Laboratory Practices in Earth Sciences: Landscape Mapping

Dr. Javed N Malik
Department of Earth Sciences
Indian Institute of Technology, Kanpur

Week- 01
Lecture- 01

Welcome to this course of laboratory practices in earth sciences and mainly emphasizing on landscape mapping. So, as you must have gone through the introductory video in which I have already mentioned that we will be focusing on three main components. One is the remote sensing, second is field base and third is the lab in which we will be mainly using the dating part. Why is remote sensing important? I will just emphasize on this and this is a brief lecture on that. So, I will be a bit quick on this, but later we will be spending more time on the lab-oriented lectures. Any image you are collecting without touching the object or without coming into the contact of the object is termed as a remote sensing technique.

These are the pictures which I am showing are also a part of remote sensing. Now the core structure if you take the details you must have got, but we will briefly touch upon this so that we understand and we know what we are going to do in this course. As I told that first component for the package will be your geosocial studies mainly and in this we are going to mainly focus on the GIS where we will also look at that what different type of data we are going to use for landscape mapping and processing part mainly and in this we will focus mostly on the land set as well as the data which has been collected by the satellite that is a panchromatic data and the softwares which we are going to use will be mainly QGIS, global mapper and NV.

I know that all the softwares is not freely available, but yes QGIS and global mapper can use it. NV is the software where which needs license, but at least we will try to teach you over the screen that how we are going to utilize the software and these softwares are mainly going we are going to use to prepare or generate different thematic maps and that will help us in a delineating or demarcating different landforms in or on the surface on earth surface. As as I told that we will try to give you an brief idea about that what are this different type of data we are going to use and as I mentioned that land set we are going to use, but that will be little focus on the land set because most of the people do it using land set, but the land set does not have that much of resolution but the Cartosat data which is been acquired from the NRHC Hyderabad and this is been taken by our Indian satellites and corona photographs also we will use, but not as much as because corona photographs are the photographs again they come in pair that is after and forward and even the Cartosat data which comes in pair after and forward taken by different two different cameras at the same flight path that part also we will discuss.

But these are the Cartosat data is having very high resolution and even the corona is also having, but the corona photographs are not geo reference photographs they have been collected way back around 30, 40 years or 50 years back by the US spy satellite, but now it is available they have declassified it and it is available you can purchase that. So, corona photographs usually what we do in our research is we use that those photographs of that the corona data to have the comparison and understanding because down 550 years what changes have been occurred naturally or through anthropogenic activities that also can be understood well if you are comparing with the recent Cartosat data. Cartosat data again comes with the two photographs of the same area that is what after and forward and that is what we call stereo vision capability and this data Cartosat data one thing is very good that they are geo referenced and orthorectified data. Even though we need to do some correction if required because the flight path may not be so simple and straight and horizontal and all that we may have some sort of a distortion. SRTM data is again available in a free domain that is your subtle data topographic machine data and that we use to partially understand the landscape, what are the different elevation change topography and all that we can use, but mostly we use Cartosat data to have a better understanding of the landscape.

As I said that we will be focusing on geo-referencing then mosaicking those because you cannot have a large area covered in a single image you will be getting different images and depending on the flight path and the row along which the data is being acquired. And another thing which I will mention, but I will cover later on also is that any stereographic stereo provision data will have 60 percent or 70 percent of overlap from one photograph to another photograph which has been taken. If you are having the one line of a flight path here, then another one which is going will have an overlap of almost like 50 to 60 percent or 60 to 70 percent. That helps in generating the 3D perspective view of the terrain and that is what we are going to teach you in this course also.

Mosaicking of this data, so that you can view the larger area of interest from this data by stitching or mosaicking them. And then we will also do one exercise that is what we call an anaglyph, generation of anaglyph. So, anaglyph is basically you will need to use the filter glasses which usually we use the cyan and red color, but you can have different colors also. This is just to allow your eye left and right to view the same image, but not viewing. If you have to view this then only the left eye will be viewing one image of and other filters because of that filter other part of the image or the data of the image will not be viewed.

But if you are having at the same time you are viewing two layers, then you will be getting the 3D image and that can be used to generate a DEM digital elevation model. So, this again we will try to teach you in through labs. Then we will use that how the landforms are been mapped and having the understanding that in Himalayas we will be using this and for

the Himalayan terrain and all that what are the tectonic landforms we can identify and also other landforms mostly will be focusing on the fluvial landforms in this. So, you can after generating the anaglyphs and all that one can also use this to generate as I mentioned about that you can generate DEM and or DSM the digital surface model and that can be used in understanding the topography. So, you can extract that data for the topographic profile and all that.

So, basically, we will be viewing the terrain in three dimensions. So, that will be on your desktop. So, earlier we used to use stereo scopes to view the terrain in 3D, but now since we have the digital data available then we can use this on our screen and you can enlarge it up to whatever the resolution you want depending on what resolution output you are putting in actually. Then we will also focus on morphometric analysis because this is another tool which or the analysis we do to understand how the landscape is changing and what are the factors which are controlling or influencing these changes. Then as I mentioned that another component will be the field base and again which will be focusing on the topographic mapping of different landforms.

So, we will be mainly initially. I would say that initially I will give an introductory lecture on different types of landforms which will come across in the fluvial regime. So, that is the landforms which are formed by or carved by rivers. So, that part we will have an understanding. So, that will make our objective easy to understand the landforms when we are viewing the terrain or the area in three dimensions and accordingly you can map. So, basically what we do is that this is the part which we will do in remote sensing.

So, mainly you're this will help in preparing the detailed geomorphic map actually. And field mainly we will be using total station, high end total stations where we will teach you how to use, how to calibrate and how to take the the data point because this will give you resolution in centimeters and you can have x, y, z that is your coordinates that is well as the elevation. And another is the RTK that is real time kinematics. So, you can have two GPS antennas and that one can be used as a base station and another can be used as a rover. So, you keep moving and collecting the points that will help in generating or we can say acquiring very dense points in the area and that helps in generating a very accurate DEM.

So, RTK and total station will be used and this again as I said that you can use other parts also. Now, the one portion was the surface mapping. Another portion also we will try to teach you is using ground penetrating radar and this will be again helpful in understanding the subsurface changes. And this technique is very robust and commonly used for utility mapping in most of the projects. And this the technique of GPR is and I would say that is quite wonderful because it is very useful and if you know this that will really help you because we have an exponential growth in terms of the infrastructure.

So, in India we need a proper understanding of what are the different sediments, subsurfaces and what are the different lithologies. And whether there are any utilities which are mainly in the urban and suburban areas if we are going to have infrastructure development in that region. So, you need to have the surface as well as subsurface information. The unit GPR unit that we are having with us can give you a very good profile or high-resolution profile or the data up to 10 meters. But even if you have that I will talk when I am talking about the GPR, what exactly GPR is and how we are going to use it, where we have used it and so we will give you some examples and we will teach you also.

So, depending on the different antennas one can also go up to 30 meters or more than that also. Then we as I said that we will be teaching you the use of an aerial vehicle that is an unmanned aerial vehicle. So, this will again be a field as well as the remote sensing part and as I said that this can also help you in generating them. So, that part you will be using and this is again as I mentioned is again a very robust technique frequently used for landscape mapping in India and in other countries also. This is a very upcoming field.

So, this is again an important part. We will try our best to put one lecture or the field-oriented lecture on resistivity survey provided our instrument is available, but at least we will try to give you a lecture on this. Practically we can do it provided the instrument is available, but we will try our best to do that. And the last part after having the mapping done of the different landforms, the other part which comes is the dating. So, if somebody is interested in doing a detailed classification of the landforms where exactly they were formed and also with the help of the different categories of the landscape one can interpret how they were formed.

So, that is another part which we are going to emphasize and that is mainly on the optically stimulated illumination dating OSL and that we will again teach you in the lab. Of course, in this course we will give a preliminary lecture on this and then can be followed by the lab-oriented lectures. So, these are few points mainly for the course content related to the course content. Recommended text books if you take, there are many on remote sensing and you can utilize the material which we are giving that will be more than enough. So, now moving to the part the general introduction of remote sensing I will I will try to emphasize little bit, but as I told that I will be bit quicker in this and but because we will be just utilizing the the technique and more emphasis will be given on the how the softwares can be used and all that.

But remote sensing as I mentioned is a technique used to collect the information about any object from a distance without touching it. Normally human eyes and many other animals use this technique either by using their eyes or by sense or of smell or hearing.

This is also part of the remote sensing, because you are sensing something which is there, but usually we try to say that no what we are acquiring in terms of the image is the remote sensing. So, as you see here that even you can what you are doing with your eyes viewing the areas or the viewing the landscape or the people that is again again part of the remote sensing. However, earth scientists and scientists are very disciplined. They use this technique of remote sensing to monitor or to measure phenomena found in earth's lithosphere, biosphere, hydrosphere and hemisphere.

So, as I said that people are using or the scientific community is using this technique to understand what overall changes are taking place at different levels in the earth and its environment. So, remote sensing of the environment is usually done with the help of mechanical devices known as remote sensors. This gadget has an ability to receive and record information about an object without coming in and like without any physical contact. So, these sensors are positioned away from the object of interest and this can be like you can install in aircraft or helicopters you can do and even what you are taking the photographs with your SLR cameras or even the the smartphones that is again what you are we are doing is a remote sensing part. So, one can, but for more accuracy, higher resolution the high end cameras are placed which can also be mounted on satellites which are flying at thousands and thousands of feet high they can also take this main formation and that is what we are having the data of Cartosat.

So, you can have the low lying low low flying planes or helicopters you can use and nowadays as I said that we can use the unmanned aerial vehicle that can also give us very high resolution photographs. So, most of the sensing devices record information about the object by measuring transmission of electromagnetic energy. So, what we usually sense either by the eyes or by the sensors is basically the process of reflecting and radiating surfaces. So, I will just briefly touch upon this about what exactly we are looking at electromagnetic energy. So, I have a few slides on electromagnetic energy and then we will move to the other part of what exactly we are looking at.

Where we will see darker images or where we will see the lighter images, why we see and on what basis we can we are able to judge that this portion is dark or this portion is lighter. Everything is based on the reflecting and the radiating energy. So, mainly the electromagnetic energy which we are looking at is coming from the source of your sun. So, that is the light and we have a very wide range starting from gamma x-ray and it goes up to low frequency waves. But, if you look at the range it is from it says the wavelength is from nanometer to meters.

And we have in between the visible light spectrum if you look at and that that mostly we learn during our schools. That is your near ultraviolet, violet, blue, green, yellow, orange,

red. So, these are mainly in micrometers and most of the remote sensing we will be looking at is from this as well as at some part will be from to the microwave remote sensing. So, further if you move this is again the same spectrum and this also shows the usage. That is where exactly this has been used.

Like for example, this is a broadband here radio radar microwave and all that. So, and this is what we were talking about the visible light spectrum. So, this is one which we all know. But, looking at the energy part and what I have I said that I have tried to briefly touch upon this and this can be a part of the understanding and knowledge you will get here that the earth energy balance because this again we relate to the earth energy balance here. So, whatever the amount of energy coming in, the same amount of energy is transmitted back into the atmosphere and that is what we call the earth's energy balance.

So, earth receives energy from this from the sun and it also reflects as well as radiates energy back into space. And this is what we need to understand what exactly is the balance. So, the earth energy budget describes net flow of energy into earth in the form of incoming short-wave radiation and outgoing infrared long wave radiation. So, incoming is a short wave whereas outgoing is a long wave. And this is what our scientists and the researchers have been utilizing in your remote sensing part also.

So, of course, other than that they use this to understand climate change also. Now, looking again , coming back to this and then moving to the overall what is the range of the wavelength. So, these are all given here. So, I will just move ahead, but one important point is that the gamma rays and X rays as we have we know that this is a high energy and hazardous to health.

Ultra violet rays 10 nanometer to 0.4 micrometer can damage living tissues, visible light from violet, blue, green, yellow to red, near infrared is 0.7 to 1.2. So, these are all ranges which have been given here which you can go through, but we will just move ahead of that that is what I was talking about that incoming radiation from the sun you are having short radiation visible and ultraviolet radiation outgoing is your long wave radiation. So, the part here is that you have like some absorption is there by the earth surface and some is reflected back and this absorption and reflection of it is taking place. This process is also important when we are viewing the images.

Because absorption means you will see if they are dark they are darker they are not able to reflect back. So, just to tell you about the energy balance. So, it has been considered that about 342 watt per meter square is the energy which has been sent from the sun to the earth and out of this, ok I would say that the same amount has been reflected back. So, we will try to continue in the next lecture and discuss more.

So, we will stop here. Thank you so much. Thank you.