Geomorphic Processes: Landforms and Landscapes

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Lecture - 16
Fluvial Processes and Related Landforms (Part II)

Welcome back. So yesterday we started a new topic and mostly we discussed about the grain size and the velocity of the channel and the velocity required to erode the sediment and transport the sediments and deposit the sediment and we also discussed briefly about the hydrological cycle and I would say that please also refer in the beginning we discussed for the hydrological cycle.

But mainly the hydrological cycle is important because the most important parameter or we can say the portion which we require for erosion or eroding the land surface or carving the landforms is your precipitation and the slope. So we also discussed about the manning equation, we also discussed about that different size of sediments clay to boulder or clay to gravel.

The clay require much more energy or the velocity to be eroded as compared to the coarser particle. We also discussed that the energy which is required or the velocity which is required to lift the sediment is different as compared to transporting the material. Now today we will start talking about the landforms mainly and that is the geomorphology of the fluvial landscape.

We also discussed that at the point of emergence that is the source or close to the source the river which flows in the uplands will usually flow slower, but it appears that it is flowing very fast and it will have the coarser deposits. So the gradient will be steeper, will have coarser deposits or the sediments to carry and as it moves towards the downward side that is basically in the lower reaches then you will have finer deposits or the finer sediments to carry.

And the velocity increases. So these are a few things we also discussed about the Holmstrom diagram, manning equation and the equation for discharge and all that. Now these are all very basic and important portions which one should know when we are talking about the fluvial

landforms. So with this let us see quickly what are the fluvial landforms and why it is so important for us to study and know it.

As I told at the end we will talk about the hazard also associated with those landforms. So coming to the stream slope and grain size if you look at this figure.

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It shows the part which we were talking about. So the grain size decreases downstream as slope decreases in the stream channel. So close to the source the grain size in the upper edges is coarser and the gradient is higher as you move further towards the mount then the grain size decreases as well as the slope decreases. Now figure A is this one, it shows that the flow is very turbulent.

But actually the movement of the water is slow as we were talking in one of the slide in the previous lecture. So the turbulent high energy river has been shown here, whereas in the downstream it is very calm. It has low gradient and it carries the finer, whereas this carries the course of material.

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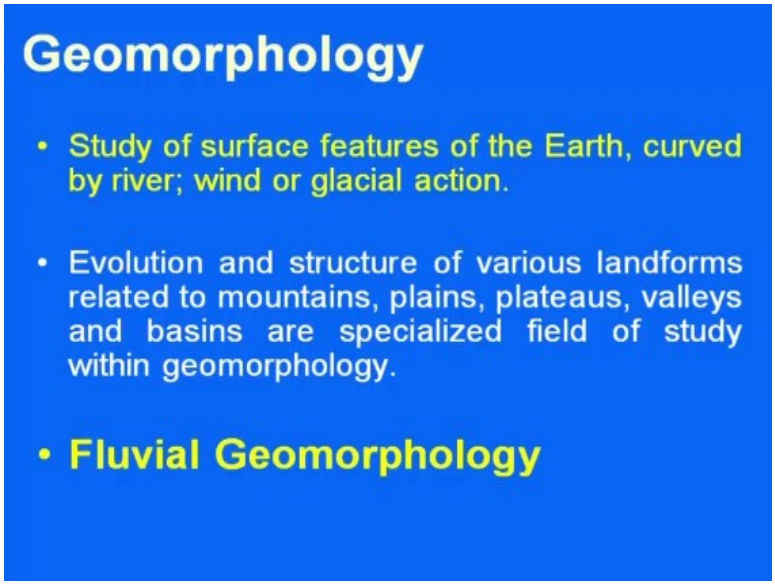

So geomorphology basically is the study of features or the surface morphology of the earth carved by 3 major agents. One is river or you can say water, wind or glacial, that is ice. So because of the action of river, wind and glacial most of the landscape of the earth or the features on the earths are carved or sculptured by this 3 agents. Evolution and structures of various landforms related to mountain, plains, plateau, valley and basins are specialised field of geomorphology or within geomorphology.

So right from the beginning what we have been talking about is plate tectonics and then we also discuss about the formation the landforms or the landscape which has an towering height of 8,800 meters and the deepest point that is your trench 11,035 meters. So these are all make structures or the mega landforms on the Earth's surface and now we are narrowing down to the smaller structures.

For example, we are going to talk about the fluvial landscape, but in total the mountains, the plains, the plateaus and valleys all these features are the forms of the or the morphology are reflecting the morphology of the Earth’s surface forms the part of geomorphology and the fluvial geomorphology is the term which is been given to the landforms or the study of the landforms which are formed or developed by river action. So fluvial geomorphology let us see what we have under this topic.

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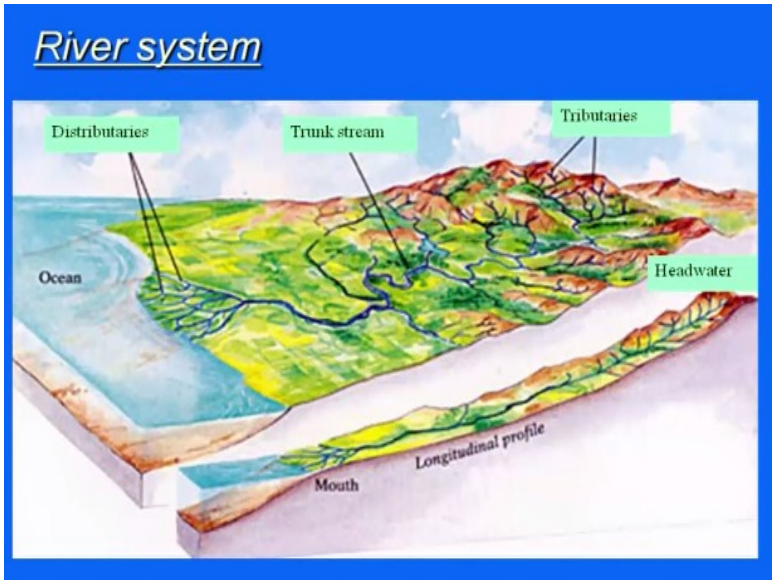

So if you take as an river system in total then what we have? We have the uplands from where it originates, then we have the flat areas on which it flows and finally, we have the region where it goes and meet, it could be an ocean, it could be an water body or it could be another channel in which it merges or it joints. So uplands, the hilly areas of course the slope is there and the gradient will be higher here.

So we have multiple smaller streams that is your tributaries and this tributaries in the headwater agents carries the material with the help of flowing water and siphonate into the major transtream. So then we have the trunk stream which is the main channel of the drainage basin and then finally, where it goes and meet then we have the distributaries. So streams coming and meeting or joining to the main one and here they are dispersing in the form of delta.

So we have throughout the journey right from the headwaters or the uplands in the upper reaches where it goes and meet the mouth throughout the journey we have different landforms which we will come across. So right from the headwater to mouth the landforms varies from place to place. So in short the river system is comprised of tributaries, trunk stream and distributaries.

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So this is the drainage basin and there are very large straining basin as well as smaller drainage basins contributing to larger run which are termed as sub-basins. So in the uplands or even in the plain regions where we have the streams, smaller streams flowing away from one another, so this stream is flowing in this direction, this direction and this stream along this slope is flowing in this direction and contributing to this main channel.

So this portion, the line where I am moving the cursor is your drainage divide. So this is the drainage divide or the boundary of one smaller drainage basin. So the streams which are flowing along the slope are contributing to this main channel which has been seen at the centre of the basin. So this is your trunk stream and this is the outlet or the mouth of the small basin which has been marked over here.

So the drainage basin, so as I told that you will have different gradient and if you draw the longitudinal profile that is longitudinal profile as the elevation and the length will show that this portion is steeper and the gradient decreases as one moves towards the mouth.

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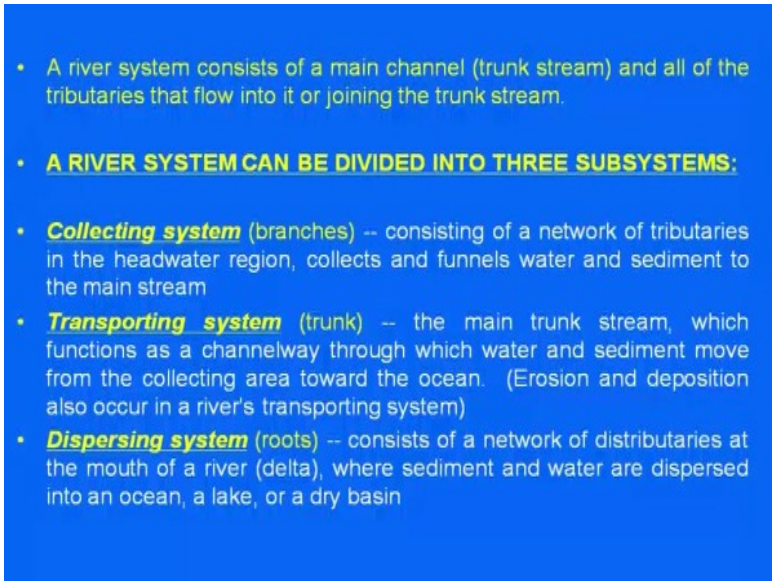

So a river system consists of a main channel that is a trunk stream and all the tributaries that flow into it or joining the trunk stream. A river system can be divided into 3 subsystems. One is your collecting system, branches and mainly this collecting system has been seen in the headwater region. It consists of network of tributaries which collect and funnels water and sediments to the main stream or we can say the trans stream.

Then comes the transporting system. So whatever material that is the sediments collected and poured into the trunk stream is transported. So transporting system, the main trunk stream which functions as a channel way through which the water and the sediment moves from the collecting area towards the ocean. It may be ocean as I told, it may be the trunk stream or another major stream to which it goes and join.

Or it may be a stationary water body either it is lake or a pond in which it goes and meet, but usually we have seen the major river system or the drainage ends it is journey in ocean. So this transporting system will have the erosion and deposition. So the product of erosion and deposition that as I was talking in previous lecture that this will result into the formation of landforms.

Then finally, the third one, that is the third sub system is your dispersing system and that what we call roots. So branching, trunk stream and roots, and roots consists of a network of distributaries at the mouth of the river and the landform which is associated or termed or given to such dispersing system is delta, where the sediment and water are dispersed into an ocean.

It could be an ocean, it could be a lake or a dry basin in which it goes and meet. So please remember the in total, the river system what we have learned in the previous slide that we have the headwaters, so we have tributaries, we have trunk stream and we have the finally, the distributaries. So the sub systems if we take so we have collecting system, transporting system and dispersing system.

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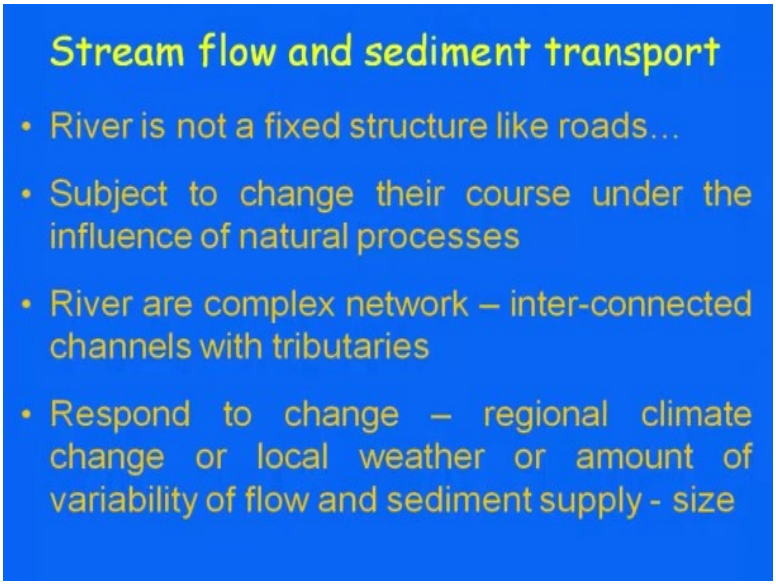

Stream flow and sediment transport; river is not a fixed structure like a road. It is subject to change it is course under the influence of natural processes. Rivers are complex network interconnected channels with tributaries. Respond to change if there is change in climate that is regional climate change. It can also change to the local weather or amount of variability of flow.

So this means the amount of variability of flow is your water and the sediment supply. Again the sediment supply will depend on the size of the sediments. As we were talking about that the sediments will be transported in different fashion that is one is as bed load and in suspension. So again the amount of flow and sediment size will play an important role. So it is not an fixed structure.

It keep changing it is course because it is influenced by the precipitation and the precipitation or the amount of rainfall or the weather will influence it is velocity and flow and the carrying capacity that is your sediment supply. So this will affect the overall fluvial system in any region. So this is important portion to be discussed.

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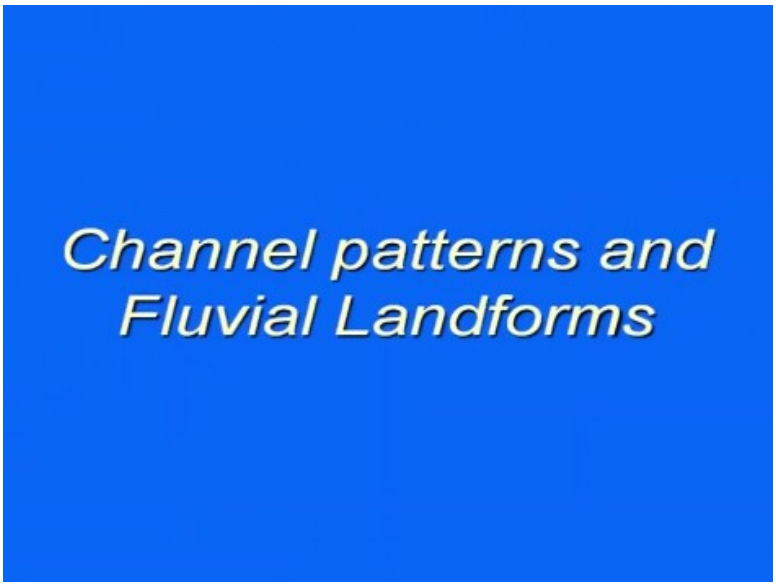

So now another and the most important portion which we were talking about is the channel pattern and the fluvial landforms. So let us look at the different channel pattern. So in total what we see throughout the river basin that the channel is either straight or channel is winding or channel is having multiple streams joining and then again bifurcating and so on. So we will quickly look at the different type of channel pattern and that channel pattern is.

So one is you have to remember I would like to mention here or emphasize right in the beginning that one is channel pattern and another is drainage pattern. So channel pattern is different than the drainage pattern. So right now we are talking about the channel pattern. So the channel pattern is the first one is the straight channel.

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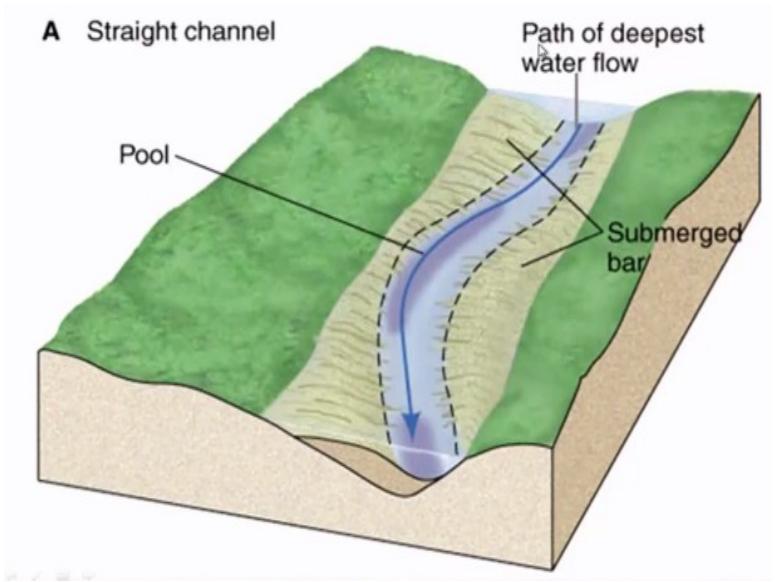

So straight channel will have the deepest water flow or the path in the centre. Then we have the meandering pattern.

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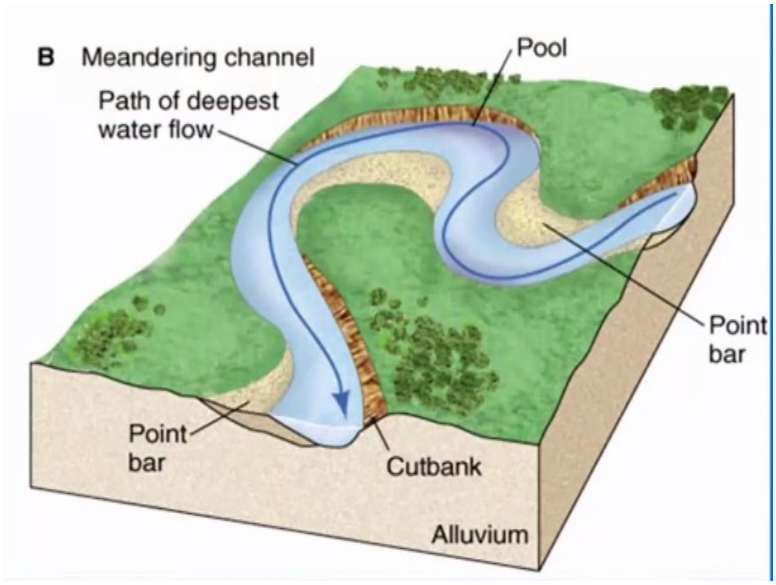

So the meandering pattern will be like a snake crawling on the surface. So it is in zigzag or sinus pattern which has been seen and the pool that is the deepest portion in the meandering channel will be on the outer side where it erodes. So this sketch what it shows that it has the portion here, the point bar and this point bar is performed because of the deposition of the sediments.

And the other side that is in the outer side is your, so the convex side is the erosive portion, the energy condition is higher and it is having deeper portion. So the pool is in the outer side

where it erodes and this region shown as an cliff or the bank along the channel and this feature are termed as point bars and cutbanks or the erosive banks. So erosion and deposition has been seen in the meandering channel.

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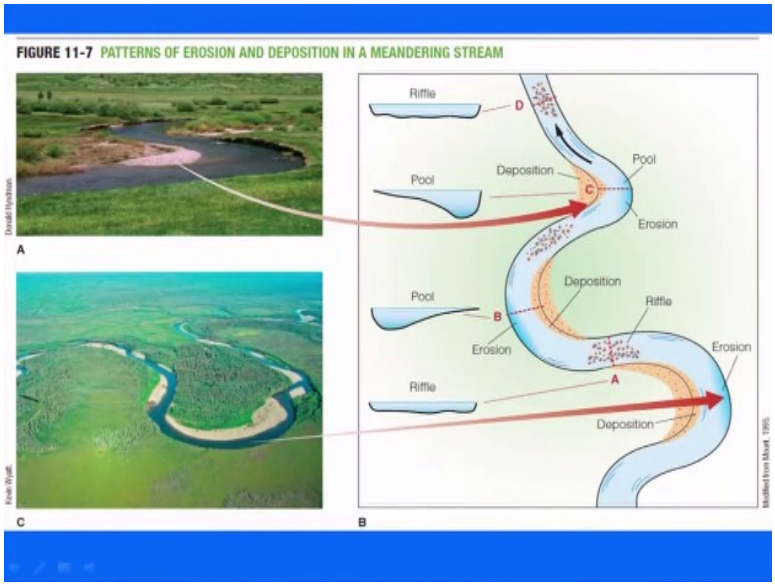

So these are the example of the meandering channel at various location. You have, if you take the straight channel and the cross section here then what you see is that the channel pattern or the boundary will be something like this and the deepest portion will be at the centre and the flow velocity. Whereas if you are having the meandering channel then the portion on the outer side will be deeper and the velocity will be higher over here.

And then deposition has been seen. So one side it will deposit that is in the inner portion it will deposit whereas outer side it will erode. So erosion and deposition, so again the deeper part will be here and the velocity will be much higher at B and at C this will be the pattern. Again at A what you see is very much similar to what you see in D. So most of the plain regions, alluvial plain regions you will be able to see the meandering channel and same one can see in the Indo-Gangetic plain.

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Now along with that these are the features which will be commonly associated in the alluvial plains or the floodplain region because of the erosion and the position will be the formation of the cut-off channel. Now this cut-off channel was the part of once the part of the flowing channel where it was connected, but now it has been cut-off from it. We will talk about that how this landform is formed.

So this will form as an back swamp where the water will keep accumulated during the rainy season and it will become like in swamp. So back swamp whereas you can also talk about that this in some portions he will have the wetlands. So these are all paleo channels or the cut off channels of the existing river system. Then we have levee. Levee is nothing but mostly the portion here will be slightly elevated.

And it will slope or the slope decreases towards the plain area or away from the channel. So the portion here will be slightly elevated. So this is this what we call the levees. So mainly in the floodplain areas most we will be able to see or you will find the cut off channels and also the erosion on this side that is an outer side will result into the migration of channel or the movement of the channel in this direction.

So it will keep on eroding and the channel will move in this direction as well as the deposition will continue, so it started here and it has reached up to this point. So this point bar has slowly evolved because of the deposition and the erosion process which is taking place here. Similarly, this portion is also moving in this direction, so the channel is moving in this direction.

And the deposition is also taking place and the landform is evolving which started from this point up to this point and it will keep moving and finally, this will be again left out as in cut-off channel. So what has been shown here in this sketch, this lighter portions of the circular of this hemi-circular are all the paleo channels are the cut off channels of the existing river system. So if you see here, but we will be talking in the coming few slides about the levees and all that.

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So what is the different landforms in the alluvial plains. So this is again another picture which shows the winding of the channel and the cut-off channels which are been sitting here whereas the lighter one here this feature it shows the paleo channel. So river used to flow here previously, but now it has shifted to this one. So this channel is it is not fixed, it will keep changing it is course because there is an unconfinement in this region.

So it will keep moving or shifting from within the reactive floodplain from one place to another place and leaving behind the cut off channels. So this is one best example of the meandering channel.

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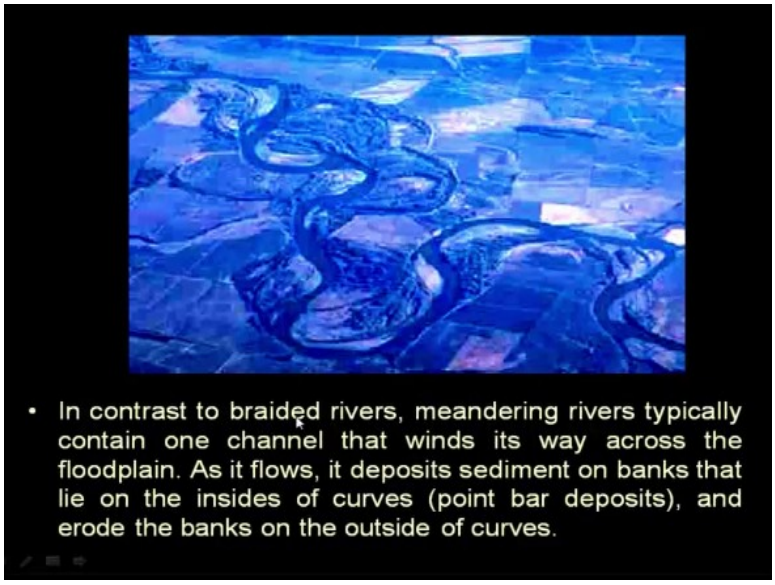

So basically, the meandering channel is in contrast we will be talking in the next slide about the braided rivers. So the meandering rivers typically can contain one channel that winds it is way across the floodplain, so it is basically, it winds it is coarse across the floodplain. We will stop here and we will continue in the next lecture. Thank you so much.