Remote Sensing: Principles and Applications

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Lecture-01
Introduction to RS and EMR

Hello everyone, welcome to this course remote sensing principles and applications. I am Dr. Eswar working as assistant professor in the department of civil engineering and also associated with the interdisciplinary program on climate studies at Indian Institute of Technology, Bombay. So, what are we going to see in this course is about remote sensing which is a fast emerging technology. In the last few decades, it has grown tremendously.

In this particular course we are going to see what are the basic physical principles behind remote sensing especially in the optical and thermal domains?

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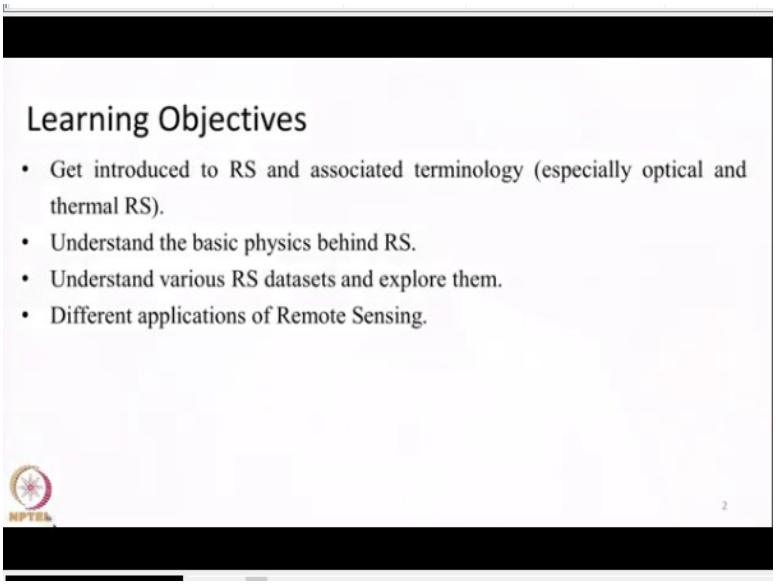

We will also be able to understand the different terminologies associated with remote sensing, what are the different satellite data sets available to us and what those satellite data sets contain and finally we will also get to know or get introduced to few applications of remote sensing at the end of this course. So, even though this lecture will be as self-contained as possible for your own understanding and appreciation I would suggest few text books for you all to go through.

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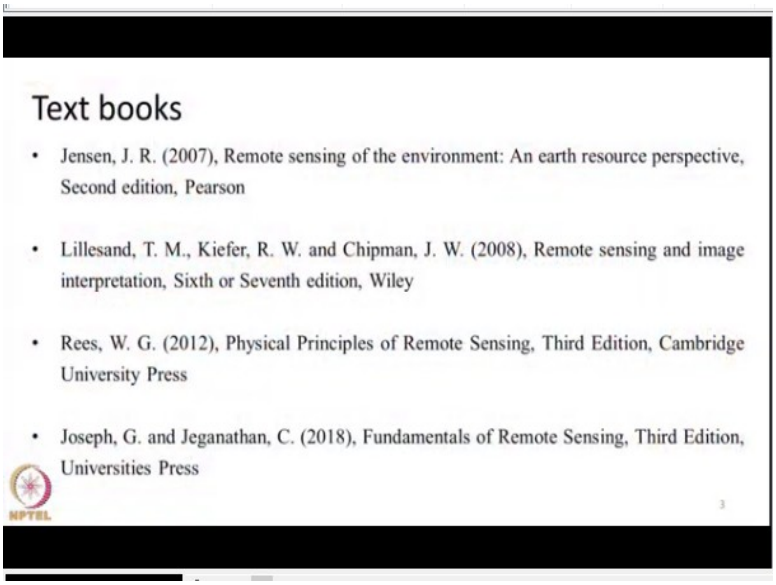

Like some of the textbooks are Remote sensing of the environment an Earth Resource Perspective by John Jensen, the classical textbook Remote Sensing And Image Interpretation by Lillesand and Kiefer, Physical Principles Of Remote Sensing by W.G Rees and The Fundamentals Of Remote Sensing by Dr. Joseph and Jeganathan. So, if you want to get like a basic introduction to the concepts then the textbook by Lillesand and Kiefer and Jensen would be like the best suggested ones.

If you want to understand the physical principles or go little bit deeper into the concepts I would suggest you to look at the textbooks by Joseph and Jeganathan and W. G Rees.

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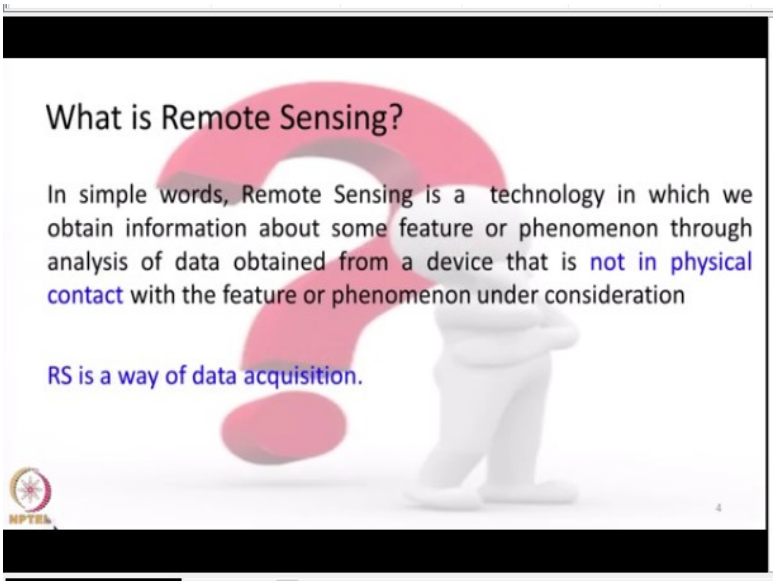

What exactly is remote sensing? So, normally when we look at our newspapers we will see any image or the cloud image for today or in TV, they will show an image like India map and

they will tell a cyclone is approaching, the cyclone is headed towards Vizag coast, the cyclone is headed towards Odisha. All these things they will say and we will be recognizing it as a satellite image. That is true, it is like a satellite image processed to some degree. So, just by looking at the image what we will be able to do? we will recognise okay there is a cyclone here and the path of the cyclone is moving like this, all such information we will get by seeing those images taken from the satellites. Exactly that is what remote sensing is as a basic definition.

So, remote sensing is a technology in which we obtain information about some feature or a phenomenon on the earth surface through data collection and analysis in which the data is collected in a non-contact manner or without being in physical contact with the object of our interest. So, one of the best example of remote sensing what we do in normal life is our own vision.

Like whatever objects we see, we see the objects from a distance. We use the natural light coming from the sun or we use some artificial light source like bulbs which falls on the object and the object will reflect light. Our eyes will receive it and we will see okay there is a table in front of me, the door is in that direction I should enter through the door. So, all these kinds of processing we do unknowingly through the data we collected through our eyes. So, our eyes act as a sensor in that sense and our brain is the data processor. So, remote sensing is essentially a data acquisition technology which we can use for various applications.

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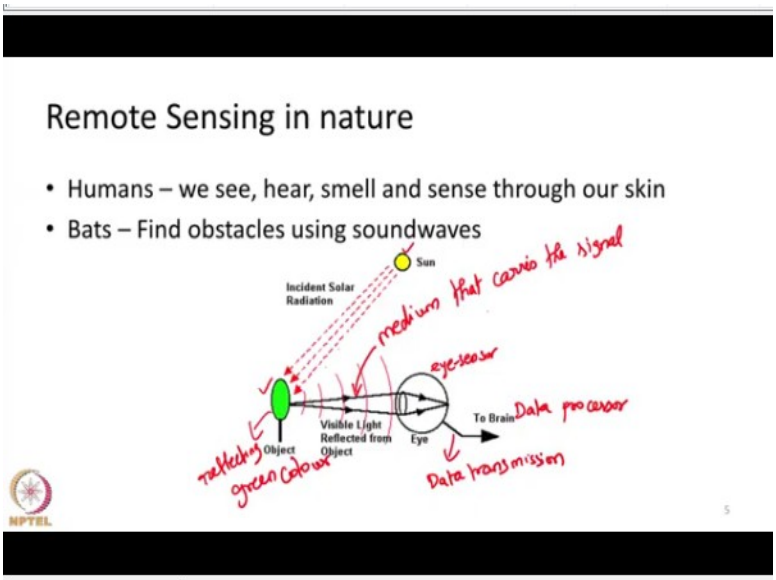

As I said before remote sensing occurs in nature itself, the process of human vision not only human, the vision of all animals is exactly an example for remote sensing. Whatever we see

we see it from a distance. The sound we hear say for example if a baby is sleeping in the bedroom and we are sitting in the living room if the baby suddenly wakes up and cries we hear it from a distance and we enter the room take the baby and pat it.

So, this information collection that is the baby has woken up and it is crying now, happens remotely. So, the process of our hearing is an example for remote sensing. So, not only this even bats when they fly, they avoid obstacles and move away from it by sending ultrasonic waves and hearing the reflection back. These are all examples of remote sensing which occurs in nature.

So, the technology that we are going to learn in this course is an extension of this natural process to study earth and various features associated with earth. And truly speaking remote sensing is not restricted only to earth, remote sensing can be carried out for planets and solar system and far beyond. People are doing it. But in this particular course we will be concentrating on remote sensing of earth's surface and its applications. We won't be looking on remote sensing of other planets.

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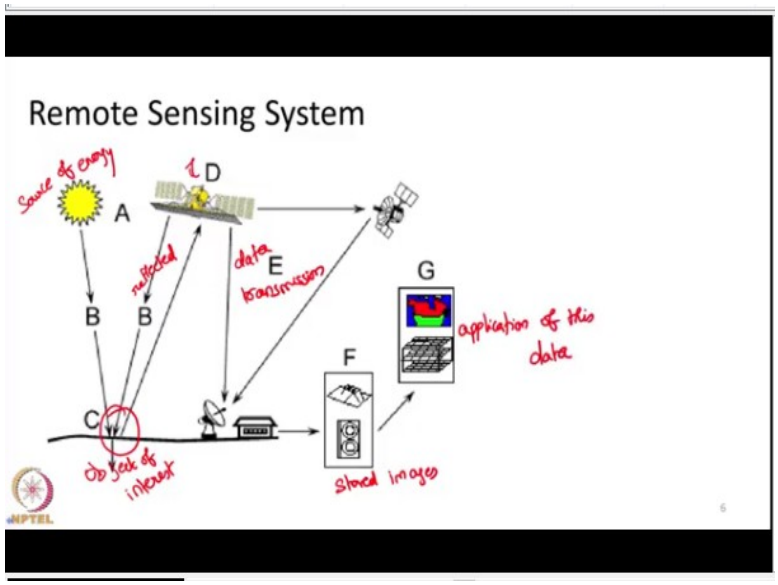


So, this is a typical remote sensing system. So, what a remote sensing system consists of? We will always take an analogy with the process of human vision and then we will learn this. So, for remote sensing to occur, first there should be an object of interest. Let us say the object of interest here is marked as point C, this is the object of our interest. So, in order for us to see that particular object we need some light source.

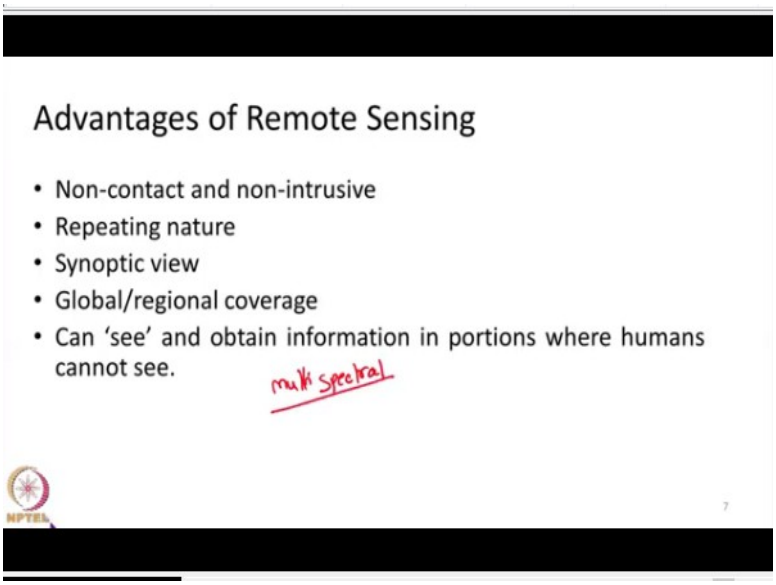
And that light source during day time is the sun or if we are within our rooms it is the bulbs that we use. So, we need a source that transmits energy towards the object of interest. What happens then is the transmitted energy towards the object, is reflected by the object of interest and come towards the sensor.

So if you take analogy of human vision, the sensor is eye, our human eyes. And if you take our normal remote sensing the sensor is located in a satellite. Then the reflected energy goes towards the sensor and the sensor collects it. So, now the sensor will transmit the data back to earth. This is known as data transmission and this transmitted data will be stored most likely in form of images. There are other ways of processing and storing remote sensing data but mostly we are used to seeing satellite images and working with it. The final step is application of this data.

As per the figure the sun is there to provide energy and the object of interest transmits that energy to our eye which acts as the sensor. So, the brain acts as the data processor and then our brain takes decision based on whatever happens. So, the data transmission happens between the eyes and the brain. So, this is like a very simple analogy of remote sensing that what we do with the help of satellites.

And this particular energy what the source of energy sends us or which carries the signal we call it as medium. So, this particular medium carries the signal and it reaches our eyes. So, basically if an object is appearing green what the object is doing, whatever the sunlight comes in it is absorbing all other energy other than green and only green is reflected back.

So, this particular object is reflecting green color and it is absorbing all other color light that is coming from the sun and that is why we are seeing that particular object as green. If an object appears white to our eyes it is reflecting almost all the colors from the sun equally and so it will appear white to our eyes. So, the basic remote sensing that we do with respect to satellites has a very good analogy with the process of human vision.



What are the advantages of remote sensing? First of all remote sensing is a non-contact and non-intrusive way of data collection, that is as I said in the definition itself remote sensing is a non-contact way of data collection, being non-contact we would not be disturbing the object or feature of our interest. So, if I want to collect data about some object I need not go, touch the object or disturb the object.

So, from a distance I can collect the data that is non-contact and non-intrusive. In addition to being non-contact way of data collection it provides access to almost all points on the earth surface where we cannot physically enter. That is say we are going to see a hurricane and track how the hurricane is going to progress, where it is going to change direction, we cannot go and collect data within a hurricane itself, it is highly risky. So, what we can do, we can collect data from satellites, safely sitting from the satellite control center, process the data and collect more information about the hurricanes, that is possible. So, the first major advantages is non-intrusive which would not disturb the object of our interest and it provides access to almost all points on the earth's surface.

The second advantage is that the remote sensing provides repeated data. Like the data collected over a particular region can be collected again and again based on our needs which will tell us how that particular object or phenomenon is changing with time. Say for example one of the major applications of remote sensing is agriculture. So, for agriculture we all know crops has a sowing date, crops will grow, crops will finally reach the harvest stage, people will harvest it, then everything will be removed from that particular parcel of agriculture land.

So, crops follow a physical phenological cycle right from sowing date to harvest date. As the plant grows the signal emitted by the plant will be different and just by seeing this change in signal we will be able to understand what is the condition of the plant, whether it is growing good or not. So, the temporal evolution of the crop cycle can be steady by taking multiple images at different times in between the phenological cycle. So, the repeated information provided by remote sensing offers us to study how the object or the phenomenon of our interest evolves with time.

The next major advantage of remote sensing is synoptic coverage that is it provides a glance of a large portion of earth's surface in a single instance. This is really necessary for people who works on meteorological applications, they want to track cloud movements, they want to track hurricane moments, they want to track how dust storm is moving, normally like dust storm from Sahara desert will move to South America or the smog coming in from stubble burning it will reach the next states and it will affect people over there. This happens every year and it is occurring in India also. So, for such studies we need to look at a much larger area, much larger than whatever eyes can see or what we can sense by our local means. So, that is called synoptic coverage. Remote sensing satellite image can provide you coverage of entire country, entire state or entire continent, sometimes even the entire globe depends on where the satellite is located. That kind of synoptic coverage will help you to understand the phenomenon in a much more clearer way.

Then the next major advantage is that the remote sensing provides global or regional coverage, most of the satellites are put in orbits to either look at the same area again and again continuously or to cover the entire globe by taking images repeatedly at different portions. So based on the satellite orbits, you will be seeing the same area continuously or you will be able to cover the entire globe.

Then the most critical thing what I will say as the advantage is remote sensing enables us to see the object in different portions of the energy band which human eyes cannot see. When I talked about the human analogy of remote sensing, I said what color the object reflects, our eyes will perceive the object in that particular color. Say if it is a green object it is reflecting only the green energy. Our eyes can only see green. So, what essentially happens is our eyes are tuned to the white light that comes from the sun, whatever energy coming within that particular energy level our eyes can sense. But sun is a good source that can provide energy

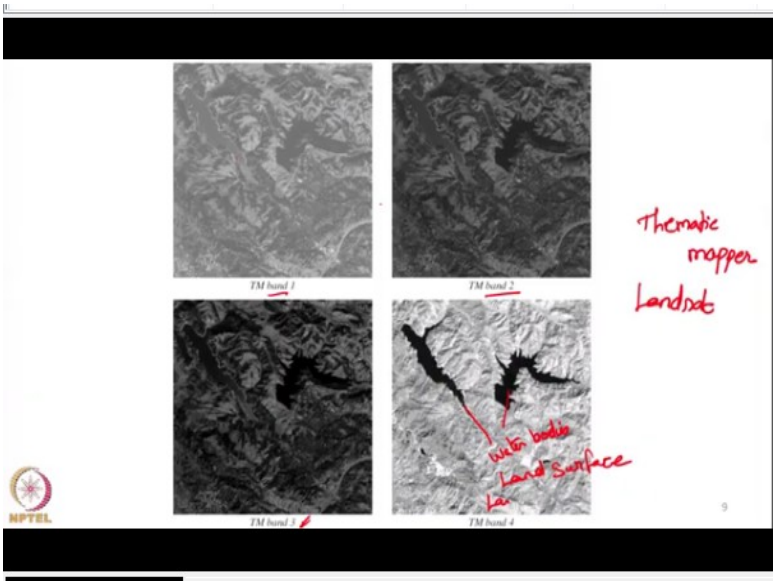
in the very large portion of electromagnetic spectrum and each object will behave differently in different portion of this incoming energy which our eyes cannot see. So, remote sensing through the use of different sensors or different detector elements helps us to see the same object in different, different way by helping us to see in different bands of energy.

So, this kind information we call as multispectral information. This multispectral information helps us to understand that particular object in a much more detailed manner than what our eyes can see.

So, a very good example of how multispectral remote sensing will help us is given here. So, this particular image is taken over the United States by a sensor called MODIS, this is like a remote sensing sensor in 2 different satellites. So, what do these bands essentially mean? These bands essentially mean different portions of the energy spectrum that is coming from the sun like what our eyes can see is a very small amount of energy from the sun.

But the sun is giving energy in many different portions of the spectrum. So, each band is a one small portion of the spectrum. So, the same area imaged by different sensors in space will give us a completely different look of the land surface. Say in band 2 we can see the land surface primarily here, in band 26 land is not visible but we are seeing the cloud patches very clearly which is not visible in band 2. In band 27 whatever we see is what is present entirely in the atmosphere and we are not seeing anything related to ground. So, same area, same sensor but by looking in different, different portions of energy we are getting different information. In band 2 and band 6 we are getting information about the ground surface. In band 26 we are able to see some clouds. In band 27 we are seeing or getting information

about the atmosphere. So, this sort of multi-spectral information will provide us many different ideas about the object of our interest.



So, this is another example of how multispectral information will help us, again this is like the same area covered by a sensor called thematic mapper, this sensor is in a satellite called landsat. So, again here band means different portions of energy. So, what happens? In this particular band 1 we are seeing 2 reservoirs. The reservoirs appear a little bit brighter and some land surface.

Band 2 appears a bit darker, if you look at band 4 we are able to clearly see the reservoir in a much darker tone. So, essentially each band gives us different, different information about the same object of our interest.

So, basically just to summarize, in this particular lecture we have learnt what remote sensing is, we have learnt what our remote sensing system comprises and then we have learnt a remote sensing system in analogy with human mission and then we saw the advantages of remote sensing. One of the major advantages, the multispectral information provided by remote sensing data and we also saw 2 examples of what multispectral information is and how the images acquired in different portions of energy will look for the same area.

Thank you very much.