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ORIGINAL ARTICLE

Using Topography Position Index for Landform Classification (Case study: Grain Mountain)

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ABSTRACT
Landform elements include land such Canyons, deeply incised streams, Midslope drainages, shallow valleys, Upland drainages, headwaters, U-shaped valleys, Plains small, Open slopes, Upper slopes, mesas, Local ridges/hills in valleys, Midslope ridges, small hills in plains and Mountain tops, high ridges. The main objective of this study is to landform classification in Grain 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 Topography Position Index (TPI) classes for landform classification for the case study. TPI values are between – 128 to 161. By using TPI, the study area was classified into landform category. The result show that there are nine landform classes that Upper slopes, mesas and Local ridges/hills in valleys have high and small area respectively.
Keywords—*topography position index, landform classification, Grain Mountain.*

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INTRODUCTION

The Landform elements include land such as hills, mountains, plateaus, canyons, valleys, seascape and oceanic water body interface features such as bays, peninsulas, seas and so forth, including sub-aqueous terrain features such as mid-ocean ridges, volcanoes, and the great ocean basins. "Landform classification is reducing terrain complexity into a limited number of easily discernible functional units [1]. Landform classification, like any other categorization attempt by human is intrinsic. It is more likely that we can understand what the categories of land reveal, than to perceiving and evaluating continuous representations. There is a long tradition of mapping, which can be attributed to the relative ease of representing discrete spatial units compared to understanding and evaluating continuous representations of surface [2]. Landform classification emerged due to complexity of the earth surface which has necessitated seeking methods to quantify its form and subdivide it into more manageable components [3,4].
Landform classification has been of great interest in earth sciences as it has a wide range of application domains, including mapping lithology [5] predicting soil properties [6], vegetation mapping, precision agriculture [7]. Landform classification indeed constitutes a central research topic in geomorphometry [8, 9]. Geomorphometry is usually referred to as a sub-discipline of geomorphology [10, 11], as an interdisciplinary field from mathematics, and Earth sciences and computer science [12].
The main objective of this study is to landform classification in Grain Mountain where located in Zagros mountain, Iran.

MATERIAL AND METHOD

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 [13], 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 [13]. 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: 14)

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).

Case study

The study area is Grain Mountains, Iran, which is located at 33º 01′ 03′′ to 34º 00′ 09′′ N and 48º 00′ 00′′ to 48º 58′ 48′′ E, with area of 1061.7 km^2 (Figure 1). The highest elevation in this area is 3645 m, which is located in the north of the basin, while the lowest elevation is 1480 m, which is located in the south and southwest of basin. The dataset for the area originates from a DEM with resolution of 90 m.

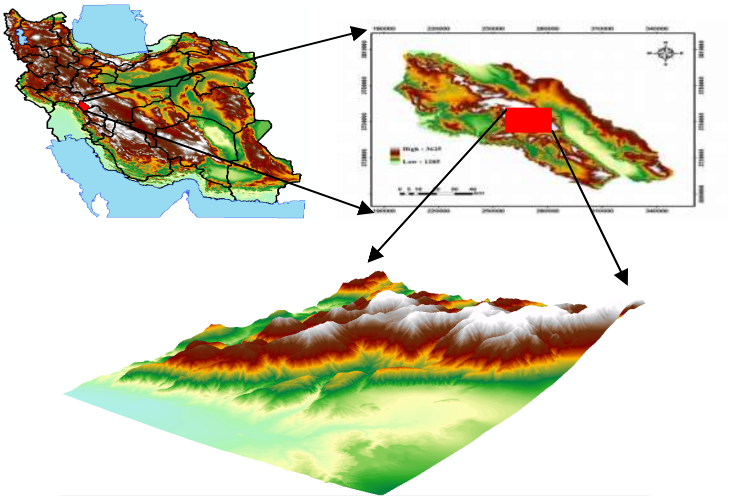

Fig. 1 Location of the study area

RESULT AND DISCUSSION

Topography Position Index (TPI)

TPI values are between – 169.24 to186.48 (Figure 2). TPI values near zero (close of -169.24) 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 (close of 186.48) values relate to peaks and ridges.

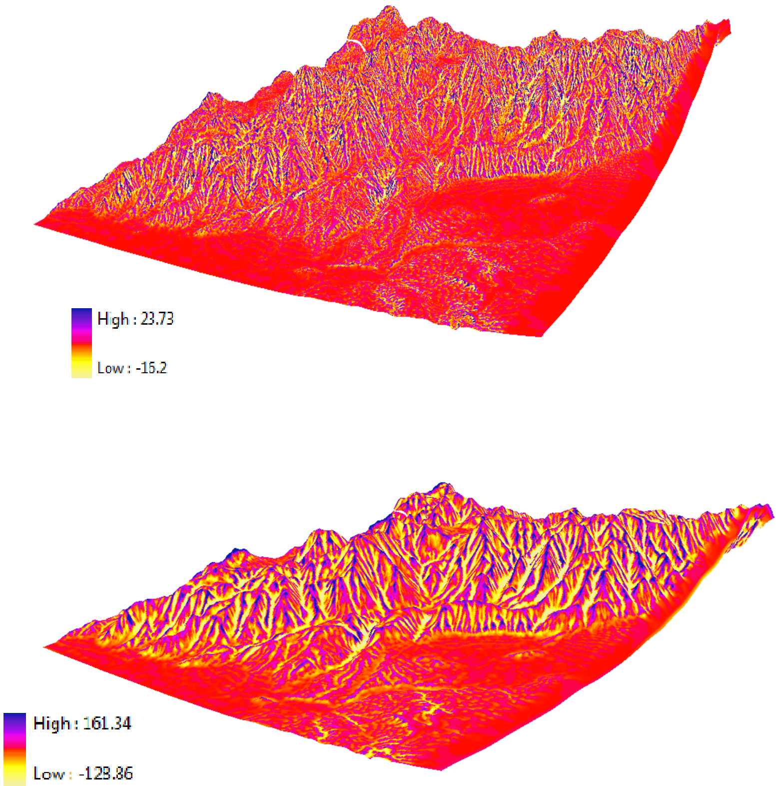

Fig. 2 Topography Position Index (TPI) 5 neighborhood (1) and 45 neighborhood (2)

Landform classification

The result show that there are three landform that consist of canyons / deeply incised streams, open slopes, and mountain tops / high ridges and the areas are 1071.02, 293.92, and 1028.11 for each of the classes respectively (Figure 3 to Figure 11 and Table 2).

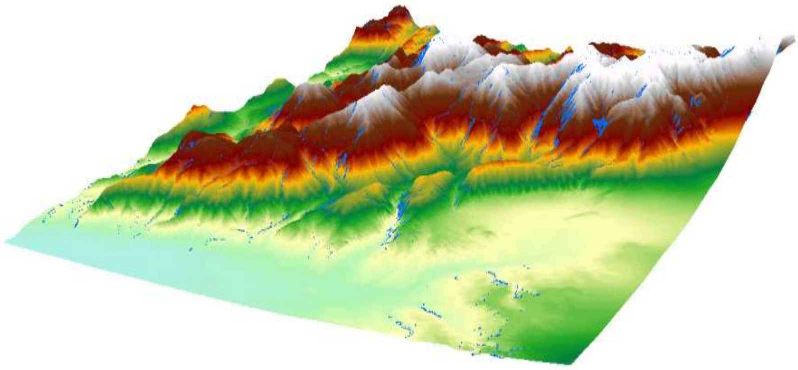

Fig. 3 Canyons, Deeply Incised Streams class for the study area

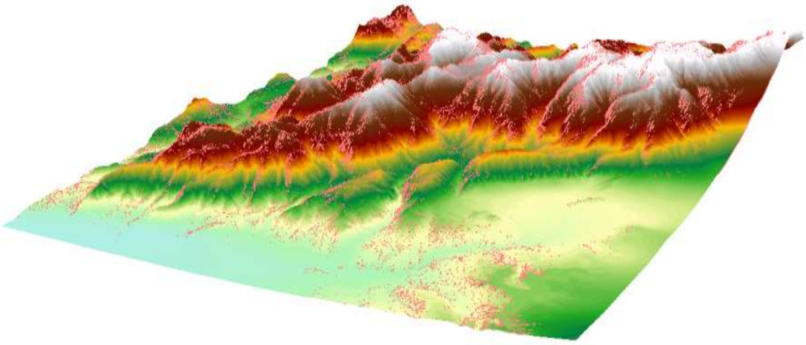

Fig. 4 Midslope drainages, shallow valleys class for the study area

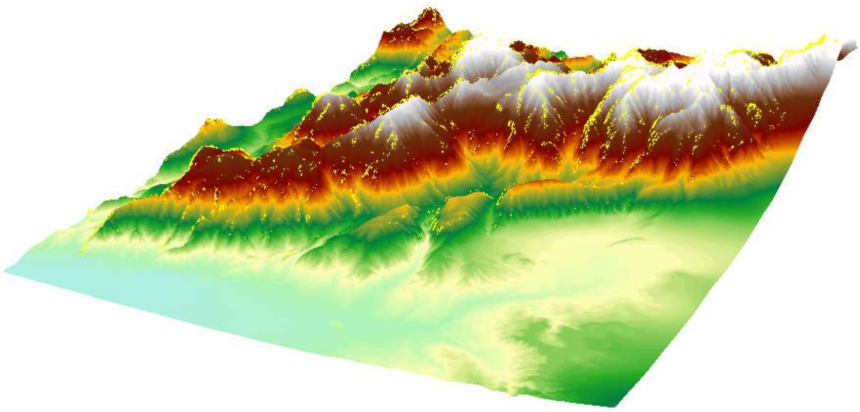

Fig. 5 Upland drainages, headwaters class for the study area

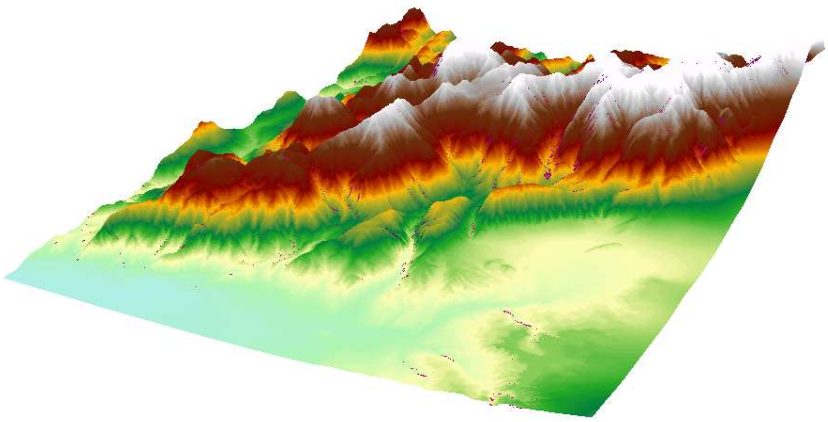

Fig. 6 U-shaped valleys class for the study area

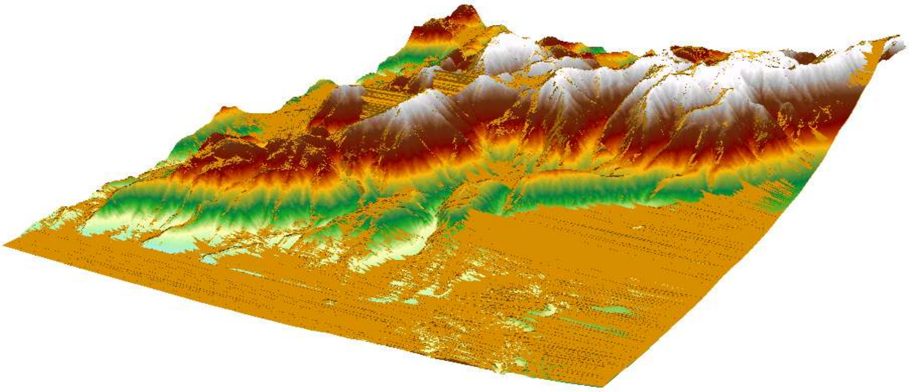

Fig. 7 Open slopes class for the study area

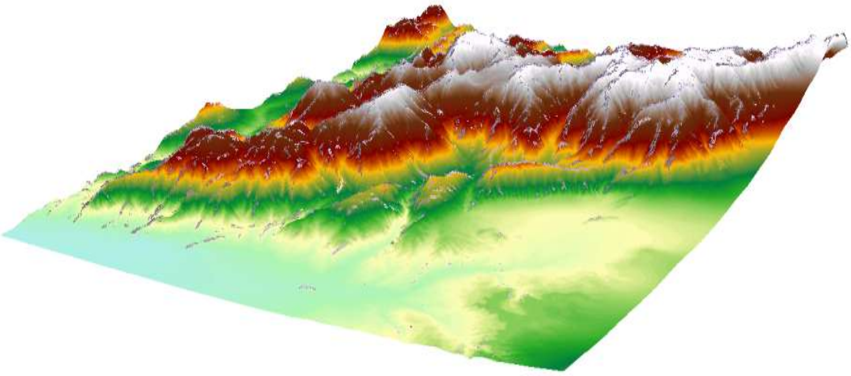

Fig. 8 Upper slopes, mesas class for the study area

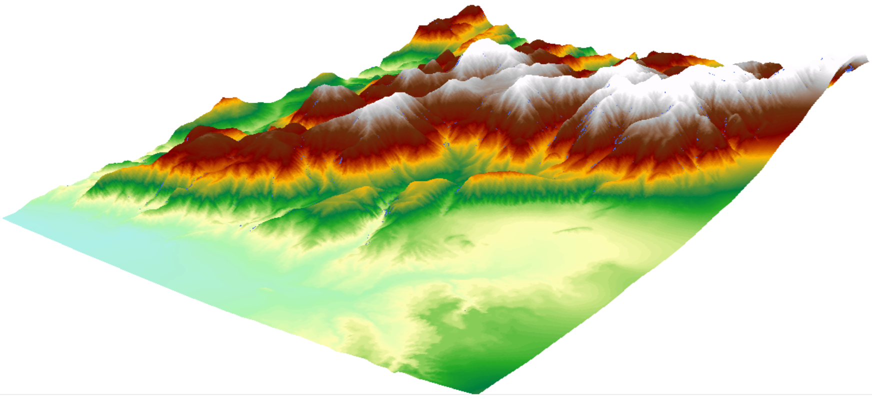

Fig. 9 Local ridges/hills in valleys class for the study area

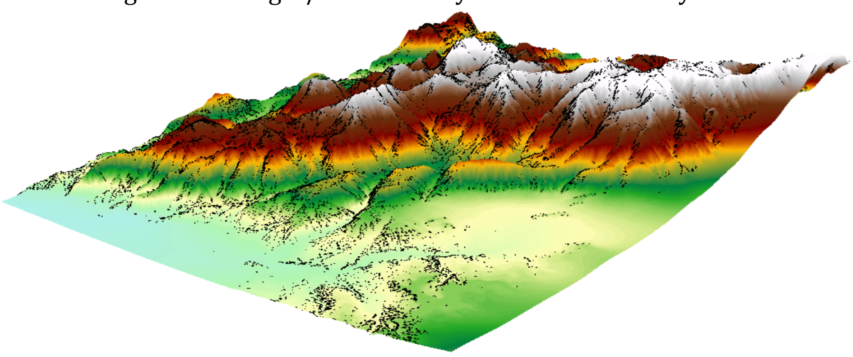

Fig. 10 Midslope ridges, small hills in plains class for the study area

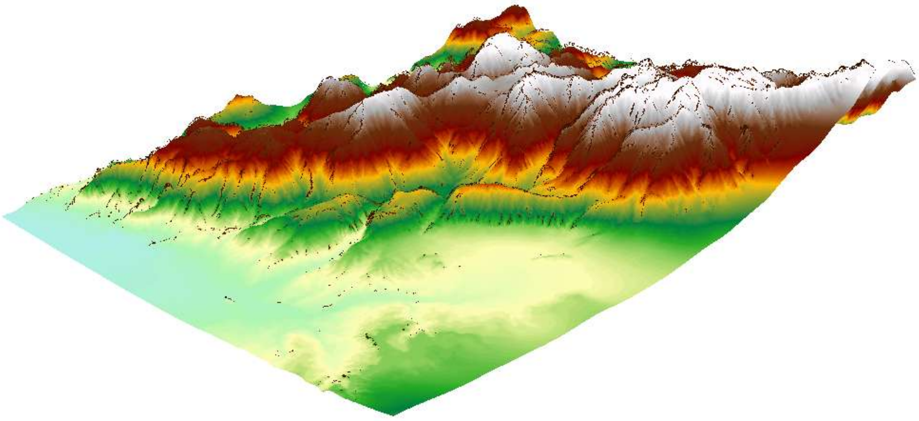

Fig.11 Mountain tops, high ridges class for the study area

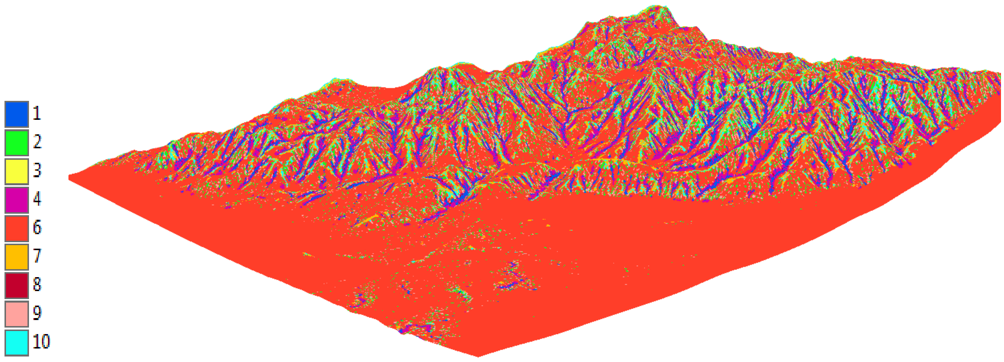

Fig. 12 Landform classification for the study area

Table 2 Area of each of landform class in the study area

Classes	Area (%)	Area (km²)
Canyons, deeply incised streams	12.32	130.78
Midslope drainages, shallow valleys	11.92	126.55
Upland drainages, headwaters	1.00	10.61
U-shaped valleys	16.32	173.31
Open slopes	15.30	162.47
Upper slopes, mesas	17.78	188.80
Local ridges/hills in valleys	0.82	8.76
Midslope ridges, small hills in plains	11.02	117.03
Mountain tops, high ridges	13.51	143.40

CONCLUSION

In this study, digital elevation models used as inputs data. TPI values are between – 169.24 to186.48. By using TPI, the study area was classified into landform category. The result show that there are three landform that consist of canyons / deeply incised streams, open slopes, and mountain tops / high ridges. Using TPI and landform classification by Weiss in 2001 for category of different area can applied.

REFERENCES

1. P. A. Burrough, P. F. M. van Gaans, R.A. MacMillan (2000)., *High resolution landform classification using fuzzy-k means*. Fuzzy Sets and Systems, 113, 37-52.
2. J. Strobl,(2007). "Segmentation-based Terrain Classification", In: Zhou Q., Lees, B., Tang, G., eds. Advances in Digital Terrain Analysis, Berlin Heidelberg: Springer-Verlag, 125-141.
3. S. Evans, (1990)."General Geomorphometry". In: Goudie, A.S., Anderson M., Burt T., Lewin, J., Richards, K., Whalley, B., Worsley, P. eds. Geomorphological Techniques. 2nd edition. Unwin Hyman, London, 44–56.
4. D. Gerçek (2010). "Object-based classification of landforms based on their local geometry and geomorphometric context." PhD diss., university of Middle east technical.

5. A.Kühni, O. A. Pfiffner, (2001). The relief of the Swiss Alps and adjacent areas and its relation to lithology and structure—topographic analysis from 250-M DEM. Geomorphology, 41, 285-307. 2001.
6. V. Florinsky, R. G. Eilers, G. Manning, L. G. Fuller, (2002). Prediction of soil properties by digital terrain modelling. Environmental Modelling & Software, 17, 295–311.
7. J. Verhagen, P. Verburg, M. Sybesma, J. Bouma, (1995).“Terrain modelling as a basis for optimal agroecological land management using dynamic simulation.” In: Robert, P.C., ed. Site-Specific Management for Agricultural Systems. ASA, CSSA, and SSSA, Madison, WI, 229–250.
8. R. J. Pike, *A bibliography of terrain modelling (geomorphometry), the quantitative representation of topography* - supplement 4.0., Open-File Rep. No. 02-465. U.S. Geological Survey, Denver, 116 p. 2002.
9. S. Rasemann, J. Schmidt, L. Schrott, R. Dikau, “Geomorphometry in mountain terrain”. In: Bishop, M.P., Shroder, J.F. eds. GIS & Mountain Geomorphology. Springer, Berlin, 101–145. 2004.
10. M. Dehn, H. Gartner, R. Dikau, (2001). *Principles of semantic modelling of landform structures*. Computers and Geosciences, 27, 1005-1010.
11. Bolongaro-Crevennaa, V. Torres-Rodriguez, V. Sorani, D. Frame, M. A. Ortiz, (2005). *Geomorphometric analysis for characterizing landforms in Morelos State, Mexico*. Geomorphology, 67, 407-422.
12. R. J. Pike, I. S. Evans, T. Hengl, (2009).“Geomorphometry: A Brief Guide.” In Hengl, T., Reuter H.I., eds. Geomorphometry-Concepts, Software, Applications. Developments in Soil Science, vol. 33, Amsterdam: Elsevier, 3-30.
13. 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,
14. Weiss, (2001). “Topographic Positions and Landforms Analysis” (Conference Poster). *ESRI International User Conference*. San Diego, CA, pp. 9-13.

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