Spatial Informatics
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Lecture - 35
Remote Sensing and GIS – V

Hello. So, we were discussing about different aspects of Remote Sensing and GIS for this Spatial Informatic course. We have seen several aspects of the things in last few lectures. Today maybe in this particular topic this is the final lecture. We will see that some more aspects of remote sensing which helps us in interpreting or different ease and support system or different analytic systems we were the things are there right.

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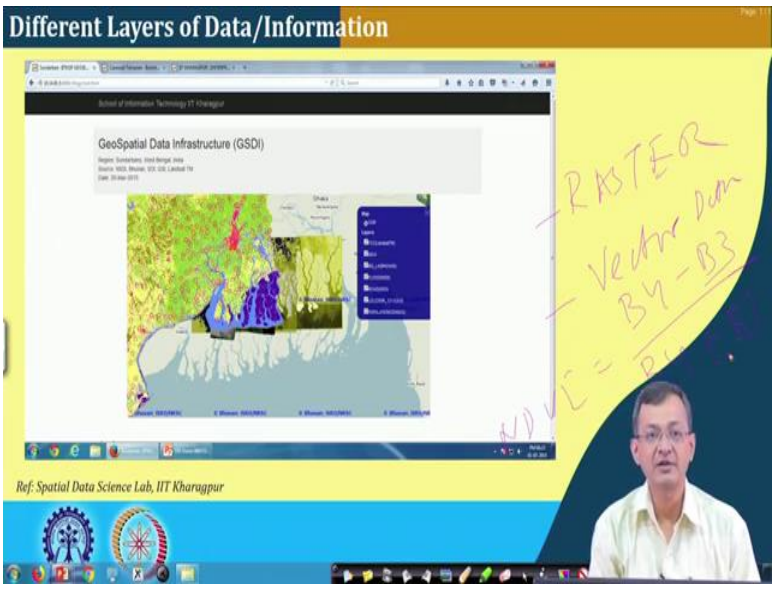

So, last lecture if you recollect we have shown that some experimentation or demonstration what we have done in at IIT Kharagpur, where different sources of data, like data from say satellite images, IRS data our own Indian Remote Sensing data which is available in Bhuvan portal of ISRO. And then some data from survey of India, GSI also from Landsat TM of USGS and a width of NSDI, like data like road, rail and type of a road and boundary and sort of things.

So, there are several data we are able to integrate them, right we are able to because they all sits on a basic reference map. So, that is the beauty of the things what we are trying to see so that it can worked it can be integrated or different sources of data, but it can be

interoperate would have different interpretations, helps in different interpretations of the things right.

So, couple of things we may be interesting to note. So, if you look at this sort of data sets some data are from remote sensing, satellite remote sensing some that is what we have seen that some sort of a NDVI or false colour composite sort of data which are from the directly the datasets with some minimal pre-processing analysis doing that.

Some of the data are classified; that means, we have to classify the data right; that means, to have some meaningful information out of it. So, we need to classify that you know like; for example, if a land use net cover data we want to say that this is my say build up area, this is the road this is or say agricultural field, water body and different type of things vegetation, water body, build up area and etcetera etcetera; that means, you need to classify them.

For classification we need to trained the things right we have to give some ground truth based on the statistical things we need to classify the thing; it is same philosophically same thing as how we do at the in case of a image processing. But here the interesting additional thing is that as we have a multispectral data that the data of different spectrum. So, which layers to be considered to extract some of the information is important right.

So, a couple of things it is interesting 1 once we take this satellite remote sensing or any remote sensing data these are all. So, to say sorry, these are all raster data set right. We and that other type of data like what we have looked at like boundary data road network these are primarily vector data set.

If you recollect at the beginning of the course, we have looked into the raster and vector data set, but nevertheless I can have them at least display together and I have to do some conversion, but still work with them together right. So, remote sensing data the things to be mention remote sensing data typically are all raster data right. So, it is a sort of agreed where the values are there what we call that DN values right or digital numbers or some values for the things.

And they are multi spectral; that means, data captured at a multiple brand and we can use them 1 or more band to look at the things. like NDVI if you recollect in the last lecture we have seen it is band 4 by NDVI what we have seen band 4 minus band 3 by band 4

plus band 3. Band 4 is the near infrared, band 3 is the red visible red. So, NIR minus R NIR plus R to normalize the thing. So, NDVI plus 1 to minus 1. So, if it is more towards plus 1 we say that if there is a lot of vegetation is positive NDVI and type of things ah.

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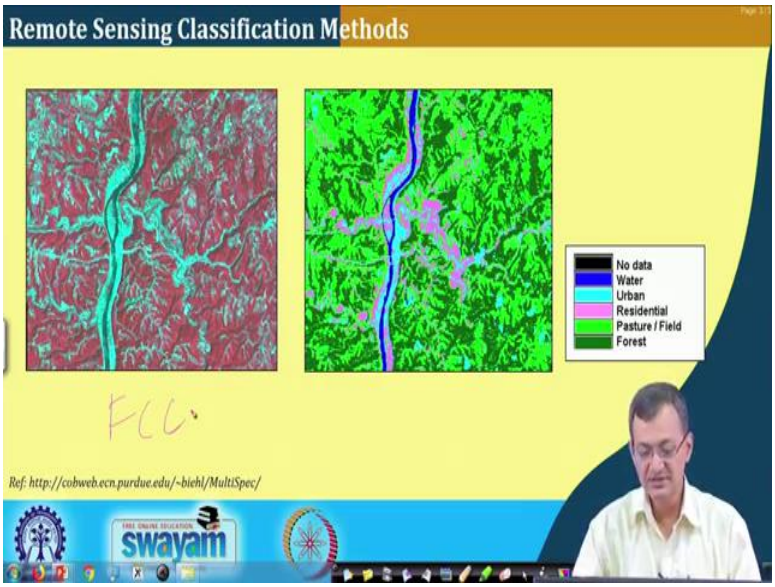

So, this is one aspect of the data set and if we look at as we were discussing. So, this is the, this portion is my raw data or rather this is a what we say false colour composite of a particular region right. False colour composite means what is the true colour red green blue. So, those are band 1 say 3 2 1 alright. So, if it is a true colour 3 2 1, but instead we put NIR in the band 4, red in the 3 in the so, NIR in the red gun RGB and then the actual that visible red spectrum into the next one and then the other one that.

So, 4 3 2 the combination is instead of 3 2 1, we have a concentration of 4 3 2 that is why this is what we say it is a false sorry, false colour composite right. So, here there as different as NIR as a major reflectance on the vegetations. So, here the reddish is the more red, this part is more of the vegetation and so and so forth. Now, this image I can have a classified image right to for better understanding interpretability of the things that requires a domain expertise over land use land cover classification of the things.

Like here what we have seen that one portion is the no data; that means, there is a not classified there is all are on all are in a separate things not classified. This bluish is the water, then urban is this magenta colour and so and so forth. The forest is deep green this other pasture or field is some other band and type of things.

Now, this thing with a legend is a classified image. So, I know that which is what right. So, I know this is the water body this is a residential area, these are deforest, this has some forest patch and around other type of things fields or agriculture feed and type of things right. So, it is important that the from the data or information to a classified in things which can be interpretable and type of things right.

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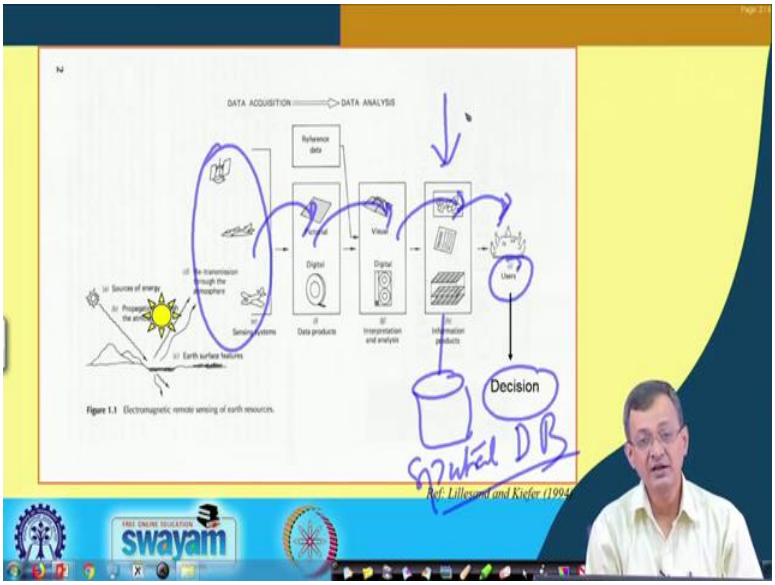

So, if we look at the whole process. So, if you look at that it is electromagnetic or EM radiation or wave which captures. So, sun accordingly sun is the source of the things and it has been captured. So, it is, it by captured by different means it can be satellite air bone things and different sensing system.

It is now transmitted or downloaded by the ground station, where which is stored by in either in some digital tapes in the magnetic tapes and etcetera. Then there are different visual representation. Now, we require a reference data set to correct the things right. Now I get the satellite image, now take from the Kharagpur. How do I know which is the how it is mapped to the Kharagpur right, like you have draw, did a land survey for road or something.

Now, you get a image by the from the satellite image, now how do I; how do I merge them. So, one basic way of merging them is to have a reference map or what we say base map or something a frame base frame over with sits. Now, how do I map? So, one best known thing is the LAT long right. So, I have some ground control point from looking at

the image right, looking at the satellite image I can see these are the ground control points right.

So, ground right mostly road crossing and or a typical a building etcetera ground control points. I know the lat long of the things. Now, I now based on that there is a, there are tools which can do it there is a geometric correction of the things and we also what we say it is a registered. So, registered with some ground truth. Now, once you did a separately a survey or of a or separately a plotting of a particular other networks say road network or something those are also ground to.

Now, they will set to one another. So, we require a reference data set to have these things into this digital map into digital map or whatever downloaded to the in a registered map. So, those things I can use these for analysis by using different tools etcetera like even the more vegetation, I can have NDVI and type of things. Or if you require some other things you can have more sort of mechanism to do that right interpretation tools.

So, once this is there it goes as a information product alright. So, based on this is I generate different layers which can go as in different information products like here it is it can be a different GIS layers, it can be a separate report generation or a map generation and type of things so it goes to a thing. And ideally there is a it is though it is not written here ideally we have a somewhere the spatial DB right.

Spatial database which harvest this data it can have a warehousing and other tools, which allows you to data mining forecasting predicting learning and type of things right which are basically used by these user community to take appropriate decisions right. So, starting from this data capturing to some sort of a downloading and pre-processing analysis and then it goes to this user community to do the actual column the things based on the map there is a call and type of things right.

So, this is the whole path from remote sensing to decision making sort of a things where and you see that this portion where this GIS or any this type of spatial decision support system come into play right. So, definitely we have spatial databases which store and harvest this data for future use or easy accessibility of the data by different community and type of things.

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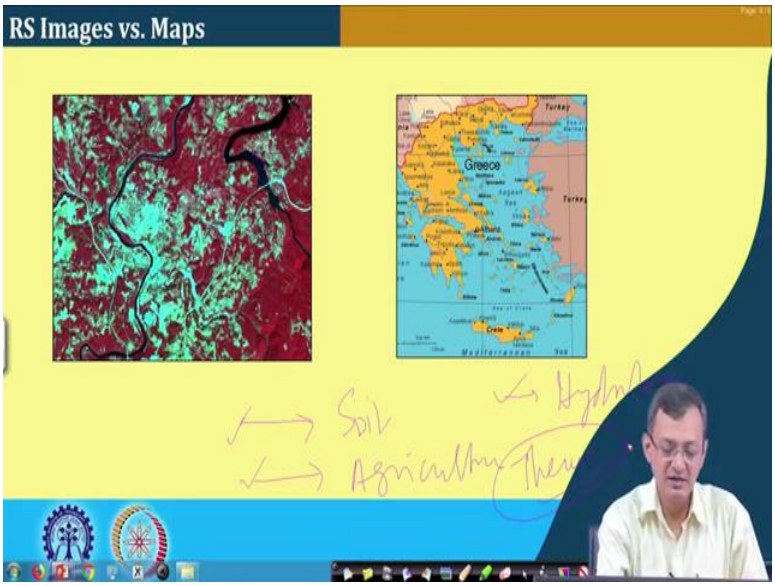

Now, so what we say what we see that it is from the it is taken from that reference what we have shown. So, it is from the remote sensing image 2 maps right. So, maps is with all other necessary information's for any type of decision making things or any type of analytics which is ready right. So, we need to go from there to there.

So, it requires definitely classification, different sort of annotation different making it to appropriate scale, may be printing or generating and other information allied information. So and sometimes as we see that from the same image the false colour composite from the satellite image we can have different type of things. Like I say I have seven band eight bands image and I generate some maps for more particular to say soil related thing right.

Or more to the vegetation or agriculture related stuff right or more agree on hydrology things. So, these are different themes, these are different themes or that is why sometimes we call these are thematic maps. So, different themes things are generating and you require thematic x part also right domain x part of that particular stuff.

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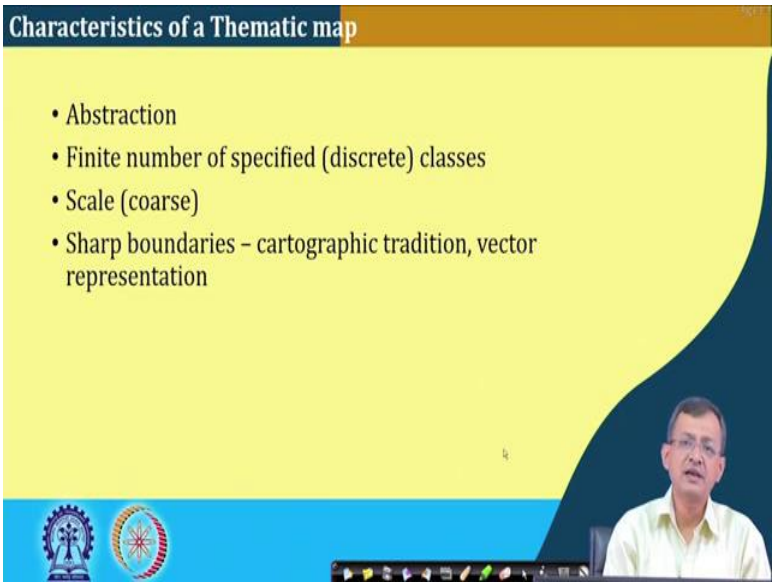

So, if we look at the thematic map there are different characteristics. So, first of all it is a abstraction of the from that information set which is remote sensing data and other analytic information. Finite number of specified or discrete classes; so there is a number of classes which is finite like if you have a soil map, your soil classes which is dictated by the soil scientist and type of things.

There is a scale of the maps it may be coarse and it can be finer and the scale of the map that is important right where the what is the scale of the map it is like we hear about 1 is to 10000, 20000, 50000 1 is to 1 million. So, what is the scale of the map which is generated there can be different type of boundaries which can be very scripts or sharp and cartographic based on cartographic tradition vector representation and so and so forth. So, it has a several characteristics or features of a thematic maps right. So, there is important to look at the different thematics maps.

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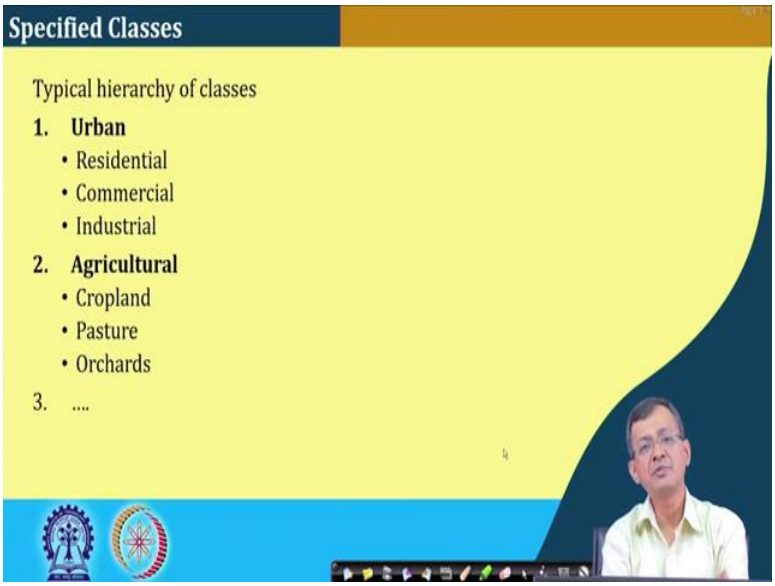

Now, there can be different specific classes, it is it depends on what sort of themes and what sort of things you are we are using. Like typically there is a hierarchy of different like at the top it is a urban maybe classification one is urban class, agriculture class. Under urban residential commercial industrial and then agriculture cropland pasture orchards and type of things.

And there were there may be different type of things water bodies or say transportation network based on that different transportation feature, different category of water bodies or even I can think of we can think of this is the if we have appropriate sensor and things like a pollution map of a region and so on and so forth. So, there are different type of classes and subclasses based on that particular theme right. So, this constitute this overall mapping factors of that particular region right.

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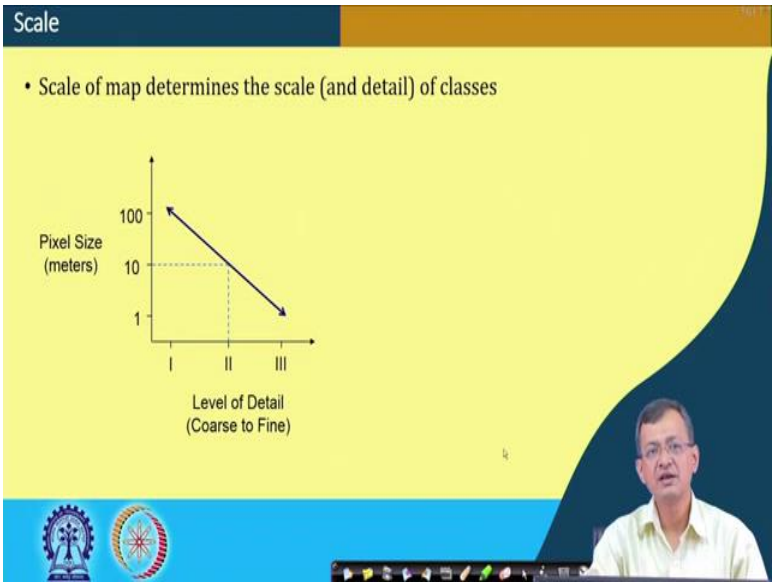

Now, scale of the map determines the scale or details of the classes alright. So, if it is a more finer scale. So, we can have more detailing of the classes, but definitely that it allowed increases right. So, it is pixel size in meters per se scale and there are different standards for that, like one is that LOD or Level of Detail 1, level of detail 2, LOD 3, LOD 2, 1 LOD 2, LOD 3; now we are LOD 4 and type of things.

So, how what is the skill? So, it all depends on that what is the application area we are looking at. So, based on that application area we can have different scale up maps.

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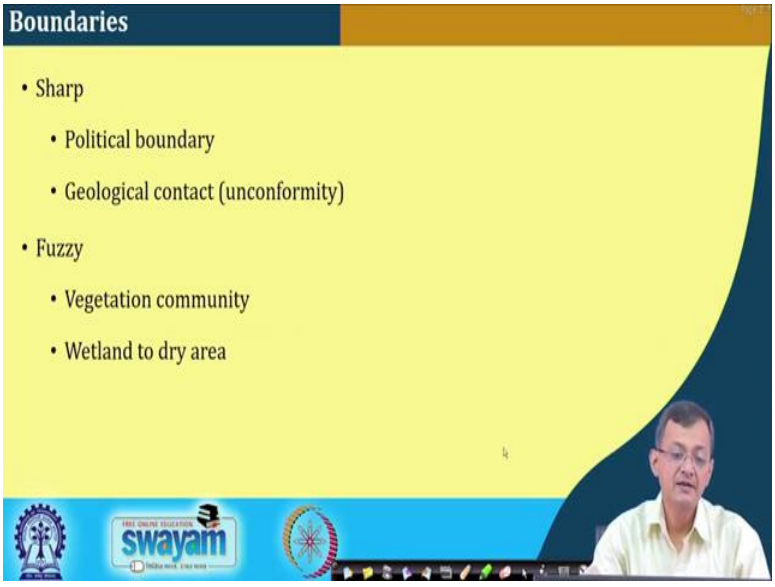

So, there are boundaries sharp or kips boundaries like which is definite of the things like any classes etcetera, how those boundaries are there. And there are geological contacts uniformity of the things there can be there. But there are fuzzy boundaries like vegetation or wetland to dry land different classes of vegetation there may be fuzzy boundaries. You cannot very finely or critically defined sharply defined that this is here that this vegetation end and these vegetation starts right a say type of forest cover or type of mangrove and type of things.

So, we have a different scale of vegetation things which are there right. Fuzzy vegetation; so these are fuzzy. So, something we have very sharp and something we are having little fuzzy on the things right.

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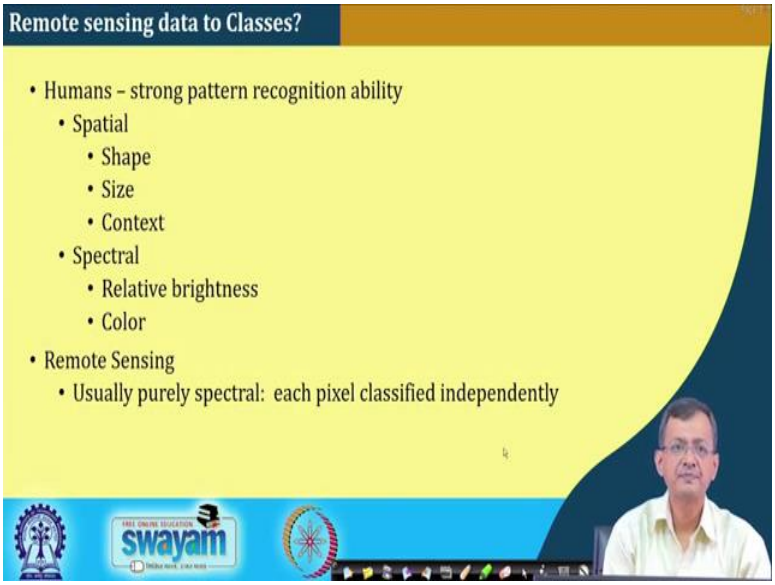

Human strong pattern recognition. Now how do I data to class how do I classify it is using data to class. One is if you have a human being to classify right, there are cases where you see the map over the and put on the map and over that you put on a transparency color and the human can a particular expert basically go on coloring the are things on the on that, but large transparency so it generates the map.

So, it is a spatial shape size context right. So, it is a shape size context which can help in spatial domain, spectral relative brightness color. So, that is as human as a strong pattern recognition ability it can able to do that. Remote sensing usually purely spectral each pixel classified independently. So, remote sensing data are purely spectral type of things

where each classes classify independently. So, there is the remote sensing category of maps right.

So, shape size context vector relative brightness color, remote so; that means, either I can have a human interpreter which is little not so convenient for large scale interpretation especially with large volume of data coming into play and we have remote sensing techniques which are there. So, mostly what we do? We do any more sensing technique and then with that classification that correction or fine tuning the things is done by the human being if required.

But if it is a gross and coarsely things, I may not fall back to this sort of human interpretation at all for doing their things. So, classification, but definitely we would give ground truth and see classification accuracy based on this accuracy level go on doing the thing.

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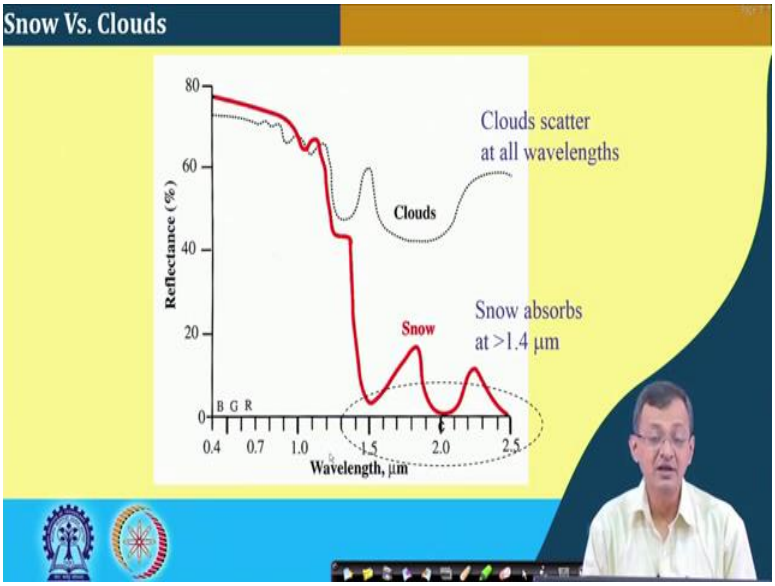

If you see it is mostly the same type of things how do we do in a image processing domain right. So, this is one example scenario, snow versus cloud. So, if you see in this range of point 4 to 1.0 these are more or less very difficult to distinguish right. So, in this particular spectral band it is difficult to distinguish.

However, if I have a spectral band from 1.5 point 2.5 nanometre then it is quite distinguishable right. In case of snow it is there in case of sound it is there right we can quickly distinguishable right things are there right.

So, that is thing so; that means, when we try to make classes or distinguish between classes we need to take care that which frequency band or which frequency spectral domain or in other case which band of data I need to consider to have this thing for interpreting this right. So, that is important in case of when we do this sort of interpretation or classification between data sets right.

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Now, there is a thing of false color composite. Why false color? So, as you are telling that instead of here if you see; here if you see instead of taking 3 2 1, we have taken 4 3 2 like it was it is ir or infrared is in the red gun. So, the red is the infrared and then you have that 3 in the green and blue in the 2.

So, these are the things which are in difference. So, it is not the thing so what say false color composite is very popular in remote sensing image interpretation and then we have a, but it gives that more that reddish things is the vegetation and type of things right. So, it is a composite.

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So, it depends that which combination we will take right, like here the combination is 5 4 7 5 4 right we are using somewhat band of in the range of mid infrared and type of things and so and so forth for the for something right. So, it depends on that what sort of data sets you are considering for this.

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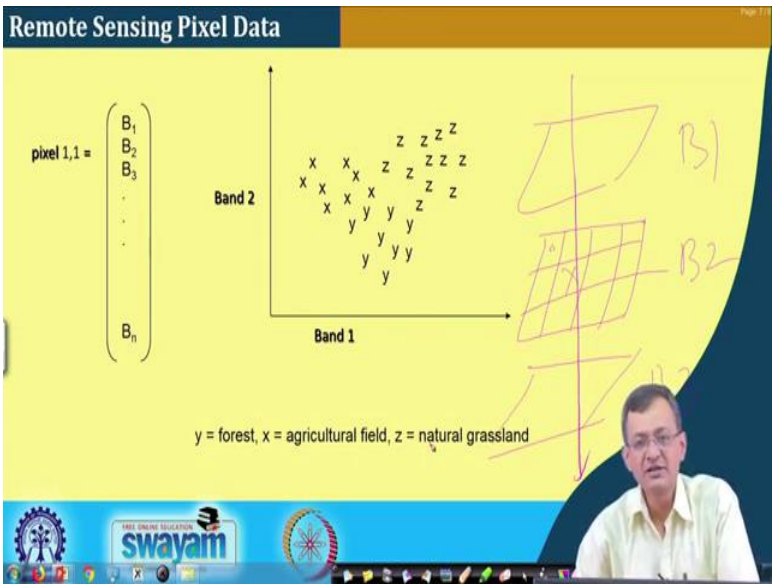

Now, what should be we are not going to the detailed classification of remote sensing that that itself is a big chapter, but we want to see that the what are the different way of approaches of doing so right. So, if we have pixel, a particular pixel 1 1 that in the in

other sense I have a right. So, a particular pixel this pixel or this pixel it has a different layers right.

So, it is it has some manifestation band 1, band 2, band 3 dot dot dot right. So, here for any piixel i i i j I have B 1 to B n type of data sets. So, I can look like this right. So, painted like this right. So, say y in this case y is forest x is agriculture z is natural gas type of a natural sorry natural grassland sort of things. Now if the band 1 band 2, if I go on plotting, they will have some clustering right some band 1 band 2 this band 1 means band i band j. So, we can plot like that right.

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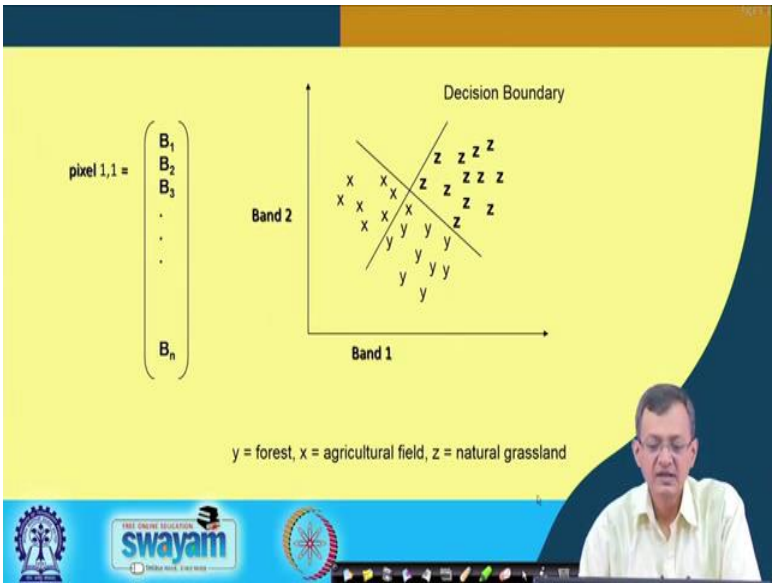

Then I can have a decision boundary like this right which tries to segregate. So, find finding out this is what should be that this boundaries is the challenge right it is the basically where our image processing and other cs techniques come into play. So, this able to distinguish their 3 classes in to thing this is a very synthetic example, but nevertheless it will be able to find out that what are sort should be the my decision boundaries right.

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So, overall classification approaches there are 2 generic approaches, in case of image also it is like that any image processing, one is supervised analyst identifies representative training sites for each information class algorithm generates decision boundaries right. So, analysts identifies representative training sites for each information class.

So, the analyst means the domain expert etcetera. So, it is a training sites mean ground truth like this ground in this I know that this is the place usually what they do they go for the survey and find out this is the forest page of this say this particular solve for a store pine and type of things patch. Now, it identifies on the ground and mark. So, based on that I look into through these bands and do different statistical mechanisms to find out that same characteristics where things are prevailing and find out that those are classified into the things.

Algorithm generate decision boundaries. So, based on this algorithms it generates a decision boundary, in case of a unsupervised; that means, I do not give I do not have the scope to keep giving this ground truth where algorithm identifies the cluster in that data using different sort of clustering techniques right and then after the cluster forms the that domain expert or the thematic expert or the analysts levels the cluster that this is forest this is water body this is so and so and type of things right.

So, these automated automatically clustering techniques mostly what we use in case of a image processing's that I have deployed. But with multi band type of things right. We have a same data into different type of bands right usually in normal image processing we have either monochrome images of single dataset or color images of RGB, but here we have a bunch of spectral brands, like not only that if you have a hyper spectral you have a huge number of bands.

So, selecting which are the bands to be seen to be subtle or to be the candidate for this classification process is also challenge that also we require some domain expertise for with has a working with this type of datasets.

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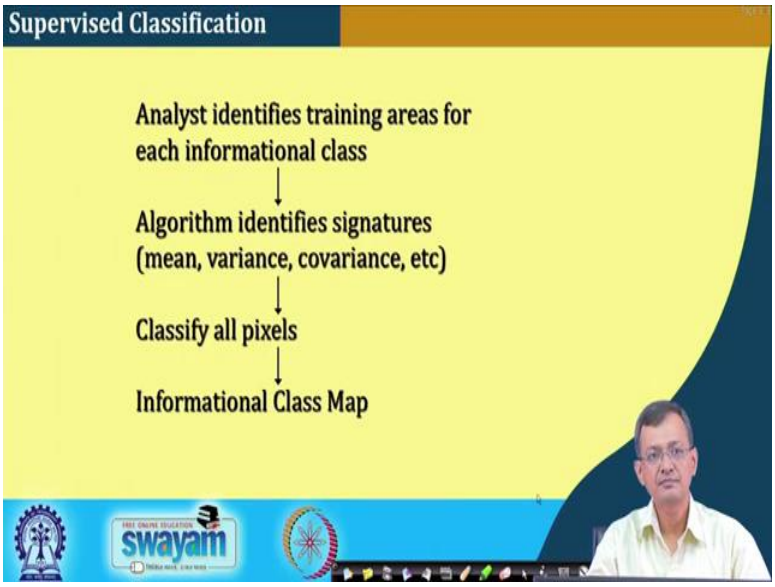

So, we have supervised classification analyst identifies the training areas for each informal classes class, algorithms identifies signatures mean variance, covariance, etcetera right, classify all pixel information class map. So, analyst identifies the training set for each informational classes right.

So, it looked at the identifies these are the training sets or the ground rule, algorithm identifies the signature. So, those are the signatures and mean variance covariance are calculated. Classify all the pixel based on those statistical information and the information class maps are generated.

So, for unsupervised algorithm cluster the data find the inherent classes by using different clustering techniques classified all the pixels based on this cluster. Spectral class map is generated analyst label the clusters may involve group of clusters right so, or may merging so this clusters to be merged together and a 1 cluster will be where informal informational sorry not informational class map is generated that end of the day I have a classified map or for looking at the things right.

So, some of the cases which is which some places which are not approachable like that. So, this type of information classes helps them.

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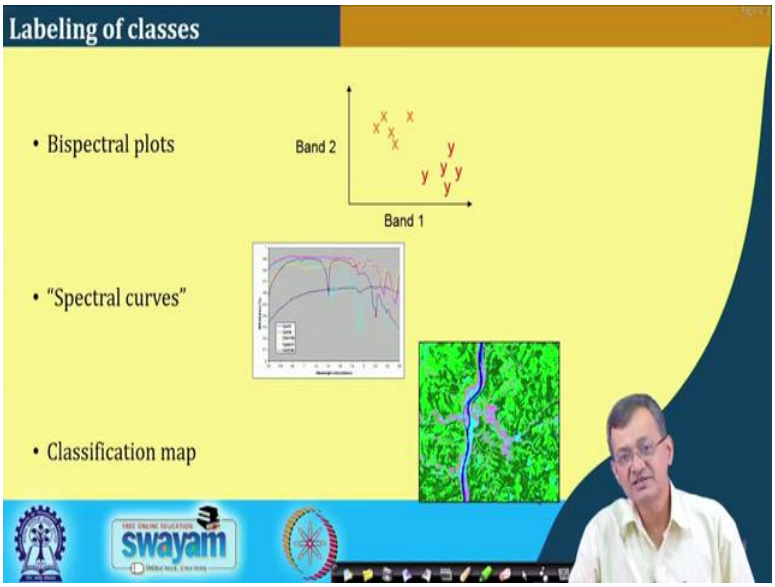

So, labelling of the class like I have seen by spectral prone like 2 band there can be spectral curves like this with a different spectral and that finally, we generate this classified map or classified image classification or satellite image classification which the classified maps is generated. So, these are the different way of looking at the things.

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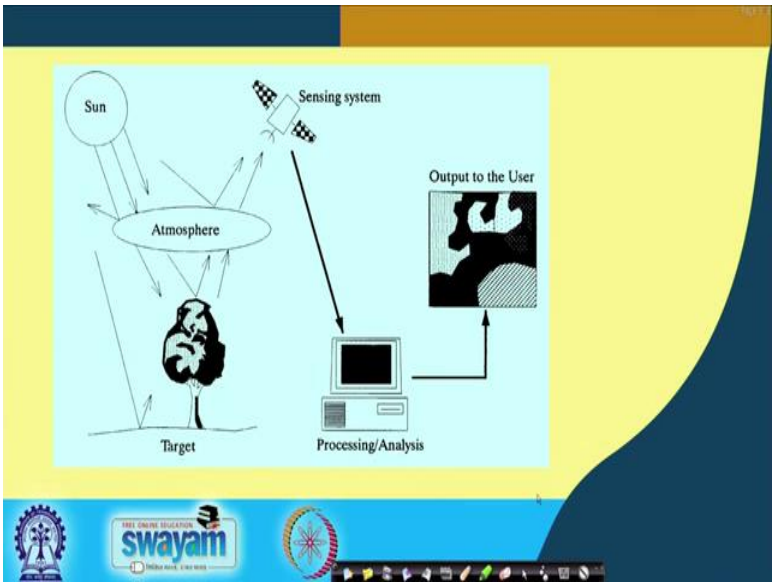

Now, let us again come back to that picture image what we have seen earlier right. So, what we see that we have started with that remote sensing data where we have we captured the data remotely either by satellite airborne or even some structure on the ground, from the ground, near the ground and then capture those data those are transmitted to the ground station for storing, processing, pre-processing analysis and of the data.

Based on that we generate the output maps which are amicable with the data sets. So, this is the whole process which works on the data set right. So, if we look at this particular topic of remote sensing and GIS what we tried including today's class, today's lecture what we are trying to see that how this remote sensing which is an important source of data which is accurate consistent timely that to can play a big role in information gathering and decision support system right.

We have also seen that there are some of the aspects like spatial resolution, spectral resolution, radiometric resolution and temporal resolution for remote sensing data which plays the important role. And also finally, what we have trying to look at that this data set in order to have a as a product we need to look at it as a, we need to classify based on taking input from the domain experts or thematic experts or analysts to a different classifier maps which are usable.

So, what we say from the remote sensing data to that useable maps that generates. So, which can act as a input to this our GIS layers along with other different type of layers which will help us in different decision support system. Another thing you need to be kept in mind this most of these when you capture this remote sensing data these are all raster data either to raster to vector conversion or some there are tools which handles that to be there.

Whereas which are whichever we are worked in other datasets are mostly vector type of datasets. So, this amalgamation of different sources of information for decision support system is one of the major aspects of looking at those this remote sensing and GIS.

So, with this let us conclude our discussion on this topic and we will be in next couple of lectures, we will try to sum up and maybe we are try to see some of the case studies related to remote sense a related to spatial informatics how they can be used where all those this whatever we have discussed we will be look at it.

Thank you.