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THE ORIGIN, DISTRIBUTION, AND CLASSIFICATION OF DESERTIFICATION

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Abstract: This article examines the origin, distribution, and classification of desertification. Drawing on research by the Russian desert scientist Professor M.P. Petrov and other scholars, it provides a detailed analysis of the causes of aridity and potential solutions.

Keywords: desertification, arid climate, subtropical latitudes, ephemerals and ephemeroids

Desertification refers to the degradation of ecological systems in arid-climate regions due to a complex of anthropogenic factors that influence rising temperatures, insufficient water resources, and the deterioration of organic life in those areas.

The formation and development of desertification stem primarily from the uneven distribution of heat and moisture across the Earth's surface, a consequence of the zonal “mechanism” in the planet’s geographic envelope. The latitudinal distribution of temperature and atmospheric pressure determines wind characteristics and the general circulation of the atmosphere. Over the equator, excessive heating of land and water surfaces causes air to rise dominantly. The warm air ascending from the equator cools slightly, losing a significant portion of its moisture. Subsequently, in the upper atmosphere, this air diverges northward and southward toward the tropics, forming flows known as anti-trade winds. Due to the Earth’s rotation, these anti-trade winds deflect to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. At approximately 30–40° latitudes (subtropics), their deflection approaches 90°. In these latitudes, air masses descend toward the heated surface, warming further during descent. Consequently, atmospheric pressure remains high year-round in the tropics, while a low-pressure zone forms over the equator. This results in persistent surface air movements from the subtropics toward the equator (trade winds). Aligned with the Earth’s motion, trade winds blow from northeast to southwest in the Northern Hemisphere and from southeast to northwest in the Southern Hemisphere. Trade winds are confined to the lower 1.5–2.5 km of the troposphere. In equatorial-tropical latitudes, the (vertical) upward motions of trade winds promote cloud development and precipitation. In subtropical latitudes, cloud cover is minimal, and incoming solar radiation is maximal. Accordingly, these regions exhibit extreme air dryness (relative humidity averaging 30% in summer) and excessively high summer temperatures. In continental tropical zones, mean summer air temperatures range from 30–35°C, with the global maximum of +58°C recorded. Annual temperature amplitude averages around +20°C, diurnal amplitude up to +50°C, and soil surface temperatures may reach 80°C. Precipitation is scant and occurs as brief showers. In subtropical latitudes (between 30° and 45° north and south), total radiation decreases, and

cyclone activity—more prevalent in cooler months—brings moisture and rainfall. However, sluggish thermal depressions induce aridity. Mean summer temperatures in these areas exceed 30°C, with maxima reaching 50°C. Intermontane basins in the subtropics are notable for extreme dryness, with annual precipitation not exceeding 100–200 mm.

Conditions for desert formation in mid-latitudes arise in continental interiors where annual precipitation is less than 200 mm, as observed in Central Asia. Central Asia is shielded from monsoons by mountain barriers, fostering summer baric depressions. The region is characterized by extreme air dryness (temperatures exceeding 40°C) and intense dust storms.

Thus, the character of general atmospheric circulation, planetary conditions, and local geographic features create the prerequisites for desert zone formation between 15° and 45° latitudes on either side of the equator. If the Earth consisted solely of land without oceans or high mountains, the desert zone would form a continuous belt with boundaries aligned to specific parallels.

Since land occupies only one-third of the Earth's surface, the distribution and extent of deserts depend on the structure, size, and configuration of continental landmasses. Desert emergence, development, high insolation, minimal or absent precipitation, and related factors are interconnected. Arid regions vary in degree of dryness, leading to their classification as hyper-arid, arid, and semi-arid. Permanent drought probability is 75–100% in hyper-arid zones, 50–75% in arid zones, and 20–40% in semi-arid zones [1]. According to Russian desert scientist Professor M.P. Petrov, deserts include areas at the arid climate boundary where annual precipitation is less than 250 mm, evaporation greatly exceeds precipitation, rainfed agriculture is impossible, soluble salts and their compounds accumulate on the surface, and soils are low in organic matter. In the Northern Hemisphere of Africa, desert zones lie between 15° and 30° north latitude, with the Sahara being the world's largest desert. In the Southern Hemisphere, the Kalahari, Namib, Somali, and Ethiopian deserts are prominent. According to D. Meigs, global arid lands cover 48,810,000 km², or 33.6% of the land surface, comprising 4% hyper-arid, 15% arid, and 14.6% semi-arid. Excluding semi-deserts, typical deserts occupy approximately 28 million km² of land. Many global deserts formed on ancient geological platforms. Deserts in Asia, Africa, and Australia typically lie at 200–600 m above sea level, while those in Central Africa and North America are at 1,000 m. Deserts constitute one of Earth's landscapes, arising lawfully like other landscapes, linked to heat and moisture distribution, organic life development, and possessing their own biogeocenotic system. Numerous deserts are encircled or bordered by mountains, which serve as river source regions; rivers traverse deserts as transit flows. Surface and groundwater flows are critical for groundwater recharge in deserts. Eroded materials from mountains accumulate in deserts. Rivers transport substantial alluvial material to plains, where it is sorted, with the finest fractions deposited on desert surfaces. Over millennia, river activity covers plains with several meters of alluvial deposits. Deserts share common natural processes: erosion, water accumulation, and wind-induced deflation. Geographic position and elevation above sea

level significantly influence desert characteristics. Central Asian deserts are distinguished by extreme conditions. Dry, hot climates persist for 5–6 months, with air temperatures reaching +50°C in shade and 60–80°C on sands. Rainfall occurs in spring and autumn. Spring and autumn are brief, winters cold. Many plants and animals are highly adapted to this environment. In Central Asian deserts, white and black saxaul are abundant, along with diverse ephemerals and ephemeroids, as well as species such as wormwood and sand acacia. Extensive literature exists on desert classification in the CIS and abroad, yet no unified approach fully resolves the issue. Some base classifications on climatic indicators, others on soil, vegetation composition, or groundwater depth. No classification currently integrates natural components comprehensively, accounting for ecological characteristics, natural conditions, resources, and geo-ecological perspectives. Most specialists rely on Russian scientist Professor M.P. Petrov's monograph *Deserts of the Globe* for desert classification.

Based on surface lithology, deserts are divided into rocky, sandy, clayey, saline, and other types. Sandy deserts comprise two-fifths of all deserts. The Kyzylkum is a sandy (stabilized) desert; sands are also present in the Yazyavan and Karakalpak deserts. The Mirzachul, Sherabad, Karshi, Dalvarzin, Malik, and Karnab deserts are clayey. The Ustyurt Plateau is a gypsum desert. Rocky deserts are widespread around residual mountains in the central Sahara, termed "hamada" by Arabs.

Scholars note that indiscriminate forest felling and improper irrigation, combined with climate change, render fertile lands unproductive. According to UN data, desertification threatens one-fifth of the global population. One-third of the world's land area is at risk of desertification, equating to four billion hectares of degraded land. Due to land degradation, six million hectares become unproductive annually since 1990. In Uzbekistan, irrigated areas are shrinking yearly. Wind dispersal of salts and minerals from the desiccated Aral Sea bed, coupled with water scarcity, intensifies desertification. Experts report high desertification levels in the Republic of Karakalpakstan, Khorezm, Navoi, Jizzakh, Syrdarya, Surkhandarya, and Kashkadarya regions. Officially, 22 million hectares in Uzbekistan are prone to desertification, with 43% of pastures degraded and desertified.

In summary, desert formation and distribution are tied to the uneven allocation of heat and moisture. Notably, scholars still lack consensus on the equivalence of the terms "desert" and "arid." For instance, arid lands are subdivided by aridity degree into hyper-arid (extremely dry), arid (dry), and semi-arid. The term "desert," however, denotes the core essence of the desert landscape [2].

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