Landform classification using topography position index (case study: salt dome of Korsia-Darab plain, Iran)

Marzieh Mokarram¹ · Gholamreza Roshan² · Saeed Negahban³

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Abstract In the research aim is to evaluate the Jennes algorithm for landform classification in salt dome of Korsia of Darab plain, Iran. The Jennes's approach uses a multi-scale approach by fitting a quadratic polynomial to a given window size using least squares. In the study used window size of 3*3 and 10*10. Input data for landform classification is digital elevation model (DEM) with resolution of 30 m. After prepared landform classification map for the study area, used geology map. The results show that the evaluated method can be helpful in the predictive mapping of geology. The algorithm of landforms classification proposed by Jennes seem to be the most applicable method.

Keywords Landform classification · Jennes algorithms · Digital elevation model · Salt dome of Korsia

Introduction

Advances in computer technology, new spatial analytical methods and the increasing availability of digital elevation data have re-oriented geomorphometry (Pike 1999) and promoted the development of computer algorithms for calculating geomorphometric properties of the Earth's surface. In the past, geomorphometric properties have been measured by calculating the geometry of the landscape manually that can be time consuming (Horton 1945; Mokarram 2015; Coates 1958). In the 1960s and early 1970s, the generally availability of computers made possible more complex, statistically-based methods to identify landscape features (Evans 1972; Chorley 1972).

Several papers document applicability of landform classification and relationship with mapping of soil especially in steep land areas (Schmidt and Hewitt 2004). There are new opportunities in this field, resulting from existence of relatively precise global and regional digital elevation models (Meybeck et al. 2001). However, the terms and methods used in different fields of science vary in detail (Barka 2009; MacMillan et al. 2000; Ratajczak and Jasiewicz 2009; Straumann and Purves 2008). Landform units can be carried using various approaches, including automated mapping of landforms (MacMillan et al. 2000; Meybeck et al. 2001; Schmidt and Hewitt 2004; Saadat et al. 2008), classification of morphometric parameters, filter techniques, cluster analysis and multivariate statistics (Dikau 1989; Dikau et al. 1995; Adediran et al. 2004).

Geomorphometrics consist of geometry, topography, and physical landforms of the Earth's horizons, over time, and branches out from the disciplines of geomorphology, geomatics and geomorphometry. It is a response to the development of this GIS technology to gather and

✉ Gholamreza Roshan
r.rowshan@yahoo.com

Marzieh Mokarram
m.mokarram@shirazu.ac.ir

Saeed Negahban
snegahban@shirazu.ac.ir

¹ Department of Range and Watershed Management, College of Agriculture and Natural Resources of Darab, Shiraz University, Shiraz, Iran

² Department of Geography, Golestan University, Gorgan, Iran

³ Department of Geography, Shiraz University, Shiraz, Iran

process DEM data (e.g. remote sensing, the Landsat program and photogrammetry). Geomorphometry provides a quantitative description of the shapes of landforms. According to Blaszczyński (1997), landforms are defined as specific geomorphic features on the earth's surface, ranging from large-scale features such as plains and mountain ranges to minor features such as individual hills and valleys. Geomorphometric properties have been measured by calculating the geometry of the landscape manually (Horton 1945; Miller 1953; Coates 1958). Recently, advances in computer technology, increased processing power, new spatial analytical methods and the increasing availability of digital elevation data have re-oriented geomorphometry (Pike 1999).

The aims of in the paper is preparing landform map based on Jennes algorithm in the salt dome of Korsia of Darab plain, Iran of Iran.

Materials and methods

The case areas were selected from ten different locations in salt dome of Korsia- Darab plain. The study area is located at $28^{\circ} 28' 46''\text{N}$ and $54^{\circ} 23' 40''\text{E}$, with area of 1083 km^2 . The locations of the case areas are shown in Fig. 1. Digital elevation models were include SRTM DEM (30 m resolution). The NASA shuttle radar topographic mission (SRTM) produced DEM with spatial resolution of 30 m.

Methods of classification

The topographic position index (TPI) (Guisan et al. 1999) used in the study area. This method was further developed by Weiss (2001) and Jenness (2006). TPI (Eq. (1)) compares the elevation of each cell in a DEM to the mean

Fig. 1 Digital elevation mountain (DEM) of the study area

Fig. 2 Input data for landform classification

Fig. 3 TPI value for the study area

elevation of a specified neighborhood around that cell. Mean elevation is subtracted from the elevation value at center.

$$TPI_i = M_0 - \sum_{n=1}^n M_n / n \quad (1)$$

where M_0 = elevation of the model point under evaluation, M_n = elevation of grid, n = the total number of surrounding points employed in the evaluation.

Results

Different values of input parameters (slope, curvature, plan, profile, elevation) (Fig. 2) used for preparing landform classification.

For landform classification via Jenness algorithm, first of all prepared TPI map for each cases that show in Fig. 3. According to Fig. 3, minimum and maximum TPI is -125 and +116 for scale of 3x3 and -237 and +29 for scale of 10x10.

After prepare TPI map for each of the cases study, the landform classification map were created (Fig. 4 and Table 1). Landform classification maps generated based on the computed TPI values are shown in Fig. 4. For this method, the classes consist of canyons/deeply incised

Table 1 Characteristics of the cases study

Name	Elevation (m)			Slope (°)	
Shahoo	Max: 3172	Min: -53	Mean: 1028	Max: 89°	Min: 0

Fig. 4 Landform classification map

Table 2 Areas of features for the landform classification maps in Fig. 4

Code	Classes	Area (%)	Area (km ²)
1	Canyons, deeply incised streams	35.22	114.62
2	Midslope drainages, shallow valleys	1.90	6.17
3	Upland drainages, headwaters	2.85	9.27
4	U-shaped valleys	6.17	20.07
5	Plains small	15.03	48.92
6	Open slopes	0.19	0.61
7	Upper slopes, mesas	3.13	10.18
8	Local ridges/hills in valleys	4.10	13.33
9	Mid slope ridges, small hills in plains	2.91	9.47
10	Mountain tops, high ridges	28.51	92.77
	Sum	100	325.41

Fig. 5 Area for each of classes

streams, midslope drainages/shallow valleys, upland drainages/headwaters, u-shaped valleys, plains small, open slopes, upper slopes/mesas, local ridges/hills in valleys, mid slope ridges/small hills in plains, mountain tops/high ridges.

The area for the each of classes show in Table 2 and Fig. 5.

For determination of landform type of dome of Korsia by Jennes method used 3 sample points that were shown in Fig. 6.

According to Fig. 6, mountain tops, high ridges was determined for dome of Korsia in the study area.

Conclusions

A landform is a natural feature of the Earth's surface. Landforms together make up a given terrain, and their arrangement on the landscape or the study of same is known as topography. Information on landforms are based on digital elevation models (DEM) and field studies. Method of Jennes is the most promising algorithm for classification of landforms. Also the results show that mountain tops, high ridges was determined for dome of Korsia in the study area.

Fig. 6 Sample points of the salt dome of Korsia

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