Remote Sensing: Principles and Applications

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Lecture No -32
Spectral Properties of Few Common Earth Features in the Visible, NIR and SWIR Bands – Part 6

Hello everyone, welcome to the next lecture in the topic spectral reflectance properties of water body. In the last class we started discussing about the spectral properties of water, how water will transmit energy, how water will absorb energy and all. So, today we will continue with that particular topic.

So, in the last class we analyzed little bit in detail about how vegetation will influence the spectral reflectance property of water. Today, we are going to start with analyzing how suspended sediments will influence the spectral reflectance property of water bodies.

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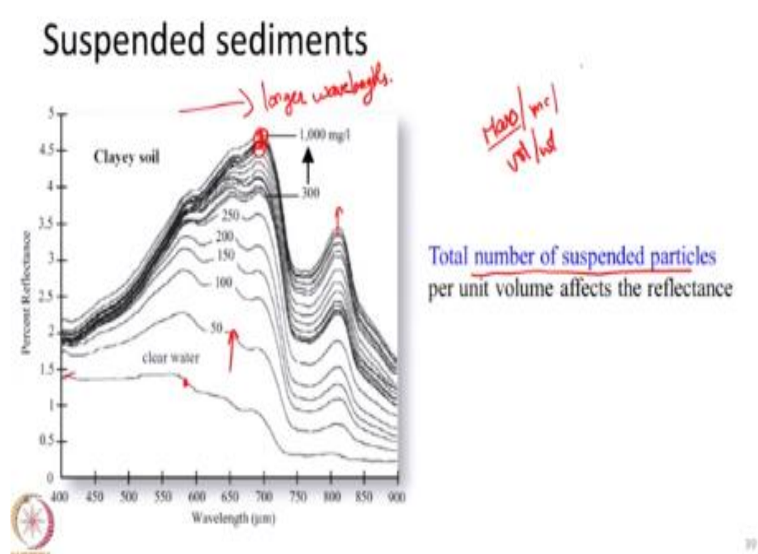

So, what exactly suspended sediments? Suspended sediments are anything that is not dissolved but present within water body. Say, you take a cup of water, put some sand in it and mix it vigorously. So, before settling down to the bottom, the sand will be floating inside the water. It will not dissolve and it will be floating, so such things are called suspended sediments.

So, after a flood, it will carry lot of soil particles and will be depositing it in the nearby water body. So the soil particles will be lingering in the water body in suspended fashion for some time. So, whatever is present in the water body without getting dissolved, we call it as suspended water bodies. So, as the concentration of suspended particles increases, the reflectance will change.

We know that for soil, we studied the reflectance of soil is actually a linearly increasing curve, the reflectance increases with increase in wavelength. Same effect will come even in water body because most of the suspended particles are soil particles. So, when soil particles or the concentration of such soil particles increases, the reflectance will increase in almost all the wavelengths.

Here in this slide you can see for clean water body, the bottom most curve, as the concentration of suspended particles increases, the reflection or the reflectance in all wavelength will basically increase. Even in NIR we will get some high reflectance because of the presence of such soil particles. And one more feature what we can observe is, as the concentration increases, the wavelength at which peak reflectance occurs actually shift towards longer wavelengths. And also another important thing that we should remember is, rather than the mass of suspended sediments per unit mass of water, the unit volume of suspended sediment per unit volume of water is most important. this is the total number of suspended particles is very important.

So, it is not the mass, some suspended sediments may be really dense but the number of particles may be quite low. Whereas for some other things the number of particles in a given mass of suspended sediment may be very high say for example clay and sand. Clay is extremely fine in nature, so for a same weight clay will have large number of particles in comparison to sand.

So, what happens is, the concentration here increases the reflectance rather than the weight, so higher the number of particles present in the water, higher will be the reflectance rather than the weight. So, this important thing we should remember. But in general, any presence of suspended matter in water body will increase the reflectance in almost all the wavelengths.

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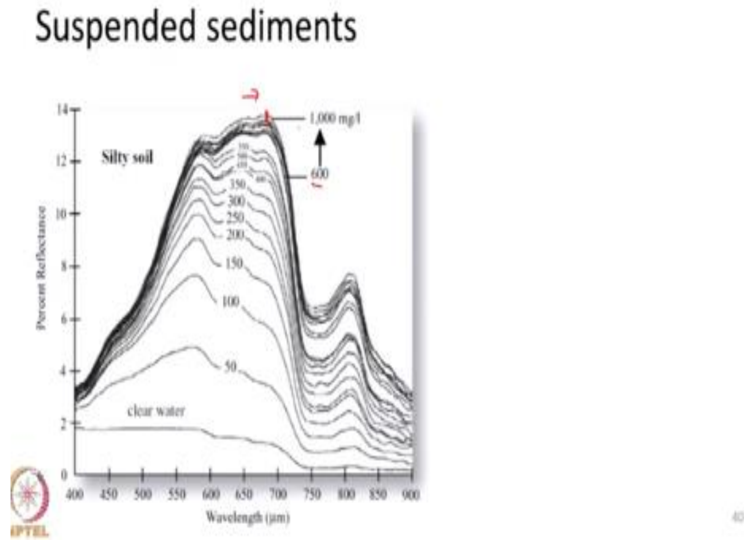

So, here again in this particular slide one more example is given. How the reflectance changes with increasing concentration? You can see the wavelength of peak reflectance shift towards longer wavelength, with increasing concentration. Then the next feature we are going to see is effect of depth of water column. I already told you that, if it is fairly shallow water, then some portion of EMR can interact with what is present on the bottom surface and it can come out of water body and that signal we may see.

So, let us assume, say the water depth is something around less than two to three meters, very shallow water body, then what will happen? Blue and green wavelength can penetrate through and if there is a thick vegetation in the surface of water, may be some algae or something is present on the surface, what will happen?

If green is capable enough of penetrating through it and when it is it will be now reflected by whatever is present there on the bottom, if it is like vegetation then green will be reflected back or if it is like something some coating has been given in water body like in swimming pools they have put some colored tiles that may come up. So all these things will basically come up. So, an example is given in this particular slide.

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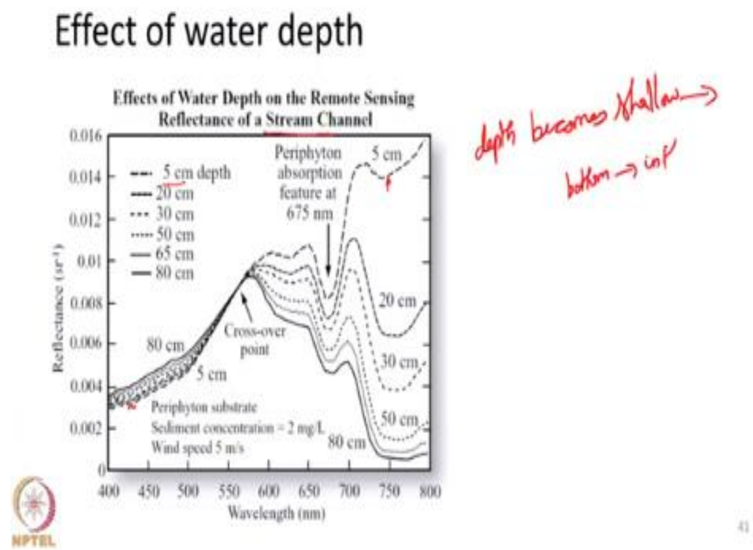

So, here the effect of water depth on a stream channel is given. So, the stream channel basically contains some sort of algae under different depths. If the depth is fairly shallow, then the reflectance from algae primarily came up. So, here you can see the vegetation, in NIR portions you can see very high reflectance. Similarly you can see a strong absorptance in blue region and so on.

So, essentially what happens is, as the depth becomes shallow so the features present in the bottom of the surface will influence the reflectance. But, if the depth increases, blue can penetrate very deep in the order of tens of meters, sometimes red can penetrate slightly shallow, green will have penetration something around say 5 meters.

So, if the penetration or if the depth of water body is more than the penetration depth of EMR, then we will not get any signal from the bottom surface. Everything will be absorbed as EMR penetrates through. But if the depth is say only 2 to 3 meters then all wavelengths will get some signal about the bottom and whatever is being present in the bottom will give its own signal. Let us see the reef example again.

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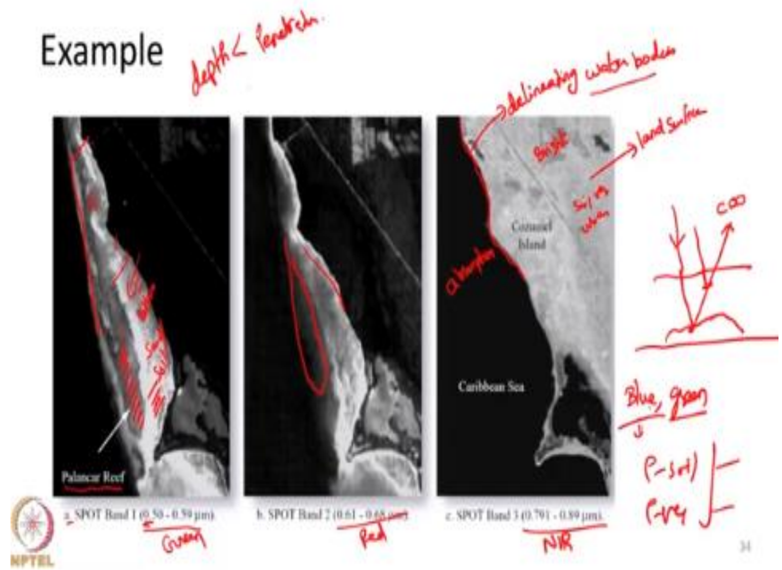

In this particular slide you can see reef may contain some sort of living things or vegetation or some soil is present. So, if you compare the reflectance of soil and reflectance of vegetation in green band, soil will have higher reflectance than vegetation, because vegetation is a good absorber of visible portion that we already know.So, that is why here in green band we are getting slightly lower reflectance.

Here in comparison to this high reflectance indicates there may be sand particles there, whereas here there can be living vegetation there. Similarly in red if you see, vegetation absorbs very high amount of red energy and that is why there is not much of signal here. Only we are getting signal from the soil portion, so vegetation absorbs lot of green. So, here in these portions wherever I am marking now, the depth of water column is actually less than the penetration depth of EMR in that particular wavelength and hence whatever is present there gives their characteristic signal and that will be seen in the remotely sensed images.

The next important concept we are going to see is the nature of radiance coming out from water bodies and the importance of atmospherically correcting it. So, we have seen now that water is primarily a very poor reflector, so it transmits lot of energy and it absorbs good fraction of energy. So, if you want to sense oceans, that being a poor reflector not much of radiance will be coming out of such oceans.

If the ocean is extremely clean, no other surface feature or surface roughness is present, then most of the EMR will be penetrating into it and they will be lost and they will be absorbed after certain time period. So, the radiance or the reflected energy coming out of water body will be fairly low, if you compare the scenario with land surface in most of the bands especially in the visible, NIR bands land surface has relatively higher reflectance than water bodies especially oceans.

So, if you want to send a sensor to space to sense oceans or deep water bodies then essentially they should be trained or they should be manufactured in such a manner they work in lower level of radiances. That is they should be calibrated such that they see all the lower values of radiances. But if you want to study land surfaces then they should be calibrated to sense higher values of radiances. On the other hand to complicate matters more, atmosphere adds a very high amount of path radiance to it. An example is given in this particular slide.

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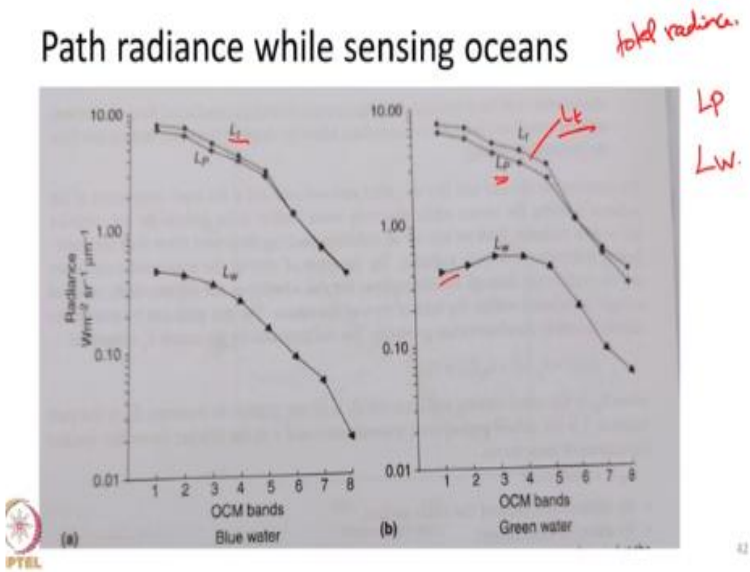

See here if you see this, the line marked as L_t represents the total radiance reaching the sensor. Here people have used some sort of modeling to understand what will be the path radiance Lp and what is the actual radiance that came out of water body. So if you split this, we will understand that the actual radiance from the water is much lower and most fraction of the L_t that reach the sensor is actually path radiance.

So, this tells us that if we want to study about water especially deep oceans, we should do a good amount of atmospheric correction. Because, the signal from ocean is very low and atmosphere adds a very large fraction of energy towards the radiance reaching the sensor. So it is mandatory for us to do proper atmospheric correction, if we want to study about deep ocean water bodies.

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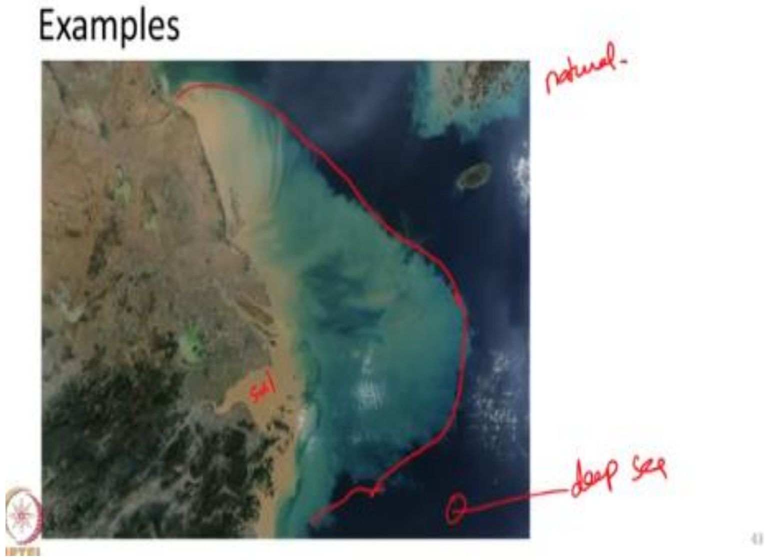

So, now, in this particular topic we will see quickly two examples about how the reflectance of water changes with different, different substances. The first example is we will see about the presence of suspended sediments. So, in this particular slide a natural color image is being given there where this is suspended soil particles.

So as the soil particles is being washed from a river delta, we can see the suspended sediments kind of spreads away and the reflectances drastically changed. We are having increased reflectance and it is appearing brown in color because of color of sand.

On the other hand if you look here, where deep sea is there, we are seeing it purely blue because no contaminant is present there. We are observing it as blue, I already told you the reason for this, blue will be scattered a lot. So, essentially the presence of suspended sediments will change the colour of water bodies.

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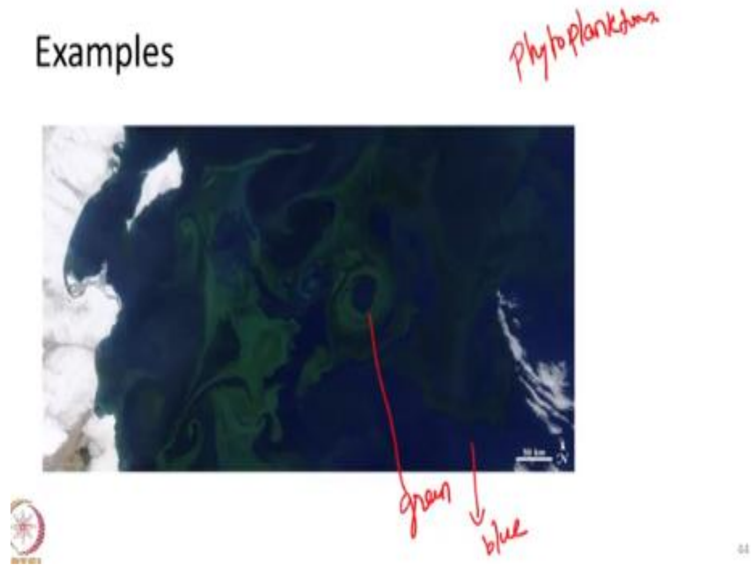

Similarly, presence of phytoplanktons or any presence of vegetation in the water will change its color. It may give a green signal, it is appearing green in colour because of mainly presence of phytoplanktons present in ocean bodies. Whereas clear ocean water bodies appear blue and where large amount of phytoplankton is present, appears green in colour.

So, as a summary for this particular lecture, we have studied in detail about the spectral reflectance properties of water and how different factors influences this. With this we end the topic of spectral reflectance property of water.

Thank you very much.