Geomorphology
Prof. Pitambar Pati
Department of Earth Sciences
Indian Institute of Technology – Roorkee

Lecture – 33
Coastal Geomorphology and Landforms

So friends good morning and welcome to this lecture series of geomorphology. Today we will discuss about this coastal geomorphology and landforms. So if you remember our last class, we are talking something about this coastal geomorphology, and we concluded that the coast the geomorphology is not only the present geomorphology that exists or what is going on in front of us at the coast changed many times from the geological past to recent so those changes by those agents.

So landforms characteristics of that particular environment or particular agent they are remaining and along this coastal zone its a relict structure and the present day coast also some new landforms are being created by the wave action, by the tides, by the currents, by the rivers and particularly the aeolian system the winds and some of these landforms. They are created by some organisms, so the present-day coastal geomorphology is a mixture or the complex combination of all those factors from the geological past to present.

For example, suppose we go to this early Holocene when there was glaciation or this late Pleistocene when there was a glaciation most of this water they were in the frigid form and the sea level was much below than the present one. So at that time as there was a gap of this sedimentation and the sink so that means this transportation or the river process river mouth the position of the river mouth was this level and the sink was at that level.

So that means the river mouth started eroding so that is why we found some of the gorge type of structures. Similarly, during glaciation there was glacier movement through some valleys and there are deep erosion and some of these erosional features they were also present in the present-day oceans, particularly along these coastal parts. So that means I want to say whatever the geomorphic features whatever these structures we are looking at the present day coast they are

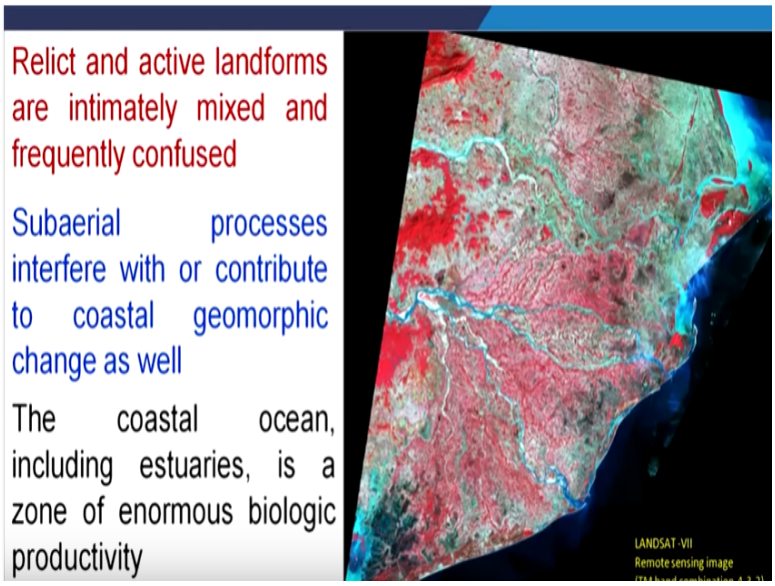
not the product of the present day processes only. Some of these processes are some of the landforms they were formed by some other agents in the geological past.

Due to climate change, due to tectonism but these are remaining there as a relict landforms. So we are talking something about the geomorphological agents we are working there. We have forget about talking about the tectonic process in the past also geological past even if in the present these coast mostly affected by the tectonic processes. For example, if we are confining ourselves along this Indian coast itself the East Coast, they are characterized by some buried basement falls, very long running basement falls are there.

Some of the basement falls they are active as a result the coast has been segmented into different parts with coast and grabens. However, this coast and grabens the irregularities they are covered by these present-day sediments. So that is why it is looking like a plain area but due to this halt activity this halting tectonic activities those area contents some of these landforms which are characteristics of that tectonic processes.

So that means along this coast we will get tectonic landform, aeolian landform, glacial landforms fluvial landforms and marine landforms. So that means in a biological landforms some of the landforms are created by human activities anthropological landform. So that means landforms are many but in the processes are also many, so we have to distinguish which type of surface that landforms they are formed by which type of process and which are the relict landforms which are formed during past processes and which are the present landform which are occurring nowadays. So this is the theme of this class today.

(Refer Slide Time: 05:32)



So relict and active landforms are intimately mixed and frequently confused. For example, if you confine ourselves here in this satellite imagery you see there are ridges see they are ridges similarly here and similarly this side also. These ridges are parallel to present day coast these ridges are the aeolian ridges they were formed in geological past. Similarly, presently you see here these are the ridges and present the coast is here and we are getting the ridges or this coastal activity some kilometer towards the land.

So these are the relict features and present day river mouths they were modified during this Pleistocene glaciation. So whatever the river mouth structure or river mouth characteristics nowadays they were once upon modified during these Pleistocene glaciation time and they are continuously modifying at the present day by the river processes. So these are the landforms there they are called relict landforms and if we date those relict landforms we can say when this relict landforms were formed, okay.

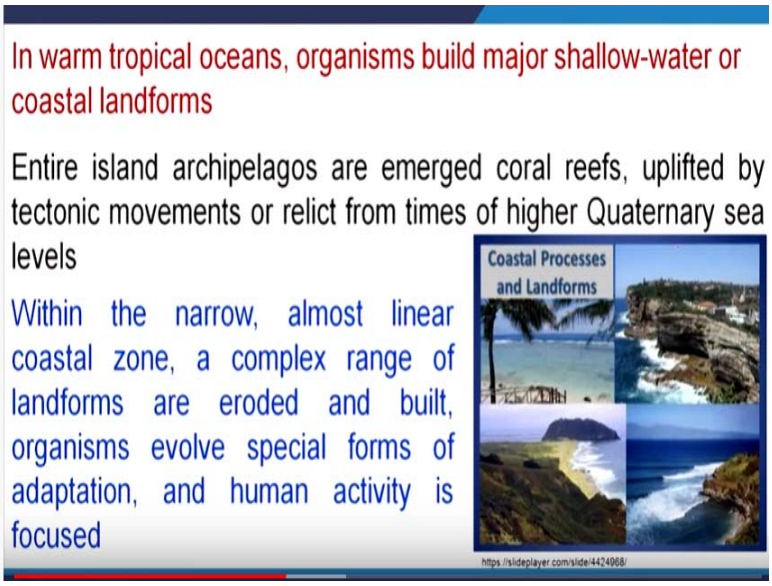
Sub-aerial processes interfere with and contribute to coastal geomorphic changes, sub-aerial processes so whenever you say about the coastal morphology, we are not only confining ourselves whether the marine activities or the ocean activity along the coast. Sub-aerial processes like wind, like rivers, the glaciers they also contribute are contributed in geological past in modifying this type of the coastal structures or coastal plains.

So the coastal ocean including estuaries is a zone of enormous biological activities. You see the estuaries or if you see this evidences from here, here there was a estuary existing here there was an estuary existing and here there was an estuary existing and these black areas along this coastal plain which is nowadays it is away from the coast and its confined within the mainland they were the estuaries of geological past.

So that means its indicating once up in a geological past this coast was somewhere here or the coast area was somewhere here, and this estuary was formed, and those estuaries are very much fertile for this product of biogenic material and these organic activities they create their own landforms. So we have a relict landforms, we have biological landforms we have aeolian landforms, these marine landforms, river landforms, the glacial landforms.

So that means this coastal zone if you confine you will find many of these agents geomorphic agents they have worked in geological part and some of these agents they are working nowadays, particularly the ocean and these aeolian activities or the wind. So if you remember when we are talking something about the aeolian activities mostly these parabolic dunes, the aeolianites they are confined along the coast zone.

(Refer Slide Time: 09:15)



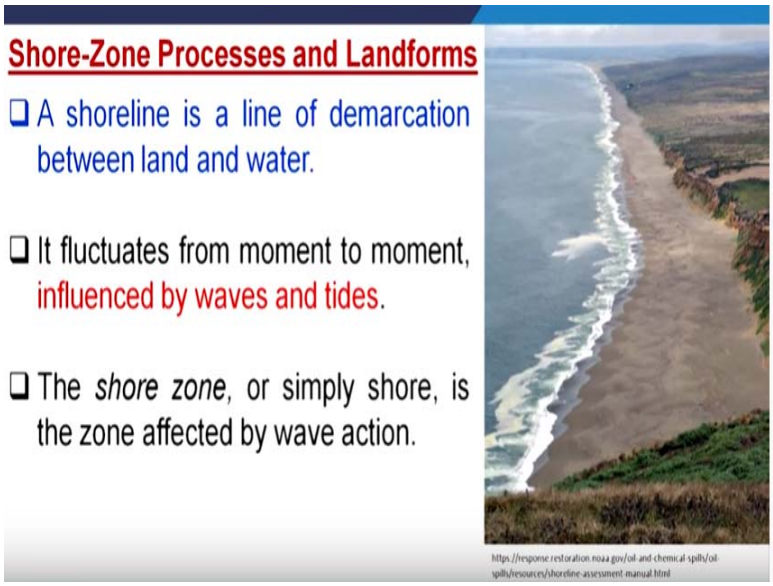
In warm Tropical Ocean organisms built major shallow water or coastal landforms. So where at what type of environment we are dealing with if it is cold environment the organic product will

be less but if it is warm environment the organics presence will be more. So more organics presence more will they modify and more they create these organic structures. So in particularly the warm water environments to those coasts which are along this warm water environment or one oceanic currents were growing along this coast.

So those parts are more vulnerable for organic products and mostly the organic landforms they are confined on these one tropical ocean. Entire Iceland archipelagos are merged coral reefs uplifted by tectonic movement of relict times higher quaternary sea level. These coral reefs they are very much sensitive to this warm water environment. So if you elaborate this coral reef, we may say they create a particular type of structure like the fringing reef, barrier reef, atolls and these are partly contributed by the tectonics.

With this narrow almost linear coastal zone a complex range of landforms are eroded and built continuously. Organisms evolve special forms of landforms and human activities also for coast. So that means this is narrow zone about 40, 50 kilometers width and somehow somewhere it is 100 kilometer width that zone is confined are highly focused with different geomorphic agents organisms human activities. So that is why the coastal landforms are more important landforms to study.

(Refer Slide Time: 11:19)



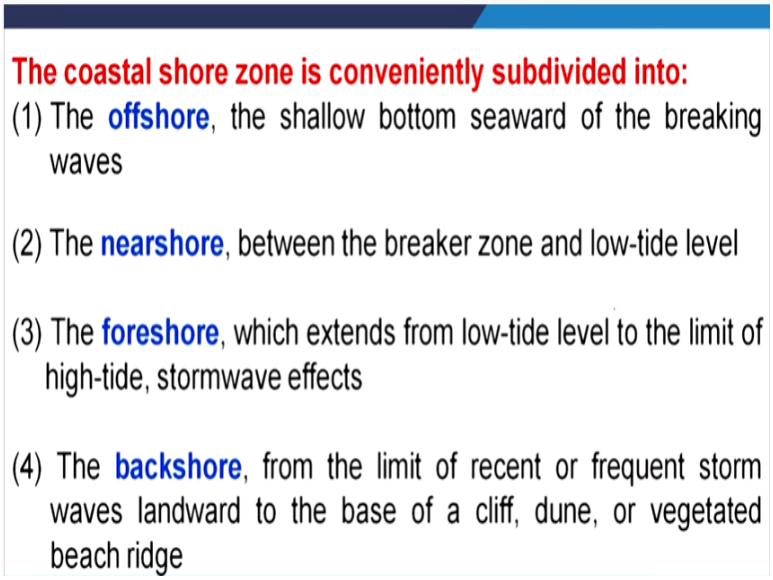
Now after coast we have to go to this shore zone environment so that means up to now, we are talking about these landforms which are near to the shore. So now let us discuss about this shore zone processes and landforms. So what is a shore zone processes? first of all we should describe what is a shoreline. So shoreline is a line of demarcation between land and water. So here if you see this is the shoreline but this shoreline it not a fixed line here.

So during high tide the shoreline moves in this way, due to low tide this shoreline moves this way. So that is why it is called shore zone rather than is only a shore. So shore zone it is a zone which is defined by these are bounded by this a high tide and low tide marks. So, that means this shore zone it is continuously affected by wave actions you see here the waves they are continuously eroding, depositing, transporting this material from the here.

So the shore zone is a very dynamic geomorphic landform which changes even if within day. So during high tide this whatever the landforms formed during the mean sea level that means other time during high time it will sense and will move sediment towards land and during low tide those sediments that will wagon moved back towards the ocean. So dynamic landform every 7 hours 6 hours or even a within day the landforms changes, it fluctuates from moment to moment influenced by waves and tides.

So it is not a fixed dune or fixed line it fluctuates this shore zone or simply it can be called shore is the zone affected by wave action. So here this is the shore zone and mostly it is the wave action it is modifying the shores.

(Refer Slide Time: 13:39)



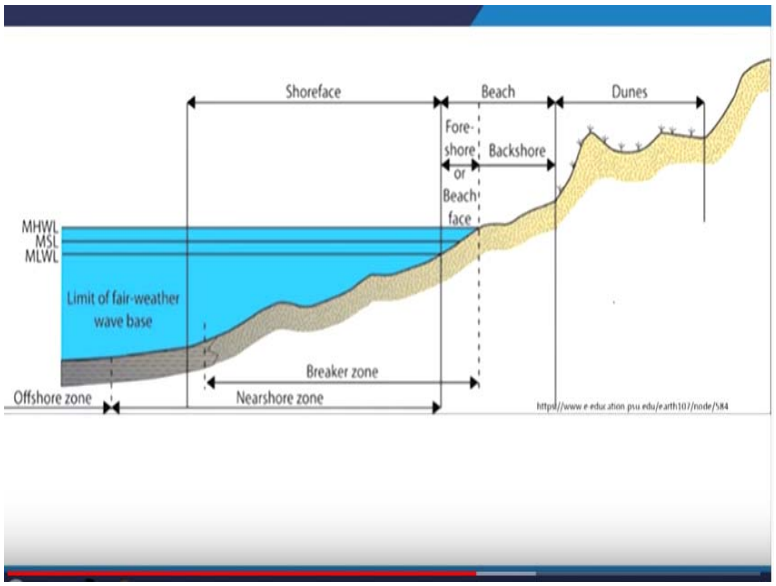
The coastal shore zone is conveniently subdivided into different segments. So depending upon the processes involved, depending upon the dominance of these processes this shore zone has been divided into different segments. First is the offshore, the shallow bottom seaward of these breaking waves. So what is offshore, off- means away so offshore it is away from the shore towards the ocean, so this is the zone it is the shallow water zone or the bottom zone where it breaks the sea waves.

When the wave is coming from this deep ocean towards the coast, this is a zone which breaks it. So breaks it means its amplitude increases wavelength decreases. So this breaker this is called also breaker zone. So this breaker zone around somehow some what kilometers away from this shore zone and it breaks the waves in two different forms so that is called offshore. Then near shore between the breaker zone and the low tide level.

Breaker zone is there from some kilometers away and the low tide low tide region that means when there is low tide. So the water level decreases so that zone which is confined between the low tide region and that breaker zone that is called near shore region. Then foreshore fore means front foreshore which extends from the low tide level to the limit of high tide level. So during high tide and during low tide this area it is called foreshore region.

So it is sometimes some other way it is called littoral zone also. So the area or the zone between high tide and low tide region that is called foreshore. Then back shore, backshore forms the limit of the recent or frequent storm waves landward to the base of this cliff, dune and vegetated ridges.

(Refer Slide Time: 15:54)



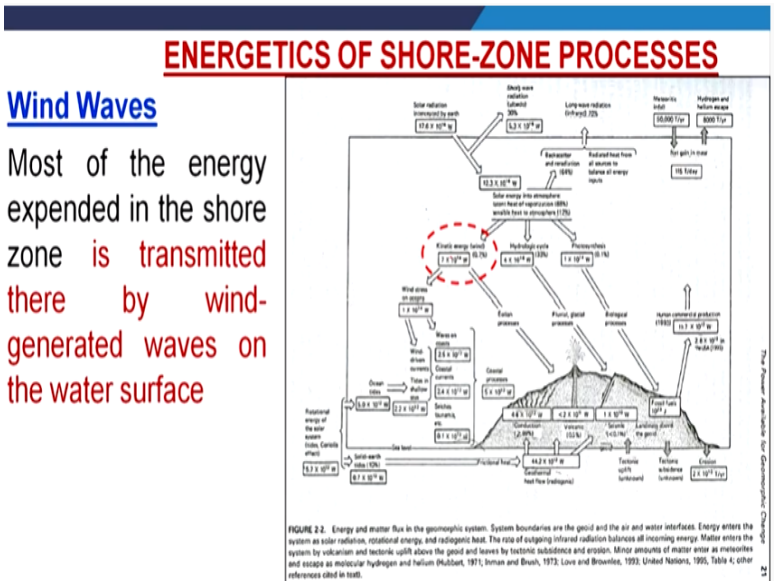
If you see in this figure all those zones has been marked here this is the back shore as we are talking now back shore is the high tide or these storm activities is there the maximum water level up to which the water can come during storm. Then it is the cliff or the vegetated part of this coast so this region it is called back shore and here this is the wave breaker the breaker zone here this the; shallow water you see it is coming and this gradually the depth suddenly it is increasing here.

So this is the breaker zone so the breaker zone and this so this is called offshore see this is the this is the main sea level here and this is a high tide level this is low tide level so this region from here to here this is called this is called so that is that is called breaker zone and similarly from high tide to low tide this is littoral zone or it is the other way called foreshore region. So these are the subdivisions and all these subdivisions are based on the nature of the wave activity.

So all these subdivisions this wave activity here is different from the wave activity here is different from the wave activity here and the main work of this zone is called breaker zone here

this total characteristics the wave which is coming from this to this direction the total characteristics changes from here and those characteristic change is responsible for weathering and erosion of this coast the transportation and deposition.

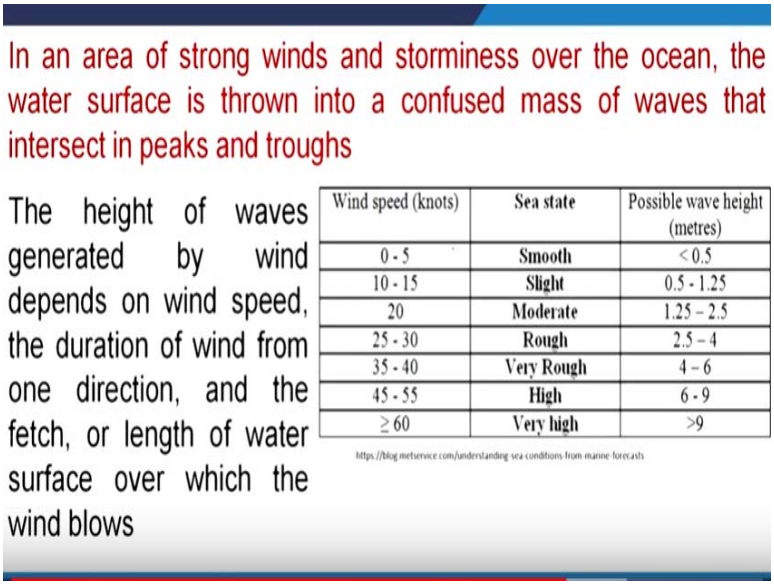
(Refer Slide Time: 17:40)



Now if we confined energy level at this coast and we know all these geomorphic agents they are energized by sun and the sun energy it is divided into different segments and finally subdivided into again either by wind by river their glaciers like that. So here wind waves if the most of this energy expended in the shore zone is transmitted there by wind generation waves or the water surface.

So here wind its creating waves there is a friction there is a shearing of wind and this water surface open water surface on the ocean body and is creating waves and that wave is coming and interacting along the shore. Due to this interaction of this waves this system either this deposit or a transport or they erode this material and finally the coastal geomorphology changes along the shore zone.

(Refer Slide Time: 18:51)



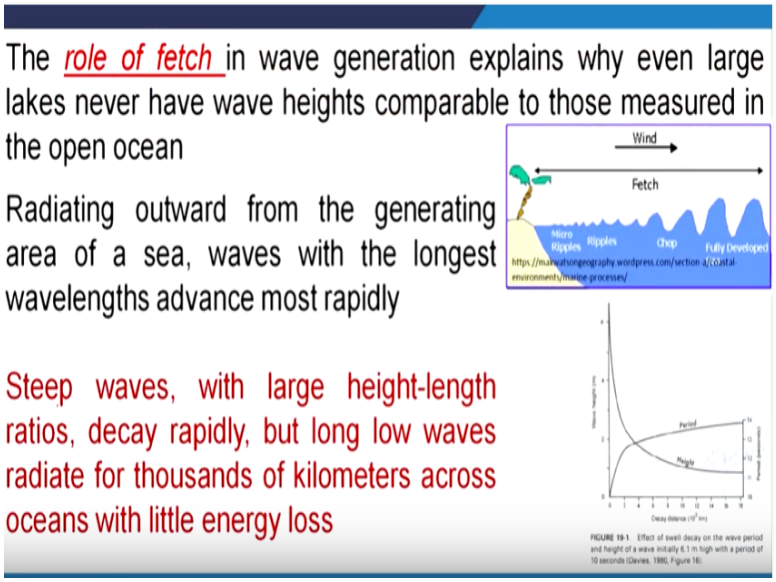
In an area of strong winds and storminess over the ocean the water surface is thrown into a confused mass of wave that is intersects the peak and troughs. So that means waves if you are creating these waves so this waves have some it is the trough and it is the crest and how much height the wave will attend what should be the wavelength of a wave wavelength. So that is depends upon the wind speed that depends upon the duration for which these wind is interacting with this ocean surface and the size of the wave that is responsible what type of landforms were going to get or along this coast zone.

So the wave nature that defines the coast geomorphology, so the height of wave generated by the wind depends upon the wind speed, the duration of the wind from one direction and the fetch of the length of the water it is very important if you see the fetch or length of this water surface over which the wind blows. So if you remember when we are talking about the aeolian processes we are talking about this a critical size of the sand that it will promote the formation of dune.

And it is the 4 to 6 meter if we have sand that is spread area 4 to 6 meter and continuous sand supply is there then we are creating a sand dune. Similarly, the fetch, fetch means it is the length of water surface over which the wind blows if the length of water surface is more that means wind had sufficient space to interact and finally it will create these waves. Otherwise the lakes are there the ponds are there though wind is blowing we are not getting waves.

Because this is a question of fetch. So fetch is the main factor here which defines how what should be the size of this wave what should be the height of this wave okay and size and height that will affect our coastal geomorphology this either erosion or deposition. How much erosion will be there how much deposition on there that depends upon the size of the wave and finally the fetch which decides what should be the size of the wave.

(Refer Slide Time: 21:26)



So it is the role of fetch in waves generation explains why even large lakes never have wave heights comparable to those measured in the open ocean. So, open ocean we have vast open area, so wind is free to move and free to interact. So that means a vast area is affected by the wind activity and continuous wind supply along this vast area it creates wave and that wave generate from a place it transforms it transmits towards the coast towards all directions and transmits towards the coast and once it is coming to the breaker zone that here this nature of the wave changes.

So once it was created as a high wavelength low amplitude wave but once it is coming to the breaker zone it is coming to low wavelength and high amplitude waves and finally breaks down. Radiating outward from the generation area of the sea waves with longest wavelength advance most rapidly and those small wavelength trailed behind. So here if you see this is the fetch and this is the wind blowing here in this direction.'

First it starts with micro ripples then the ripple size increases then it stops then finally it is a fully developed wave. So this fully developed web it migrates in this way so once it reaches to the breaker zone it breaks and this nature whatever the wave height and this wave size is here at the breaker zone its changes. So, steep waves with large height length ratio decay repeatedly but the long wave will radiate for thousands of kilometers across the ocean with little energy loss.

So it is very important to understand here those long wavelengths they travel fast and there can travel in hemispheric distance. So that is why it is said that the energy for wave erosion in that area not necessarily this energy will be supplied from kilometers away it may be the other hemisphere. So this wavelength if it is so high wavelength there can travel to the other hemisphere even thousands of kilometer and it will interact with the coast here.

So that means I want to say here this coastal region is the combination of many processes and mostly the wave which is currently modifying these coastal processes and coastal plain but that does not mean the coastal plain is the only product of this present activity. The coastal plain whatever the geomorphology geology and the landforms are there where the combination of many processes in the geological past and including the present and the past geomorphic processes or geomorphic landforms.

They are called the relict landforms and some of the relict landforms they are constantly being modified by the present day processes and the ultimate product is the coastal products. So thank you very much thank you and we will meet in the next class.