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Lecture - 54
Remote Sensing and GPS Application in Agriculture and NRM (Introduction)

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Remote sensing and GIS application in agriculture and NRM

Participants today, we will start a new topic and that is on Remote Sensing and GIS Application in Agriculture and Natural Resource Management. Now, all of you know that current time, remote sensing and GIS are two important tools which are being used significantly for natural resource management and also for various other fields.
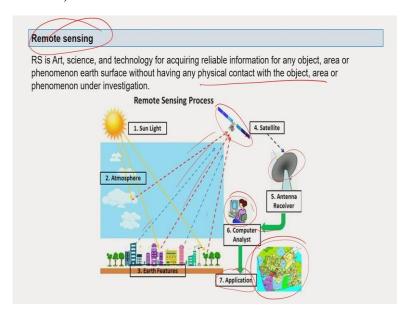
Now, these two aspects specialty remote sensing and GIS, our country India is doing great. We have really state of the art capability to work on these fields and remote sensing GIS techniques also help us to understand the extent of uses of natural resource management and thus provide us a better opportunity to manage these natural resources in a better manner.

So, in this lecture, we will discuss deliberate upon various aspect technical aspects of this two techniques as well as how in the field we can apply. One thing is that, that in this lecture, we will not go very detail of this remote sensing and GIS or technique because that is not the scope of this course. Instead, we will try to discuss about these two techniques in brief and

then look different aspects of these two tools, how we can actually apply for natural resource management.
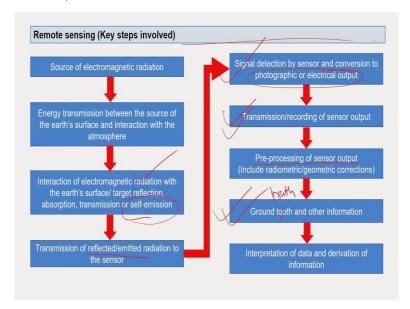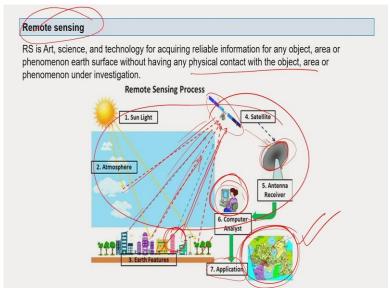
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Now, all of you know that remote sensing is an art, science and also technology for collecting, accumulating, collecting, reliable information for any kind of object, an area or space, an incident suppose a fire has taken place without having any physical contact with the object, that is the importance or the area or the phenomenon, which is actually under our investigation.

So, from a distance you can actually remotely sense it and that is why the name has come remote sensing. You need not to be there at the point of the event that has taken place. So, satellites actually help to get the signals from various surfaces and then it says the signals are received by the antenna. From antenna it goes to the computer or the hub, where actually the data gets downloaded and then processed. And then applications are taken and you get to see beautiful maps showing you different resources extends of its uses, etc.

Now, in case of remote sensing, there are a few key steps involved, which we need to understand. The first step is that the source of the electromagnetic radiation. See the picture from here, unless until some signals goes the satellite will not be able to capture. The satellite will be able to send some signals to the antenna when it gets some signals from the different surfaces.

So, the source of electromagnetic radiation, once you get that electromagnetic radiation, then energy transmission between the source of the surface, and interaction with the atmosphere because it passes through atmosphere before it goes to the satellite.

So, energy transmission is taking place between the sources of the earth's surface, a building, vegetation, maybe a crop field, forest area and that signal passes through the atmosphere. So,
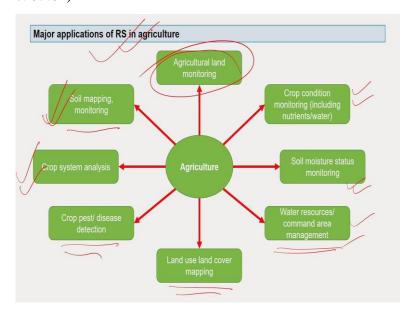
definitely there will be some interaction before it reaches to the satellite up there, it passes through the atmosphere.

Next, interactions of these electromagnetic radiations with the earth surface; there will be absorption, there will be transmission or sometimes even self emissions by trees and buildings, etc. So, transmissions of the reflected or emitted radiation, it goes to the sensor which is there up there in the satellite. The signals which are being sent from the surfaces of the earth are get detected by a sensor and then get converted to photographic or electrical output.

Once that photographic electrical output is ready, it get transmitted, transmission gets takes place. Then it gets recorded also as a output from the sensor. Then once the output comes out then where it goes. Output once comes out then pre processing of the sensor output will be done at the hub where actually the informations are coming in. Once the information are there, pre processing done, then you go for cross checking, ground truthing to check the information in the pictorial form or signal that you have received from the satellite through the antenna, how much those information are factually correct. So, for that we go for ground truth.

So, ground truthing is once done then finally, you go for interpretation of data. And from those interpretation, you finally come out with a map kind of things which you can present and people can very easily understand. Any decision maker policymaker, they will not understand this entire process only this one the final outcome in the form of a map. So, this is what is the basics steps which are involved in case of remote sensing.
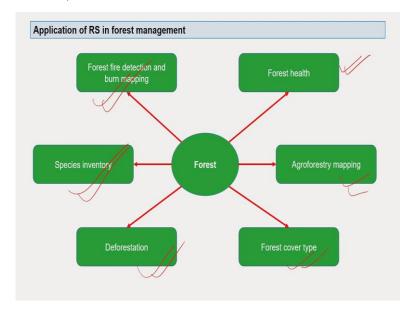
Now, what the major application of remote sensing in agriculture is. Lot of applications as you see in this slide, starting from crop condition monitoring, soil moisture status monitoring, water resources command area management in case of water harvesting or watershed management, we have discussed about this. Remote sensing can play a very important role for command area management, land use land cover mapping, absolutely critical, crop based disease detection; they can help you to understand how much area is under the infestation by pest or a disease.

Crop system analysis, crop system itself you can analyze and here you can bring in the crop model also and can integrate with remote sensing or GIS. Soil mapping and monitoring and of course, agriculture land monitoring is there how much area is covered under crop. So, various applications are there using remote sensing.
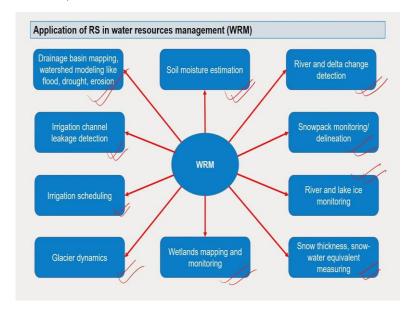
Remote sensing can also be used for forest management. We know that you can actually use it remote sensing data for forest health management, agro forestry mapping, forest cover type, which are the different type of forests actually available in a particular area, if any deforestation takes place, how much area deforestation because that will allow you to devise your plan of action. You cannot go there from a long distance maybe hundred, thousands of kilometers away. From the remote sensing data, you can analyze and you can send some information to the decision makers of that particular area, please do this, please do that; do not do that.
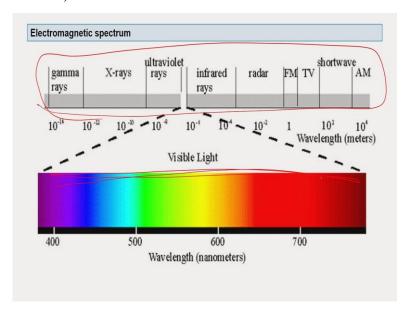
So, species inventory can also be possible. Suppose you have different type of plant species, different type of plants in the field. So, with the help of ground truthing ground data and remote sensing data, you can also come with species inventory. Forest fire detective, this is another aspect that remote sensing help in a great manner, because you cannot go inside the forest, where the forest burning is taking place. So, from remote sensing data again, you can actually estimate the amount of area which is under the forest fire and how much resources that you may require to manage that kind of forest fire. So, it helps in that way.
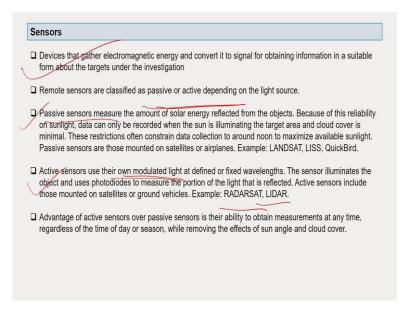
Application of remote sensing in water resource management, enormous; briefly in watershed management lectures, I have discussed about the applications. Now here you see that how much different type of applications that you can think using remote sensing. Soil moisture estimation, river paths change detections, snowpack monitoring, how much snow has glaciers has melted, river lake ice monitoring, snow thickness, how much thickness is the snow sheet. So, snow water equivalent measurement also it helps, wetlands mapping and monitoring, glacier dynamics many people these days are very actively working. In India we have several groups working on glacier dynamics. Irrigation scheduling, already I mentioned in watershed management lecture, irrigation channel leakage detection can also be carried out, drainage basin mapping, watershed modeling, so on and so forth. So, you see that, I mean, how much different type of uses the remote sensing allows us to do.

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Now, this entire thing happens because of certain signal emission and signal capturing. So, basically on the basis of electromagnetic signal, we get all this information through remote sensing. So, these are the visible light range as you know, so, within this range, whichever signal comes in, it gets captured by the sensors.

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Now, sensors are devices that gather electromagnetic energy and convert it to signal for obtaining information in a form that we can understand. Remote sensors are classified as passive or active depending on the source of light from where the signal is coming to source. On the basis of source you have passive or active remote sensors.

Now, passive sensors, they measure the amount of solar energy reflected from the objects. And due to this, the reliability of sunlight and the data can only be recorded when you have a bright sun on the target area especially. Suppose you want to cover your district and at that point of time, when the satellite is moving, it is very thick cloudy, you may not get a proper data, because it is not capturing the signal properly. So, these restrictions often in case of remote sensing, we can miss some information, especially when the satellite is moving in a particular time when it cross through my targeted area. And that day it was cloudy, so you will miss some time this kind of information.

Active sensor, they use their own modulated light. They do not depend upon the sunlight or reflections. At these active sensors using their own modulated light at defined and fixed wavelength, a sensors will illuminate the object, the object which actually it is wants to sense. The active sensors include those which are mounted on the satellites or on the ground vehicles. There are certain times you will see that in countries like United States they use ground vehicles and we also have started using ground vehicles.

So, in ground vehicles we carry different kind of active sensors like LIDAR, RADARSAT. You might find if you go sometime some parts of Punjab and other side some experiments are going on, they will have vehicle with the RADARSAT or LIDAR kind of sensors. Advantage of these active sensors over the passive sensor is there actually ability to obtain measurements at any point of time.

So, active sensors, they do not need to wait for bright sunlight or they do not anyway bother about the cloudy weather or so. Active sensor can carry out because it creates its own modulated light and then sends to the object. So, the differences between passive and active sensors are that active sensors can any point of time can get the information from the object of target, passive sensors cannot.

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Then we have hyperspectral and multispectral remote sensing very popular, you might have heard about these things. Now hyperspectral remote sensing, what is this briefly about that. Hyperspectral remote sensing also called as imaging spectroscopy. These are used often to identify different kind of minerals, vegetation, and forest cover. The information which is collected in through hyperspectral remote sensing are also processed from across the electromagnetic spectrum; entire electromagnetic spectrum it can process the data. And the goal of this hyper spectral remote sensing is to obtain the spectrum for each pixel in the image of a scene meaning of an area that it captures.
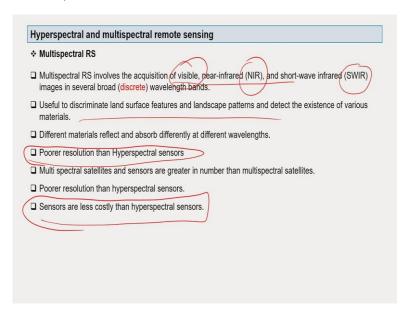
Now, the data sets which you get in this kind of remote sensing are generally composed of 100 to 200 spectral bands, continuous spectral bands having relatively narrow bandwidth, 5 to 10 nanometer. The spectral information which is provided by hyperspectral data, they are able to identify and also distinguish spectrally similar materials, that is one good thing is there.

Hyperspectral data also allows for the identification of many kind of materials, even if they are mixed with each another say minerals under soil, if there is some kind of mixing of course, there will be some mixed minerals, but they can through hyperspectral it can be able to get differentiation of these minerals.

Hyperspectral are also able to provide several kind of information about crop biophysical properties. And they can also accurately estimate the yield area, yield data, how much actually total suppose you have 10 acres of land, how much yield you are going to get. So,

that also is possible. Cost and complexity are the two major disadvantages for hyperspectral remote sensing, costly and complex. So, you need all type of very fast computers, you need very sensitive detectors means all high and sophisticated instruments you need.
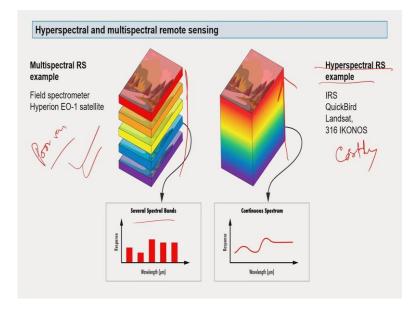
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Multispectral remote sensing; this actually involves in the acquisition of visible and near infrared and also short infrared region images unlike hyperspectral. So, this three NIR, SWIR and visible, you can get through multispectral remote sensing. It is useful also to discriminate the surface features, landscape pattern; it can also detect the existence of any kind of special material in any area. Different materials, we know that will reflect and absorb different kind of wavelengths. So, on that basis multispectral remote sensing can sense or give the information about different kind of material.

Multispectral remote sensing is poorer in resolution, at least in comparison to hyperspectral sensor. Multispectral satellites and sensors are greater in number than hyperspectral satellites. So, poorer resolutions also sometimes effect our analysis. So, this is one of the drawbacks that people will find with multispectral remote sensing. Sensor is of course less costly than hyperspectral sensor. So, you can understand that especially in developing countries on the basis of cost if they will go for multispectral remote sensing.
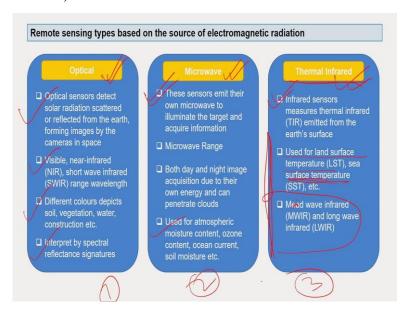
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Now, this slide is shows the differences between hyperspectral and multispectral remote sensing. If you see that on your left hand side multispectral remote sensing one example, field spectrometer how actually it works. So, it has different spectral bands and it can differentiate between the different spectral bands and can give individual informations whereas in case of hyperspectral remote sensing, it will give you a kind of a continuous spectrum and informations.

So, as I said that these two has two different beneficial activities or beneficial points. In one we have very costly data costly instrumentations and here we have little poor resolution. So you have to actually have a trade-off between these two. In certain purposes, you can go for multispectral; for certain you can go for hyperspectral.

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Now, remote sensing types are based on the source of electromagnetic radiation. We mentioned just a couple of minutes back. Now there are three type of electromagnetic radiations which can actually differentiate the nature and types of remote sensing that we are talking about. One is optical, another is microwave, and the third one is thermal infrared. These are the three different electromagnetic radiations mainly we deal with the remote sensing technique.

Now, in case of optical sensors they detect the solar radiations which was scattered reflected from the surfaces of the earth forming different kind of images by the cameras which are located in the satellite. It can capture a visible, near infrared and short wave infrared range of wavelength. Different colors depict, soil, vegetation, water. And it is interpreted by spectral reflectance signatures, microwave, and electromagnetic radiations. These in case of microwave base or sensor these sensors emit their own microwave to illuminate the target.

From the sensor, the microwave will come on to the target and illuminate it and acquire information that means even if there is cloudy day you can use this sensor. So, microwave range it works both day and night image can be acquired. These are used for atmospheric moisture content, ozone content, ocean currents, soil moistures. So, 24 by 7 you can get information.

Thermal infrared; infrared sensors measures thermal infrared, which are emitted from the earth surface and these information are used for land surface temperature, sea surface temperature because from the surface the signals which are coming in the form of TIR,

thermal infrared radiation, these electromagnetic radiation can be used to measure land surface, sea surface temperature. It helps very significantly in the field of climate change research.

Then we have mid wave actually infrared radiations and then we have long wave infrared radiations. So, these are the basically three different types of electromagnetic radiations which decides the type different types of remote sensing that we can use for various purposes.