Fractal analysis of the Loess Plateau in China

Kamila Justyna Lis
Nanjing Normal University
kamikabo@gmail.com

Tang Guoan
Nanjing Normal University
tangguoan@njnu.edu.cn

Abstract—Fractal dimension is an important indicator for the understanding the loess plateau geographic features. This study employed this method to investigate this. The preliminary results show that terrain in the study area has a complex landscape structure based on the fractal dimensions evaluated. The final work is to integrate the fractal dimension and slope for the test sites to showcase how these landscape parameters can help define the landform evolution in the Loess plateau.

Keywords—integration, dimension; slope; DEM; bathemetry

I. INTRODUCTION

The field of remote sensing and geographic information systems (GIS) continues to grow rapidly as computer and mathematics profession get an informed understanding of the earth surface and its physical features. The study of landforms for example has been a prime issue of concern and importance in the geomorphometry [1-3].

Loess plateau belongs to the family of landforms that has been of strategic important to the Chinese Government and have attracted several studies about its natural features, underlying geomorphology, the climate conditions and accumulation of soil deposits [4-8]. Though, a large number of studies have been conducted in loess plateau, the employment of fractal dimension originally develop by Mandelbrot [9] to describe accurately and precisely natural physical features in this plateau has been limited. Therefore, this study employed the fractal dimension technique to extract the physical features in this zone. The study conducted this in four test cases located in the Shaanxi Province of China. It is expected that this study would provide baseline understanding of the use of fractals in this region and further, boosts the informed understanding of the evolution of the loess plateau.

II. MATERIALS AND METHODS

A. Data Sources

The digital elevation models (DEMs) were obtained from the Shaanxi project conducted using bathymetry. These included two test sites – Changwu and Chunhua.

B. Methods

The method employed in this study is the implementation of the fractal dimension technique. In fractal analysis, the fractal dimension (D) is estimated as follows:

$$D_f = \lim_{r \to 0} \frac{\log N_r}{\log\left(\frac{1}{r}\right)} \quad (1)$$

Where

$$N_r = \sum_{i,j}^{M} n_r(s,s) \quad (2)$$

And

$$n_r(s,s) = L - K + 1 \quad (3)$$

Where, (s, s) is the size of the box counter and in this case was adopted as 250 x 250.

III. RESULTS

The preliminary results about the fractal analysis for the test sites have been presented in figure 1. The complete work is to consider the effects of D_f and slope variation in the test sites and how these two help to describe the complexity of a landscape.

IV. CONCLUSION

The adoption of fractals is important in understanding the different anthropogenic activities in the Loess Plateau. This study used bathymetry studies conducted in four test sites. The comparison of the fractal dimension and slope maps shows distinctive differences. The slope show the general existing conditions of the landscape while the fractals determined the degree of anthropogenic of each of these attributes described by the slope map. Therefore, it is anticipated the employment of the fractal and slope attribute for the analysis of DEM can provide useful information for an in-depth classification of the loess plateau.

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Figure 1. Preliminary results of spatial fractal dimension for study sites