Geographic Information Systems
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Lecture – 16
Pre-processing of Spatial Datasets - 02

Hello everyone! and welcome to discuss on pre-processing of spatial datasets. Earlier, we also touched upon this. And some processing or pre-processing of a spatial dataset, we have discussed in part 1. So, now we will have in part 2 and also one more part is there, part 3 which we discuss after this discussion.

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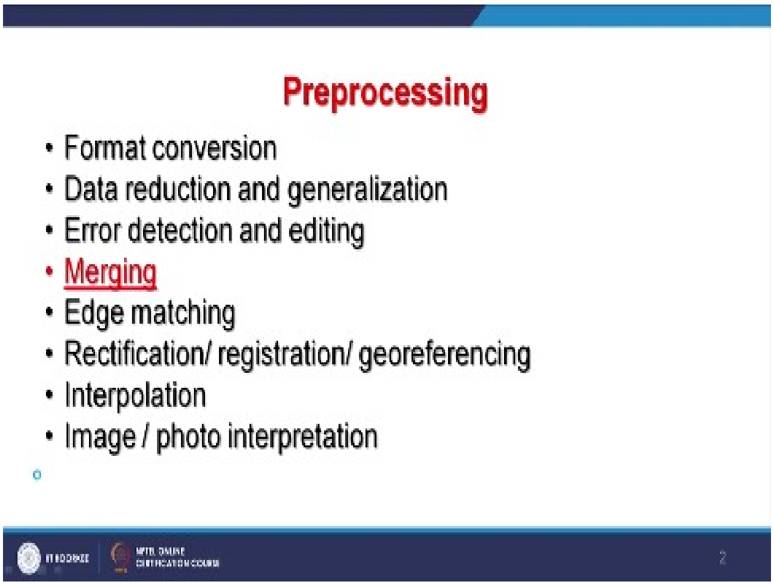

As you know that format conversion, data reduction and generalization, error detection this we have all discussed. Now in this discussion, I would like to have on merging. Merging has got little different meanings but in order to separate it; one is edge matching and that is the adjacent datasets are merged or matched whereas merging can be also merging 2 different datasets belonging to the same geographic system and then creating a new product that is also merging.

Some people also use word in digital image processing domain. They use the word you know, this edge announcement; not really exactly edge announcement but image fusion. They also use image fusion or image sharpen. So, there are different terminologies are there because as you know in GIS, lot of tools or techniques which were there in other domains have been incorporated or are being incorporated.

Therefore, sometimes little different terminologies are there. So, merging means merging 2 different datasets belong into the same area; same geographic coverage, also PAN sharpening they say also. PAN for using panchromatic data; PAN sharpening and also image fusion. So, all these will come under this category. So, let us start with that.

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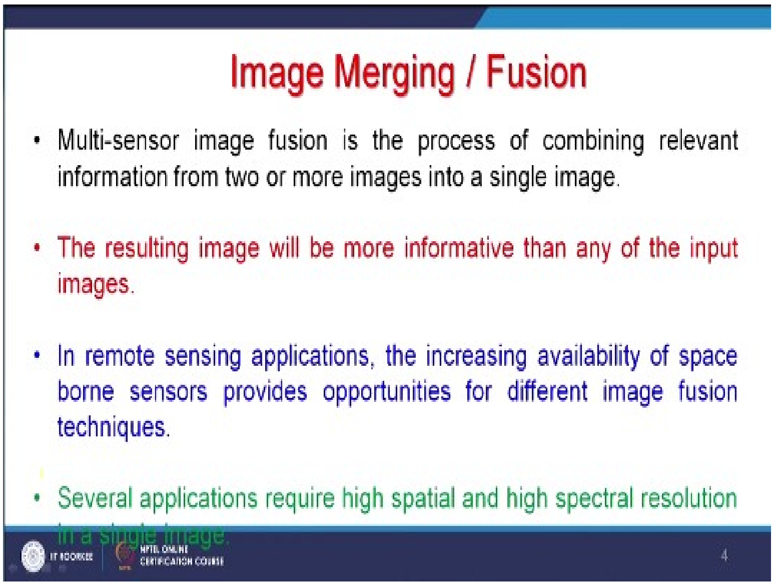

That here what we do basically, this is a typical discussion related with digital image processing but in GIS we also keep doing all this. So, that is why it is important to discuss here also. Because major input in our GIS nowadays as data is coming from satellite data and therefore, as we know that there are various satellites having various sensors and many of such datasets are freely available and therefore, user tried to use them as innovatively or judiciously for different kinds of projects.

So, in this discussion, I will be showing some real examples which I have used in different projects or different research or studies to bring out some very relevant information. So, multi-sensor image fusion is the process of combining basically relevant information of the same area from 2 or more images into a single image. Now when we say 2 or more images, there may be a scanned map also and that map, we can treat as an image and can merge with the other data sets.

So, it has got different meanings here but the main purpose is that 2 different datasets belong to the same area are merged or fused or PAN sharpen. And whatever we do in this image merging or fusion, the result can be more informative than the individual input image and you would see in the examples also, how they become beneficial. So, if 2 different resolution images are with you of the same area, say belonging to the almost same time, they may not be that useful individually.

But if I merge them or fuse them, I may take a lot of advantages of that means taking advantage of one thing from one image. Another advantage of another image and then fusing it and creating more thing. And as I have already said that lot of data is becoming available and lot of data is also available on net, free of cost. So, we can try all these combinations. Now in many applications, sometimes we require both high spectral and high spatial resolution.

High spectral means here those may not be familiar with remote sensing. High spectral means that for the same part of electromagnetic band, there are more narrow bands are available and more number of bands are available. And therefore, we say high spectral. Suppose there might be an earlier sensor system; there might be band having you know, 0.1 micro meter difference. Now we are having 0.05 micro meter difference.

So, more narrow bands are available; more number of bands are available for the same part of EMI spectrum and therefore, we call as the highest spectral resolution.

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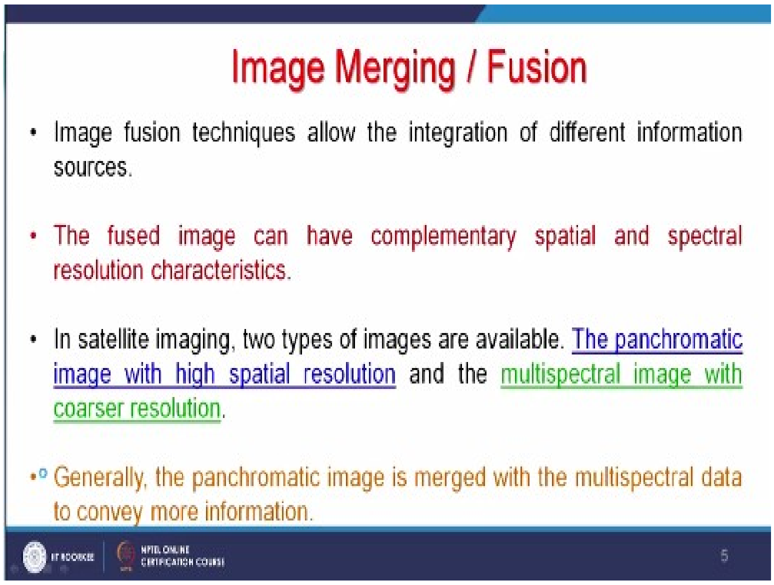

So, image fusion basically allows us to integrate different information sources. I have also said that image with map; map after scanning can also become a raster image and that can be merged. And these fused or merge images can have complimentary spatial and spectral characteristics. And as you know in the satellite based remote sensing or satellite imaging, 2 types of images are available.

Panchromatic which has become quite common with high spatial resolution and multispectral images with relatively coarser resolution. So, one is a panchromatic that means black and white image but having high spatial resolution. Another one is having relatively coarser resolution but having multispectral images that means the colored images, I can create. So, by exploiting this image fusion or image merging technique, I can exploit both best of these 2; panchromatic as well as multispectral images.

So, I can exploit the high spatial resolution of panchromatic images and I can exploit the multispectral or different bands of relatively coarser resolution images and can create a new product. As you know that for a PAN sharpen; when we say PAN sharpen, so PAN stand here for panchromatic. So, these panchromatic images are generally merged with multispectral data to bring more information out of that or can be better information.

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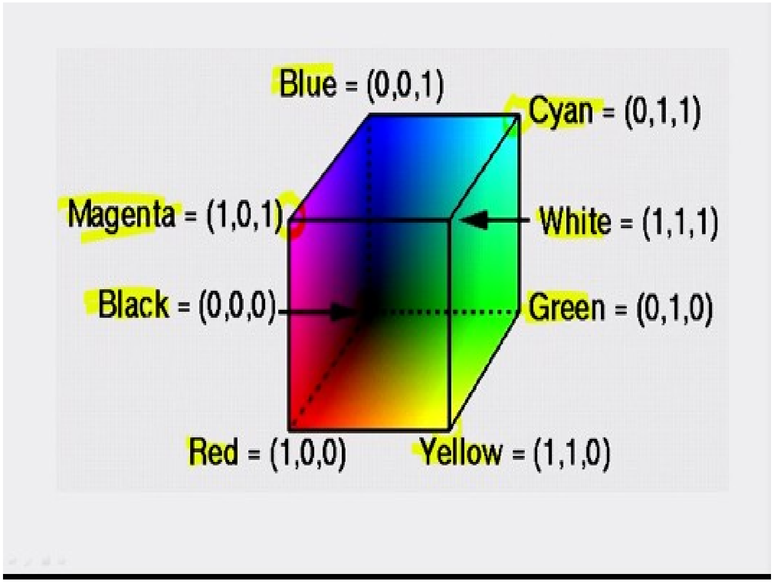

Before that just little fundamental, I have to discuss this color's space or color cube is known to us since our you know, High School or CBSE High School or so. As you know that there are 8 corners in this one; this in color's space. Color's space can be represented using different models. I am using this color cube model. So, on one corner. you are having of this cube, I am having the red color.

And then on another diagonally opposite corner, I am having blue color and again diagonally opposite to these blue and red, I am having green color. So that means say using this color's space, I can create a plane which can touch all these 3 primary colors that is red, green and blue. But the same time, these are called additive color schemes and the same time, I can also use a different plane which you will start says, cyan color.

Then I am having diagonally opposite color is the magenta color, at this corner. Cyan is this corner and then finally, I am having yellow color. So, this scheme is called subtractive color scheme. This scheme we have discussed in earlier discussion that this scheme is followed by the printing devices. But for our computer screen or projection systems, we used the primary color schemes.

Now after completing 6 colors that is red, green and blue, magenta, cyan and yellow. Now, Now, we left with 2 more ends of these or corners of this color cube. One is the white and another one is the black which is you know, at the far end of this color cube. So that makes our complete color space. Now, I can create a plane which will touch red, green, blue.

I can create a plane which can touch cyan, magenta, yellow. And black and white can become my intensity. So, using this concept, I can play with the colors within our data or within our images and exploiting this, I can also create merged or fused image. So, this is how it is important. Now I can also take out a cone out of this cube which you can see here.

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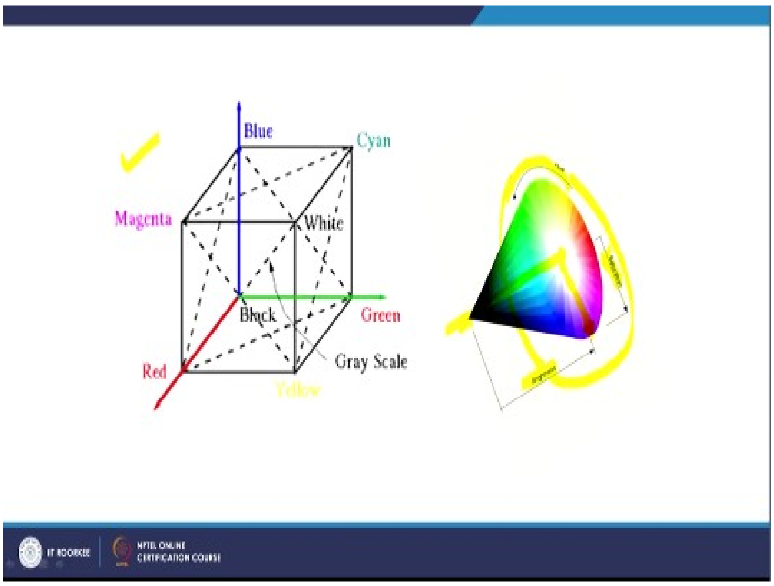

So that on the periphery it becomes the hue or colors. So, as I you know rotate around on this, I keep changing the colors or from centre of or from base of this cube or centre of this cone axis. If I go away from that then I am going towards more saturation. So, this becomes my saturation. And then I am having also brightness or intensity starting from zero which is the base of the cone or apex of the cone.

And the base is here which is white. So that means out of this color cube which is shown here on the left side, I can take out a color cone as well to understand these things in a much easier manner.

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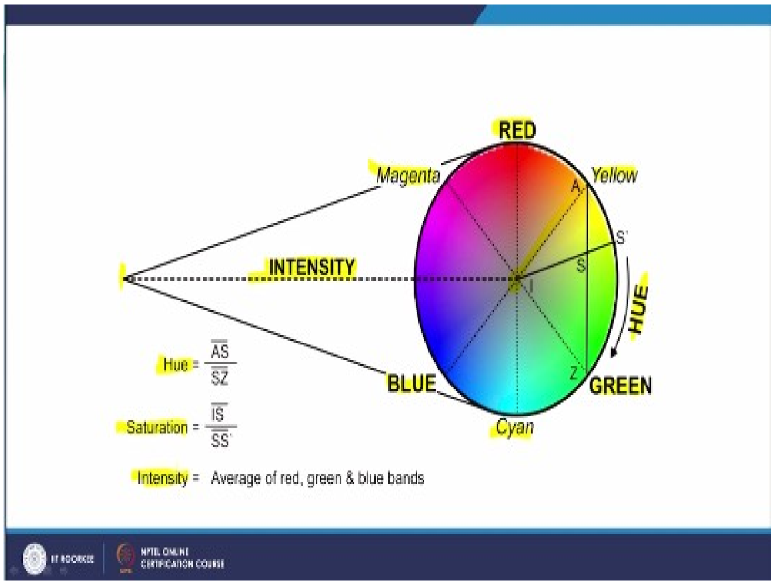

Now instead of 3D, I can now also represent in 2D in more simplified manner that I am having on this hue periphery. I can have red and green and blue; RGB is here. Cyan, magenta and yellow are here. And of course, if I go downward then this is my intensity scale and of course, this is black and this is white. And if I come out from the centre of this base of the cone to away from that, that becomes my saturation so here the saturation.

So, I can use these equations to achieve all this by playing within this color cube. So now, what example I am going to show you in which I am using a PAN image or you call as a PAN sharpening or PAN image merging, image fusion technique.

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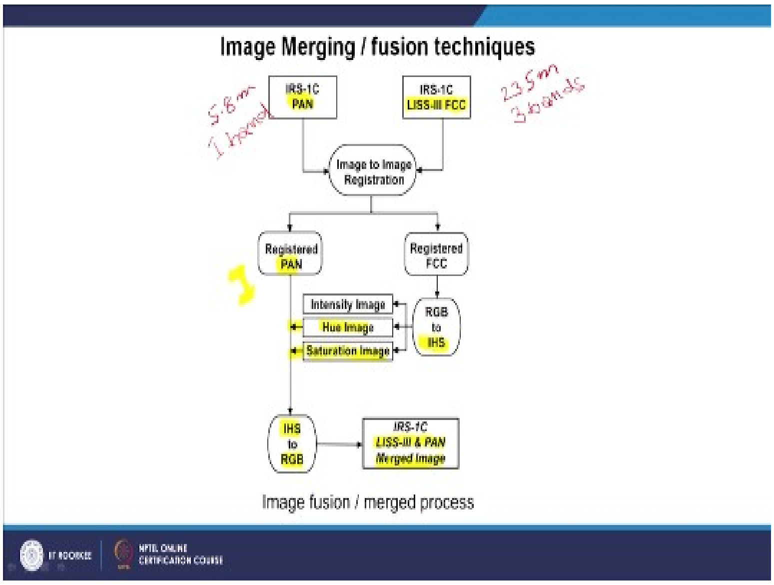

So, I am having a PAN image which is having high spatial resolution 5.8 meter. And I am having LISS-III FCC image which is having 23.5-meter resolution. So, LISS-III image is having but this is a false color composite that means it is representing a multispectral image but relatively it is having coarser resolution. So, what resolution it is having about 23.5 meter and this one PAN is having 5.8 meter.

But here this is a PAN image so single band; I am having just 1 band. 1 band here and when it is FCC so I am having 3 bands here. So, using these 2 qualities of 2 different images belonging to the same area, the first step is to do the image-to-image registration. Recall the Geo-referencing that means I am asking here the geo referencing. So, after doing this geo referencing, I can now play with that color space.

And what we can do that since this is RGB; this is red, green and blue image, this one. So, what I will do? I will split into IHS because that I can play in color's space instead of projecting my image into RGB plane within color's space. I can project into IHS that is intensity, hue and saturation. So here that image which was colored image for FCC; RGB image has been you know, splitted into 3 components; intensity, hue and saturation.

So, this intensity image is dropped here whereas a hue image and saturation image continue for our use. And our PAN image which is having high spatial resolution becomes our intensity image. So, this becomes our intensity image and these 2 hue and saturation image then we can go for backward transformation that is from IHS to RGB. So, first we splitted into RGB to HIS; I was draw, I was replaced with the PAN image.

Hue and saturation image continued and then later on, did the backward transformation from IHS to RGB and then we can achieve a merge image which will have the best qualities of both PAN and FCC image or colored image or multispectral image. And by which, we can create very unique product, very useful product which will bear the best qualities of these 2 input datasets.

In isolation, dependently these 2 datasets may not be very useful but if I combined, this output image can be very useful. Now certain constraints are there. The first one is that the date of these 2 scenes should be as near as possible or if it is same, that is very good like in our example. But if it is not same because the season if the season changes or year changes may be having the same date or same time but if year changes then you may get the differences and that would be unnecessary information or artifacts.

So, we do not want therefore, one should try to get the same database and it is not difficult nowadays because a lot of data is available and that can be exploited.

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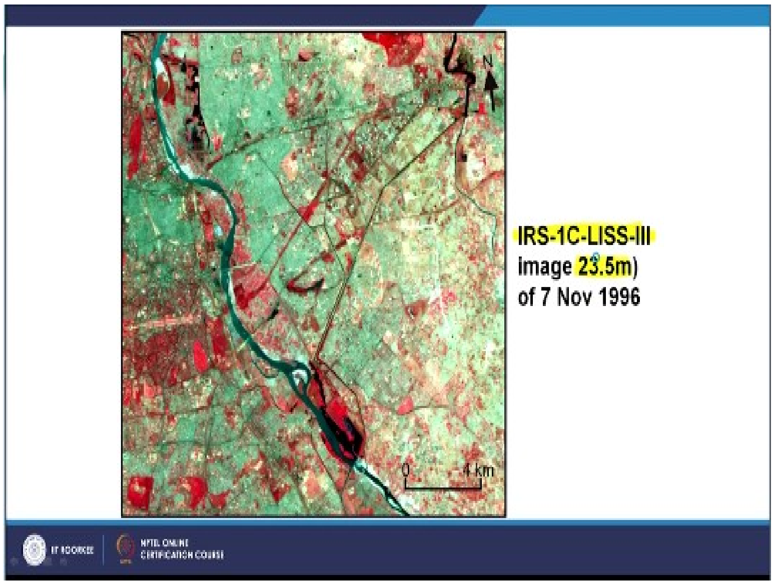

Now, this is our input PAN image which you can see here and then this is our LISS-III image which is of course, false color composite or colored image. This is having a 23.5-meter resolution and this is having 5.8-meter resolution. So, by showing this flowchart or methodology, we can merge these 2 images into a new product.

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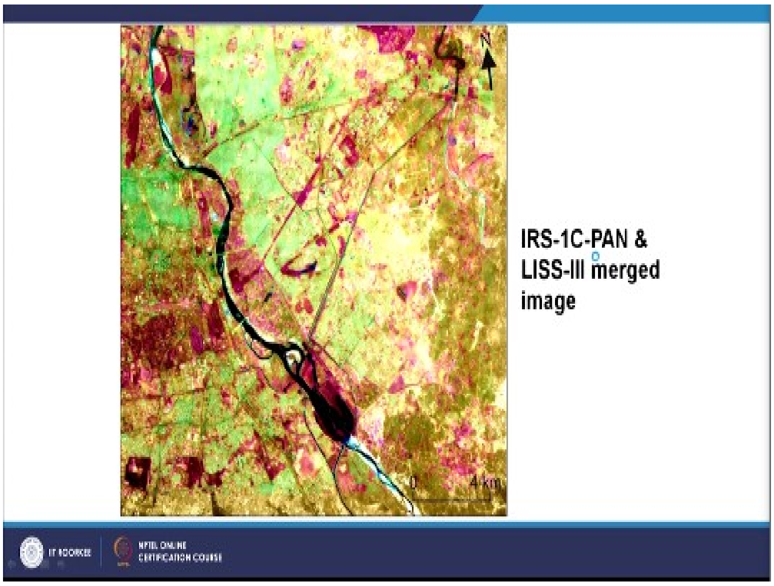

Now, this product is bearing high spatial resolution as well as colors. At this same zoom level, you may not see the efficacies or advantages of merge images.

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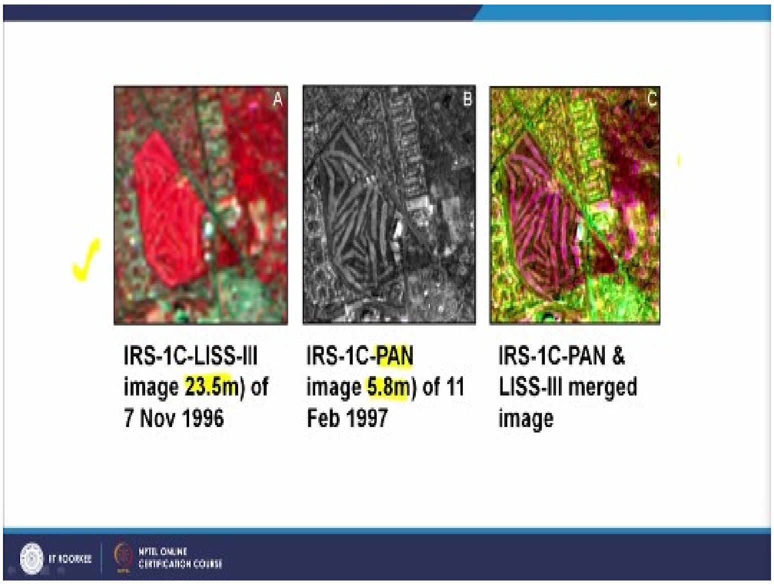

So let me bring a more you know, zoomed part of this image which is the Delhi golf course as you can see in the FCC image which is having 23.5-meter resolution. The inducible holes of golf course cannot be seen very easily in this image. Whereas if you see in PAN image, though it is black and white image but it is having high spatial resolution that is 5.8-meter and therefore, these different holes of this golf course are very much visible.

And when we go for this merge image as you can see that now this image has become colored as well as all those golf holes which we are not visible in FCC image are also available here. So, spatial resolution has come from PAN image and spectral resolution has come from MSS or LISS-III image and then we get a new product. So, this is how we can take advantage of this.

Now once you become comfortable with such a merging techniques, you can play further with these techniques because this is just playing within the color's space using your images and this is what we did.

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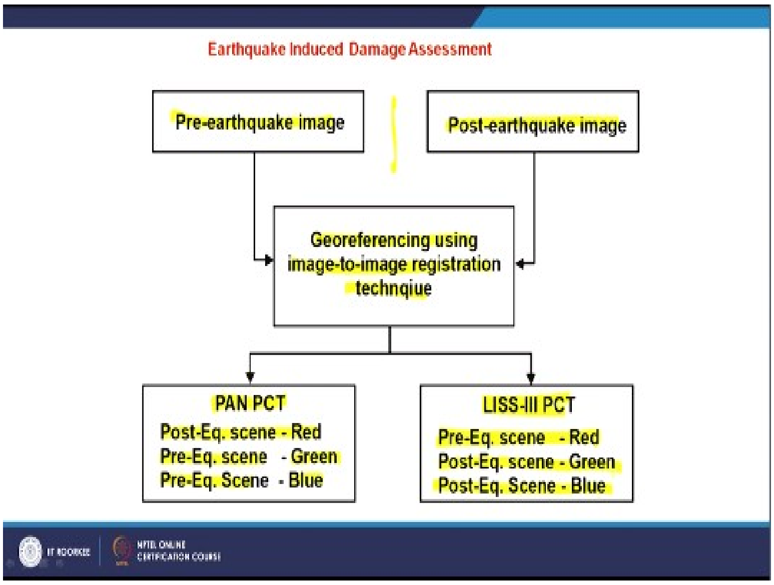

We wanted to detect the changes induced by an earthquake event. And that means we were not basically looking for 2 different spatial resolution images but 2 different images. And in between these 2 images when they were acquired, in between the earthquake has occurred. So almost the same technique but little variation that the pre-earthquake image was taken, post-earthquake image was taken from the same sensor having time difference and in between we are having an earthquake event.

Of course, Geo-referencing has to be done or image to image registration has to be done so that both you know, stacks together very nicely. Then I can do this technique on PAN images. And I can also do this technique on LISS-III images to detect changes induced by an earthquake. So, I am having both the examples where what we did? In case of PAN image, we assign red channel to the post-image.

And for pre-earthquake scene, we assign green and blue. And then what it will bring; any changes which in terms of reflection that means reflection has increased, will appear in red color in this PCT that is called pseudo color transformation or pseudo color transform image. Similarly in case of LISS-III, pre-earthquake image was assigned red color.

So, there is a difference here; the pre-earthquake image was assigned here in case of PAN post-color because here we are handling the infrared channel because we wanted to detect the moisture or water bodies. So, infrared channel was assigned red color in the pre-image and post-image green and blue. And by which, we can again bring a pseudo color image and transform image and that will bring some beautiful results.

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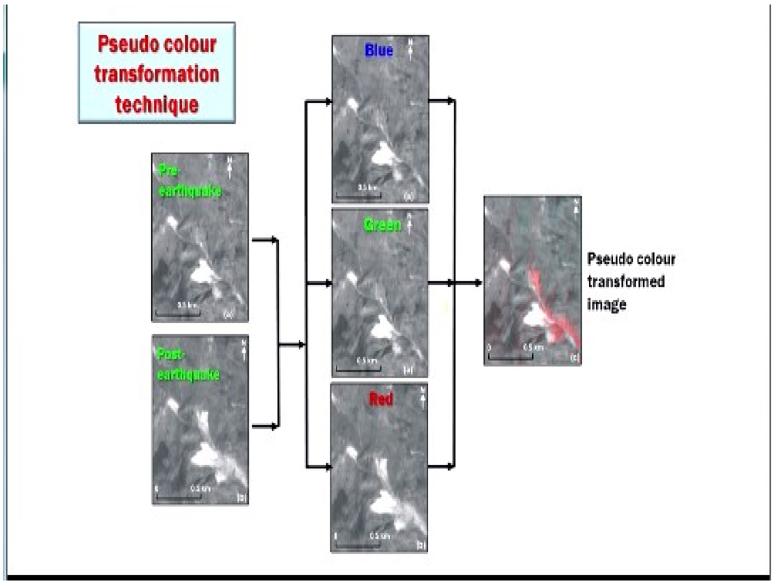

So, let us see the example here. The same thing; it is a pre-earthquake image, post-earthquake image, now they have been you know blue, green, red and 3 components because this is additive color scheme was followed and a new product has been created which is called pseudo color transform image.

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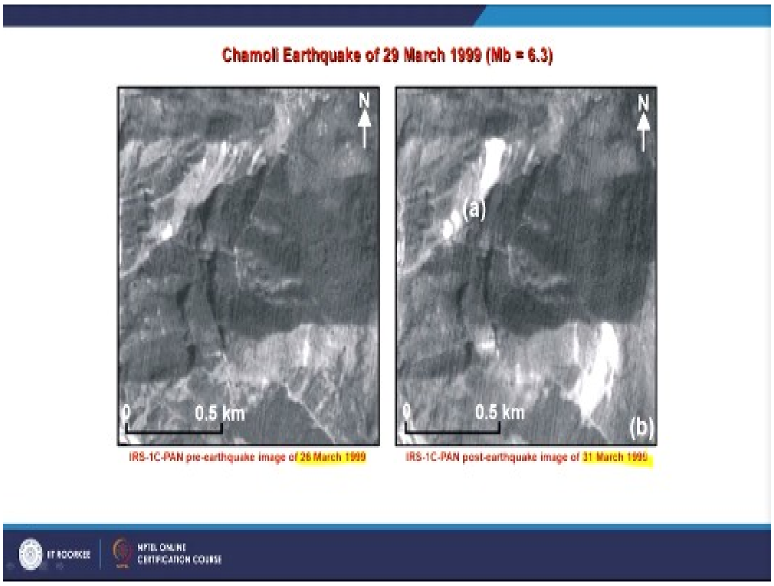

Now results are like this that on the left side you are seeing pre-earthquake image on 26 March 99. Here you are saying 31st March 99 post-earthquake image and earthquake occurred on 29th March that means between these 2 dates. So, this is something like matching to images or figures but it is not very convenient.

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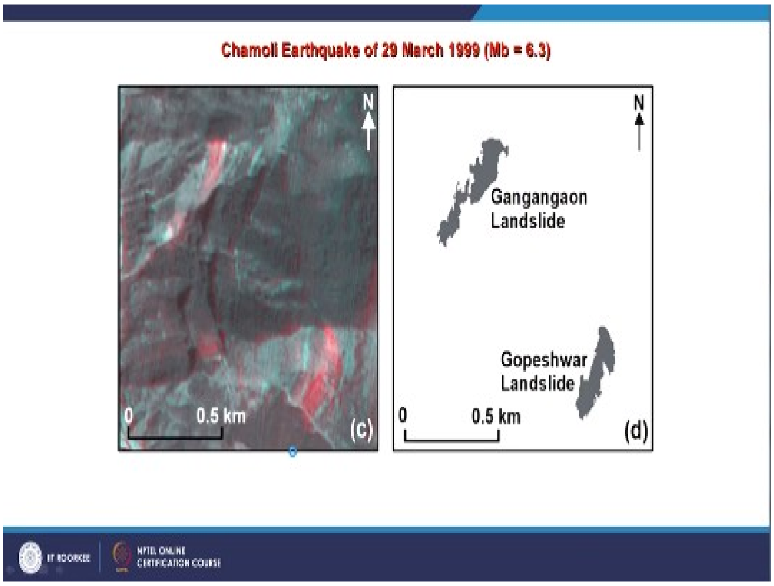

So, using this pseudo color transformation technique, we created one single image which was showing the changes which has occurred between these 2 input images dates. And the red areas are showing the changes in terms of reflection that increase reflection and this is because of landslides which were induced by this Chamoli earthquake of March 29 on 1999. So, then it becomes much easier rather than interpreting these images having you know, 2 different dates.

Now, these 2 different dates images have been transformed using that color's space concept and a pseudo color transformation image was created. And this is what you see. Another important thing you might observed that there are still white area. White areas are depicting that no chain between these 2 dates have occurred. That means they were already landslides here or here which were not got disturbed but other places, it got disturbed.

Now these are digital images. So, we can do further processing like we can mask every other thing except the red area like done on the right-side image and you can exactly match landslide affected area within that image.

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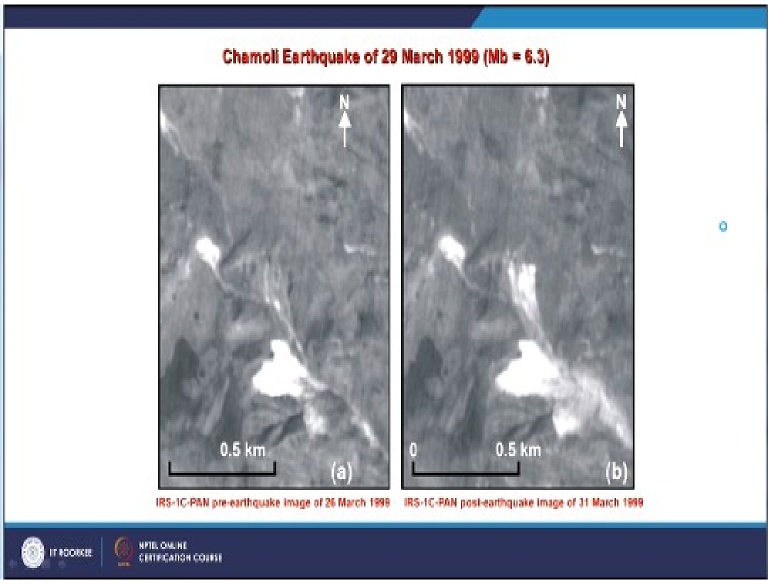

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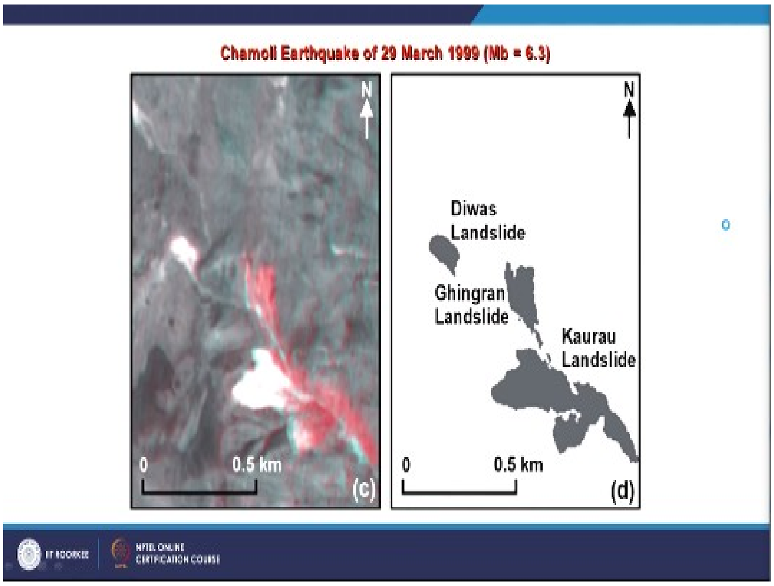

Similarly, one more example is here; pre-earthquake image, post-earthquake image of the same dates, same sensor but when we merge it, it brings a beautifully the new landslides or enhancement into already existing landslide. So, white colors are again depicting that landslides were already existing; no change in terms of reflection whereas red color are showing the changes. You know, new surface has been exposed means vegetation has disappeared.

And that can happen due to fresh landslide and that has happened because of that 29th March earthquake. Again, you can mask everything and you can bring only landslide affected. Reason you can do the measurements and other things very easily.

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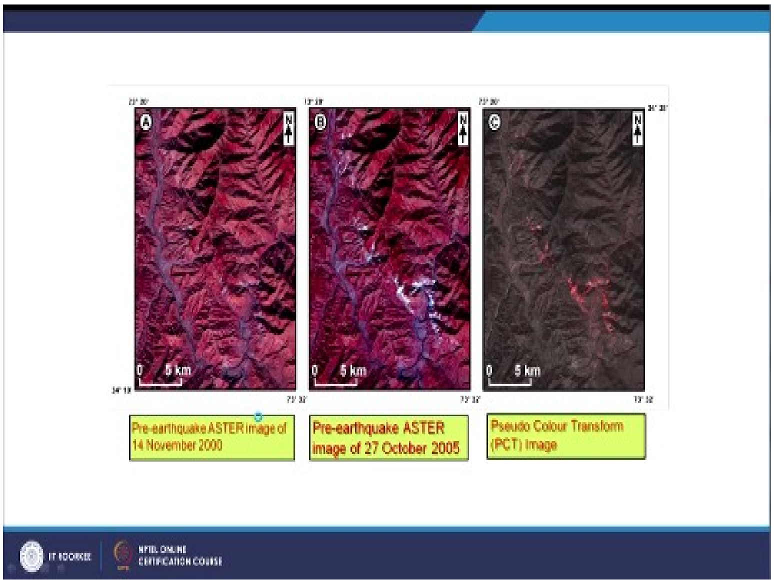

Similarly in many other earthquakes, same way we have did the color transformation. In the previous Chamoli example, we have taken you know PAN images, high spatial resolution images. Here we have taken the false color composite images and still you can do the same pseudo color transformation as the right-most image depicts that one. If time gap is minimum then you get the very good results. If time gap is large, you do not get those good results.

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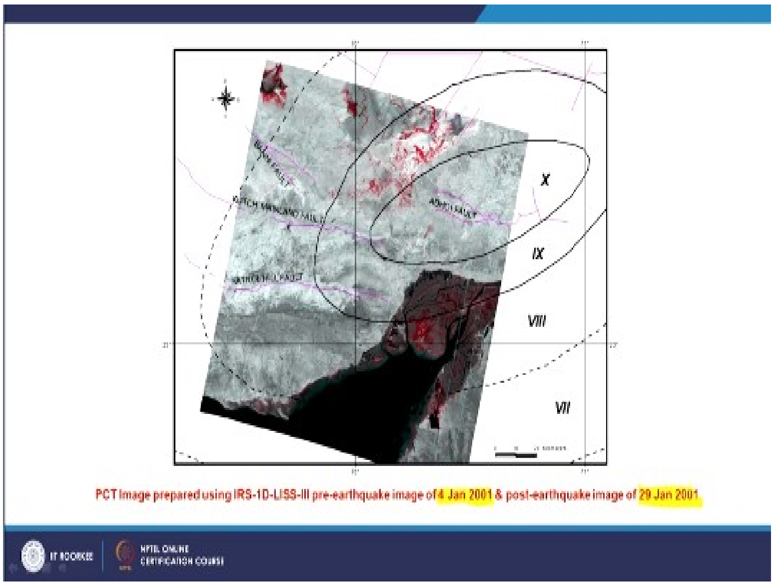

One more example and that is playing with the infrared channel. Here, we wanted to highlight that whatever has changed in terms of moisture or new water bodies because of an earthquake event, we wanted to you know highlight or bring out of these 2 input images. So, 2 input images; that is, 4th January 2001, 29th of January 2001. And in between on 26th of January 2001, Bhuj earthquake occurred.

So, when we took this infrared channel and assign the red color for pre and post green and blue and when we made the pseudo color transform image, what you are seeing in this that all red areas are showing the changes in terms of more moisture or water bodies and a lot of because there is a co-seismic phenomenon which is called liquefaction.

So, in a large area; north of epicentral area, they were liquefaction occurred and water bodies for some time or water for some time appeared on the surface and then disappeared in between these data were acquired. And when we did the pseudo color transform analysis, we get this thing very clearly. These images as I was mentioning that once you can understand you know, the magic or advantages or efficacies of color's space, you can really exploit.

And create new products using high spatial resolution or high spectral resolution of 2 different sensors images of the same area or even the same sensor images having 2 different dates of the same area. So various ways, you can really exploit this color's space and can create new products. So, this brings to the end of part 2 of pre-processing of a GIS database and then we will go and discuss later. After this, we will discuss the last part that is part 3. Thank you very much.