**Laboratory Practices in Earth Sciences: Landscape Mapping**

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**Week- 03**
**Lecture- 14**

Welcome back. So, today we are going to discuss an important portion of this course, which we will learn and we will try to understand the landforms, fluvial landforms because these are the most common landforms on the earth surface and this will help us in undertaking the mapping part using the remote sensing data. So, fluvial landforms are mainly related to your river erosion and deposition. So, along with this we will also look at the drainage pattern because drainage pattern also helps us in understanding what exists below the surface. Because that is that whatever the material exists below the surface will get reflected or its manifestations will be seen in terms of the drainage if at all the precipitation is available that is your rainfall. So, the most important is wherever we have the water and slope available we will see to the formation of drainage systems.

So, coming to the river system if we look at it then running water is the most important agent of erosion on the continents and the river valleys are the most common landforms. Rivers flowing to the ocean drain about 68 percent of the earth's land surface and the remainder of the area is either covered by ice or drained to closed basins. And as I said that this is one of the most common landforms and the river systems are responsible for sculpting the landscape, eroding and depositing the material. So, if you take an example of how the drainage basin develops.

So, here the example or illustration has been shown that if you have a slope in the area and you have the precipitation then you tend to see the formation of drainage basin and drainage basin usually what you see is that they will develop towards the headward. So, they will keep developing, extending towards the headward as it has been shown here. So, the slope is the same , the rainfall is constant here and then the slope. So, you will keep adding slowly as the time goes the drainage basin will evolve. So, this is the time which has been given in an experimental setup.

So, when it started after 2 hours small drainages were formed that are your tributaries. So, if I put that in. So, small streams will start connecting and then it is like I am showing like this, but it keeps on extending like this. So, it will extend further up and then it will develop a basin. So, once it forms , the channel erodes headward and lengthens.

So, the length will keep on increasing. So, if you see here then further and slowly you are

having the tributaries which are joined from the sideways. So, this is what we call the channel network formed by bifurcation of the headward eroding channels. So, there are small channels which will keep bifurcating. So, bifurcation is like for example, if you have one channel it will bifurcate another. Here there is further bifurcation and so on.

And similarly, it will go this way also. So, the drainage usually is seen that they have been formed by headward erosion. And another important part of the drainage basin is your drainage divide. So, this is what we have the ridge line here and then there is a slope in this direction on this side and then there is a slope on this side. So, streams are flowing that are what we call tributaries.

So, they are flowing to one of the major trunk streams. And even this trunk streams so, for this side of the drainage this one will be the trunk stream and finally, it merges and goes to the major channel. So, this one will become the main trunk stream of this one and what we will also talk about is the order of the channels. So, one thing that is important is that we were talking about the divide. We can say that this is what has been shown here. So, this is what we call the drainage divide.

So, you have multiple drainage divides which will be seen along the terrain. So, water through surface runoff and tributary feet into a river forms the part of the drainage basin and is separated by a divide known as what we call the drainage divide. So, these are the drainage divides. So, changes what we observe downstream. So, when you analyze the satellite photos of a given area, then you will also see that the drainage does not remain the same throughout.

It changes as you move from the source area to the area where it is debauching. So, the valley width also changes and the pattern also changes. So, in this lecture we are going to look at the drainage pattern and the channel pattern. So, these two points you should keep in mind one is your drainage pattern and another one is the channel pattern. These two points you should keep in mind are two different things, but part of the same drainage basin or you can say the fluvial system.

So, this is the drainage divide. So, this is the drainage divide. So, what we see is that in the upstream channel depths are shallow though steep slopes. So, it will have a steep slope, but the channel depths will be shallow and the discharge is low. The stream beds cause much more resistance to flow the shallow channel.

So, there is also what we call the channel flow roughness and all that it will be more in the shallow channels in the upstream. Discharge increases downstream. So, here what we are having there is a discharge is low in the upstream, but in the downstream the discharge

increases. Discharge increases as the reason is that you are having a large amount of water which has been introduced from the tributaries. So, as we have seen, this is the main channel here.

So, downstream you will have more tributaries which are feeding water to the main channel. Not only that, but the bed load will also increase. So, it will have more material coming into the main channel. To accommodate the greater volume of water velocity increases together with the cross-sectional area. Cross sectional area basically we are talking about this area.

So, if you compare the cross-sectional area in the upstream this is your upstream and the medial part and the downstream you will be able to judge that this is more or less a v shape valley slightly broad, but it is quite broad here in the downstream direction or in the downstream part. So, this also is important and the illustration which has been shown here helps you in understanding what we have discussed over here. Because that shows the discharge part here and depth also. So, at different locations, that is your A, B and C, what you are able to see in terms of the width, in terms of the depth, in terms of the velocity, in terms of the gradient. So, in a nutshell what we see is that the channel pattern varies from upstream to downstream velocity varies from upstream to downstream carrying capacity varies from upstream to downstream.

So, based on this also one can identify which portion of the area you are looking at in the fluvial regime. Now, another associated process which usually we come across with the fluvial system is your flooding. And this is most commonly observed or experienced in every monsoon and many locations are getting flooded because of the excess water coming into the channels. So, we will try to look at a few examples of that also. So, flooding occurs when the amount of water entering a stream either from rising groundwater or precipitation surface runoff causes the level of the stream to surplus the capacity of the channel.

And this is where we should take care of the cross-sectional area. So, if the water is flowing within the channel then it is fine, but if it flows on top of or above the cross-sectional area then we say that this stream is in the flooding state. So, flood usually is a natural process, but there is a question again which one can put in whether it is a natural process or natural hazard or it is a manmade one. Anyway, we will just look at this. So, natural streams cause disaster only when humans place themselves in its way and that is what we call a harmful location.

And this has been connected to the areas which we are occupying in metro cities. So, we are blocking the drainage, we are occupying the areas and finally, getting into the constructions of concrete jungles. So, we are also hampering the original or natural fluvial

system. So, this has been termed as a disaster when we humans place ourselves on its way. And modern civilization continues or continues to build near rivers and this is not only modern.

If you go to the history or even you look at the ancient cultural settlements which are clearly indicative that they were flourishing or they flourished along the major river system. And this is what is happening today also and the reason is that you get the farmland, fertile land is available and of course, that the modernization or urbanization of any region will also provide jobs. So, more settlements are seen near river banks. Modern residences built on the flood plain often chose a site near the river on a flat area; this is one that in the flat areas are also termed as terraces. We will come to what are terraces and we will discuss that or on an inactive floodplain.

The flood plains which have flood plains are the part of the river channels, but if they are abundant flood plains then we also term that as a terrace if they are located at the elevation. They also try to build a modern residence on the outside bend of the meander. So, what is the meander we will come to. We discuss in the coming slide what are terraces, but the main part is that we usually like to go for the construction on the flat areas. So, the houses stand well above the river channel to provide greater views. So, usually we try to look at the areas which are elevated for example, if you are having a river here and then you are having an elevated area over here then you will try to build your house on this flat area.

And mostly if you go to the hill stations also you will find that most of the hotels or the resorts are sitting at the top and then you will find the river view resort and all that named as. So, even if you are living in residential areas we try to build on the flat areas close to the river bank because of this we will get a greater view of that. So, this is a common desire everybody has. Unfortunately, in doing so, in case of meander they locate in the area of greatest bank erosion during a flat. Now, why this meandering channel?

So, this is one of the channel patterns that are dangerous during the flooding event because they will tend to experience bank erosion mainly. So, that part also we will learn and why it is so, that also we will talk. Now, if we make artificial changes in a channel the river tries to adjust. So, the river will always try to bring itself in equilibrium. So, and that is what we call the if you take the this is the elevation here and this is the distance and if I plot a short of a river profile then it will be something like this.

So, whenever there is a change in this river profile, this is what we call either you can say river profile or you can say the longitudinal profile. So, whenever there is any change either it is natural that is due to natural processes or manmade. The river will always try to adjust and get into an equilibrium. So, this is natural to equilibrium. So, this is one important part

which one should keep in mind.

So, again we will just read out that if we make artificial changes in a channel the river tries to adjust and this adjustment is here coming back to the equilibrium to minimize those changes. Today we understand how river change in response to human impact has increased the flood risk. So, in this part we are not just trying to tell you about that how to map the fluvial landscape, but along with that what is the risk which is posed by the river system in a condition where we put ourselves in front of that system or we are coming on the way of the drainage system or fluvial channels. So, increasing urbanization is the main cause. In not only in India, but in many parts of the world promotes increasing number of flash floods and higher flood levels and these are facts that we usually if you whosoever is staying in the metro cities and all that you will try to learn or you might have seen that many areas which were drained by previous river system are being choked and they have been occupied for construction.

Now, this is one of the most common hazards that can be predicted and they are seasonal as I told you that every season every monsoon we face the problem. Now, can be predictable again we are not going to talk about this, but I can put few sentences here that prediction will be like I would say that it will have a value if you have the other constant parameters like the precipitation that is your rain is constant the area in which the drainage is flowing or flowing through is not modified. Then we can say that this prediction will work, but mostly what we see is that the area has been modified or occupied by human settlements. So, in this case you will not be able to have the proper prediction. The example is right here. It is the case of 2012.

In Uttarkashi the constructions were done very close to the channel and during this peak flood most of the houses which are sitting along this bank collapsed or were destroyed by the river's high velocity of the river water and even you can see the bridge was blown off in this event. Another example of the cloudburst was an unfortunate event, but the question was whether similar events occurred in the past or not. The answer is yes because if one can look at the deposits one can identify that there are the similar events where there in the past also, but this was bit unfortunate that we without having proper understanding the constructions where been allowed in this area that resulted into the disaster. This was in 2013 this was the situation then flooding in Uttarkashi in 2013 again during the same period many houses were built. So, this is what we were talking about: that many houses will get affected if they are close to the banks and the construction is usually seen on a flat area.

So, these are flat areas which we are talking about. This is one here and this goes above here and then the third one is here. This is the top one. So, the erosion along this line there is tree and the river is flowing in this direction. So, erosion of the banks will lead to the

collapse of houses. These two houses if you see carefully they are hanging in the air and that was because of the undercutting of banks. So, this is typical of the meandering system we will come to in the next few slides.

There is another view of the same area where you can see the houses close to the bank that collapsed even though this one is hanging in the air. This is again related to the flu well hazards. So, thank you so much we will continue with the further discussion in the next lecture. Thank you.