Laboratory Practices in Earth Sciences: Landscape Mapping

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Week- 01
Lecture- 02

Welcome back. So, in the last lecture we discussed the energy budget and energy balance between the radiation coming in and going out into the atmosphere. And I emphasize that the solar input or the radiation which has been coming from the sun is about 342 watts and all that. So, again the importance here is I do not just want you to remember all this, but yes this will be for your knowledge. But the important point of this part is that we understand that what is the amount of reflection we are getting from different objects and how it varies from object to object or landform to landform is what we want to emphasize in this lecture in particular. So, just a few more slides on this.

So, the energy budget basically means that what we were talking about is that the energy budget diagram is the next slide which will be coming that shows the energy flow in and away from the earth. So, whatever the energy is coming from the sun is going back into the atmosphere and meaning in the mean way whatever the reflections we are getting from the objects we are able to capture and use for the remote sensing analysis or the remote sensing studies. So, if we are we are we are talking about the radiated energy budget diagram then one can calculate the the amount of energy radiated based on the Stefan Boltzmann law of blackbody radiation and this has been given as P is equal to sigma A T by T raise to 4 watts per meter square where P is the energy radiated and sigma is your Stefan constant or you can say Stefan Boltzmann constant, A is the surface area of the body from which the energy has been radiated back T is the temperature of the body in Kelvin. So, this is also important for the temperature of the body.

So, again this will vary from place to place considering the environment. If it is in a hotter environment the radiated energy will be different and in the cooler environment it will be different. So, these are all factors which are controlling the radiation. For example, reflected energy can be reflected back from clouds and the atmosphere is about like 23 percent. That is 23 percent has been taken into consideration keeping in mind 342 or 340 watts per meter square that is what the incoming energy is. So, almost 77 watt per meter square has been radiated or reflected back I would say from clouds and the atmosphere and from the surface it is around 7 percent from solar energy input to earth we have around 70 percent absorbed by the atmosphere.

So, this is what the energy coming in and getting absorbed is around 23 percent. So, if you just look at it here , you also have the balance. So, energy has been reflected and absorbed is also again 23 oks. So, let us move further. So, just to show you how the earth energy budget and balance has been seen and what are the parameters which have been considered here and which are the areas from which the energy is being reflected or getting absorbed by the earth or by the atmosphere or being reflected back into the atmosphere.

So, if you look at the first part here is that the incoming solar radiation is around 30 342 watts per meter square. So, it is around it coming in that is the incoming radiation or the solar energy and then reflected back is around 79 here and then again this is reflected back by clouds and atmosphere and then this one is reflected back to the atmosphere by the surface earth surface. So, in total it goes up to like 102. So, if you add this 2 then you will get 102 . This is what is finally, getting out of that. And then if you look at here then this is again outgoing through various portions which have been given here.

So, in total if you add these 2 oks then you will get the same. So, that is your 3 239 plus 102 oks. So, then that you get is 1 here then this goes 4 and 3. So, this is the same actually. So, this is exactly what we are talking about: energy balance.

Now, again the energy available for remote sensing and transmission of radiation through the atmosphere. So, very small window which is available and that is known as the atmospheric window and which also includes your visible light spectrum and that that is from 0.4 to 0.7 micrometer and rest areas we can we can say that it is like the scattering is taking place, but the other portion which is not very useful to us is your black body radiation. This is mainly because we will see that maximum radiation has been absorbed and it is not reflected back.

So, we have this window which is known as your atmospheric window and so, this atmospheric window if you take this is the spectral region of least absorption. So, least absorption is taking place when there is mostly what we see here is in other senses that we get good reflection out of the sector. So, we do so, this is the portion of the overall electromagnetic irradiation spectrum that we are getting is the atmospheric window through which. So, this is because the least absorption their capability is having and so, we can use this for the aerial surveys or the flow or for taking the information or collecting the information through remote sensing from space platforms and all that. So, this is another important part which we need to remember.

So, now, for example, if you look at this, what I am showing is the Landsat image or we can say the false color composite. We will come in more detail because when we are talking about what these colors are, what is what are indicating, but quickly if you want to look at the red color what we are having is your vegetation. And whereas, the darker colors what you see here and this one this shows the water bodies and the it is it is it is showing a maximum absorption. So, the one reason could be that they are having things like they are quite deep. So, the energy which has been transmitted to this area is getting absorbed and not reflected back into, but at the same time.

So, here you are having dark here, but here this one is brighter . What is this region? Usually such sort of and brighter reflections are seen in the snow-covered areas. Mainly in the glacial terrain and all that wherever we see immediately we say the white portion is your snow cover. But, but this is not snow this is the area of of salt and crustacean and or we can say the salt pans, I would not say salt pan, but this is this is the area having the salt

and crustacean and this is what we we call the great rann of Kachchh. Then the second part here if you carefully look at this is basically because of the reflections and all that this is the land part. This is what we are getting is that slightly brown and the dark one these are the rocks here, but these are all all again the hard rocks.

Darkers are the hard rocks and these are all alluvium areas. And this is the light grayish color what you see here is mainly the tidal flats and marshy areas. So, and plus what we see here with this line here if you look at there is a demarcation here we will come to that later on, but this is all having a very typical style of landforms here and these are all sand dunes. So, then and the area which I was talking about is thick. It shows good vegetation because reddish color in false color composite shows the indication of the vegetation and source some vegetation also seen over here in this area, but this is in Pakistan. This is in Pakistan and this part is what we call the Palio channel of Indus or tributary of Indus.

So, one thing is very clear that based on the reflections of or the energy which is radiated back to the atmosphere captured by the cameras or the or the the sensors in the satellite one can have an very clear picture of the form of the landform that is the shape what we are having and also based on the the color or the reflections what we are getting some are darker some are brighter. So, this is the part which you should keep in mind and try to incorporate or when you are using the satellite data for interpretations. So, this is the interpretations what we are having here is that this area which you see in the previous one this one here is in a sort of a lake which has been formed and it is not in very shallow slightly deeper and this is the part of what we say the Palio channel of Shatadru river or Nara river a part of the Indus. So, and this image I am sorry I forgot to tell you, but this is from the great run of this is from Kachchh area this is the Kachchh area and this is what we were talking about this is the great rann of Kachchh the white venre or the cover by the salt whitish part. So, this is a ground photograph of the ponding condition of the Nara river.

So, mostly we try to use the satellite data and then the field is a must to check what we are looking at and what is our interpretation. This again another image which shows this is not actually the false color composite, but you can generate false color composite using different band data. So, that can be done. This is again a Landsat data, but a clearer picture here you can see here. But here whatever you are looking at is like the green colors are showing your vegetation thick vegetation.

So, there are various remote sensing platforms for investigation and identification of earth's resources people have been using and many scientific groups have been using this data. And so, again if you look at the sketch here carefully then on the y axis what we are having is the height the elevation or the height at which you can fly and take the information.
So, you can have directly you can have very close like you can yourself you can take the photographs. So, manually and then even one can take the photographs or the information you can generate again by remote sensing by sitting in the hydraulic platform like a rig or crane. And then another is through the balloon you can fly the balloon and then take the photographs and low flying areas again you can use a helicopter.

And then the aircrafts you can use and then what we are looking at the rocket, but then comes into the satellite and all that. So, these are all like very high-altitude sensors or we can say the equipment which have been used to collect the remote sensing data. So, there are ways now. So, depending on that of course, we can we can say that this is not going to give very high-resolution data, but this will of course, if you are talking about the low flying zone then you are going to in using the low flying aircrafts then you are going to get very good information. And as I said that now this is coming up and it is a very robust technique using an unmanned vehicle that is your UAV.

So, now we can have very good data with very high resolution using and it will sort of say that present day data you will be getting using the UAV. So, again this is in short what we have discussed that we are having the solar radiation coming in. And so, some will get absorbed and some will get reflected back and also some will have natural emission. So, natural emission again is what we are looking at. I have an example which I will show you.

So, if there is no direct sunlight coming in, but then also there is radiation I will show what you can use. So, using different sensors you can do the measurements of the energy which has been radiated out. So, you have a laser and all that through an active source. So, from the surface you will have the energy which is radiated back. And this is again what we are talking about: what sort of analysis one can do using different techniques.

Using the space or aerial or terrestrial you can use and you can use the radar and laser here, you can do radiometric mapping and imaging systems, you can take photographs with that. So, how the data is stored. Data is stored either in a form of a tape or that is you are having the negatives, but they are available in form of tapes, continuous camera rolling and you will have the recording which is going on. And then another is the analog that we normally use as a photograph. And then after the ground truth thing if what you are looking at.

So, this is what you are having the data products ok, this we were talking about the data products. And these are the sensors here. So, what different sensors you can use and then the part is that what we are talking about is the interpretation. How you are going to interpret that. So, the ground truth thing is important of course, but interpretation can be done either if you are having the visualize like visuals or the black and white photographs or colored photographs even.

So, that if you are having in the stereo vision with the stereo vision then you can use this what is been shown here is your stereo scope. So, this is your stereo scope. So, stereoscopes can be used to view the terrain in three dimensions. So, this will give you 3D perspective. And another is that you can use this data if it is available in digital platform.

And then that's what I was talking about in the beginning. So, you can have digital data on your screens and you can do mapping. Earlier we used to do mostly the analog like paper print was available as we will be doing for our photographs. So, if you are clicking the photographs on the film and then negatives are washed and printed and then you see the paper prints coming out and photographs are printed. So, that can be used, but now the same data, if it is available on the digital platform, can be used for interpretation and

preparing, I would say, high resolution thematic maps.

Thematic maps may be of different types like you can have the elevation map, you can have the contour maps, you can say or you can have the geological map, geomorphological map and you can have the maps containing information of the residential areas and all that. So, different thematic maps can be prepared and that can be that again will be depending on the user. What exactly we want to extract the information from the satellite because you will have n number of information in the satellite data. So, whether you want to talk about the lithology, what rock types and material is available here, whether you want to talk about the shape of the channel or the river occupying the particular area and all that. So, you can do that depending on the requirement of the user.

So, this has already been discussed, but I will just go ahead with this further. So, we were talking about how all surfaces emit radiation and in particular if that is what I was talking about, those hot objects. The temperature is also important in terms of the energy which is getting radiated. The hot object's radiation in the form of light, cooler objects emit heat radiation. So, that is what the hot object in the best example is the sun we are having.

So, its radiation is in the form of light whereas the cooler objects emit heat radiation. Earth emits exactly as much energy as it absorbs from the sun. That is what we are calling about the energy balance. So, this is what we will see if you are having different types of like I would say the state you have like it is hot object or cooler object then you will see this. So, this is a picture of the hot object radiating usually if you look at this as a thermal image actually. So, if you try to look at this one then it shows that there are some brighter or the we can say reddish part here depending on the scale what color you are taking, but these are the areas of hot. So, the windows of the houses show that the rest area is cooler, but the hot objects radiate more energy than the cool hotter objects that have a shorter wavelength.

So, this is why we are having the hotter objects in the houses. So, this is again the thermal images can also be used. This is a suburban scene of the night from the US. So, black and violet tone lower temperature this is what is showing is the lower temperature here. So, this all shows the lower temperature here, yellow and red are of higher temperature.

So, these are all higher temperatures you are looking at. So, when ground and sky coldest. So, windows of the heated home are warmest. So, you can understand about the type of radiation again using thermal images helps in identifying the hotter and cooler objects in the area. Now, as I was talking about the great rann of kachchh.

So, we see whitish areas and all that. So, this is what usually we say the term which has been used for the reflection of light is albedo. So, albedo is basically the percentage of solar shortwave radiation reflected back into the atmosphere and depends upon the property of the material again. So, albedo for different materials for example, if you take snow and ice it is around 45 to 85 percent. So, whatever the energy is coming in and has not been absorbed it has been 8 to 45 to 85 percent like half and more than half almost like 85 percent has been reflected back from the snow because of its nature of the material and white color. Water albedo is 2 oks that means, if you are having the radiation which is coming in is 100

percent and out of that only 2 percent is going out that is maximum absorption is taken up by the water.

So, the water bodies will usually occur in darker ones as compared to the other portion. An earth and atmosphere system at most 30 percent are reflected back. So, this point you should keep in mind and that will become easier when we are talking about the different landscapes and the landform identification. So, water bodies you will be able to identify easily by looking at the shape of the boundaries as well as the albedo of what we are talking about here. So, there is another point. There are a few more points which are important, like the M atmospheric scattering.

So, mainly when the sun's energy reaches the earth's atmosphere some of it is reflected back, it is reflected back or to space and the rest is absorbed and reradiated by greenhouse gasses. This is one of the slides you should go back and try to look at exactly what we are looking at in the greenhouse and all that. So, the greenhouse effect is a natural process that warms the earth surface. So, the radiation reflected and emitted by the earth passes through the atmosphere . It has to pass through the atmosphere because it comes through the atmosphere also. So, in this process it interacts with the atmosphere.

So, atmosphere such as gasses or the greenhouse gasses and the suspended material such as aerosol, dust particles and all that. Now, here is a very good example which you can think of looking at is that if you are having for example, sometime we say when we are we we were traveling through in in an aircraft you will find that you are not able to see a very clear picture of the ground earth surface and that is because of the the scattering what is taking place and that is because what we say that it is quite hazy it is not clear maybe because of the cloud maybe because of the dust, but it could be because of the aerosols also. So, this scattering will not give you a very clear picture. So, mostly whenever we have to take a very low angle, not low angle, low altitude photography has to be done then we try to identify the spell or the time when we are having less of this sort of scattering is taking place because of the cloudy nature or maybe because of the dust. So, if you are having a clear atmosphere devoid of such aerosols and all that then nowadays in the winter mostly we will see that we will that mostly it is hazy and all that because a lot of aerosols are there in the dust particles that are getting stuck.

So, greenhouse gasses, I have learnt, atmospheric scattering is the result of diffuse multi reflections of electromagnetic radiation by gas molecules and suspended particles in the atmosphere. So, this is what we will see. So, during interaction it gets partly scattered, absorbed and transmitted. The degree of atmospheric interaction depends on the path length and wavelength.

So, this is again important. So, path length is that at what is the coming in and and plus what is the wavelength. So, if this is the surface here then what is the wavelength of and what is the path length from which the source is coming. So, that will depend again on the scattering and what is scattering is taking place here before it reaches the atmosphere. So, we will stop here and continue in the next lecture. So, thank you so much.