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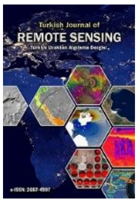

Landform Maps: An Example of Küçük Menderes Watershed

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Keywords
Geographical Information Systems,
Digital elevation model,
Landform,
Küçük Menderes Basin.

ABSTRACT

Landforms can be prepared easily due to the advantages of remote sensing, geographical information systems, automatic generation of landforms, and storage in databases. Therefore, it has begun to be used more effectively by many disciplines interested in physical plans such as geology, geomorphology, and soil. In this study, a land-use map was prepared in the Küçük Menderes Basin, one of Turkey's toluene water basins, with the Topographic Position Index (TPI) using Aster GDEM with a spatial resolution of 30 m in the Geographical Information Systems environment. The regional geographic structure was examined with environmental variables, such as slope and curvature, generated from the DEM data in the formation of the land morphology. The Jennes algorithm used in TPI calculation uses a multiscale approach by inserting a quadratic polynomial to the window size determined using least squares. The research results were compared using the DEM data with 300 m and 2000 m window widths. The morphological classes formed were gathered in 10 categories as Canyons, Shallow valleys, Upland drainages, U-Shape valleys, Plains, Open slopes, Upper slopes, Hills in valleys, Midslope ridged, High ridges.

Arazi Şekli Harita Örneği: Küçük Menderes Havzası

Anahtar Kelimeler:
Coğrafi Bilgi Sistemleri
Sayısal yükseklik modeli
Arazi kullanımı
Küçük Menderes havzası

ÖZ

Yeryüzü şekilleri günümüzde uzaktan algılama ve coğrafi bilgi sistemleri ile birlikte, arazi formlarının otomatik üretilmesi, veri tabanlarında depolanmasındaki avantajlarla rahatlıkla hazırlanabilmektedir. Dolayısıyla, jeoloji, jeomorfoloji, toprak gibi fiziki planlarla ilgilenen pek çok bilim dalı tarafından daha etkin kullanılmaya başlamıştır. Bu çalışmada Türkiye'de bulunan su toplama havzalarından biri olan Küçük Menderes havzasında, Coğrafi Bilgi Sistemleri ortamında 30 m mekansal çözünürlüğe sahip AsterGDEM kullanılarak Topografik Pozisyon İndeksi (TPI) ile arazi kullanımı haritası hazırlanmıştır. Arazi morfolojisinin oluşturulmasında Sayısal Yükseklik Modeli verilerinden üretilen eğim, yamaç eğrisellikleri gibi çevresel değişkenler ile bölgesel coğrafik yapı incelenmiştir. TPI hesaplanmasında kullanılan Jennes algoritması, en küçük kareleri kullanarak belirlenen pencere boyutuna ikinci dereceden bir polinom yerleştirerek çok ölçekli bir yaklaşım kullanmaktadır. Araştırmada SYM verisi ile 300 m ve 2000 m pencere genişliği kullanılarak sonuçlar karşılaştırılmıştır. Oluşturulan morfolojk sınıflar kanyonlar, sığ vadiler, yaylalar, tabanlı vadiler, ovalar, açık yamaçlar, dik yamaçlar, vadilerde tepeler, orta eğimli sırtlar veya ovalardaki küçük tepeler, zirveler olmak üzere 10 sınıfta toplanmaktadır.

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1. INTRODUCTION

Geographical Information Systems (GIS) can be easily produced maps due to technology development and the diversity of land on earth geomorphological maps. GIS show high performance in terms of analysing with quantitative data and investigating the accuracy of analysis results (Tagil & Jenness 2008; Grohmann & Riccomini 2009; De Reu et al.2012; Ilia et al. 2013; Seif 2014; Mokarram et al.2016; Rigol-Sanchez et al.2015; Skentos & Ourania 2017; Mokarram & Sathyamoorthy 2018; Çilek et al., 2019). In interpreting the topographic structure of the earth, valleys, river systems, mountains, hills, flat areas, slopes, valleys and so on, the classification of landforms holds an important place in the work of many different disciplines (Minar & Evans, 2008). River systems formed by the water collecting spaces (the basin), boundaries forming the ridge and the top of digital elevation models (DEM) can be obtained. Current technology can be made in the desired detail with model configuration techniques and D8 algorithms (Weiss, 2001).

Digital elevation models (DEM) are the quantitative expression of the earth's topography. It is one of the most essential parameters in obtaining and interpreting geomorphometric data. In geomorphology research, the evaluation of land morphometry is used in the interpretation of the landform. Land morphology provides a different perspective in examining many geographic structures such as geology, soil, land cover/use, and fault lines belonging to a region. In this study, Turkey land within the boundaries set by the DS, one of the 25 major catchments in the Küçük Menderes basin, the land use map, 30 m using a digital elevation model with a spatial resolution topographic position allows the index (TPI) has been prepared with the help of parameters. The Küçük Menderes basin has an aerial area of 6.975 km2 (Figure 1).

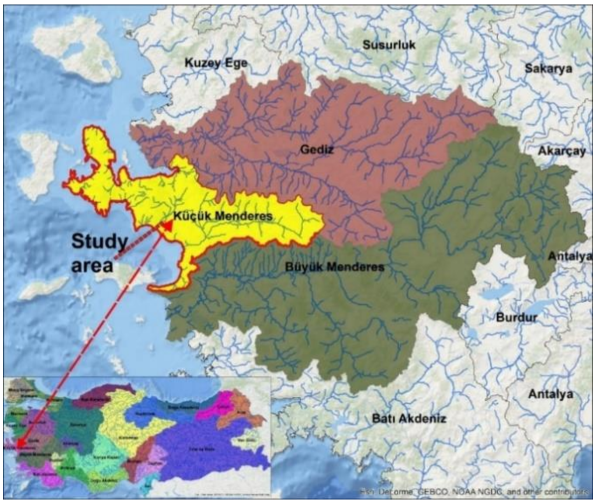


Figure 1. Study area.

2. MATERIAL

The Küçük Menderes Basin is in the west of Turkey, located in the Aegean Region. It is between the Gediz and Büyük Menderes Basins. The basin is located between 38 ° 41'05'' and 37 ° 24'08'' north latitudes and 28 ° 24'36 '' and 26° 11'48'' east longitudes. The basin area is 6975 km2, which is equivalent to 0.8% of the surface area of Turkey (Küçük Menderes HKEP, 2013). It is surrounded by Mount Karadağı, Mount Çulha and Mount Ayrık (Oyuk) from the east, by Mount Kümeli from south to west, by Mount Bozdağ, Mount Çallıba, Mount Mahmut and Mount Kesme from north to west, and by the Aegean Sea and İzmir Bay in the west. The topographic factors, including slope and aspect, were prepared from 30 m DEM (Digital Elevation Model). The elevation ranges between 0 and 2138 m, gradually decreases from west to east (Figure 2a), and is represented by steep slopes up to 71 degrees. The slopes of less than 10 degrees corresponding to 60.16 % of the study area around the watershed sharpen and its surroundings (Figure 2b). According to Turkey's soil maps (Karabulut et al. 2011), 23.88% of the study area consists of colluvial soils, whereas 17.29% consists of alluvial soils and 15.14% consists of brown forest soils (Figure 2c). According to the CORINE land use map, 50.07% of the Küçük Menderes basin consists of forest and semi-natural areas. On the other hand, the agricultural area and artificial regions, located in regions where alluvial plains are located and where the slope is below 10 °, has a percentage of 39.77% (Figure 2d).

3. METHODOLOGY

The model configuration technique developed by Jenness (2006) in the ArcGIS environment is a slightly improved version of the algorithm produced by Weiss (2001). According to Jenness (2006), the algorithm calculates the height value and the average value of neighboring pixels around that cell. If the value is positive, it means that the pixel is higher than the other pixels. On the other hand, if it is negative, it means that it is low. In addition, the degree of inclination of the pixel is calculated in some classes. If a cell is significantly higher than its neighboring cells, those regions are classified as hills or ridges. Significantly lower values than neighboring cells indicate that that cell is valley bottom or close to the bottom. Values close to zero are classified as flat or medium-slope areas (Çilek et al., 2019). In this case, the calculation includes the gradient, and the areas with medium slopes are distinguished from the flat areas (Figure 3).

4. RESULTS

4.1. Landform classification

To reveal the morphological structure of the study area, the final map was produced using TPI 300 and TPI 2000 parameters (Figure 4a, b) with model building techniques. The land classification created according to Jenness (2006) using TPI 300 and TPI 2000 values shown in figure 5. 42% of the Küçük Medneres basin consists of Open slopes, whereas 26% consists of plains, and the least common geomorphology class is Midslope ridges and small hills in plains (2.5%)

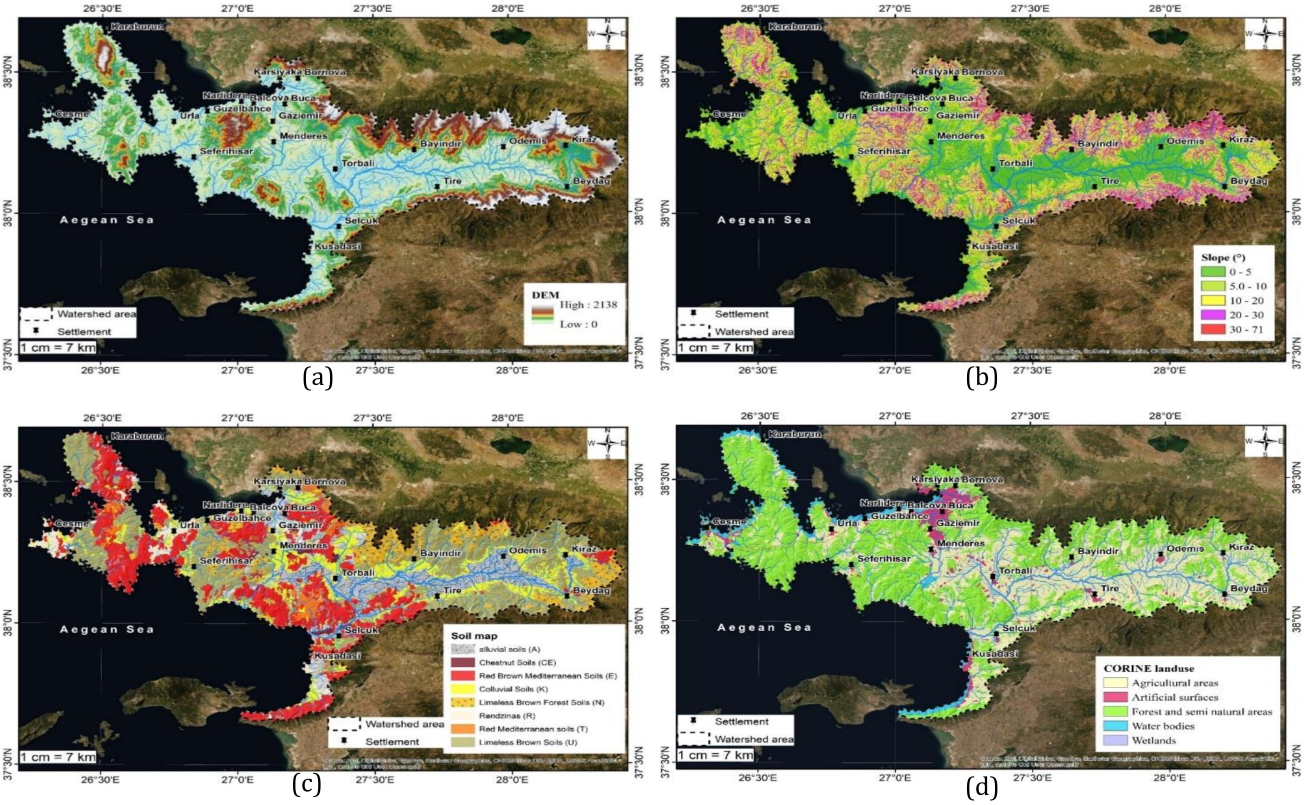


Figure 2. Digital elevation models (a), Slope (b), Soil (c), Landuse (d), maps of Küçük Menderes Watershed.

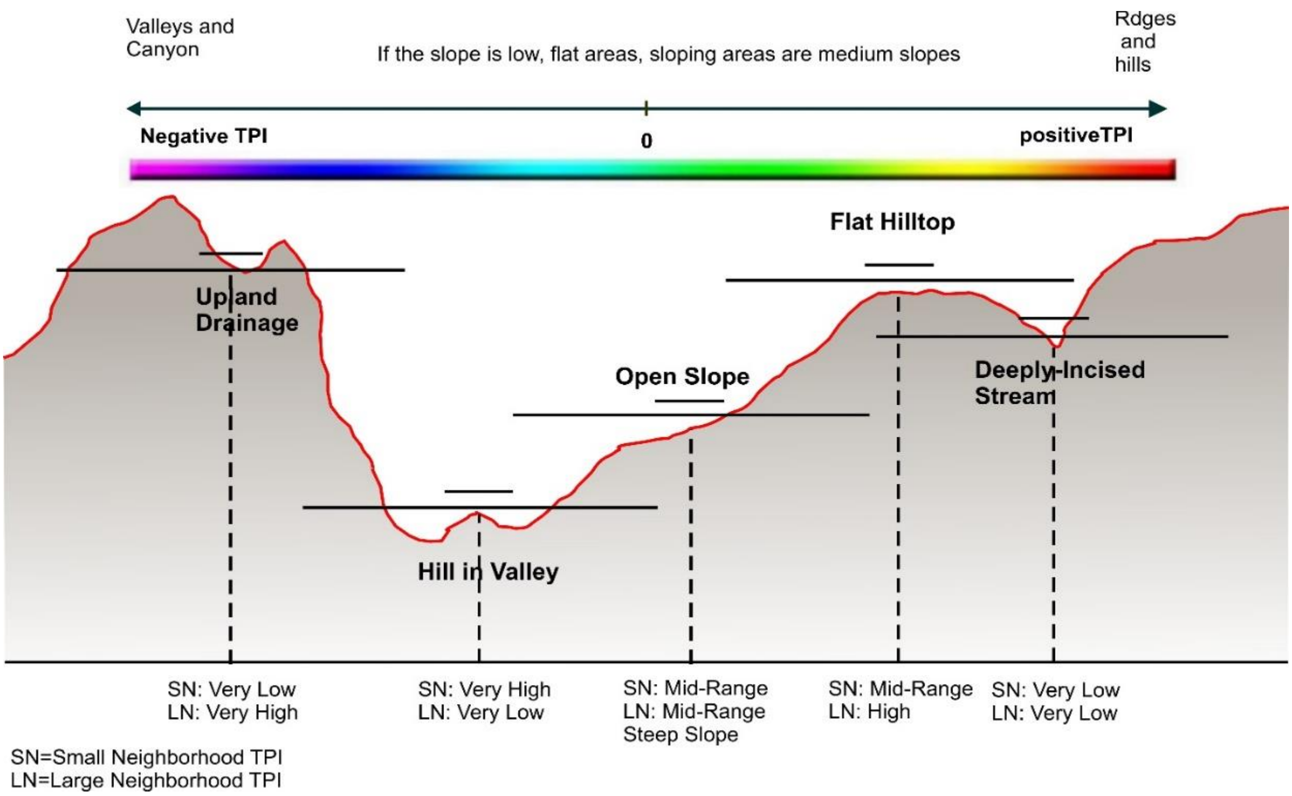
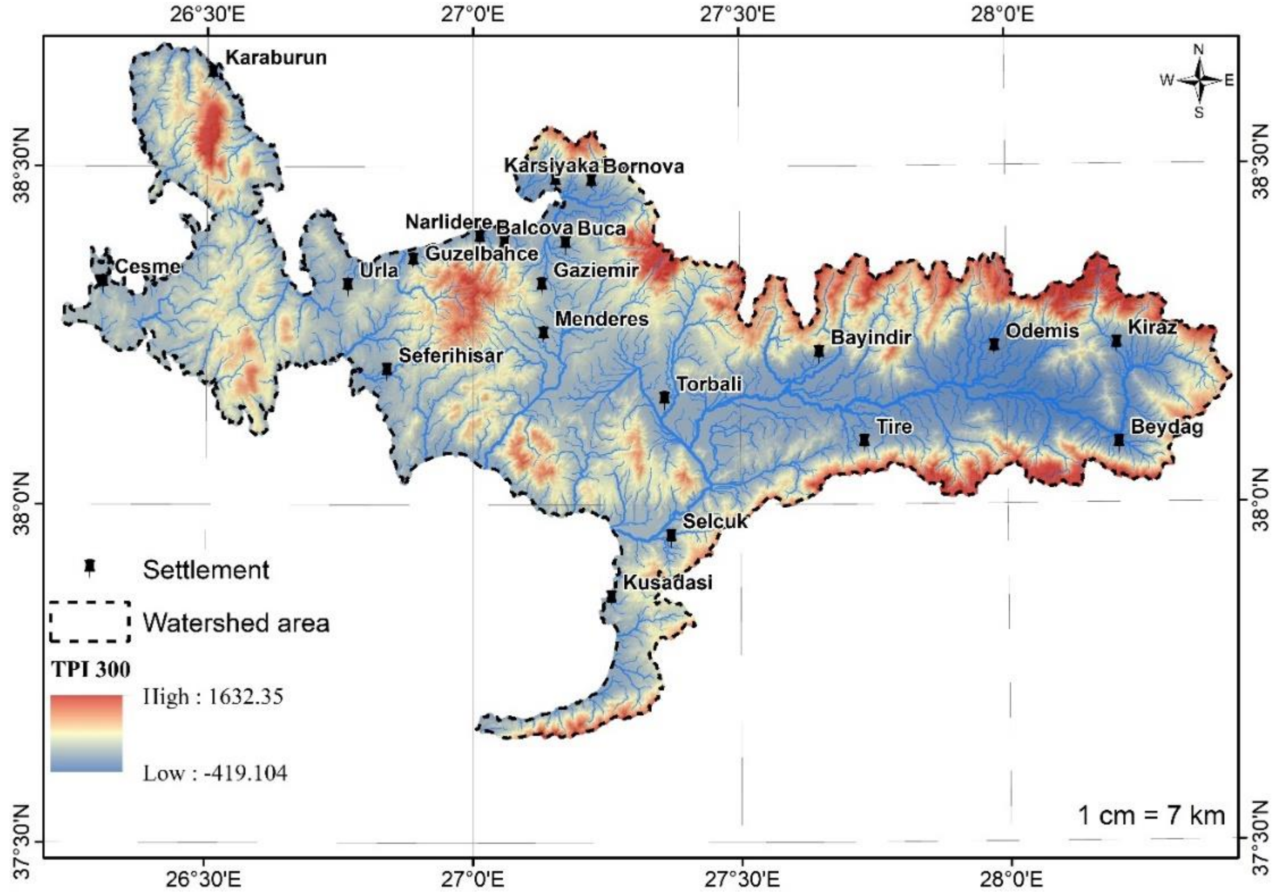
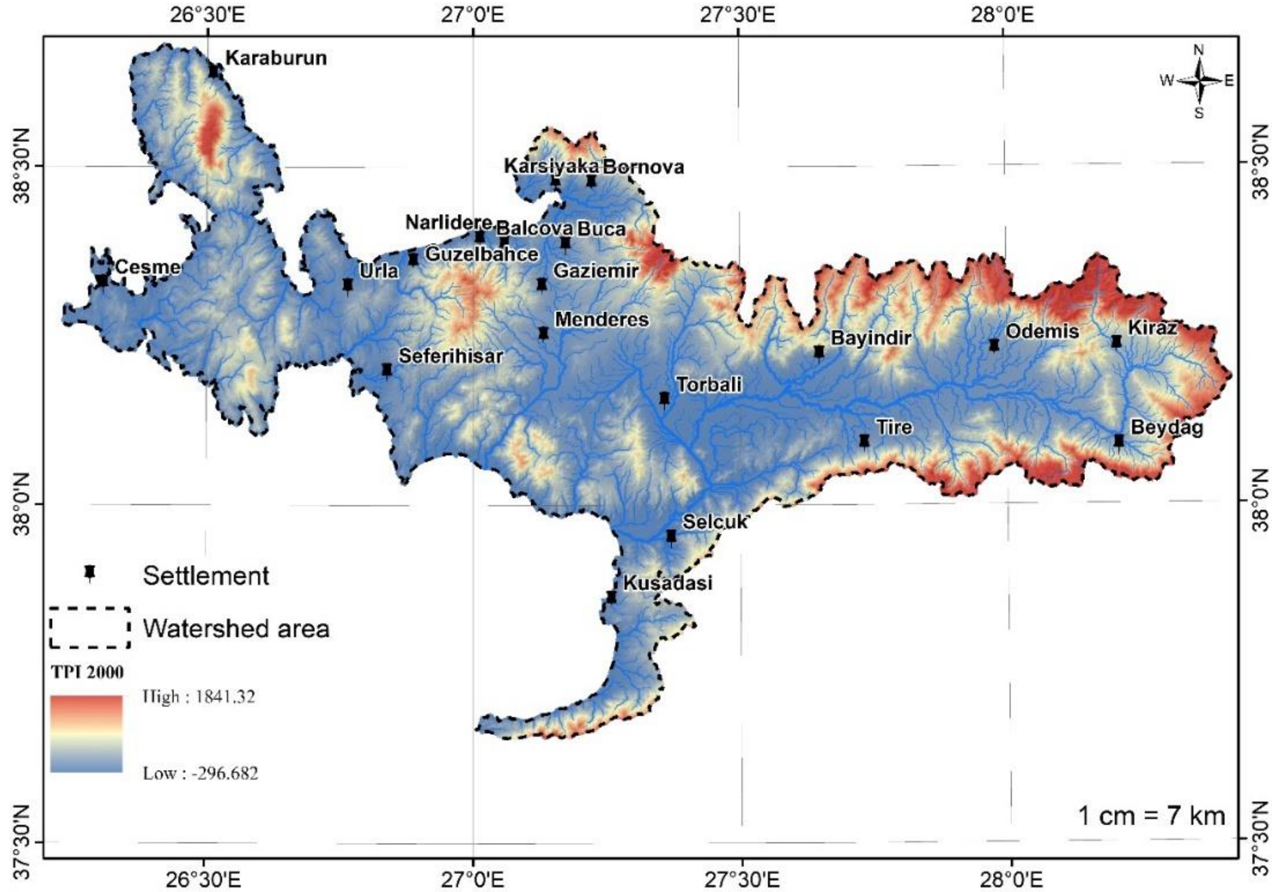


Figure 3. TPI and landform classification in neighborhood difference calculations (Jenness 2006).



(a)



(b)

Figure 4. TPI300 (a) and TPI 2000 (b) maps of the study area.

The accuracy analysis was obtained by comparing the pixel values containing the verification areas outside the training data determined for each field class. The incorrect classification of the pixels causes incorrect values. The Kappa statistics, one of the most widely used methods, were preferred to show the degree of accuracy in classification. For the accuracy assessment of the map produced for this purpose, 352 points were chosen randomly according to the areal sizes in the study area, and the ground truth data of each point were compared. The accuracy evaluation results for each landform class created with error matrices are given in Table 1. In the accuracy analysis, the overall Kappa statistics as well as the user's accuracy and manufacturer's accuracy were calculated for each class. It is seen that the Küçük Menderes basin landform map is 95% correct according to the Error matrix classification. The general Kappa statistic value was calculated as 92.15. According to Foody (2002), classifications with an accuracy of more than 85% are acceptable.

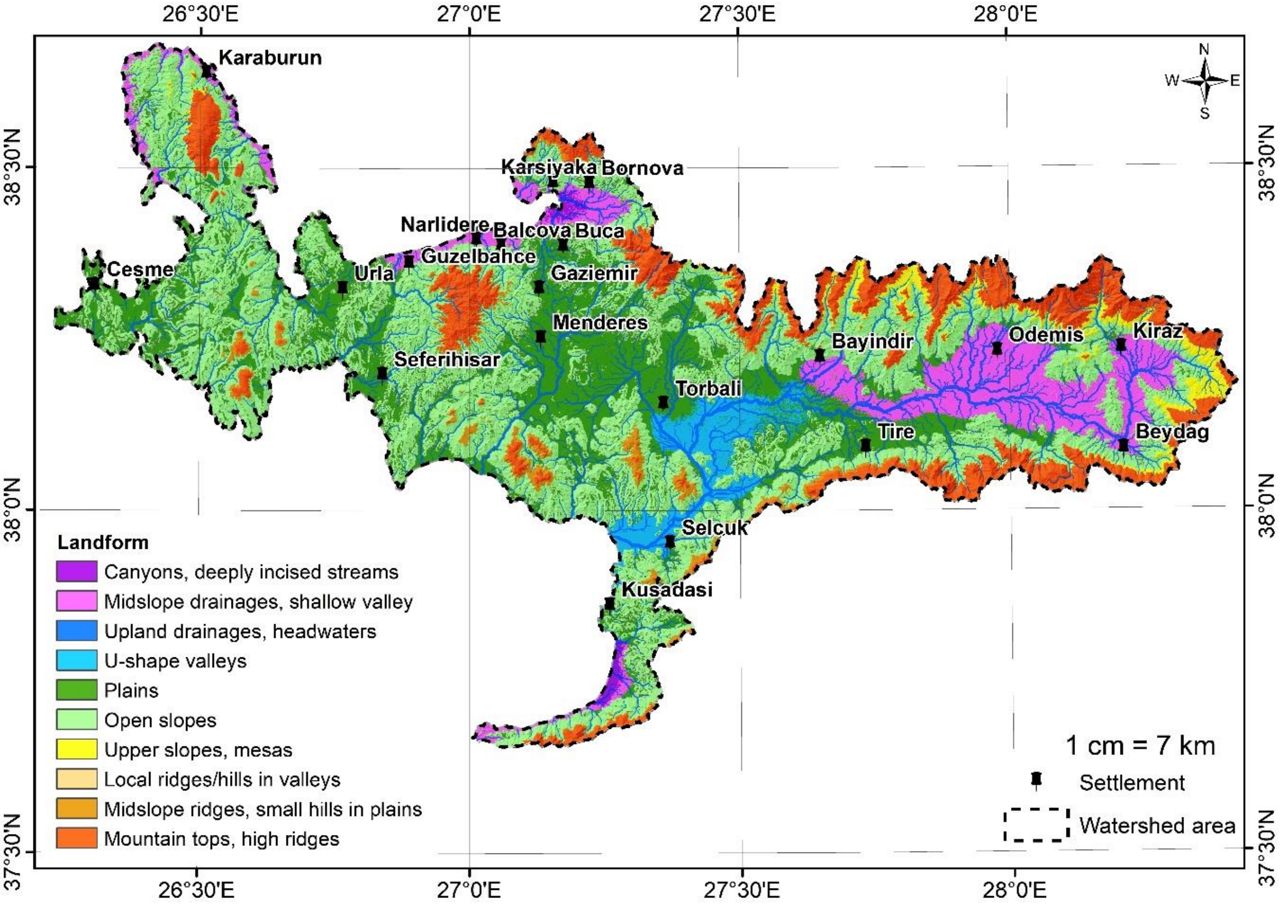


Figure 5. Landform classification maps of Küçük Menderes Watershed area.

Table 1. Landforms classes accuracy analysis matrix (Weiss, 2001).

Classes name	A	B	C	D	E	F	G	H	I	J	Field study accuracy
A	83	0	0	0	0	0	0	0	1	4	0.94
B	0	20	0	0	0	0	0	0	2	0	0.91
C	0	0	25	0	2	4	0	0	0	0	1.03
D	1	0	0	32	0	3	0	0	0	0	0.89
E	0	0	0	0	24	0	0	0	0	0	1.00
F	0	0	0	0	0	18	0	0	0	0	1.00
G	0	0	3	0	0	0	23	0	0	0	0.88
H	0	0	0	1	4	0	0	28	0	0	0.85
I	0	1	0	0	0	0	1	1	21	0	0.88
J	0	0	0	2	0	0	0	0	0	78	0.98
Analysis accuracy	**0.99**	**0.95**	**0.89**	**0.91**	**0.80**	**0.72**	**0.96**	**0.97**	**0.88**		**0.95**

A: Canyons **B:** Shallow valleys **C:** Upland drainages **D:** U-Shape valleys **E:**Plains **F:** Open slopes **G:** Upper slopes **H:** Hills in valleys **I:**Midslope ridged **J**: High ridges

Kappa statistics: 0.92 Accuracy (%) 92.15

5. CONCLUSION

Based on geomorphological analysis are useful tools for the management of natural resources. In this study, the TPI index was used to produce semi-automatic landform classes. Using the method developed by Weiss (2001), results that can be important for researchers working on subjects such as ecology, soil, geology, planning, and provide a wide variety of morphological features were obtained. At the same time; It has been revealed that TPI is a powerful tool for defining topographical features in Küçük Menderes Basin. While a large part of the area is composed of plain areas, it is seen that many canyons occur around river networks. As a result, canyons appear to be factors contributing to the geomorphological development of the geological environment and the topography. Creating the landform and determining such different land types come to the fore. It demonstrates that automatic landform classification is a powerful geographic processing technique for sciences dealing with morphology. The association of landform classes with geological units can be used for meaningful information about geomorphological structures and their formations. In addition to these data, more detailed morphometric analyses can be made with data such as relief, curvature, topographic gradient, valley depth, and surface roughness produced from DEM data.

Author contribution atatements

The author declares that has contributed 100% to the article.

Conflicts of interest

The author declares no conflict of interest.

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