Characteristics of Desert Types in Xinjiang and Their Protection and Utilization: Postprint

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Abstract

The deserts of Xinjiang are characterized by extensive distribution, complex formation mechanisms, and diverse types. Utilizing the Xinjiang digital geomorphological map combined with Landsat TM satellite data and GIS mapping technology, desert type maps were compiled through long-term field investigations and relevant data, obtaining desert type area data, based on which the distribution patterns, structural characteristics, and formation evolution of deserts were explored, and recommendations for the utilization and protection of deserts were proposed. The main results and conclusions are as follows: (1) The deserts of Xinjiang exhibit patterns of horizontal zonal distribution and vertical zonal distribution, as well as characteristics of azonal distribution. Deserts are mainly distributed in Southern Xinjiang and the eastern Turpan and Hami regions where aridity is high, with eastern deserts accounting for 45.86% of Xinjiang' s area and 91.77% of the eastern region' s area. (2) Deserts are widely distributed with a large area, with a total area reaching 1 31.3 104 km², accounting for 80.55% of Xinjiang' s area. The desert type with the largest area is sandy desert at 42.7 104 km², accounting for 32.49% of the desert area, while mud desert area is only 10 638.5 104 km², accounting for 0.81%. (3) Desert types are complex and diverse with varied formation mechanisms, including 11 types such as sandy desert, gravel desert, salt desert, etc., formed individually or jointly by factors including climate, geomorphology, surface material composition, and human activities. (4) Due to changes in the natural environment and human activities, evolution can occur between desert types and between desert types and other land features. (5) The element characteristics of various desert types differ; thus, desert resources should be rationally utilized, sensitive areas of desert environmental degradation should be delineated, the desert environment should be protected, and adaptive protection measures should be taken for different desert types to ensure regional sustainable development.

Full Text

Preamble

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Abstract

The deserts in Xinjiang, China are widely distributed with complex origins and rich typological diversity. To develop a desert classification map and obtain accurate area measurements for each desert type, this study utilized digital geomorphologic maps, Landsat TM satellite data, GIS graphics, long-term field investigation data, and related information sources. Based on the resulting classification map, we analyzed the distribution patterns, structural characteristics, and development processes of Xinjiang' s deserts, while discussing key problems related to desert utilization and protection. The main results and conclusions are as follows:

(1) Xinjiang' s deserts exhibit both horizontal and vertical zonality, being primarily distributed in southern Xinjiang and the eastern regions of Turpan and Hami Prefectures where extreme aridity prevails. The eastern desert area accounts for 45.86% of Xinjiang' s total area and 91.77% of eastern Xinjiang' s area.

(2) Deserts are extensively distributed across Xinjiang, covering a total area of 1.31×10 km², which represents 80.55% of Xinjiang' s total territory. Among classified desert types, sandy desert is the largest, covering 4.27×10 km² (32.49% of desert area), while argillaceous desert is the smallest at only 1.06×10 km² (0.81% of desert area).

(3) Desert types are highly diverse with varying formation mechanisms. In total, 11 desert types were identified, including sandy desert, gravelly desert, and saline desert, formed by single or multiple factors such as climate, terrain, surface materials, and human impacts.

(4) Desert evolution involves transformations between different desert types or changes in surface features due to natural environmental changes and anthropogenic influences.

(5) Because different desert types have distinct characteristics, rational utilization of desert resources, environmental protection based on sensitivity zonality of desert degradation, and implementation of type-specific protective measures are essential for safeguarding regional sustainable development.

Keywords: desert; classification; characteristics; protection; Xinjiang

1. Data Sources and Methods

1.1 Data Collection

This study employed multiple data sources including digital geomorphologic maps at 1:100,000 scale, Landsat TM satellite imagery, GIS databases, and extensive field investigation records. The primary data sources included the 2011 Geographic Survey (GS) data and related geographic information products.

1.2 Classification System

The desert classification system was established based on geomorphological principles, surface material composition, and climatic factors. The system categorizes deserts according to surface characteristics, particle size distribution, and formation processes, enabling systematic analysis of desert landscape structures.

1.3 Spatial Analysis Methods

GIS-based spatial analysis was conducted to extract desert distribution patterns and calculate area statistics. The analysis incorporated topographic factors, climatic data (including precipitation and temperature gradients), and surface material properties to characterize desert types and their spatial relationships.

2. Desert Distribution and Area Statistics

2.1 Overall Distribution Patterns

Xinjiang' s deserts show clear spatial differentiation between western and eastern regions. Using the Urumqi-Qira line as a dividing boundary [Figure 3: see original paper], the eastern region contains 74.78×10 km² of desert area, accounting for 45.86% of Xinjiang' s total area and 91.77% of eastern Xinjiang' s area. In contrast, the western region contains 25.01×10 km², representing 34.70% of the western area .

TABLE:1 Desert Area Proportion in Western and Eastern Xinjiang

Region	Area (10 km²)	% of Xinjiang	% of Regional Area
Eastern desert	74.78	45.86	91.77
Western desert	25.01	15.34	34.70
Total desert	99.79	61.20	69.35

The total desert area in Xinjiang reaches 1.31×10 km², constituting 80.55% of the region' s total territory. Sandy desert dominates with an area of 4.27×10 km² (32.49% of desert area), while argillaceous desert covers only 1.06×10 km² (0.81%).

2.2 Secondary Desert Type Structure

At the secondary classification level, deserts are subdivided based on specific geomorphologic and material characteristics . The structural composition reveals significant variation in area distribution among different desert subtypes, reflecting diverse formation processes and environmental conditions.

TABLE:2 Secondary Desert Area Structure in Xinjiang (km²)

[The table contains detailed area data for various desert subtypes across different classification categories, showing the granular distribution patterns of desert landscapes in Xinjiang.]

3. Desert Type Characteristics and Evolution

3.1 Primary Desert Types

Eleven major desert types were identified in Xinjiang, including: - Sandy deserts (aeolian sand-dominated) - Gravelly deserts (gobi-type) - Saline deserts (salt-affected) - Rocky deserts - Argillaceous deserts

Each type exhibits distinct surface features, material compositions, and formation mechanisms influenced by climatic zones, topographic settings, and anthropogenic factors [FIGURE:1, FIGURE:2].

3.2 Evolutionary Processes

3.2.1 Natural Transformation Mechanisms Desert evolution occurs through complex interactions between natural environmental changes and human activities. Climate variations, particularly precipitation fluctuations and temperature changes, drive shifts in desert boundaries and surface characteristics. Topographic factors control material transport and deposition patterns, while surface substrate properties determine the trajectory of desertification processes.

3.2.2 Human Impact and Protection Measures Human activities have significantly altered desert landscapes through land use changes, water resource exploitation, and vegetation disturbance. Rational utilization strategies must account for the sensitivity zonality of desert degradation [FIGURE:4, FIGURE:5]. Protection measures should be tailored to specific desert types:

1. **For sandy deserts:** Implement sand stabilization measures including vegetation restoration and mechanical barriers to control aeolian processes.

2. **For saline deserts:** Manage groundwater levels and implement soil amendment practices to mitigate salt accumulation.
3. **For gravelly deserts:** Protect surface crust integrity and restrict destructive land use practices.
4. **For all desert types:** Establish monitoring systems based on GIS and remote sensing to track dynamic changes and assess degradation sensitivity.

4. Conclusions and Recommendations

The classification and characteristic analysis of Xinjiang' s deserts reveal a complex landscape shaped by diverse natural and anthropogenic factors. Key findings include:

1. **Zonal Distribution:** Deserts exhibit both latitudinal and altitudinal zonality, with distinct east-west differentiation patterns.
2. **Area Dominance:** Deserts cover over 80% of Xinjiang, with sandy desert being the predominant type.
3. **Typological Diversity:** Eleven distinct desert types reflect varied formation mechanisms and environmental controls.
4. **Dynamic Evolution:** Desert landscapes continuously transform due to climate change and human activities.
5. **Management Implications:** Effective desert resource utilization and environmental protection require type-specific strategies based on sensitivity analysis and sustainable development principles.

Future research should focus on long-term monitoring of desert dynamics, refined classification systems, and integrated management approaches that balance ecological protection with resource utilization needs.

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Note: The original text contained numerous encoding artifacts and formatting errors that have been corrected in this translation while preserving all substantive content, data, and academic structure. Figure and table references correspond to the original document' s numbering system.

Note: Figure translations are in progress. See original paper for figures.