Introduction to Remote Sensing
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Lecture 10
Image characteristics and different resolutions in Remote Sensing

Hello everyone, welcome to this 10th lecture on this course which is introduction to remote sensing in this particular lecture we will be discussing about image characteristics how what basically image meaning or especially I am talking about digital image form computer point of view or data handling point of view, also we will be discussing different types of resolutions, though in previous lectures we have touched but in detail we will see and how images will look different in different resolutions and of remote sensing images.

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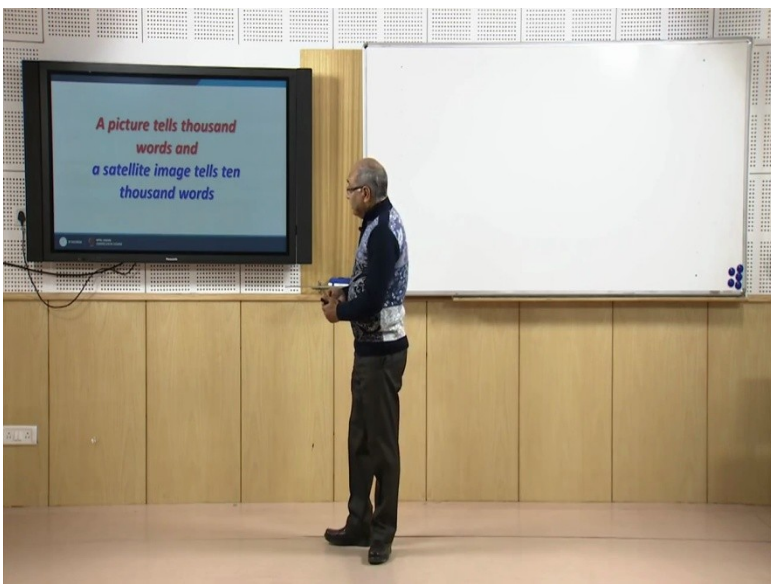

As you know that old saying is that a picture tells 10000 words, we can add one more line in it that a satellite image can tell 10000 words, so instead of just 1000 words a satellite image can tell 10000 words, the reason why we have added this line because not only it is a saying but if you are having time series data then it can tell you the changes which has occurred, so for change detection studies satellite images are being used extensively because of availability of archive and other data sets.

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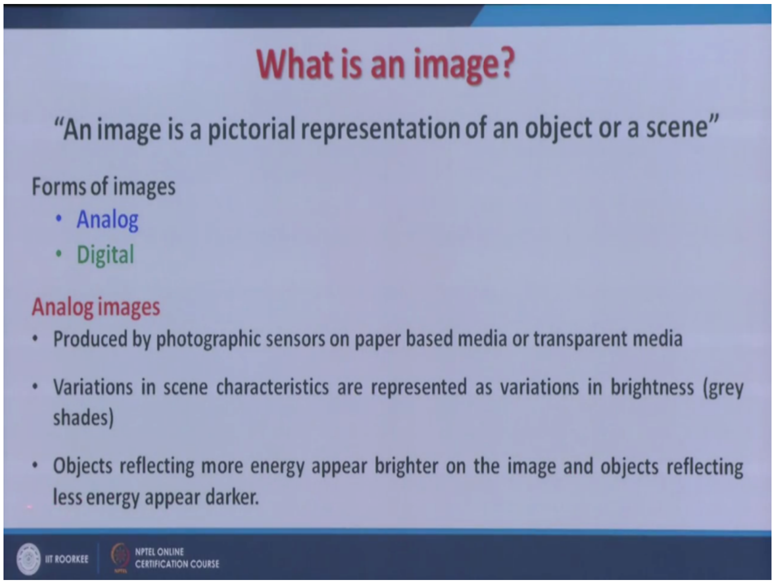

Basically what is an image and that is basically a satellite image we are talking now days we use digital cameras and even through our mobile cameras we take a picture that is snapshot, though it also makes a 2 dimensional matrix and a you are having depending on the resolution of your camera you are having the size of pixels there.

But it is a snapshot, this this is there is a difference between a snapshot and a scanning devices which we have also discussed in some other previous lectures, so satellite images are not really a snapshot except for geostationary satellites but in this polar orbiting satellite these are the images scanned line by line as like in your table or flatbed scanners it is done that the entire document or map is scanned line by line rather than a snapshot.

So when we take a when you take a snapshot we call as a picture but when when we take a scanner and scan an image or part of the earth using satellite based sensors then we call an image, so thus the one of the major differences between an image and a picture or a photograph. So photograph is just a snapshot whereas this is scanned line by line, so an image by if we look the definition an image is a pictorial representation of an object or a scene, here we are, we have to think that image is being taken by the sensor which are on board of different satellite.

So this is line by line data acquisition is done. There are various forms of images, earlier we know that there are analog images, digital images, so all satellite based remote sensing images are digital images. Originally they are acquired through those opto-electro devices and they are all in digital numbers.

Analog images like photographic earlier we used to have photographic film or we now days print also, so that we call as produce by photographic sensors on paper based media or transparent media that was the analog and various variations in still characteristic are represented as variations in brightness or great sets if it is black and white image and the objects reflecting more energy appear brighter on the image and objects reflecting less energy appear darker, so same concept as in case of analog image so in the digital as well.

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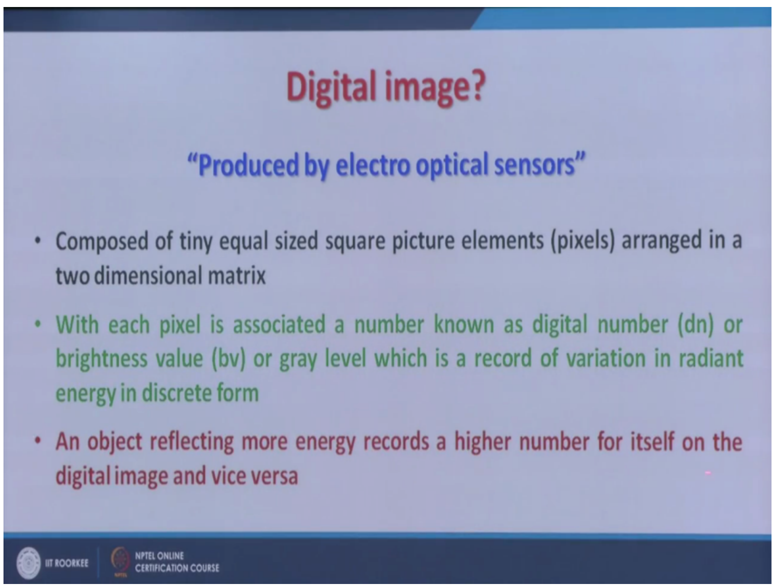

Digital image basically produce by electro optical sensors, so these sensors whether it is a on a satellite or any other devices they are all so there is lot of similarity between these table top or flatbed scanners and the scanners which are in space they scan line by line they produce, they produce images of any document or map of part of the earth using this concept of electro optical sensors.

Now the unit of an image is a pixel which is an abbreviation which is called picture element, if you recall in previous lecture I mentioned that like in Landsat 1 the MSS sensor the it was not a perfect square, the pixel was not a perfect square and there because it was one pixel was being overlapped with another so we used to call as mixel but now days that problem is no more existent all our remote sensing centres sensors, so we call as a pixel and so it is a unit of an image which is always square in shape, accept in case of Landsat MSS.

In future or in current satellites this concept is going to remain that unit of an image is pixel and pixel is always square in shape and this is these pixels are arranged as a 2 dimensional matrix and each pixel is associated with a number and that number is basically the quantisation number, so we will see that how the but what basically they are recording is the value is brightness value is being recorded if an object is reflecting very high than higher brightness value will be recorded in terms of digital values it will be higher value will be recorded if it is reflecting very low then a lower value will be recorded.

If we still, if we change this value number digital numbers pixel values into the range of grey values then the dark are showing the less reflecting (val) objects and brighter are showing high reflecting objects and they because of the variation in the radiant energy it discreet form. And a an object reflecting more energy records a high number of itself on the digital image and vice versa.

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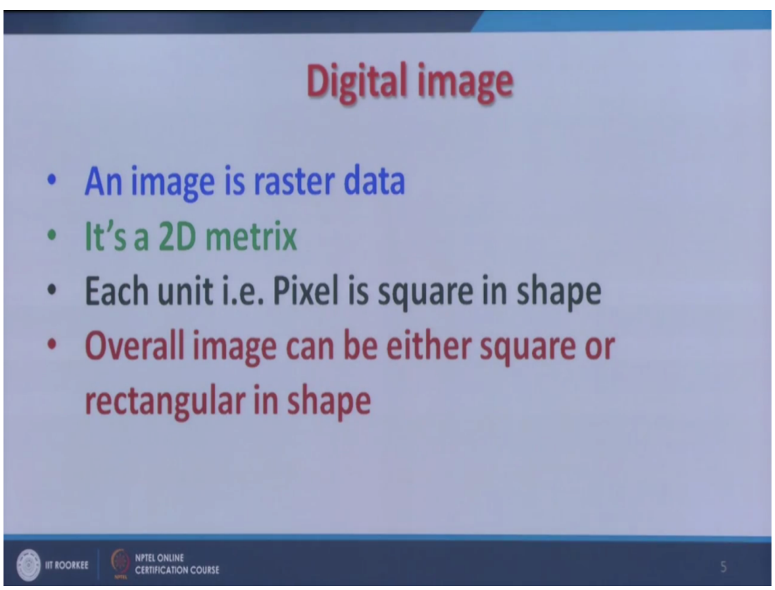

And the digital image in in our GIS terminology also otherwise from mathematical domain also that we call as an raster image it is nothing but a 2 dimensional matrix and it is a each unit as I have already mention of an digital image is called pixel, pixel is always square in shape. However overall size of an digital image can be either square or rectangular, so this is very important to note that the unit of an image is a pixel which is always in square but overall size of an image can be either square or rectangle, no other than these 2 shape an image can have.

But when we go for, when we want want to show only a image of an arbitrary area or a circular area then what would happen, so there is a concept which has been introduced and that no data, so the areas which are beyond this circle but within the rectangle or square are assigned a value which is no date value and generally it if we are displaying on the screen then it is mixed with the (orbi) the same value as background value is given and therefore we don't see anything there. So we feel that image is circular but in fact in the computer the image can only have 2 shapes, either rectangular or square, however unit of an image is always a square in shape.

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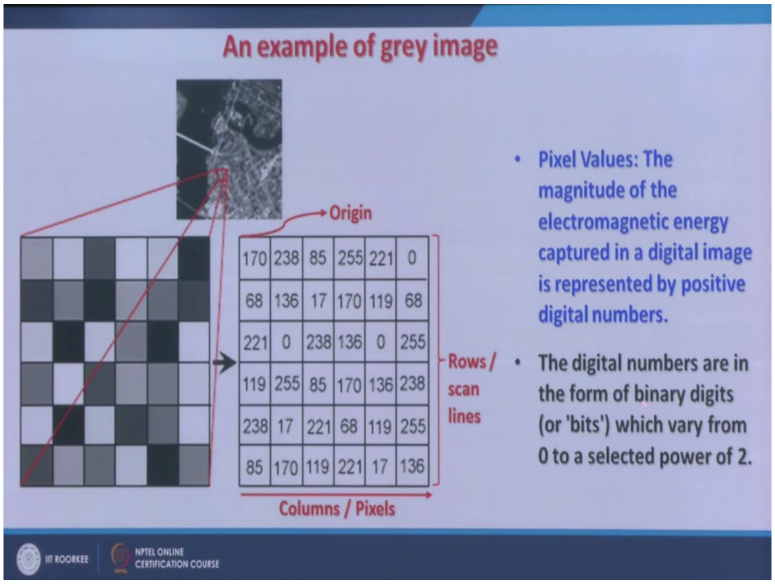

And when though there are images if we zoom a small part of a digital image this is what we see expect this sharp the grid which you are seeing here, this grid is being just to use to demonstration but in real zooming of an image you will not see these lines this the grid of the pixel and because these are having some values this is an example of 8 bit image. So we are having value 0 as well as 255 total range of pixels values are available of total 256.

So we in digital image processing or in our 2 dimensional matrix concept we call these are the columns and these are the rows or also we call as scanned line or these call pixel and this is another very important thing to note that origin of a image, an image a digital image is always considered from the top left this concept will we use later when we go for geo referencing and there we have to change this one because in in geo referencing that means when we willing the geographic coordinate systems and to correct an image geometrically then our coordinate system will start from bottom left corner instead of top left corner, so that that thing will be so therefore it is important to note here that the origin of an image will start from top left corner.

Pixel values as I have said is the magnitude of the electromagnetic energy captured in a digital image is represented by a positive numbers. Now this is very very important that an (ima) the value of a pixel will always be a positive integer value, I am going to repeat it again, it is very important that a value of a pixel of a digital image is always is going to be a positive integer value but in like in GIS or for other raster types like for digital elevation models there the cell value can be positive integer negative integer even real value negative or positive but in case of a digital image the pixel value is always going to be the positive integer value, so this one has to remember.

And they are basically in the binary digits or bits so when say this binary mage that means we are having pixel value I within an image either 0 or 1, that means either black or white, no other shades of grey in between these 2 extreme shades means black and white can happen then it is image is binary or single bit image, but when a we increase this quantisation or number of this then we get more number of values or a if we think in terms of shades of grey than we can have more shades of grey between 2 these extreme values black and white, that we will see little later.

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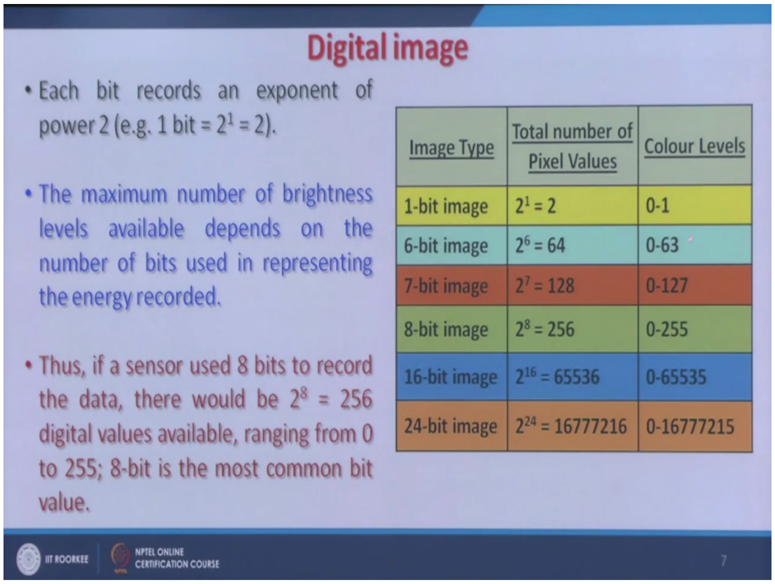

So each but records and exponents of power of 2 that is a it is one bit that is 2 power 1 equal to 2, so either 0 or 1 total number 2. When it we improve on this the then this the number available will improve very significantly we will see that example as well, so the maximum number of brightness level available depending on the number of bits used in representing energy recorded. Of course no satellite records at a bit level of course now they are either 7 bit, 8 bit, 9 bit, 10 bits, 11 bits like NOAA AVHRR records data at 11 bits.

So if but very standard one especially because many of the digital image processing software's are capable of handling 8 bits data, therefore 8 bits digital satellite images are the most common one or they are restrained so that they are become much earlier to use with the digital imaging processing software, so 8 bit satellite images are very popular, 8 bit means true, true power 8 that means the total number of values available for each pixel to choose is 256 and the values will vary between 0 to 255 total number would be 256 including 0 and 8 bit as I mentioned is a very common one.

So just to for completeness if we see that 1 bit image that true power 1 equal to 2 only 2 sets are available or 2 colors can be assigned values are just between 0 and 1 total 2, if it is 6 bits like in case of IRS 1C pan camera we had a 6 bit images that means the total number of pixel values could vary between 0 to 63 total number where 64 in LISS 3 we had a like a 7 but images and that means the values were ranging between 10 range within an image and depending on the ground conditions between 0 to 127 total number 128.

If it is 8 bit as said the most common one then the values of pixels within an image can vary between 0 to 255 total 256 that means 2 power 8, 16 bit mages with the satellite based remote sensing are not common yet but definitely because things are improving so the readymade acquisition is improving with future satellite. So hopefully we are going to have even the 16 bits and you can see that the range is 0 to 65535 total number 65536 and here 20 bit images 2 power 24 that means 1.67 million number of pixel or values or range is available for each pixel.

And this 24 bit I want to emphasis here because when we create a false color composite or color composite using 3 different bands of 8 bits each than your output image becomes 24 bits, instead of having just 256 colors available for all 3 then it becomes 1.67 million colors.

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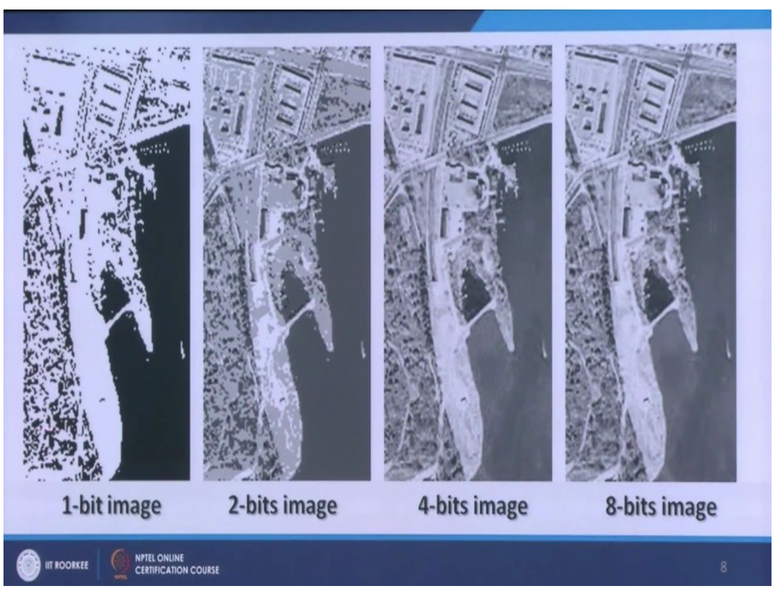

And see this the difference what the difference it creates, if we increase just 1 bit instead of 1 bit if we go for 2 bit see this is just binary image black and white, so pixel values either are white just for representation the the one has been assigned one one has been assigned white and 0 has been assigned black so you are seeing either white or black pixels, no other in between.

But if you go for 2 bit then we are having black we are having white and in between as well, when we go for 4 again more number of values are increasing when we go for 8, so the 0 value is assigned the back color, the 255 value has been assigned your white color and rest of the values are in between, total range is available here 256 to choose for each pixel and as if you compare the 1 bit image and just see the quality of image, so as the bits have improved that means the radiometric resolution has improved and say the quality of image has improved, your interpretation can become much more reliable, you can distinguish different objects much more easily as compared to in a binary image. So that is the advantage of having higher radiometric resolution images which are becoming now possible.

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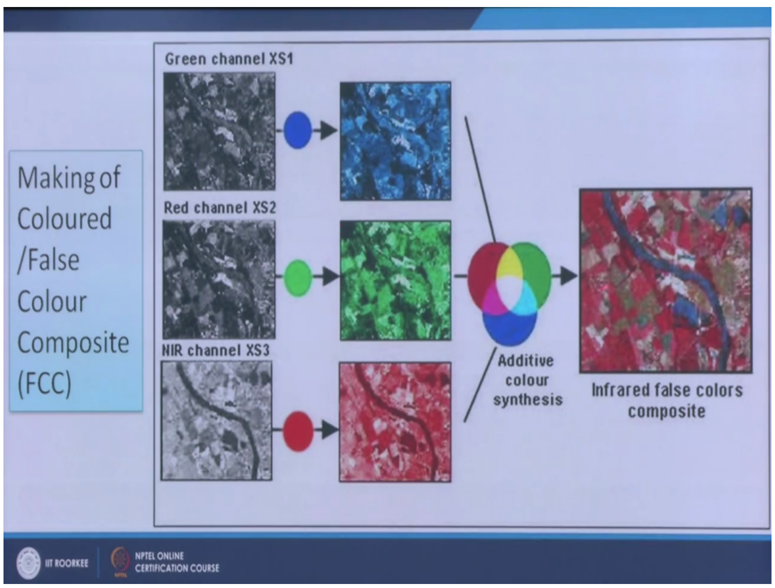

I was mentioning about the 24 bit images so when you use the 8 bit data 3 channel so 3 bands data create a color composite in this example a false color composite assigning 3 different channels using this concept of additive color screen and primary colors red, green, blue then this image will become 24 bits image and that means the (nu) each pixel can have values of the spectrum which is available is 1.67 million color.

So any value between those 0 to 1.67 million colors can come to represent that is why generally colored images are much more useful as compared to black and white images of any channel or any band which we are seeing. That is why it is a very useful though in terms of quantisation it has improved but the basic thing limitation if we wish to call with each band will remain same so this output image because 3 channels have been combined therefore instead of 8 now we are having 24 bits image.

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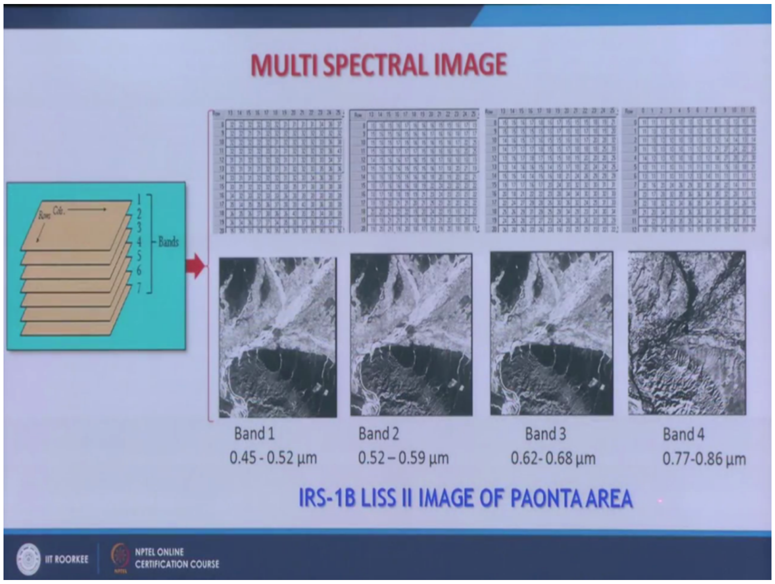

In case of this example about a particular sensor that is a IRS 1 les 2 image of Paonta Saheb of Himachal Pradesh area, so if we see the digital numbers this is how it looks, remember that these lines these boxes or grid which are just seen here for our own convenience but image itself will never have, it is having just raise in columns and in this you are having values in continuation.

So this is how the values will vary between different channels and the once the values varies the when we assign the shade grey shades then the image itself also varies, so from computer point of view or from digital image point of view this is how the image is there in 2 dimensional matrix, each cell is a pixel which is unit, pixel is a square over all shape of an image can be square or rectangular.

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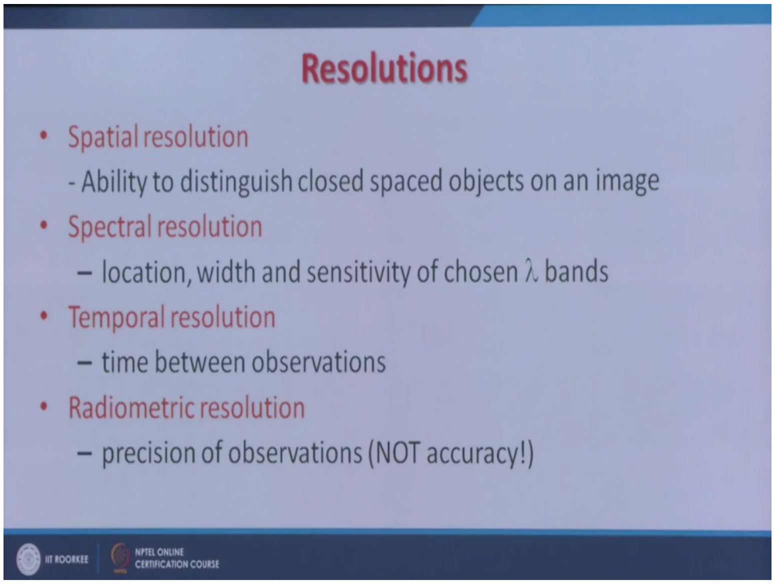

Now we come to different types of resolutions and first we take the spatial resolution which we have been mentioning few times which is basically the if we look the definition it is the ability to distinguish close space object on an image, that means the resolving power. How nicely you can see the boundary between 2 adjacent objects available within 2 pixels adjacent pixels. So if a if you are able to resolve that thing much easier than we say higher spatial resolution images and when we are unable to do that then we call a coarser relatively coarser so this is related term. There is a no highest spatial resolution images in terms of in the field of remote sensing and neither there is a coarsest in that sense.

So it is the ability to distinguish close space objects on an image, higher the value for a pixel that it covers the area because it is square shape, so if I say 10 meter resolution image I mean it is representing 10 meter of the ground in width and height wise or length wise, so 10 is square that means 100 square meter of area is being represented by 1 pixel of a satellite image, when I say a 10 meter resolution image. But when I say 1 meter resolution image that means I am representing now only 1 square kilometre of the area width and height is 1 meter, so a small area is now being represented.

So once you are having a very small value in case of a spatial resolution we call as a higher spatial resolution, so it is inverse kind of relation. The larger the spatial (resolute) value of spatial resolution we say a fine resolution, whereas if we are having coarser that me and we say larger the value then we are saying it is a coarser spatial resolution when the value is small like instead of 10 meter when you are having 1 meter then we say relatively a higher spatial resolution.

So one has to understand this the spatial resolution is very important as we are seeing we go through the history of a present day remote sensing and satellites then what we find that spatial resolution in Landsat MSS was available about 80 metre now it has improved even to 30 centimetre even in some panchromatic or multi-spectre data sets like in world view or global view and kind of satellites. Second type of resolution which we will see further details of this is spectral resolution that is the basically how many channels within available EM spectrum are there what is the best of this channels.

So the location of the channels or bands width, narrower the width more number of channels higher the spectral resolution, broader the bands broader the bands means covering the large part of EM spectrum and less number of bands are there within that part of EM spectrum we say coarser spectrum resolution. So with the time this spectrum resolution is also improving and slowly slowly we are going towards hyper spectral, there we will have spectral bands for each point 1 micro metre as well and this basically sensitivity of chosen lambda bands means at the different wave lengths that is another very important thing.

The spectral resolution will also depend in which part of EM spectrum one is looking for because that amount of sufficient amount of energy has to reach to the sensor to get recorded, so that is another important thing. The third out of 4 types of resolution the third one is the temporal resolution, temporal resolution means the time between observations, how frequently a satellite is being revisited or is visiting the same part of the land again and again. If a like a let me give you an example of NOAA AVHRR is NOAA satellites, it is covering the same parts of the earth at least twice in a day in 24 hours, so repeativity here is 2 times in a day whereas a very high coarse resolution satellites might be revisiting that area again after 22 days.

So A is 2 times in a day and once in a 22 days, so this when this the length time gap or the time between observations becomes a very small we call a higher temporal resolution, so in this front NOAA provides a higher temporal resolution say as compared to our Resourcesat or other IRS satellites or even Landsat, so on that front because the swath date is much larger during a coarser resolution NOAA provide higher temporal resolution, so it is kind of a trade of and the last one among the resolutions is the radiometric resolution that the precession of observations showed accuracy.

Precession basically depends on the sensitivity of sensor whereas a accuracy is a statistical terms. So these are 2 different terms which are there, one has to remember so 4 resolutions spatial resolution, spectral resolution, temporal resolution and radiometric resolution, these 4 type of resolution are known in remote sensing we will see one by one details about this.

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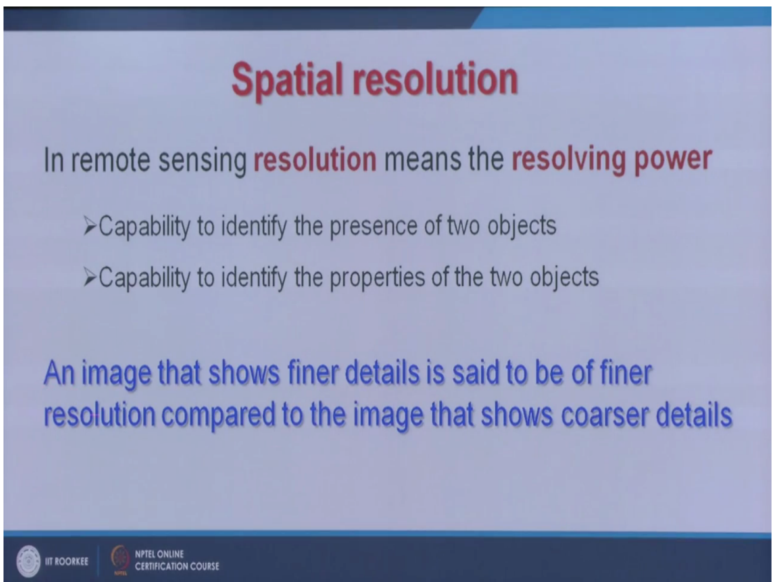

In remote sensing the resolution means resolving power and the capability to identify the presence of 2 objects, how nicely we can resolve these 2 objects, capability to identify the properties of 2 objects and how these properties of 2 objects are recorded in terms of different pixel values if same pixel values are recorded for 2 adjacent objects that means we cannot resolve we cannot distinguish between these 2 objects and therefore we will say a poor might be a poor spatial resolution. So an image that shows finer details is said to be a finer resolution compared to the image that shows the coarser details.

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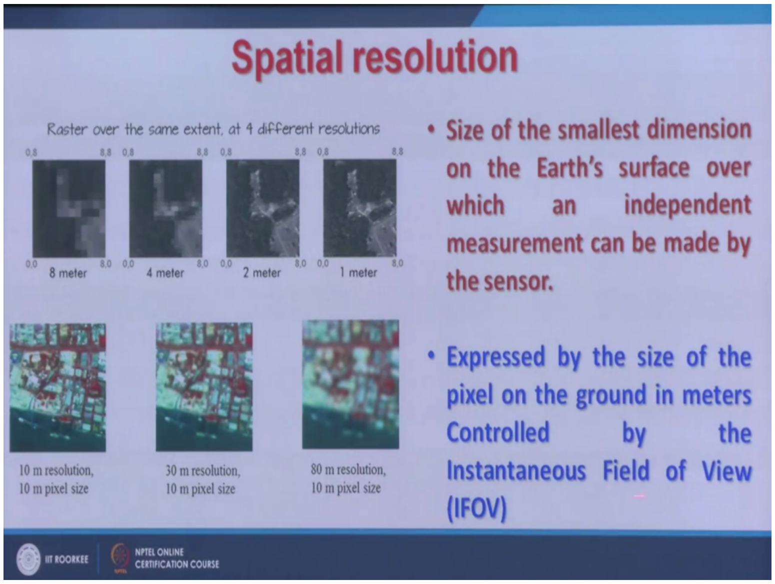

And we will see the example here. Here what we are seeing that it is 8 metre resolution the pixels are looking very coarse and you cannot resolve anything here. Basically you cannot make what different objects are there but if we see relatively instead of 8 meter we go for 1 meter, now we can see different objects in a much easier. So the ability to resolve or distinguish between 2 adjacent object is much much better relatively in case of 1 meter spatial resolution satellite image compared to 8 meter.

Another example instead of panchromatic another example is given in the this false color composite that this is 10 metre example we are able to resolve things very easily, we are able to distinguish but if we compare this image with 80 meter resolution then things are not easily identifiable, so thus this is how the spatial resolution makes the difference.

So higher spatial resolution means a smaller value here digital value and more number of pixels will be there in an image, more number of rows and more number of columns would be there but a compare by here 8 time in case of 1 meter here you will have 8 times more number of rows and columns but the quality will improve significantly. So size of smallest dimension on earth surface over which an independent measure can be made by the sensor that is what in sense the spatial resolution and this is expressed by the size of pixel on the ground in meters controlled by the instantaneous field of view.

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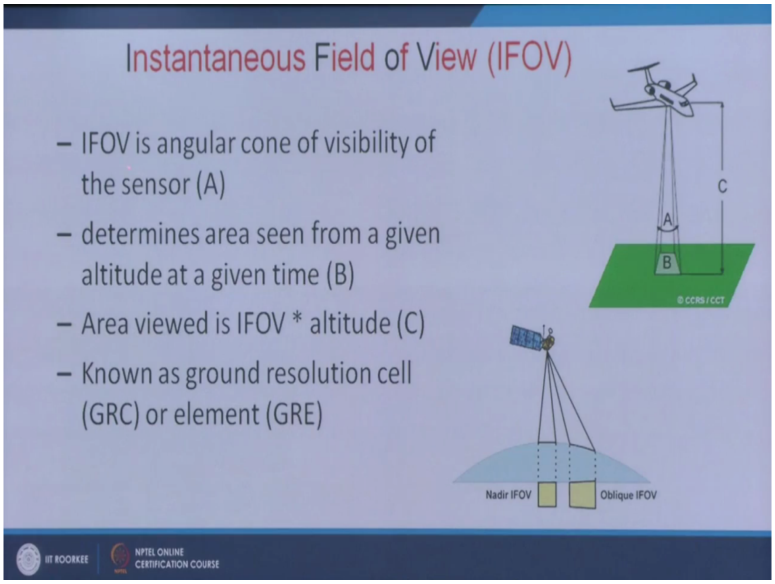

So we will bring this one as well this concept of instantaneous field of view or IOV but basically when when the satellite is a looking completely downward then we say the Nadir IFOB and when because if the swath is much larger like in case of NOAA AVHRR, the swath is 2800 kilometre then we will have Nadir IFOB as well as we will have for an image Oblique IFOB and these the size of pixels are changing here whereas IFOB is a solid angle, so we say basically you can say it is a 3 dimensional angle whereas you you are projecting on a 2D surface, so that also makes the difference.

So the IFOB is a ambler cone of visibility of a sensor with sole here this cool is A determines area seen from a given altitude at a given B this is the area which is been covered, area viewed is IFOB ad that is altitude the sea in depending on if it is very flying at very high height then IFOB is the size of pixel the coverage it will have much larger of the earth with the same sensor, so that is the known as the ground resolution cell GRC or element or pixel.

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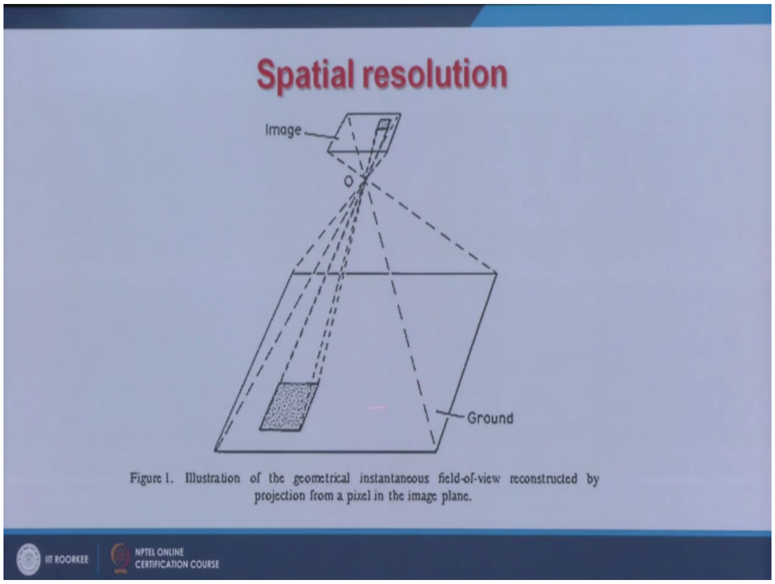

So it depends on as I mentioned that this is how the in area is recorded an image and this is a solid angle then is converted to this one.

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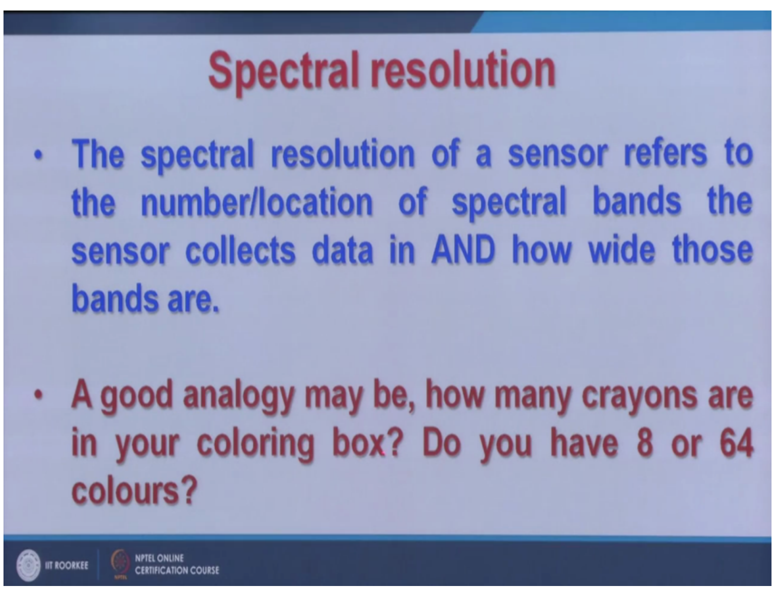

Now the second one is the spectral resolution of a sensor refers to the number of location of band sensors collected in and how wide those bands are. So initially Landsat MSS was there it covered a same part of EM spectrum that it has the same width for at least first 3 bands and these were quite broad, wide or broad. Later on like in Landsat OLI series that is Landsat 8 they are these bands are covering very small (num) very small width of EM spectrum focusing more on the way the threshold is available in the atmospheric windows for different objects in part of EM spectrum 1 and number of bands have also improved. So the location and number that makes the spectral resolution, so a good analogy maybe how many acrons are in your coloring box, you have 8 or 64 colors that makes the difference here.

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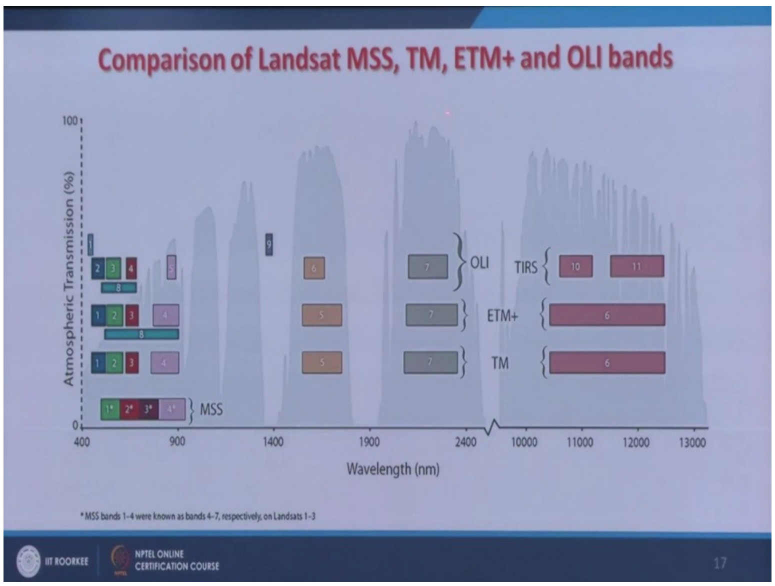

Here is the example, now in this one MSS TM ETM plus and OLI, so far whatever the Landsat series of satellite all 4 types of sensors have been covered in this, they are in the background the grey shades are showing the areas where we are having atmospheric windows the white areas in the background are the opaque areas but we see here the Landsat MSS continuous data one band was ending another band was starting without having much inputs from the threshold of these atmospheric windows and that is why these were continued slice down in a small part later on in Landsat TM things improved, number of bands increased and the width of band have reduced.

So if width is narrow, higher the spectral resolution, if width is large poorer the spectral resolution. If number of bands are more higher the spectral resolution if less number of bands are there in sensor, poorer the resolution. If we compare the Landsat MSS to the Landsat OLI that is Landsat 8 see the difference, see though the numbering has changed but if we say second here

Landsat MSS band 2 and this red continues. See it has become further narrow. So it provides the better (distinc) distinguibility of different objects which are present on the surface of the earth as compared to Landsat MSS data.

And in the other sensors are other bands are also shown you can see we compare Landsat TM EDM both were almost same expect we introduce one more band in EDM plus which was the panchromatic band though this panchromatic band was made further narrow in case of Landsat 8 OLI series and all these bands 6 and 7 also made narrower and instead of having 16 1 ETM plus the 6th band which is thermal channel instead of thermal band which was a very broad, it has now have been proven.

So we if we want to say about the spectral resolution in relative sense we would say that the Landsat 8 OLI series is having higher spectral resolution as compared to Landsat 1 MSS because the number of bands have increased second the width of these bands have also gone to very narrow in size.

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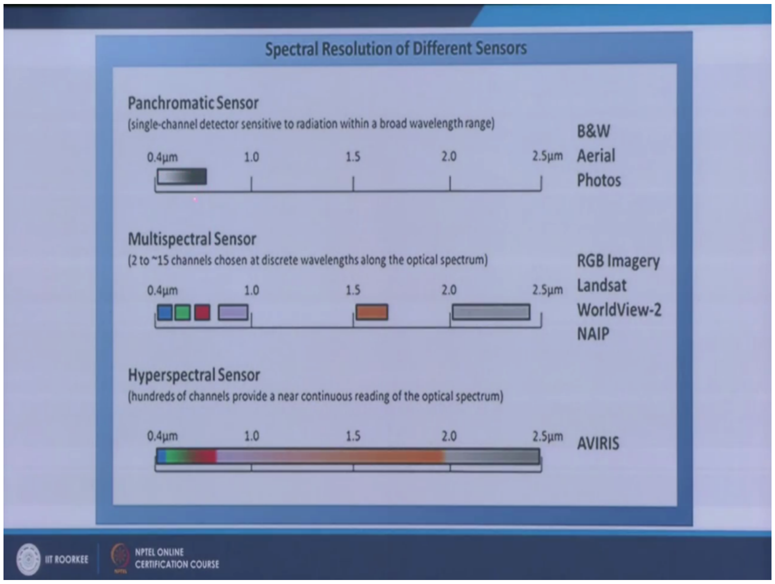

What we see that in black and white and in panchromatic generally the bands are quite wider but when we go for multi spectral like RBB imagery this colored image example is giving or a word view then these bands are many more and a narrower bands are there. So we instead of like multi spectral sensors, we instead of having just 1 or 2 now good people are going for 15 channels hyper spectral and no discontinuity between 1 band to another. It is completely continuous, example is Everest sensor and a there are 256 bands and 100's of channels 100's of bands providing near continuous reading of obstacle spectrum.

So entire part of EM spectrum between that range point 4 micro meter to 2.5 micro meter is covered, so any object which is present on the surface of the earth can be distinguished by channels which are in large in number, so we don't have any gap left in this number of channels has increased the thickness of these channels or the bandwidth has decreased very significantly and that will ultimately providing higher spectral resolution. So in in this case of spectral resolution the number of bands increases we say higher spectral resolution when bands or channels becomes narrower we again say higher spectral resolution.

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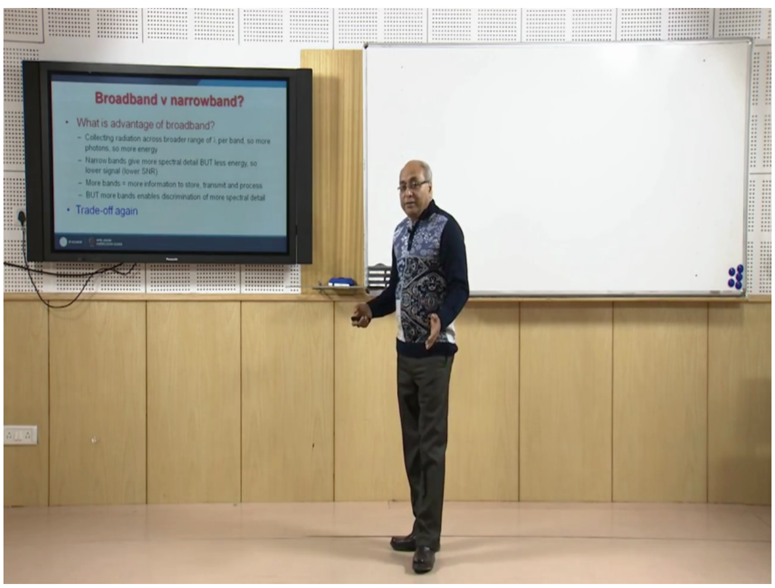

Now broadband is mainly common now a days in panchromatic but they even in Landsat 8 OLI series this has further been reduced because people realise that there is a always advantage of having narrower bands rather than broadband. So the what basically if we are having broadband data what is the advantage, collective radiation across border range of lambda per band or other EM spectrum, so more protons and so more energy.

Because why this this question can come that why panchromatic channels are having relatively broader band as compared to multi spectral channels, the reason basically is that in that part of

EM spectrum the energy which is required to be recorded why a sensor on board of a satellite is much more. So if you are in very narrow band the you might not have a that part of EM spectrum sufficient energy to be recorded by a satellite, so therefore in earlier stages when our sensors capabilities were not up to as in that quality as today, we used to have broader band or channels, now the electronics part is improving so we are now going narrower channels in point one micro meter channels and more number of channels are there.

So broadband advantage is that it provides the sufficient energy so that it can be recorded by sensor which is about 850 kilometre in space. Narrower bands whereas gives the more spectral detail but less energy, so the lower signal or lower signal to noise ratio, so there as I have just mentioned that if band is very less there are chances the sufficient amount of energy may not reach and this ratio is going to be much higher, so as electronics is improving, sensors are improving and therefore it is becoming now possible to have more number of channels within the given EM part of spectrum 1 and a narrower channels are becoming possible because we are improving on the sensors this SNR or signal to noise ratio. We are making further lower and lower and therefore can increase the number of bands.

More bands also more information to store transmitter in process, this is a is kind of trade of, everything more is not good in case of remote sensor because then the application will change, like for example of NOAA AVHRR it coves a large swath of the earth 2 times in a day but at the same time it is having relatively coarser spatial resolution. So there is a trade off but the data storage requirement relatively is very less but if I compare with say 65 centimetre spatial resolution data then data requirement is very huge and therefore processing time, transmission time everything will increase exponentially or where is highly significantly.

So always it is not good so it is it because now days the choice is available, so we are having now different types of bands are available different type of sensors are available, so first we have to decide for what we are going to apply remote sensing data and accordingly choose that particular sensor which is most appropriate. For example if you are going to cover a small part of a city at a very high resolution, no problem the choice is there, you can go for 65 centimetre, even 30 centimetre resolution data because your aim is to cover a very small part of of a city.

But if I am going to cover the entire India, say for example then that high resolution remote sensing data is not going to be useful. I will, I will require too much of data to handle to store and process, so I will approach and go for a relatively coarser spatial resolution data, so for every application, every type of data is not appropriate depending on the application one should choose the appropriate type of data for in case of a spatial resolution as well as for a spectral resolution and other temporal and radiometric resolution which we will see.

So if we continue with this broad and narrow band but more bands enables discrimination of more spectral details but to certain applications if I am working for say for example for mineral exploration, I want to see the slight change in the any mineral concentration say in case of copper then I am, I am looking those slight changes of the ground, so therefore for me broadband channels or broadband Datasat is not going to be useful, I am looking for very narrow band data, more bands data.

So immediately I should be able to pick that ok at this location I am getting the signals of the presence of the copper on the surface. So there is a always trade off, higher bands means higher storage requirement, transmission requirements, processing requirements, higher spatial resolution again storage transmission and higher processing requirement, lower spatial resolution large area coverage but less thing but you don't get those detail, so depending on the application one has to choose the data.

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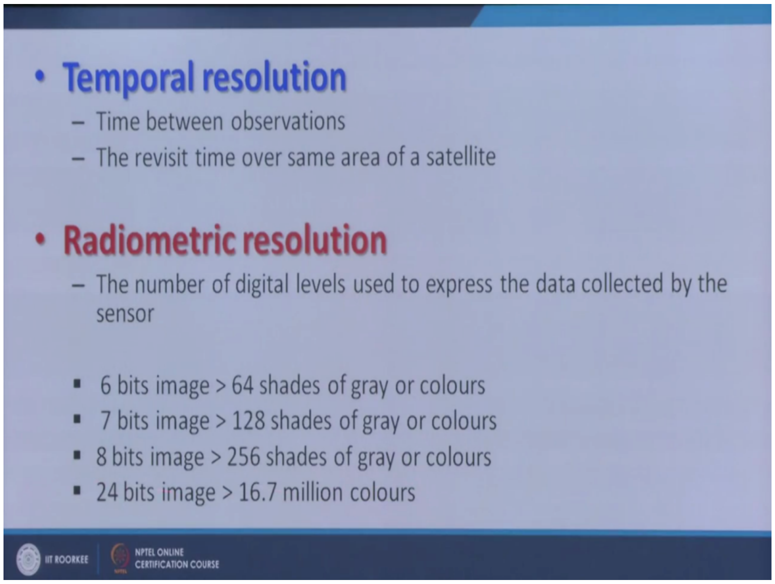

Now the last in this one is the temporal resolution that the time between observations, how repeatedly the data is the satellite is covering that area, some satellites covers like a radar satellite generally will revisit the area after 35 days and whereas I have mentioned earlier also that like no IVHRR will cover and two times in a day, so relatively no IVHRR is having much higher temporal resolution as compared to other many satellites.

The revisit time over the same area by a satellite we put as a temporal resolution and the last one in this one is the radiometric resolution that is the number of digital image used to express the data collected by the sensor, so again if we go for higher radiometric resolutions we are going an higher in quantisation, more data handling, more data storage requirements but off course it is a trader so we are getting better higher quality images.

So depends on the application and a and the cost of project as well, because some projects maybe very low cost project, you just require to prepare a land use map say at 10000 scale, so you need not to go for a 65 centimetre or 30 centimetre resolution data, you may still prepare a 10000 scale map for land use using sale is three data of 23.5 metre, so spatial resolution radiometric resolution all will depend that for what you are going to use the Datasat. As a in case of radiometric resolution higher you will go more sats or more number of values to choose for each pixel are available, as you can see in 6 bit 64, 7 bits 128, 8 256 very standard one and then 24 16.7 million colors.

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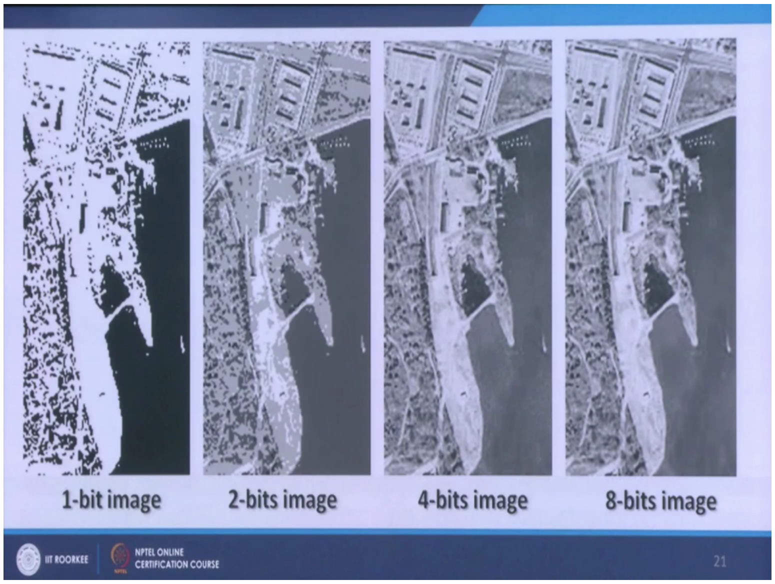

Now just to that is a repetition of this image that 1 bit how is binary image how it looks there.

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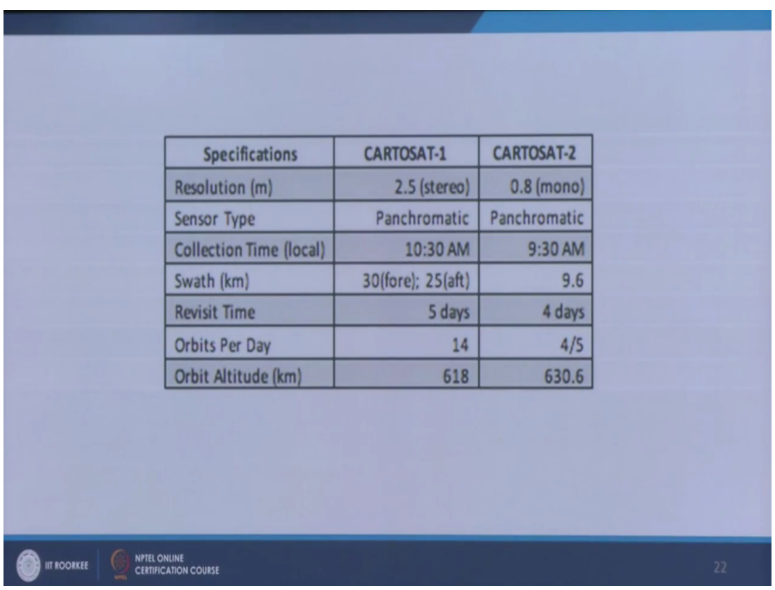

Specifications	CARTOSAT-1	CARTOSAT-2
Resolution (m)	2.5 (stereo)	0.8 (mono)
Sensor Type	Panchromatic	Panchromatic
Collection Time (local)	10:30 AM	9:30 AM
Swath (km)	30(fore); 25(aft)	9.6
Revisit Time	5 days	4 days
Orbits Per Day	14	4/5
Orbit Altitude (km)	618	630.6

Now if I compare just a these resolutions between 2 sensors which we are on 2 Cartosat's 1 and Cartosat 1 and 2, the spatial resolution in Cartosat 1 was 2.5 stereo, so it has stereo capability but relatively resolution was coarser as compared to land Cartosat 2 where is it is a point 8 and more not stereo, monoscopic. Sensor type of course both are panchromatic collection time where different swath, see the swath as the spatial resolution has improved the swath has reduced, here the space and resolution is relatively poor, swath is and this 4A and after is a because it is a stereo data collection so when it is looking forward it was collecting data at this swat was 30 meter when it was looking backward the swath was 25 kilometre. Revisit time here in cartosat it was improved instead of 5 days in cartosat 1 improve to 4 days and orbits per day of course this revisit times are interlinked and altitude were also change in this case. So this brings to end of this presentation, thank you very much.