Influence of the Hotan River in Xinjiang on the Spatial Pattern of Aeolian Landforms on Both Sides: Postprint

Authors: Wang Xumin, Gao Xin, Hu Zihao, Zhou Jie

Date: 2025-02-27T00:00:00+00:00

Abstract

Aeolian-fluvial interactions play a crucial role in shaping the morphology and spatial distribution patterns of aeolian landforms, and quantifying the influence of rivers on aeolian landforms has long been a challenge in aeolian geomorphology research. This study selected the Hotan River basin in the Taklamakan Desert and its surrounding aeolian landforms as the research area. Based on high-resolution remote sensing imagery, DEM, and NDVI data, through comparative analysis of relevant characteristic parameters of typical cross-sections and analysis of variations in aeolian landform patterns and channel morphology parameters, the following main results were obtained: (1) In the intersection zone between the Hotan River and aeolian landforms, an NDVI value of 0.05 can serve as a threshold to distinguish the influence of the river on aeolian landform patterns, and based on this, the area of influence of the Hotan River on aeolian landforms was determined to be approximately 20,700 km^2; (2) The channel morphology of the Hotan River exhibits minor changes, making it difficult to cause long-distance lateral migration, and the area of influence on surrounding aeolian landforms will not undergo significant changes. The river plays a dominant role in the aeolian-fluvial interaction process, but the intensity of its influence differs between the southern and northern river sections, being stronger in the southern section and weaker in the northern section; (3) The identifiable spatial distribution pattern of aeolian landforms is as follows: from the river channel outward to both sides, shrub coppice dunes, linear dunes, transverse ridges, and grid dunes occur in sequence, and this pattern is the result of long-term aeolian-fluvial interactions.

Full Text

Preamble

ARID ZONE RESEARCH Vol. 42 No. 2 Feb. 2025

Effect of the Hotan River on the spatial pattern of surrounding aeolian landforms in Xinjiang

WANG Xumin[1,2], GAO Xin[1], HU Zihao[3], ZHOU Jie[1]

[1]Key Laboratory of Ecological Safety and Sustainable Development in Arid Lands, Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Urumqi, Xinjiang, China
[2]University of Chinese Academy of Sciences, Beijing, China
[3]School of Emergency Management, University of Emergency Management (Preparatory), Beijing, China

---

Abstract

The interaction between wind and water plays a crucial role in shaping the morphology and spatial distribution patterns of aeolian landforms. Quantifying the influence of rivers on aeolian landforms has long been a challenge in aeolian geomorphology research. This study selected the Hotan River basin and its surrounding aeolian landforms in the Taklamakan Desert as the research object. Based on high-resolution remote sensing imagery, DEM data, and NDVI data, we conducted comparative analyses of characteristic parameters from typical cross-sections and examined variations in aeolian landform patterns and river channel morphological parameters. The results demonstrate that: (1) In the intersection zone between the Hotan River and aeolian landforms, NDVI = 0.05 can serve as a critical threshold for distinguishing the river' s influence on aeolian landform patterns. Accordingly, the spatial extent of the Hotan River' s influence on surrounding aeolian landforms was determined, covering an area of approximately 20,700 km^2 with widths ranging from 6 to 121 km. (2) The Hotan River exhibits minimal morphological changes, making it difficult to trigger long-distance lateral migration; consequently, the affected area of surrounding aeolian landforms remains relatively stable. In the wind-water interaction process, the river plays a dominant role, with the southern segment representing a completely fluvial-dominated type and the northern segment representing a predominantly fluvial-dominated type. (3) The recognizable distribution pattern of aeolian landforms extends sequentially from the river channel outward as shrub coppice dunes, linear dunes, transverse ridges, and reticulate dunes —a pattern resulting from long-term wind-water interactions. These findings provide valuable insights for understanding river influences on aeolian landform patterns in similar regions.

Keywords: Hotan River; aeolian landform pattern; dune type; wind-water interaction; Taklamakan Desert

Introduction

Wind and water are the two primary external forces shaping landform morphology. Aeolian landforms, predominantly formed under wind action, are widely distributed across arid and semi-arid regions. Fluvial landforms can develop in various climatic zones. In dry desert regions, well-watered rivers may flow along desert margins, penetrate desert interiors, or even traverse entire deserts, creating wind-fluvial interaction zones. Examples include fluvio-aeolian systems in the northeastern Sahara, the Athabasca dunes along Canada' s William River, and dunes in Antarctica' s Victoria Valley. When rivers encounter deserts, interactions between these two systems cause varying degrees of morphological change in one or both systems. In desert-river transition zones, both water flow and wind power play important roles in arid land geomorphological development. Recent years have witnessed growing recognition of the importance of wind-water interactions.

In wind-water interaction zones, river flow direction and wind direction exhibit different intersection angles. Using the connecting line between a river' s entry and exit points in its desert segment as its flow direction and dune migration direction as the dominant wind direction for aeolian landforms, a Google Earth survey of river and dune patterns at 50 global locations revealed various intersection angles (perpendicular, parallel, oblique) between river flow and wind direction. Different dune types show significant frequency variations in their intersection angles with rivers. Among transverse dunes intersecting rivers, the most frequent angle is notably higher than for other dune types. In contrast, the highest frequency angles for barchan and longitudinal dunes are not particularly pronounced. However, for specific desert-river intersection zones, the intersection angles between similar dune types and rivers are confined to narrow ranges.

The relative magnitude of wind and water forces typically serves as the key indicator for determining dominance in wind-water interactions. Based on this, scholars have proposed three types: wind-dominated, water-dominated, and wind-water interaction processes, as well as a six-type classification scheme: completely wind-dominated, predominantly wind-dominated, wind-water balanced, predominantly fluvial-dominated, completely fluvial-dominated, and alternating wind-water dominance. Other researchers have classified river-dune distribution patterns based on river type, flow direction, wind direction, and dune orientation, categorizing them as dune-crossing, parallel, perpendicular, or reticulate-isolated patterns. The former approach emphasizes dominance in wind-water interactions, while the latter highlights spatial distribution differences. In reality, the spatial distribution patterns revealed by the latter classification system are also influenced by wind-water interactions and their relative magnitudes.

The Taklamakan Desert, located in the Tarim Basin, is fed by numerous rivers originating from surrounding mountains, some of which flow into or even traverse the desert, creating a series of river-desert interaction zones. Previous studies have examined the formation, evolution, and influencing factors of these river-aeolian intersection zones, as well as the dominant forces in the region' s river-aeolian systems. In desert-river transition zones, wind-water interactions determine the spatial patterns of rivers and dune landforms, with different intersection modes affecting interaction intensity. Seasonal variations in river discharge also influence wind-water interaction strength, even periodically altering the dominance of river versus aeolian processes. Additionally, lateral river migration and the ways aeolian processes affect rivers influence the relative strength of these two external forces. Therefore, in wind-dominated desert regions, the degree of influence that desert-crossing rivers exert on aeolian landforms remains an important scientific question in aeolian landform evolution and spatial pattern studies. Rivers influence aeolian landform patterns through two primary mechanisms: (1) direct erosion and sediment transport, affecting only the channel and floodplain zones; and (2) indirect effects through groundwater recharge and riparian vegetation development that enhances sand stabilization, with influence ranges determinable through NDVI critical values reflecting vegetation development status. The degree of river influence can be comprehensively analyzed through key indicators including channel connectivity, lateral migration capacity, typical channel morphological parameters, discharge and its variability, riparian vegetation development and width, and regional wind regimes.

1.1 Study Area Overview

The Taklamakan Desert, situated in the Tarim Basin of Xinjiang, China, extends approximately 1,000 km east-west and 400 km north-south, covering 337,600 km^2. It is China' s largest desert and the world' s second-largest shifting desert, with shifting dunes accounting for over 80% of its area. The desert is bounded by the Tianshan Mountains to the north, the Pamir Plateau to the west, the Kunlun and Altyn Mountains to the south, and Lop Nur to the east. The region experiences an extremely arid continental climate with mean annual temperatures of 9.9–12.6°C, maximum summer temperatures reaching 67.2°C, and diurnal temperature ranges exceeding 40°C. Annual precipitation ranges from 17.4 to 66.3 mm, while annual evaporation reaches 2,500–3,400 mm. The eastern and southeastern desert experiences northeasterly winds, while the western and northern regions are dominated by westerly, northerly, and northwesterly winds. The desert' s fine, dry sand is highly mobile and prone to dust emission under frequent wind action, making it a major dust source for East Asia and globally.

The study area encompasses the Hotan River basin and its adjacent aeolian landforms in the western Taklamakan Desert (Figure [Figure 1: see original paper]), including the Karakax River, Yurungkax River, and the Hotan River mainstream, spanning 79.24°-81.55°E and 36.51°-40.24°N. The Hotan River flows northward through the entire desert, maintaining channel connectivity through long-term interactions with adjacent aeolian landforms. The river' s multi-year average discharge at its source (sum of flows at Wuluwati Station on the Karakax River and Tongguziluoke Station on the Yurungkax River) is 51.4 $\times 10^8$ m^3, while the multi-year average discharge at its outlet (Xiaota Station) is 12.76 $\times 10^8$ m^3. The river effectively maintains ecosystems along both banks and the Tarim River, significantly influencing aeolian landform evolution. The study area features diverse aeolian landforms including shrub coppice dunes, longitudinal dunes, transverse dunes, and reticulate dunes, making it an ideal region for investigating river influences on the spatial patterns of adjacent aeolian landforms.

1.2 Data Sources

Data sources include remote sensing imagery, Digital Elevation Model (DEM), Normalized Difference Vegetation Index (NDVI) data, and wind regime data. Remote sensing imagery and spatial distribution data for the study area and cross-sections were obtained from Google Maps at 7.5-30 m resolution. Selected imagery dates to 2013, facilitating visual interpretation of high-resolution images for comparing channel evolution and revealing influences on adjacent aeolian landform patterns. Wind regime data were downloaded from the China Meteorological Data Network (http://www.data.cma.cn). All data types and resolutions meet research requirements.

---

2. Results and Analysis

2.1 NDVI Variation Characteristics

2.1.1 Cross-Section NDVI Variation Ten cross-sections (C1–C10) perpendicular to the Hotan River or its tributaries were selected to study lateral variation trends and identify river influence zones. Each cross-section' s starting point is its western endpoint and its terminus is the eastern endpoint. Cross-sections C1–C3 represent the Hotan River' s alluvial fan at the mountain outlet, where NDVI generally ranges from 0.2 to 0.6, showing high values overall. In the middle Hotan River reaches (C4–C9), NDVI exhibits significant high-value zones near the channel, decreasing sharply to low values away from the riverbanks. Cross-section C10 spans the terminal desert segment, where NDVI values increase noticeably. Compared with middle reaches, the high-value zones on C9 and C10 extend farther from the channel, reflecting the river' s relatively wide and shallow morphology with multiple braided channels in this segment. During high-flow periods, water distributes across multiple channels, providing relatively abundant moisture to broader aeolian landform areas and promoting vegetation development in wider zones outside the channel belt.

2.1.2 Longitudinal Profile NDVI Variation A longitudinal profile (L1) was established along the left bank of the Karakax and Hotan Rivers to examine along-stream variation trends. Within the southern 50 km of the profile, NDVI shows significant high values, reflecting the distribution of relatively dense vegetation on the Hotan River' s alluvial fan at the Kunlun Mountains piedmont. Between 30–100 km along the profile, NDVI decreases sharply from >0.05 to <0.05, then increases slightly, generally remaining >0.05. In the 100–140 km segment, NDVI values increase markedly. Between 140–320 km, NDVI values are relatively low, but increase again near 330 km. NDVI variations along cross-sections reflect the river' s lateral influence on vegetation distribution. Significant high NDVI values near both banks indicate the river' s substantial effect on promoting riparian vegetation development. High-value zones also appear on one side of the channel, indicating relatively adequate water supply in those areas.

Vegetation zones with relatively developed growth, primarily shrub coppice dunes, distribute in belts along both banks. Outside these shrub dune zones, longitudinal dune fields occur, with maximum height differences reaching 30 m in near-channel areas. Beyond these, transverse ridges with maximum height differences of 20 m are distributed. In some areas, the sequence from channel outward comprises shrub coppice dunes followed by low-height longitudinal dunes. These phenomena indicate that high NDVI zones on cross-sections are clearly influenced by the river, with NDVI = 0.05 serving as the critical threshold for the Hotan River' s influence on vegetation and, by extension, on adjacent aeolian landform patterns.

2.1.3 River Influence and NDVI Critical Value To further explore relationships between river influence zones, dune morphology, and vegetation development, 20-km segments were selected from cross-sections C4, C7, and C10, including the river channel. Annual average NDVI values were plotted to examine relationships between river influence, dune forms, and vegetation status. Higher NDVI values (>0.05) typically occur near both banks, while distant areas show lower values (<0.05). Vegetation development zones with NDVI > 0.05 exist on both seasonal floodplain sides, though their widths are much smaller than those of the main channel. These relatively developed vegetation zones are dominated by shrub coppice dunes distributed in belts along the Hotan River.

Based on NDVI spatial distribution, the critical value for river influence on vegetation and aeolian landform patterns is determined to be NDVI = 0.05. The area affected by the Hotan River on surrounding aeolian landforms covers 20,700 km^2, with maximum width reaching 121 km in the southern oasis segment and minimum width of 6 km in the middle desert segment. The river' s influence extends 460 km north-south through the desert interior.

2.2 River-Aeolian Landform Patterns

2.2.1 River Influence Area The NDVI > 0.05 zone represents both the river' s influence on vegetation and its impact area on adjacent aeolian landform patterns. This affected area varies across years. Compared with 2013, the 2016 influence area contracted noticeably in the middle-southern Hotan River while expanding significantly in the northern right-bank zone, with left-bank areas showing initial expansion followed by contraction. Overall, the 2022 influence area differed markedly from previous years, primarily contracting upstream and expanding downstream. During these years, the affected areas were 20,700 km^2 (2013), 20,800 km^2 (2016), 20,900 km^2 (2022), and 20,700 km^2 (2013–2022 average), showing minimal overall variation. The multi-year average NDVI = 0.05 contour defines the long-term average influence area, indicating relative stability in the river' s impact on surrounding aeolian landforms, with dominance primarily by fluvial processes.

2.2.2 River-Aeolian Landform Distribution Patterns The intersection angle between river flow direction and prevailing wind direction significantly influences aeolian landform patterns. Mean wind regime data from meteorological stations around the Hotan River (1991–2020) reveal distinct prevailing wind directions across different segments: north-northeasterly in the northern segment, westerly and southwesterly in the southeastern Cele and Yutian stations, and northwesterly in the western stations. The Hotan River basin and its periphery exhibit variable prevailing winds, with stations far from the river making accurate determination of near-river wind directions difficult.

Dune morphology can reflect net sand drift direction (prevailing wind direction), enabling more accurate measurement of compound geomorphological parameters. In the intersection zone, the Hotan River and its tributaries flow at 192.5°, while dune migration directions indicate prevailing winds of 354.5° (north wind) in some areas and 174.5° (south wind) in others. The intersection angle between river flow and prevailing wind direction thus ranges from 167° to 174.5°, representing a large obtuse angle (nearly opposite directions). This results in relatively weak interaction intensity between the river and aeolian landforms.

To clarify the Hotan River' s influence, three areas (A, B, C) were selected for detailed analysis. Area A, near the tributary confluence, shows a braided channel with well-developed mid-channel bars and a wide floodplain containing flood channels. Outside the floodplain, longitudinal dunes are distributed with their crest lines oriented parallel to the 45° azimuth, indicating a sand drift direction of 315° (northwesterly wind). The river flow direction (192.5°) intersects the prevailing wind direction at an average angle of 82.5° in this area, representing a large acute angle where sand readily enters the channel.

Area B, in the middle reaches, also features a braided channel with a wide floodplain. Longitudinal dunes outside the floodplain have crest lines parallel to the 45° azimuth, with sand drift direction of 315° (northwesterly wind). The intersection angle between river flow (192.5°) and prevailing wind is 82.5°, again a large acute angle facilitating sand entry.

Area C, in the terminal segment, shows a typical braided channel with mid-channel bar development and a wide floodplain containing flood channels. Longitudinal dunes outside the floodplain have crest lines parallel to the 22.5° azimuth, with sand drift direction of 292.5° (northwesterly wind). The intersection angle between river flow (192.5°) and prevailing wind is 100°, a large obtuse angle where sand entry is less likely.

In the long-term interaction between the Hotan River and adjacent aeolian processes, the lateral distribution pattern from the channel outward sequentially comprises shrub coppice dunes, longitudinal dunes (linear dunes), transverse ridges, and reticulate dunes. This represents the general distribution pattern of dune landforms along both sides of the Hotan River basin, though local exceptions exist. River influence is mainly confined to shrub coppice dune and linear dune zones, sometimes extending to transverse ridges, with influence gradually decreasing with distance.

---

3. Discussion

The results reveal complex influences of the Hotan River on aeolian landforms in the intersection zone, with varying responses from aeolian landforms to river processes. This study focuses on revealing river influences on aeolian landform patterns, necessitating examination of the river' s lateral migration capacity during evolution, discharge magnitude and sediment transport capacity reflecting fluvial dynamics, regional variations in intersection angles between river flow and dune migration directions, and determination of relative dominance between fluvial and aeolian processes.

3.1 Channel Evolution and Variability of Influence Area

Channel sinuosity and gradient parameters can be used to analyze river variability potential. Sinuosity reflects lateral migration capacity—higher values indicate stronger lateral migration ability and greater migration distances, resulting in larger variability in river influence on aeolian landforms. Gradient reflects fluvial dynamics—higher values indicate stronger flow energy, greater bed erosion and sediment transport capacity, and enhanced stability of river influence zones.

Spatial variations in sinuosity and gradient along the Hotan River and its tributaries (2013–2022) show that most river segments have low sinuosity (<1.20), indicating weak lateral erosion capacity and inability to undergo long-distance lateral migration. Consequently, river influence zones remain relatively stable. However, near tributary confluences and in the terminal segment (below C9), sinuosity is slightly higher (1.27–1.35) and lateral activity stronger, suggesting greater variability in influence zones. The 2013-2022 variation in influence area is more pronounced in the terminal segment, where sudden floodplain inundation during high-flow periods has the potential to temporarily expand river influence locally.

Gradient is larger in the southern oasis segment (C1-C2) and tributary reaches (2.5-5.0‰) but smaller in the middle and lower mainstream reaches (0.2-0.6‰). Higher gradients in tributaries generate stronger hydrodynamic forces, enabling them to transport substantial sediment loads to the Hotan River. The mainstream' s lower gradient results in weaker hydrodynamic force compared to tributaries. Sediment from tributaries partially deposits in the channel, while invading dunes cause temporary local deposition. Despite an average deposition rate of 1.7 $mm \cdot a^{-1}$ and 0.02 m average aggradation thickness from 2013-2022, this low rate indicates the Hotan River is slightly depositional but generally near equilibrium. This hydrodynamic state helps maintain the river' s long-term development trend, suggesting relative stability in its influence on aeolian landforms with fluvial processes playing the dominant role.

3.2 Runoff and Variability of Influence Area

The Hotan River' s source runoff is highly concentrated seasonally but shows small interannual variation, while its inflow to the Tarim River is summer-concentrated with large interannual variability. Monthly average discharge at the source reaches maximum values in July-August (14.45×10^8 m^3) and minimum values in January-February (0.82×10^8 m^3), with an extreme ratio of 17.6. During high summer flows, the Hotan River significantly modifies its bed and transports sediment; during low winter-spring flows, most of the riverbed becomes exposed, providing potential sediment sources for aeolian processes.

Desert river discharge and water consumption are closely related to influence zones on aeolian landforms. As a major source of the Tarim River, the Hotan River delivers 1.26×10^9 m^3 annually to the main stem. Annual water consumption in the southern oasis zone is substantial (12.6×10^8 m^3), with irrigation and ecological water use accounting for most consumption. This artificial water use, combined with natural channel losses (seepage, evaporation, overflow), replenishes groundwater and supports riparian vegetation growth, indirectly influencing aeolian landform evolution. Water loss rates in the desert interior are significantly smaller than in the southern oasis, determining the spatial distribution of river influence—wider in the south and narrower in the middle-north, consistent with NDVI-based delineation.

3.3 Intensity and Dominance of River-Aeolian Interactions

Relative wind and water force intensity determines wind-water interaction development. The intersection angle between river flow and prevailing wind direction (0°-180°) partially reflects interaction intensity. Assuming constant dune migration rates, when wind direction is perpendicular to river flow (90°), dune advance speed and sand supply to the river reach maximum values, requiring maximum fluvial power to transport aeolian sand completely. Conversely, small acute or large obtuse angles result in lower sand supply and required fluvial power.

The Hotan River maintains long-term connectivity across the Taklamakan Desert, indicating its dominant role in interactions with adjacent aeolian landforms. The intersection angle between the Hotan River and prevailing wind direction ranges from 167° to 174.5°, representing a large obtuse angle that suggests weak interaction intensity. However, the river' s sustained passage through the desert demonstrates its dominance over aeolian processes.

Monthly flow and wind regime variations reveal interaction intensity and dominance. Based on 1991–2020 data, the Hotan River' s average discharge (sum of Tongguziluoke and Wuluwati stations) accounts for 83.6% of annual flow in July–August and only 0.02% in January–February. The outlet station (Xiaota) shows 99.98% of discharge concentrated in 3 months, with other months essentially dry. This means direct fluvial influence on aeolian landforms lasts about 3 months annually in the northern segment, while the southern segment experiences longer flow duration.

Wind regimes differ significantly between the southern Hetian Station and northern Aral Station. Hetian Station shows westerly and southwesterly prevailing winds, intersecting the southern segment flow direction at 82.5° and 100°—large acute and obtuse angles, respectively. Aral Station shows northeasterly winds intersecting the northern segment flow at 17.5° and 37.5°—small acute angles where sand readily enters the channel. Maximum and average wind speeds are generally higher in the northern segment, indicating stronger aeolian influence on the river there.

In summary, considering monthly flow distribution, intersection angle characteristics, and wind speeds, the intensity of water-sand interactions and fluvial dominance over aeolian landform patterns are greater in the southern segment than the northern segment, showing clear spatial differentiation. The southern segment is completely fluvial-dominated, while the northern segment is predominantly fluvial-dominated.

---

4. Conclusions

Through investigation of interactions between the Hotan River and its adjacent aeolian landforms, analysis of NDVI variations and dune distribution patterns on typical cross-sections, the following main conclusions are drawn:

1. **NDVI = 0.05 serves as the critical threshold** for the Hotan River' s influence on aeolian landform patterns. Based on the spatial distribution of multi-year average NDVI values, the river' s influence area on surrounding aeolian landforms covers 20,700 km^2 with widths of 6–121 km.

2. **The Hotan River plays a dominant role** in wind-water interactions, though interaction intensity differs between southern and northern segments. The southern segment is completely fluvial-dominated, while the northern segment is predominantly fluvial-dominated, as determined by potential aeolian sand entry rates, fluvial sediment transport energy consumption, and monthly wind regime variations.
3. **A regular distribution pattern** has emerged through long-term wind-water interactions: from the channel outward, shrub coppice dunes, linear dunes, transverse ridges, and reticulate dunes appear sequentially, though local exceptions may exist.
4. **Minimal channel morphological changes** prevent large-scale lateral migration, so channel evolution generally does not cause significant changes in the river' s influence area. Seasonal discharge variations and occasional flooding cause interannual variability in local influence zones but do not alter the long-term average influence area.

Acknowledgments

We express sincere gratitude to teachers and classmates who provided guidance and assistance during this research.

References

[1] Baz F, Maingue M, Robinson C. Fluvio-aeolian dynamics in the north-eastern Sahara: The relationship between fluvial/aeolian systems and ground water concentration[J]. Journal of Arid Environments, 2000, 44(2): 173-183.

[2] Smith N D, Smith D G. William River: An outstanding example of channel widening and braiding caused by bed load addition[J]. Geology, 1984, 12(2): 78-82.

[3] Bourke M C, Ewing R C, Finnegan D, et al. Sand dune movement in the Victoria Valley, Antarctica[J]. Geomorphology, 2009, 109(3-4): 148-160.

[4] Liu B, Coulthard T J. Mapping the interactions between rivers and sand dunes: Implications for fluvial and aeolian geomorphology[J]. Geomorphology, 2015, 231: 246-257.

[5] Song Yang, Liu Lianyou, Yan Ping. A review on complex erosion by wind and water research[J]. Acta Geographica Sinica, 2006, 61(1): 77-88.

[6] Bullard J E, Livingstone I. Interactions between aeolian and fluvial systems in dryland environments[J]. Area, 2002, 34(1): 8-16.

[7] Krapf C B E, Stollhofen H, Stanistreet I G. Contrasting styles of ephemeral river systems and their interaction with dunes of the Skeleton Coast erg (Namibia)[J]. Quaternary International, 2003, 104(1): 41-52.

[8] Field J P, Breshears D D, Whicker J J. Toward a more holistic perspective of soil erosion: why aeolian research needs to explicitly consider fluvial processes and interactions[J]. Aeolian Research, 2009, 1(1-2): 9-17.

[9] Draut A E. Effects of river regulation on aeolian landscapes, Colorado River, southwestern USA[J]. Journal of Geophysics Research, 2012, 117: F02022.

[10] Yu L P, Lai Z P, An P, et al. Aeolian sediments evolution controlled by fluvial processes, climate change and human activities since LGM in the Qaidam Basin, Qinghai Tibetan Plateau[J]. Quaternary International, 2015, 372: 23-32.

[11] Li Yongshan, Peng Wenchang, Ren Liang, et al. Evolution of Ulan Buh Desert braided channel of the Yellow River in recent 50 years[J]. Journal of Desert Research, 2016, 36(6): 1689-1694.

[12] Kirkby M J. The Stream Head as A Significant Geomorphic Threshold[D]. Leeds, UK: University of Leeds, 1978.

[13] Al Masrahy M A, Mountney N P. A classification scheme for fluvial-aeolian system interaction in desert margin settings[J]. Aeolian Research, 2015, 17: 67-88.

[14] Zhao Y, Gao X, Lei J, et al. Interactions between paleochannels and aeolian processes and their implications on aeolian dune patterns[J]. Geomatics, Natural Hazards and Risk, 2019, 10(1): 1176-1193.

[15] Wu Zheng. Aeolian Landform and Sand Control Engineering[M]. Beijing: Science Press, 2003.

[16] Song Q, Gao X, Lei J, et al. Spatial distribution of sand dunes and their relationship with fluvial systems on the southern margin of the Taklimakan Desert, China[J]. Geomatics, Natural Hazards and Risk, 2019, 10(1): 2408-2428.

[17] Yan P, Li X M, Ma Y F, et al. Morphological characteristics of interactions between deserts and rivers in northern China[J]. Aeolian Research, 2015, 19: 225-233.

[18] Li Xiaomei, Yan Ping. Landscape pattern characteristics of deserts and rivers in Northern China[J]. Progress in Geography, 2014, 33(9): 1198-1208.

[19] Zhu Zhenda, Chen Zhiping, Wu Zheng, et al. Research on Aeolian Landform in the Taklamakan Desert[M]. Beijing: Science Press, 1981.

[20] Zhu Zhenda, Wu Zheng, Li Juzhang, et al. Research on aeolian landform in the Taklamakan Desert[J]. Science Bulletin, 1966(13): 620-624.

[21] Wang H, Jia X. Field observations of windblown sand and dust in the Taklimakan Desert, NW China, and insights into modern dust sources[J]. Land Degradation & Development, 2013, 24(4): 323-333.

[22] Zu R, Xue X, Qiang M, et al. Characteristics of near surface wind regimes in the Taklimakan Desert, China[J]. Geomorphology, 2008, 96(1-2): 39-47.

[23] Xiao Fang, Li Xiao, Li Chengsen, et al. Understanding the Taklamakan Desert[J]. The World of Life, 2019(2): 52-53.

[24] Shao Y, Dong C H. A review on East Asian dust storm climate, modelling and monitoring[J]. Global & Planetary Change, 2006, 52(1-4): 1-22.

[25] Zhang X Y, Gong S L, Zhao T L, et al. Sources of Asian dust and role of climate change versus desertification in Asian dust emission[J]. Geophysical Research Letters, 2003, 30(24): 5-8.

[26] Liu Xin, Gao Xin. Migration velocity of barchan dunes at the southern margin of the Taklamakan Desert[J]. Arid Zone Research, 2024, 41(4): 661-673.

[27] Yu Qiying, Bai Yungang, Zhang Jianghui, et al. Analysis of water consumption process in the main stream of Hotan River Basin[J]. Journal of Water Resources & Water Engineering, 2021, 32(2): 73-79.

[28] Huang Lingmei, Shen Bing. Analysis on runoff evolution and cause of Hotan River flowing into the Tarim River[J]. Journal of Water Resources & Water Engineering, 2012, 23(2): 26-28.

[29] Li Weihong, Li Feng, Chen Zhongsheng, et al. Analysis of driving force of water consumption in plain and suitable scale of oasis in Hotan River Basin[J]. Journal of Glaciology and Geocryology, 2011, 33(5): 1161-1168.

[30] Xia Tingting, Xue Xuan, Wang Haowei, et al. Changes in terrestrial water storage and its drivers on the north slope of Kunlun Mountains[J]. Arid Land Geography, 2024, 47(8): 1292-1303.

[31] Han Xingsheng, Chen Xiongbo. Analysis of erosion and deposition characteristics of Hotan River channel[J]. Yellow River, 2024, 46(S1): 26-28.

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