Geomorphology
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Lecture-41
Coastal Geomorphology - VIII

So, friends, welcome to this coastal geomorphology and if you remember in the last class we just started the barriers. So, the barriers that we can say it is a long elongated and much not much width is sand body which is running parallel to the coasts. And the existence and this continuity of this barrier is a function of sand supply so, the sand supply may be offshore or maybe onshore.

So, there will be continuous sand supply maybe from the continental side or due to from this erosion of these sea cliff along this coasts or it may be from this offshore by this current offshore current and due do to this littoral current along this coasts. So, all those factors that continuously work together to define how long this barrier will be and if you continue with that, so, nowadays it is seen the barriers they are eroding.

So, why this is eroding because due to discontinuous sand supply, so, this sand supply discontinuity is due to this waterfront reclamation. So, you might have heard that in worlds many waterfronts in this coastal sites even if in Indian context also, we have different riverfront reclamation different waterfront reclamation, so, that is why we are making it concrete. So, once we are making it concrete, so, that means we are not allowing it to erode by this wind action.

And this supply of sand to this barrier is gradually we are reducing. So, it needs a policy matter in the policy has to be changed or some policy has to be formulated. And in some developed countries like USA, Australia, they have made some policy that this much distance from this seacoast will not be allowed or not be reclaimed. And this is due to this restoration of this natural environment.

So, that is in our country or any World Wide any country need to reach formulate a policies so that this natural environment should be remain intact and so that it will continuously supply sand

to this barrier growth. So, extensive reclamation of waterfront and waterfront stabilization projects actually endanger barriers and become unless sand is free to move with changing wave condition erosion result.

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So, that is so, whatever they see barriers which are formed during this late quaternary and they like the 65 to 6000 years back. Now, some of them are many of them are getting eroded. So, this erosion is due to these anthropogenic activities due to reclamation of this waterfront.

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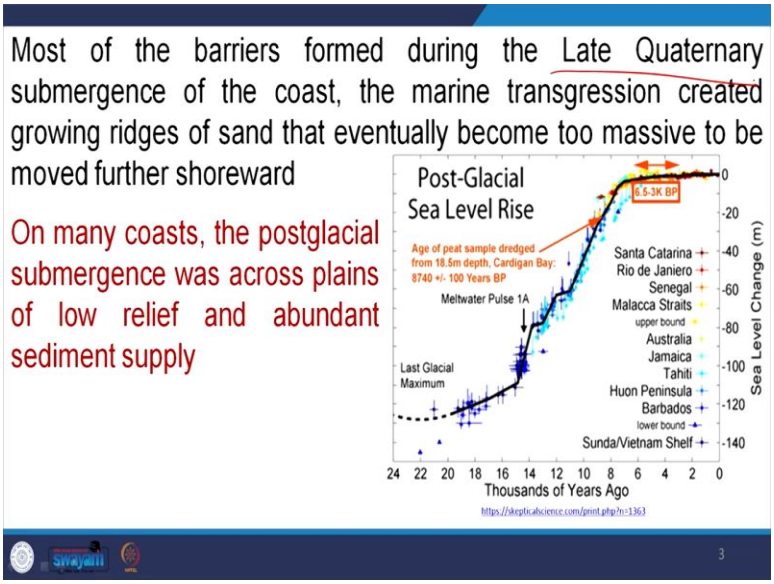

Most of this barriers formed during late quaternary submergence of this coasts the Marine transgression created growing ridges of sand that eventually become more massive to be moved

further shoreward on many coasts. The postglacial submergence was across plains of low relief and abundant sediment supply for now the question arises what was the main reason during interglacial periods?

So here if you see we are talking about the late quaternary it is an interglacial period. Similarly here on the west coasts, the postglacial submergence that means it is also interglacial period. So those interglacial periods they are more prone or more suitable for generation of these sandbars this coastal bars. So probably this is the reason that during this interglacial period, the rivers become more active, abundant water supply to this rivers.

So there will be much waterfront erosion in the continental side, so much sand supply much sediment supply to this coasts. At the same time, we are taking large amount of sediment to the sea and we are increasing the sea level. So once we are increasing the sea level because we are in the interglacial period, so that means we are increasing the sea level. So, sand is supplied, but this supplied or sand is not able to go inside this sea. So that means most of the sediment that remains along this coasts, so due to this reason, they are able to build sand barriers along this coasts too.

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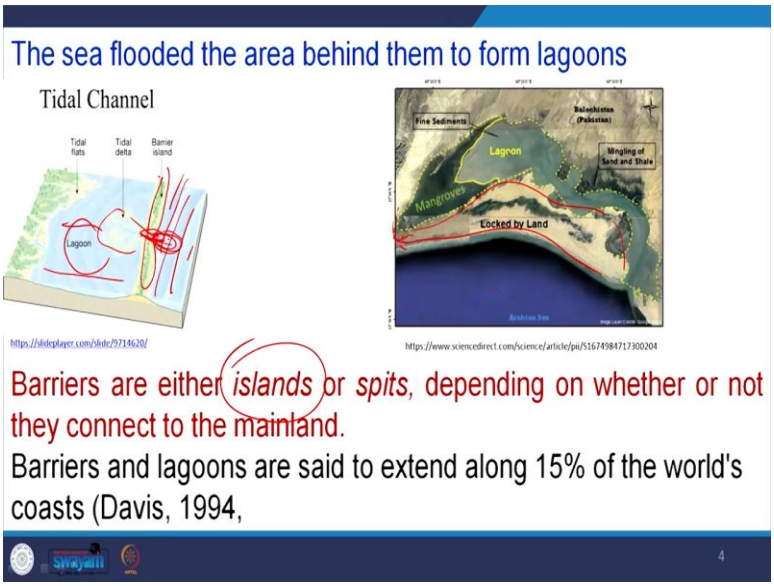

So, these sea flooded the area behind them to form lagoons because once we have a sand supply, abundance sand supply, we have wave action and so we are created barriers and behind the

barriers we are creating lagoons. So here is the barrier and this is the inlet, so during high tide, the sediment will deposit this way and during low tide sediment will deposit it this way and that depository sediment is called tidal inlet delta.

So, this sediment either it will be formed Delta or it will redistribute by this littoral current that will be depends upon the strength of this littoral current and strength of this tidal system. So, barriers are either Island or Spits Island means, they are isolated systems like here, they are not associated with the mainland and they are this is for example, here this is a spit because though it is a barrier, it is separating the lagoons from the main sea.

But it is in this way it is associated with the mainland so, this is spit. So, either a barrier will be spit or an island that depending upon whether or not they connected to the mainland. So, if it is associated the mainland that is called spit, it is not associated it is isolated, that is called barriers. So, barriers and lagoons are said to extent along 15% of these worlds coasts 15% coasts is due to this barrier and spits is there.

So, as we have discussed here, the interglacial period the sufficient sand supply sufficient sediment supply the increase of sea level. So, they all factors responsible for this generation of barrier, but there are many theory developed about this development of this generation of these barriers, but some of them are quite strong and some of them are abandoned. So, now, there are 3 schools of thought to discuss or to describe what was the main reason for this barrier development. So, first says the barriers were thought to represent submarine Sand bars that have grown very large and then emerged by tectonic uplift or drop of sea level.

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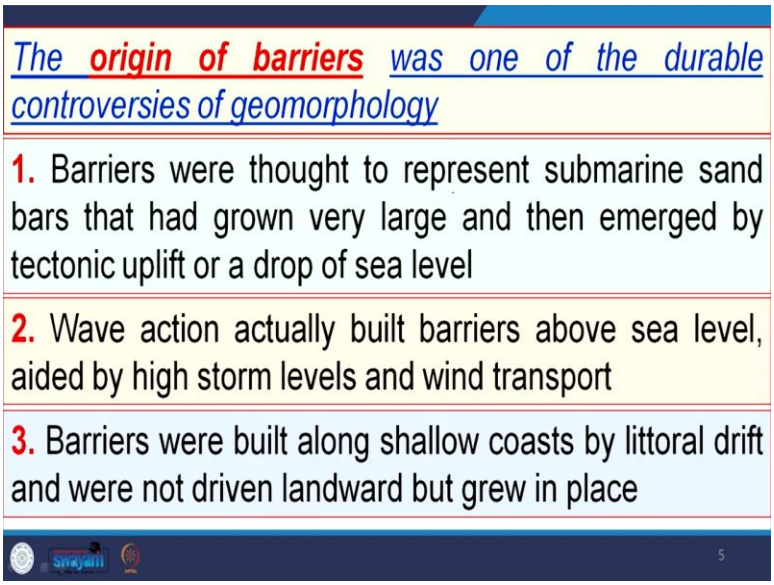

So, these are this they are thought to be the represent or submarine sandbars either they are uplifted coasts or this sea level fallen down so that they are emerged as barriers. So, second school of thought that wave action actually built barriers above sea level added by high storm levels and wind transport.

And the third school of thought says barriers were built along shallow coasts by littoral drift and were not driven landward, but grew in place. So, these are the different schools of thought the responder suggested for this barrier development. But what exactly this mechanism what is the reason, the barrier growth and what is inside of the barrier? What is the science inside for the barrier growth, it was proved by numerous borehole studies. So, numerous borehole studies says in barrier and their associated lagoons prove that many were built in last 6000 year.

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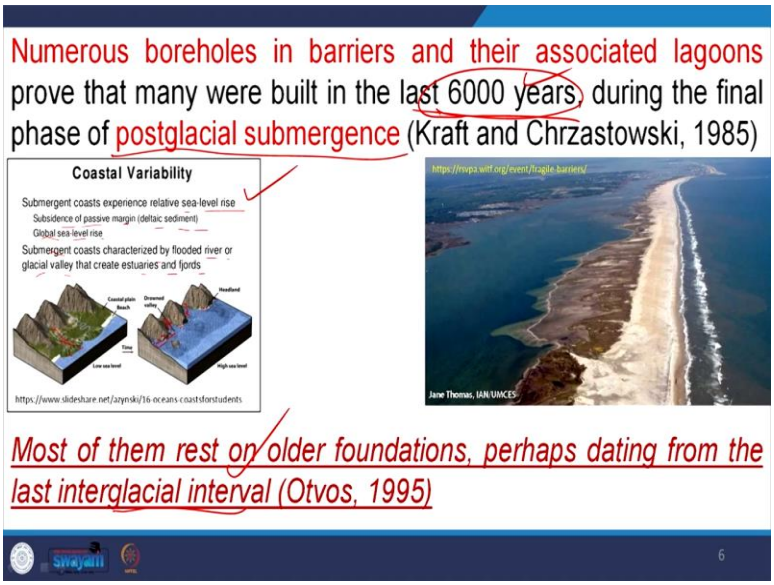

So that means it in the late quaternary product 6000 years during the final phases of postglacial submergence, so in this last 6000 years, number of barriers of the most of these barriers worldwide they were formed, most of them rest on the older foundation, perhaps getting from this last interglacial intervals. So here, we have interglacial here; we have last interglacial's. So, in any case, once we are saying this barrier, that means, we are indicating the interglacial periods.

So, the interglacial periods as we are discussed, much of the sediments are supplied from this continent and sea level due to rise of the sea level, the sediment was not able to go inside to the deep sea, and they remain along this coasts did the wave action due to this littoral current, these sediments has been redistributed and finally formed the barriers. And it cut off from this main water body and form lagoon inside.

So, here in this figure it has been discussed submergent coast experienced relative sea level rise, subsidence of passive margin deltaic sediments, global sea level rise, submergence of coasts characterized by flooded rivers and glacial valley created estuaries and fjords. So, here if you see, once suppose once the river they are debouching their sediments here and due to this sea level rise.

Now, the rivers they are restricted around this. So, the sediment which was supplied by this rivers, they are restricted near to the coast. And due to this wave action and due to this littoral current, they are distributed and form these barriers there.

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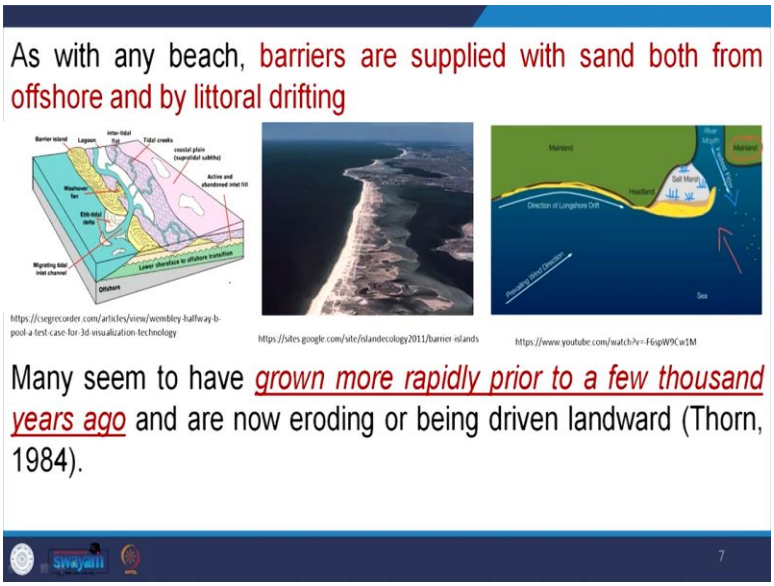

As with any beach, barriers are supplied with sand, both from this offshore and by littoral drift many seem to have grown more rapidly prior to this few 1000s years ago and now eroding being driven Landward. So, this erosion is due to this discontinuous sand supply and is mostly it is by this anthropogenic activities. So, this barrier which were able to build in the late quaternary due to this climate change, due to sediment supply due to the sea level rise we are very few minutes or very few years we are able to erode it So, that means, there is a discontinuous sand supply to this barriers.

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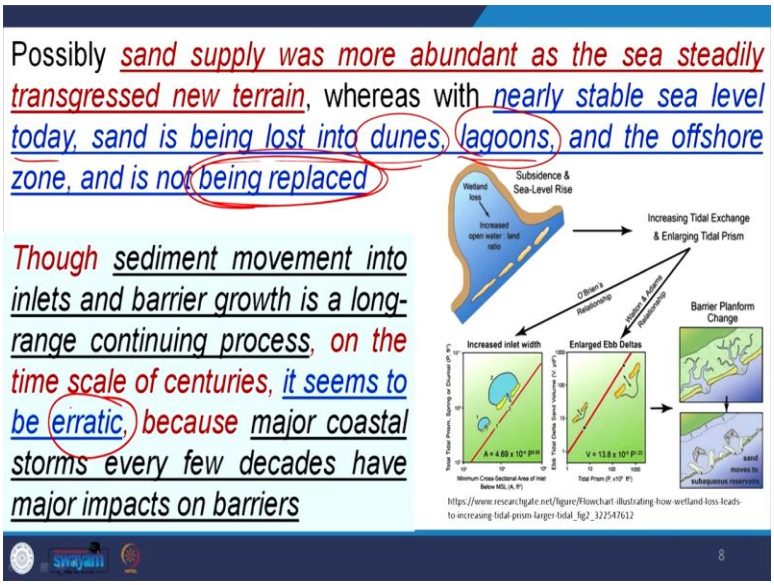

Possibly sand supply was more abundant as the sea steadily transgressed new terrain, whereas nearly stable sea level today sand is being lost to dunes and to lagoons and to offshore zone and not being replaced. So, this replacement of the sand is due to partly by this anthropogenic activities. So this sand which is driven out from this barriers, they are not again replaced by this erosion of this coasts, because we have made this coasts total concrete.

So, here this late quaternary these barriers which are developed nowadays the sand of this barrier has been distributed by this wind action but it is sea level today it is been lost due to dunes due to wind action due to lagoon and due to this lagoon this and some of these sands replaced from this barrier to these lagoons and this offshore zone due to the wave action and due to this current action and due to the ebb tide.

So due to the ebb tide it is or the rip current it has been moved to deep sea, though sediment movement into inlets and barriers, growth is a long range continuous process, but in the time scale of centuries it seems to be erratic, very important to understand here. So, this barrier growth and sand supply, it is a long term process in terms of centuries, but it is not continuous, it is not a uniform rate.

Similarly, if I talking about this flood plain development, or flood plain erosion of these coastal systems, we are talking about the tsunamis. So, though sand supply is continuous, but it is during

the tsunamis there are huge sand huge sediment supplied and finally, the whole system is modified within a minute or hour. Similarly, this sands supply though it is a continuous process barrier growth and barrier erosion is a continuous process in terms of centuries.

But the supply is erratic. So there will be peak where high sediment supply will be there and there will be a peak where high sediment erosion will be there. So, this is not of uniform nature. So, Major coastal storms every few decades have major impact on barriers the coastal terms. So in; for example; to talk about this Indian east coast, in the Indian context only where every year, we are facing 4, 3 cyclones.

And those cyclonic system, they modify the coasts very rapidly, and within an hour within a day, a modification will be occur, which do not possibly even if in centuries, so, this type of erratic events that will supply or erode sand from this barrier and modify it instantly.

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Barriers may grow narrow by erosion of their exposed beach face, as well as on their lagoon side until they are so narrow that they becomes unstable and begin to migrate, that do not necessarily maintain the constant mass of sand at the retreat either. So, that means here to be on to say, this barrier, it is not a constant mass of sand is there, there will be sand supplies and erosion, either towards the sea or towards the beach and towards the lagoon.

So, this lagoon side we have sand erosion towards the sea, we have sand erosion towards the littoral through the littoral drift we have sand erosion. So, by this way, if continuous sand supplies not there, the size of the barrier gradually decreases and decreases and finally, in times of centuries or even a few decades, there will be total vanishing of the barriers. So, there are examples.

If you see the satellite imagery of different coasts with a temporal scale, in different time scale you will see it sometimes the barrier is developing and after a few years or few decades you will find the barriers are vanishing. So, this is due to this function of this sand supply and sand migration and sand replacement with different mechanisms.

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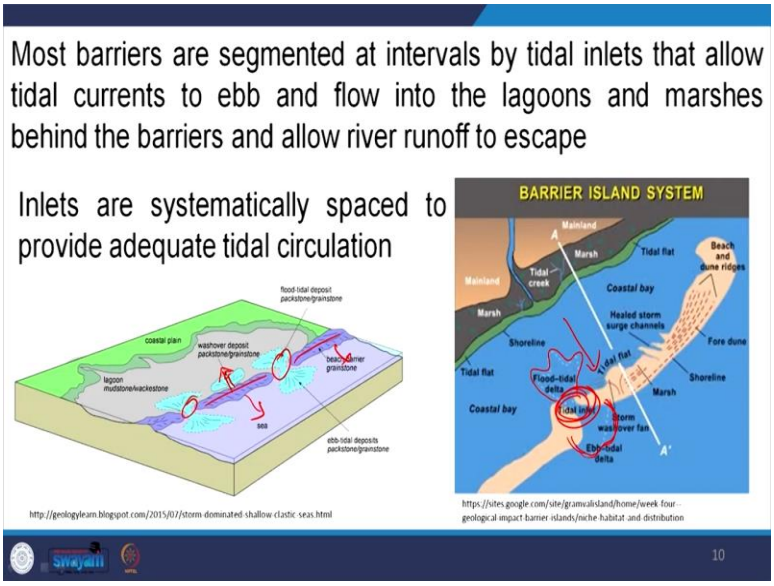

Most barriers are segmented at intervals by tidal inlets that allows tidal currents to ebb and flow into the lagoons and marshes behind the barriers and allow river runoff to escape. inlets are systematically spaced to provide adequate tidal circulations. So, if you see here, this is for example, this is the barrier and through this barrier, we have erosion or eroding sand towards the lagoon and we are eroding sand towards the sea.

And these are the inlets, different inlets are there. They are tidal inlets, they are called tidal inlets. Similarly, here, this is the tidal inlet through this tidal inlet. There are huge sediments supplied either to the lagoon or from the lagoon towards the main sea. So, due to this sediment supply,

this tidal inlets they are deeply eroded. And if you see here, this is called flood tidal delta is flood tidal delta deforming into the lagoons.

Similarly, here, this side is ebb tidal delta, ebb tide, during ebb tide when this water is current is flowing from this lagoons towards sea, here sediment will be deposited that is called ebb tidal delta. So, that is why these tidal inlets there divide the barrier into different segments. And each segment behave differently depending upon the strength of the tides and strength of this wave and sediment supply.

So, it is not necessarily all these tidal inlets they will grow at the similar inlet or they are deep, similar depth as compared to others. So, the sediment supply this will even if the sediment supply will be somewhere if it is somewhat higher sediment supply, but due to this high current action high tide action, that will be removed back. So, that means sediment supply in a particular segment that does not mean that will build this barrier. So, that depends upon the function of the sediment supply and sediment removal.

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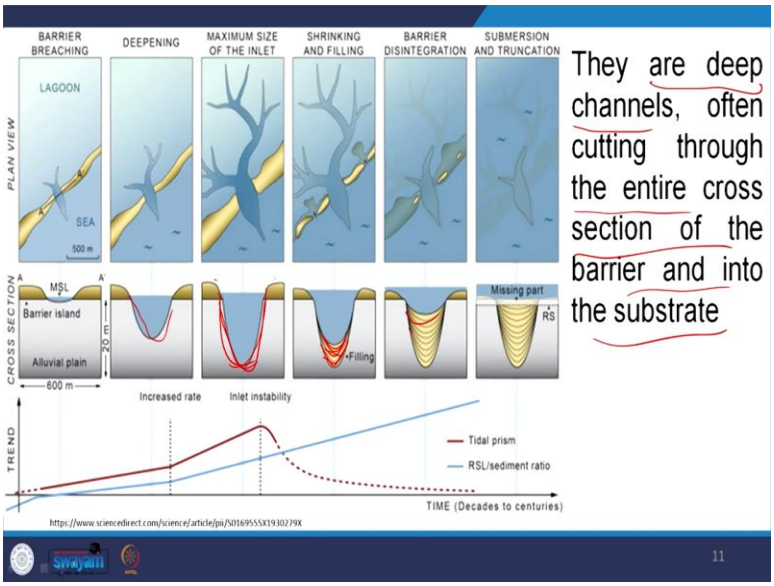

If you see here, they are deep channels, these tidal inlets they are deep channels often cutting through this entire cross section of the barrier and into substrate. For example, if you see here, this is MSL and in these 3 figures here, they have cross cutting and they tidal inlets they are too

deep. So, that means they can erode the whole system this side but here see, when this tidal action is not high.

So, here the sand supply is more, you see, this system is depositing. So, that means here that is channels accretion. So, that means, that what would be the nature of this tidal inlet, how depth it will how deep it will be, whether it will be sediment filled or it will be caught into this sea substrate that depends upon the sediment supply that depends upon the tidal conditions at that particular space.

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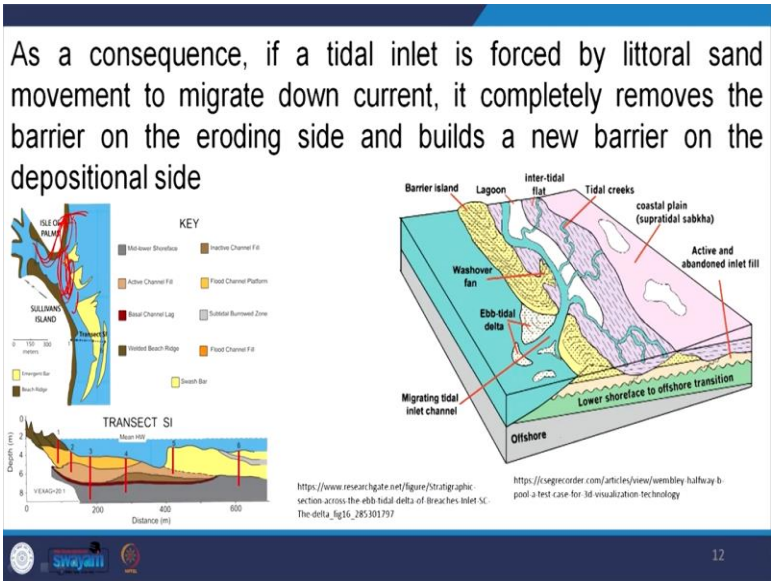

As a consequence, if a tidal inlet is forced by littoral sand movement to migrate down current, it completely removes the barrier on the eroding side and build the new barrier on the depositional side. It is very important to understand here suppose, we are blocking this river system here by this tidal by this river system or the tidal inlet by this barrier, so, that means this tidal inlet will migrate.

So, once the tidal inlet system or the inlet will migrate, this barrier that will be segmented here earlier once this barrier was here, this part will be segmented. So, here at the downstream, this barrier will erode and the upstream it will deposited that means a consequence if the tidal inlet is forced by littoral sand movement to migrate down current, it completely removes this barrier on this eroding side and rebuild it in the depositional side.

So, that is why these barriers migrate along these coasts. And this migration is due to a function of total this inlet system this coastal this ebb tides this rip tides, this is littoral currents and sediment supplies all those functions together and finally, that defines whether this barrier will migrate to what extent it will migrate.

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Historical records, so that when inlet migrate too far in this way, a new inlet breaks through this barrier, somewhere up current and in turn migrate the direction of sand transport. So, here if you see this is the satellite imagery of the same place in different times, here you see, we have a tidal inlet and through this tidal inlet, there was current which was the river was passing through and now.

You see with time this system it is a spit, this is not a barrier it is a barrier but it is a spit not Island. So, here you see this total system is closed. Once the system is closed the river this here, it inlet and created another inlet here. So, that means here it was deposited and another inlet is created in the upstream directions. Similarly, here if you see in this figure earlier the river was depositing sediment here.

And this was a tidal inlet, so, with time this tidal inlet was closed and finally, the river breached this barrier here and finally, the tidal inlet was created here. So, that means, I want to say this

tidal inlet, its position changes, this barrier size changes, the barrier migrates, the size reduces or enlarge this is totally a function of the sand supply the river action this tide action, this rip current is the littoral current all those together decide whether and what would be the size of this how this what will be the nature of this tidal barrier.

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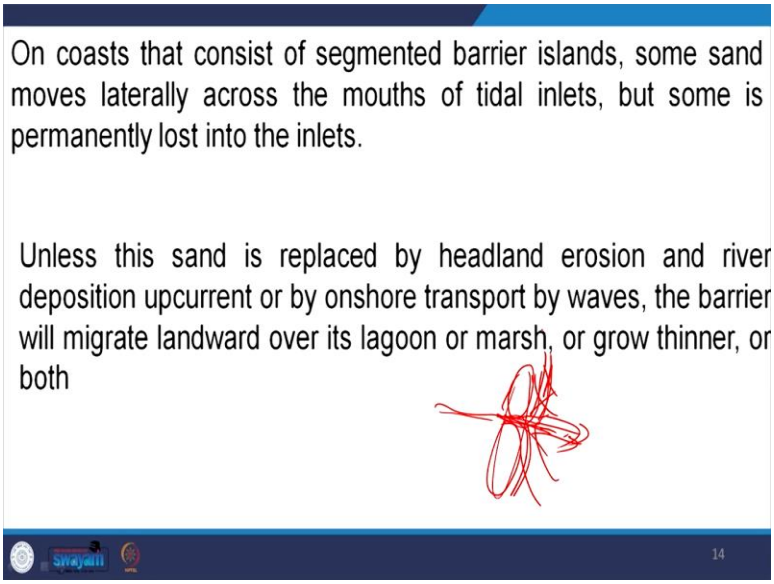

On coasts that consists of segmented barrier islands. Some sand moves laterally across the mouth of the tidal inlet, but some is permanently lost into the inlets, see one suppose we have a tidal barrier and this river is their river. This is the inlet and through this inlet the river is depositing their sediments here. So it is on coasts that consist of segmented barrier islands. So it is one segment. another segment is there.

Some sand moves laterally across the mouth of the tidal inlet and some is permanently lost into the inlet, why lost into this? Because through this inlet, they move into the deep sea and through this tide this littoral current, some of the sand that will migrate like this, that migrate like this. So some of the sand bars they are developed parallel very close to this islands of these barriers and some of the sand is lost permanently and moves to the deep sea.

But once it is reaching to this breaker zone again due to the braking action, it may again further migrate to these coastal systems unless this sand is replaced by headland erosion and by river deposition upcurrent or by onshore transport by waves, this barrier will migrate landward over its

lagoons or marsh or grow in thinner on both. So, that means, here it is said that this growth of this barrier is totally dependent upon the sand supply.

The permanent lost sand which is moving to this breaker zone or deep sea if it is going to the deep sea there is no coasts in that it until unless there is a huge tsunami or some storm activity, it will remove again back to the shore otherwise, if it is in the breaker zone, that is the chances due to this breaker waves, it will come to suspension and finally, it will again come to this shore zone.

And similarly, the headland erosion, it will contribute to these sediments supply to this coasts the shore. Similarly, the sea cliff erosion it will supply sediment to the shore similarly, river transport it will supply to the sand to the shore. So, that means, these are the mechanisms through which the sand supply occurs to these coasts and due to these coastal processes, they modify, they form these barriers, these barriers migrate or their loss or they grow.

And through this waterfront reclamation, we divert, we force the sand to loss and these are these mechanisms either man made or this natural mechanisms. They together work and decide whether this barrier will be there or not, if it will be there what should be its length, what should be height, what should be its width and what should be this size. So, that all depends upon that. So I think we should stop here and we will meet in the next class with a new topic. Thank you.