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Earth's Dynamic Systems: Deserts

The Dry Places

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Conclusion

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Introduction

A desert is a landscape where little precipitation occurs and, consequently, living conditions create unique biomes and ecosystems. The lack of vegetation exposes the unprotected surface of the ground to denudation. About one-third of the land surface of the Earth is arid or semi-arid. This includes much of the polar regions, where little precipitation occurs, and which are sometimes called polar deserts or "cold deserts".

Deserts can be classified by the amount of precipitation that falls, by the temperature that prevails, by the causes of desertification or by their geographical location. Deserts are formed by weathering processes as large variations in temperature between day and night strain the rocks, which consequently break into pieces. Although rain seldom occurs in deserts, there are occasional downpours that can result in flash floods.

Rain falling on hot rocks can cause them to shatter, and the resulting fragments and rubble strewn over the desert floor are further eroded by the wind. This picks up particles of sand and dust, which can remain airborne for extended periods - sometimes causing the formation of sand storms or dust storms. Wind-blown sand grains striking any solid object in their path can abrade the surface. Rocks are smoothed down, and the wind sorts sand into uniform deposits.

The grains end up as level sheets of sand or are piled high in billowing dunes. Other deserts are flat, stony plains where all the fine material has been blown away and the surface consists of a mosaic of smooth stones, often forming desert pavements, and little further erosion occurs. Other desert features include rock outcrops, exposed bedrock and clays once deposited by flowing water. Temporary lakes may form and salt pans may be left when waters evaporate.

Animals need to keep cool and find enough food and water to survive. Many are nocturnal and stay in the shade or underground during the day's heat.

The chapters that follow move through this subject in the order a researcher would meet it. First comes the historical discovery of deserts, how travelers and scientists came to map and name the world's drylands. Then the physical science: why deserts exist where they do, how wind and water shape them, and what their climates are like. The middle chapters cover the characteristic landforms, the instruments and expeditions that have measured them, and the deserts of other worlds. The closing chapters look forward to the research questions of the coming decades and end with a collection of the odder facts the subject has accumulated along the way.

Chapter 1: The Discovery of Deserts

Some annual plants germinate, bloom, and die within a few weeks after rainfall, while other long-lived plants survive for

They tend to be efficient at conserving water, extracting most of their needs from their food and concentrating their urine. Some animals remain in a state of dormancy for long periods, ready to become active again during the rare rainfall. They then reproduce rapidly while conditions are favorable before returning to dormancy. People have struggled to live in deserts and the surrounding semi-arid lands for millennia.

Nomads have moved their flocks and herds to wherever grazing is available, and oases have provided opportunities for a more settled way of life. The cultivation of semi-arid regions encourages erosion of soil and is one of the causes of increased desertification. Desert farming is possible with the aid of irrigation, and the Imperial Valley in California provides an example of how previously barren land can be made productive by the import of water from an outside source.

Many trade routes have been forged across deserts, especially across the Sahara, and traditionally were used by caravans of camels carrying salt, gold, ivory and other goods. Large numbers of slaves were also taken northwards across the Sahara. Some mineral extraction also takes place in deserts, and the uninterrupted sunlight gives potential for capturing large quantities of solar energy.

English desert and its Romance cognates (including Italian and Portuguese deserto, French désert and Spanish desierto) all come from the ecclesiastical Latin d?sertum (originally "an abandoned place"), a participle of d?serere, "to abandon". The correlation between aridity and sparse population is complex and dynamic, varying by culture, era, and technologies; thus the use of the word desert can cause confusion.

In English before the 20th century, desert was often used in the sense of "unpopulated area", without specific reference to aridity; but today the word is most often used in its climate-science sense (an area of low precipitation). Phrases such as "desert island" and "Great American Desert", or Shakespeare's "deserts of Bohemia" (The Winter's Tale) in previous centuries did not necessarily imply sand or aridity; their focus was the sparse population. Deserts occupy about one third of Earth's land surface. Bottomlands may be salt-covered flats.

Eolian processes are major factors in shaping desert landscapes. Polar deserts

(also seen as "cold deserts") have similar features, except the main form of precipitation is snow rather than rain. Antarctica is the world's largest cold desert (composed of about 98% thick continental ice sheet and 2% barren rock).

Some of the barren rock is to be found in the so-called Dry Valleys of Antarctica that almost never get snow, which can have ice-encrusted saline lakes that suggest evaporation far greater than the rare snowfall due to the strong katabatic winds that even evaporate ice. Deserts, both hot and cold, play a part in moderating Earth's temperature, because they reflect more of the incoming light and their albedo is higher than that of forests or the sea.

A desert is a region of land that is very dry because it receives low amounts of precipitation (usually in the form of rain, but it may be snow, mist or fog), often has little coverage by plants, and in which streams dry up unless they are supplied by water from outside the area. Deserts generally receive less than 250 mm (10 in) of precipitation each year.

The potential evapotranspiration may be large but (in the absence of available water) the actual evapotranspiration may be close to zero. Semi-deserts are regions which receive between 250 and 500 mm (10 and 20 in) and when clad in grass, these are known as steppes. Most deserts on Earth such as the Sahara Desert, Grand Australian Desert and the Great Basin Desert, occur in low altitudes. One of the driest places on Earth is the Atacama Desert.

It is virtually devoid of life because it is blocked from receiving precipitation by the Andes mountains to the east and the Chilean Coast Range to the west. The cold Humboldt Current and the anticyclone of the Pacific are essential to keep the dry climate of the Atacama. The average precipitation in the Chilean region of Antofagasta is just 1 mm (0.039 in) per year. Some weather stations in the Atacama have never received rain.

Evidence suggests that the Atacama may not have had any significant rainfall from 1570 to 1971. It is so arid that mountains that reach as high as 6,885 m (22,589 ft) are completely free of glaciers and, in the southern part from 25°S to 27°S, may have been glacier-free throughout the Quaternary, though permafrost extends down to an altitude of 4,400 m (14,400 ft) and is continuous above 5,600 m (18,400 ft).

There may be underground water sources in the form of springs and seepages from aquifers. Where these are found, oases can occur. Plants and animals living in the desert need special adaptations to survive in the harsh environment. Plants tend to be tough and wiry with small or no leaves, water-resistant cuticles, and often spines to deter herbivory.

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ABOUT THE AUTHOR

Aira Astralis is a science writer specializing in astronomy and space exploration. Her work spans the full breadth of humanity's relationship with the cosmos -- from the earliest naked-eye observations to the engineering marvels of modern space missions.

Her books are built on a foundation of primary sources: peer-reviewed research, mission archives, and direct engagement with the scientific community. She writes for readers who want to understand not just what we know about the universe, but how we came to know it.

She believes that the most important frontier is not out there but in the gap between what scientists discover and what the public understands. Her books exist to close that gap.