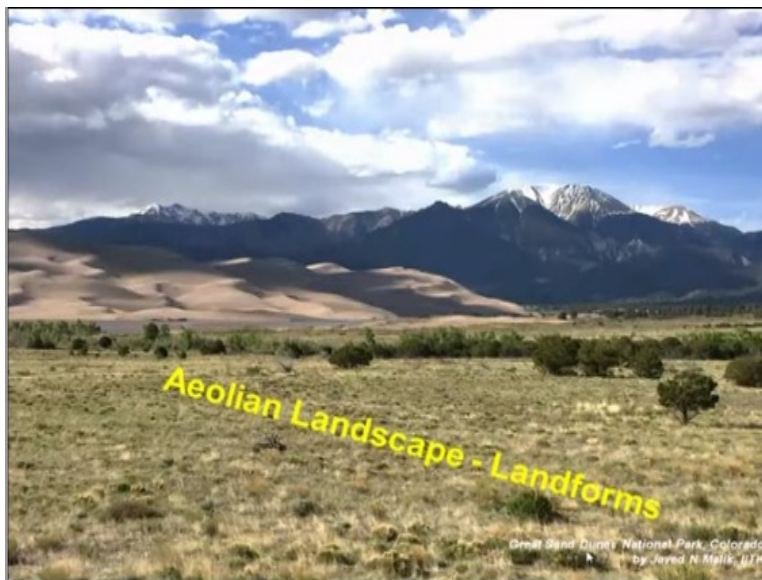


Geomorphic processes: Landforms and Landscapes
Prof. Javed N. Malik
Department of Earth Sciences
Indian Institute of Technology Kanpur

Lecture -35
Aeolian Processes and Landforms (Part I)

So welcome back this is the probably the last topic which we are going to cover in this course and this is related to the landforms developed by wind action. So, basically what we called that as an Aeolian or Eolian. Either you say Eolian or Aeolian just a matter of the the words but the landscape remains the same.

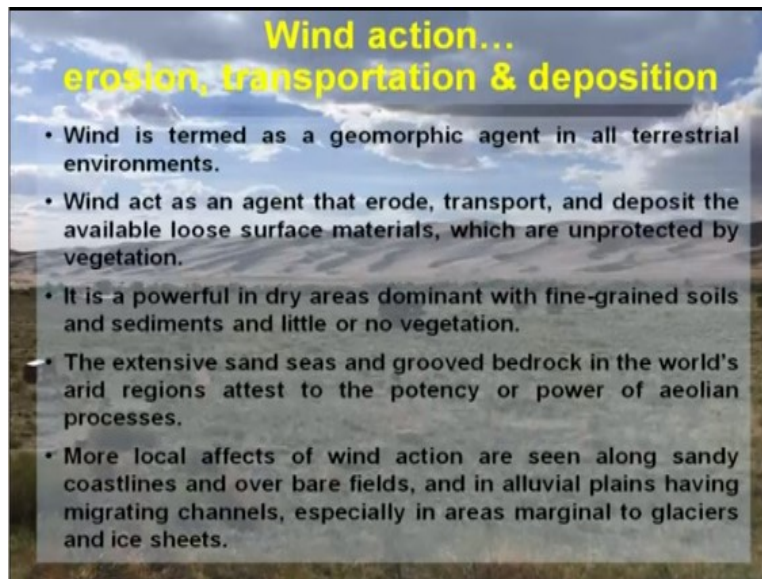
(Refer Slide Time: 00:49)



So, what you see at the background here in the first photograph is the cold desert. So, we will be looking at some examples of the deserts from different regions or the continents around the globe and also I try to show you couple of satellite data couple of in couple of slides or from India also. So, let gets started so what do you see is mainly as soon as we talk about the Aeolian landforms the first thing which comes in our mind is sand dunes.

So, the best location in India to view the or to enjoy the desert or the admire the sand dunes is your ah Rajasthan. This is another picture of the sand dunes and this photograph is from as I told from the US and this area is named as Great sand dunes National Park, Colorado.

Refer Slide Time: 01:55)



Now, when we talk about the wind as an agent then there are three main important points which comes in mind is that wind action will result into erosion. And if erosion is there again very much similar to what we discussed in the fluvial systems that erosion transportation and deposition. So, here also the wind as an agent will erode transport and deposit. But there the water was the agent here the wind is the agent so this is the only difference between the two.

So, further if you look at a few important points so if you say wind is a term it is termed as a geomorphic agent in all terrestrial environments. Wind act as an agent that erode, transport and deposit the loose surface material whichever is available to wet on its way which are mostly the areas the erosion will be extensive in the areas which are devoid of vegetation. So, it is a powerful in dry areas dominant with fine grained soil and sediments and little or no vegetation.

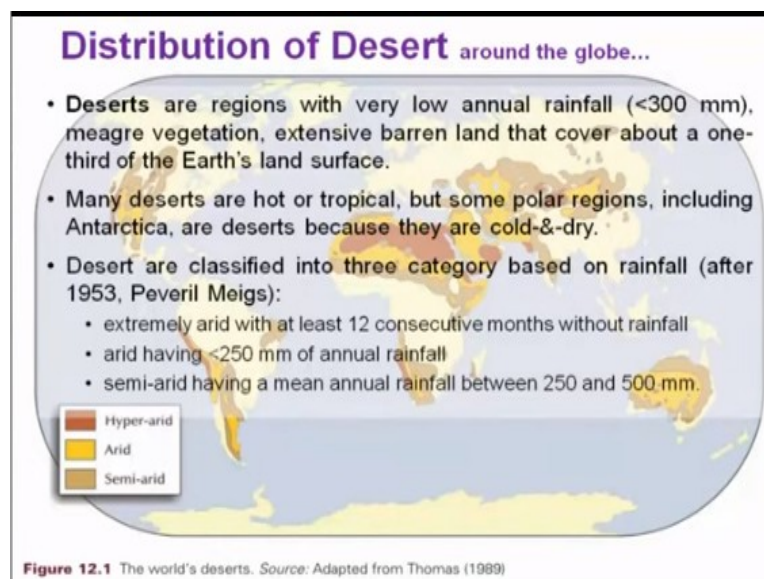
So, mainly the action that is we are talking about the wind action will be extremely dominant in the region where the sediments are loose and fine grains not the coarse and deposits. But, if you are having fine grain soil which is barren not covered with the vegetation so the wind action will be extremely dominated or it will be powerful. The extensive sand seas and grooved bedrocks in the world's arid regions attest to the potency or power of Aeolian processes.

So, the like wind action can also erode the bedrocks and it can groove the bedrock so it is one of the powerful agent of the process Aeolian processes are quite powerful in eroding the landscape and sculpturing the landscape. More local effects of wind action are seen along sandy coast line and over barren fields and in alluvial plains. So, if we consider this in context with India then we will be able to pick up the wind action as well as the Aeolian landscape though it may not be in complete desert.

But you will be able to see the development of the landforms related to the Aeolian activity and the coastal areas as well as the in areas where there is the area is bearing like the devoid of vegetation. It could be either the areas close to the river banks where the channels have turned as into migrate or areas marginal to glacial. So, I was talking about the cold desert so again in that region you will come across where the landscape is totally barren.

The wind action will result into the sculpturing of the landscape it can erode the bedrock, erode the material transport the material fine deposits as well as coarse deposit and result into the deposition in the formation of the landscape.

(Refer Slide Time: 06:12)



Now distribution of the desert across the globe you will be able to note us that in the middle part the globe that is we are talking about the topics you will not able to see much of the desert formation. Locally, as I was talking about you can come across in the areas like coastlines where

the rivers are migrating that those areas can also still show the local deposition by the wind action and all that.

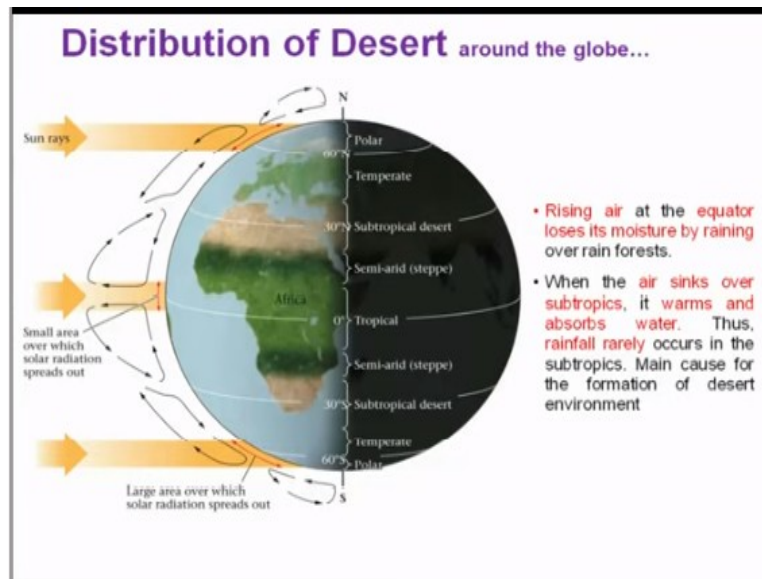
But mostly that the overall distribution if you look at then you see in an areas which are hyper-arid as well as arid region but in semi-arid regions you will not be able to see much of the formation of deserts. So, distribution of desert around the globe: deserts are regions with very low rainfall and the rainfall ranges less than like 300 millimeter meager vegetation, extensive barren land that covers about one third of earth's land surface.

So, deserts are also extensive and it is not that the way we see the deserts in a very limited pockets but it covers about a one third of earth's land surface. Many deserts are hot or tropical, but some are polar in the polar regions also. So, we have cold desert areas including Antarctica are desert because they are cold and dry. So most of the deserts are hot or you can say the tropic or sub tropic regions but some are in the areas where we are having glaciers so it is cold and dry.

So, desert are classified in three categories based on the rainfall extreme arid areas with at least 12 consequent months without rainfall. So, throughout the year the area experiences a dry phase then comes that is you can classify that as an hyper arid areas, the arid regions are the areas which are having the rainfall that is an annual rainfall less than 250 millimeter. So based on because the rainfall is less vegetation will be very sparse and most of the areas will be exposed to erosion.

So, when you say that the rainfall is less of course the water is not so much available as in agent so wind action will be more dominant in such regions. And then the third is semi-arid regions with a mean annual rainfall between which ranges between 250 to 500 millimeter. So, these are the three areas and based on this rainfall pattern one can classify the deserts and mostly the deserts you will see that the extensive deserts are in hyper arid areas.

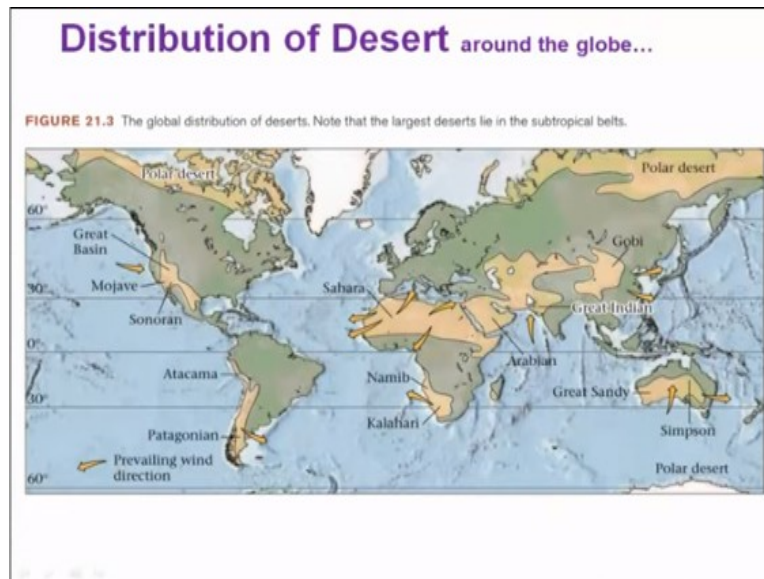
(Refer Slide Time: 09:54)



Further, if you look at the globe then we have the north and the south poles we have polar areas and then gets into the temperate, subtropical deserts on either side on the southern hemisphere as well as in the northern hemisphere and then we have the tropical in the center and then semi-arid on again on the either side of the equator. So, the reason here is very simple is the rising air at the equator loses its moisture by raining and this rainfall is mostly seen in the rain forest area in that.

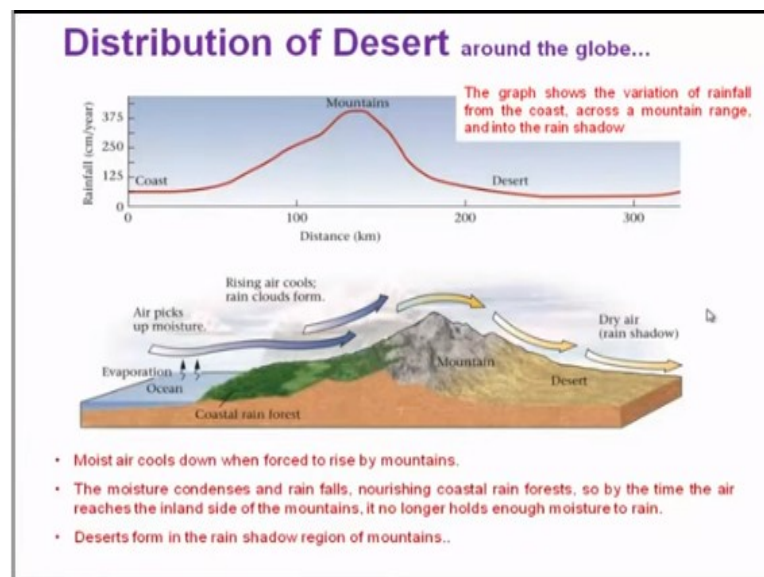
And then what we have is when the air sinks over subtropics, it warms and absorb water. Thus, rain rainfall is rare in subtropical areas main cause for the formation of desert is the rare rainfall in the subtropical areas and this is because of the absorbed water whereas in the tropical regions the rising air loses its moisture giving rise to the rainfall. So, this is this two are the main reasons for the location or the development or the formation of the deserts in subtropical areas mainly in the northern as well as the southern hemisphere.

(Refer Slide Time: 11:45)



These are the major deserts or the distribution of desert around the globe. So, if you want to see the extensive one which is been shown here is your Sahara desert and then on the northern side you have the polar desert and so on. And this region I will show couple of one or two slides of this, this region is your Great Indian Desert that is termed as Thar Desert.

(Refer Slide Time: 12:17)



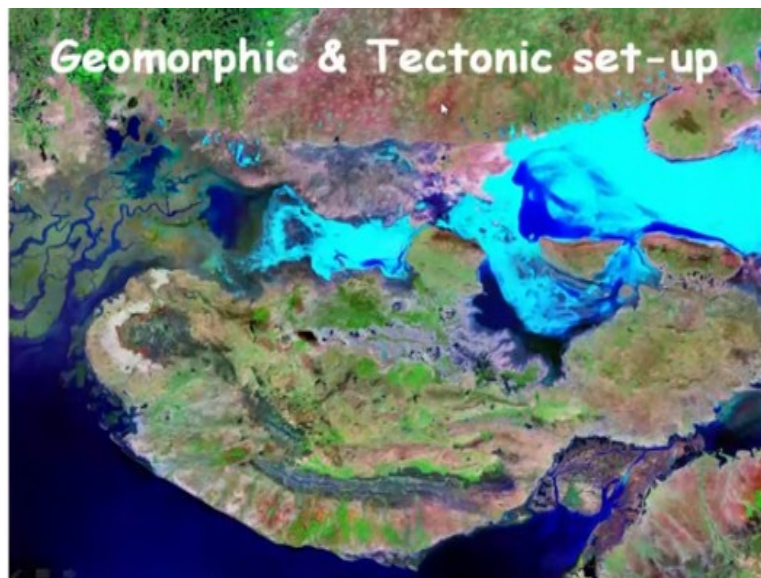
Now, this is another important factor which will play a key role in development of desert on the liver side of the mountains with respect to the wind direction. Suppose you having a landscape within coastal area which is been shown on your left and the moist air which picks up the

moisture from the ocean through evaporation will flow towards the land. So if the rising air because of the origin of because of the effect of the mountains will rise and air cools down and result into the rainfall.

But when the air crosses the mountains it is dry and that is what we called the rain shadow zone. So, moist air cools down when forced to rise by mountains. This is in particular in this area when the moist air comes here from the ocean and so it will result into the rainfall. So the moisture condenses and rain falls, nourishing coastal rain forests, so by the time the air reaches the inland side of the mountains it no longer holds enough moisture to rain and that is what we called the rain shadow area.

And this graph which shows here is the rainfall centimeter per year and as we move away in away from the mountains on the back side of the mountains then you have very low rainfall. So, maximum rainfall is over here and that is close to the mountains and the foot hills there is no very very less amount of rainfall. So, graph shows the variation of rainfall from the coast across a mountain range and into the rain shadow region. So, this is also one of the the reason if we consider the topography which plays an important role.

(Refer Slide Time: 14:53)



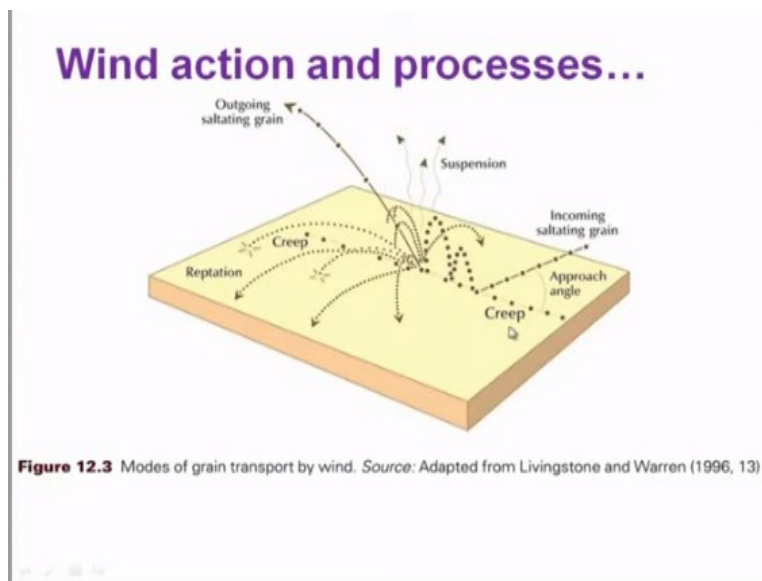
This is what I was mentioning about the desert the Great Indian desert is this one which marks the boundary between India and Pakistan here this is the border and Gujarat and this is what this side is Pakistan. So this landscape is the Great Indian Desert or you can say the Thar Desert.

(Refer Slide Time: 15:24)



Another photograph of that so this is an this is an satellite image (15:30) composite image of the region so this pattern of the landscape is indicative of desert that is what we are we called as a Thar desert.

(Refer Slide Time: 15:44)



Now, wind action and processes so there are number of patterns in which the transportation of material will take place either it is in suspension and saltation, reptation, creep. So, there will be

number of pattern in which the material will be transported and this again it will depend on the energy condition of the wind as well as the material which is been carried that is the size also. So you cannot expect and complete blow or saltation or the transportation of the coarse and material.

So, let see the different wind action and processes which are involved in terms of transportation.

(Refer Slide Time: 16:44)

Wind action and proce

Outgoing saltating grain

4 Suspension

- **Wind transport encompasses four processes –**
- **Saltation:** It is a motion of the sand grains confined to a short distance transport and lifting of the grain at a height of ~2m. When the sand grain is dropped on surface it rebounds and impart renewed energy to other sand grains.
- **Reptation:** On hitting the surface, saltating grains release a small splash-like shower of particles that make small hops from the point of impact. This process is reptation.
- **Suspension:** Particles of silt and clay lifted into the atmosphere become suspended and may be carried to a greater distance.
- **Creep:** Coarse sand and small pebbles moved forward by rolling and sliding with the momentum gained from the impact of jumping sand particles

So, wind transport encompasses four processes so one is saltation now it saltation is a motion of sand grains confined to a short distance where the material is transported for a short distance and lifting of the grain at a height of about 2 meters from the surface. So, when the sand grain is dropped on the surface it rebounds and impart renewed energy to another grain. So, if you drop some material from an elevation and if you are having on the ground surface which has an cover of thin sand cover.

Then you will have that the few sand grains will blow off where you have dropped the material or any stone or anything. So, this same process which is been talked here is that it imparts renewed energy to other sand grains. Now, coming to another one another process of transportation is reptation. Now, this is on hitting the surface saltating grains release a small splash of shower that is when you it drop one grain it will result into the other grains to move from that location.

So, shower of the particles that makes small hops like features so this has been shown here so if you see the saltation then this is what is taking place or reptation. So when you drop one grain here then you will have the sparkling or the movement of the grains from that particular point that is your reptation. Suspension: particles of silt and clay size lifted in the atmosphere become suspended and may be carried for a greater distance.

Now, in case of this two where we are talking about a short distance and this also is just an hopping from one place where the previous grain is hitting the surface movement is not for the very very long distance. But if you look at this one this is a fine grain silt and clay so if the wind action or the wind energy condition is very high then it will result into the lifting of into the atmosphere and it will be transported for a greater distance.

Now, fourth one is creep. Now this will happen in case of coarse sand and small pebbles so even the pebbles or the or you can say the gravel of pebble size can be moved forward by rolling and sliding. So, once it the material gains the momentum from the impact of jumping sand particles it can be slid. So it can roll or slide. So, coarse sand and small pebble moved forward by rolling and sliding with the momentum gained by the impact of jumping sand particles.

So, this will come from reptation so the four processes should be kept in mind which will be very commonly observed in the desert area and these processes are responsible for transporting and depositing the material ranging from pebble size to silt and clay size.

(Refer Slide Time: 21:23)

Wind action and processes...

- Wind erodes dry, bare, fine-grained soils and sediments. It is most effective in deserts, sandy coasts, and alluvial plains next to glaciers.
- Particles caught/transported by the wind bounce (saltation), hop (reptation), float (suspension), or roll and slide (creep).
- Several landforms are products of wind erosion. e.g., are lag deposits and stone pavements, deflation hollows and pans, yardangs and Zeugen, and ventifacts.
- Sand accumulations range in size from ripples, through dunes, to dune-fields and sand seas.
- Dunes may be grouped into free and anchored types.

Further wind erodes dry, bare, fine grain soils and sediments. It is most effective in deserts so wind erodes mainly the dry material. This is more effective in deserts, sandy coasts and alluvial plains next to glacier. Particles transported by the wind bounces that is what you called saltation, it hops reptation, floats suspension and roll and slide which is we called creeping. Now, because of the different action or the wind transport or the processes transport processes different landforms can be formed.

We will discuss few here where the most common is I was talking about that as soon as we talk about the desert then you can you say that fine it is the desert will be comprising of sand dunes. But there are many which are seen or observed in the areas where you are having different material which are transported by the wind. So, several landforms are product of wind erosion examples are lag deposits and stone pavements, deflation hollows and pans, yardangs zeugen and ventifacts.

We will see few of them so sand accumulation if we take in terms of the size of the landforms it can result into the different categories. One is very small you can say ripple marks or the ripples which are formed for this by the wind action then you can have dunes, you can have dune fields or you can have sand seas. So, extensive deserts and then another what we see usually is the dune may be grouped into free and anchored types either the dune can move keep moving or they are

anchored to any vegetal cover. So we will stop here and continue in the next lecture. Thank you so much.