Remote Sensing Essentials
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Lecture - 47
Principles of Image Interpretation

Hello everyone, and today we are going to discuss principles of image interpretation. Indirectly once or twice we have interpreted some images, but we need to know what are the key or different you know, key components are keys of image interpretation, because, image interpretation is very much required because of the reason that after all these images have to be used for certain applications.

One image interpretation or that pattern recognition while discussing image classification and techniques especially you know the unsupervised classification techniques we have discussed indirectly about the image interpretation but many times that automatic way of classifying an image may not be solution, because in single image we are having lot of variations which are present there.

Lot of heterogeneities which are present there and human interventions or intuitions are required to get the information. Another point also, you recall that picture tells 1000 words and I have added in that that an image, a satellite image tells 10,000 words. Because whatever you are seeing on an image much more is there inside or when we start doing interpretation. So, that is skill one has to really learn while using the images. So, these are the basic things which are we are going to seen or discuss in this image interpretation. So, the basic principle is here is the visual interpretation.

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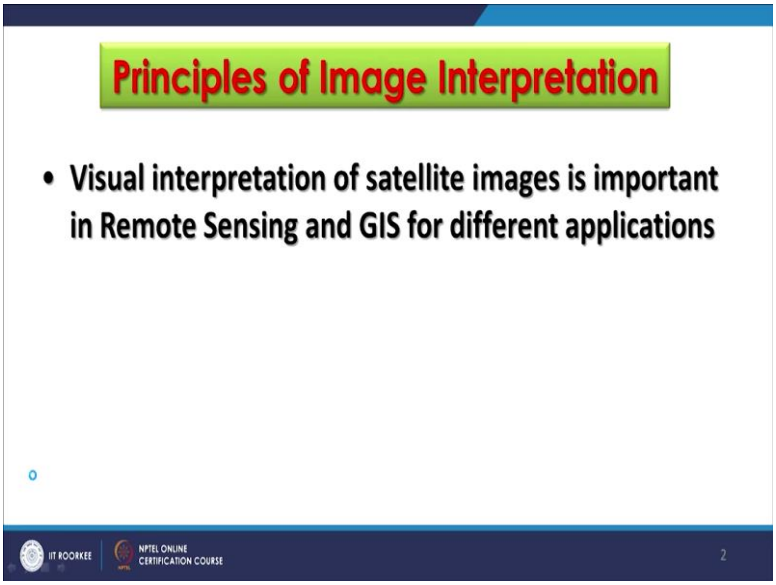

Using our eyes and mind of satellite images is important because for different applications, as I have just mentioned. Visual interpretation is a skill that has to be learned by the interpreter applying equally to an image or many images together. And nowadays a lot of data is being used for change detection is studies. And therefore, whatever we do through automatic methods, we must also verify through our visual interpretations, skills as well.

So that is skill we have to learn. You know, earlier when we started a remote sensing or aerial photographs, they were photographic products. And these, there we could not do much analysis except for interpretation.

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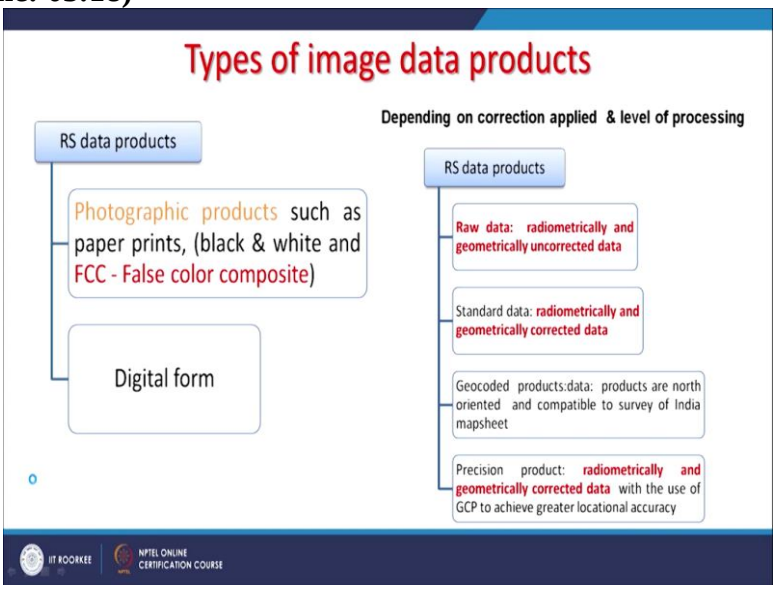

But now, most of these satellite images which we are handling today are in digital form. So, instead of seeing on papers or in form of films, now, we see generally on the screen on computer screen. Originally the data is collected as in digital form, but earlier we did not

have such facilities. So, we used to go for analog products and or photographic products. So, depending on what kind of correction applied and level of processing which has been done on satellite data, ultimately that data has to be interpreted or used for different applications.

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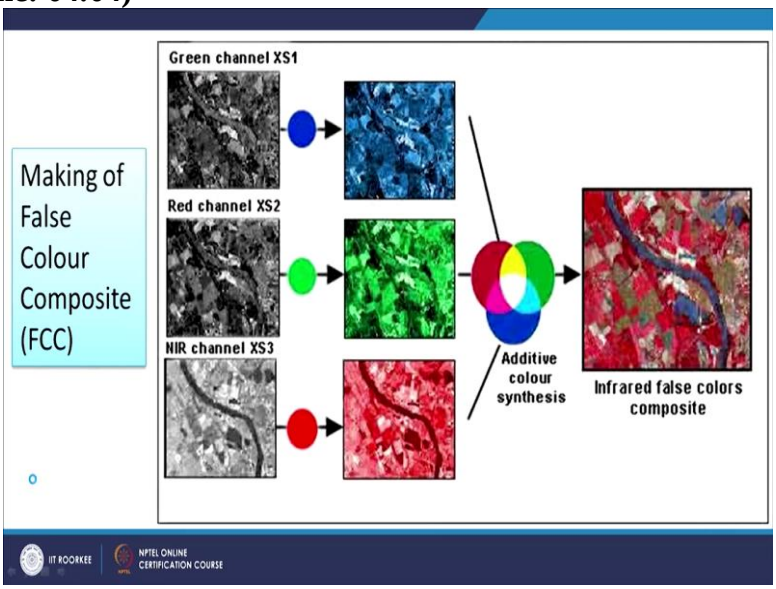

So, there are various keys are there and before that, I would like to remind this slide which we have also used when discussing colour transformations. As you know that different we are having nowadays multispectral scanners of course since 1972 onward, Landsat 1 also had multi spectrally scanner that is MSS had the 4 bands and if I now talk and then today we are having hyper spectrally scanners which are having more than 200 bands.

But creating colour composite is always has been a very common practice. So, in colour composite as you know we use the additive colour scheme and then we take the 3 bands 3 different bands which are highly uncorrelated or not correlated. And then generally in a standard false colour composite we assigned and for infrared channel we assign red colour and accordingly then green and blue.

And by after this colour transformation, or edit through additive colour scheme we get a false colour composite image like this. Now interpretation because 3 bands information is combined in 1 and black and white images are not as easy to human for image interpretation as the colour is always human is always comfortable with coloured images. Because discrimination becomes much more; stronger in coloured images then compare to black and white image.

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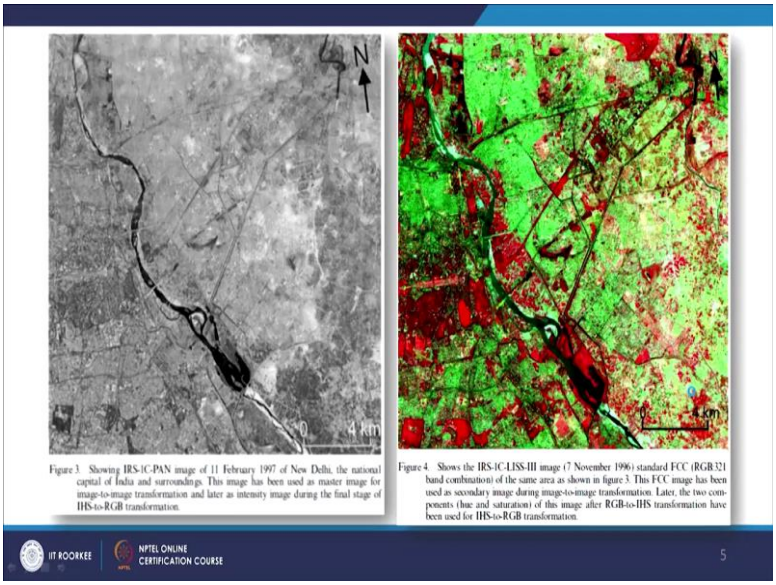

For example, these are left image is the panchromatic image of Delhi region and Delhi area and on the right side what you are seeing is the colour composite and much more it is this is a IRS-1C-LISS-III image which is standard false colour composite that means, and infrared channel has been assigned red colour and that you can also see that the areas which are having very strong presents of vegetation are appearing in this false colour composite in red colour.

So, as you can see that a lot of ease is there with coloured images rather than black and white image. However, black and white image though it is having higher spatial resolution, and that resolution is about 5.8 meter resolution, whereas, this LISS 3 is having 23.5 meter resolution, but it is multispectral and therefore, it is much easier for us to interpret as image because vegetated areas or agricultural lands or whatever the forested part or a forested part all can be recognized very easily also built up land and other thing.

So, therefore, a coloured images interpretation is very much required. Now, what should be the, when I go for interpretation, what should be the strategies for image interpretation or visual image interpretation. Basically, the purpose here is to identify what we see on the images.

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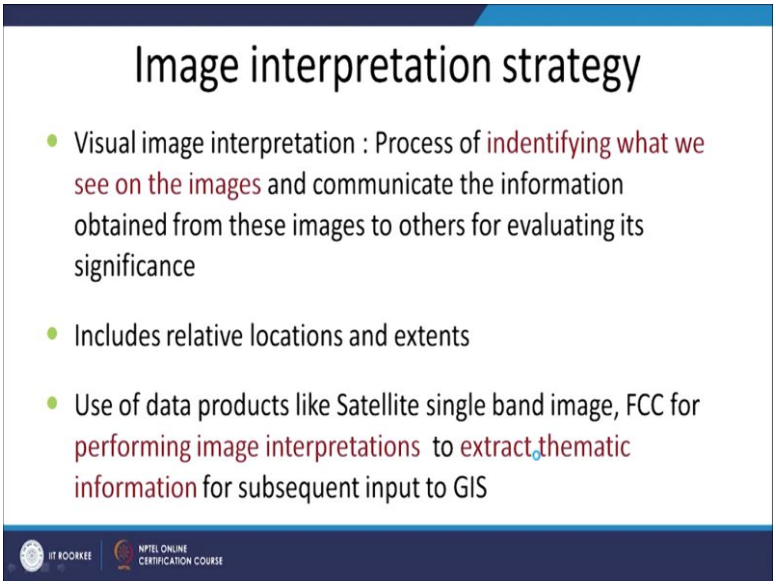

As in the previous image we were seen similarly, that whenever we get an image then we try to identify and different objects which are present in the image and these objects we identify based on certain key criterias. So, those criterias we are going to discuss in detail and once we what we see on the image and communicate the information obtained from these images to others for evaluating, its significant.

And so, like we the; whoever is having that kind of skill of a visual image interpretations can do and then reports and other maps can also be prepared. This also includes that what is the location and extent of that image like here. When we saw the Delhi image once the location is known now we know that there are a lot of built up area which is in this false colour composite it is appearing as ah green colour.

And lot of vegetated areas are also there and some water bodies. So, 3 4 distinct the land uses or land parts are there. So, this also includes there the image belongs to what is the extent of that image and use of such products like satellite images false colour being used single band also sometimes, if it is black and white or panchromatic image, then sometimes panchromatic images.

Images are used false colour in composites are used or also we use the merge images means exploiting high spatial resolution data of panchromatic and merging with multispectral data and can create a merged coloured image. So, all these kind of products can be used for image interpretation.

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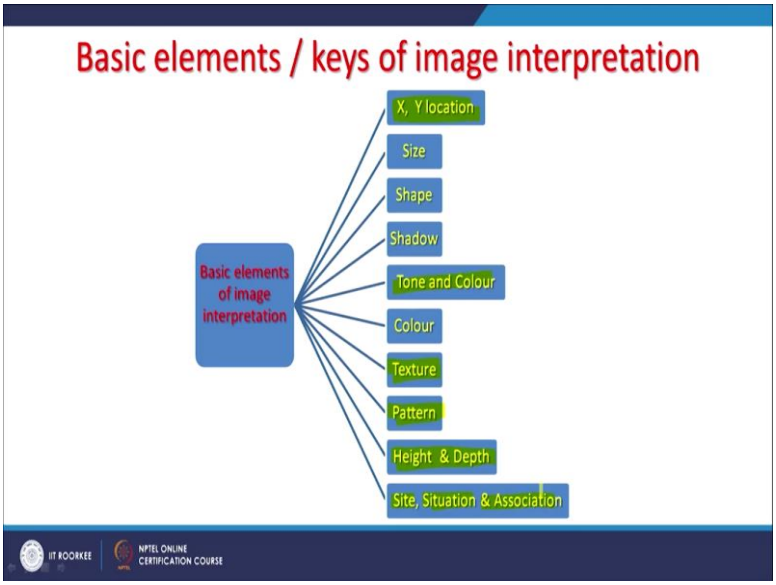

Now, what are the levels of interpretation keys are that these criteria which we use to identify different objects which are present in the image, the key interpretations are the basic elements of image interpretations are the first is the location, what is the location of these, objects which are present in. Because if I am seeing a river, then along the river I might be seeing some features which are always associated with the river.

So, similarly, if I am seeing some built up area and I am seeing a green area, maybe having a square or rectangular or circular body, I may interpret it as a garden or a park being that built up. So the location is very, very important for one, which is one of the key about basic elements of image interpretation, then the size of the object which we see here because we must do the scale of that image, which we are seeing on screen.

Because of now we do the interpretation directly on the screen of computer. So, therefore, the scale also should be known to us. Then shape what is the shape of that object. If it is a completely very, very straight line and throughout its a thickness the width is not varying then and sometimes we see some stations also along that track, then we can interpret that as a railway track.

But if it is a say river, then on that river is flowing in a plane areas like invocated plane, then that will have a you know, wavy kind of appearance and that we can interpret it very easily that is a river. So, the shape of also matters then shadow because if I am working in a hilly area audit doing interpretation, image interpretation of hilly terrain. There also shadow will play a very important role also in the urban areas.

Tone and colour that also very important key of image interpretation that what is the tone and what is the colour if it is black and white, then we say tone ever it is colour composite and we use the colour and texture is also a very important and whether it is a very smooth texture or a speckle texture or having some pattern in the datasets or in the image associated with certain objects that also exploited.

Then height and depth. Sometimes, we get that information indirectly and that can also be used in image interpretation. Because if there is a say building will have a shadow and because of looking the shadow, we can have some idea about the height of the that building. So, that is why height or depth plays very important role in the site that is location situation, how it is situated and association with what features it is associated.

If it is it, we are seeing roads, we are seeing railway track, we are seeing some water body and lot of built up land, then we it is easy to conclude that it is a some village or town or cities there depending on the size of that area. So, in that way image interpretations are there. Now, we will go one by one of these key interpretations.

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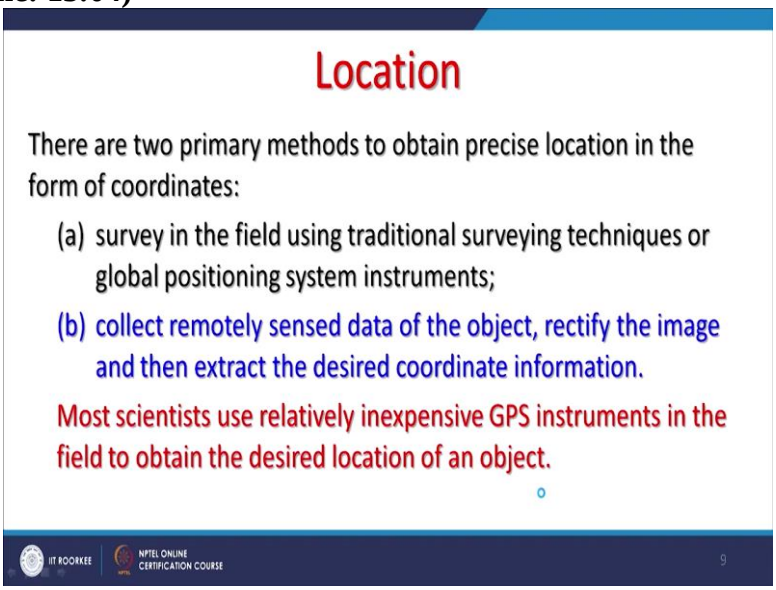

And will along with that we will be also seeing some examples. So, there are 2 primary methods to obtain precise location in the form of coordinates. One is the do the survey in the field using traditional surveying techniques or may be using our GNSS or global GPS systems. And that can also be used to collect the exact location of different objects which are present or I am seeing in the image as well as in the field.

Also collect remote sensing data for which we are going to have the interpretation and rectify the image, geo reference the image and extract the desired coordinate information. So, that information can be extracted from these geo reference images. And most users or scientists are relatively they use the inexpensive GPS instruments may be for not going for very accurate positioning, but may be little coarser positioning but as time is passing more navigation systems nowadays are available.

Earlier only US that is, GPS was available. Now multiple and navigation systems are available and therefore the receivers which GNSS receivers which now we use in the field are giving very relatively very good accuracy say about 3 meter or 4 meter in open areas, that is very good for such kind of a studies in which we need to do the interpretation and one and using one of this key is the location.

Now, the next key is the size. Size of the objects is one of the most distinguished characteristics, important characteristics and one of the more important elements of interpretation because, if, there is an object by seeing the relative size also we can have some idea about the object very quickly. So, what size includes the length, width, perimeter, which can be measured or it is necessary to also the dimension, the scale of the image or photograph.

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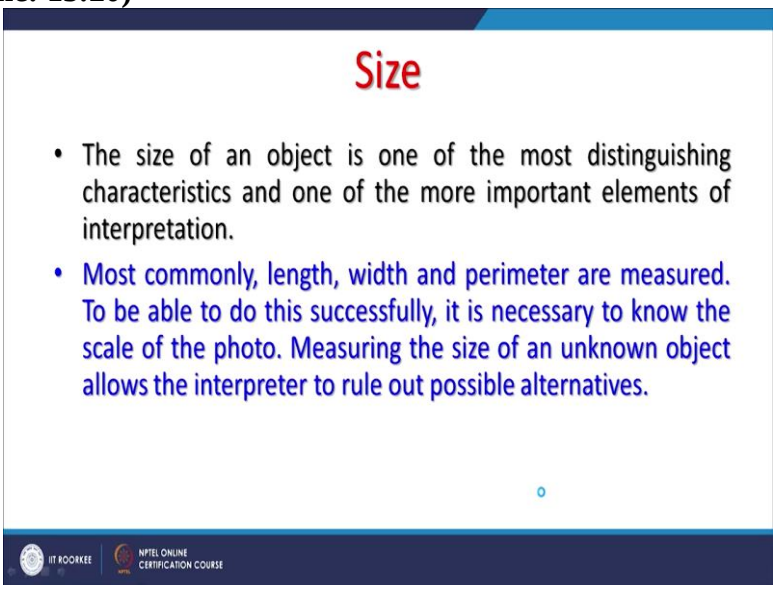

If I am doing an interpretation on print out of a image then I should know the scale. Because if I do know the scale then probably the idea about the size I may miss. So, that is why it is

important to know the scale. Most commonly measured parameters for the size or length, width, perimeter, area and occasionally maybe volume is required. So, if I am seeing a water body and its association, colour and everything I then I can identify that perhaps it is a water body.

Now, it is might be upon a reservoir or may be a river stream. So, depending on the size, shape and other things which we will see so shape, like size important key of image interpretation.

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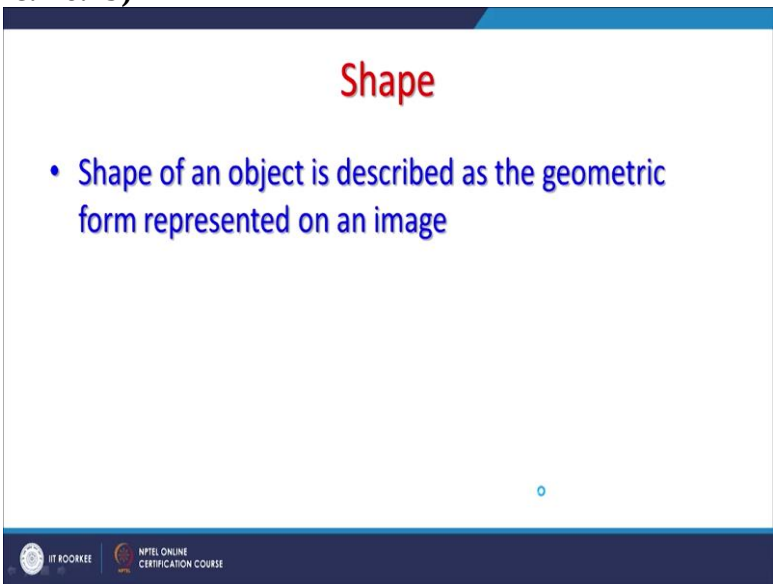

So, the shape is very important to do the reliable interpretations of any satellite image. So, it is basically the geometric form which is represented on the image of by that object. Regular shapes if I am seeing and repeatedly which are being seen, then these those shapes might be sign of a manmade objects. Like there might be a big colony and all buildings are of the same size and shape.

And they are located maybe in 20 numbers or 30 or 40 numbers or 100s of numbers then regular shapes are there then it is very it becomes easier to identify that it is perhaps a colony or well developed town or well planned town is there. Regular shapes with the no distinct geometrical pattern or sign of natural environment because in nature may not leave those kind of regular shapes or patterns.

So, therefore, if such situations are there we see. Like no distinct geometrical pattern in regular may be forested part or maybe you know a fluvial system, any such a thing which

may not be having a regular shape it is these might be having irregular shape, so, based on that also we learn how to identify such objects. Next and another important key of image interpretation is the shadow.

The because as you know that these images are generally optical images are generally acquired in the day time, and of course, the between these sun synchronous satellites are acquiring images between 9 30 to 10 30 and if you recall the discussion on false topographic perception phenomena. There we have discussed that how shadows plays very important role in the image interpretation.

If we do not care about that false topographic perception phenomena which is because of the shadow, then we are bound to make wrong interpretation especially, of images of a hilly terrain. So, shadows is very, very important. Now, so between this 9 30 to 10 30 when there are overpasses by the satellites. Generally sun is around 45 degree 49 degree above the region and we may have long shadows at that time. So, shadows are there and shadows can also be exploited in image interpretation. And then, our interpretations becomes much easier. So, shadows on some, of course, they obscure other objects.

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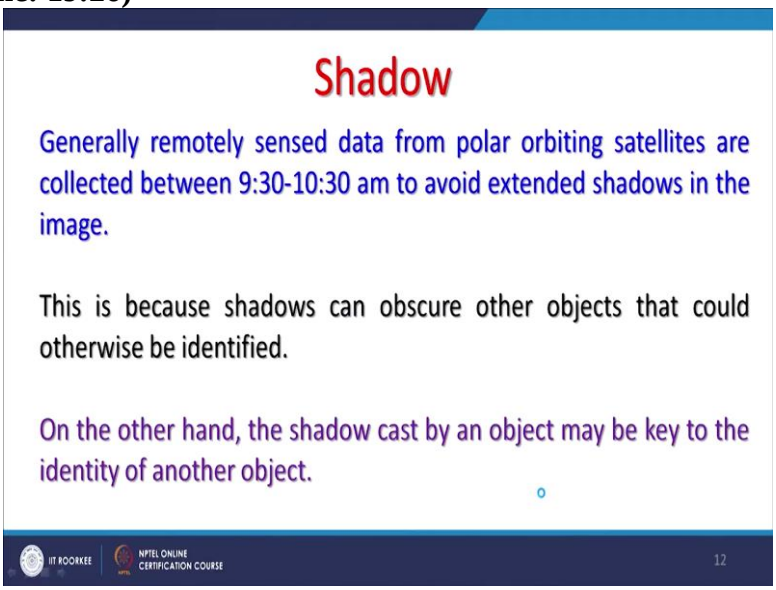

But same time they also provide you know, help to identify different objects which might be present within that image.

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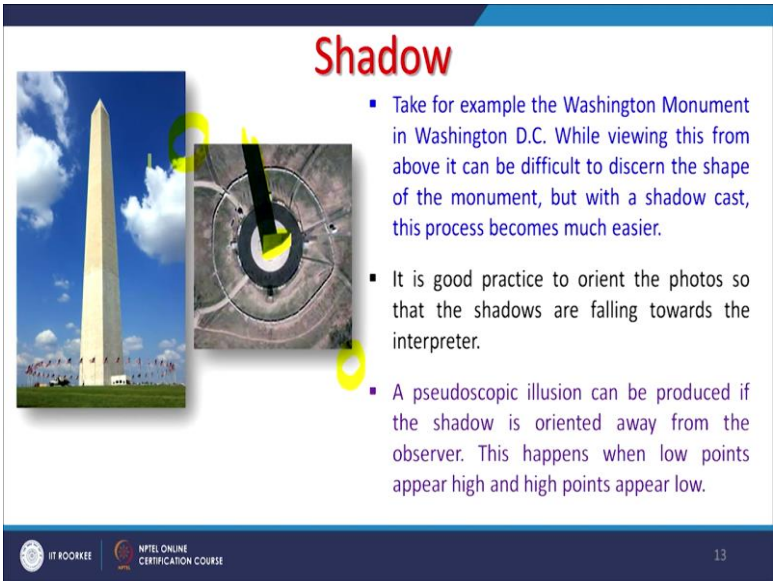

For example here and this is a very famous monument which is called Washington monument and Washington DC, USA. On the left image you are seeing the photograph taken by a camera and on the right one you are seeing a satellite image taken in the morning hour. See so, if you see very carefully the object looks very small as I have just highlighted with the highlighter.

Whereas the shadow is in black and very long, which is going like this. So, just looking like this, we can have some idea about the height of the object. This is a very high resolution satellite image and still the shadow plays. So, that means the even this image was acquired and north is upward that means the sun was somewhere here. And this is what we have been discussing in FTPP discussion false topographic perception discussion.

That generally the sun is in the southeast quadrant. So, it is very easy to identify that this Washington monument is a very, very having a very big height and this object because based on the shadow, if suppose, that we did not have the shadow, then it becomes very difficult to identify that this object is having big height. So, this example as I have just shown, becomes very difficult to interpret, if we do not have shadows.

So, shadows sometimes obscured, because the objects which are below this shadow or have gone in the shadow are now very difficult to identify true. But the same time as some other objects are identified easily if we are having the shadow. So, generally it is good practice to orient the photos that shadows are falling towards the interpreter that means, we should assume that sun is here in the northwest direction.

Then we get a current depth perception also. Now, this psedoscopic illusion or false topographic perception can create problems of areas which are having lot of shadows, especially in hilly terrain. And therefore, a shadow must be taken very carefully.

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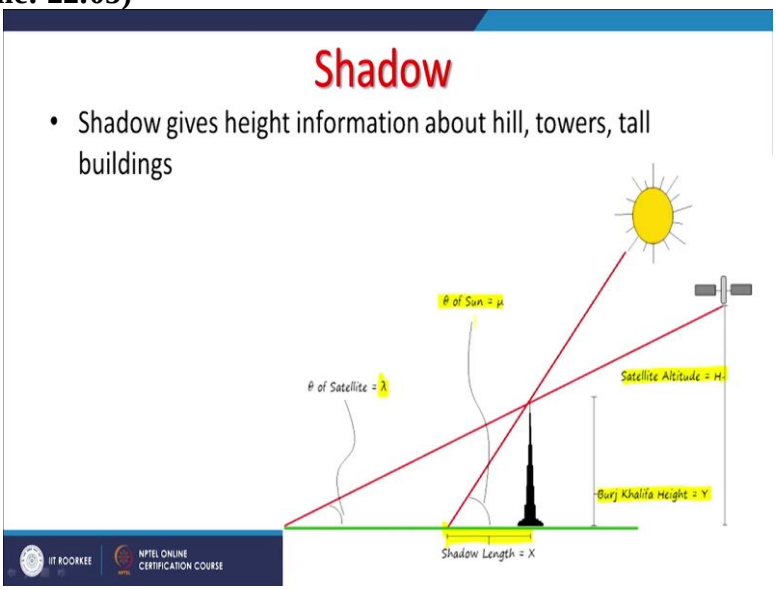

You know that using shadow we can also determine the height of the building as well. So, this is what is that if shadow length is this much which is x here. The position of the sun is here so we are getting the length of the shadow. We know what is the height of the satellite or altitude. So, this has been calculated for you know the tallest building on the earth so far that is Burj khalifa in Dubai in UAE.

And then height can be calculated using this you know this theta of the sun or mu and that way we can have the estimate of height also. So, this is we are having this angle theta of the satellite that is lambda and mu and that can be used. So, shadow though it obscures the objects and create problems for interpreting other objects, but this and the shadow also helps us to identify various objects which are having besides or hilly areas and also we can determine their height as well.

And one other thing is that while interpreting areas which are having a lot of shadow or hilly images one should take care about the direction of illumination. So, that means we should have either we rotate the image or do the false topographic corrections and then do the interpretation.

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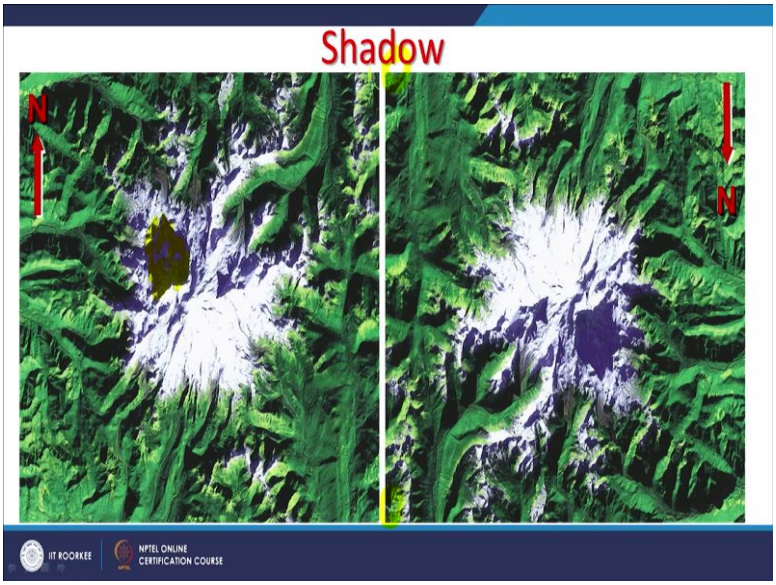

Now shadow as this false topographic perception and discussing this slide is from there, what we are seeing that when north is upward, sun is in the southeast quadrant, then its snow peak pairing is in depression, which is its own perception. And this is all happening just because of the shadows. You see here this part is completely in the shadow, which is there. And when we rotate by 180 degree north is downward.

Now, we are seeing incorrect perception and what we have done is we have force the sun by rotating to go in the northwest direction and therefore, we get correct perception and once you start getting correct perception you are bound to make and good interpretations are correct interpretation but if you are getting wrong perception it is inevitable that you would make wrong interpretations. So, the shadow plays very important role in image interpretations.

Next key is the tone and colour and this like a which band I am using or the; which part of EM spectrum I am using and there it plays very important role. So, tone when I am using shades of grey then single band scenario might be and the my values pixel values will be bearing between these 2 extremes black and white and rest of the values are in grayscale.

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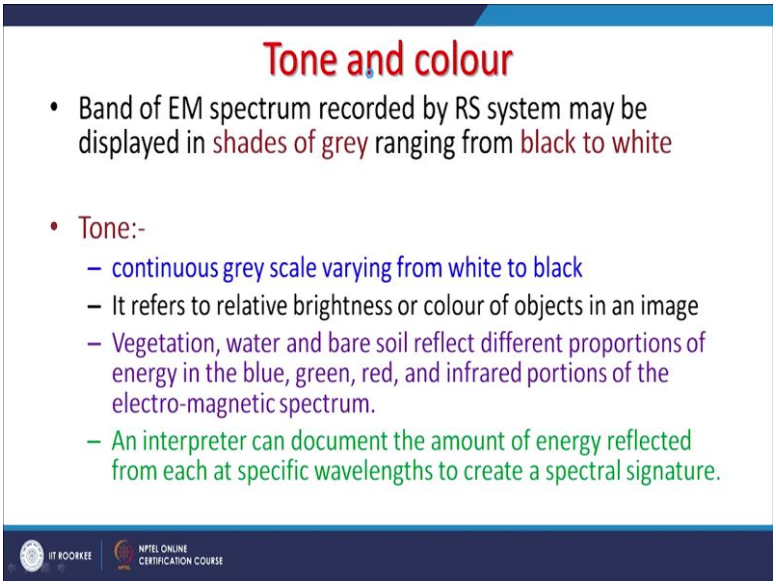

So, tone here basically is a continuous grey scale bearing from extremes black and white. And it is a basically relative brightness or colour if I am using colour or object and image. So vegetation, water, bare soil and rocks, everything will have their own tone and colour, depending on whether I am using black and white images or coloured images. And the interpreter, the person who is doing this analysis or interpretation can document or can write, while preparing reports. That the amount of energy reflected from each at specific wave length to create a spectral signature so tone is very, very important as well as colour.

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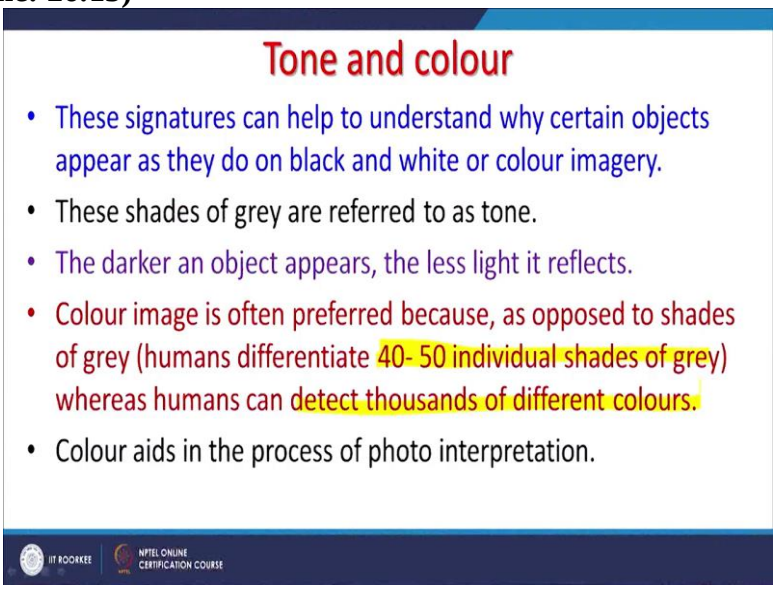

And these signatures can help to understand why certain objects appear as they do on black and white. So after doings initially these exercises where learning these image interpretations using tone and colour. Later on you do not have to really plot, but one learns the skill and

start doing interpretations when even if you are having black and white images or coloured images, generally the in black and white images or in grey images.

If I want to be more precise an darker object appears that means that less light it is reflected and brighter objects will have just oppose it to this. So the colour if I am using then preferred all most of the time because we are having now multispectral scanners. So, then as I mentioned that the black and white will allow us to differentiate only 40 to 50 individual shades of grey whereas human is very comfortable colour and because it makes interpretations very, very accurately.

And therefore the coloured images can allow to detect 1000 dollar different colours. So that is the difference between generally we should try to go for interpretations of coloured images, colours. Of course, it is in the process of image interpretation.

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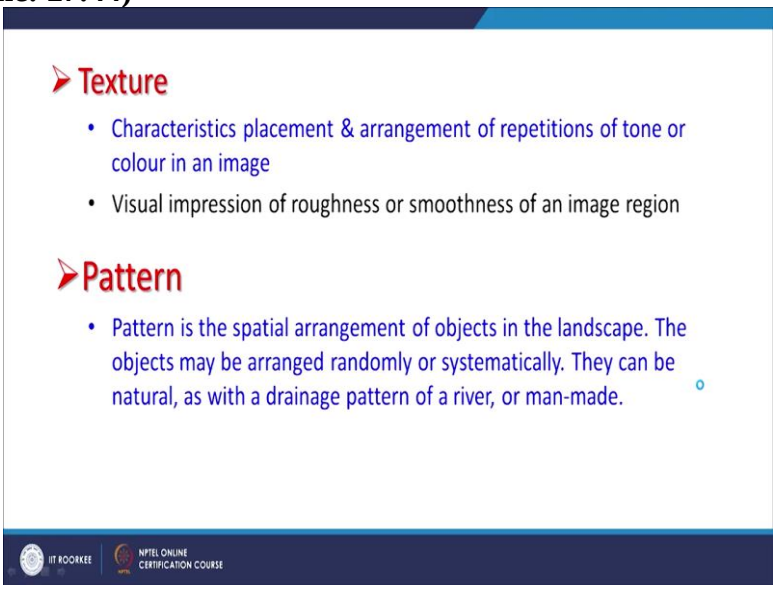

Next key is the texture. What is the texture? It is this the characteristics placement and arrangement of repetitions of tone or colour in image that makes the basically texture, visual impression be we get about certain objects or the area and looking there is smoothness roughness in the image or in a region of the image or a part of the image. Another is the pattern how these things are, you know, distributed in a space within the image.

So pattern is as a spatial arrangement of objects in the landscape. And the objects maybe arrange randomly or systematically man made structures as mentioned might be arranged systematically and but in a small town or village is the built up land may not have a distinct

pattern, but still when we find the houses and roads then it is become easier to identify and that it is a settlement or a village or a town is there may not be having a very good systematic pattern there.

So, mainly 2, 3 types of these patterns that maybe the natural one and like a drainage pattern of river man made maybe of buildings and other things roads, railway tracks, many such things are there. And typical adjectives used in describing pattern are like random systematic circular, oval, linear, rectangular, and curvilinear. So, many of these patterns can be identified if we are getting a some natural circular body and maybe certain blocks or a structure.

Then we identify that it is having irregular or circular pattern or linear pattern there may be a geological fault and then it has to be in a linear generally it is in linear fashion on the surface. So, we identify as a linear. Drainage pattern might be of having different shapes and different patterns. So, we identify accordingly. Now, the next key is the site situation and association. How these things are associated.

When we see generally association let me tell you that. When we see a big building, generally and associated a runway or a track and which barely we identifying very clearly, then it becomes very easy to identify that is an airport. So, how we have identified that airport because of association of building and runway together and might be close to some cities. So, that way and these things we learn and that kind of this skill and we start interpreting things very quickly and very reliably also. So, this is the association or situation where they are.

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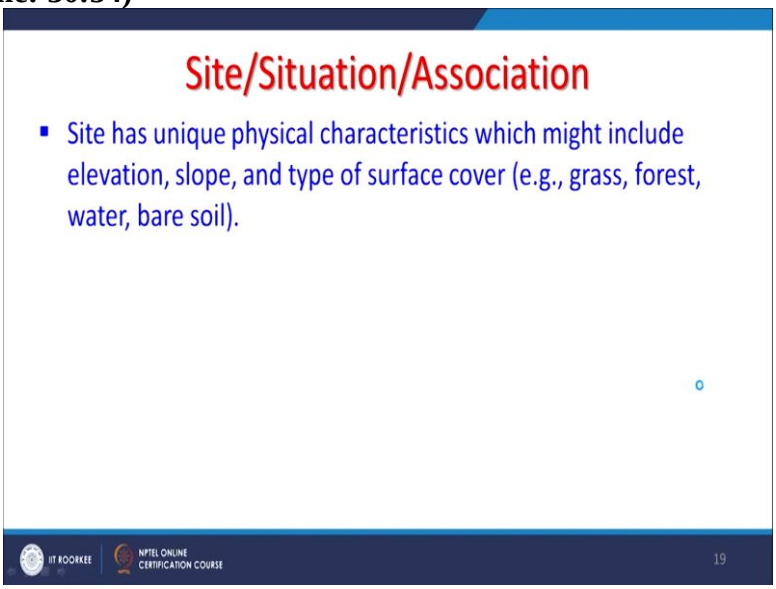

They are has the and unique physical characteristics, which may include the elevation, slope, type of surface covered for example, grass forests, bare soil, bare surface, cemented surface or these surfaces like we are having for runways at the airport. Also these association might be socioeconomic characteristics might be there and which are close to that close to water body. Generally, this is how the settlement started.

So, we can identify those things, if they are close to certain thing, hilly region or something, we can identify accordingly and this situation basically the first that how the objects in an image are organized or on the land organised and situated respect to each other. So, they say that is why site, situation, association all are together and association of different objects becomes much important to identify objects much easily.

Further on this most like I give the example of airports like most power plants, which will have material and building associated in fairly predictable manner. So, if there is a thermal power plant, then we might be having a disposal site which is having the dumping of the flyers we might be having a coal site where the coal is there so, we might be having objects which are very bright in tone or coal, very dark in tone.

And some building some smoke some chimney based on that we can identify that it is a thermal power plant. So, this association and pattern is allowing us to make reliable interpretations.

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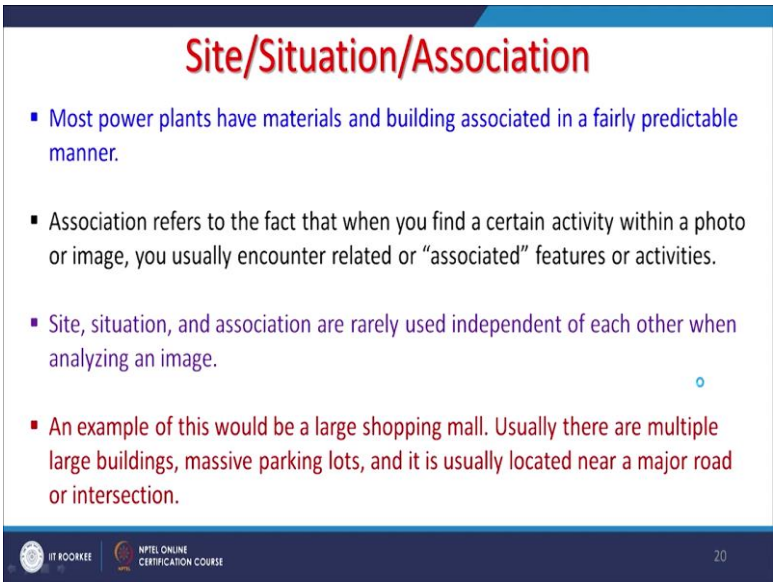

And this site, situation and association and are also rarely use in independent manner. They are used all ways in association means in for the surrounding objects. And nowadays for the built up areas in cities we might be seeing large shopping malls. So, there are multiple might bare large, multiple buildings, massive parking lots, and they are usually located near or inside a building inside a city and therefore, we can identify that that might be a mall. So, likewise we can identify.

Let me give you an example, which is more or less very natural example. And how image interpretation can be done and how it is can be very helpful. And sometimes also in order to, get more confidence in our image interpretation, we would like to use some other datasets along with the satellite image. So, this example is with that also what we are seeing on the left image is a false colour composite image of IRSA-LISS-II and that is 36.5 meter spatial resolution.

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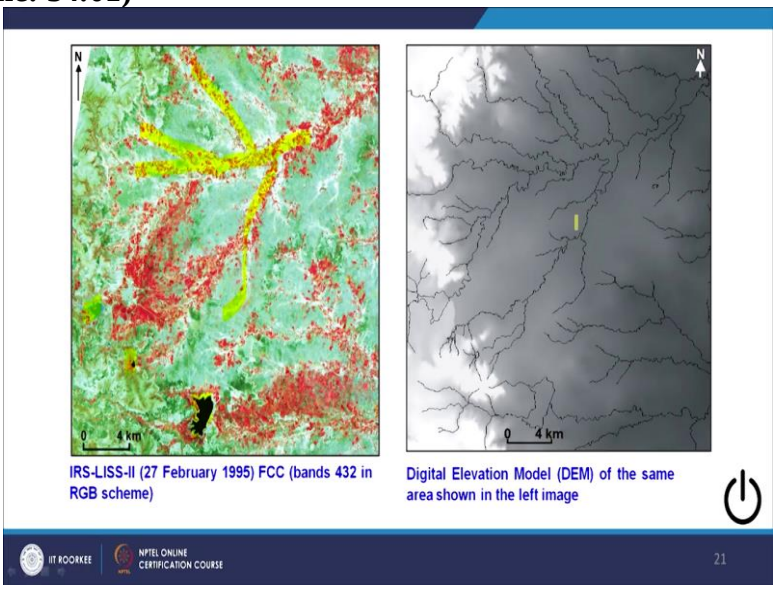

And what we are seeing that there are 3 big water bodies rather 2 big water bodies and one is small water bodies seen here. And because this is false colour composite, so, in the downstream of these water bodies, we are seeing growth of vegetation. So, now we are using not only the colours, but association and pattern as well. And these are the scattered fields small fields might be having different crops or maybe of same type of almost same type of crop.

But different stages and therefore, and this pattern is a in that way is very random or a special kind of thing. But in false colour composite, these agricultural fields are appearing as red. So,

therefore, it becomes much easier to say that these are agricultural field and water bodies generally either if it is pure water without any pollution, without much pollution or turbidity, then it should appear completely black.

If it is not then it may appear in blue colour or grey colour and so on. There also seen some drainage pattern which you can identify very easily so, kind of dendritic pattern. So, based on this, what we can identify that proudly that terrain belongs to a hard rock terrain also by seeing these images and the whatever the shadow which we are having, we can also identified that these are the areas which are higher ground.

And these are the areas of lower ground. And in order to have confidence in our interpretation, we can use other datasets like in this one and this dataset which is a digital elevation model of the same area of which this image belongs. And what we see that of course, these white areas lighter tone, areas are having higher grounds higher elevation because this is digital elevation model.

And lower grounds and other things are having darker areas. So, we can make very good interpretations and can tell lot many things about this area just using this image and some other datasets. And one of the discussion which we are going to have and on how to use remote sensing images for groundwater exploration and the charges studies in which this left image and of course, right digital elevation model.

And we will bring back again these images or datasets, and we will start doing interpretation for groundwater as well by just making interpretations from satellite images, false colour composite, along with maybe one or 2 other datasets, we can have some idea about the groundwater conditions of the area. Though directly we are not getting any evidence, but indirectly through image interpretations.

As such information can be extracted and that is the skill basically, is required in image interpretation. This brings to the end of this discussion. Basically, this is the first part. Now in the next part we will be looking different objects is basically geological structures and how these pictures are interpreted and to extract the information about geological conditions of that particular area of which the satellite image belongs to. So, this brings to the end of this discussion. Thank you very much.