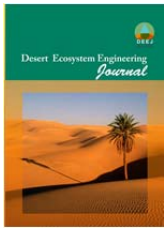
DEEJ (2024) 13 (1) 1-2

University of Kashan

Desert Ecosystem Engineering Journal

Journal homepage: http://deej.kashanu.ac.ir



Investigating the Spatial Distribution and Interaction of Sand Dunes: A Case Study of Kalateh Mazinan Region

Mohammad Javad Yousefi,[1] Mohsen Hosseinalizadeh,[2]* Alireza Rashki,[3] Narges Kariminejad,[4] Hamidreza Abbasi,[5] Ali Mohammadian Behbahani[6]

Received: 13/02/2024 Accepted: 08/09/2024

Extended Abstract

Introduction: Recognized as the hosts of a wide variety of formative processes, deserts represent vital ecosystems within Iran's natural landscape. On the other hand, wind erosion exerts particularly significant influence on such arid regions, playing a key role in shaping the environment while posing serious environmental risks. Moreover, wind-driven movement of active and semi-active sand dunes decreases the comfort levels for local inhabitants, putting agricultural lands, settlements, and transportation routes at risks. Consequently, studying the dynamic behavior and variability of wind-driven sediments, especially in arid and desert regions, is of great importance. While UAVs (Unmanned Aerial Vehicles) may not fully replace traditional methods of spatial data collection, their unique capabilities allow them to be integral to the map-making process, offering more economical alternatives. Analyzing statistical summaries within the study timeframe facilitates an understanding of the spatial and temporal patterns of the sand dunes. As with many natural phenomena, wind erosion and sand dune dynamics can be complex and elusive; therefore, the investigation of their various impacts requires the application of contemporary methods such as statistical analysis. In this regard, this study mainly sought to develop a conceptual framework that outlines the patterns of sand features in the study area and elaborates on their interrelationships.

Materials and methods: This study was conducted in an area covering approximately 200 hectares of sand dunes in the southern region of Mezinan Kalate, located in western Sabzevar city. The area features various sand formations, including Nebkha and Barkhan. To analyze the spatial patterns of the complications observed, the exact locations of such complications were identified, followed by an assessment of their distribution patterns. The paired univariate function (g(r)) was then employed to investigate the distribution patterns of different complications and their impacts on similar types. Additionally, the bivariate pairwise correlation function ($g_{12}(r)$) was utilized to explore the interactions among various complications in the study area. Initially, a general assessment of the region was conducted through a field visit, followed by aerial photography using a drone to collect the required data regarding the complications from the study area. After analyzing the images, an

1. PhD student of desert management and control, Gorgan University of Agricultural Sciences and Natural Resources.
2. Associate Professor, Department of Arid Zone Management, Gorgan University of Agricultural Sciences and Natural Resources; Email: mhalizadeh@gau.ac.ir
3. Associate Professor, Department of Arid Zone and Desert Management, Faculty of Natural Resources and Environment, Ferdowsi University of Mashhad
4. Assistant professor. Department of Natural Resources and Enviromental Engineeing. Faculty of Agriculture. Shiraz University
5. Assistant professor. Research Institute of Forests and Ralands. Agricultural Education and Extension Research Organization
6. Associate Professor, Department of Arid Zone Management, Gorgan University of Agricultural Sciences and Natural Resources
Doi: 10.22052/deej.2024.254137.1046

orthophoto was generated. Then, a point map was created for spatial locations via ArcGIS 10.2, detailing the distribution of sand dunes and vegetation within the study area. Furthermore, the Kolmogorov-Smirnov test was applied to evaluate the normality of the statistical data. Finally, data processing and spatial analysis were carried out using the Programita software, which involved univariate and bivariate correlation functions, along with O-ring functions. The software employed a Monte Carlo simulation with 199 repetitions, achieving a 95% confidence level and a 5% significance level for the random distribution of the two species investigated.

Results: The diagram illustrating the distribution pattern of sand dunes employs the O-ring function, utilizing the g(r) function values to analyze the spatial arrangement of the dunes. Findings from the application of this univariate function indicated that Barkhans did not display a significant spatial pattern. The finding is supported by the O(r) function, reaffirming that the spatial arrangement of Barkhans lacks any significance. The results of the g(r) function in examining the spatial pattern of Nebkhas via univariate functions revealed that within distances ranging from zero to 270 meters, the spatial pattern of the species was characterized by cumulative or clustered shape, and that no significant pattern was detected beyond 270 meters. Similarly, the results of O(r) function suggested that the spatial arrangement of Nebkhas formed clusters within the 0 to 270 meters range, with no significant pattern being observed beyond 250 meters. Additionally, the results obtained from the bivariate function $g_{12}(r)$ showed a negative correlation between these two elements up to about 500 meters, demonstrating their opposing influences on each other's formation and distribution. This finding is consistent with the distribution map of the two elements. The bivariate function $O_{12}(r)$ was also used to validate the results found in $g_{12}(r)$, yielding consistent outcomes with those derived from the pairwise correlation analysis.

Discussion and Conclusion: The findings obtained from the spatial analysis of sand dunes and Nebkha indicated that the distribution of sand dunes in this area was intricate, while the arrangement of Nebkhas remained inconsistent. Together, these factors adversely impacted the formation and development of both phenomena. This situation may arise from the phenomena's similar requirements for the establishment, specifically the availability of sand. It may also be driven by the presence of certain favorable environmental conditions.

Keywords: Univariate Functions, Bivariate Functions, Spatial Pattern, Sand Dune Interaction, Spatial Functions, Nebkha.