

1 2  **Distribution and Causes of Dry Lands**

- What Is Meant by *Dry*?
 - A dry climate is one where yearly precipitation is not as great as the potential for evaporation
 - Dry regions cover 30 percent of Earth's land surface
 - Two water-deficient climatic types are commonly recognized
 - Desert (or arid) regions, and
 - Steppe (or semiarid) regions
- Desertification: the persistent degradation of dry-land ecosystems—desert-like conditions are expanding worldwide

3 **Dry Climates**4 **Distribution and Causes of Dry Lands**

- Subtropical Deserts and Steppes
 - Lie between the Tropics of Cancer and Capricorn
 - Virtually unbroken desert environment stretching for more than 9300 kilometers
 - Subsiding air masses
 - The basic cause of bands of arid and semi-arid areas
 - Regions of high pressure (sinking air that is compressed and warmed)
 - Few chances for cloud formation and precipitation

5 **Subtropical Deserts**6 **Distribution and Causes of Dry Lands**

- Subtropical Deserts and Steppes
 - West Coast Subtropical Deserts
 - Cold ocean current cools air and prevents it from rising
 - Few chances for cloud formation and precipitation
 - Often foggy areas
 - » Atacama Desert, South America
 - » Namib Desert, south-western Africa

7 **Distribution and Causes of Dry Lands**

- Middle-Latitude Deserts and Steppes
 - Sheltered in deep interiors of large landmasses
 - Far-removed from ocean moisture
 - Gobi Desert, central Asia
 - Mountain barriers
 - As prevailing winds meet mountains, the air is forced to ascend where it rises, expands and cools, producing clouds and precipitation
 - Air flowing over the leeward side of the mountain is dry and forms a rainshadow
 - Coast Ranges, Sierra Nevada and Cascades, North America

8 **Rain Shadow Deserts**9 **Precipitation in Washington**10 **Geologic Processes in Arid Climates**

- Weathering
 - Chemical weathering processes not as prominent
 - Mechanical weathering more prominent
 - Some chemical weathering does occur over long spans of time
 - Produces clay, thin soils, and oxidation of iron-rich sediments

11 **Geologic Processes in Arid Climates**

- The Role of Water
 - Water still plays an important role in shaping dry landscapes
 - Most streambeds are dry most of the time
 - Ephemeral streams (intermittent streams) only carry water in response to specific

periods of rainfall

– May only flow a few days or hours a year

- When rain falls, it is too much to soak in and most of it flows as runoff into the streambeds

– Desert floods arrive suddenly and subside quickly

12 Ephemeral Stream

13 Geologic Processes in Arid Climates

- Different names are used for ephemeral streams in various regions
 - *Wash* and *arroyo* (western United States)
 - *Wadi* (Arabia and North Africa)
 - *Donga* (South America)
 - *Nullah* (India)

14 Wadi in North Africa

15 Geologic Processes in Arid Climates

- The Role of Water
 - Some permanent streams do cross arid regions
 - Originate *outside* the desert in well-watered mountains
 - Must contain enough water to compensate for loss from evaporation in arid region
 - Example: Colorado and Nile Rivers
 - While infrequent, running water does *most* of the erosional work in deserts

16 Basin and Range: The Evolution of a Desert Landscape

- Arid regions typically have interior drainage because the intermittent streams do not flow to the ocean
 - *Basin and Range* province has basins, local base levels, so erosion occurs without reference to the ocean
- Landscape evolution
 - Uplift of mountains
 - Running water erodes and transports materials to the basin

17 Landscape Evolution in the Basin and Range

18 Basin and Range: The Evolution of a Desert Landscape

- Landscape Evolution
 - Sediment-laden rivers from sporadic rains deposit debris at the mouth of a canyon
 - Runoff spreads out over gentler slopes and quickly loses velocity
 - This fan-shaped sediment deposit is called an alluvial fan
 - Coarsest material deposited first
 - A bajada forms from the coalescing of multiple fans

19 Bajada

20 Basin and Range: The Evolution of a Desert Landscape

- Landscape Evolution
 - During heavy rainfall, streams flow across the bajada to form a shallow, short-lived playa lake
 - The dry, flat lake bed left after the water evaporates is called a playa
 - Continued erosion diminishes the mountains to a few isolated bedrock knobs called inselbergs

21 Playa in Death Valley

22 Death Valley

23 Transportation of Sediment by Wind

- Differs from that of running water in two ways:
 - Wind is lower density and less capable of picking up and transporting coarse materials
 - Wind is not confined to channels and can spread sediment over large areas

24 Transportation of Sediment by Wind

- Bed Load

- The bed load is carried by wind close to the surface
 - Consists mostly of sand grains
 - Sand moves across the surface in a process called saltation (by bumping and skipping)
- Height of the bed load rarely exceeds one meter above the surface, generally no higher than 0.5 meters

25 **Transporting Sand**

26 **Transportation of Sediment by Wind**

- Suspended Load
 - The suspended load is carried high into the atmosphere
 - Consists mostly of silt-sized particles
 - Surface area must be high compared to weight
 - Example: flat clay particles
 - Hard to move fine particles unless they have been disturbed on the surface
 - Example: a clay road with and without a car driving over it
 - The suspended load can be transported far distances
 - Dust from the Sahara can reach the Caribbean

27 **Wind's Suspended Load**

28 **Wind Erosion**

- Compared with glaciers and running water, wind is an insignificant erosional agent
 - More effective in arid regions
 - Dryness and scant vegetation are important for wind to be effective at eroding
 - Example: Dust Bowl in 1930s

29 **Wind Erosion**

- Deflation and Blowouts
 - Deflation is the lifting and removal of loose material
 - Hard to notice because the entire surface is being lowered
 - During the Dust Bowl, vast areas were lowered by one meter in a few years
 - Deflation also produces blowouts (shallow depressions)
 - Can range from small dimples to depressions that are 50 meters deep and several kilometers across

30 **Blowouts**

31 **Wind Erosion**

- Desert Pavement
 - Many deserts have a veneer of pebbles and cobble called desert pavement
 - Forms from an initial surface of coarse pebbles
 - Fine, windblown grains are trapped between the pebbles
 - Gravity and infiltrating rainwater move the fine sediments beneath the cobbles

32 **Desert Pavement**

33 **Formation of Desert Pavement**

34 **Wind Erosion**

- Ventifacts and Yardangs
 - Wind also erodes by abrasion (scraping)
 - Windblown sand *cuts and polishes* rock surfaces
 - Creates interestingly shaped stones called ventifacts
 - Wind also creates streamlined landforms oriented parallel to the prevailing wind direction called yardangs

35 **Shaped by the Wind**

36 **Wind Deposits**

- Two types of depositional landforms are created by wind
 - Dunes
 - mounds and ridges of sand from the wind's bed load
 - Loess

- extensive blankets of silt once carried in suspension

37 Wind Deposits

- Sand Deposits
 - Sand will accumulate wherever an obstruction blocks wind flow, creating a dune
 - Dunes often form around a clump of vegetation or rocks
 - Most dunes have an *asymmetrical profile*
 - Windward slope is gently inclined and the steeper leeward slope is called the slip face
 - » The slip face typically maintains an angle of 34 degree (the angle of repose for sand)

38 White Sands National Monument

39 Wind Deposits

- Sand Deposits
 - As sand is deposited on the slip face, layers form *inclined to prevailing wind direction*, creating cross bedding
 - Moving sand can be troublesome for permanent structures like roads and buildings

40 Cross Bedding

41 Moving Sands

42 Wind Deposits

- Types of Sand Dunes
 - Dunes are classified into six basic types *based on their size and shape*
 - Barchan dunes are solitary sand dunes shaped like crescents
 - Form where sand supplies are limited and the surface is flat, hard, and lacking vegetation
 - Transverse dunes are a series of long ridges oriented at right angles to prevailing winds
 - Form where sand is plentiful and vegetation is sparse
 - Most coastal beach dunes are transverse dunes
 - Barchanoid dunes are an intermediate form of dune between barchan and transverse dunes

43 Wind Deposits

- Types of Sand Dunes
 - Longitudinal dunes form parallel to prevailing winds where sand supplies are moderate
 - Parabolic dunes form when vegetation partially covers the sand
 - Star dunes are isolated hills of sand that develop when wind directions are variable

44 Types of Sand Dunes

45 Wind Deposits

- Loess (Silt) Deposits
 - Windblown silt deposits
 - Material is deposited by storms over thousands of years
 - Sources of sediments come from deserts and glacial outwash deposits
 - Loess in China originates from desert basins in central Asia
 - Loess in the United States and Europe is the product of glacial material

46 Loess

47