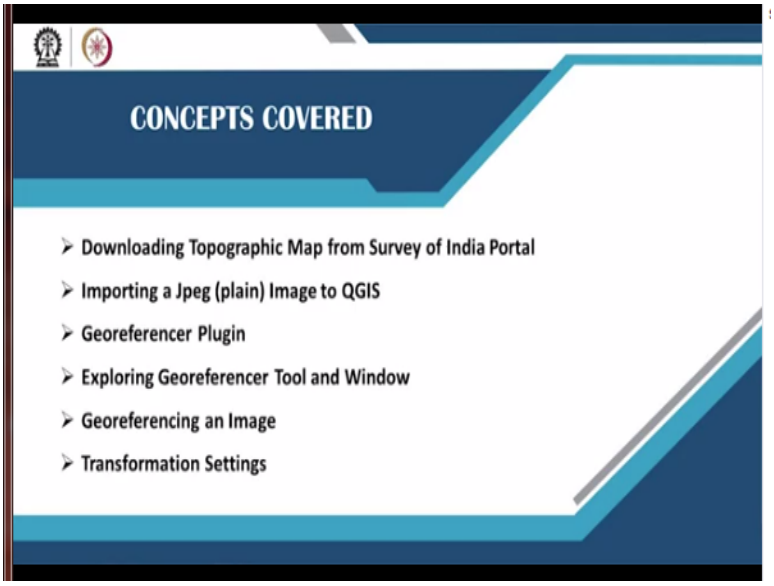
Geographic Information Systems
Prof. Chandan MC
Teaching Assistant
Ranbir and Chitra Gupta School of Infrastructure Design and Management
Indian Institute of Technology-Kharagpur

Module-10
Lecture-48
Georeferencing an Image

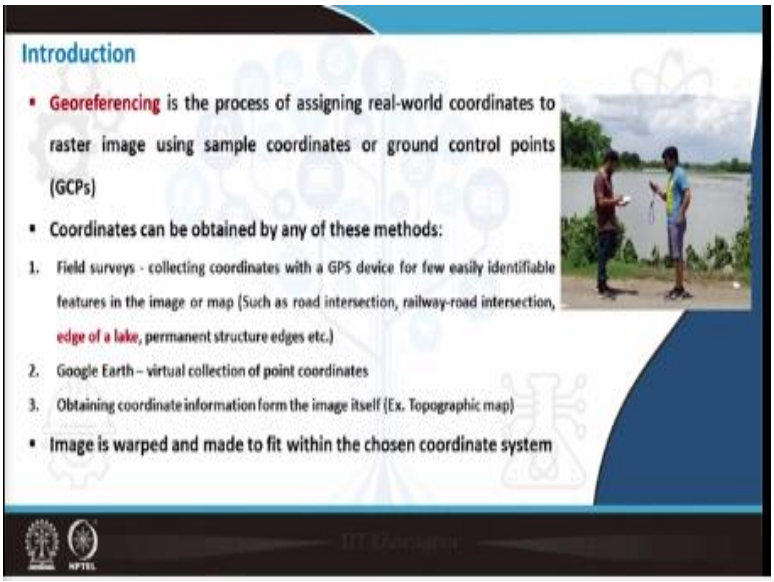
Namaste welcome back to NPTEL online certification course on geographic information systems. In this module, we are looking at GIS as a software application and in this particular hands on session, we are going to see how to georeference an image myself Chandan MC. I am from Ranbir and Chitra Gupta School of infrastructure design and management, IIT Kharagpur.

(Refer Slide Time: 00:48)



So the concepts covered in this particular session will be downloading the topographic map from survey of India portal importing a Jpeg image into QGIS georeferencing plugin, exploring the georeferencer tool and window, georeferencing and image using various options. And finally, we will also see how to transform the settings for a plain ungeoreferenced image to a georeference image.

(Refer Slide Time: 01:23)



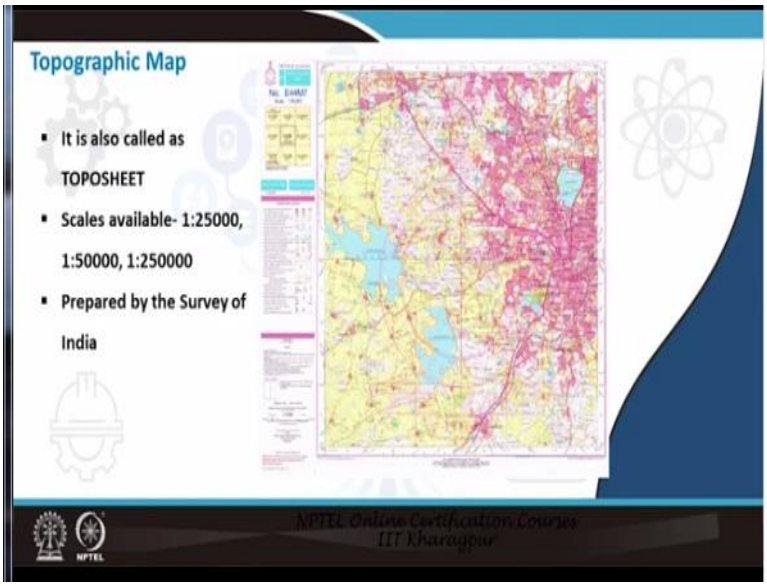
When we look at the term georeferencing it is nothing but the process of assigning real world coordinates to raster image using sample coordinates on ground control points. Now, whenever we take a jpeg image, it does not have any coordinate information embedded within that. So what we need to do is, we need to embed the coordinate information within this jpeg image and that becomes a transformed image, so to obtain the coordinates we have various methods.

The first one is field survey, during the field survey we can collect the coordinate with the help of GPS device intersections basically, for example road intersection. Road intersection does not change for a long time and that can be taken as a reference point or a ground control point. Similarly, we can also take a road and railway intersection or it may be a edge of a lake or a permanent structure edge.

Like in the figure you can see we are taking the ground control point with the help of a GPS at the edge of a lake, so this serves as a permanent mark for collecting the coordinates. The second one is Google earth when the places is not accessible you can go to Google earth and collect the points virtually. And the last method for obtaining coordinates is from the map itself or from the image itself.

For example, if you take a topographic map or a toposheet it has the coordinate information at the corners, so we can take the information from there.

(Refer Slide Time: 03:02)



As we all know in the previous sessions we have discussed about topographic map it is also called as a toposheet, it has a scale of 1:25000 or it may be 1:50000 or it may be 1:250000 depending upon what kind of application we are going to use it. And these toposheets are prepared by survey of India which is available for free online. So how to access the toposheets is what you can do is **(Video Starts: 03:32)** you can go to Google and you can just search for soi nakshe and then press enter.

This will take you to the first search that is nakshe portal, when you click on nakshe portal this takes you to the survey of India web page. So this is how the survey of India homepage looks like, once you get to the homepage, you say get started. So here, if you enter your Aadhar number and the captcha they will send you a onetime password with which you can login into the survey of India web page.

Once you login into the survey of India web page you can also give other informations such as your name, gender, state, district, age, mobile number, etc. Once you give all these user details it will be then taking you to the home screen of topographic map download page. So this is how the map download page looks like. Here, you have 2 tabs, one is you can search the map if you already know the sheet number and the second one is geographic search meaning to say you can key in the name of the place.

So in the next tab, we can see here I am entering the state name of Telangana and here I am entering the district as Hyderabad, let us say I need the toposheet for Hyderabad city. So I will give this details and when I click on search it will be displaying 2 results. The first one is with OSM number E 44 M 7 and sheet number 56 K bar 7 and the second one will be E 44 M 11. For this exercise, we will be downloading the first download option that is 56 K bar 7.

Just click on privacy policy and you will be asked to agree for certain terms and conditions then your topographic map will be downloaded in PDF format. Now if you want to open the topographic map since this is a very secure PDF map, you have to use your last 8 digits of your Aadhar number as a password. Once the PDF is open, then you can convert the PDF into a jpeg image using any of the online conversion tools.

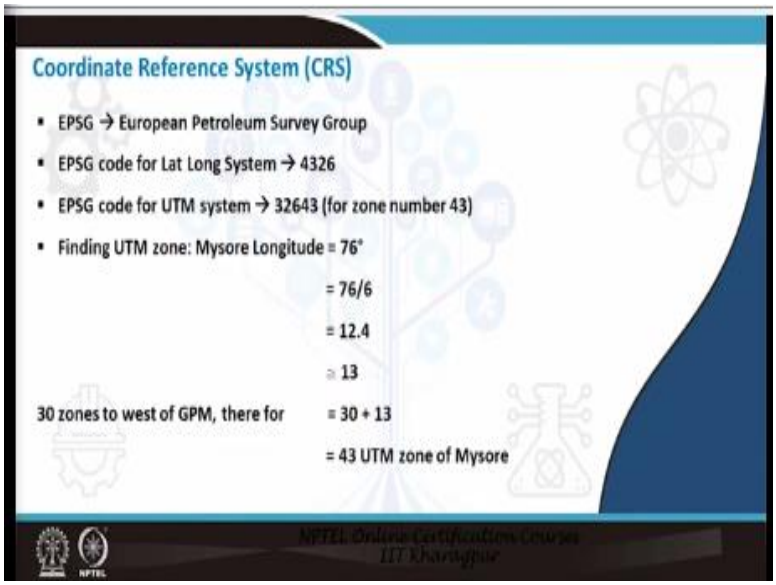
Finally, the final jpeg image looks similar to this and now this jpeg image we can use for georeferencing in QGIS. So I have downloaded the topographic map for Hyderabad and I have also converted the PDF to jpeg image. Now let us see how do I add this plain jpeg image into QGIS interface. So this is the QGIS interface you are very familiar with in the previous sessions to add a plain jpeg image it is a raster.

So you need to go to layer in the menu bar, add layer and onto the right go to add raster layer. So here in the source you can browse to the folder, where you have kept all your datasets. We have also provided the raster data for Hyderabad in the raster folder it is by the name TOPO 56 K 7. I will just click on this and then say open and then say add, now it is asking for coordinate reference system selector.

Since this particular image is jpeg format it does not have any coordinate information system. I will just brief you about what are the different raster formats. And then we can go to the georeferencing section, georeferenced tagged image file format that is geotiff or famously known as dot tiff formats are very commonly used for file formats of GIS operations, this also includes the satellite data. And other extensions for raster include dot jpeg, the one which we saw just now the PDF converted into jpeg.

And the second one is dot img it is ERDAS Imagine img files proprietary format of hexagon geospatial. And the third one is dot bil that is Band Interleaved by line, here the raster information is stored line by line. The fourth one is bip Band Interleaved by pixel. Here the raster is information is saved in terms of pixels and row by row, the last one is Band sequential that is dot bsq. Here you can see the raster information is saved in terms of separate bands by row**.(Video Ends: 08:35)**

(Refer Slide Time: 08:35)



We are also aware of coordinate reference system, now there are code for each and every coordinate reference system these codes are given by EPSG. EPSG is nothing but European Petroleum Survey Group, EPSG code for lat long system is 4326 please make a note of this. Because we will be using this in all our analysis and EPSG code for UTM system will be 32643, this is that last 2 digit 32643 the 43 is for the UTM zone number 43.

Now let us say you do not know a place UTM zone, how do you find it, finding UTM zone is very simple. For example, if I consider Mysore longitude is 76 degrees, so what you need to do is, you just divide the 76 degree divided by 6. Because in UTM zone what we do is, the world we consider as 360 degrees and the 360 degree is divided into 6 degrees zones each. If I divide 360 by 6, it is 60 zones is the total number of zones covering the entire earth of this we consider Greenwich Prime Meridian as the central meridian.

So to the left or to the west of Greenwich Prime Meridian we have 30 zones and to the right we have 30 zones. So here I have divided the longitude by 6, so I am getting a value of 12.4, I can just round this value to the next digit that is 13. Since there are 30 zones to the west of Greenwich Prime Meridian, I am just adding 32 this number that is 30 + 13 which will give me 43, 43 is nothing but the UTM zone for Mysore.

Similarly, if you know a place longitude, you can easily find out it is UTM zone **(Video Starts: 10:28).** Now coming back to the QGIS interface coordinate reference system selector. Since we are loading a jpeg image, I do not have to select any coordinate reference for this particular image. I will just press cancel, so on to the left to the layer panel you can see a toposheet with the name Topo underscore 56 K 7 that has nothing but Hyderabad toposheet has been loaded in the QGIS.

You can close this tab, you can also check for the metadata of this particular image right click, go to properties. In the information tab, you can see the name that is Topo 56 K7, path that is nothing but it gives the local directory path to this file, CRS coordinate reference system by default it is taking as lat long. And if you see the extent is random extent, so, this means the image is not georeferenced.

So, next you can see unit is degrees, width is nothing but the width covered by number of pixels, height covered by a number of pixels and then here the type is jpeg. So once you view all this information, you can just close this tab. Now I will just select zoom in or pan in tab and select the corners to see what are the extents of this particular image. Since this is a 1:250000 scale image, the interval between any 2 edges any 2 corners will be 15 minutes.

This has been taught to you in the previous lectures on map numbering system. So if I go to the top left corner and zooming it here, here I can see the coordinate values. Here for this particular corner point the coordinate value is longitude of 78 degrees 15 minutes, latitude of 17 degrees and 30 minutes. Whenever you see a toposheet it is always better to observe the coordinates at the 4 extents.

So here I am going to the bottom most part that is bottom left part. If you zoom in, you can also see the coordinates here for this particular intersection point, the coordinate will be 78 degree 15 minute east of Greenwich and 17 degree 15 minute from the equator. So now, how do I georeference this particular image for this what we need to do is. We can use the tool called georeferencer, this has been explained to you by Prakash in the previous session, how to install georeferencer plugin.

I will just go to the plugin manage and install plugin, it will connect to the QGIS official plugin repository, here you can say georeferencer. And here you can see the georeferencer GDAL plugin has already been installed in my system. If it is not installed, you can just click on this and say install, once it is installed, you can close this tab. So now the georeferencer plugin, you can find it under raster and here you have georeferencer tool, just click on georeferencer tool it will be directed to a new window.

So this is the georeferencer window, wherein you also have the menu such as file, edit, view and settings, this is the menu bar. Next, you will find toolbar, in the toolbar you have a shortcut open raster start georeferencing, load GCP points if you have already saved the GCP points, transformation settings, add a point, delete a point, move a point, pan, zoom in, zoom out. So these are the tools, next section what you see here is the map display area.

And finally at the bottom you have GCP table. Now let us see how do I bring in a plain jpeg image into this georeferencer tool, go to file and say open roster So here it will navigate you to the local directory, here the data provided to you, raster I will choose Topo 56 K7, this is a plain jpeg image and then say open. Again it is asking for coordinate reference system selector, so far we have not done any kind of georeferencing, so I am just cancelling this.

Once you click on cancel, the image will be automatically loaded in the map display area. So here now I will start georeferencing from the top left corner. So what I will do is, I will go to the zoom in tab and I will zoom to the top left corner, you have to zoom in to such an extent that you

can see these 2 intersections clearly at pixel levels. So what I am doing here is I am doing to such an extent, wherein I can see the intersection of latitude and longitude in terms of pixels.

So here is the centre point for this particular top left point, so what I will do here is I will go to add point, click on this. Now you will get a crosser and just drag the crosser to exactly at the center of the 2 intersections and left click. Now one more tab has been open this is enter map coordinates, here you can enter map coordinates in terms of degree minutes seconds or decimal degrees or projected coordinate such as UTM in terms of meters.

Now here the coordinates which I am referring is in terms of degree minutes second, that is DD space MM space SS dot SS. That is degree minute and second, you do not have to type degree symbol or minute symbol, all you need to do is just enter the coordinates with space. So let us see, how do I enter the first value. The first point I have the value of east as 78 degree and 15 minutes, so I will type 78 space 15 and the latitude value is nothing but 17 degree and 30 minutes 17 space 30.

So the first point is done I will press on ok, now you can see a red dot has appeared here at the intersection. And once you press ok, it will also give you the first point in the GCP table with an ID 0, it starts from 0, 1, 2, 3 like that and you can see destination x and y ok. Now what I will do is I will zoom out and I will add one more point exactly at the top center. So I will zoom into the top center again you have to find the exact intersection.

Here you can see the latitude value remains the same that is nothing but 17 degree 30 minutes, whereas the longitude changes, the longitude here would be 78 degree, 22 minutes and 30 seconds, so I will find the exact intersection here ok. Now I will again go to add point, one more crosser has come, so I will drag to the exact intersection of latitude and longitude and left click. So here I need to enter the map coordinates again the easting here is 7822 space 30.

Similarly northing here will be 17 degree space 30 minutes, once that is done I will press on ok, you can see the second point is added with the red mark. And then in the GCP table you can also find the details of the second point. Now I will zoom out again, now this time for adding the

third point I am going to top right corner. So here I can see the coordinates of this particular intersection is 78 degree 30 minutes east, 17 degree 30 minutes north.

So I will zoom to pixel level detail, here I will take once again add point exactly at the center I will click, so easting is 78 degrees space 30 minutes, northing is 17 degrees space 30 minutes then click ok, I will zoom out. Now onto the right, I will again zoom to the centre line, I will zoom again to the pixel level detail and add a point here this will be my fourth point. So here the easting would be 78 degree 30 minutes and the northing would be 17 degree 22 minutes and 30 seconds.

So here I have given all the details then I will press on ok, fourth point has been added, I will zoom out. Now, I will proceed to the fifth point that is bottom right corner and I will zoom to the intersection. Here you can see longitude value is 78 degree 30 minutes, latitude is 17 degree 15 minutes. So let us enter this exactly at the intersection zoom to the pixel level and add a point exactly at the intersection, easting is 78 degree 30 minutes and northing is 17 degree 15 minutes ok, zoom out, we have completed 5 points.

One important thing to notice here is, I am adding the points starting from here point number 1, 2, 3, 4, 5. I am ordering in clockwise direction, please make a note that georeferencing has to be in a proper order either you can take a clockwise direction or an anticlockwise direction, please do not mix both. You cannot take points randomly, for example, let us say first point you have taken at the top left corner, second point you cannot take at bottom right and then again go to top right, this is not correct.

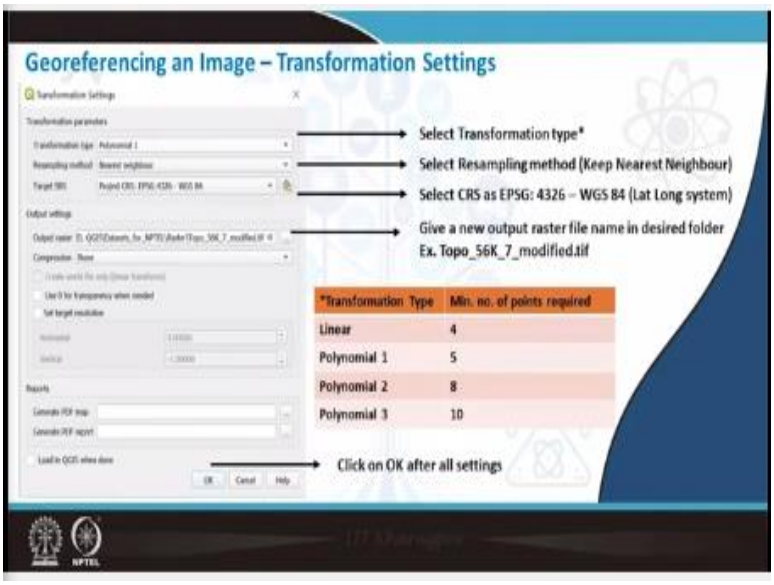
Because it also records, how you are taking the points and based on that it will calculate the RMSE that is nothing but residual or root mean square error. So please be careful while selecting the points, only mark the points in a certain order, for example clockwise direction. Now I am going to the fifth point that is bottom middle. So here exactly at the intersection I am marking one more point the easting for this point will be 78 degree, 22 minutes and 30 seconds.

Similarly northing would be 17 degree 15 minutes then I will say ok. Now proceeding to point number 6 please make a note that if you want more accurate results, you need to add more number of points, may be it can be 12 points or 16 points, but it has to be in a cyclic order. So now going to the 7th point, here I will add 1 more and the easting value here would be 78 degree 15 minutes and the northing value would be 17 degree 15 minutes I will press ok.

We are left with the last point to go that would be left middle. So here you can see point number 1 with an ID 0, 2, 3, 4, 5, 6, 7 and we would be adding the last point here exactly at the middle. So the easting value here is 78 degree 15 minutes and northing value would be 17 degree 22 minutes and 30 seconds press ok. Now we have added total number of 8 points for the jpeg image. So once this is done, what you can do is you can go to settings and then click on transformation settings.

Here it will now give you a new window transformation settings tab. You can see transmission type resampling method, target SRS, what are these transformation types, how to choose transformation type based on number. **(Video Ends: 25:12)** Now suppose let us say you have 4 number of points, then what you can do is, you can select a transformation type which is called as linear.

(Refer Slide Time: 25:21)



Suppose if you have taken 5 number of points then you can select the transformation type as polynomial. Similarly if you have 8 number of points you can take polynomial 2, if you have more than 10 points you can take polynomial 3 these are different type of transformation, which are available in QGIS. Similarly in the next you have resampling method, this by default it will be nearest neighbor, what is nearest neighbor.

That means if you are assigning a coordinate to a pixel, it will also consider the nearest 8 pixels surrounding that particular pixel ok. Then target SRS is nothing but your coordinate reference system, **(Video Starts: 26:11)** let us go back to QGIS interface. So here I am taking polynomial 1 nearest neighbor resampling method, target SRS I am keeping it default that is nothing but the lat long system EPSG 4326. And in the output raster, I am browsing and here in the output folder I am giving a file name Topo 56 K7 modified and then say save but at the bottom you can see save the file type dot tif.

So here I will keep it as such and then say save, now we are ready to do the transformation settings you can click on ok. So once you click on ok, now you can see there is dx pixels dy pixels and residual pixels. So this residual pixel is nothing but your RMSE that is root mean square error, please make a note that this particular residual pixels should be less than 1. If the residual is more than 1, that means your map will not be accurate.

So here some of the points have residual of 2.2, 1.08, 1.7 like that. So what you can do is, you can either delete that point and add the point again or you can edit the point with this particular tab it is called as move GCP points. So now I will just try to move the first point which is having a residual of 1.9, if you zoom to this particular first point. Now it is also showing you this is the market point, but this is where it had to be.

So I will just try to move this point a little by selecting, please observe the residual pixels it is gradually reducing for the first point it was initially 1.7, now it is 1.38. Similarly I will also identify what other points are causing this error, for example point number 6. So point number 6 is, this one, I will zoom to point number 6 and just see what is happening. So in the point number 6, the point which I have marked is here, but actually the point should have been here.

So I will again select the move tool or move GCP tool and select on this, now you can observe how the RMSE is reducing. So like this, what you need to do is, you have to make sure that all of these 8 points should be with the residual less than 1, as of now due to the time constraint I am just going ahead with this particular residual. You can also see how it will affect the accuracy, so once you make this less than 1 you can go to start georeferencing this will be present in file menu bar then you can press on start georeferencing.

So this takes a little time to process georeferencing, once that is done you will get a message georeference successful, that means the jpeg image which you had taken has now been transformed into a tiff tagged image file format with all these lat long coordinates embedded into that. Now what you can do is, you can minimize this georeferencer tab, you can go to project and select new, you can discard this current project.

Now you can go to layer, add layer and say add raster layer. Now I will browse to the folder, where I have just now saved the output of the georeferenced image that is named as Topo underscore 56 K7 modified, select this press open and then say add, now I will close this. As you can see, I am also getting the points behind, that is because the georeferencer tab is still open, what I will do is I will **cro** close this georeferencer tab.

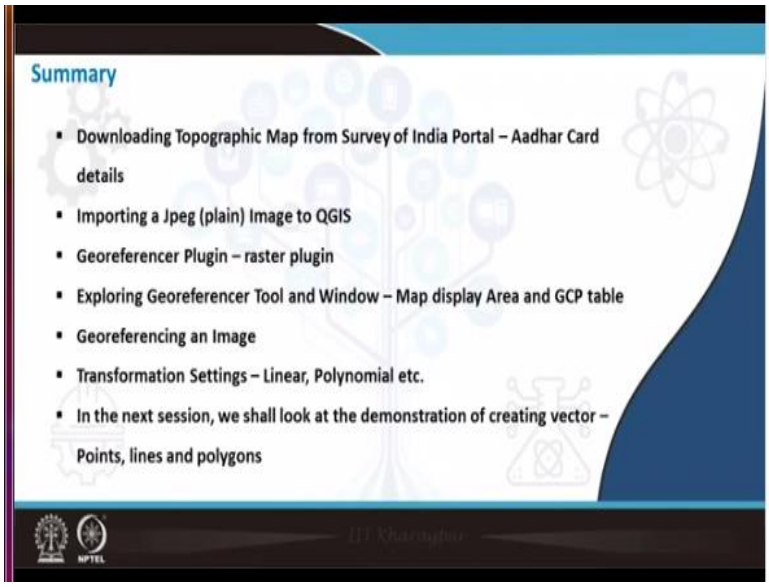
If you want to save the GCP points you can save, otherwise you can discard I will save the GCP points. Now you can see the GCP points is gone, however let us inspect the properties of this particular file, right click go to properties. Here you can see the name CRS is coordinate reference system it has been correctly referenced to lat long system, how can we make out by extent, you can see the extent and unit is degrees and other details.

Now I will press ok, so how do I verify whether the georeferenced map is correct or not. In the previous session, Prakash has demonstrated how to bring Google earth images into QGIS or OSM into QGIS. Now I will go to web quick map service search QMS, so here I can add Google satellite images, I will just press on add and close this. Now we can see at the background, Google earth has been loaded.

Now if I want to check whether the georeferencing is correct or not, this is Hyderabad image. So I will zoom to Hussain Sagar lake, so this is Hussain Sagar lake, I will just turn off this layer for a while. So you can see at the background in the Google earth also it is Hussain Sagar lake. By this we can say that the image is clearly georeferenced and the accuracy which I was speaking regarding the RMSE or the residual, you can zoom to any particular junction and see how much discrepancy is there.

For example, this is a road junction, so if I turn off this layer, it is almost correct. So this particular image has been georeferenced successfully **(Video Ends: 33:07)**.

(Refer Slide Time: 33:08)



To summaries today's lecture, we have seen how to download a topographic map from survey of India portal that is basically you have to give your Aadhar details and then we saw how to convert that particular PDF into a plain jpeg image. Then how to bring the plain jpeg image into the georeferencer tab and how to georeference using various points. And finally we also saw transformation settings that is either linear polynomial or etc.

And in the next session, we shall look at creating vector layers that is basically a point layer, line and polygon, thank you very much.