Spatial Informatics
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Lecture – 33
Remote Sensing and GIS – III

Hello. We will continue our discussion on Remote Sensing and GIS in this Spatial Informatics course. So, last one or two lectures we discussed about the different techniques of technologies of a remote sensing more of a basic of the thing and then the GIS applications, why it is needed and how things are there. Today's class we will be looking little bit on more little detail on the remote sensing part to understand that how it helps us in data acquisition and types like that right.

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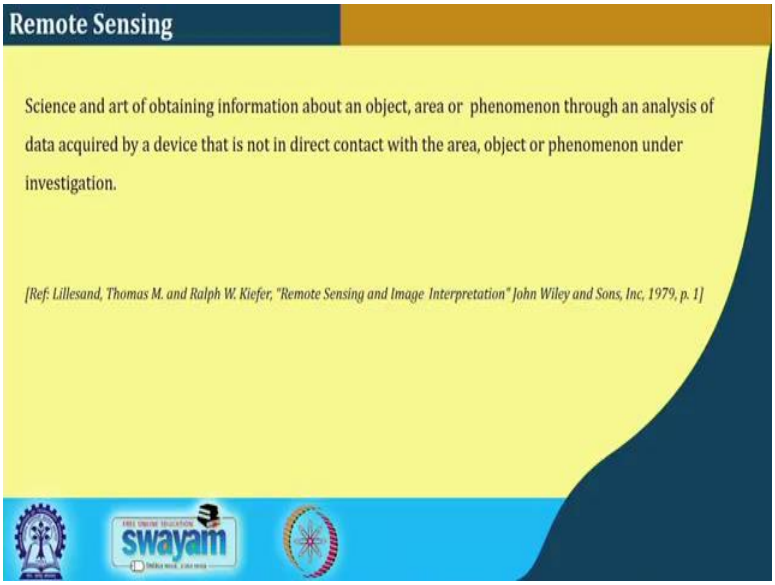

So, as we discussed so, there is a first cart definition long back in late 70s that the defined as a remote sensing as a science and art of obtaining information about object, area or phenomena through a analysis of data required by a device that is not in direct contact with that particular area, object or phenomenon under investigation. So, it says all that something which is not sensed on a in direct contact or direct touch of the things right; so, it is remotely sensed right.

So, rather the same philosophy continues today it also and we have with better resolution satellites or sensor capacities. We have lot of a mechanisms which can allows us to capture data in a much accurate timely manner.

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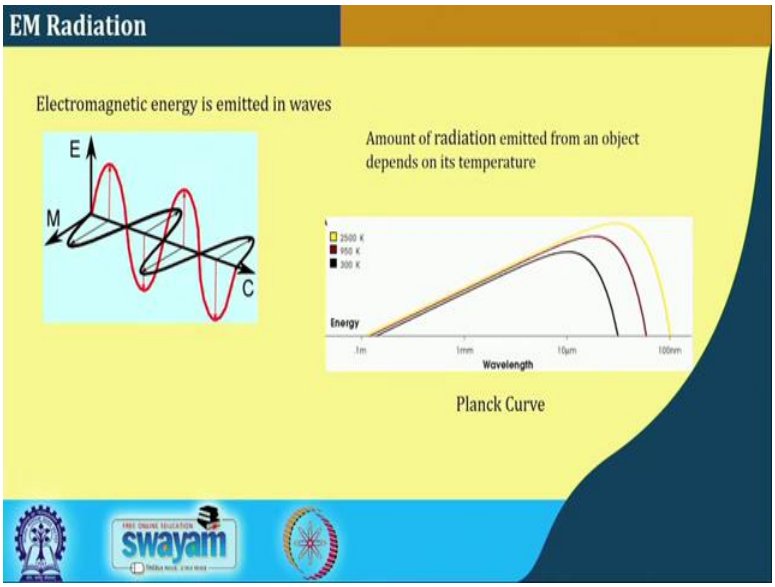

So, just to quick recap we have seen that all our this sensory things works on the basic phenomena of electromagnetic radiation right. So, in other sense that electromagnetic energy is emitted in forms of waves which are captured by these sensors in some form of other alright. So, rather the amount of radiation emitted from an object depends on its so, called temperature or the overall energy of the things. This is also another implication of the things right.

So, now what we whatever we are having here is that electromagnetic energy radiation. So, either the source is the active source; that means, it I put something on the target and then receive or it may be a passive source. Like I get that input energy from somewhere and that radiated thing is electromagnetic radio wave which is radiated from that target or object is captured other things. So, this is the two broad phenomena how it works right.

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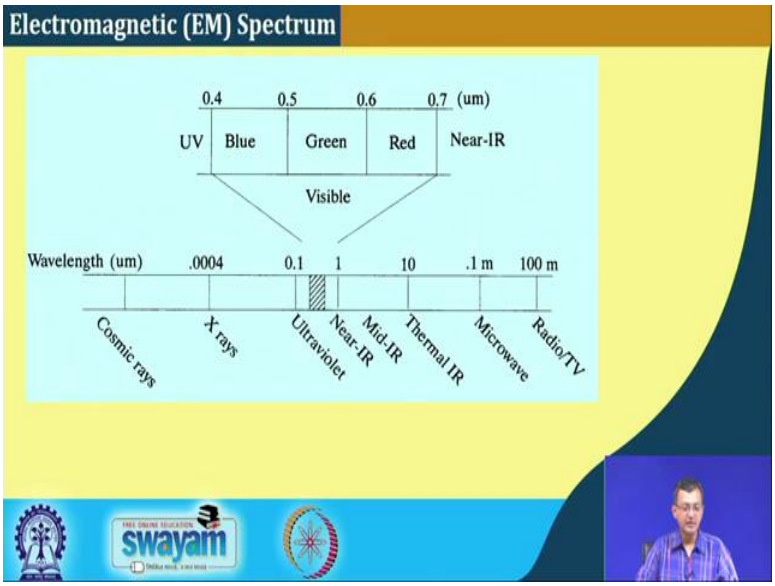

So, and also we have seen that electromagnetic ranges like different spectrum of the things. So, how it varies? It varies on the frequency range or what we say in spectral ranges right. So, this middle one where this hashed one is our things which can visible from our human eye or the what we say in the visible range which is from the blue, green, red are the most prominent ranges which are we basically considered for in our bands also and there are near infrared NIR band just the other side of the array.

And we have other things like middle infrared, thermal IR, microwave and type of things right. So, based on the sensors which range it is working the things are captured. In other sense if we think about that that pay load or the sensor pay load whatever is there on the particular aircraft or any flying objects or the remotely any remote sensed the device. So, what it is having? It is having a different sensory sensors which can record data in different scale. Like in a particular remote sensing satellite payload I can have different type of centres, like a I can have NIR near infrared, red, green, blue thermal and type of things.

Typically, a standard remote sensing sensory system come with 7-8 sensors right. So, what it does when it is passing through a particular earth surface? It goes on capturing the things, the same object or same area of interest are being captured by different sensors right. This gives us a difference, these gives us a way of distinguishing or identifying the objects in a different scale.

Like for example, that some object may not be very much prominent, if we take about we if we consider that say red. But, it is it may be manifestation is more prominent in blue right or in the air near infrared or I can have a thermal right. And, some of the cases in microwave we have different type of things like we can have say texture or in microwave the difference between say for that matter say wet sand and dry sand are different right whereas, in other optical sensor that may not be much distinction is possible.

So, in other sense if I want to have a appropriate way of segmenting, classifying these data and finding out that what is the particular land use and type of things, things can be there I can have multiple sensors on the board. Rather with that hyper spectral bands like we can have huge number of a spectrum within small ranges, like it goes up to around 200 bands right. So, it can vary finally, able to we will be able to distinguish nevertheless these are all capturing mechanisms. So, what they do? They capture in that electromagnetic form and transmit them to the ground station; now the rest of the thing is the processing of at the ground station part right.

So, what we try to see here that is what is the basic so, called quote unquote physics behind in capturing the data from these different electromagnetic waves. So, typically red, green, blue, near infrared rather thermal microwave these are the things which are the sensors are there.

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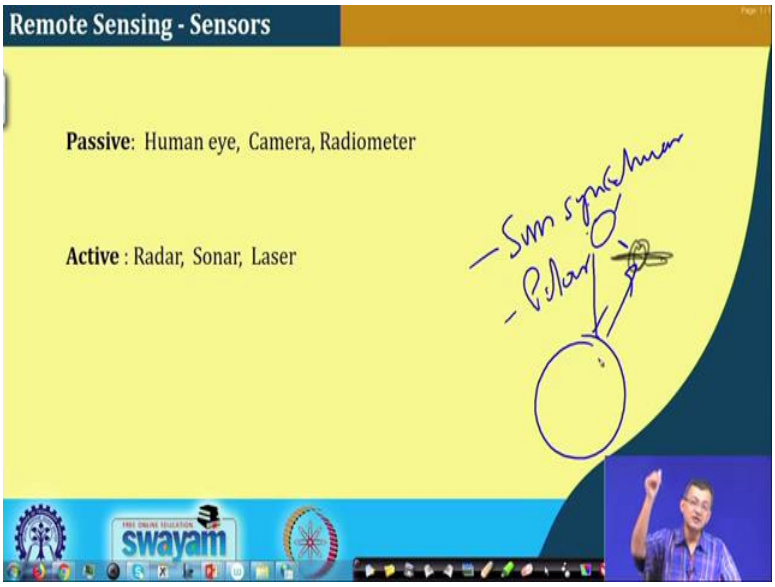

Now, if we look at the since such as we are discussing some are passive like was we told that human eye is a passive right, we are not throwing any light into the thing. So, whatever we are reading or sensing is based on the external light right; it can be sun, it can be artificial light so, that it is passive even our standard cameras as passive right. So, you have a flash with additional to that, there are different radio meters which are passive rather these are the standard things which we see. Not only that in several airborne and satellite things these are passive which uses this sun thing.

Rather that is why this sort of remote sensing satellites sometimes we also called sun synchronous or we will see polar satellites right. Sometimes these remote sensing satellites, we say sun synchronous right or I will see that polar satellites right. Because, sun synchronous means it is basically coming on the area of interest when the sun is there right. So, if I consider so, if I my satellite is something I am not good at drawing. So, it basically it looks at this when the sun rays are falling here and then it is getting reflected. So, this is the source of energy right.

So, it is not a thing for our passive sensor, for active sensor where radar or the SAR images and type of things there is a active sensor. So, it sends a signal and captures that, that is why this sort of passive sensor where the things are used they are not a cannot record at night right or when there is a cloud cover right. The signal will not come that the there is and then it is receiving the reflected signal is also difficult.

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So, and also there can be different category of a remote sensing platform that is ground based platforms or aircraft or satellite or a systems right so, which capture only things these. So, these there can be different type of platforms to look at it right so, but all the basic philosophy is still same that you have that sensors which kept are kept out a data from the things. Nowadays we have platforms like use drones to capture things or low flying aircraft which can be a air craft to capture those things right.

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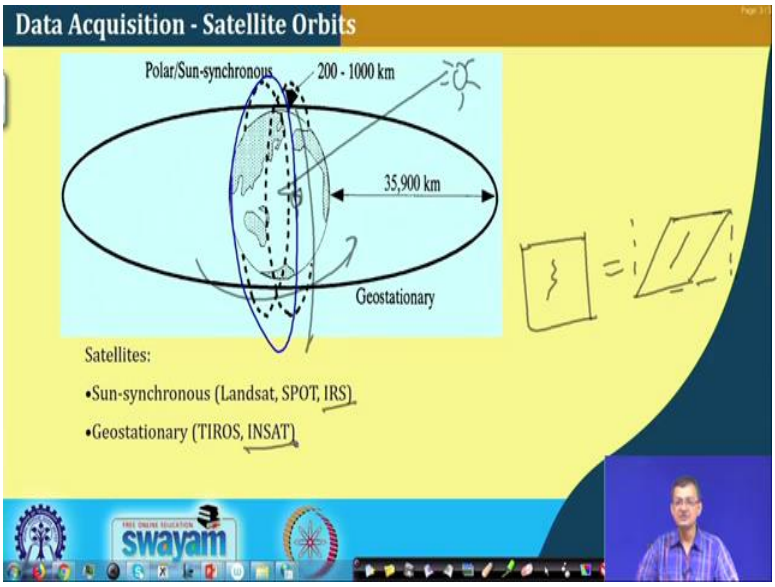

Now, as we are discussing as we are talking about that acquisition system so, satellite orbit there are different two major category of satellites; so, to say civilian satellites. So, one is sun synchronous right so, these are or in polar orbits. So, these are some of the things which are which we see right, this is these are revolving around the pole right. What, why sun synchronous? Whenever the sunray is there, the satellite system also come to that particular area when the sun is there. So, it gets reflected and get the reflection from the things right.

So, in other since this category is that IRS is Indian Remote Sensing satellites it is more from it will come over that over India or the area of interest of the India when the sunrise over India right. So, typically between 10 to 11 in the morning, it will come of the things right. So, that has a things, but it may be capturing other part of the world wherever the sun is there things are there. So, these polar satellites hovers around the pole and there is some challenges are there. See earth is moving like this, this fellow this satellite is

moving like this. So, what happened that, but when it captures the image so, it captures the image like this right.

So, it is a snaps right if I take a snap, but as such as such there is a drifting of the things by that time earth has moved some portion and satellite also has moved some portion right. So, satellite is moving like this, earth is moving like this. So, there is a wind captures though that things like looks like this, but we require a geometric correction because there is a shifting of the thing.

Once we do a geometric correction, it shapes up in the images shapes up in some form right or rather these are zero field or something blank thing; so, my image shifted. So, in other sense image scale to make it make it appropriate or other while capturing the things has moved. So now, I have to do a correction on the image at the ground station to have this type of thing. So, like my data could have been here, but it could have been something disturbing in this case right.

So, I corrected things; so, this type of corrections are required, but things are systematic right like we can we know the earth movement things, we also know that satellite movement the path is different. So, these are I can do a systematic correction on the things right. So, two category and another category of satellites which are mostly used for communication purpose and type of things these are geostationary right. So, these are it is a it circles in a much bigger way around 36,000 kilometre from the earth's surface. And, it goes on that its circles around the earth with the same what we say quote unquote in the same speed or so.

So, in other sense if a geostationary satellite if it is earth on over India say over Kharagpur, it is over Kharagpur right. So, it is used for communication purpose, but these are pretty far away right 36,000 kilometre which is these are within 1000 kilometre. Typically, it is written 100, 200 to 1000, but 200 is not usually it is between 500 to 1000 kilometre which are much nearer. So, the what we will see the spatial resolution the resolution of the images which captures by the geostationary, if it is for satellite for remote sensing purpose it is very difficult or the resolution is so, poor cannot do any meaningful analysis of the things right.

So, this is what we say geostationary or stationary with these things, our category of satellites where ISRO which launches the inside category of satellites which are geostationary right.

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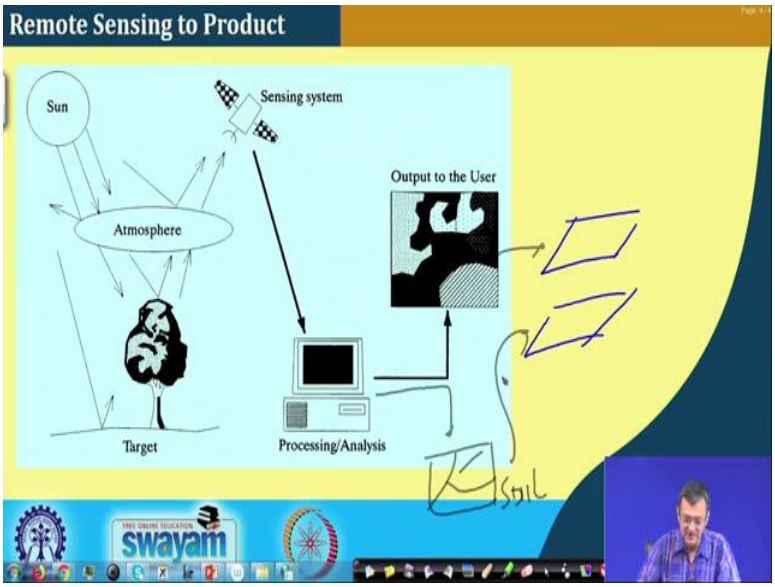

So, this picture again what we have seen that if we have the target or this object; so, the sun ray is coming, it is getting reflected to the thing, in between atmosphere is there. So, there are challenges with the atmosphere, there are absorption of the electromagnetic waves etcetera and once that is sensing, then it comes to the processing and analysis. So, it is downloaded to the ground station right. So, and the from the ground station the processing is being done to output to the user rather this is a input to the can be input to the GIS system. So, my if we recollect the GIS system is a collection of the layers so, this can be one of the things.

Suppose, I did a some sort of a forest map or a vegetation map, that goes as a input to this one of the layer right. Same type of things I do another analysis to may do something of the say soil related, these may go as a another input to the things right. I can have different type of a layers which are generated by these things. So, this becomes the thing or user can directly interpret on the things right. So, these are the way it gets its form a from a sensing to so, to say quote unquote product type of things.

So, it becomes a product which is usable by the user in this sense we say human user or a system user type of things right. So, this is another aspect. So, these are the things what all you see that how remote sensing acts a input to our GIS system.

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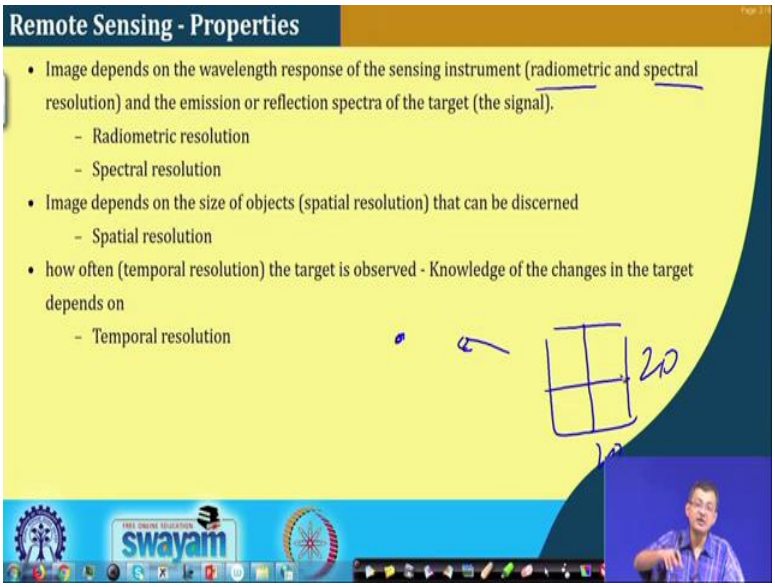

So, some of the properties which are important or four major image depends on the wavelength response of the instrument, radiometric and spectral resolution right. So, these two things are important: radiometric and spectral resolution, radiometric resolution and spectra resolution and emission of the reflection spectral of the things right. So, we will see that what are the things. So, I need to have that what is the radiometric resolution and spectral resolution of the things.

Other thing image depends on the size of the object spatial resolution and can be that can be discerned or that the spatial resolution, it means how granularities. Like I say when the spatial resolution at 20 metre my 20 metre, it means 20 metre 20 metre on the earth is a point on the surface right. If my spatial resolution a 10 metre, 10 metre, the 10 metre, 10 metre on the point on the a area on earth is a point on the image right. So, higher the spatial resolution, I can have a better clay or better information gathering from the earth surface right.

So, ideally it should be 1 by 1 is to 1 right 1 meter 1 object is directly mapped to the things, but when we increase the spatial resolution the challenges come, that I have more data to store right. If I do not require that for the things suppose I was doing a forest

mapping, I may not require a submitter resolution right or I, but when I want to count the number of buildings or number the tree; I may require a submitted resolution right. So, when I say that a say 20 meter cross 20 meter; that means, 20 meter 20 meter earth becomes a pixel dot in the image right.

Now, the now if it is required fine, if it is not required in the data; now if I make 10 metre right; so, instead of 4 instead of 120 metre I require a 4. So, it depends on what sort of application you are having and what sort of things really. How often that temporal target is observed that is another things, that how often I am retracting the or touching this a receiving this target that is also important; that this is especially important for change detection and change calculation and type of things. So, these are temporal.

So, if we see radiometric, spectral, spatial, temporal these are the four fundamental properties of remote sensing data right, whether it is satellite remote sensing and aircraft borne or any type of remote sensing data; we need to look at these type of things right. And, what we expect that this resolution will remain consistent over different passes right. So, say like our own satellite Indian remote sensor satellite covering this Kharagpur now, I will come back to maybe another within 72 hours right. So, I have a repetitive image of the things and I explained what is there the spatial resolution of those things are consistent.

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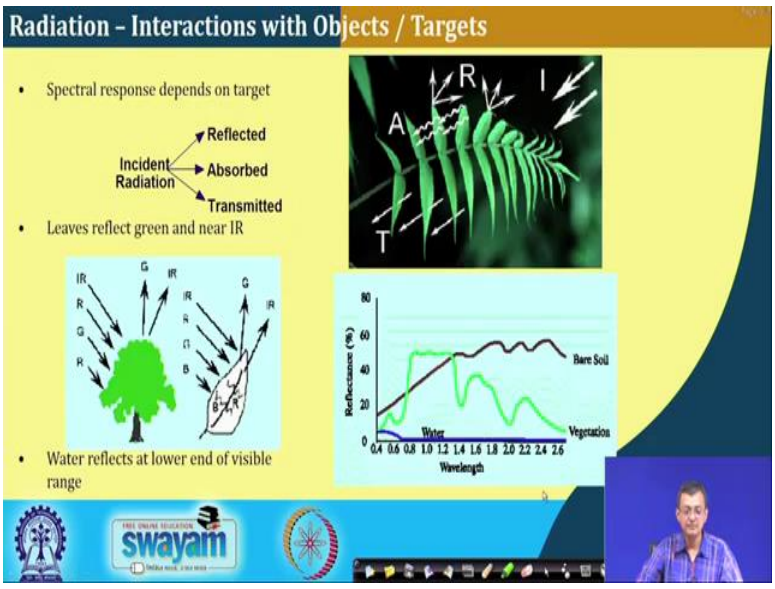

So, when we say radiation interaction with the objects and the or targets right. So, reflected absorbed transmitted so, spare. So, it depends on the property of the object what is reflected, absorbed and things. Like a the for reflection, absorption and transmission of a say concrete slab will be different between a canopy cover or tree right, will be different for a water body, will be different for say sand or wetland and type of things right. So, this gives me a variation of the values recorded in the sensors which is important right.

So, by these different values of the things I can now able to able to recognize which is the object down the line right. For our normal optical things or the cameras what we see? Whatever is there it is directly reflected, I can directly interpret right, but in this case I that deep based on the sensors specially which are near infrared or microwave; I have need to interpret on the things right. And if you see for different objects vegetation, bare soil the wavelength versus reflectance are different right. Water reflects has lower end of the visible range, leaves reflect green and near IR and type of things right. So, these are the things which are there.

So now, if we so, this is fine. So, once it comes from the from the sun, it gets either reflected; some portion reflected, absorbed and some get transmitted right. And, it may vary on the object to object and that we are able.

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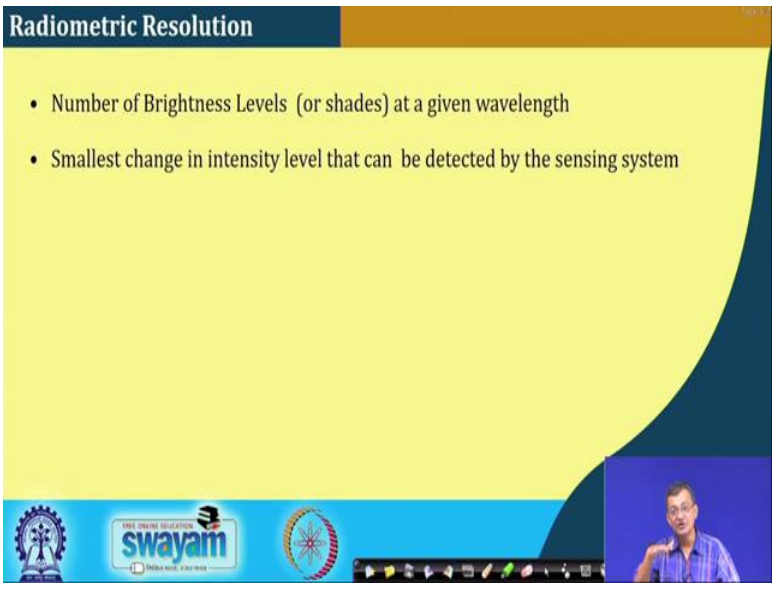

So, radioactive resolution number of brightness level or shades so, for a given wavelength right. So, particular wavelength how much band brightness level I am having. So, if I am having 2 brightness level, I can recognize whether this is there or not; if I having say 250 brightness level, I have more clarity on the things right. The smallest change in the intensity level that can be detected in the sensing thing. So, based on the brightness level I can basically what is the minimal change in the intensity level, I will do able to detect on the sensor things right.

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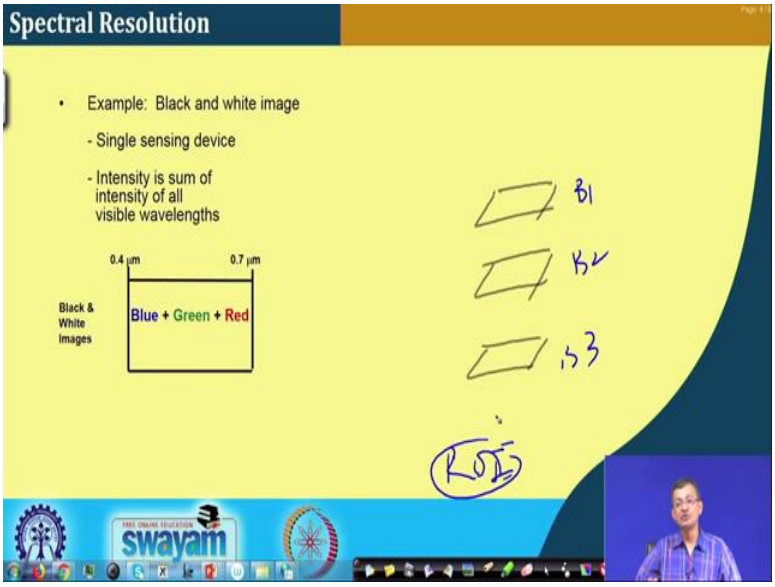

Now, if you look at the spectral resolution. So, one is the black and white image that how much spectrum is there right, one is black and white single sensing device; so, it there. It can be intensity is the sum of the intensity of all the visible wavelength right, so, it can be like that. So, or I can have different spectrum, right I can have a spare if I say IRS or Landsat type of things, we have NIR, red, green, blue right thermal to thermal band right. And so, it gives 6 to there are more finer things so, 6 to 8 bands or I can have my spectral resolution is so, many things right.

In other sense capturing this particular image, I can have now different same area, same ROI; I can have different things captured at different things. So, this may be band 1, these may be band 2, these may be band 3 and dot dot right. So, I can have different spectrum of the things. So, these are, but the ROI or the basic region of interest or the capture which is my region of interest is the same or the same thing I kept captured in

multiple spectrum ranges right. So, the spectral resolution also helps me to have different type of latter on we will see that I can have different, like there is a concept of NDVI like vegetation index like. So, that high NDVI value from the image it will have the will give me that what is the more vegetation coverage or type of things.

So, band 4 minus band 3 by band 4 plus band 3 is my NDVI calculation right. So, as I have different bands of data I can do, if I have only one either it is there or not right. So, in hyper spectral band I have number of bands rights, are two that you tune of 150, 160, 200 number of bands. So, but the more I make have this spectral bands, the more is my complexity of the sensory system right; more is that data load on the things right. So, it depends, but if it is so, it based on the application and need we want to look at those thing.

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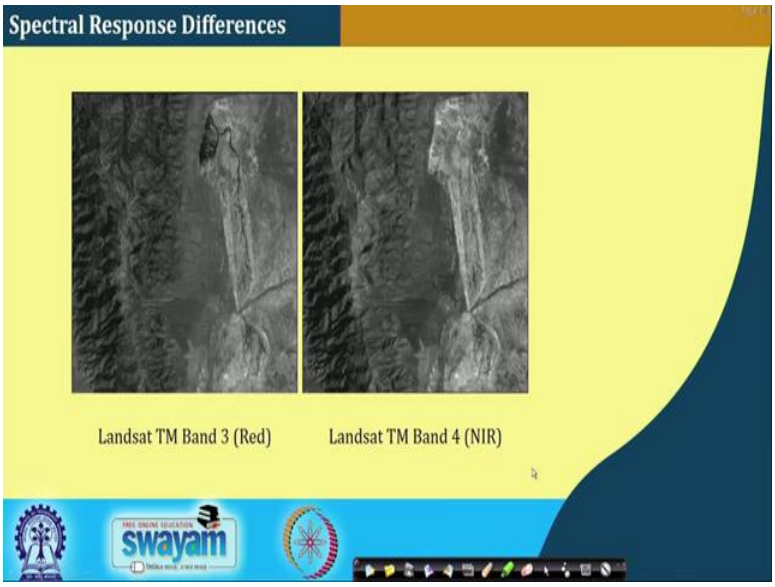

So, like spectral response difference Landsat band 3 is a for the red band the data is like this, for Landsat band 4 NIR band is data is like this. So, these are the two different same surface temperature say two different different bands of the same region right. So, one is the red band region another is in NIR region right. So, these are the different spectral responses.

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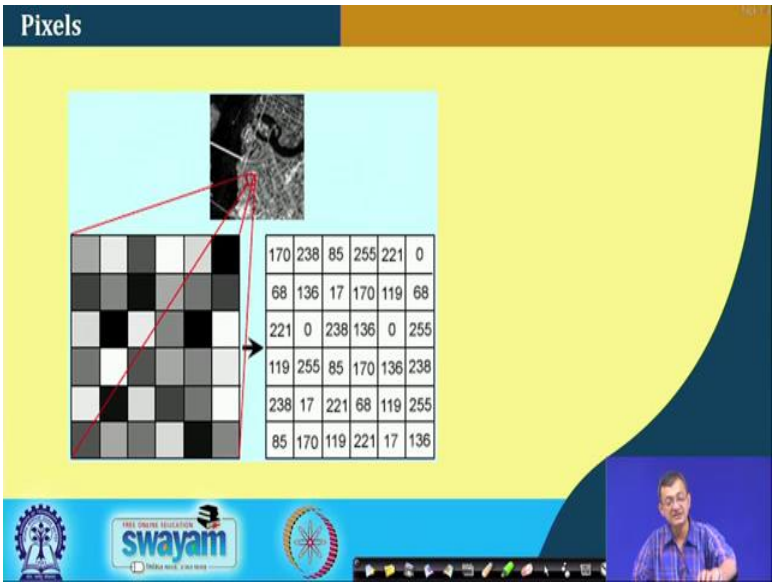

The every time and then we are coming to a pixel; pixel is known to mostly all of us we are used to this pixel for our normal camera and mobile cameras and type of things. Nevertheless, a pixel represent the value or what we say digital number or DN value of that particular captured thing right. So, typically if it is a 8 bit thing so, we have a value from 0 to 255 right.

So, I have number of bands say 8, 10, 20 bands, every band has a layer of a which every pixel which contains a matrix of pixel; every pixel having a DN value or digital value which is between 0 to 255 right. So, this is way it is captured. So, these are the different pixel values of the things. So, for a particular region I can have the whole matrix as the different pixel values. So, when we calculate say when we are telling that NDVI, I am calculating band 4 minus band 3, band 4 plus band 3 then I am calculating over this pixel values.

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So, other aspects is a special resolution which already you have discussed, spatial resolution refers the size of 1 pixel to the ground right. So, if it is a 1 pixel so, how much area is represent? One is that value of the pixel; so, it is aggregated value of the things, one is number of layers another is that 1 pixel how much area is covering right. If it is a 10 metre 10 metre resolution so, 10 metre 10 metre on the ground is this, if it is a say 23 metre, 23 metre is this, if it is 100 metre, 100 metre, 100 metres on this right. So, more finer like 10 1 metre resolution, more clarity of the objects on the things I can get right.

But, I may not always want to count the number of trees and the things I want a overall vegetation cover on the particular ground right. So, that time I do not require because, one size as we have seen; once I go more finer the data load increase in a fourfold manner right. 10 metre to 10 metre, if there is one image if there is a yeah if it is a 20 metre 20 metre one image and if the resolution 10 metre, then I require a 4 image to capture the same place right. If it is a requirement, it is a requirement; application needs otherwise it is a costly affair.

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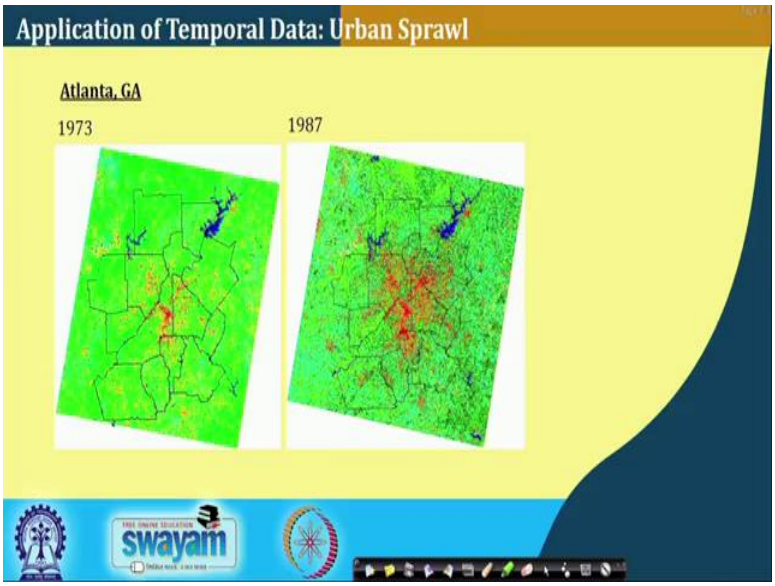

Now, given this what are the different, how we are have different type of application? One major application is temporal data right, if I have a temporal resolution over the time how it is changing right. So, one is urban sprawl right, changing course of river basins or river flow, the or in case of a flood type of situation how things changes over hourly basis or daily basis or type of things. How much inundated or how much water has retreat and type of things right. So, it becomes necessary to have the same type of like same spectral resolution, same spatial resolution; keeping all other things constant.

Repetitively capturing the things to have some sort of a change detection study which is one of the major aspects of remote sensing things right. So, once I can have a change detection, I can use other techniques analytics techniques to this you when I have different temporal my t 0 t 1 t 2 t 3 t 4 t 5; this type of data. Then I can use different type of techniques or algorithms to learn from the things and have a some predictive or predictive or forecasting models, that what will happen and that type of things. So, these are the things which can be done.

So, what we come back to the again that for any satellite image; so, we have four major aspects; one is that spectral, radiometric, spatial and temporal. So, these four aspects are important for any image related, any satellite image processing etcetera. We have also seen that this can now become an input for next analytic tools which are can be stored in appropriate manner in a GIS system with a underlining database which can be queried or

for mining the data, warehousing the data; means appropriate storing and warehousing that I can mine the data for any type of decent support systems.

So, that we see that the how these data captured on a from a remote sensing system like a remote sensing satellite system or something can be put into use or put into the end user or for the systems to for any decent support or doing some analytics things. So, today what we discussed is that what are the different aspects or the major aspects of this satellite system which is pretty important for sensory systems pretty important, for the application for everyone to use.

And, we have also seen that how a data captured can be put into practice. In the subsequent lectures one at least one or maybe one or two, we will try to see that how this remote sensing and GIS are used for other different aspects right. Rather we will see some of the other matrices like as we discussed about NDVI, there are thing called LST, NDVI and type of things; how it helps us in doing some sort of a analyses at a very basic level alright.

Thank you.