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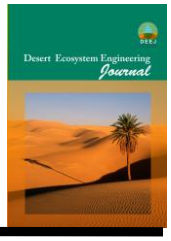

Investigating Climatic Zoning of Hamoon Helmand Desert Catchment Using Cluster Analysis and Auditing

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Extended Abstract

Introduction: The diversity of climatic elements and their Spatio-temporal behavior make the mixed study of climatic elements a difficult, complex, and time-consuming task. On the other hand, in studies conducted on space in more stations or cells, the complexity and difficulty of the study increases. In such cases, data classification can be helpful. The application of classification methods in climatology has begun since the early twentieth century. The weakness of traditional methods of climatic classification in the presentation of climatic facts led researchers to use multivariate statistical techniques for climatic classification which uses a variety of variables to classify climates. However, computational tools minimize the probability of error in the voluminous, complex, and time-consuming calculations involved in multivariate classification methods.

Hamoon Helmand catchment has unique climatic features such as Sistan's 120-day winds and severe dust storms. In different parts of this basin, different climatic parameters have different intensities and weaknesses, leading to the creation of different climatic zones in this catchment area with their own unique conditions. Recognition of these zones and the changes in their area over the last three decades could help planners and decision-makers in the integrated management of the Hamoon Helmand desert watershed.

Materials and methods: Considering the small number and high dispersion of synoptic stations that have all the desired climatic parameters of the intended climatic zoning with a suitable statistical period, this study used the relevant data collected by nearby synoptic stations. To conduct climatic zoning of Hamoon catchment, the data concerning the average, minimum, and maximum temperature parameters, average, minimum, and maximum humidity, precipitation, wind, and dust was used for the statistical period 1989 to 2018. Climate analysis and audit analysis methods were also used for climatic zoning of the Hamoon catchment area.

Cluster analysis is a widely used method for multivariate data analysis. It is primarily used in situations where the target, i.e., the class classification, is an example of n person (item) with p attribute. In this process, similar people are placed in the same group. In this method which helps identify real groups and reduces the volume of data, classification is done based on similarities or distances.

As a multivariate technical analysis, that deals with separating distinct sets of objects (or observations) and assigning new objects (or observations) to previously defined categories, audit analysis ultimately seeks to create a linear combination between variables used for group individuals, turning a complex multivariate problem into a simple mono-variable statistical problem. Since the application of the audit analysis method requires prior knowledge of the number of groups, it can be used to test the clusters obtained from cluster analysis. Therefore, this study used the audit analysis method to test the competence of cluster analysis for grouping.

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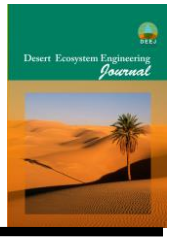

Results: According to the results of climatic analysis on five climatic zones, dendrograms were identified for the Hamoon catchment. To investigate the changes in these areas during three 10-year climate periods, the area of each zone was studied and analyzed based on cluster and audit analyses.

The zoning of climatic elements of the first period which was conducted based on cluster analysis indicated that the northern and western parts of the basin were heavily rainy, both of which are low dust areas with a low temperature. Next to this zone, towards the central part of the basin, there was a rainy area with a relatively low temperature and moderate dust. The south of the basin was a low dust area with a moderate rainfall rate. The eastern part of the basin was a very hot and dusty area with a very low rainfall rate, 72.22 days of annual dust, and extreme wind speed. Moreover, the investigation of climatic zoning in the second period showed that the northern part of the basin is a very rainy zone with a significantly lower area than that of the first period. In addition, the precipitation rate was 112.4 mm in this area during the second period which was 54 mm lower than that of the first period.

The central part of the basin was located in a dusty area with a low rainfall rate, ranking second in terms of dust and wind speed. The area of this zone (low rainfall) has decreased by 3.8% compared to its area in the first period, with part of it turning into a very low-rainfall area and another part into an area with moderate rainfall. The northern part of the basin is located at a high rainfall area with 153.2 mm annual precipitation, showing a 41 mm increase compared with the second period and a 14 mm reduction compared to the first period. Moreover, the area of this zone has decreased compared to the first and second periods, indicating the movement of the basin towards the mainland.

Conclusion: The results obtained from the climatic zoning of the Hamoon catchment area indicated the existence of five climatic zones in the study area: 1. Moderate rainfall area with gentle wind and low dust; 2. A hot, highly dusty, and low rainfall area with strong wind speed; 3- A highly dusty, low-rainfall area with low temperature - and moderate wind speed; 4- A high-rainfall, moderately dusty area with low temperature; and 5- A very dusty, very hot, and very low-rainfall area with strong wind speed. The analysis of changes in the area of designated zones during three decades (the study period) in a complete climatic period showed a reduction in the number of rainfall areas and an increase in the number of low rainfall areas, indicating the prevalence of drought conditions in the basin within the recent periods. Therefore, it could be concluded that awareness of the prevailing climatic characteristics of each part of the basin helps regional planners and decision-makers prioritize executive operations and adapt themselves to the climatic conditions of different parts of this desert basin.

Keywords: Climatic Zone, Cluster Analysis, Audit Analysis, Hamoun Watershed.