Comparison of fractal dimension and geomorphologic characteristics in the management of Aqda Basin

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Extended abstract

1- Introduction

Different natural phenomena have many variables that make it difficult to find relations among 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 procedure of scrutinizing and explaining. In this way, we can use the fractal geometry with the theory that the order of many natural phenomena is chaotic. Fractal geometry is a quantitative tool for studying the geomorphology of drainage networks and modeling many complex natural phenomena. In fact, geophysical phenomena such as basins are fractal phenomena with fractal behavior. An understanding of geomorphologic characteristics and their performance over basins is very important in the watershed management. This paper focuses on the relationship between fractal dimensions of basin shape and drainage network with the geomorphologic characteristics of basin. Therefore, through an analysis of fractal dimensions and its comparison with geomorphologic characteristics, the fractal behavior of this basin is investigated.

2- Methodology

The present study consists of four main sections. The first section is the collection of maps and data. In this section, topographic maps at scale of 1:50000 and geological map at scale of 1:100000 from area were provided. Then, the required layers were extracted from them such as drainage networks and geological units. Sensitivity to erosion of formations was studied in this basin using PSIAC method. In order to investigate more precisely, the Aqda was divided into nine hydrological sub-basins (independent), five non-hydrological sub-basins (dependent) and four hybrid sub-basins. The second section, 18 geomorphologic characteristics were calculated for each sub-basin. In the third section of this study, fractal dimension of drainage networks and basin shape was calculated by box counting method using Fractalyse software in each sub-basin. The focus of the final section is on the relationship between fractal dimensions of basin shape and drainage network with the geomorphologic characteristics of basin.

3- Results

The results showed that the T8 and To3 sub-basins, respectively, with values of 1.47 and 1.60 have the highest fractal dimensions of the drainage network. Also, the highest fractal dimensions of the basin shape were obtained with values of 1.05 and 1.08, respectively, in the same sub-basins (T8 and To3). The results also indicated that there were significant relations among the fractal dimensions of the basin shape and the drainage network with geomorphologic characteristics. The highest correlation belongs to the regression relations between the total length of stream, basin area and erodible area with the fractal dimension of the drainage network (0.98, 0.97 and 0.95 respectively). Fractal dimension of the basin shape showed the highest correlation of 0.82 and 0.8 respectively with the number of networks and the total length of stream (significant at 99 percent level). Then, the erodible status in Aqda Basin was determined by studying the geomorphologic characteristics and comparing it with the fractal dimensions of the basin shape and the drainage network. The highest erodible status

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is in T8, T1, T6 and TO3 sub-basins which should be considered in strategies to manage Aqda basin. In fact, this study showed that fractal dimensions allow a quick and accurate analysis of the geomorphologic characteristics of the basin and the drainage network.

4- Discussion & Conclusions

Identification, evaluation and prioritization of different areas can produce valuable information for the watershed comprehensive plans, soil conservation and mitigation of the erosion types based on amount of erosion and sedimentation. For this purpose, the geomorphologic characteristics should be investigated in basins. But extraction of these characteristics and estimation of the erodible status in basins are time-consuming and costly. Therefore, it is very necessary to use an index that has an appropriate estimation of the erodible status in basins. Fractal dimension, with time and cost management, can determine sensitive and high priority basins. With knowledge about the relationship between geomorphologic characteristics basins with fractal dimension, we can predict the other characteristics of basin. The results of this study indicated that there were significant relation between the geomorphic characteristics of sub-basins study and fractal dimension of the basin shape and the drainage network. Other researches on fractal dimension analysis have shown that there is a significant relation between fractal dimension and characteristics such as basin shape, area, branching ratio, drainage density and length ratio of drainage network. But in this study, two characteristics of branching ratio and length ratio of drainage network were not significantly correlated with any of the characteristics and fractal dimensions, and the drainage density was correlated only with frequency rank. Therefore, basins with high erosion will not always have high drainage density. For example, quaternary alluvial deposits have high erosion, but their drainage density is not very high (T4 sub-basin). For this reason, in the future studies, it is better to separate the tectonic streams from the erosion streams. Finally, the results of this study can confirm the findings of other researchers that fractal dimension of drainage network reflects the complexity of the basin shape and can be used as a quantitative index for basin analysis and evolution of the basin.

Key Words: Box Counting, Fractal Dimension, Geomorphologic characteristics, Watershed management.