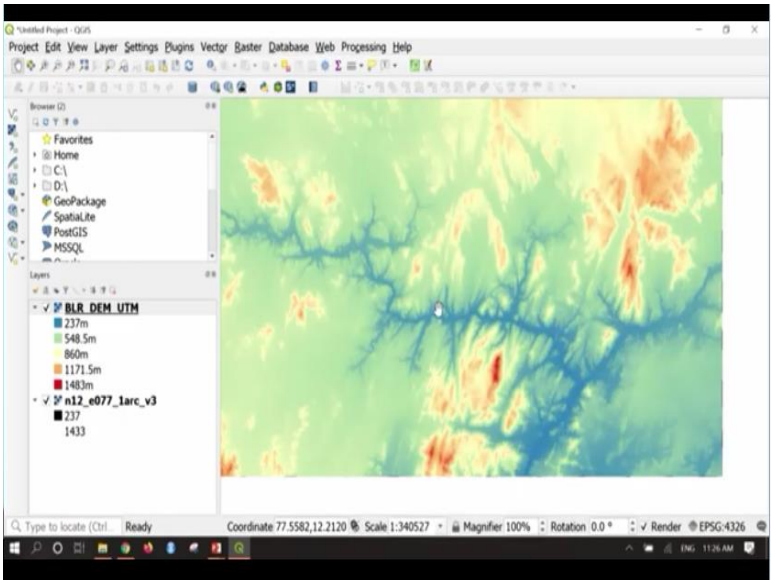

Now you can see the DEM we have added various colours. So at this particular point, where you are seeing blue color corresponds to 237 meters, which is very, very low. So this may be a river okay. Similarly, wherever there is red, it is very high elevation, that is this may be in nearly 1400 meters. If you want to inquire, you can just go to the information tab and press on inquire.

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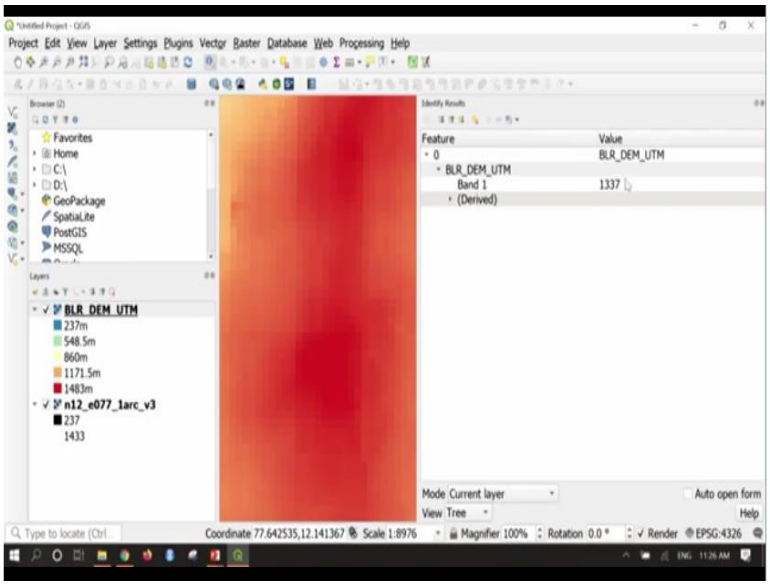

So here you can see band 1, it is 1337 meters above mean sea level. So this is how you interpret with various colour recognition and as of now for this class, we will stop here. In the next class, we will see how to do various raster analysis, such as slope, hillshade and other raster calculator operations. Thank you.