Geomorphic Processes: Landforms and Landscapes
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Lecture - 17
Fluvial Processes and Related Landforms (Part III)

Welcome back, so in last lecture we discussed about different type of channel pattern starting from straight meander and we will see now a braided system also and another one more is the anastomosing system. So we discussed in briefly about the landforms, which are associated with the meandering river. So on the outer side it will erode and in the inner side it will deposit.

So erosion and deposition process will lead to the formation of different landforms and the deposition which is taking place in the inner side, the landform, which has been created is termed as point bar. So in most of the locations if such erosion and the position is taking place in like mostly in the plane areas where the meanders are having the tendency to move from one place to another place within the active floodplain.

So within the floodplain it will leave behind some features or the landforms which are termed as the cut-off banks and this cut-off banks will be the area where the back swamp will form in future.

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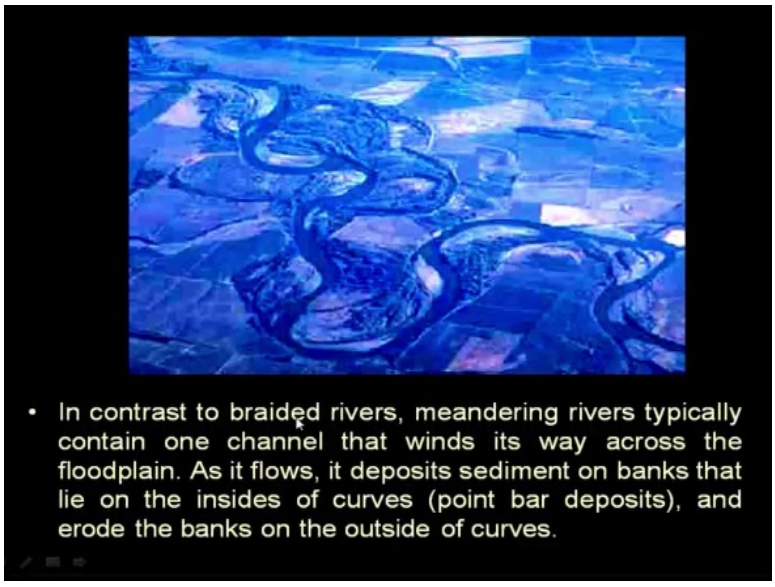

So the photo which you see on the screen is showing the older scars or the channels of the paleo channels of the, so paleo means ancient channel or the channel which along which the river flowed during past. So this is the old channel along which the river used to flow, but now it is flowing over here and many locations you see that they are cut off banks. So this is one most important landform which you come across in the plane areas.

And in terms of India if you take then we see this type of channel pattern or the meanders mainly in the Indo-Gangetic plain.

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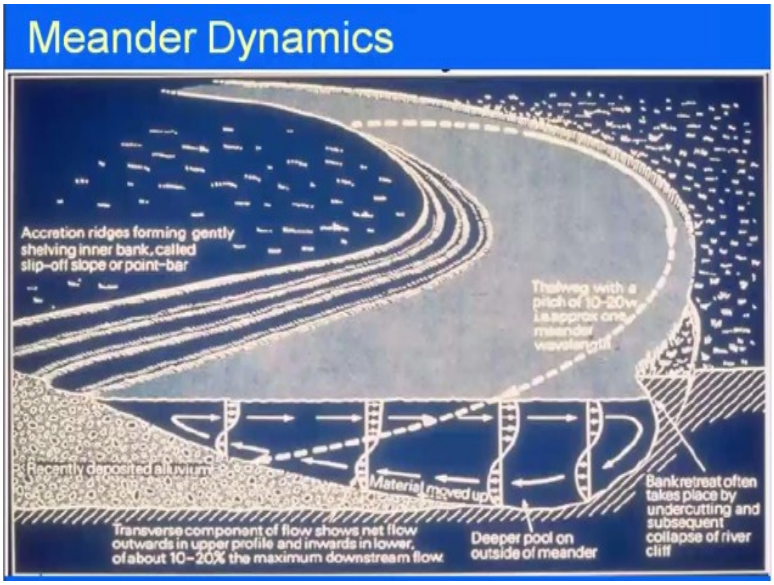

So meandering river if you take the as we were talking about some of the cross sections if you take that is across the river channel then the deepest part will be over here and this steepest part will be towards the outer side where the erosion is taking place and the velocity also will be higher on this side whereas the deposition is taking place here and will result into the occasion of the sediments and formation of the point bar.

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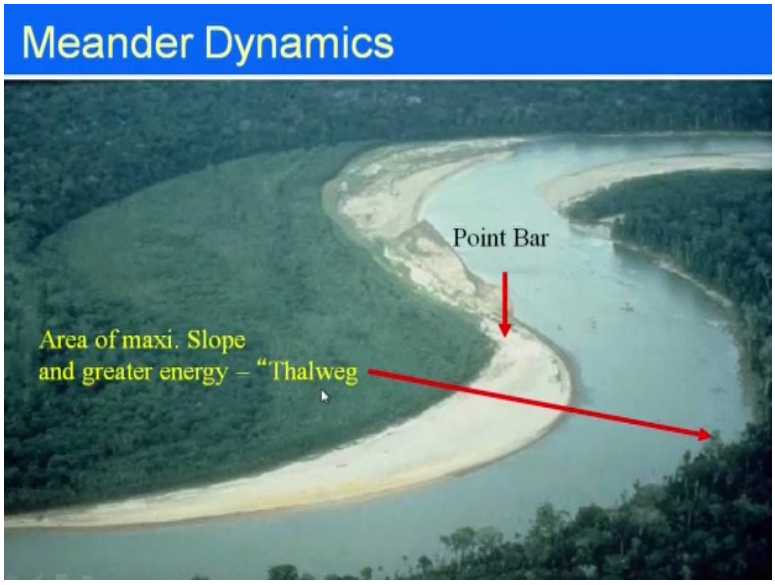

So another photograph which shows the older bank were here and they present a bank over here and this portion has been cut by the present meandering and the deposition is taking place and the inner side and resulting into the formation of the point bar. So this portion will be having the deeper part as well as the velocity will be higher as compared to this point across the channel.

So these are termed as point bars and the area of maximum slope and greater energy is termed as Thalweg.

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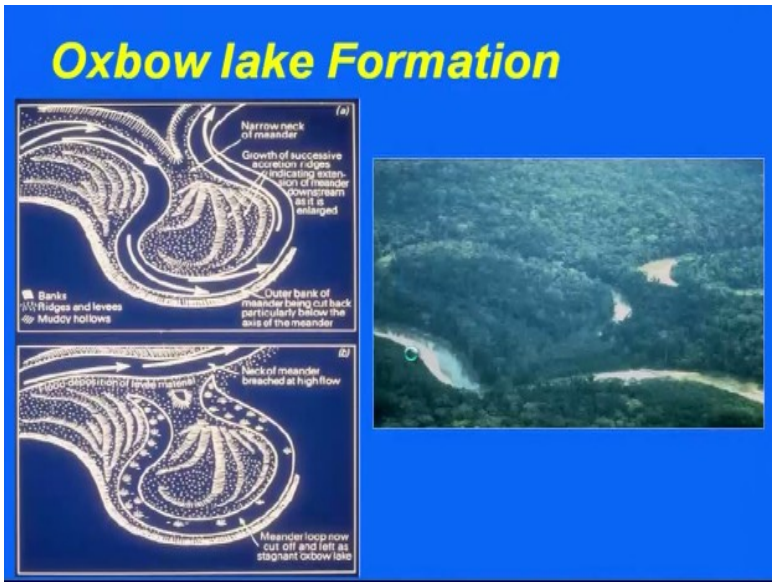

Now the formation of cut-off channel or we can say the Oxbow lake mainly can be explained by the erosion activity which is going on the convex side of the channel. So this channel if you look at the arrow which flows which shows that the channel is flowing in this direction

like that and then this 2 portions of the outer side over here under the erosion regime. So the erosion is taking place and as I told that the erosion will take place on the outer side.

And the deposition will be in the inner side and this will keep on grading or migrating from one place as it moves. So the time will come when this channel which is eroding in this direction and this is also moving in this direction will keep on coming closer to one another and finally, it will meet to form a straight channel and this will be left out. So this is an oxbow lake which has been termed as because of the shape of like an oxbow.

So it has been termed as an oxbow lake which also is called as cut-off channel and this area will be the area for fuel formation of or the development of the back swamp in future.

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So here you can see the location or the similar feature of the oxbow lake and the straight channel. Now the next one will be this one. This will keep on moving in this direction eroding and then this portion will come closer and next oxbow lake or the cut off channel will be this one.

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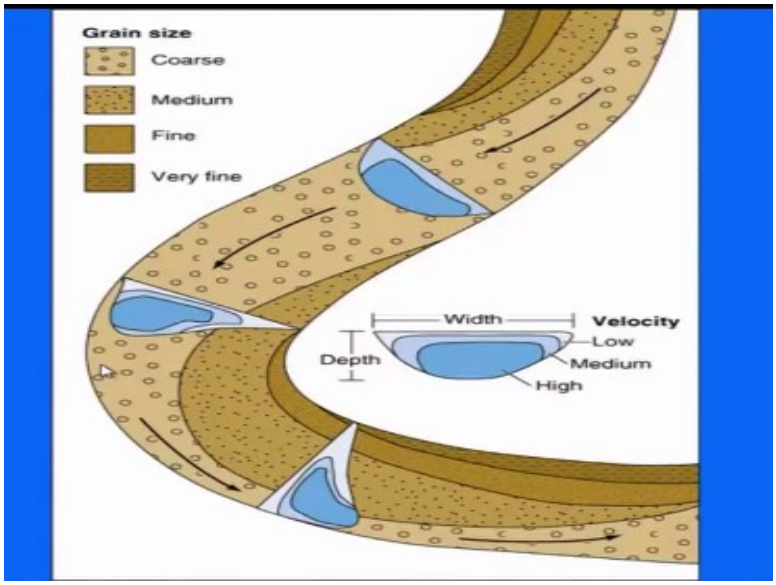

So again throughout the channel what you will see is the different size of material or the grain size will vary from place to place, so the point bars mostly you will find is sitting in the finer domain. So finer sediments will be seen or the point bars will comprise the farmer for finest elements to make the medium sediments and this portion which is having the higher velocities will have coarser deposits.

So bed load mainly will be seen in the portion on the outer side that is the portion, which is eroding and the deposition side mostly you will see the finer deposits.

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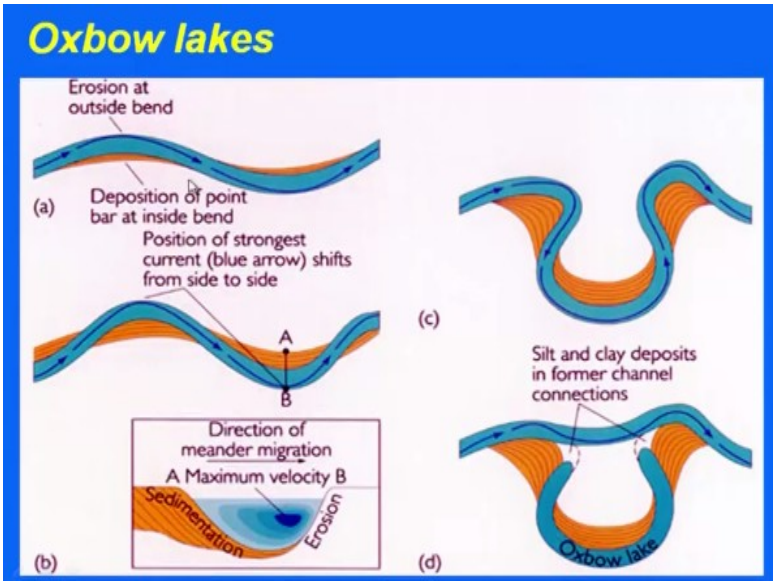

So the formation of the oxbow lake, so the outer side the outside band is the ocean and the inside band is the pollution and this keep on increasing the sinuosity. So this will migrate this side as well as this will keep on migrating this side and becoming tight meander and finally,

what you see is the cut off channel. So you can in one of the photograph I was showing this type of lines, which shows the migration of the channel that is moving.

The channel is moving from this place to this place and the accretion of the sediments is taking place, which has resulted into the formation of point bars.

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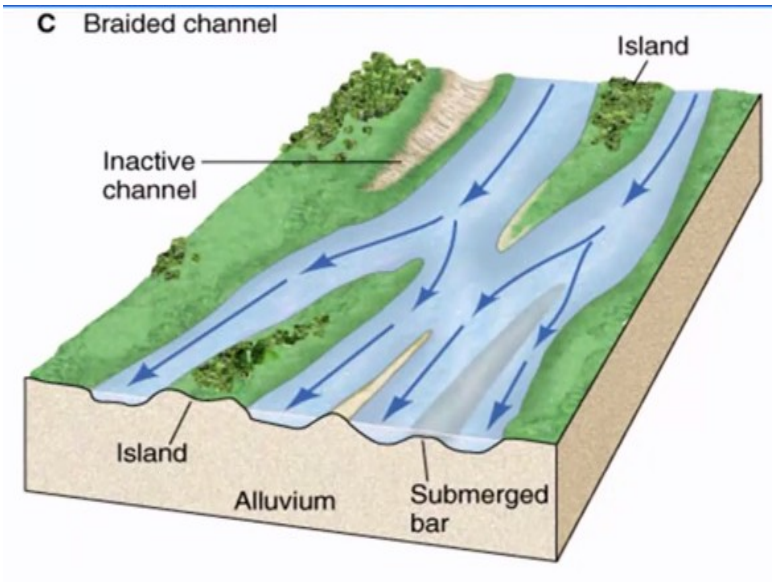

Now coming to the last pattern, which we discussed is the braided channel. So in braided channel what we see is the multiple channels or the more than one channel which bifurcate and joints or rejoin and result in to the formation of and smaller islands or the braid bars in between the 2 channels. So multiple channels rejoin and flow. So we braided system mainly you will find the multiple channels.

And the portions which are in between the 2 channels are also termed as an island because this becomes an island covered by water from all side and are also termed as the braid bars.

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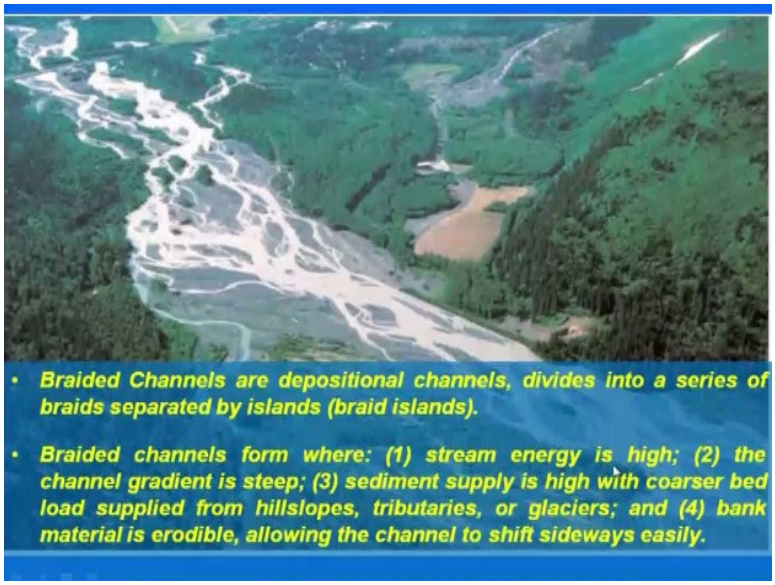

So this is an example of the braid bar, so if you look at the slightly greater detail of this, that relay in relation with the slope and the sediment it carries. Then it says that the braided channels are depositional channels divided into a series of braid separated by islands. So you have multiple islands in between as you can see here and you have the divided channels and then braided channels form where the condition is the stream energy is high.

So this is important, the channel gradient is steep, so you have steeper gradient, energy condition is higher, sediment supply is high with coarser bed load supplied from hillslope, tributaries or glaciers and fourth is bank material is erodible, allowing the channel to shift sideways easily. So these are the conditions where the energy is high, gradient is steeper, sediment supply is high and the area or the floodplain we cannot exactly the floodplain.

But the active channel area allows the channel to shift sideways easily. So these are the conditions where you will find the formation of the braided channel. So there are difference between the straight channel, braided channel and the meandering channel and the landforms also what you see you will find that the landforms varies along with the different channel.

And the regions where I am talking about the regions in the sense, the slope where you will find the braided channels are mostly seen along the steeper slope whereas the meandering channels are being seen or are formed in the area where the slope is less. So this is an example again of the braided channel.

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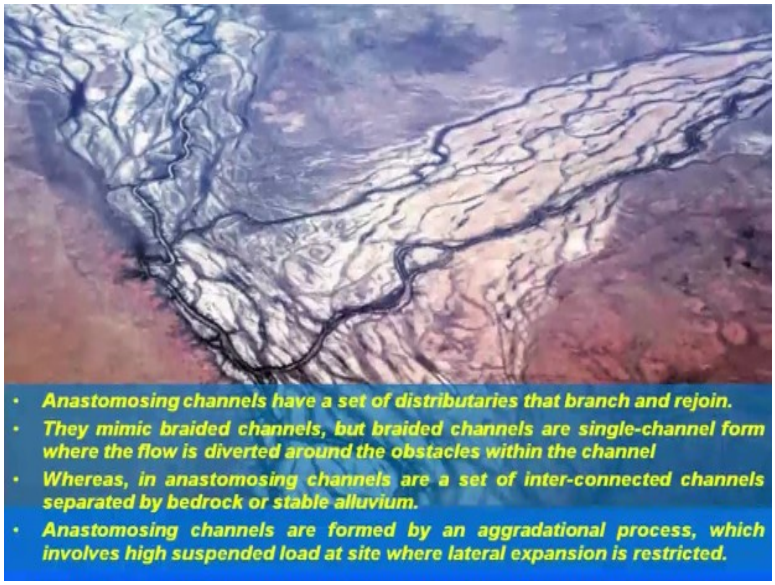

Now similar to braided channel, but this is something where you have more channels, which are winding up or joining with each other and this are termed as anastomosing channels. So anastomosing channels have a set of distributaries that branches and rejoin. They mimic braided channel, but braided channels are single channel form where the flow is diverted around the obstacle within the channel.

Then this obstacle are your islands or the island bars. Whereas in anastomosing channels a set of interconnected channel separates by bedrock or stable alluvium. So anastomosing channels are formed by an aggradation process. So mainly the deposition process, you see aggradation means the deposition process, which involves high suspended load at site where lateral expansion is restricted.

So these are the main difference between the anastomosing channel and the braided channel, so please remember this. So now we have seen in total, one is straight.

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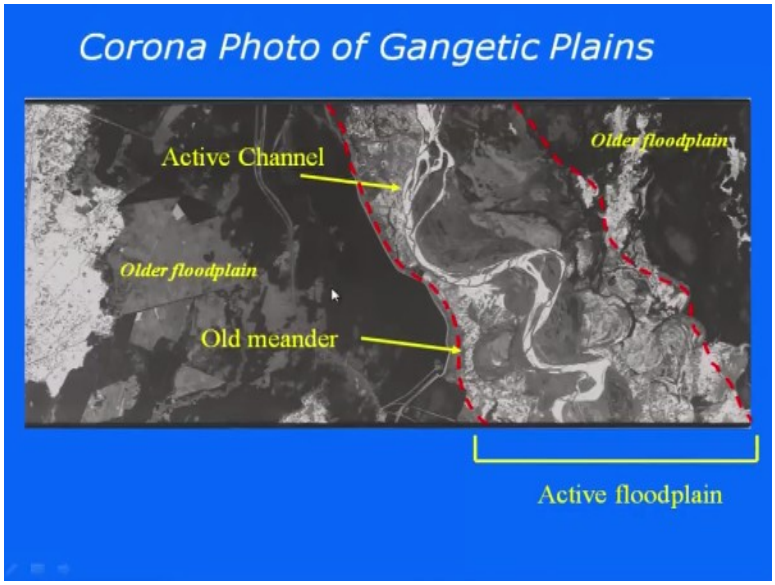

Then we have the braided channel, we have meandering channel, we have seen about the anastomosing channel. Now I will show one photograph, satellite photograph of Gangetic plain where this is on Corona satellite photo panchromatic photograph, which basically is showing the tonal variation and based on the tonal variation and the shape of the features which you see on this photograph is the reflection of the ground.

What we see and based on the shape you can identify the landforms. So now what if you see here the best and first you can easily pick up because we are talking about the rivers or the fluvial system, so you can pick up here that there is a channel here which is not so tightly meandering, but slowly as you move down then you have the tight meanders and we have the older scars here which are the cut off channels.

And best cut off channel has been seen here and the old scar of the riverbanks where the paleo riverbank of the channel and this portion is your huge point bar which indicates not the channel used to flow here and now it has moved to this position. So similarly, as we have discussed in future this portion will be left out as in cut-off channel and this 2 point will join. So what you see further is in this area is that you have the older scars which are sitting.

And limited between this point and this point here, so we have the active channel, then we have the old channels or the old meander which has been seen here and this marking which has been marked by the red dash line is the location of the active floodplain. So river has tendency to migrate or move or shift within this zone that is your active floodplain and this area should not be occupied even though for the residential or any construction purposes.

Because the channel will definitely move within this zone of active floodplain if it is in flooding state. So whenever there is an flood and excess water in this channel, the channel tend to shift or move from one place to another place and leave behind the landforms which are one of the landform which has been seen here is the cut-off channel. So this portion is the older floodplain which is surely at little bit higher ground as compared to this one.

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And then we have the active floodplain. So these are the ways to identify using high resolution satellite data the landforms associated with the channels and the boundaries of the older floodplains and the newer floodplains. This again is the similar type of aerial photograph, which shows the location of the channel and then the active floodplain. So this greenish part which has been seen as a portion of the active floodplain and you have the meander scars.

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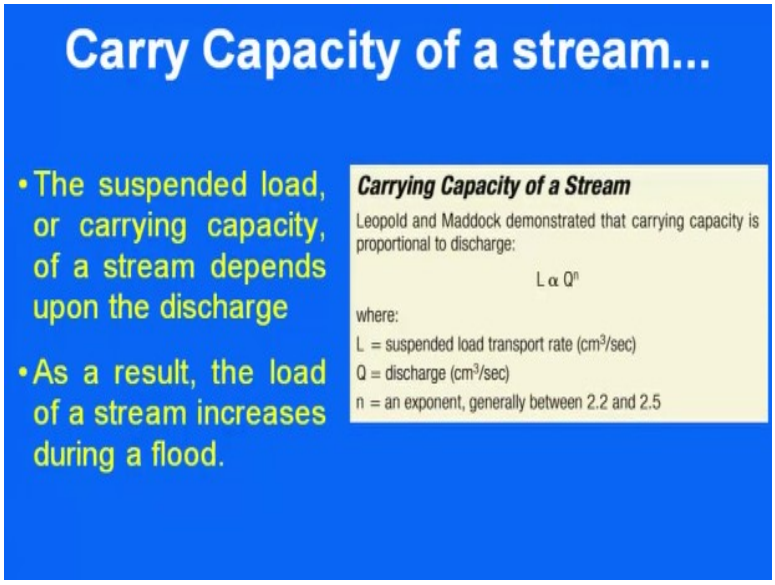

So if we try to understand the carrying capacity of a stream then mainly the carrying capacity is dependent on the discharge. So as well as the carrying capacity, the erosion and everything will depend on discharge and the channel where it is flowing in which region, either it is a rocky area or it is an plain area, alluvial area where the alluvial area mainly the area where which is comprised of mostly the loose sediments.

So the hard rock terrain or it is within the alluvial plain like Indo-Gangetic plain then the energy conditions which are required to erode is different, but as a thumb rule as it has been given here what it says the suspended load or carrying capacity of the stream depends upon the discharge. As a result, the load of a stream increases during a flood. So during floods the carrying capacity will increase.

So whatever the landforms we are going to see more as well as what we have learnt until now, the most important aspect of knowing and understanding this land form is also related to the hazard, which is associated with it and as you must have watched on television that during this monsoon also most of the portion or the parts of India were affected by floods. Reasons are very clear.

Of course it was heavy precipitation and inadequate drainage. So the drainage to siphon out the pouring rain water was not adequate enough. We can say the runoff was very fast and the infiltration was very slow. Anyways coming back to this part so what we have here is the carrying capacity of the stream. So we have Q as an discharge, cubic centimetre per second and n is an exponent generally between which ranges between 2.2-2.5.

L is the suspended load, which is again cubic centimetre per second that is the suspended load transport rate. So the carrying capacity or you can see the suspended load transport rate is proportional to discharge. So this is an equation which has been demonstrated by Leopold and Maddock.

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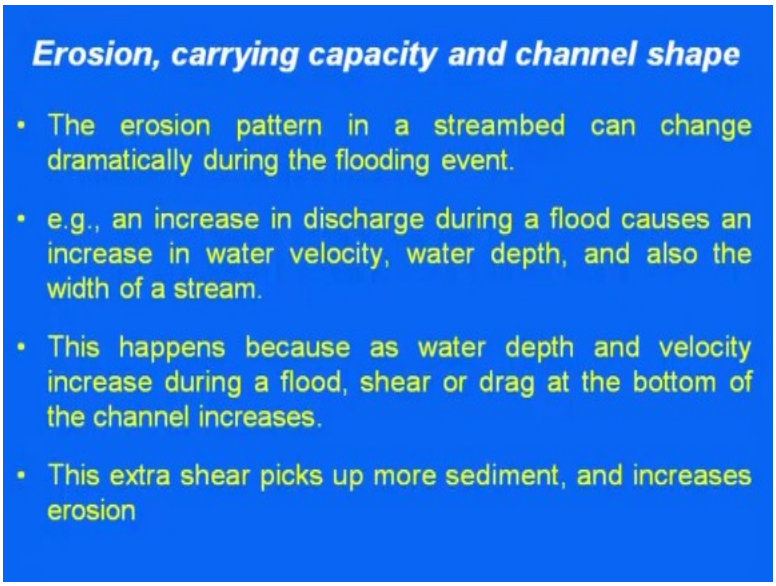

So erosion carrying capacity and channel shape. The channel shape will change during flooding conditions. So one has to be extremely careful in understanding the dynamic of the river that during the normal condition, the channel depth or the shape will be different of course it will not change much as compared to what we will see from meander to braided something like that it will not change.

But of course as we were discussing that if you are having the higher carrying capacity the erosion will also increase and may lead to the straight channel from the meandering channel. So the erosion pattern in a stream bed can change dramatically during the flooding event. Example, an increase in discharge during a flood causes an increase in water velocity, water depth and also the width of the stream or the width of the channel.

So if your discharge increases that means you have more water, so velocity is higher, water depth will increase and the width of the channel will also be, so you experience widening of channel and this also we can say that the erosion will be higher. This happens because as water depth and velocity increases during a flood shear or drag at the bottom of the channel increases and this shear and drag will result into erosion.

So this extra shear picks up more sediments and increases erosion. So you have to keep this in mind that a few increase they discharge the carrying capacity will increase and when we say the carrying capacity means we are talking about more supply of sediment and more supply of sediment can be yield because of erosion and when we say the carrying capacity increase is experienced then we have more water.

So more water that means the channel or the river is having excess water. So if you are having excess water that means you are in flooding state. So these are all interconnected. So there will be erosion carrying capacity and channel shaped relationship. So quickly if you look at this, so increase in discharge during flood, so higher precipitation, increase in water velocity, water depth and width of the stream, drag will increase during the flooding state and this drag will pick up more sediments and will result into erosion. So we will stop here and continue in the next lecture. Thank you so much.