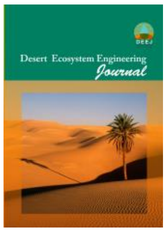
DEEJ (2019) 8 (24) 1-18

University of Kashan

Desert Ecosystem Engineering Journal

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



The Application of fractal dimension and morphometric properties of drainage networks in the analysis of formation sensibility in arid areas (Case Study, Yazd-Ardakan Basin)

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Received: 15/01/2019 Accepted: 19/05/2019

Extended Abstract

Introduction: Many natural phenomena have many variables that make it difficult to find relationships between them using common mathematical methods. This problem, along with the impossibility of measuring all elements of nature, has led to a major evolution in the way of understanding and explaining phenomena. In this way, one can use the fractal geometry with the theory that many natural phenomena are order in the chaos. Each element of nature is represented as a fractal geometry number. In fact, fractal geometry is a quantitative tool for studying the geomorphology of drainage networks and modeling many complex natural phenomena. Since geological variables have a profound effect on the nature and activity of the drainage networks. In this study, the role of lithology and geological formations is studied to quantify the drainage networks and used fractal dimension to indicate sensitivity to erosion of the formations of this area.

Material and Method: The present study consists of four main sections. The first section is the collection of maps and data. In this section, geological maps of 1:100000 areas were provided and selected from the geological formations of Yazd- Ardakan basin, three geological formations of Kahar, Granit and Taft. Sensitivity to erosion of these formations was studied in this area using PSIAC, Feyznia and Selby methods. In second section, fractal dimension is estimated in 30 plots of 1×1 km^2, three geological formations of Kahar, Granite and Taft. In each geological formation, fractal dimension was calculated by box counting method using Fractalyse software and the number of plots required in each formation was determined using Graphical method. In the third section of this study, morphometric indices were calculated including drainage density, number of ranks, average length of rank and rank frequency. In the final section, uncertainty analysis of fractal dimension efficiency was studied in classification and separation of geological formations. In most studies in the field of fractal dimension, the uncertainty of this method is not considered. As a result, their findings do

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DOI: 10.22052/deej.2018.7.24.1

not have enough accuracy to generalize to natural phenomena. Therefore, in this study, uncertainty of fractal dimension efficiency was investigated in 30 plots of 1 × 1 km^2 that were excluded from other study sections for testing this method.

Result: The mean fractal dimension of 1.149 represents Taft formation, the mean fractal dimension of 1.161, is Granite formation and the amount of 1.207 is Kahar formation. The highest fractal dimension was calculated in Kahar formation (1.279) and the lowest in Taft formation (1.046). In addition, the correlation coefficient is 99%. The results also indicated a significant and meaningful relationship between fractal dimensions of drainage networks and morphometric properties. In this paper, a positive relationship is observed between morphometric parameters and fractal dimension, so that the greatest correlation coefficient is found between the fractal dimension and the drainage density (0.99). The results of uncertainty analysis of fractal dimension showed which fractal dimension in the geological formation of Kahar with 90% has a steady trend and in two geological formations of Taft and Granite, this amount is about 70%. Therefore, fractal dimension in the drainage network identification of the Kahar formation is more powerful than two other granite and Taft formations.

Discussion and conclusion: The drainage networks are the most prominent landscapes on earth that are the basis of many hydrological and geomorphological models. Due to the geomorphological characteristics of the region, the drainage network shows its own fractal properties that are saved as code in it. In fact, drainage networks are fractal phenomena with fractal behavior. In this study, the fractal dimension and morphometric properties of the drainage network were used to analyze the sensitivity to erosion of the geological formations of this area. PSIAC and Feyznia methods did not perform well in separating the sensitivity to erosion of Taft and granite formation, and they are unable to distinguish between these two formations. So, using the Selby method, six effective factors were investigated on the resistance and sensitivity of formations to erosion (Schmidt Rebound Hardness, weathering, distance between joints, direction of the joints relative to the slope, the width and connection of the joints) in Taft and Granite formations. The study of these factors leads to field visits and spends a lot of time and cost. As the results of the resistance to erosion of formations were shown by Selby method, Granite formation has less resistance to Taft formation. Due to the climatic conditions in this area, Granit formation is susceptible to weathering. Extreme weathering acts as arenization process. In fact, fractal dimension in three geological formations of the study area is well showed the difference in resistance to erosion of both Taft and Granite formations. The results of this study showed that fractal dimension allows for a quick and accurate analysis of the erosion characteristics and sensitivity to erosion of the formations of this area.

Keywords: Drainage network, Fractal dimension, Geological formation, Yazd-Ardakan Basin, uncertainty.