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ORIGINAL ARTICLE

Landform Classification by Slope Position classes

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ABSTRACT
The main objective of this study is to landform classification in Oshtorankooh Mountain where located in Zagros mountain, Iran. In order to landform classification used Digital Elevation Models (DEMs) with 90 m resolution. In this study used slope position classes for landform classification for the Oshtorankooh Mountain where located in Zagros Mountain, Iran. By using slope position index, the study area was classified into landform category. The results show that there is variety of landform (valley, lower slope, flat slope, middle slope, upper slope and ridge) that valley class and flat slope have maximum and minimum percentage respectively in the study area.
Keywords: *landform classification, Oshtorankooh Mountain, Digital Elevation Models (DEMs), Slope Position Index.*

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INTRODUCTION
The 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 [1].
Landform units can be carried using various approaches, including automated mapping of landforms [2-6], classification of morphometric parameters, filter techniques, cluster analysis and multivariate statistics [7-10]. Derivation of landform units can be carried using various approaches, including classification of morphometric parameters, filter techniques, cluster analysis, and multivariate statistics [10]. Morphometric studies usually begin with the extraction of basic components of relief, such as elevation, slope, and aspect. Also description of the landform may be achieved by using spatial derivatives of these initial descriptors, as well as useful indicators, e.g., the topographic wetness index [11], stream power index, slope position index [12]and aggradations and degradation index.
The purpose in the study is landform classification by slope position index in the Oshtorankooh Mountain where located in Zagros Mountain, Iran.

MATERIAL AND METHOD
Topography Position Index (TPI)
Topographic Position Index (TPI) is an adaptation of this method which compares the elevation of each cell in a DEM to the mean elevation of a specified neighborhood around that cell. Local mean elevation is subtracted from the elevation value at centre of the local window. Algorithm is provided as an ESRI script by Jenness Enterprises [12], and it has local window options of; rectangular, circular and annulus.

$$TPI_i = Z_0 - \frac{\sum_{1-n} Z_n}{n}$$

Where;
Z0 = elevation of the model point under evaluation
Zn = elevation of grid within the local window
n = the total number of surrounding points employed in the evaluation

Positive TPI values represent locations that are higher than the average of the local window e.g. ridges. Negative TPI values represent locations that are lower e.g. valleys. TPI values near zero are either flat areas (where the slope is near zero) or areas of constant slope (where the slope of the point is significantly greater than zero), high positive values relate to peaks and ridges.

Landform classification

The TPI is the basis of the classification system and is simply the difference between a cell elevation value and the average elevation of the neighborhood around that cell. Positive values mean the cell is higher than its surroundings while negative values mean it is lower [12]. Combining TPI at small and large scales allows a variety of nested landforms to be distinguished (Table 1).

Table 1: ***Landform classification based on TPI .***
(Source: Weiss 2001)

Classes	Description
Canyons, deeply incised streams	Small Neighborhood: $z_o \leq -1$ Large Neighborhood: $z_o \leq -1$
Midslope drainages, shallow valleys	Small Neighborhood: $z_o \leq -1$ Large Neighborhood: $-1 < z_o < 1$
upland drainages, headwaters	Small Neighborhood: $z_o \leq -1$ Large Neighborhood: $z_o \geq 1$
U-shaped valleys	Small Neighborhood: $-1 < z_o < 1$ Large Neighborhood: $z_o \leq -1$
Plains small	Neighborhood: $-1 < z_o < 1$ Large Neighborhood: $-1 < z_o < 1$ Slope ≤ 5°
Open slopes	Small Neighborhood: $-1 < z_o < 1$ Large Neighborhood: $-1 < z_o < 1$ Slope > 5°
Upper slopes, mesas	Small Neighborhood: $-1 < z_o < 1$ Large Neighborhood: $z_o \geq 1$
Local ridges/hills in valleys	Small Neighborhood: $z_o \geq 1$ Large Neighborhood: $z_o \leq -1$
Midslope ridges, small hills in plains	Small Neighborhood: $z_o \geq 1$ Large Neighborhood: $-1 < z_o < 1$
Mountain tops, high ridges	Small Neighborhood: $z_o \geq 1$ Large Neighborhood: $z_o \geq 1$

TPI values can easily be classified into slope position classes based on how extreme they are and by the slope at each point. TPI values above a certain threshold might be classified as ridge tops or hilltops, while TPI values below a threshold might be classified as valley bottoms or depressions. TPI values near 0 could be classified as flat plains (if the slope is near 0) or as mid- slope areas (if the slope is above a certain threshold) (Table 2).

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Table 2: Class of landform by slope position classes (Weiss 2001)

Class	TPI
Valley	$TPI \leq -1$ SD
Lower Slope	-1 SD $< TPI \leq -0.5$ SD
Flat Slope	-0.5 SD $< TPI < 0.5$ SD, $Slope \leq 5°$
Middle Slope	-0.5 SD $< TPI < 0.5$ SD, $Slope > 5°$
Upper Slope	0.5 SD $< TPI \leq 1$ SD
Ridge	$TPI > 1$ SD

Case study

The study area is Oshtorankooh Mountains, Iran, which is located at 32º 42′ 59′′ to 33º 28′ 30′′N and 48º 51′ 53′′ to 49º 41′ 11′′E, with area of 3,260.62 km^2 (Figure 1). The highest elevation in this area is 4,049 m, which is located in the south of the basin, while the lowest elevation is 885 m, which is located in the north of basin. The dataset for the area originates from a DEM with resolution of 90 m (SRTM), which was downloaded from http://srtm.csi.cgiar.org.

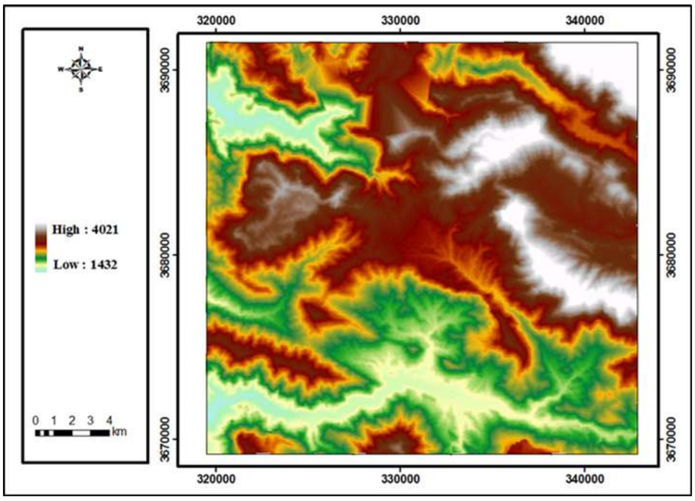


Fig. 1 Location of the study area

RESULT AND DISCUSSION

Topography Position Index (TPI)

The result show that in the study area, TPI in the verity scale have difference value that show that Figure 2 to Figure 5.

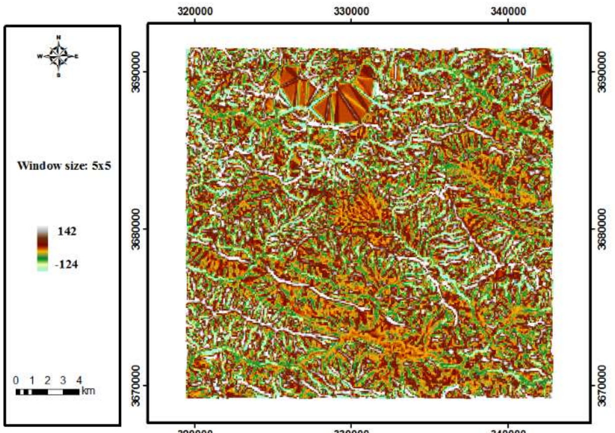


Fig. 2 Topographic position index for scale of 5 m.

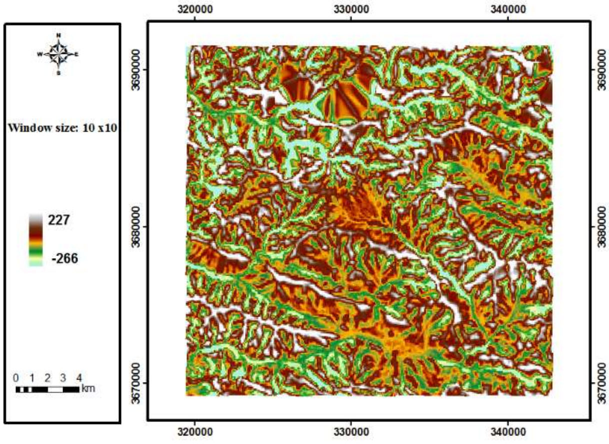


Fig. 3 Topographic position index for scale of 10 m.

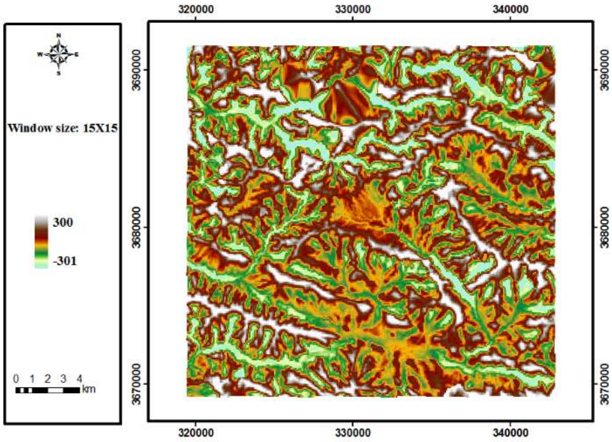


Fig. 4 Topographic position index for scale of 15 m.

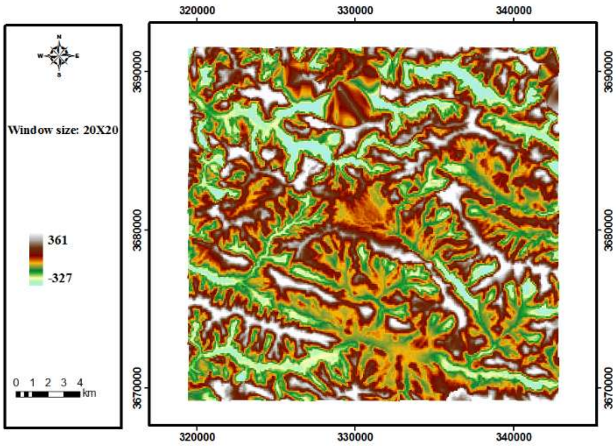
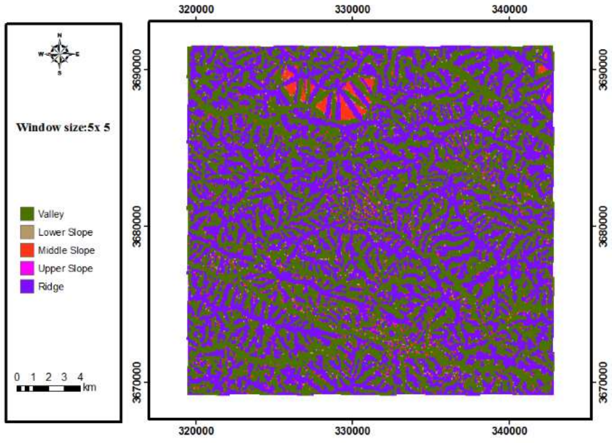


Fig. 5 Topographic position index for scale of 20 m.

Landform classification

The results show that there are 6 classes that consist of: alley, lower slope, flat slope, middle slope, upper slope and ridge that show that Figure 6 and Figure 9 and Table 3.

Fig. 6 landform classes by slope position classes for the scale of 5 m.



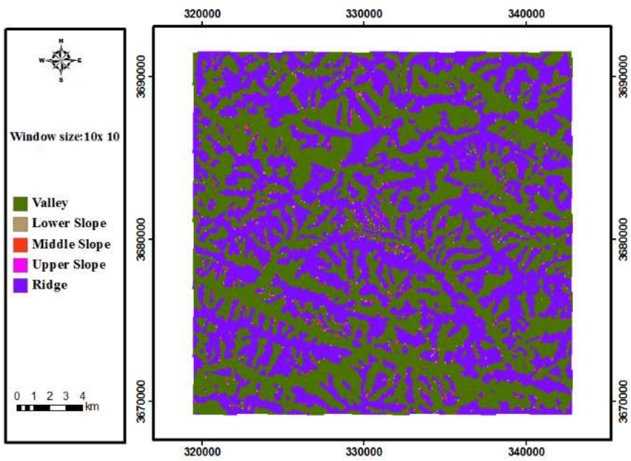


Fig. 7 landform classes by slope position classes for the scale of 10m.

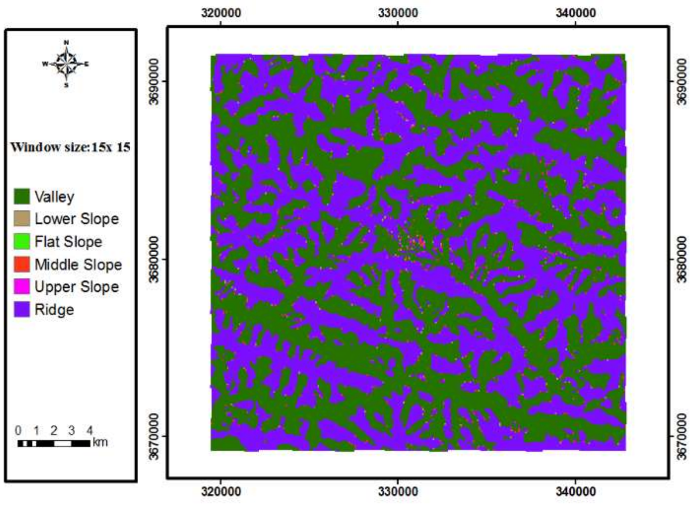


Fig. 8 landform classes by slope position classes for the scale of 15 m.

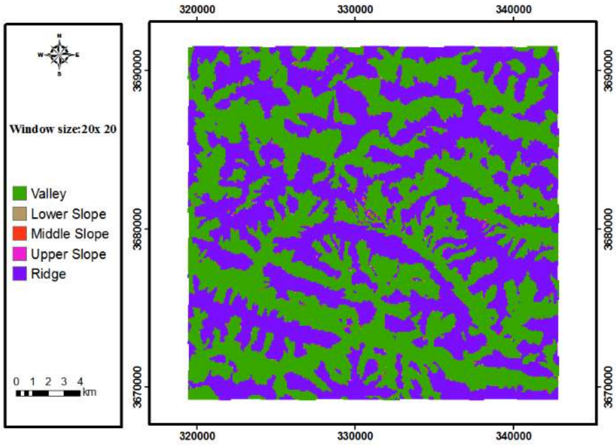


Fig. 9 landform classes by slope position classes for the scale of 20 m.

*Table 3: **area of landform classes by slope position classes for the study area***

Class	Code	Area (km²)			
		Scale of 5	Scale of 10	Scale of 15	Scale of 20
Valley	1	262.10	270.96	1.00	1.00
Lower Slope	2	6.71	2.42	2.00	0.00
Flat Slope	3	0.00	0.00	3.00	2.00
Middle Slope	4	15.30	4.73	4.00	4.00
Upper Slope	5	5.59	2.58	5.00	5.00
Ridge	6	232.24	241.25	6.00	6.00

The comparison of classes show in 10 to Figure 13.

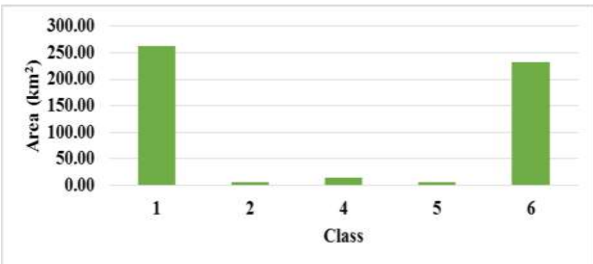


Fig. 10 Percentage of each landform classes for the scale of 5m.

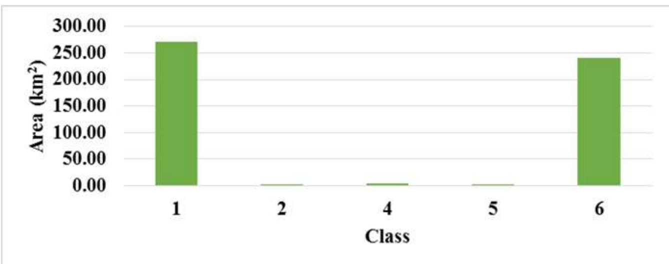


Fig. 11 Percentage of each landform classes for the scale of 10 m.

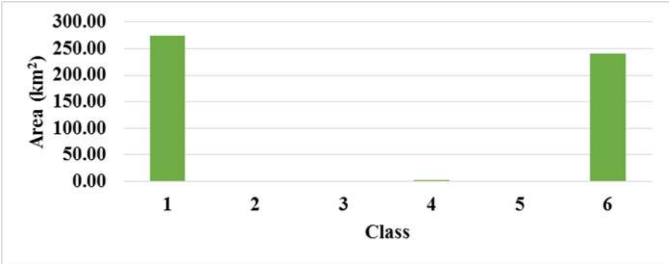


Fig. 12 Percentage of each landform classes for the scale of 15 m.

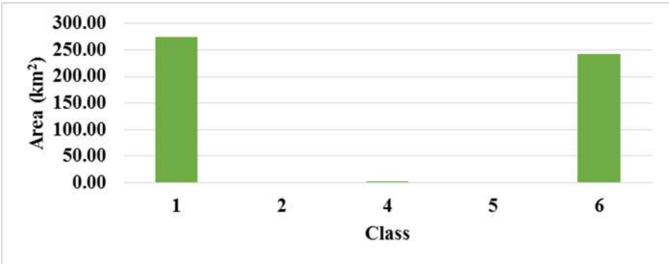


Fig. 13 Percentage of each landform classes for the scale of 20 m.

CONCLUSION

In this study, topographic position classes were used to generate landform elements according to Weiss [13] and Jenness [12]. Digital elevation models used as inputs data in the study area. The result shows that there are variety of landform in the study area. In all of the neighborhoods (valley, lower slope, flat slope, middle slope, upper slope and ridge) that valley class and flat slope have maximum and minimum percentage respectively in the study area.

REFERENCES

1. J. S. Blaszczynski, (1997). Landform characterization with geographic information systems. Photogrammetric Eng. Remote Sens., 63: 183-191.
2. R. Macmillan, W. Pettapiece, S. Nolan, T. Goddard, (2000). A generic procedure automatically segmenting landforms into landform elements using DEMs, heuristic rules and fuzzy logic. Fuzzy sets and Systems 113, 81–109.
3. P. A. Burrough, van P. F. M. Gaans, R. A. MacMillan, (2000).High resolution landform classification using fuzzy-k means. Fuzzy Sets and Systems 113, 37-52.
4. M. Meybeck, P. Green, C. J. Vorosmarty, (2001). A New Typology for Mountains and Other Relief Classes: An Application to Global Continental Water Resources and Population Distribution, Mount. Research & Development 21, 34 - 45.
5. H. Saadat, R. Bonnell, F. Sharifi, G. Mehuys, M. Namdar, S. Ale-Ebrahim, (2008).Landform classification from a digital elevation model and satellite imagery. Geomorphology 100, 453–464.
6. J. Schmidt, A. Hewitt, (2004).Fuzzy land element classification from DTMs based on geometry and terrain position. Geoderma 121, 243–256.
7. R. Dikau, (1989). The application of a digital relief model to landform analysis in geomorphology. In: Raper, J. (Ed.), Three-dimensional Applications in Geographical Information Systems. Taylor & Francis, London, pp. 51–77..
8. R. Dikau, E. E. Brabb, R. K. Mark, R. J. Pike, (1995). Morphometric landform analysis of New Mexico. Zeitschrift für Geomorphologie, N.F., Suppl.-Bd., 101, 109-126.
9. J. R. Sulebak, B. Etzelmqller, J. L. Sollid, (1997).Landscape regionalization by automatic classification of landform elements. Norsk Geografisk Tidsskrift 51 (1), 35– 45.
10. A.O. Adediran, I. Parcharidis, M. Poscolieri, K. Pavlopoulos, (2004). Computer-assisted discrimination of morphological units on north-central Crete (Greece) by applying multivariate statistics to local relief gradients. Geomorphology 58, 357–370.
11. D. Moore, J. L. Nieber,(1989). 'Landscape assessment of soil erosion and nonpoint source pollution', J . Minnesota Acad. Sci., 55, 18-25.
12. J. Jenness, (2010). Topographic Position Index (tpi_jen.avx) extension for ArcView 3.x, v. 1.3a. Jenness Enterprises, http://www.jennessent.com/arcview/tpi.htm.

13. Weiss, A. (2001). Topographic Positions and Landforms Analysis (Conference Poster). ESRI International User Conference. San Diego, CA, pp. 9-13.

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