Geomorphic Processes: Landforms and Landscapes

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Lecture – 31
Coastal Processes and Landforms (Part I)

Welcome back, so today we are going to start with a new topic coastal processes and landforms as we did in the previous lecture of glacial landforms and glacial environment. We will try our best to show you the examples from the coastal regions and I will try my best to show you the examples from Andaman and the coastal landforms which we had we studied and identified which indicates the ancient sea level.

Fluctuations or the signature of the palace sea levels and all that and how the landform changes over the time that also we will discuss briefly and at the end of this part of the coastal processes and landforms I will also try to show you some with some slides that what we are doing in terms of the tsunami studies. So coastal landforms of coastal is very important because we have a very extensive coastline of the mainland India.

If you start from the east to west so it has a very we have very long coastline and of coastal a lot of people or the then you can say the population is extensive settled along the coastal zone. So coastal landforms of the landscape is extremely important for us to understand and partly we have discussed in and in the previous lecture. Also where we were talking about the Glacial integration cycles.

So this is another important aspect that which will be of concern for all of us in terms of the climate change and if there is an climate change. If we experience more warmer climatic conditions then the sea level will rise and the sea level rise will engulf most of the coastal regions which are right now exposed or which are occupied by the people all may be by the settlements. Or you can say they there are few urban centres but not all are there.

But yes of coastal they will be they will be engulfed by the high sea level and one of the region which will be affected the most and very quickly will be the areas of Sundarbans because the

height of we can say the innovation with respect to the mean sea level is hardly 1 meter or 2 meters. So if one meter there is slight change in the sea level it will try to inundate the most of the regions of that area.

Now this is not a very quick phenomena but of coastal as we discussed in the tectonics and morphologic part that such fluctuations or the change in the base level not exactly we are talking about right now or like I am saying about the coastal landform. But if you if we considered what were the tectonics morphology we talked about the base level change in of the rivers in Himalayas.

So similarly if there is an there is a deformation along the subduction zones then the landscape will change and then subduction zone earthquakes will result into the uplift or subsidence of the coastal areas and we would like I would say that we have the area in Andaman and Nicobar which experience the such land level change which was tectonic land level change and was not related to the new static sea level change.

So the land level will change I would say that the land level change means that the area has gone up or area has gone down and the sea level has remained the same. But if the sea level goes down there also you will experience or maybe you can relatively you can say that the area has emerged. So in that sense I was talking about the land level change in eustatic sea level change if the sea level fall then you will have the areas will be along the coastal zones will be exposed.

And if the sea level rises there then then it will be inundated. So let us move ahead with the with the coastal processes and landforms.

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And this beautiful photograph which you are looking at is from Andaman the east coast of Andaman was a small island which got uplifted during 2004 Sumatra Andaman earthquake.

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So most of us are very fascinated with the landscape or the landforms which are in the coastal zones and mostly we get fascinated with the beaches. There are other landforms which are associated and we walked through most of them if we are visiting and if some of you have and some of you if had a chance to visit the coastal areas. Then of coastal you will you will love to see the beaches and all that.

But along with that there are many other features while you walk through the landscape but you never notice. So after this lecture on the coastal process in landforms I hope you will when you go to such exotic locations you will be able to see such features and identify such features very easily.

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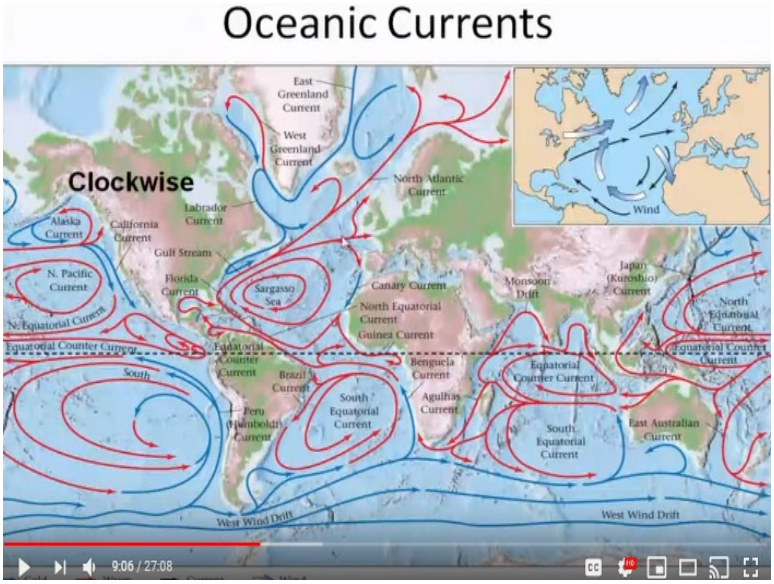

The most important aspect of the landscape which usually evolves along the coastal zones. The ocean currents plays an important role. So if you look at a different region either it is north of equator or south of equator. The ocean currents moves in different directions and again the ocean currents are affected not only by the event which are blowing on the surface.

So the surface ocean currents field will be affected as well as the ocean currents will be will get affected by the rotation of the earth and of coastal the tidal waves which we know that it is because of the attraction of Sun and Moon. But at the same time the Coriolis effect will also play an important role in the movement of the ocean currents. So red lines with arrows arrow shows the direction and the reds are the warmer waters whereas the blue lines are with arrows are showing thee are the cold waters which are moving in the different ocean.

And this line is your equator and this is the region which has been shown here the cold water warm water current direction and the wind direction. So this is your wind direction which has been shown here and what if you if you look at the Indian part what we have is mostly warm

currents which are moving in the two ocean that is Arabian Sea and the Indian Ocean. So for us this is important so the ocean currents which comes from south of equator moves along the coast and the western side and then again it the same follows and goes out in this direction.

So this is important so if we see to the north of this equator line then most of the regions will have the clockwise movement of the oceanic current. Whereas the south southern side will have counter clockwise motion.

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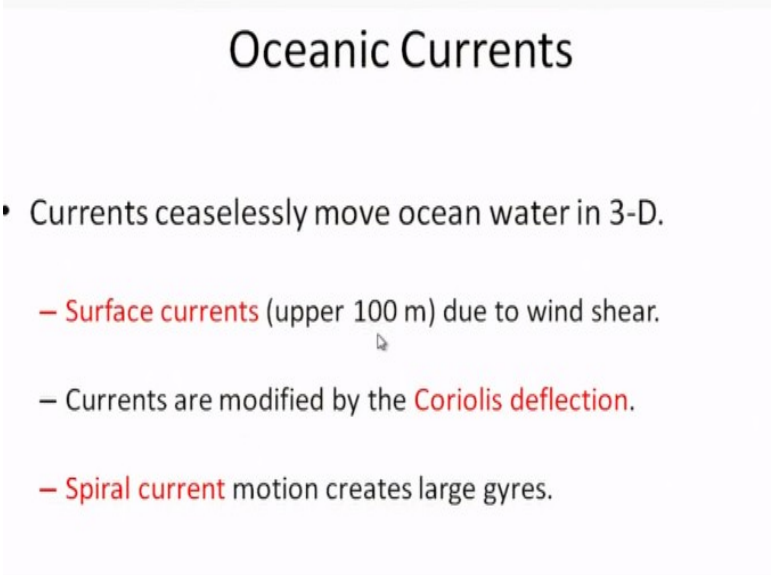

So in total what we see is that the current moves in 3D fashion and the surface currents are controlled or affected due to the wind shear which are blowing on the surface of the water and the modification what we see in terms of the emotion or the moment are because of the Coriolis effect. Whereas the spiral current motion creates at large gyres. So basically up to the surface currents of up to like the depth of or the upper part of the 100 meters will be affected by the wind shear.

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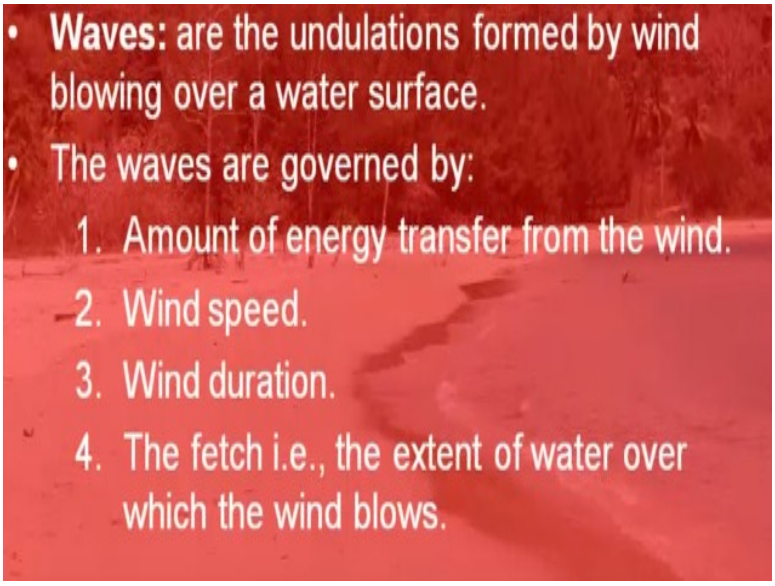

Now the motion or the movement of the currents will also play as I was talking about the important role in shaping up the landscape in many regions along the coastal areas and also that how the waves are with respect to all the ocean waters are coming in contact with the landscape. That means the configuration of the geomorphic landscape geomorphology of the region whether it is directly coming and meeting the coast or it is oblique.

So waves are basically what we see is the undulations formed by wind blowing over the water surface. The waves are governed by one amount of energy transfer from the wind and depends on the wind speed with duration and the fetch that is the extent of water over which the wind blows. So the area which has been covered by the wind blows will also be taken into consideration and you are talking about the formation of the landforms.

So in short if we talk about the waves then these are the parameters which will govern the wave formation. So amount of energy of traverse will be depend on the wind speed wind duration and the area on which the wind is blowing and this will affect the ocean water and generate the waves.

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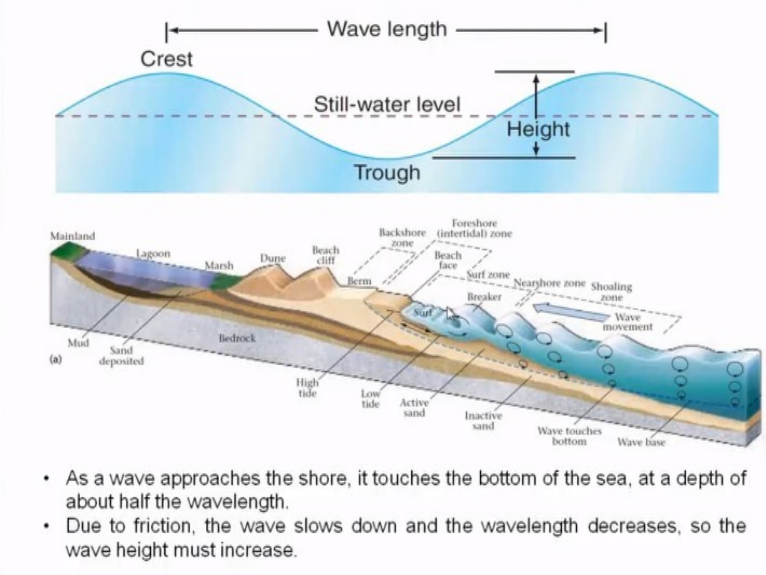

So if you take an complete section of the wave then we have the crust and trough. So most of the waves you will find is with the crust and trough and the important part is that the motion of the waves will vary from the from it location with respect to the coast and also with respect to the depth. So as wave approaches the shore it touches the bottom of the sea at a depth about half the wavelength.

So in the deeper part the motion will be different but as it moves closer to the coast the depth varies as well as the motion in which it was moving this will be different from the deeper deep waters. So this is due to friction because when it moves towards the coarse it approaches the coast then the depth decreases and with the shallowness the friction also increases and due to increase in the friction the wave slows down the wavelength decreases.

So the wave height must increase. So close to the coast you see the wavelength decreases and the wave height increases whereas in the deep water the wavelength will be much larger and the motion will also be different and the wave height that is the height which you see of the crust will be smaller. Whereas the height of the crust is larger. So in short what we can say that the waves which are moving towards the coast are squeezed.

And squeezing of because of the friction which has been like is produced between the base of the coastal region and that will result into the height increase and because of this in most of the coast

coastlines what you see is the surf zone and the surf zones will be mostly seen close to the beach areas. So you have before the intertidal zones you will have surf zone and the back shore areas behind the beach resist and all that.

So usually this phenomena will also result into the formation of the beach ridges all the alien activities which are which will result into the deposition or the formation of the dunes and behind the dunes above mean sea level or at mean sea level the black marsh will form and black marsh or Lagoon area. So these are the blackish water which you will see mostly and during the high tide or super high tide the water may spill over or pass through the tidal channels and enter into the marshy land or you can see the lagoons.

So these are a few very common landforms which you will come across and all are dependent on the on the wave action and the coastal configuration. That I was talking about that the geomorphology of the area and how the what is the configuration whether you are looking at the bay area or you are having the straight coastline with respect to the direction of the waves and all that so that will result into the formation of different landforms.

So waves will have crust and trough associated and the height as well as the motion will vary from place to place. In the deeper portion the motion will be different and in close to the coastal of reasoning will be different. So as the waves approaches the shore it touches the bottom of the sea at depth of about half of the wavelength due to friction the wave slows down wavelength decreases and the height increases.

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So wave refraction size as was talking about that depending on the configuration of the land scape that is coastal landscape the wave action will also varies and in some regions the wave refraction what we will see will take place and this will result into the formation of the different landforms

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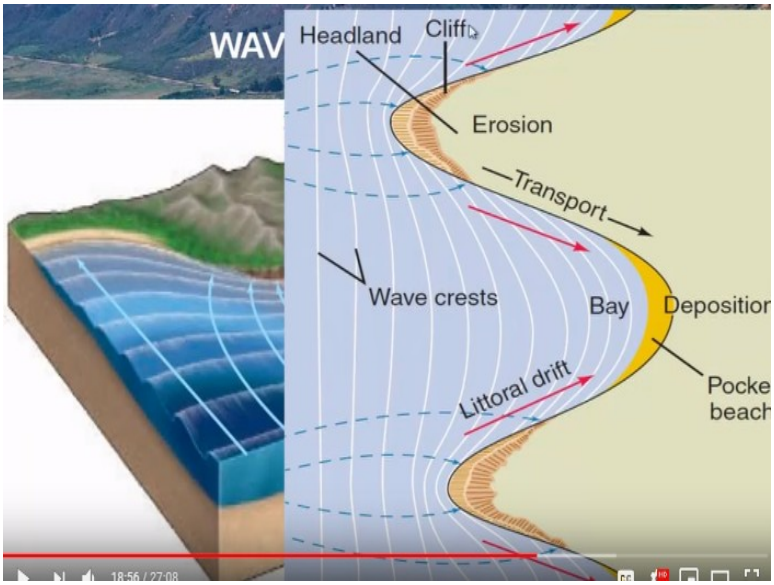

So and because the landforms which we see are again in the form of deposition landforms and evolutional landforms. So in particularly the bay areas where the waves are been moving or directly approaching will result into the formation of the bigger the beaches and the whereas in this region you will have erosion and that will result into the formation of the beach in the bay areas.

Whereas the headlands which are the erosional cliffs in the in the notch part. So this is how the headlands and the sediments are being formed. Now this is what we see here is that this part is erosion and the transportation of the sediments will take place and result into the deposition in the bay area. So you have this notch area not exactly the notch I am talking about the sea notches but it is sharp peak here which is which is directly getting affected and will result into erosion.

Whereas this one this region is slightly the bay area or the pocket where the deposition will take place and result into the formation of beaches. So at what angle the landforms will be seen of by or the where the waves will come and meet the land portion depending on the configuration of the bay above the coastal region the erosion and the coastal features will be now seen.

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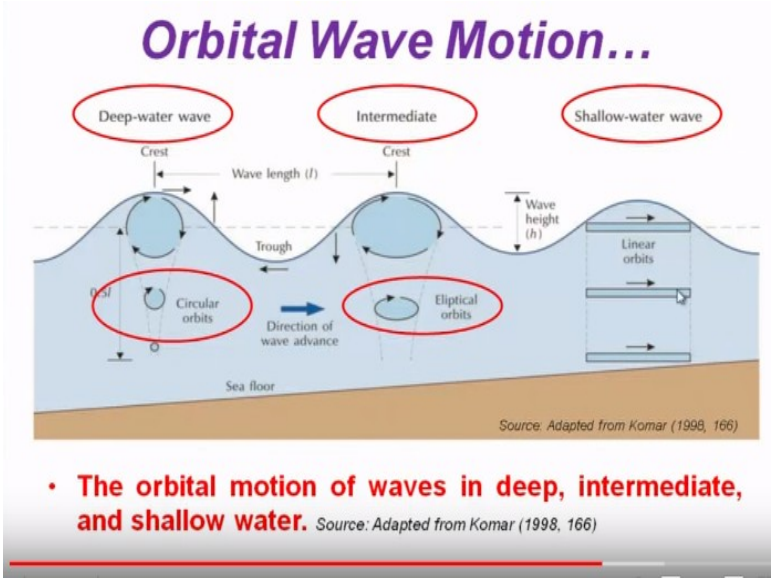

So orbital wave motion this is what we were talking about that in the deeper part you will have mostly the different motion. So the orbital motion of wave in deep intermediate and the shallow waters which has been shown here. So you are having the deeper waters here so mostly what you will see is circular motion. So the circular motion will be experienced in the deeper water the wavelength is much larger as compared to what we see the wavelength close to the beach or maybe close to the coastal region where it becomes the depth of water that becomes shallower.

Intermediate it is elliptical whereas in the shallow waters close to the coastal regions at the motion is like almost flat. So this has been modified to an flat motion.

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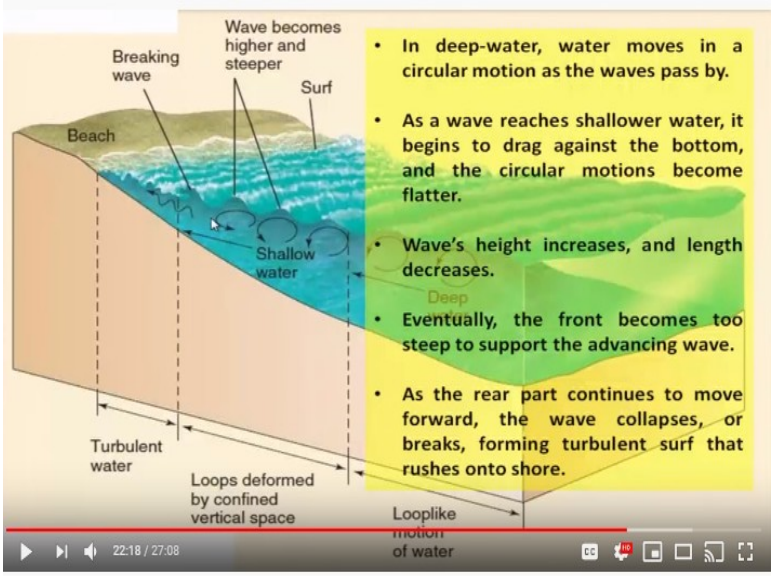

So linear motion so this is what it shows not if you have you are in the deeper part then you have where the motion is almost circular in the deeper waters. As a wave reaches shallow water it begins to drag against the bottom and the circular motion becomes flatter wave height increases and the length decreases. So the wavelength decreases whereas the height of the waves increases eventually the front become too steep to support the advancing wave.

As the rear part continues to move forward the wave collapse and or it breaks. So mostly the breaking wave which you will hear as because of the increase in height and decrease in length. So it will collapse and which allows the waves to break down forming turbulence itself. So the surfs which are been formed are because of the waves entering into the shallow areas and where the height increases at length of the waves decreases and that will result into the turbulent waves or this surf that rushes on to the shore. So these are a few things which are important.

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So another example of coastal landforms what you see here is the bay is the area is here whereas this is the typical example of the erosional landform and headlands. So coastal landforms mainly related to see or ocean and land contact. Landforms are basically the result of one sea-level fluctuation. High sea level we can correlate this with interglacial. So when we are looking or experiencing the warmer climate so sea level will rise.

Because of the excess melting of the of the snow or glaciers and then low sea is glacial period when more and more water has been stored as in as an ice or snow. So sea waves wave erosions or the or erosion caused by wave action. So that will result into the formation of landform and example which we were looking in the previous slide is the headwater headland and the formation of the beach.

So the erosion can also result into the formation of cliffy coastlines as we were looking at the photographs a few seconds back so further due to tectonic movement also we see the formation of the landforms. So you can have the cliffy banks you can have the formation of so cliffy banks formation of the headlands or you can say the terraces as we saw the terraces rural terraces when we are talking about the rural landforms here what we say is the change in the sea level either it is tectonic or eustatic because of the climatic effect glacial interglacial period we can see or what we will experience the formation of marine terraces.

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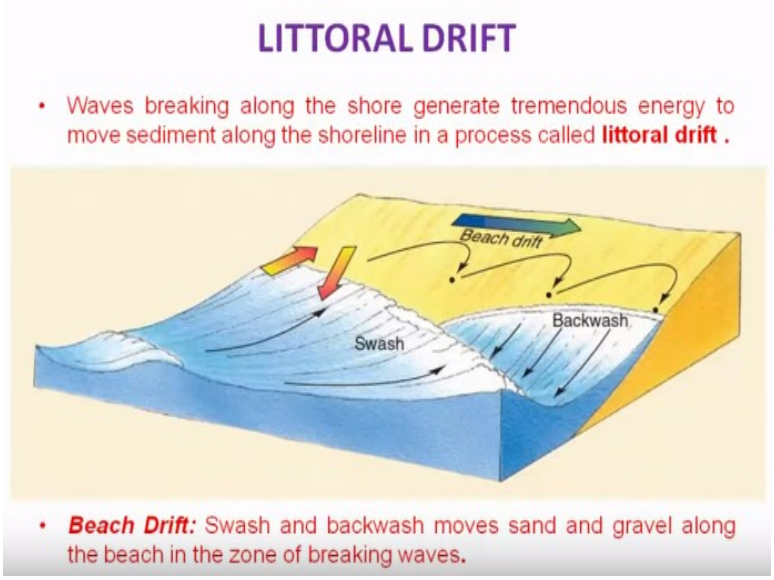

Now coming to this part of the littoral drift usually what we see is the wave waves breaking along the shore generate tremendous energy to move sediments along the shoreline in a process called littoral drift. Now this littoral drift in different location will allow us to see the formation of different landforms. So the red arrow shows the wave action and the back flow or the backwash of the waves which will result into the formation of beach.

Now the drift direction what you see here is the ocean water is coming here and getting down here so the drift direction is this one here. So the beach drift what we see is the swash and the backwash. So swash and the backwards move the sand and gravel along the beach in the zone of breaking waves. So we will stop here and we will try to continue in the next lecture. So in next lecture further we will see more of landforms and then how the waves are important they play an important role in developing the or creating the landforms or the landscape along the coastline. Thank you so much.