Spatial Informatics
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Lecture – 34
Remote Sensing and GIS – IV

Hello. So, we were discussing for last couple of a lectures on Remote Sensing and GIS at different aspects of remote sensing GIS. So, primarily we are looking for satellite remote sensing, but it can be other sort of a sensing mechanisms also remotely and what are the basic things of geographical information. So, we will continue that discussion and try to see that how they, means what we say; coupled to with each other that how the remote sensing data are used in GIS and so that for any decision making support system.

So, our major objective as we see that we get the data in a repetitive manner. I, we want to get the data in a repetitive, accurate and quote unquote dependable manner; that means, consistent manner and want to use that for different decision support system, analytics and type of things. So, this is one of the things.

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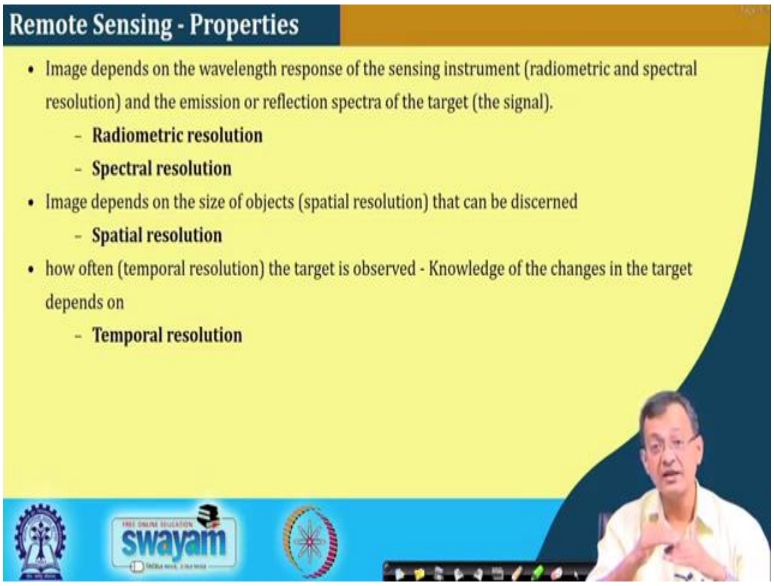

So, last day we discussed about four major aspects or properties of a remote sensing. One is the radiometric resolution, spectral resolution, spatial resolution, temporal resolution, right. So, if we see radiometric is a primarily what we have seen; it is how the data is being captured is in the different band of the electromagnetic wave, right.

So, based on that how the sensors is tuned, it takes the those particular range of sense between the electromagnetic energy or the electromagnetic reflectance from the earth surface. So, there is a source of light, it may be sun or it may be active sensors where like radar or such type of images where the signal is sent to the Earth's surface, reflected and being captured by the sensors, right. So, based on that how many bands I can take, it is my spectral how spectral spreads are there, right.

So, typically our own satellite like here is one IRS category of satellites. Now, there are lot of advanced sensors, but what we see that there are around six to seven bands. Similarly, that a popular Landsat TM or ETM sensors or the payload of this your USGS where we have a similarly those sort of bands, right. So, these are our spectral bands.

Radiometric means given a wavelength, how many levels of data I can; what are the number of levels we can have. Spatial resolution is the how is the spatial coverage of the things, like as we discussed that if we say a 20 meter or 23 meter resolution; that means, 20 meter by 20 meter on the earth is a pixel or on the image.

That means a pixel value is determined by this 20 meter 20 meter value of the things; that means, it is that reflected EM wave converted to the digital form. Calculated a value has been calculated in the range where it is stored. If it is a 8 bit data what is storing, so the range the pixel value or popularly known as DN value is 0 to 255, right. So, maximum is 255, the minimum is 0; out of that one value is there. So, it represent if it is a 20 meter 20 meter resolution, spatial resolution. So, 20 meter 20 meter on the earth is pixel on the things.

So, as we understand if it is a 1 meter resolution, one meter one meter on the earth and things. So, if it is a say 20 meter, so any object less than 20 meter it is distinguishing from the things is difficult, for that matter not possible because it is now averaged out, right. So, it depends and on the other hand, if I go for finer resolution; the image size or the image overall load increases, right. So, it depends on that what is your, what is the application area and so and so forth. So, this spectral and spatial is one of the major aspects what we see.

And another aspect is the temporal, how frequently I am visiting these things, right. As it is a as we have seen this is a polar orbiting or sun synchronous that is when the sun is there the satellite is there on the region of interest; like for our IRS satellite in a remote sensing satellite, our region of interest is India, right. So, our country. So, that the when that satellite flows over the this India, it should be on the sunshine or daytime type of things, right. And of course, it may cover some other things where the sun rays are there, right.

So, but how repeatable right; whether every day, every other day it is repeating or something that repeatability of the data is important. It may not be the repeatability from the same payload; it may be from different payloads, but how temporal. This helps us in doing change detection and type of different type of applications. So, this is also important.

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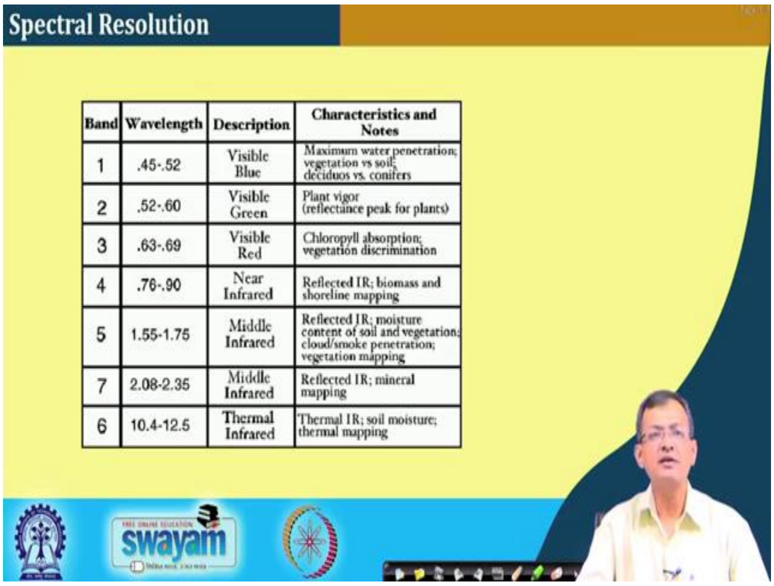

So, this one chart taken from the internet like if we see that there are different bands like band 1, 2, 3, 4, 5, 6, 7 and like band 1 is visible blue, band 2 is visible green, band 3 is visible red, then NIR; near infrared and 5 is middle infrared and 6 is thermal infrared and this is another portion; this portion of the thing is the middle infrared, right.

Now, you see based on this wavelength band, the type of or the characteristics of the things which are being the where the prominent reflection from the objects are is given on the right hand side. Like for band 1, maximum water penetration right. So, it penetrates the water, vegetation versus soil and deciduous versus conifer. This helps us into distinguishing this, right. Like band 2 is a plant vigour, reflectance peak at a for plants.

Band 3 is a chlorophyll absorption, right or vegetation discrimination helps in band 3, band 4. Reflected IR, biomass and shoreline mapping that is used, similarly middle infrared and thermal and type of things, right. So, these are different application. So, what we see these band are just not like that, we can have different type of application on the things, right. Nevertheless only these may not help us right, we need to do some sort of a metric type of things. We will see that one of the very popular metric in DVI for vegetation indexing or final vegetation mapping where which is a combination of this band know.

Now, this is our standard. There are these days satellites with hyperspectral band, their number of bands goes up to 200, more finer wavelength and it helps in different type of studies; studies from definitely different agricultural biomass type of things to different type of soil type, possibility of where which type of minerals are there and type of things, right.

So, there are variety of a application areas which dictates these things. So, what we see, there are a couple of important things. One is that I, we require a domain expertise to look at; like I am not a soil expert to see that which is how the image is coming up. So, domain expertise require lot of a physics behind it, right. And of course, there are technologies CS guys who where we can, who can help these things to model etcetera.

So, it is a definitely a multidisciplinary things and then you will find that this remote sensing is being studied or used in different departments for different purpose. The thing is that the same type of data I can have different things; like in soil scientist used for soil, agricultural scientist use for agriculture, a geologist used for some different geological features and so and so forth. So, it has a different same set of data we can use a different thing.

This data are as we have seen is accurate or the error or whatever that distortion are there, these are systemic distortion; we can recover from this. They are repetitive in nature; the satellite is moving and after a few days coming, so there are studies of change due to X ray and forecasting etcetera is there and they are consistent, right. They have maintained a height and type of data they are collecting in a consistent manner. And so, this becomes a important source, information source for building information framework or database.

Like we can build up warehouse, we can data warehouse or a spatial data repositories or so to say in a spatial data infrastructure will help us in doing different type of analysis down the line.

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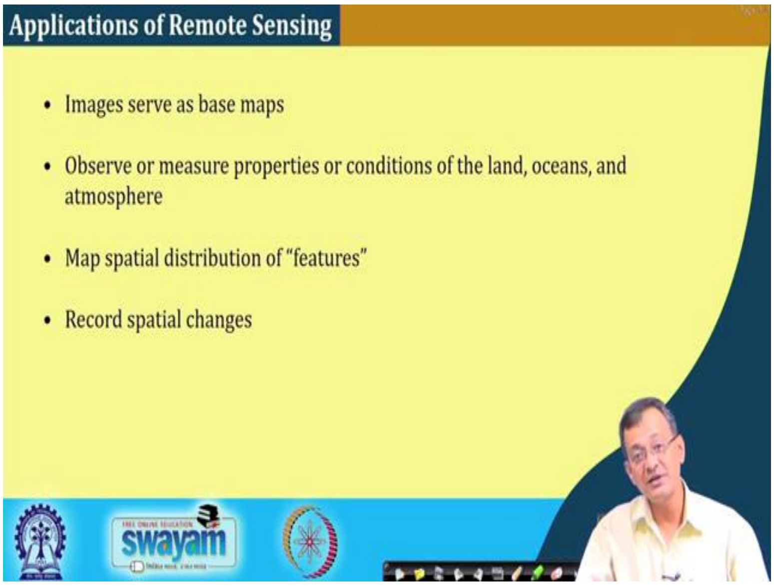

So, if you again if you look at the application areas, there are different application. First of all there is a difference between this image and the base map, right. Image is the raw picture of the things.

If a map is classified, annotated for usable product, right, so there is a transformation from what we collected from the things and how to make it usable. Rather these maps or different categories like same as we are discussing, same image we can use for same different type of things; like we can have a soil map, we can have different type of structures.

So, those things can be achieved by this using different type of maps. And this can be input to a information system like geographical information system which can work on it to do different business support system. So, observe or measure property or conditional condition of the land, ocean atmosphere, this is one of the major things; like what we are thinking that one of the major aspect of remote sensing thing is natural resource management monitoring, right.

So, observation means signalling for initiating corrective action etcetera. Map spatial distribution of features right record spatial changes, right. So, it tries to map the spatial distribution of the features right, if we say what so to say that land use land cover type of map and record spatial changes, that if it is over the temporal how things are changing, right.

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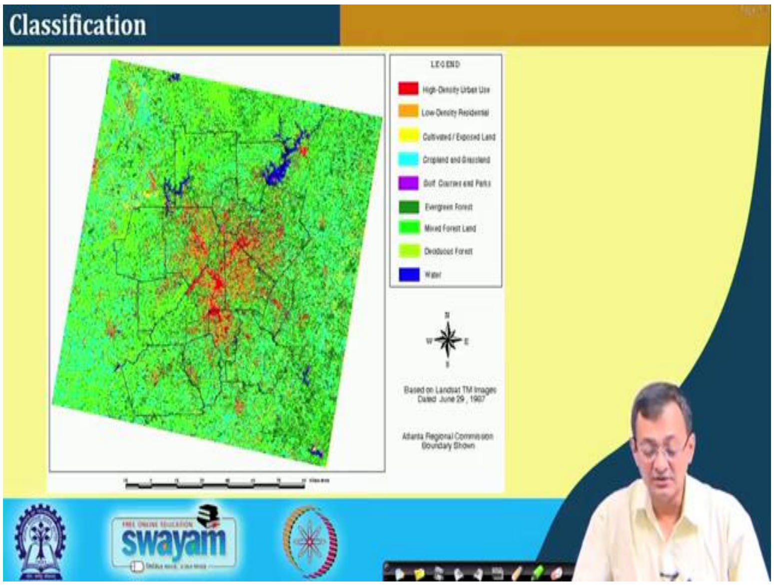

So, these are the things. So, again a image is taken from these Landsat image taken from internet, some sources. So, it is you see this gives a some sort of a classified things like high density urban use, low density residential to evergreen forest, a fixed forests, deciduous forests water. So, this needs to be classified. So, I we classified that need to be, image need to be classified in some form of other right. So, this is one type of thing, so this becomes a usable. Over that if you see there is a boundary maps right, now see this boundary map is not seeing from the Earth's surface.

So, this has been digitized or taken from some other source like say from survey etcetera and put on the things, right. So, this is the application where I have a multi-layer, more than one layer into the things to do the things. So, now, we can find out that in this particular this region of internet or this state, how much cultivated range is there or I can say which state having maximum cultivated region or which state has made maximum water body and type of things, right. So, these are the things possible with these maps.

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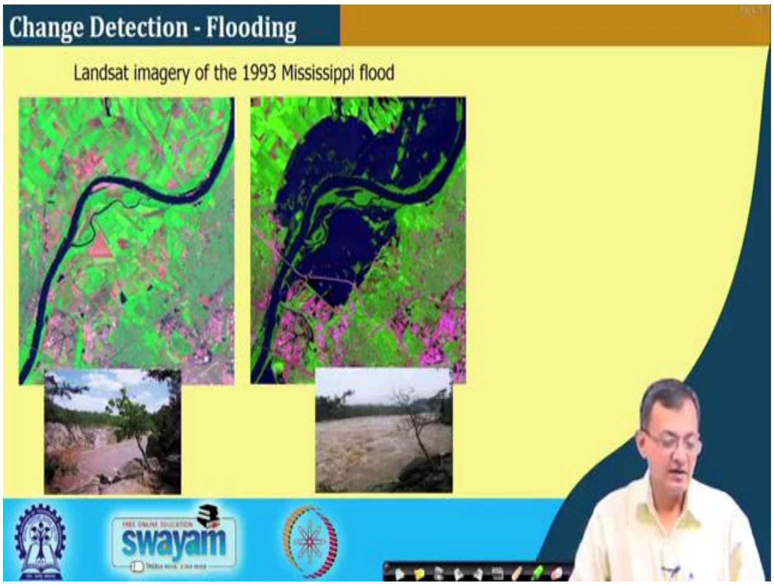

Like this is another changed detection, again take from internet resources like Landsat imaginary of 1993 Mississippi flood, right. So, this is a image and of two temporal scales, so normal and flooded. So, this can this is used on the things.

So, I can see from the things, this is water body of the things like over that if we overlay the these are some of the agricultural fields etcetera like or some build up areas also there. So, if I overlay those build up maps etcetera from the other source; I can find out that which how much area is inundated, which road is inundated, which road is likely to be accessible and type of things.

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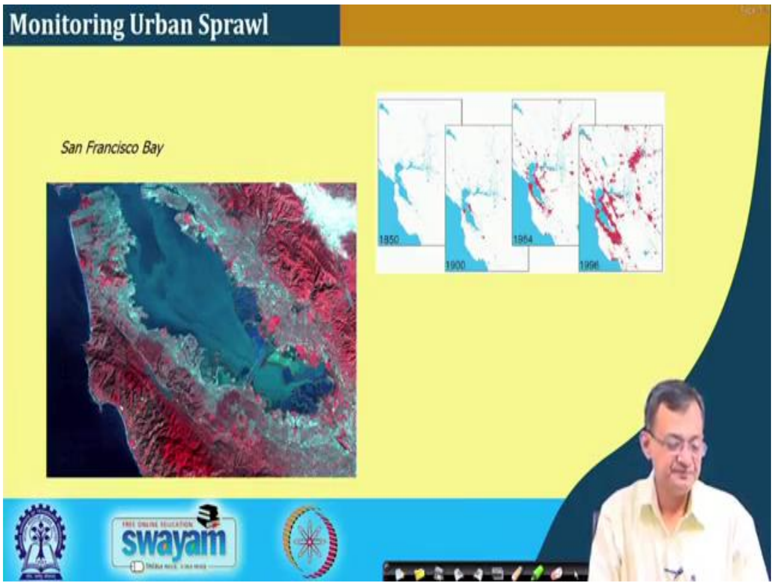

Monitoring Urban's Sprawl right; San Francisco Bay. So, this is the thing of different years. Again, a study using may be carried out by USGS or some things, taken from the internet like 1918, 50 and type of things that how urban fall is there.

So, it was practically nothing to there is a lot of growth on the things. So, these are possible, because I have a repeated data of the things and I can happy minded. How do I find a urban sprawl either by that is why I should be a mechanism to find out the build-up areas right, to give a indication like in DBI type of things which have a some matrices which gives a find out the build-up area on the things or I can have a survey of the things and put on the maps on the stuff.

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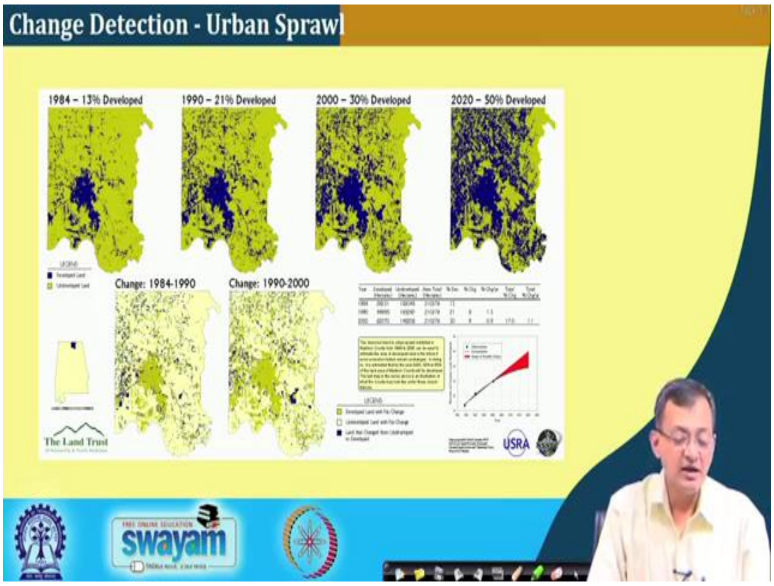

So, change detection and of the Urban sprawl from these US array data set or some image set. So, we have 1984, 13 percent developed to 2020 expected 50 percent developed right. So, similarly climate changes between this region and this region. So, these are some of the things which are there for doing change detection study, forecasting and type of things. This is a some sort of forecasting mechanism right; 2020 what is going to be there, right.

So, this is what is the change detection studies etcetera. So, by that decision maker or federal governments and other, they can take corrective action or necessary action for the things, right. So, accommodate for the things. So, this is helps us in a in doing in having different decision support system for development planning and different government programs and so and so forth.

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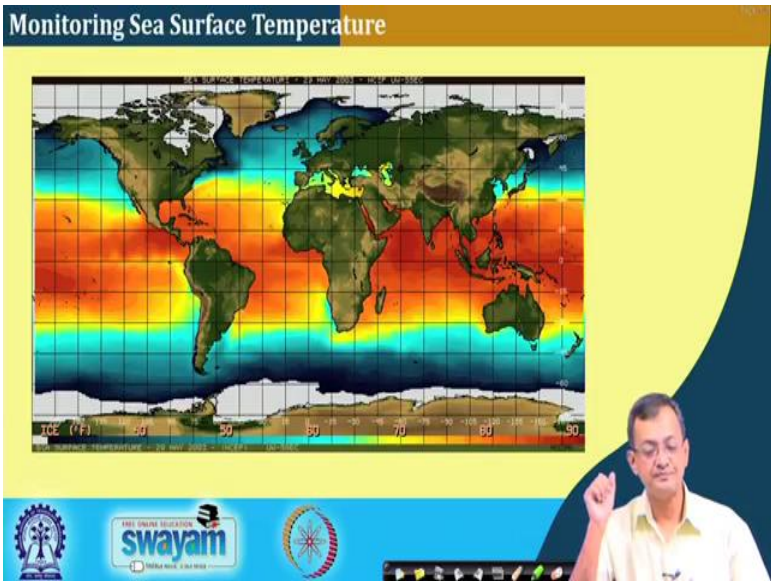

This is another data set taken for sea surface temperatures. This is the range it is given from ice to different grade of Fahrenheit, that what are the different sea surface temperature mapping. Now, this changes over time right, then on a particular like this is 23 May 2003 in CEP and some collected and mapped by the things. It will go on changing the things right, I can have different spatial temporal analysis to see that how things works and type of things, right.

So, these are the type of studies we can do on sea surface temperature to urban sprawl to agricultural change to site flood monitoring. So, you see that there is a variety of applications where this sort of remote sensing data can be deployed right or it can be used to have different manifestation of the things, right.

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Now, one aspects which is like to see with some more details like maybe couple of slides; that is one is that vegetation index. So, measuring vegetation cover, this is important for mankind per se and for our overall planning and type of things for the government for it; because that is the source of food all right. So, there is a index called Normalized Difference Vegetation Index or NDVI right. So, this index helps us in doing, finding that what is the nature of vegetation coverage is there.

So, see one part what we see with this remote sensing data, I can do a large scale mapping of the data right. I can have the data in a large scale mapping, right. So, distinct colour, wavelengths of visible and infrared sunlight reflected by the plants, determine the density of the green on a patch of land or ocean, right. So, what we say that wavelengths in the visible range and NIR range, near infrared range, reflected by the plants will may help us in finding that how much the greenery, so called quote, unquote greenery on that particular region of interest, right.

So, that is one of the precursor of the things. The pigments in the plant leaves, like typically the chlorophyll, strongly absorb visible light from 0.4 to 0.5 range and to from 0.6 to 0.7 micrometer. So, this is a characteristics of this particular pigment chlorophyll, for use of photosynthesis. So, it is absorbed for the photosynthesis. The cell structure of the leaves on the other hand strongly reflect the near infrared between 0.7 to 1.1.

So, this is interesting right. It absorbs a portion of the thing 0.4 to 0.5 and 0.6 to 0.7, where NIR or near infrared range of 0.7 to 1.1 micrometer are strongly reflected, all right. So, the more leaves in the plant has more phytoplankton there in the column right, the more of these wavelengths of the lights are affected respectively.

In other sense what we say, if we have more leaves or has more leaves in the plant; means that is sort of a more diverse of the scenes, I am not a biologist. So, I am not going to comment on the things, but from if we look at that from the point of view of finding the vegetation, so if there are more leaves or in other say phytoplankton there in the columns. So, more of these wavelengths are affected right; that means, some more are absorbed a particular things and more are NIR are reflected, right.

Now, from this I can have a idea that how much vegetation cover is there. We can do a little means, what we say functional modelling of the things to get that reflectance things or get that particular measurement for the vegetation in a little more clearer fashion.

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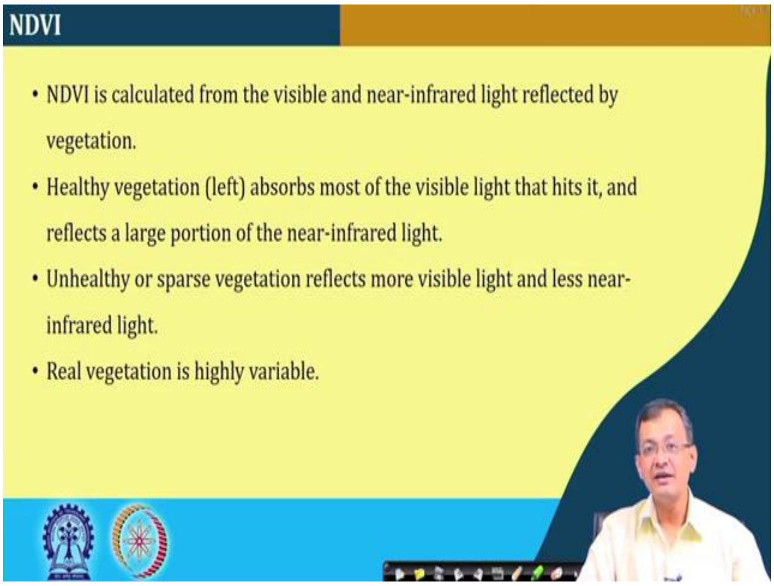

So, NDVI is calculated from the visible and near infrared light reflected by the vegetation. So, NDVI or what we have seen normalized difference vegetation index is calculated based on the things.

So, what is the difference? One is absorbed, one is reflected. So, the difference will be NIR minus if I near infrared or IR infrared region minus the say the red band or this visible range; then that will be the difference. Now, this difference may vary from that type of things right. So, in order to make it normalize, we have that NIR plus IR divided by the things right. So, that is the way. So, healthy vegetation absorbs most of the visible light that hits, and reflects large portion of the near infrared light right that we have seen. And unhealthy or sparse vegetation reflects more visible light and less infrared light all right.

So, real vegetation is highly variable. So, actually vegetation covers a really highly variable. So, it is very just by making a difference or looking at the only the reflectance value of that different wavelength, it may be difficult to comment that whether it is healthy or unhealthy and type of things.

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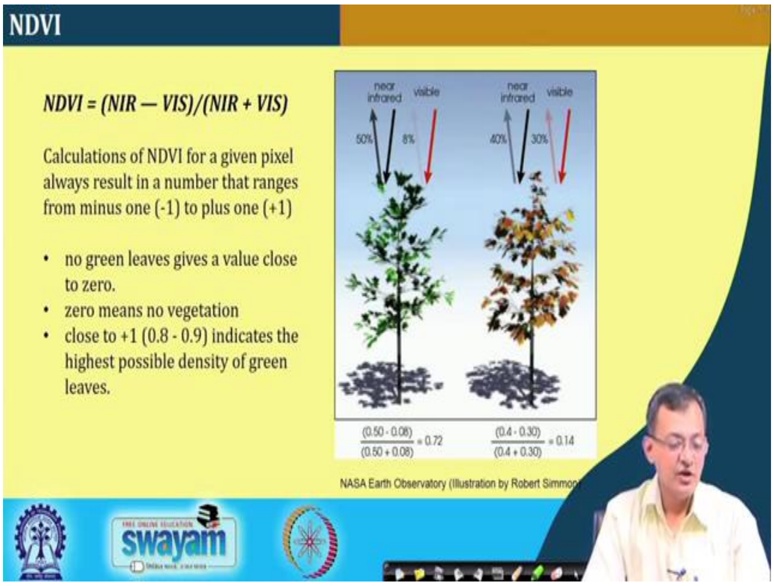

So, NDVI is NIR minus visible by NIR plus visible all right. So, NDVI is NIR minus visible minus NIR plus visible. Calculation of NDVI for a given pixel always result in a number of, number that ranges between the minus 1 to plus 1 right. So, that because it is normalized all right. So, it is. So, no green leaves gives a value close to zero.

So, absolutely no green leave, it will be close to zero; as we have seen here that unhealthy or sparse vegetation; that means, effectively no green leaf, as a more visible light and less NIR light. So, this will be close to zero; that difference will be very less. Zero means no vegetation. So, if there is no vegetation there is zero; close to plus 1 that is 0.8, 0.9 indicates that highest possible density of the green leaves right.

So, more we are going to the plus 1, the highest possible vegetation right. So, NDVI gives us a calculation of the vegetation mapping. So, one of the major aspects of a any remote sensing application is finding the vegetation mapping. Here also Government of India with help of is flowing the culture they are having some project for pre harvest calculation of the crop program, crop production right. So, that helps in government procuring or taking stock of reserve, take remedial action and type of things right, these days are extensively used.

So, vegetation becomes a major aspect. Like here if it is 0.5 and this is the 0.72, it is a the more greenery right. So, near infrared 50 percent reflected, visible 8 percent reflected; it is on a dry thing that is green is less. So, near is 40 percent, where visible 30 percent. So, NIR is a sorry NDVI is 0.14. So, at it depends, then how green is your green right so; that means, how the vegetation cover is, how healthy it is. So, this gives a indication of the things.

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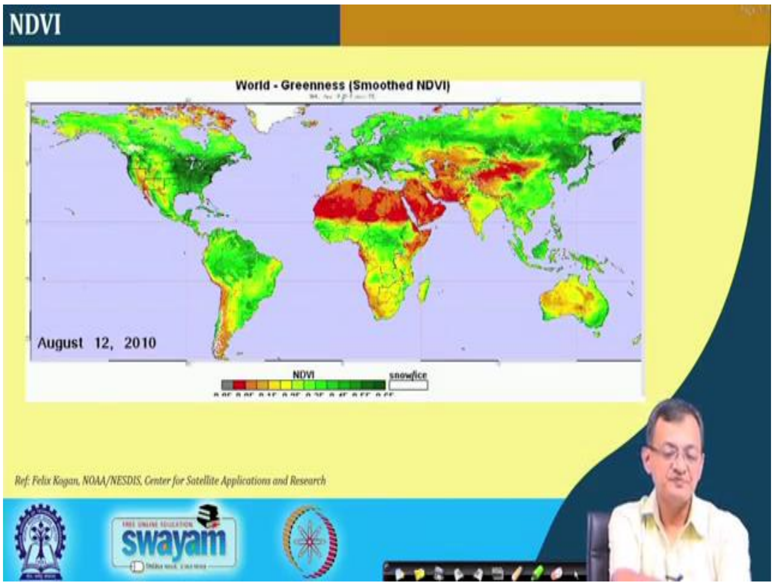

Now, this is a world greenness or smoothed NDVI, this is again a image taken from the internet, taken somewhere 2010 and it gives a scale of a different NDVI scale right. So, it thing is little not visible. So, the low NDVI is in this brownish, then red and more green is the more greenish. So, if I have a 0 minus 1 to plus 1, I can basically range to different aspects of the things right. So, this gives us a handle to find out that how much greenery is there right. So, this sort of calculation we do, right.

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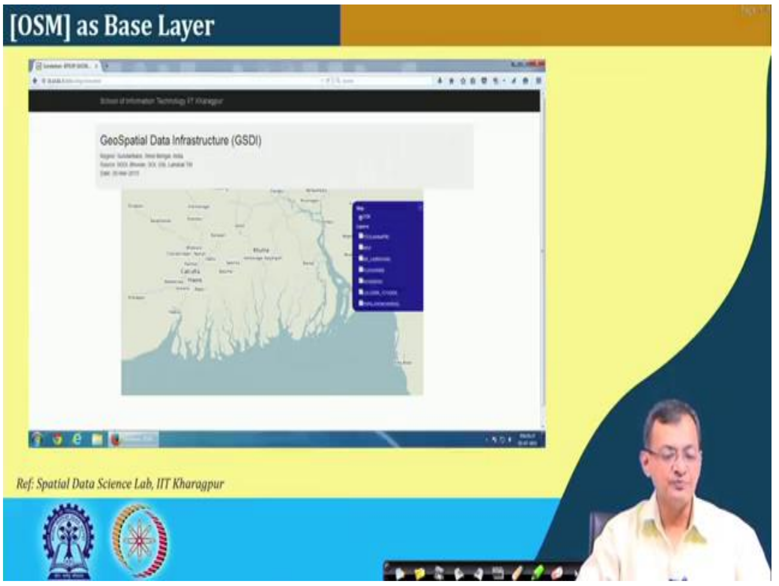

So, after this we like to have a give you a short case study of the work done here at IIT Kharagpur. Try to see that how different datasets can be merged together or looked into looked in a complete fashion right. This is the area, where we have a, this is a Sunderban area, where it is this southern part of West Bengal, South of West Bengal this is this over Bay of Bengal right.

So, this is a area which is a particular image of the things. So, we have used some of the data from Landsat TM like USGS, survey of India Bhuvan ISRO, geological survey of India GSI and there is national spatial data infrastructure. So, all those data whatever we have used are available over the accessible or freely available over the internet all right or through their websites all right.

So, this is a very large scale; that means, spatially spatial resolution is pretty high, may not be very significant for very ground level planning; but it gives the idea that how we can march together things like that right. So, here we have an over and above we have a OSM that is open street map layer also on the things, right.

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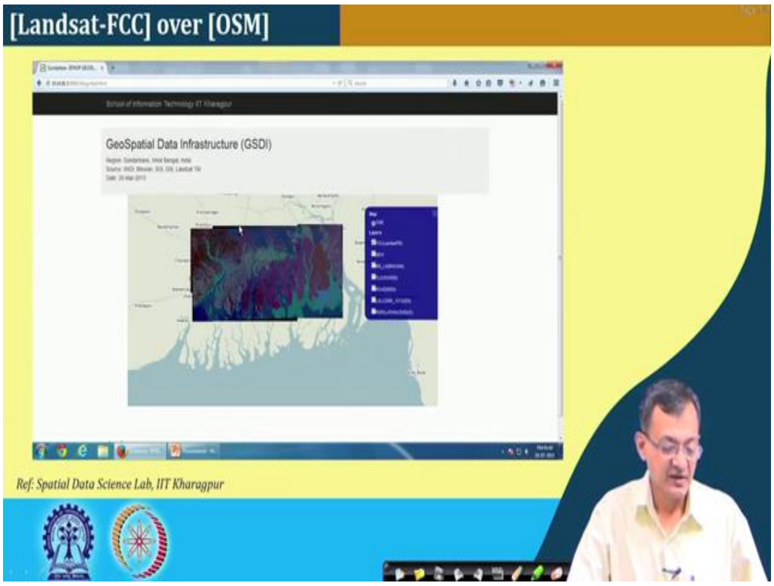

So, over that if we overlay these false color composite or band 432 combination of the Landsat TM on the image. So, we have a data, over that we overlay this OSM map right. So, the a sorry this Landsat map. So, this is the satellite imagery, right.

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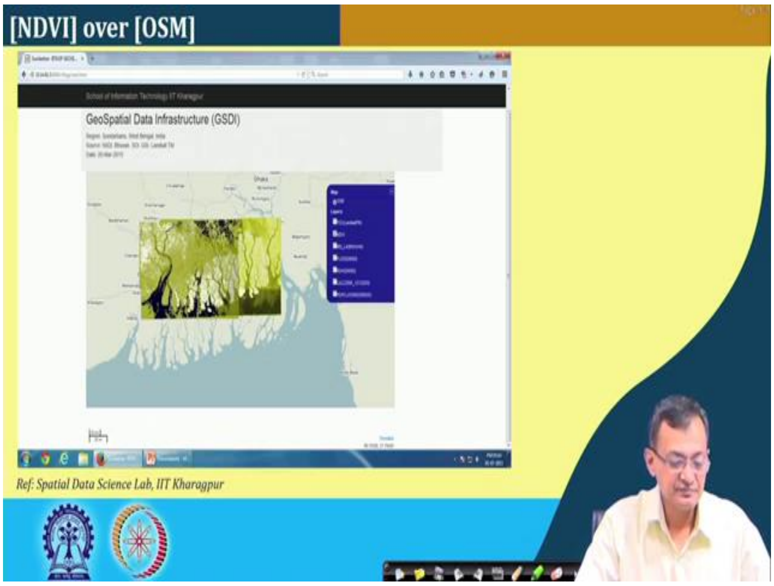

So, here we can calculate this NDVI right. So, NDVI from where using this Landsat data right. So, Landsat data we calculate the NDVI and then I put on the things; that means, how much vegetation coverage is there in that particular region, Sunderban is basically a more cleaner region, there is a lot of coverages; but there are different pockets which are being dried up and type of things. So, this is a NDVI map, right.

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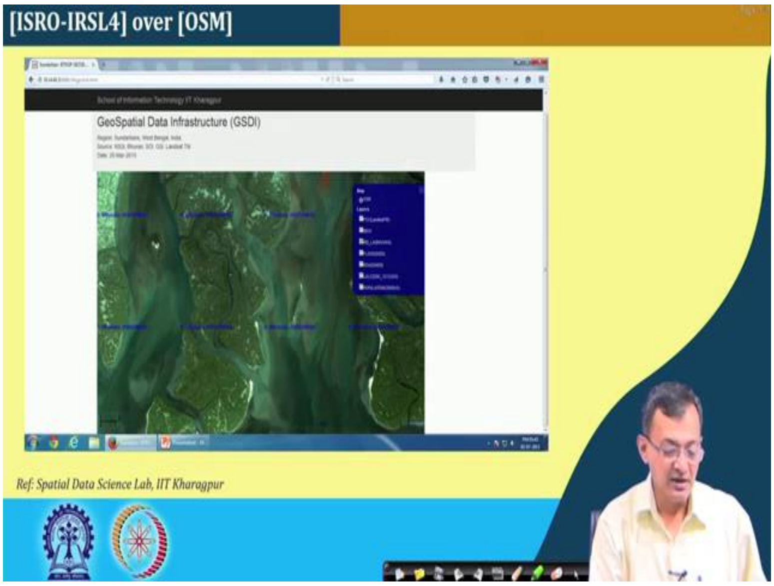

And this is a thing which is our IRS data, IRSL 4 data off from the Bhuvan website. So, that same area, the maps are they are taken from the IRS.

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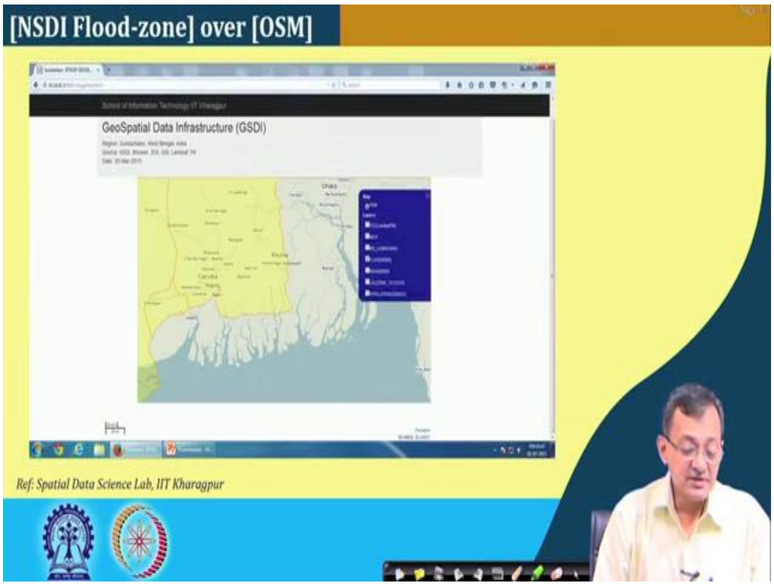

They says looking at that NSDI flood zone. So, a data set which is from the NSDI flood zone; that means, that NSDI the NSDI spatial data infrastructure they have a flood zone generated and shared by some agency may be disasters management or somebody in the survey of India or something you see it or even ISRO and type of things. So, this is from the flood zone taken from the NSDI.

What we are trying to see here, see all data sets are registered; in other sense they are registered for to a batch base map right. Once they are registered to a base map we can now match them together right, we can match them together in a particular session, right. So, this is the important aspect. So, we want to see that different layers, how they can sit over one another.

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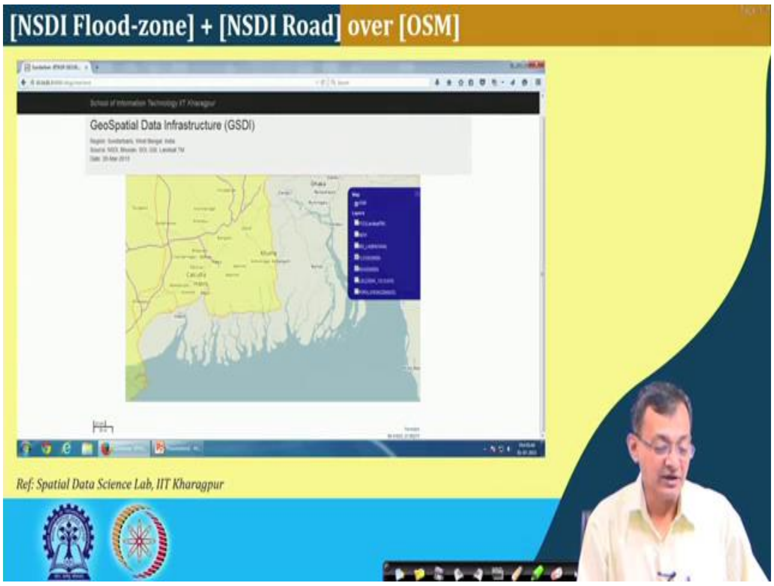

Now, here what we say that this flood zone from NSDI, road network from NSDI, over that available map, right. So, this road network from the NSDI, flood zone and we put it on the that our base map right, here we can see. See by we can by a simple application we can design whereby the which we can design those things.

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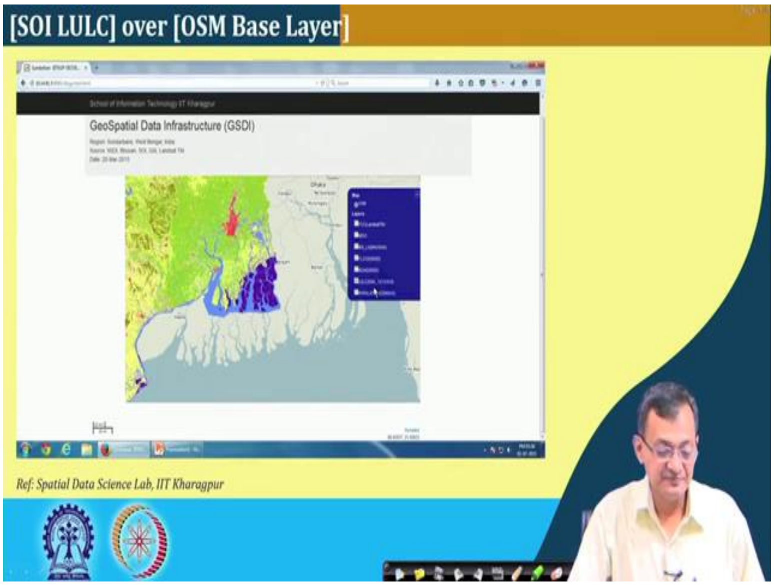

Now, survey of Indian land use land cover maps want to overlay over other things right. So, map generated by a survey of India. So, why this portion is not there, because we did not get that right and some portion is going to the Bangladesh area. So, this survey of India, these land use and cover a this portion goes to the Bangladesh area; anyway do not consider this two scale.

So; that means, this boundary etcetera may not be that creeps and type of things, it is just for reference for our academic purpose only right, not to be looked into a as a more of a what we say planning purpose or something like that right. So, land use land cover map which is generated by LULC that Land Use Land Cover may have generated by the survey of India can be mapped over this, right. So, this is another aspects of the thing.

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And now ISRO IRSL 4 with NSDI Flood and NSDI Road try to map it right. So, taking that this ISRO IRSL 4 data around with NSDI map along this NSDI road map which is from another source can be there, it can come from a any source.

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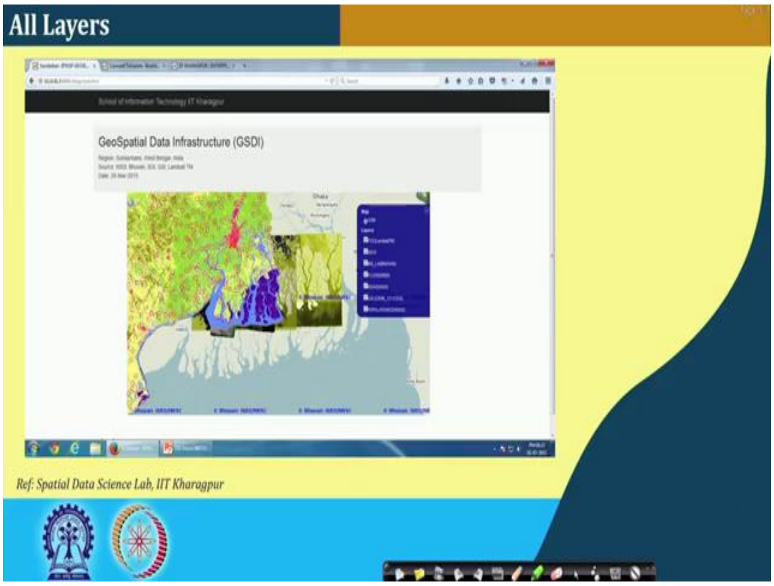

So, what we are trying to show is that overall interoperability of the things like. Here we are having all layers like which has Landsat, NDVI, IRS data from whatever shared by Bhuvan website, flood, road, some LULC and there are some of the things which are population related data right; which are basically non-spatial, so to say data right, map to a spatial location, but they are non-spatial datasets.

So, what we try to see that, I remote sensing acts as a very critical thing; like it is taking from the data from different sources and type of things right. And also I like I we have created that ISRO IRSL 4 data is from the remote sensing data and the data from classified image or land use land cover is classified from the remote sensing data, NDVI from the remote sensing data. We have other sort of data also right; like a vector maps, a this road map, flood zone are same these are polygon and line data and type of things.

So, what we see that it is possible to have integration of the things, and I can do this is as a decent support system; this could have been gone as a GIS layers, can do different type of things. I want to find out in this flood zone is saying how much vegetation could have been affected or which are the road inundation or inundated by the flood and type of things. So, there are different type of things, what we can do with this type of active means there.

So, what we discussed today's class is looking at some of the aspects of the remote sensing; specifically looking at some whether the how it can be utilized, how that can be merged with this geospatial or sorry other layers for have a some sort of a decent support systems right. And in our subsequent lecture we try to see few more small small aspects of the things on remote sensing and GIS.

Thank you.