Remote Sensing and GIS
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Lecture – 23
Applications of Remote Sensing and GIS - I

In this lecture we will see what are the potential application of remote sensing and GIS in our different areas? So, let us start with the digital elevation model, digital elevation model is one of the significant output of remote sensing and GIS technique.

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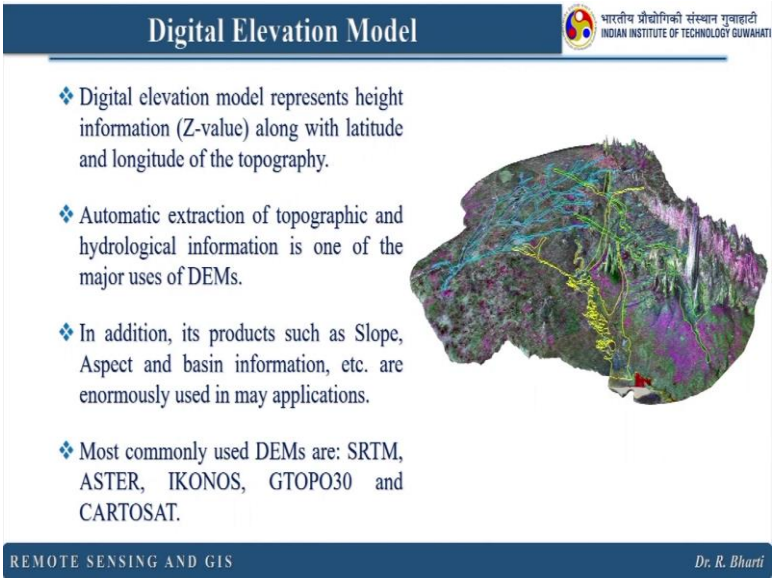

So, here let us see what exactly this digital elevation model mean. So, Digital elevation Model represents height information then that is your Z value along with latitude and longitude of the topography. So, you must remember this is our satellite image product right and here what information we had we had x, y and z.

So, x was latitude y was longitude and Z was the DN value which was captured by your sensor. But here when we are talking about digital elevation model, we are replacing this digital number that is your z value from this pixel with the height information. So that will become your altitude. So when you are having altitude information for every pixel, what additional information you will get.

You will get the topography what kind of topography your area is having. So whether it is a flat land or very hilly terrain, so those information you can easily extract from digital

elevation model. So, automatic extraction of topography and hydrological information is one of the major use of the DEMs. In addition its products such as slope aspect and basin information etc. are enormously used in many applications.

So, digital elevation model is very frequently used in many application does not matter whether you are familiar with remote sensing and GIS but people are using DEMs an input in their different application or a studies. Most commonly used DEMs are SRTM, Aster, IKONOS, GTOPO30 and CARTOSAT. So, these are very popular nowadays. So, you can just Google it and you can see their website what are the different modes? How you can acquire those data sets or how you can procure those data sets that you will learn from their websites.

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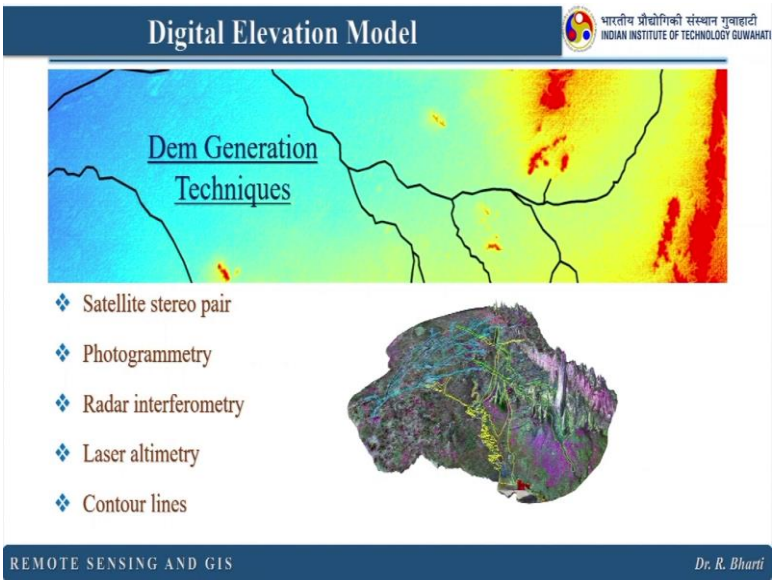

Now, let us see what are the different techniques we use to generate a digital elevation model? So, first one is by using satellite stereo pair, second one is photogrammetry third one is radar interferometry and fourth one is laser altimetry and the last one is contour lines. So, once you have this contour lines that means, that contours are having the height information.

Then you can use different interpolation technique or maybe you can use the TIN and you can generate your digital elevation model that I have explained you in GIS lecture.

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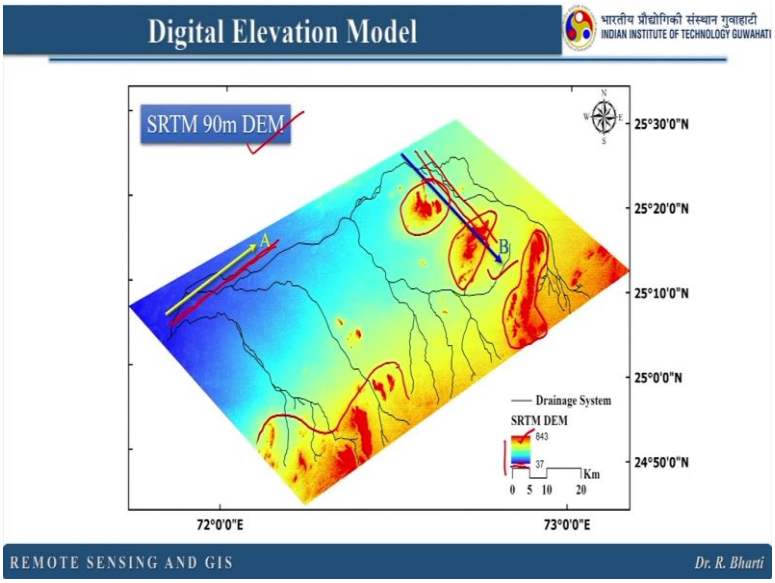

Now, let us see what exactly we mean by this digital elevation model and how it is going to help me now you are familiar that z value here corresponds to altitude, but in satellite remote sensing data, we have digital numbers it can be reflected or emitted or backscattered value, but here you are having altitude value height information. So, is there any way we can merge these 2 information together.

So, that our input are the analysis will be more advanced to let us see this example where I am having SRTM 90 meter DEM and let us see what is the profile along this A line and along this B line. So, I will show you how it appears when you draw or when you extract the values DEM values along these lines. So, here you can see, this is basically the scale of your DEM. So, blue is basically the low lying areas and red is basically elevated areas.

So, all these red colours actually represent high altitude locations right. So, this must be some hill or this must be some hill right. So, if you have drawn a section here in the blue colour that means, it is almost flat it may be varying but very slowly the slope will be very less, but here, when we are taking this particular section, here, you can see it is crossing this particular Hill. So, that information we should get from the profile.

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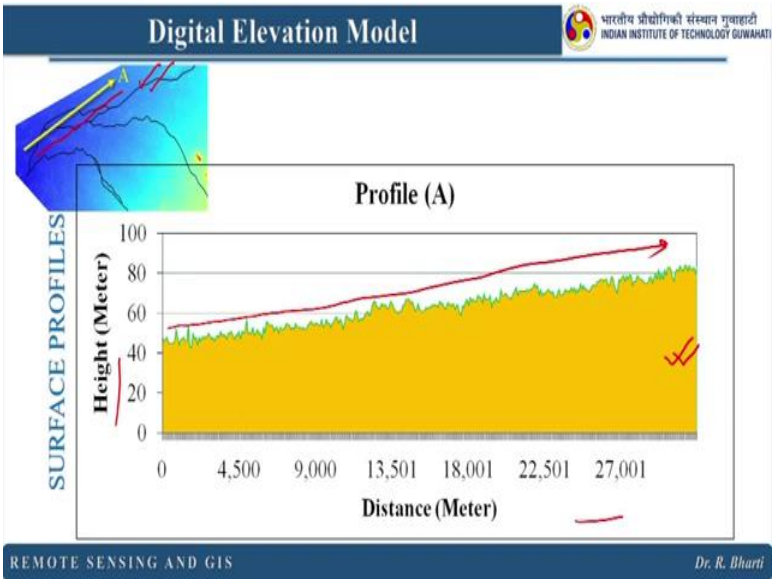

So, let us see one by one how they appear. So, along this a line, this is the profile. So, this is the distance in meters and height in meters. So, you can see this area is basically increasing like this right. So, very gentle slope, here also it is visible in the blue colour now it is slowly going towards this light or yellow colour. So, that means it is increasing slowly. So, such information can be easily derived from your digital elevation model. Now, this kind of profile can be extracted from the Google Earth that you can try.

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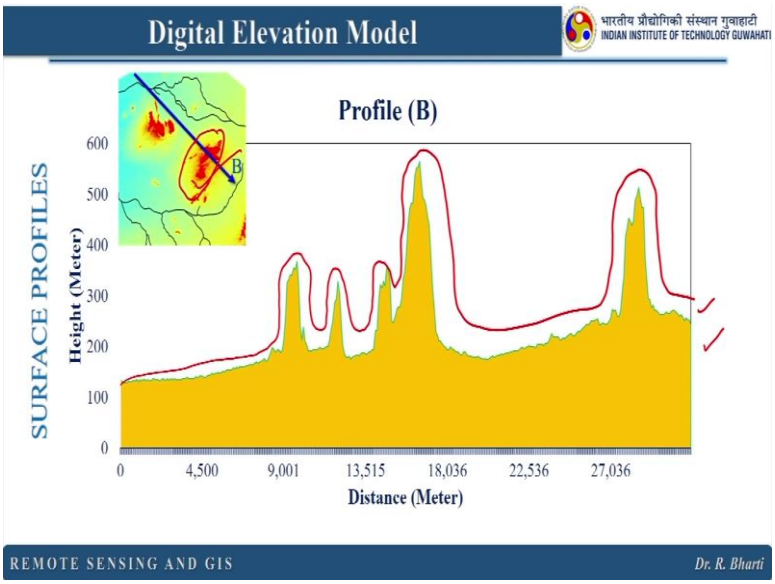

In the next section where we have this hills in between let us see how they are appearing. Now, you can see this is showing this undulations that means, these are the hills which are falling in between, right. So, it is very clear from this section that this area is not a flat land and the surface profile gives you the exact scenario and here you can do a lots of analysis like what is this slope. What is the aspect everything you can calculate. And, once you are having

this information you can merge it with the satellite remote sensing data does not matter whether it is from space or airborne, then the input data will make more sense and definitely your analysis will be better than the earlier one.

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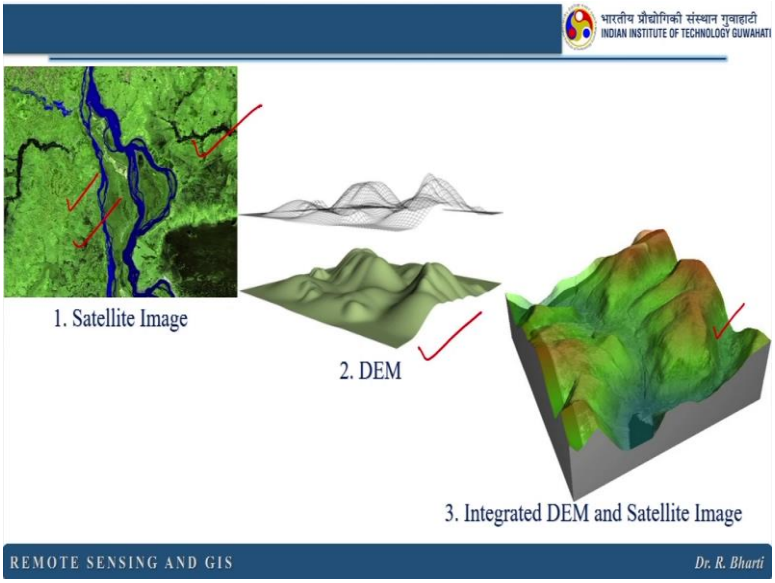

So, let us see how they appear when you join them with the digital elevation model. So this was your satellite data. This is the digital elevation model for this area. This is just for example, and once you combine them, then you will have both the features here when you join them together. You can easily build a 3D model for that area, because you are having the elevation the altitude. So this is one of the potential areas where you can look for your research right.

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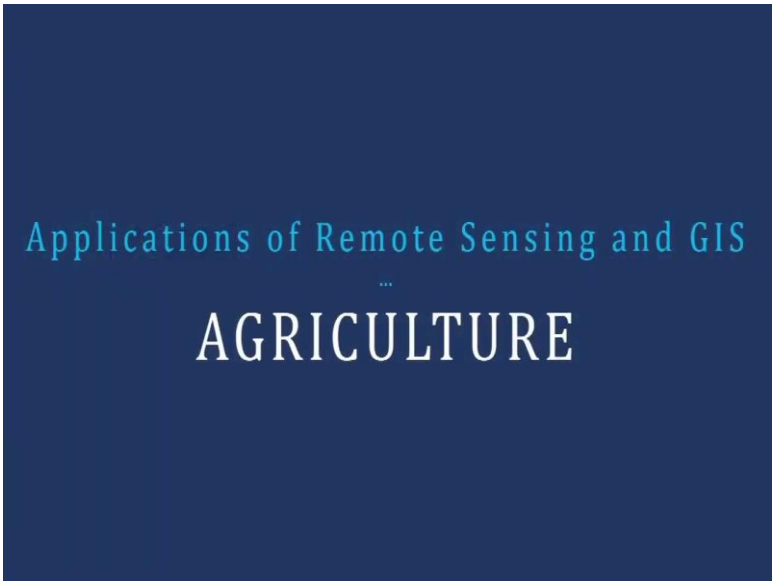

Now let us see what are the different application or the potential application of remote sensing and GIS in Agriculture Engineering.

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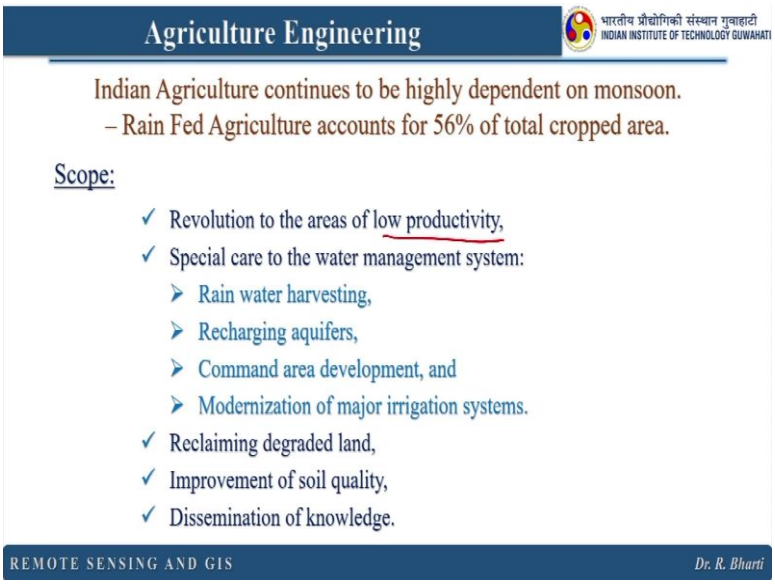

So, first let us start why this Agriculture Engineering is so important. So, Indian Agriculture continues to be highly dependent on monsoon and rain fed agriculture accounts for 56% of the total crop area. So, here you can see how important it is to monitor your rain right and how important this agriculture is to survive, right. So, in Agriculture Engineering, there is lots of scope where you can look for the GIS and remote sensing application as we know, agriculture is our back bone right. So, we need to increase the productivity we need to monitor all different parameters so that the production will be or yield will be more. So, let us see what are the different scope where we can use our remote sensing and GIS technique so, the first and very important aspect of this problem is revolution to the areas of low productivity then special care to the water management system.

So, in water management system what we can do, we can use the rain water harvesting recharging aquifers command area development. And how do we improve our major irrigation system right then reclaiming of degraded land. So, that is again, it will go to low productivity how we are reclaiming that one right, then improvement of soil quality and dissemination of knowledge because we need to educate our farmers with this new technology, so that they will be aware of all the drawbacks and the other problems for their cultivation.

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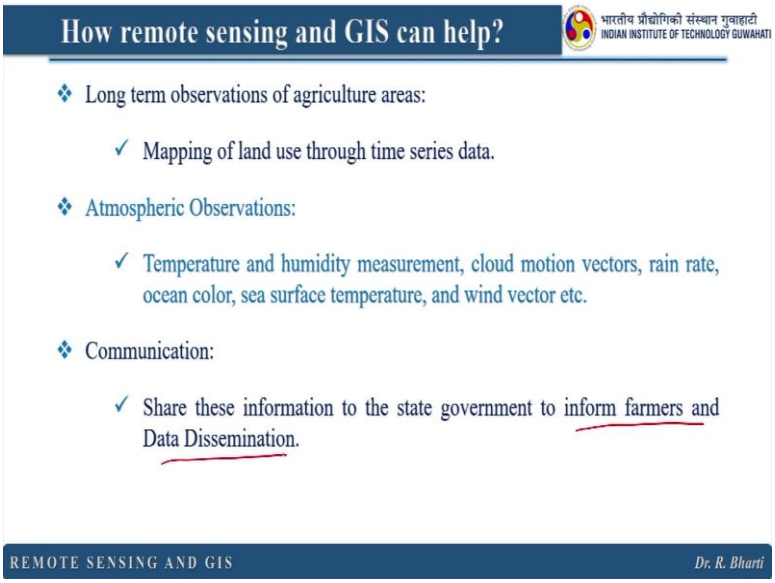

Now, let us see how this remote sensing GIS can help. So long term observation of agriculture areas. There you can apply your remote sensing and GIS so mapping of land use through time series data. So you can exactly monitor whether this cropping area is reducing or increasing. So, we do not want to reduce our agricultural land. So, we want to make sure that at least it should provide the sufficient food to the people.

Atmospheric observation as I told you, the major portion of the agriculture depends on our rain, right. So temperature and humidity measurement cloud motion vectors rain rate ocean colour, sea surface temperature and when directed these things can be easily derived from the remote sensing and GIS technique. Then communication definitely satellites are very important part of that. So share these information to the state government to inform farmers and data dissemination.

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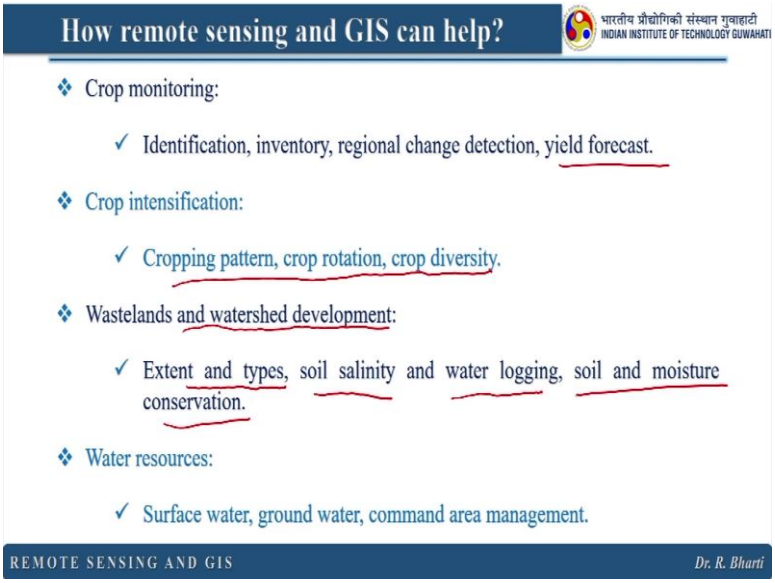

Then very important aspect of remote sensing and GIS application is crop monitoring, what is the health what is the yield that also you can estimate using this technology. So identification inventory, regional change detection, yield forecast, these things are very popular example of this remote sensing and GIS, crop intensification, crop pattern, crop rotation, crop diversity, so these things you can easily identify wasteland and water said development.

Here, extent and type soil salinity and water logging, soil and moisture conservation. So, these problems are very common in your agriculture. So, you need to dissolve that or you need to at least identify what are the problems with this particular piece of land and then you can start the remedial measurements, water resources that is very important in agriculture, so, surface water budget, groundwater command area management. So, these are the potential application of remote sensing GIS is where you can think of applying these techniques or you can refer some of the published literature if you are willing to work in this particular area.

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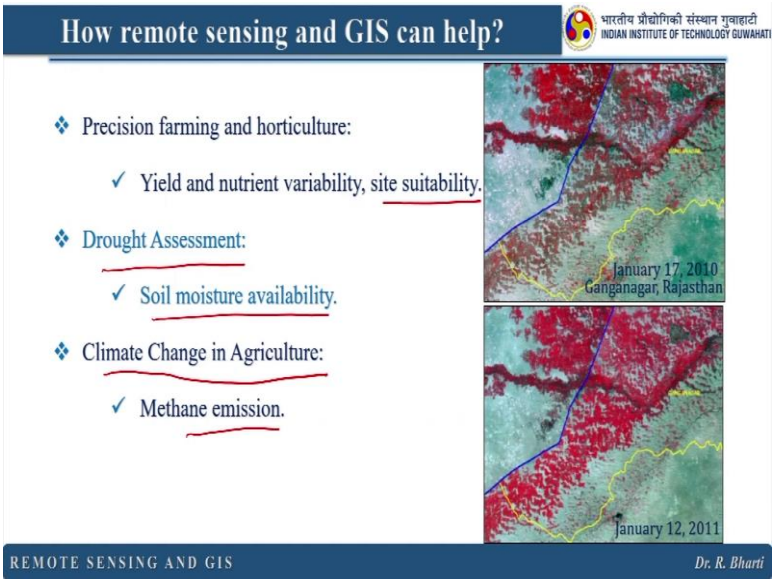

And see, what are the different works has been done using remote sensing and GIS and what or how you can contribute more Precision farming and horticulture is another areas. Where you can look for the application of remote sensing and GIS, inland nutrient variability sites suitability, then Drought Assessment, soil moisture availability, Climate Change in Agriculture, Methane emission because that affects a lot to your crops.

For such application you can evolve with a method by using this remote sensing and GIS and conventional techniques and solve a problem that is the main objective of this course.

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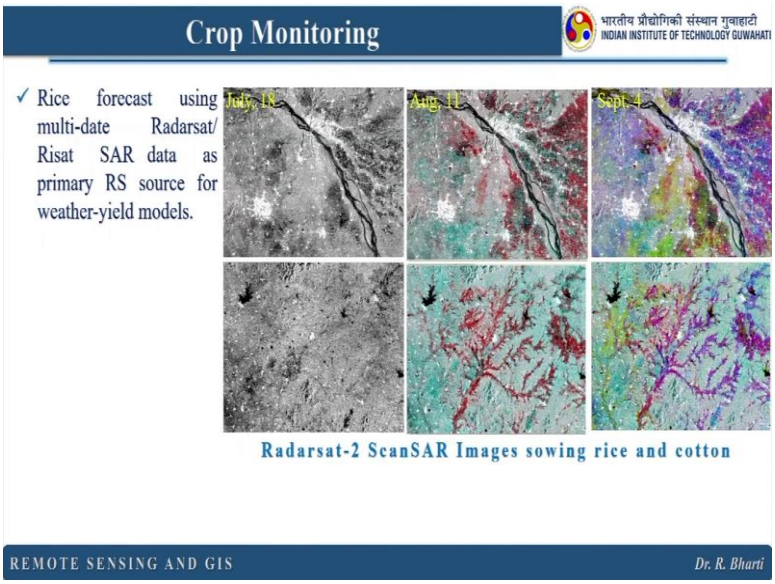

Crop monitoring another this is one example from Radarsat 2 Scan SAR data showing a rice and cotton. So, rice forecast using multi-date Radarsat or Risat SAR data as primary remote sensing source of weather or yield model.

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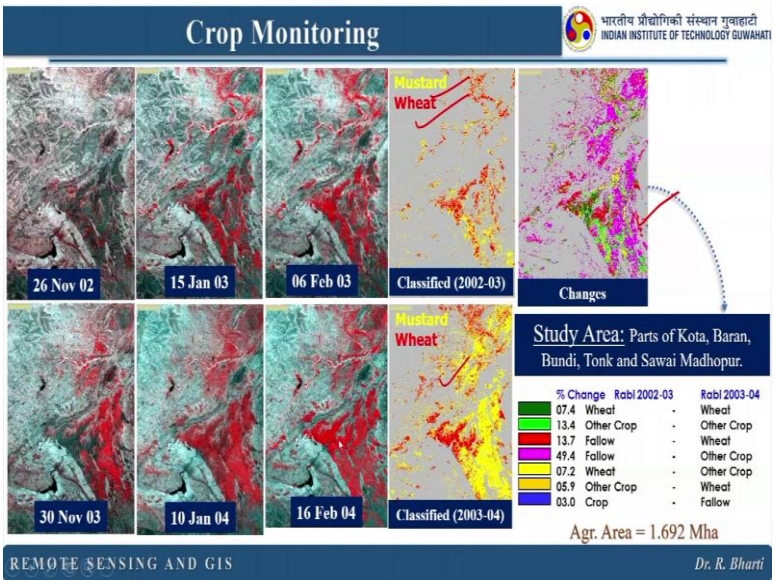

So, these are the potential areas where you can think of to start your research, here you can see this is for 2002 and 2003. So, yellow colour represent mustard red colour represents wheat and here for 2003 and 2004. You can see the area has been increased right. So, you can easily find out what are the changes. So, the changes can be identified. And here you can see this Lrgrnd, following such methodology you can easily find out how much area has been used as agriculture and what are the different crops have been cultivated and whether it is more or less compared to last few years right.

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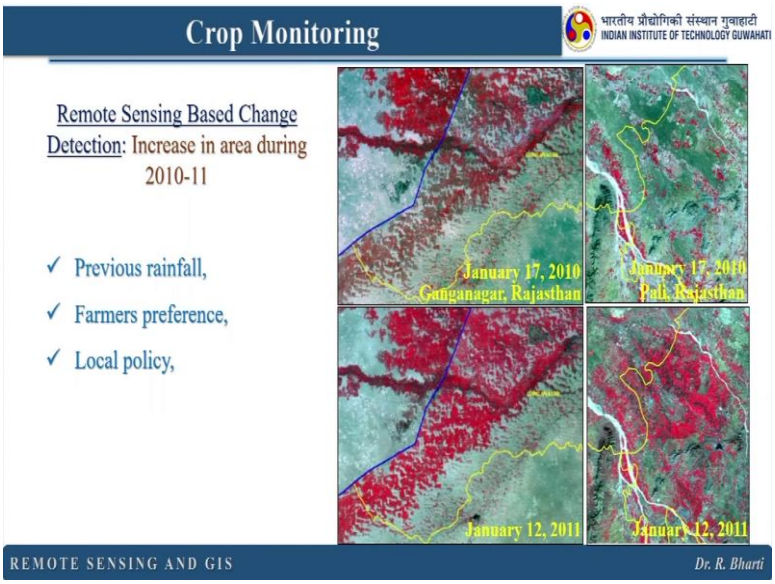

Then next one is remote sensing based change detection. I already showed you one example here for 2010 and 11. And basically for this one, you need to have the data like previous

rainfall farmers preference local policy then you can integrate all these things in GIS environment and you can perform the analysis.

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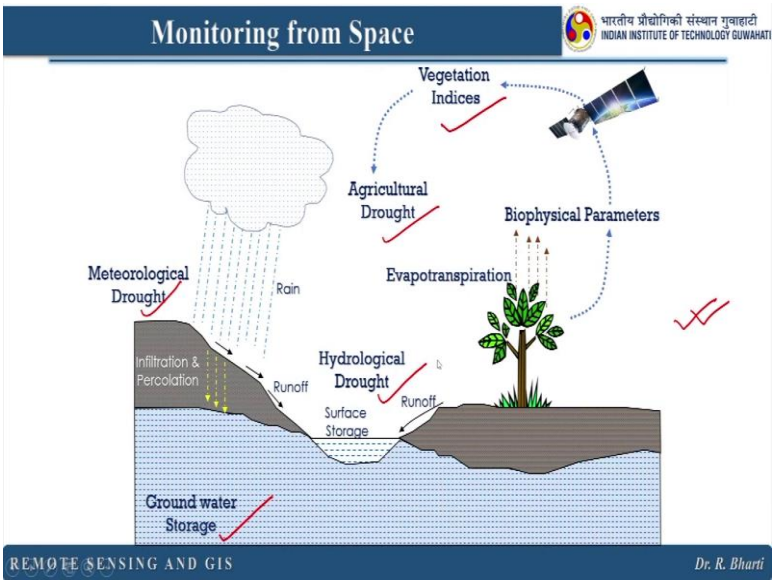

Now, let us see what are the different aspects you can monitor from space? So, let us see one by one here you can see this is groundwater storage and there are different components here and all of them can be monitored by this remote sensing and GIS. So, let us see one by one, this is for surfaces storage, then rain you can always estimate then evapo-transpiration then different aspect like biophysical parameters with vegetation indices, agriculture drought, methodological drought, hydrological drought. So, such parameters you can estimate from the remote sensing and GIS.

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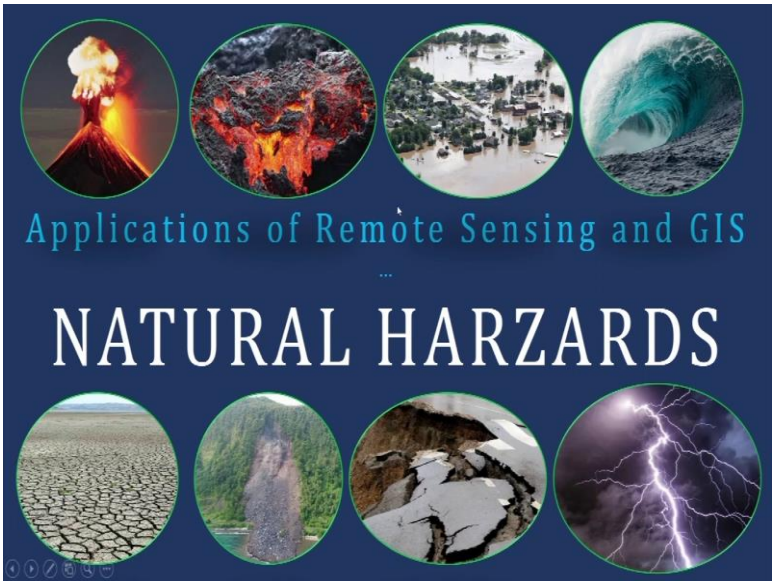

Let us see some potential application of remote sensing and GIS in natural hazards. So, here you may be aware like the different natural hazards or geo hazards which are causing damage to our life and property right. So, let us see some of the very good example where people have used this remote sensing and GIS or where you can use remote sensing and GIS. So, this is in the case of landslide for landslide it will be very good if you can develop a early warning system right.

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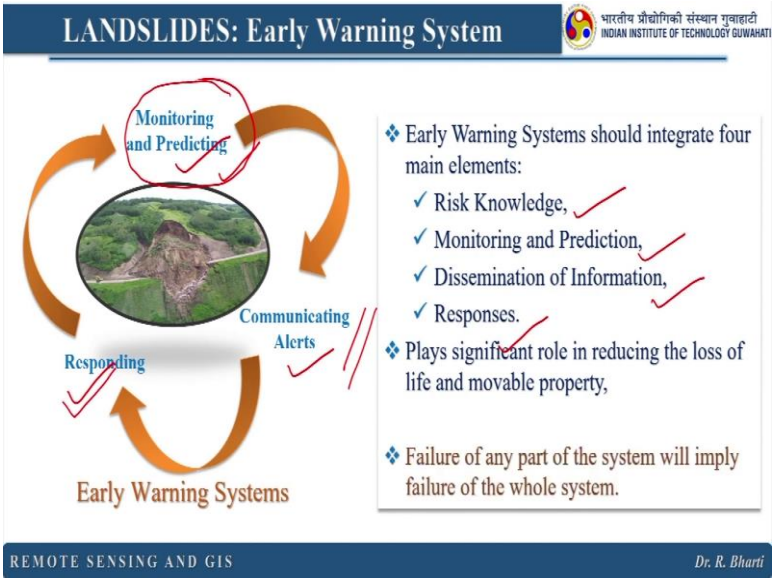

So, what are the different parameters you can evolve or derive or estimate through this remote sensing and GIS that may help to develop this early warning system for landslide right? So, early warning system should integrate 4 main elements that is very important. So when you are having this chain, you can see here the first one is monitoring and prediction. The second one is communicating alerts, and then responding. So communicating alert, that is the responsibility of the analyst. But the responding is the responsibility of government.

It may be central government or a state government, but they should plan the rescue mission or maybe this evacuation processes. So here is the risk knowledge monitoring and prediction, dissemination of information and responses are important parameters of this early warning system. If one of them fails, then the whole early warning system will fail. So that is why if you are trying to monitor or predict something that will be part of this early warning system or decision support system right. So failure of any part of this system will imply failure of the whole system, so, when you are evolving with such early warning system Please take care of all these parameters. Now, let us see one component of this early warning system that is the

landslide hazard monitoring right or where it has been occurred or where it is likely to occur right on what are the areas which are more prone to such natural hazards.

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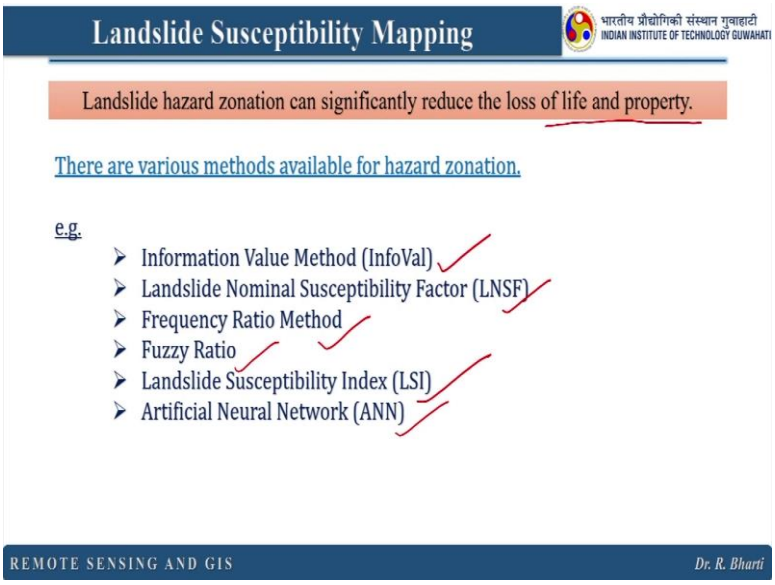

So, landslide hazard zonation can significantly reduce the loss of life and property. There are various methods of level for hazard donation, so you can use any one of them or all of them to evaluate the accuracy of your output, right. So here, you may use InfoVal Information Value Method, Landslide Nominal Susceptibility Factor, Frequency Ratio Method, Fuzzy Ratio, Landslide Susceptibility Index, Artificial Neural Network or Support Vector Machine, there are many different methods. If you are interested to work in this particular area, you can refer several works which are available in different journals and may be you start following them.

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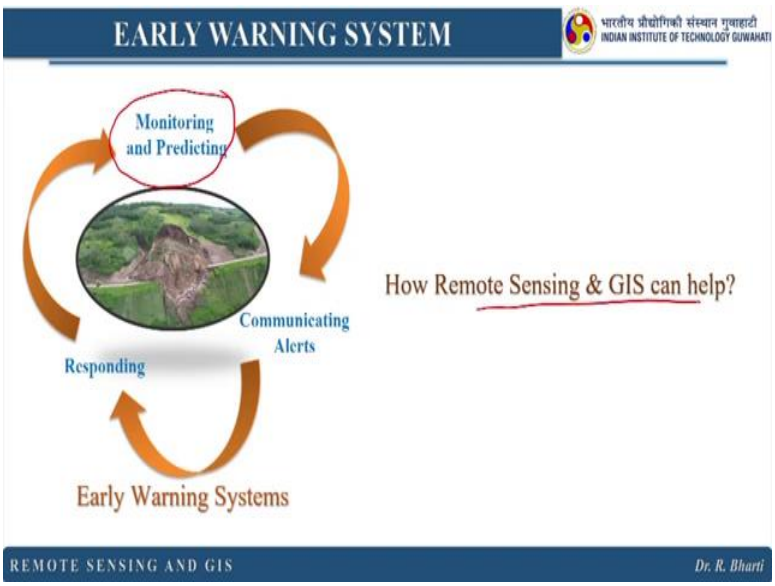

You have seen in the previous slide that what the different methods which can be used to monitor or predict this landslide event. So, let us understand how the remote sensing and GIS can help.

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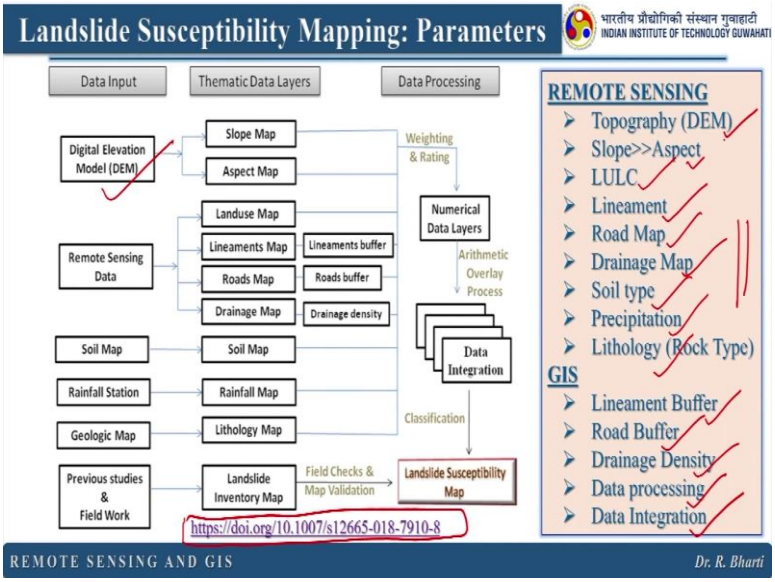

So, this is one methodology which is taken from this particular literature you can refer this and here you can see different parameters have been used like digital elevation. This is a product from remote sensing and GIS. So, from remote sensing you can derive this Topography from DEM, Slope and aspect. Land is land cover, Lineament, Road Map, Drainage Map, Soil Type, Precipitation, and Lithology from GIS Lineament Buffer, Road Buffer, Drainage Density, Data Processing and Data Integration.

So, you can see there are many inputs which can be derived from this remote sensing and GIS and ultimately, since this will be spatial data. You can use a GIS environment to analyse these data sets and come up with the landslide prone areas. And then you can characterize this is the class one class two or class three class four areas right. These are the references which I have followed. So you can refer them to know more about the application of remote sensing and GIS in landslide hazard monitoring. Now, the next Natural Hazard is Flood. Which is devastating right. So, here,

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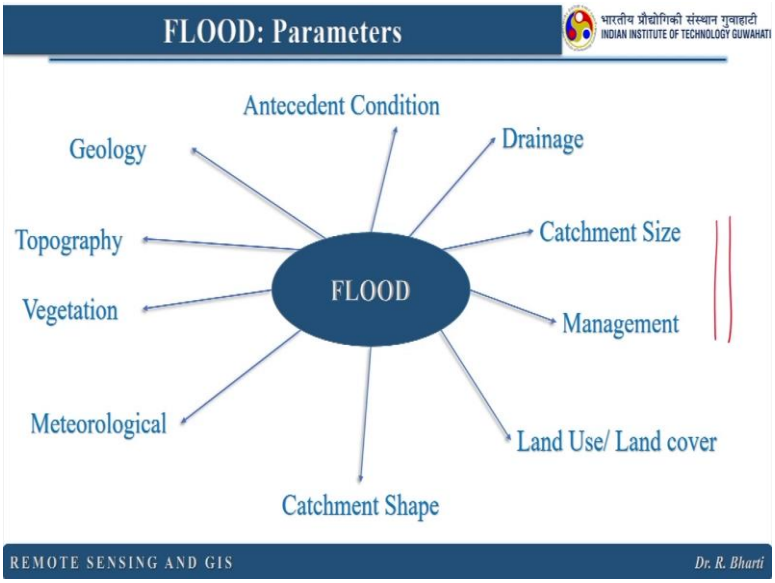

What are the different parameters we will quickly go through? So, let us see first parameter which we need for this Flood studies, that is your Drainage pattern that you can easily derive from remote sensing. The next one is Catchment Size that is also possible from remote sensing Management Land use land cover that also comes from remote sensing and GIS catchment shape Methodological parameter that is from another sources then Vegetation, then Topography, then Geology and then Antecedent Condition.

So, these are the parameters which plays very critical role in Flood analysis. So, many of them can be derived from this remote sensing and GIS. The next natural has is Drought.

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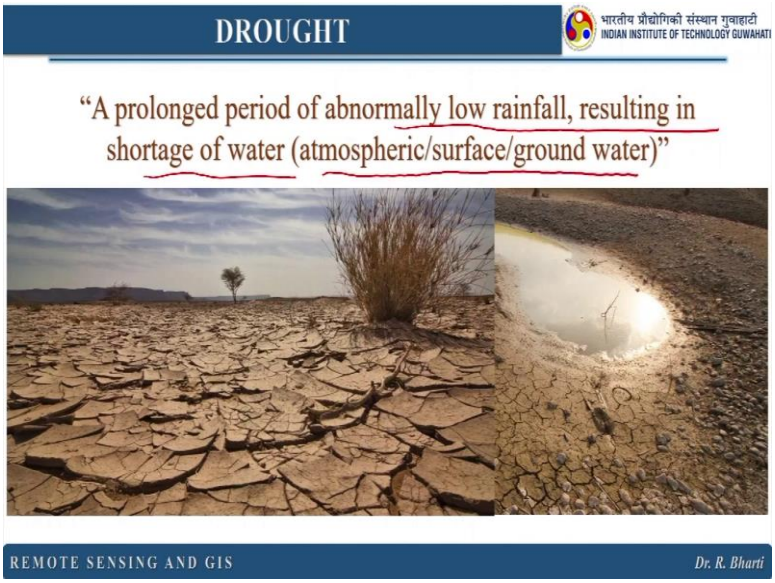

So, as we know drought is a prolonged period of abnormally low rainfall resulting in shortage of water that may be atmospheric surface or groundwater right. So, it can be any of these three.

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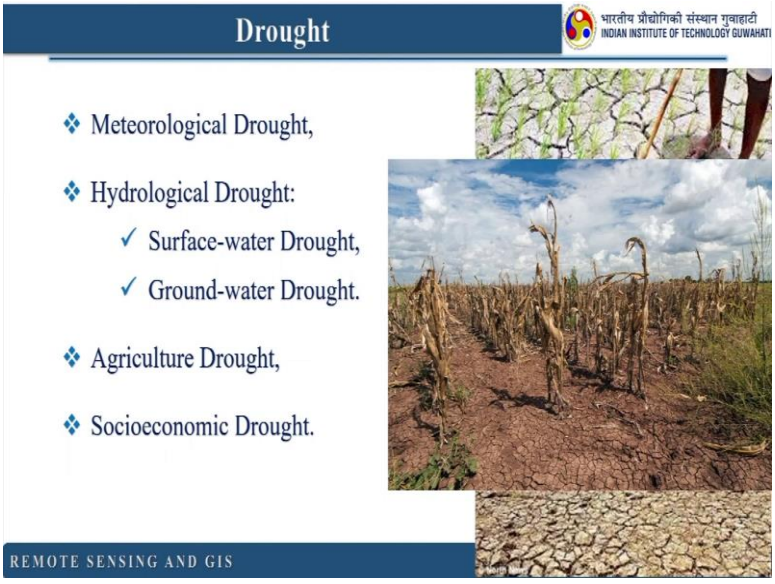

There are different types of Drought which occurred like Methodological Drought, Hydrological Drought; hydrological drought is classified in further two categories. First one is surface water drought; second one is groundwater drought, then agriculture drought, then socio economic drought. So, these are different types of drought. So, you may start thinking like how we can utilize this remote sensing and GIS technology in this particular problem.

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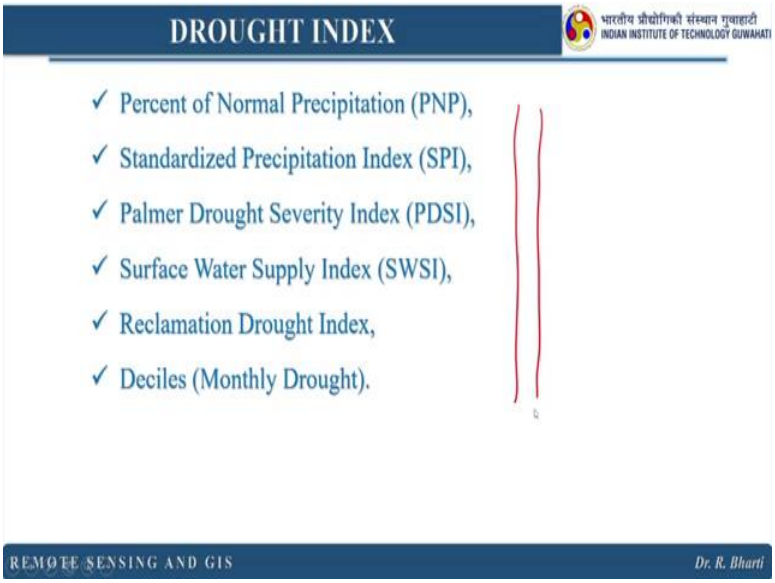

So, these are the different methods which can be used to assess the drought intensity and you can map the areas and this Drought Index can be easily calculated using the remote sensing data. So, in case if you are interested in this please refer some of the literature which are published in this particular domain. So, this is also one of the potential areas where you can start thinking of your research.

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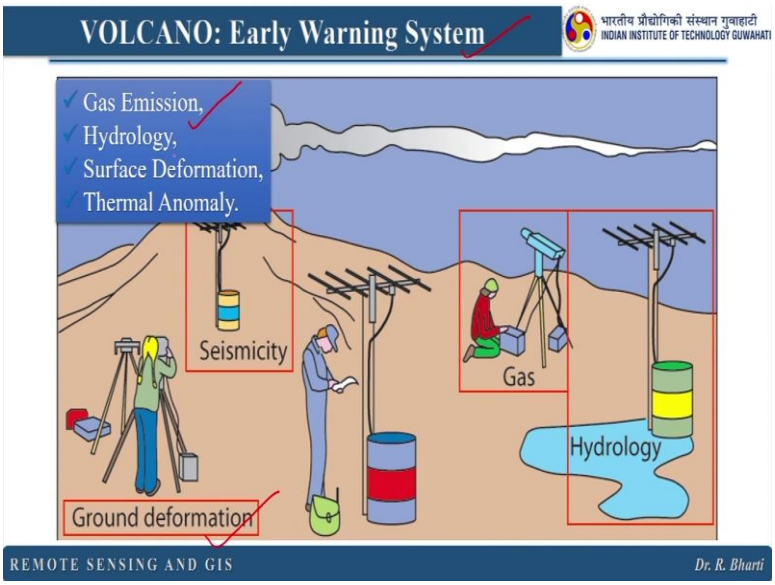

Now, the next Natural Hazard is Volcano in this figure different parameters are represented, which can be used as an indicator of volcanic eruption. So, here first one is Seismicity, so before it erupts, you may have some tremors right if you keep on monitoring that particular area, that seismic activities can give you an indication about the upcoming event. The next one is gaseous explosion or maybe there may be a seepage from which the gases are coming from the mantle right.

The next one is hydrology if there is a slight leakage of liquid or may be gases. And, if you have a river system in that area that will change the quality of the river water that can also be used as an indicator of such volcanic eruption. This can also lead to decrease or increasing amount of water in the river system. The next one is deformation studies whether the plates are moving away from each other towards each other or whether there is any deformation in that particular area or not that you can monitor.

So, here the most important parameters are Gas Emission, Hydrology, Surface Deformation and Thermal Anomaly. So, you can definitely use the thermal remote sensing data to monitor or to predict such events in any given area.

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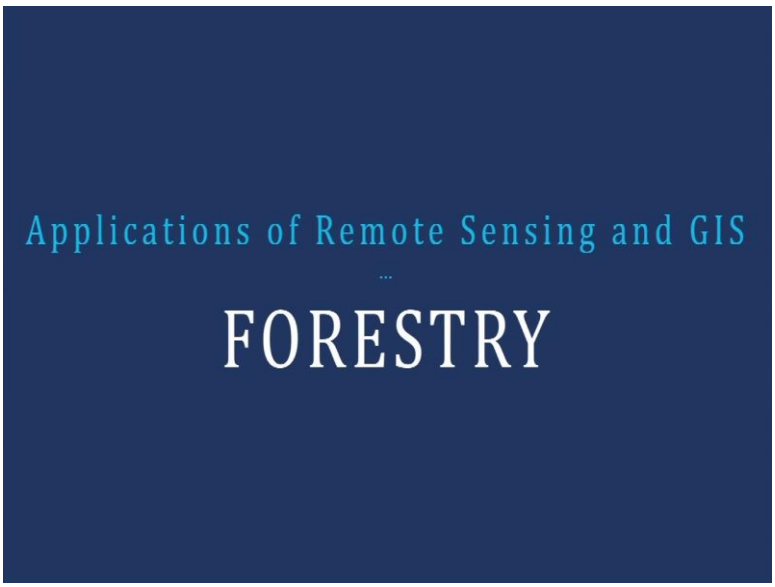

Now let us see some potential application of remote sensing and GIS in forestry. So here, depending upon.

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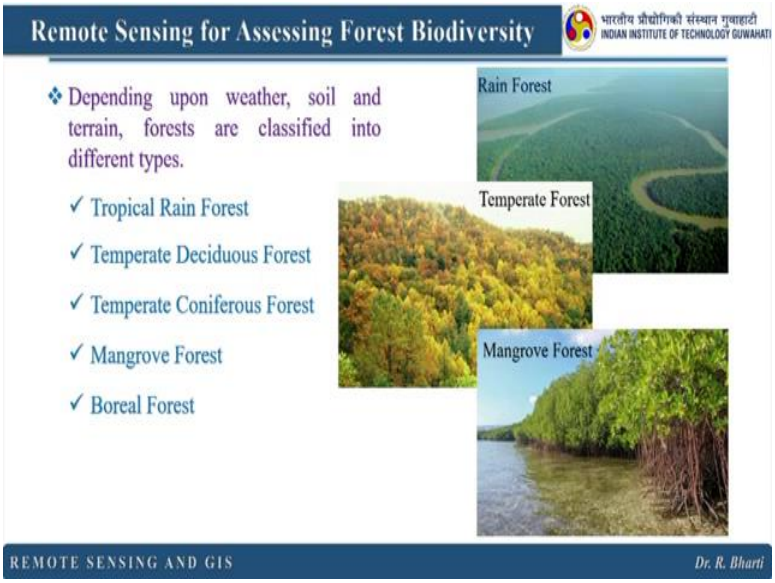

Whether soil and terrain forests are classified in two different types like tropical rain forest temperate, deciduous, temperate coniferous mangrove forest so there are different types. So, these are the different types of forest classified based on the weather soil and terrain. So, terrain is basically the topography right.

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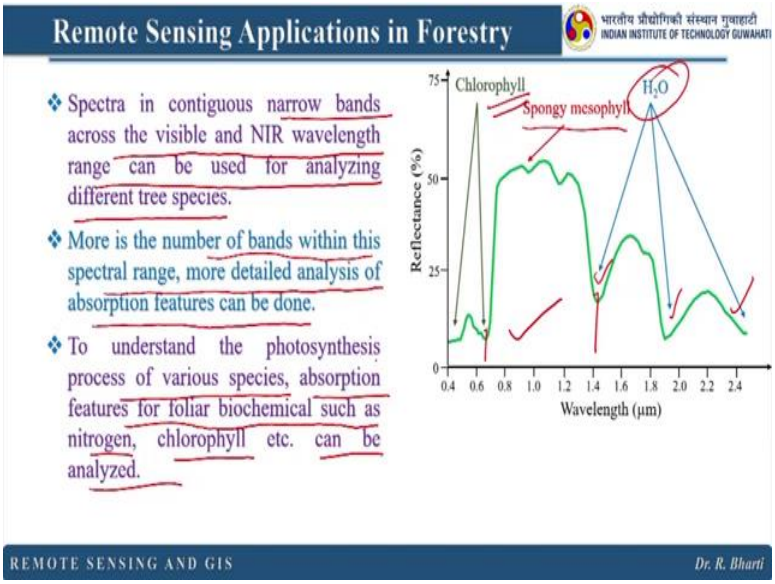

So, how exactly we are availing or using or utilizing this particular technique. So spectra in contiguous narrow bands across the visible and NIR wavelength range can be used for analyzing different tree species, right. I hope you remember the vegetation spectral profile. So, here the position is actually the indicator of the composition and internal atomic structure right. So, if there is a slight change in the position or the orientation, then it says this is different types of species, some more in number of bands within this spectral range more detailed analysis of absorption feature can be done.

That is already understood from earlier lectures. To understand the photosynthesis process of various species absorption feature for foliar biochemical such as nitrogen chlorophyll etc. can be analysed. So, this you can see here. So, these absorption features are basically for H2O this is for Spongy Mesophyll. This is for chlorophyll 2 see you can develop a methodology where you can utilize this particular knowledge and you can evolve with the very informative output.

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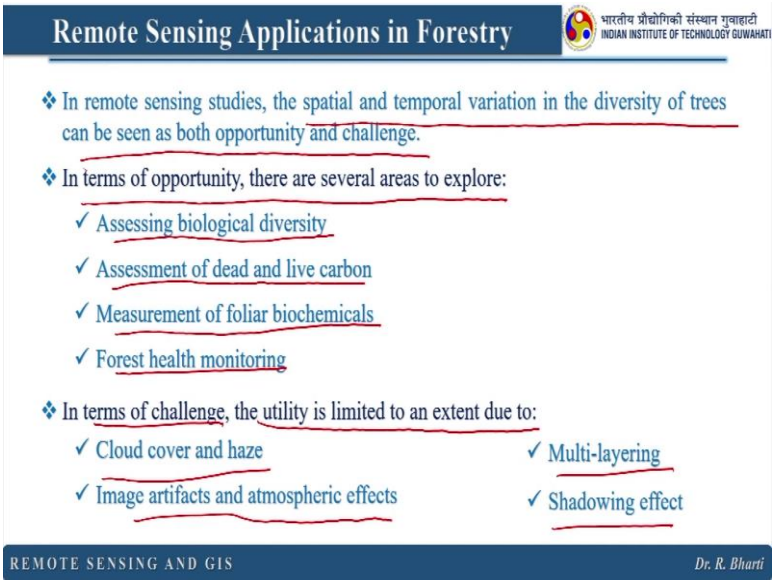

In remote sensing studies the spatial and temporal variation in diversities of trees can be seen as both opportunity and challenge. In terms of opportunity there are several areas to explore like assessment of biological diversity, assessment of dead and live carbon measurement of foliar biochemicals forest health monitoring, in terms of challenges, the utility is limited to an extent due to cloud cover and haze that is the limitation with the remote sensing image artefacts and atmospheric effects..

So, unless until you do not remove all the errors from your data, it cannot be used for any quantitative analysis so such errors are always associated with your remotely sensed image. So, you need to take care before using it in any application.

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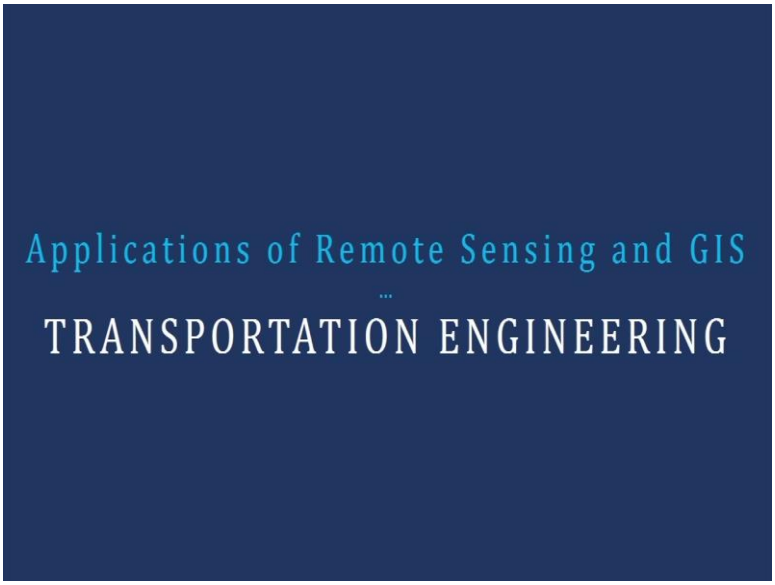

Now, let us see Transportation Engineering, I have already covered this portion, but I want to highlight some of the important aspect which I did not highlighted in the previous one like site selection.

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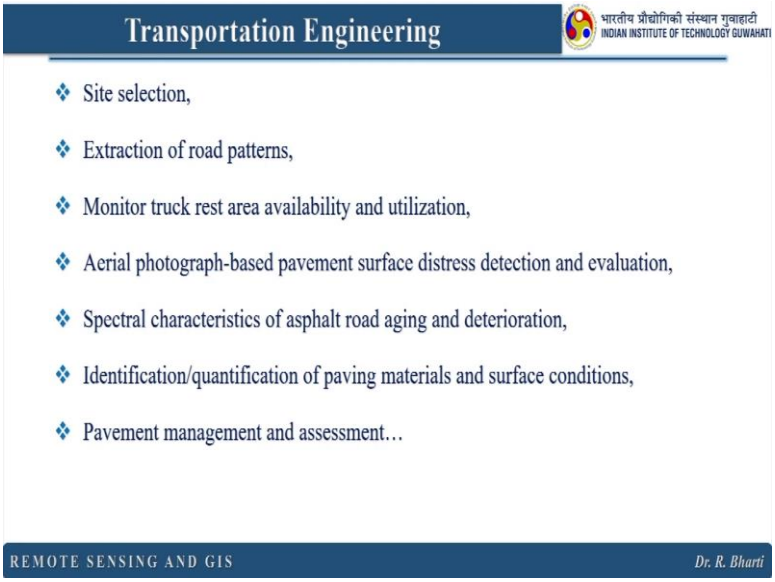

Extraction of road pattern monitor truck rest area availability and utilization, aerial photograph based pavement surface distress detection and evaluation, spectral characteristic of asphalt road aging and deterioration, identification or quantification of paving material and surface condition pavement management and assessment. So, these are very important aspect of transportation engineering. And you can think of applying this remote sensing and GIS knowledge this particular field.

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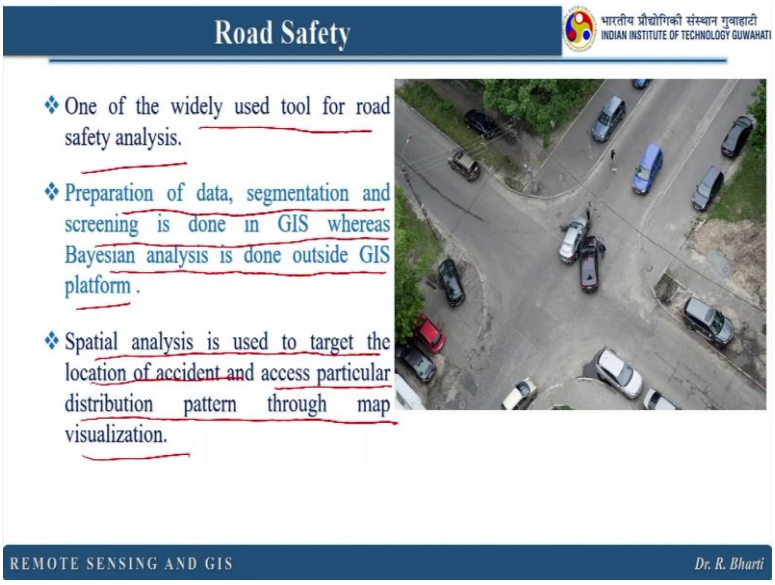

Road Safety is another very important dimension of Transportation Engineering where the GIS is frequently used. So one of the widely used tool for Road Safety Analysis that is GIS preparation of data segmentation and screening is done in GIS whereas, Bayesian Analysis is done outside GIS platform. Spatial analysis is used to target the location and accident and access particular distribution pattern through map visualization.

So basically when we are involved with GIS or in GIS environment, then definitely we are having spatial data. That means the location data is always involved. Plus, remote sensing data gives you the power of visualization.

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This is when we are talking about navigation. So nowadays you people are familiar with this Google map, you can easily find out so ISRO has also developed their own app, you can use that Bhuwan website you can visit and you can explore more.

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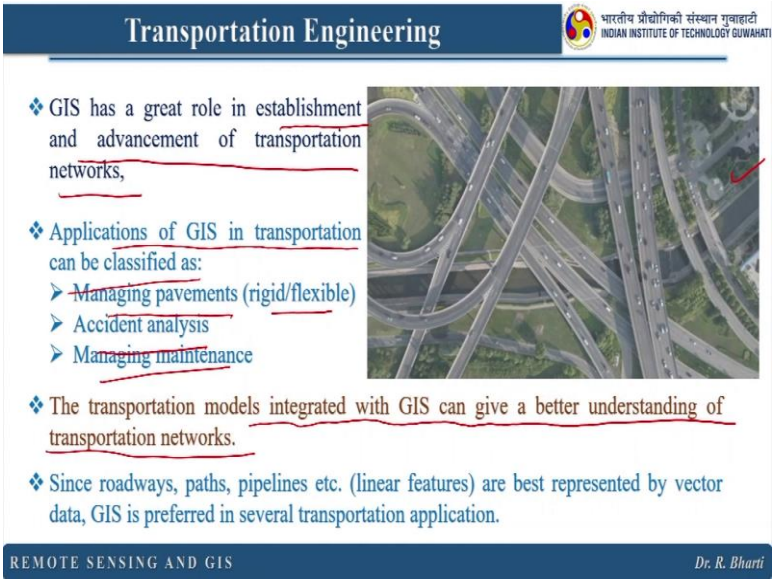

GIS plays very critical role in establishment and advancement of transportation network because you can use the remote sensing data in GIS environment. And you can visualize then application of GIS in transportation engineering can be classified as managing payments. So rigid or flexible accident analysis, managing maintenance, the transportation models integrated with GIS can give a better understanding of transportation network.

So this where the more work need to be done. So you can think of applying this knowledge since roadways, paths, pipelines etc. are best represented by vector data GIS is preferred in several transportation application.

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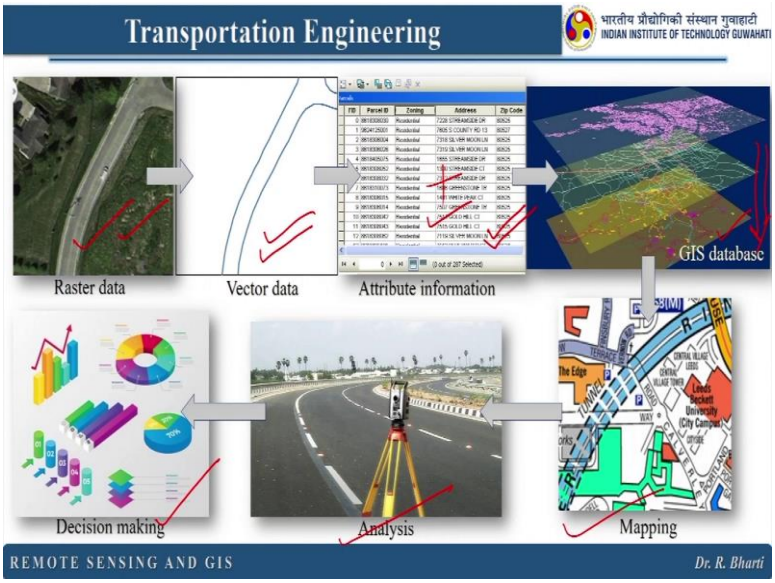

This slide gives you the overall understanding how this remotely sensed and GIS can help you in Transportation Engineering. So, here we have used this raster data and then we have converted into vector by digitizing or maybe you can use the automatic extraction techniques. Then these are the attributes which we have attached to this particular data by conducting a field investigation.

So, you are having the remotely sensed information plus you have converted to point line collagen plus you have incorporated the field information and then you can model this in 3D, Right after that you can integrate digital elevation model. In this particular data and you can map the area you can perform the analysis and then you can represent this data in different format like map, graphical data or may be pie chart bar chart, it is up to you, how do you want. So, this GIS gives you full control over the analysis. So, you must remember that I gave you one flowchart a typical structure of GIS. So start from first by defining your problem. And then end with your output and this is in support system right.

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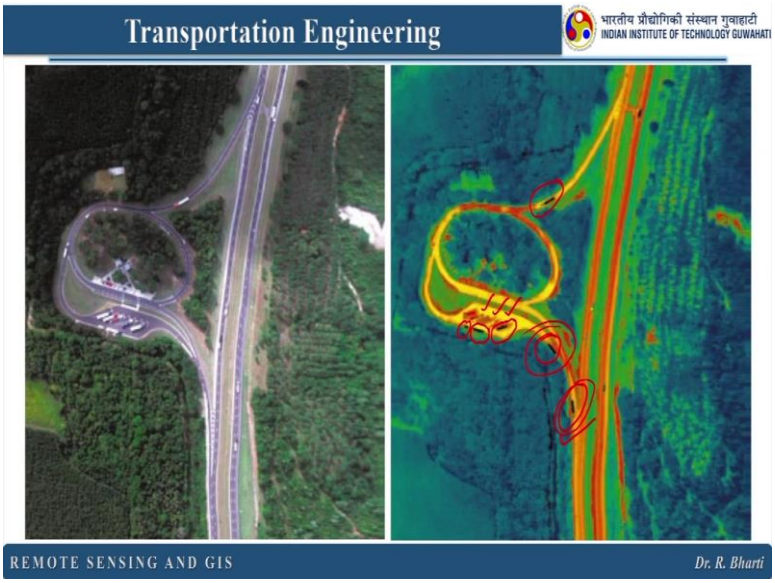

This is a very interesting work which has been done to identify the truck resting areas. So here you can easily find by using this thermal remote sensing data that some of the vehicles are of dark colour. These are the black one right. So that means these trucks are lying here for a long time rest are basically if you can see all these. So, here whichever is coming in the red there, this is a temperature data.

So the red colour represents it is just parked and it may start soon and it will leave this place. But these dark colours vehicles, it seems like they are parked here for a long time. This technique can be used by the government officials to identify what are the vehicles which are lying there for long time and where you want to construct more parking areas. And what are the places which are not utilized or which are the areas or parking lots which have been utilized more than its capacity.

So those things we can always perform in this particular domain, now, here, this was the normal raw data this was thermal. So, you can easily find out how you are getting the benefit of different wavelengths in Transportation Engineering.

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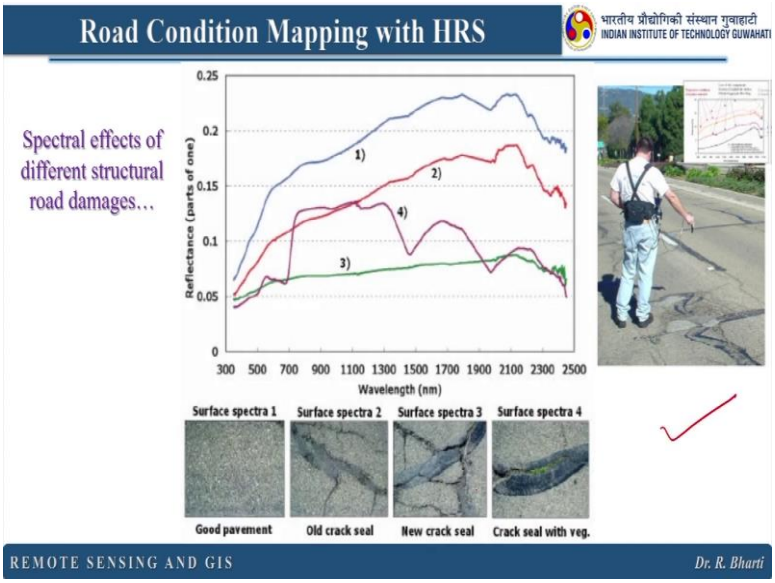

This already I have explained you in my previous lectures. Where this hyperspectral remote sensing data is used to identify the paving material and surface condition another example I showed you for the identification of road condition using the spectral profiles. In another work I explained you how this remote sensing or in particular hyperspectral remote sensing can be used for the aging and deterioration studies.

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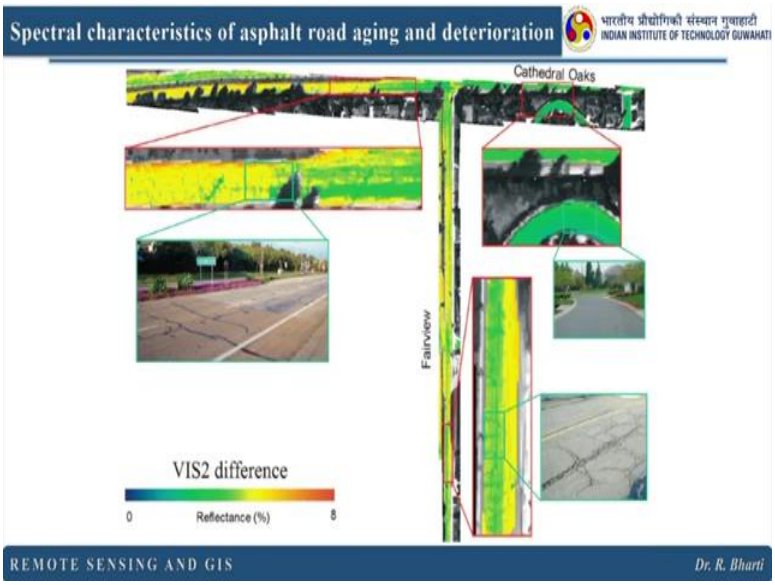

And this already I have experience I will skip this part. So, we will continue this application of remote sensing and GIS in my next lectures. Thank you.