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LANDFORM CLASSIFICATION USING MORPHOMETRIC CHARACTERISTICS

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Abstract—The main objective of this study is to landform classification in the elevation of north of Iran. In this study used morphometric feature for landform classification for the elevation of north of Iran. In order to landform classification used Digital Elevation Models (DEMs) with 90 m resolution. For sixclasses; ridge,peak,pass,channel,pit and planar used slope, positive values of maximum curvature and negative values of minimum curvature.The result show that there are six landform (ridge,peak,pass,channel,pit and planar) that ridge class and pit class have maximum and minimum percentage respectively in the study area.

***Keywords*—landform classification, Digital Elevation Models (DEMs), morphometric feature**.

I. INTRODUCTION

THELandforms are the result of geologic and geomorphologic processes that occur on the earth's surface. Landform units can be carried using various approaches, including automated mapping of landforms (classification of morphometric parameters, filter techniques, cluster analysis and multivariate statistics (Dikau et al., 1995; Dikau, 1989; Sulebak et al., 1997; Adediran et al., 2004). Derivation of landform units can be carried using various approaches, including classification of morphometric parameters, filter techniques, cluster analysis, and multivariate statistics (Adediran et al., 2004). Geomorphometry, has for its object the quantitative and qualitative description and measurement of landform (Dehn et al., 2001; Pike, 2002) and is based principally on the analysis of variations in elevation as a function of distance. A basic principal underlying geomorphometrics is that there exists a relationship between relief form and the numerical parameters used to describe it, as well as to the processes related to its genesis and evolution. This is to say that landforms are not chaotic, they are structured by geologic and geomorphic processes over time. One aim of geomorphologists working with landform models is to obtain better and better approximations of physical reality. Derivation of landform units can be carried using various approaches, including classification of morphometric parameters, filter techniques, cluster analysis, and multivariate statistics (Dikau, 1989; Sulebak et al., 1997; Etzelmu¨ ller and Sulebak, 2000; Adediran et al., 2004).
Automatic classification of geomorphological land units mainly focuses on morphometric parameters (Giles and Franklin, 1998; Bue and Stepinski, 2006), which can describe the form of a land surface in relation to landform formation processes (Jamieson et al., 2004). In geomorphometry, simple morphometric features such as saddles, channels, ridges and planes are identified, based on the value of these parameters and predefined rules (Wood, 1996a; Pike, 2000; Fisher et al., 2004). Van Asselen and Seijmonsbergen, (2006) presented an expert-driven semi-automated method to define geomorphological units from a high-resolution DEM and an object-oriented classification approach.

The purpose in the study is landform classification by morphometric feature in the elevation of north of Iran.

II. MATERIAL AND METHOD

A. *landform classification*

From all morphometric parameters, Wood (1996a) considered slope, cross-sectional curvature, maximum curvature and minimum curvature as a unique set to identify morphometric features of point (peak, pit and pass), linear (ridge and channel) and areal (planes) categories. A moving window is passed over a DEM and change in gradient and a central point in relation to its neighbors is derived by a second-order polynomial function:

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$$Z = ax^2 + by^2 + cxy + dx + ey + f \quad (1)$$

where x, y, and Z are local coordinates, and a to f are quadratic coefficients.
Then,

$$\text{Slope} = \arctan\left(\text{sqrt}\left(d^2 + e^2\right)\right) \quad (2)$$

$$\text{Cross-sectional curvature} = n*g\ (b*d^2+a*e^2 - c*d*e)/(d^2+e^2) \quad (3)$$

$$\text{Maximum curvature} = n*g\left(-a - b + \text{sqrt}\left((a-b)*(a-b) + c^2\right)\right) \quad (4)$$

$$\text{Minimum curvature} = n*g\left(-a - b - \text{sqrt}\left((a-b)*(a-b) + c^2\right)\right) \quad (5)$$

Wood (1996a) defined a set of criteria to classify a digital elevation model into morphometric classes using the above four parameters (Table 1).

Morphometric feature	Slope	Cross-sectional curvature	Maximum curvature	Minimum curvature
Peak	0	#	+	+
Ridge	0	#	+	0
Pass	+	+	*	*
	0	#	+	-
Plane	0	#	0	0
	+	0	*	*
Channel	0	#	0	-
	+	-	*	*
pit	0	#	-	-

Table 1 Wood's morphometric feature classification criteria (Wood (1996a))

#: Undefined value, *: Not part of selection criteria.
For features with positive (+) values of slope, cross-sectional curvature should be considered; but for features with zero slope (0), cross-section curvature is *undefined (#) so the maximum and minimum curvatures are the main criteria.*

The morphometric classes proposed by Wood were ridge, channel, plane, peak, pit, and pass (Fig. 1), numerical representations which are considered to represent the name of real forms (Fig. 2). Additional numerical forms, such as cliff and ramp, were suggested by Felicı´simo (1999).

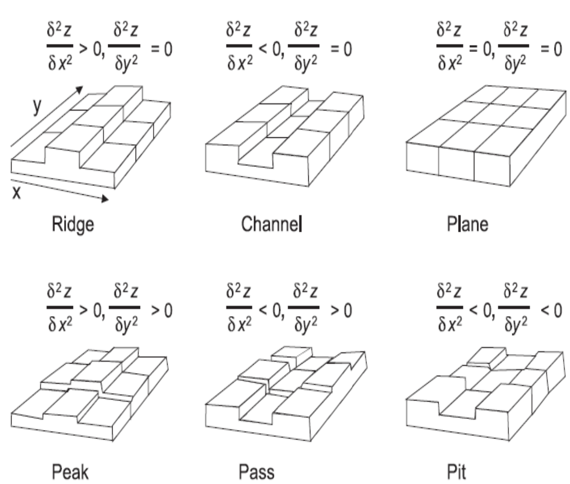


Fig. 1. Morphometric classes (Wood, 1996a).

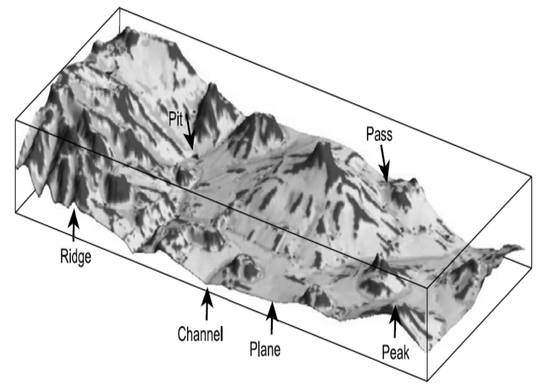
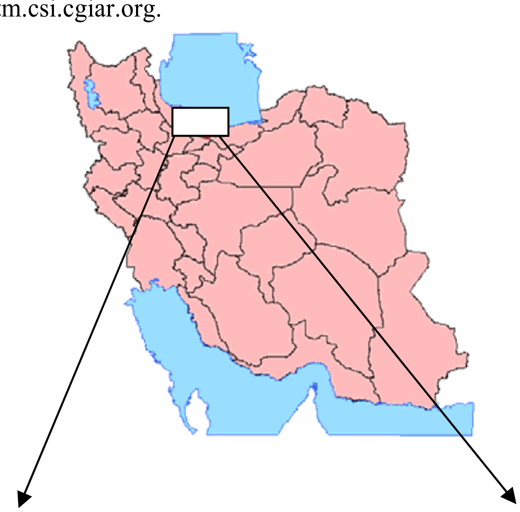


Fig. 2. Profile scheme of six morphometric classes.

B. *Case study*

The study area is north of Iran, which is located at 36°08′ 24″ to 37°42′ 59″N and 49°45′ 36″ to 52°19′ 48″E, with area of 3,260.62 km^2 (Figure 1). The highest elevation in this area is 5,597 m, which is located in the south of the basin, while the lowest elevation is - 241 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.



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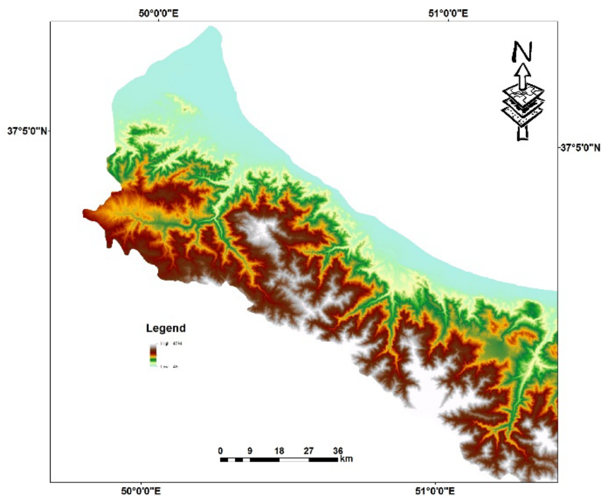

Fig. 3 location of the study area

III. RESULT AND DISCUSSION

As previouslymentioned, there are generaland specific geomorphometry Forgeneralgeomorphometry, the best known classification schemewas proposed byPeucker andDouglas(1974), for sixclasses; ridge,peak,pass,channel,pit and planar (Figure 1 and Table 1).Itis abasedon a3x3evaluationof DEMs, e.g.ifthealtitudeofthecenterofthewindowishighercomparedtootherneighboring cells,then the centralpixelisclassified as'peak'.Thisscheme hasbeenadoptedbymany authors(Bolongaro-Crevennaetal.,2005).

For the study are six morphometric features were created that show that Figure 4to Figure 9.

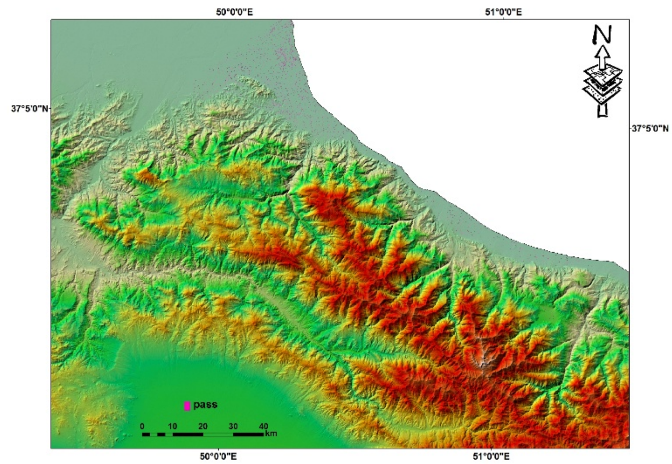

Fig.4 morphometric feature (pass)

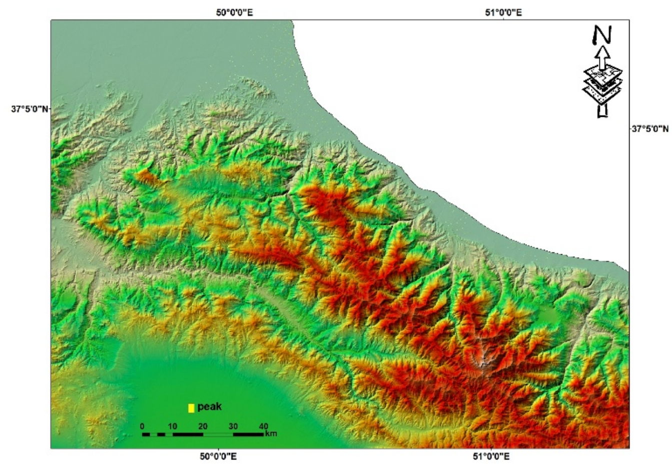

Fig.5 morphometric feature (peak)

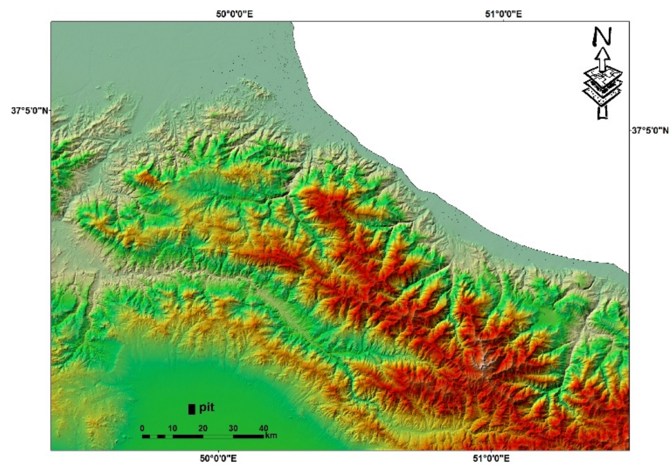

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Fig.6 morphometric feature (pit)

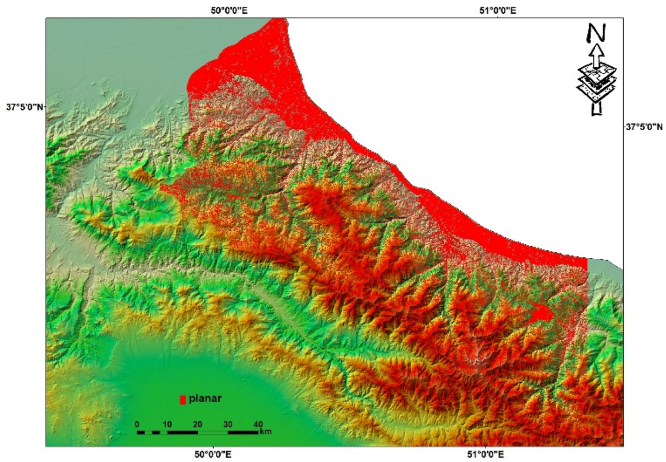

Fig.7 morphometric feature (planar)

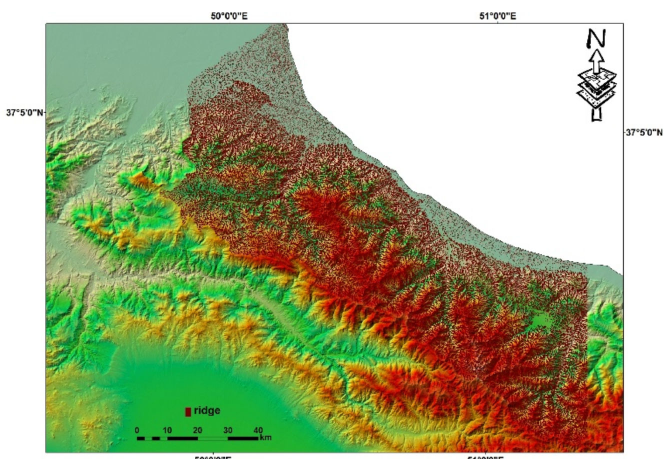

Fig.8 morphometric feature (ridge)

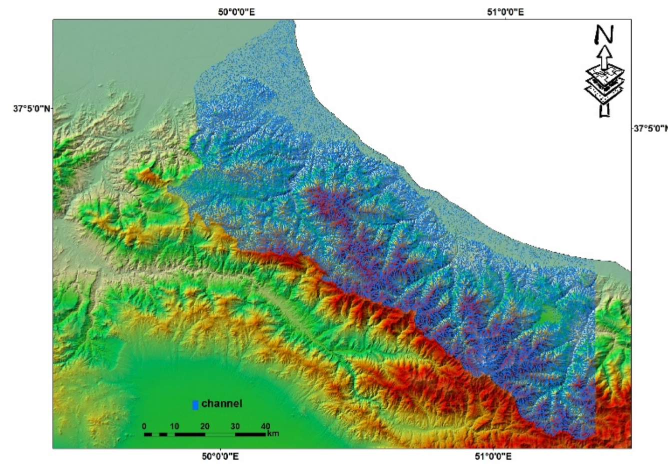

Fig.9 morphometric feature (channel)

Landform classification map based on morphometric feature show in Figure 10. The area of each of morphometric feature show in Table 2 and Figure 11.

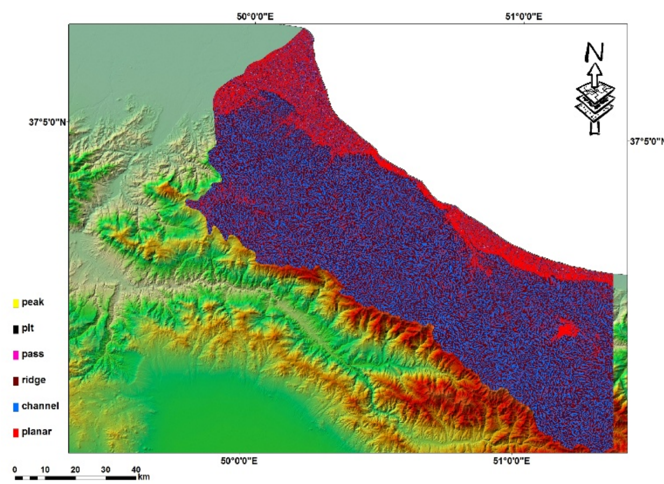

Fig. 10 landform classification map for the study area

Table 2 percentage of morphometric features

Morphometric feature	Area (%)	Area (km^2)
peak	0.001	13.06767
pit	0.001	10.87204
pass	0.004	38.52555
ridge	0.351	3838.01

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channel	0.337	3683.075
plane	0.306	3348.45
	Sum	10932

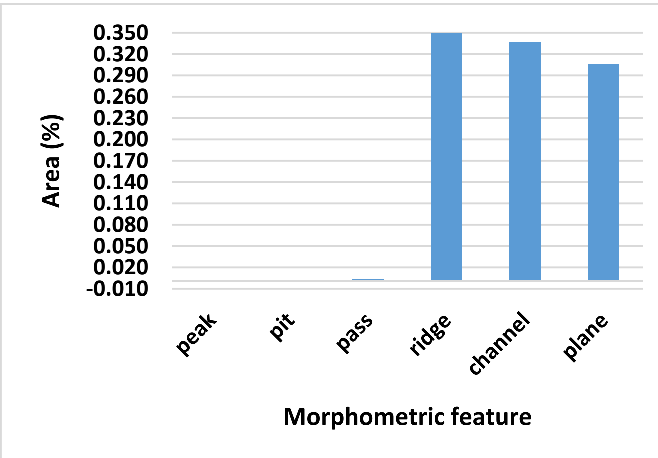

Fig. 11 percentage of morphometric features in the study area

IV. CONCLUSION

In this study, morphometric features was used to generate landform map. The result show that there are six landform (ridge,peak,pass,channel,pit and planar) that ridge class and pit class have maximum and minimum percentage respectively in the study area.

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