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Morphometric approach to geomorphologic characteristics of Zeytinli Stream basin

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Abstract

In this study, the numeric data of the Zeytinli stream Basin's, which is located on the Kaz (Mt. Ida) Mountain massif in the North of Edremit Gulf, elevation - area - volume statistics, elevation levels, hypsographic curve values, profile series, drainage type, length and longitudinal profiles, bed slope values, bifurcation ratio, drainage density and frequency, SL index, stream size gradient, and asymmetry factors considered thalweg reconstructions was formed by using ArcGIS Desktop program with the help of numeric integration method. In these applications 1:25.000 scale topographic maps were based. In addition to this, all the analysis, calculations and evaluations were conducted in computers, too.
The aim of the study is to search of the geomorphological evolution and development which is occured in the river basin via analysis and calculation. The other aim of the study is to expose the characteristics of displacement – development by making table, graphic and maps with the gathered data of analysis and calculation.
In the conclusion of the study, it is shown that the effects of the different denudational process and tectonic activity have a big role in the formation of geomorphological characteristics of Zeytinli Stream Basin.

Keywords: drainage density, thalweg, bifurcation rate, asymmetry factor

1. Introduction

The studies related to identification of geomorphologic characteristics of river basins are based on field surveys and preparation of special geomorphologic maps created as the result of the field surveys undertaken. However, it is essential to support the visual data with numeric data in quantitative identification of geomorphologic characteristics of basins and that of intrabasin morphological units. Researchers interested in this issue have resorted to creating various indices by taking different characteristics of the geomorphologic units into consideration [2].

Morphometric approaches such as effects of tectonic activities on drainage systems and modeling by geomorphologic indices are among the most important work in this regard. Morphometric features of a drainage basin can be interpreted through the calculation of topographic parameters such as elevation/altitude, slope and area obtained by digitalizing topographical maps in addition to interpretations of these measurements through aerial photos and high resolution satellite images. These data may be helpful in the comparative representation of factors effective in the geomorphologic development of a field. Using Digital Elevation Models (DEM) during raw data creation phase is instrumental in the provision of data reliability. Geomorphic indices such as "Hypsometric Curve and Hypsometric Integral", "Drainage Basin Asymmetry" "Stream Length-Gradient Index (SL)" and "Ratio of Valley-floor Width to Valley Height" can be used in the investigation of the drainage basins [3]. Digital data for the implementation of these indices can be obtained from the quantitative data provided by digitalizing the topographical map whose X-Y-Z coordinates are identified; hence the margin of error that is probable during classical data creation phase is minimized [4].

Zeytinli basin is located southern aspect of Kazdağı (Mount Ida) massive situated on the northern part of Edremit Gulf (Fig.1).

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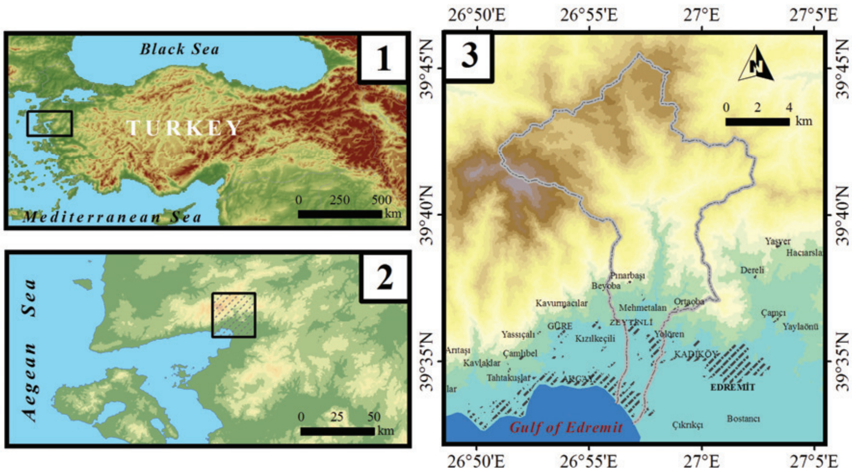

Figure 1: Map of location

The geological characteristics of the basin (Fig.2) consist of metamorphic, sedimentary, and volcanic rocks such as metamorphic rocks, limestone, crystalline limestone, granodiorite, gneiss and alluvion.

In terms of their geological ages, these structures that are Quaternary, Triassic, Jurassic and Paleozoic eras respectively.

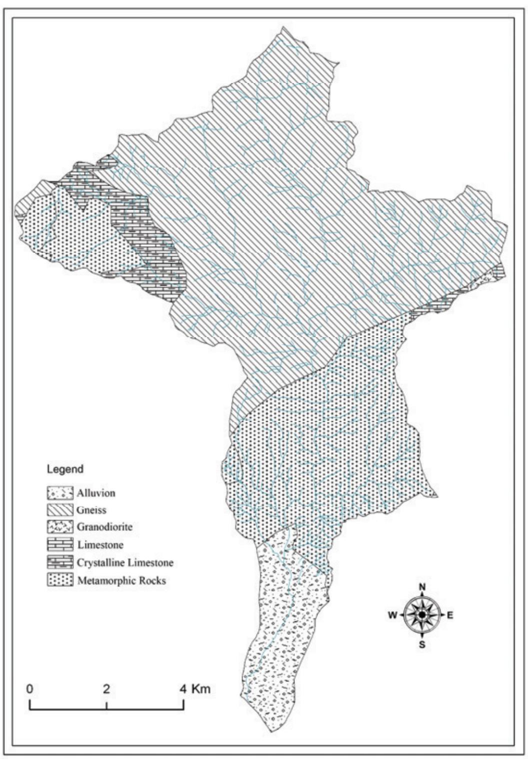

Figure 2: Map of geomorphological units

2. Material and Methods

Basin borders were determined by using topographic maps scaled 1/25000 that include Zeytinli Stream Basin and digitalization process with 50 m range contours were undertaken with the help of ArcGIS Desktop - ArcMAP program. Contours identified in digital environment were processed in ArcScene program to produce digital elevation model. With this modeling, it was possible to calculate the area and volume related to basin and elevation levels. Hypsometric curve and hypsometric integral for the basin were identified by considering the area and volume calculations for the altitude steps and graphics were created. Operations such as V Basin, elevation/altitude integral, SL index, bifurcation ratio, drainage density and frequency were also undertaken digitally. Additionally, the profile series for the Basin and geomorphologic map were produced from the topography map. Rivers and their lengths, the mid basin curve and thalweg (river bed) lines were determined and the obtained data were used to produce index data by using various formulas.

3. Findings

3.1. Elevation, Area and Volume Statistics

When the topography and slope maps of the basin are compared, it is seen that the area displays characteristics of a young area with high slope levels and average elevation/altitude (Fig.3-Fig.4).

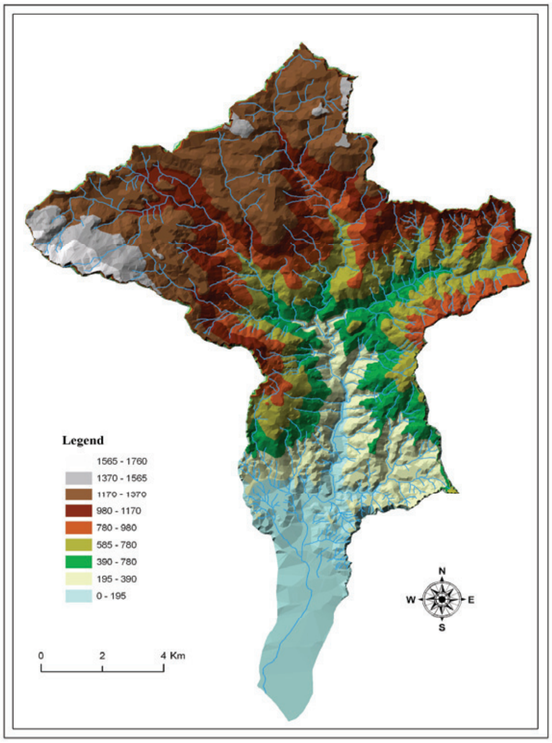

Fig.3. Elevation Level

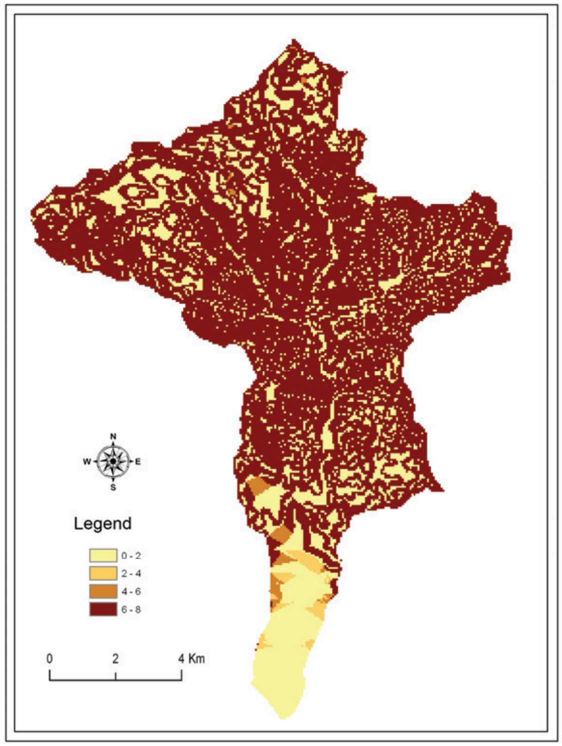

Fig.4. Slope Map

The average height is approximately 784 m and the slope levels are between 6-8%. The highest point with 1710 m is Kırklar Hill (Kırklar Tepe).

Two profiles based on basin line and river bed were developed in order to display the power of erosion and the mass that Zeytinli Stream causes to erode from the river settlement. These two profiles were combined in one graph to display the difference (Graph I). The difference between the generalized and the corroded area was calculated to be 363 m³.

Generalized contour lines were drawn with the same aim by using screen digitizing method on topography maps scaled 1:25.000 that includes Zeytinli Stream Basin. When the current topography and generalized topography maps are compared the parallelism between elevation/altitude and power of erosion can easily be seen (Fig.5-Fig.6).

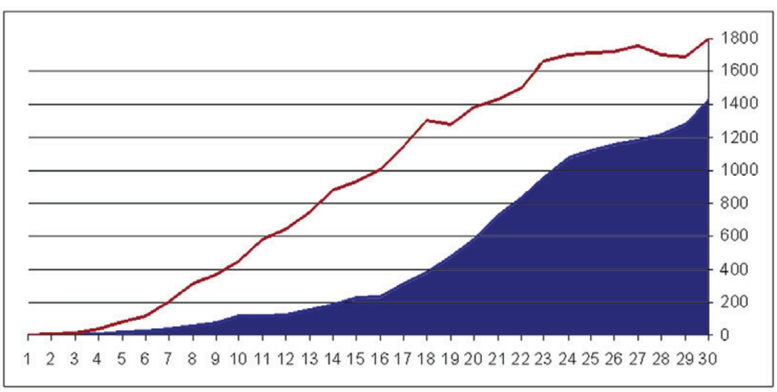

Fig. 5. Basin and Vein Profile

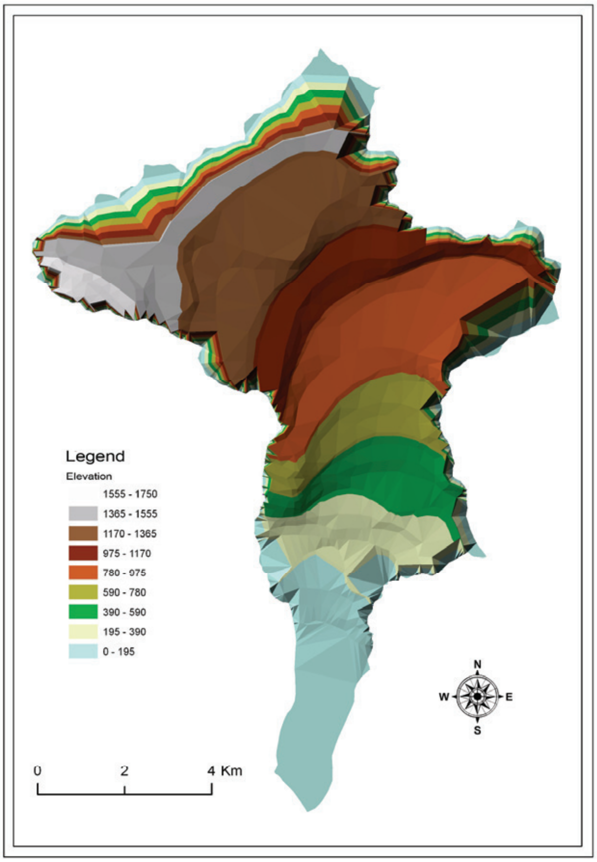

Fig.6. Universalized Countour Line

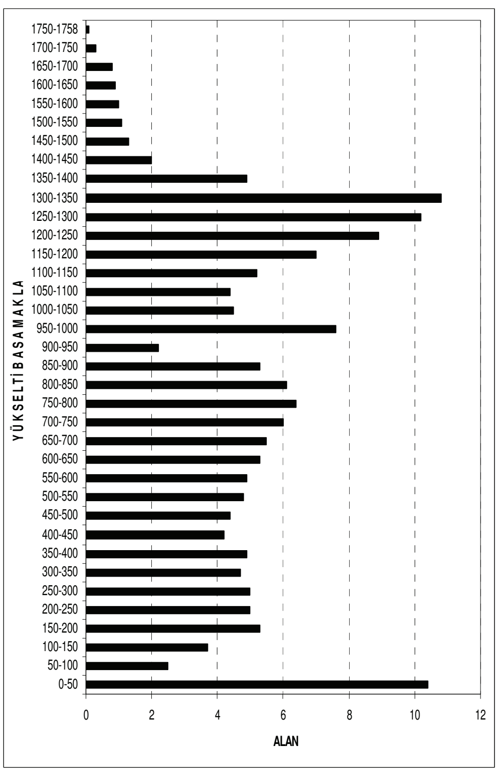

Fig.7

Elevation Levels	Area	% Rate	Elevation Levels	Area	% Rate
0-50	10,4	6,2	900-950	2,2	1,3
50-100	2,5	1,5	950-1000	7,6	4,5
100-150	3,7	2,2	1000-1050	4,5	2,7
150-200	5,3	3,2	1050-1100	4,4	2,6
200-250	5	3	1100-1150	5,2	3,1
250-300	5	3	1150-1200	7	4,2
300-350	4,7	2,8	1200-1250	8,9	5,3
350-400	4,9	2,9	1250-1300	10,2	6,1
400-450	4,2	2,5	1300-1350	10,8	6,4
450-500	4,4	2,6	1350-1400	4,9	2,9
500-550	4,8	2,9	1400-1450	2	1,2
550-600	4,9	2,9	1450-1500	1,3	0,8
600-650	5,3	3,2	1500-1550	1,1	0,7
650-700	5,5	3,3	1550-1600	1	0,6
700-750	6	3,6	1600-1650	0,9	0,5
750-800	6,4	3,8	1650-1700	0,8	0,5
800-850	6,1	3,6	1700-1750	0,3	0,2
850-900	5,3	3,2	1750-1758	0,1	0,1
			TOTAL	167,6	100

Table 1

3.1.1. Elevation Levels

Graph (Table 2) developed by calculating the proportional elevation levels (Table I) in the basin corresponds to the geomorphologic map produced by using the topography map (Fig.7). When the graph is examined, it is possible to differentiate a plain of 0-50 m, a deeply incised plateaus of 200-1400 m (plateau) and a summit area of 1400 m and higher (mountain areas).

3.1.2. Hypsographic Curve

The form of the hypsographic curve and the proportional values developed by calculating the proportional distribution of altitude zones in the basin (Table I) contribute to the description of the geomorphologic characters of the basin (Figure I). The elevation levels have an average areal value of 4,65 km². The highest areal distribution is seen at 1300-1350 m elevation level with 10,8 km² and the lowest exists at 1700-1750 m elevation level with 0,1 km², the 0-50 elevation level displays a higher than average value of 10,4 km² since it collects the alluvial materials that the river erosion form the basin. The elevation levels of 1100-1400 m are especially noteworthy due to their higher than average areal distributions (Fig.8-Fig.9).

Hypsometric integral is formed on the basis of the relationship among the minimum, average and maximum elevation levels;

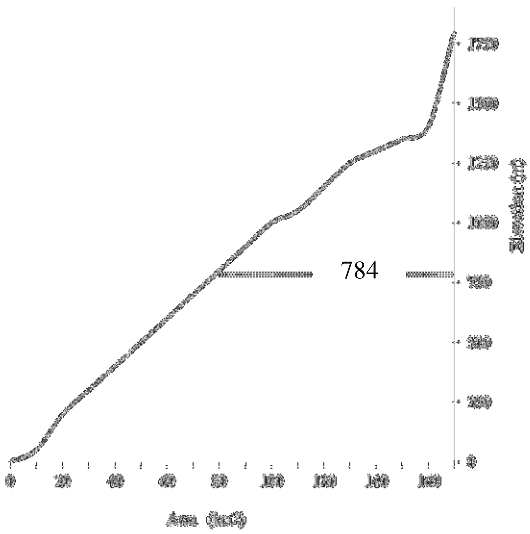

Fig. 8. Hypsographic Curve

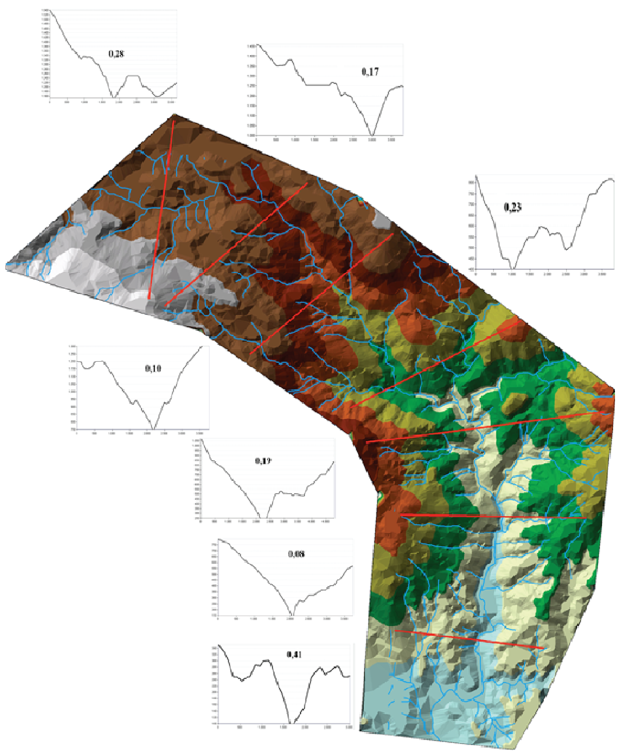

Fig. 9. "V" Rates of Profile

Hyp. Int.= Average Elevation – Minimum Elevation/Maximum Elevation – Minimum Elevation

Elevation of Zeytinli Stream Basin changes between 0-1758m and the average altitude is 784 m. When these values are placed in the formula, hypsometric integral value of 0,45 is found.

3.1.3. Profile Series

Profile series were developed by using location diagrams scaled 1:25.000 in order to show the relief features of Zeytinli Stream Basin. Profile lines were selected in 1 km range and contour lines coinciding with the paper sheets that were previously prepared were marked. Afterward, each profile sheet was placed on profile base prepared according to scale on a tracing paper to create superimposed (Fig.), compound (Fig.) and projection (Fig.) profiles.

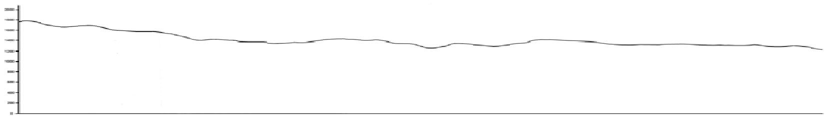

Figure 10. Compaund profile

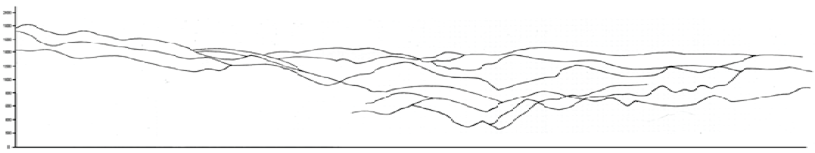

Figure 11. Profile series

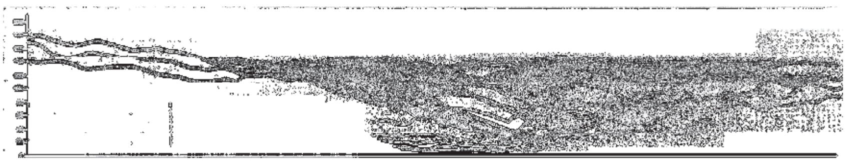

Figure 12. Superimposed profile

3.2. Drainage

3.2.1. Drainage Type

Various drainage types have developed in the Zeytinli Stream Basin due to lithological, tectonic and geomorphological reasons. In general, basin carries dendritic drainage network features (Fig.13-Fig.14.). Radial drainage, parallel drainage and centripetal drainage are common in the main drainage network where barbed drainage patterns can also be seen in areas with fault lines. This situation is most apparent in Alan Creek and its branches.

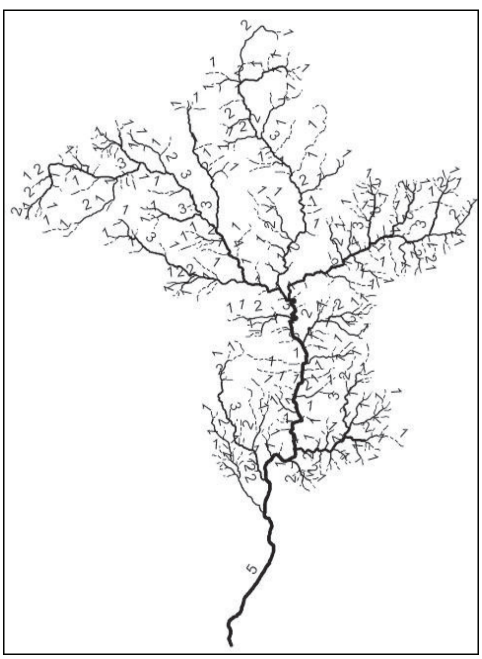

Figure 13. Dichotomy Rate and Drainage type

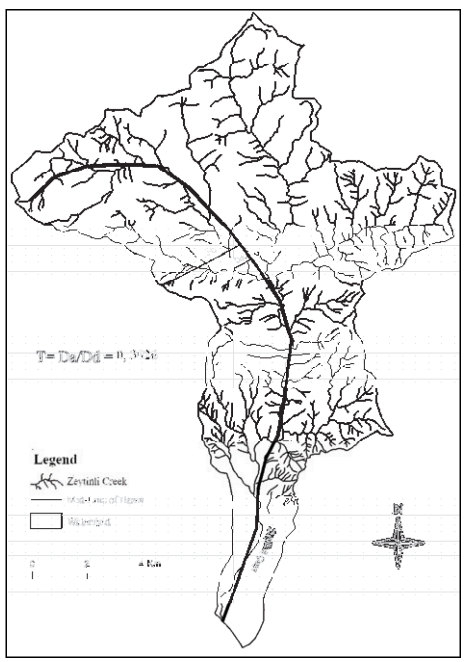

Figure 14. Analysis of Length

3.2.2. Bifurcation Ratio

The bifurcation ratio in Zeytinli Stream Basin was calculated based on the drainage system constructed from the topography map scaled 1:25.000. Strahler Method was used in the process and 5 phases were identified as a result (Table 2 and Fig.15).

It is a fact that these values will change towards augmentation in more detailed maps. According to this, the number of branches of Zeytinli Stream from the first degree is calculated to be 314. The fact that the number of branches from the first degree is less compared to the other branches can be an indicator of how effective the flood ravines in the source sections of the river. The number of second level branches of the Stream is 82. There is approximately a difference of four times between the first and second level braches (Table 2). There is a fivefold difference between second and third level of branches whereas triple difference is seen between third and fourth level branches.

Apparent differences among branches is an indicator that the floor level of the Stream is affected by tectonic and eustatic movements [5].

Table 2: Dichotomy Rate

Branch	Branch No	Total Length (m)	Mean Lenght (m)
1	314	147443	469
2	82	57496	701
3	15	48680	3245
4	4	12177	3044
5	1	15400	15400

3.2.3. Drainage Density

Drainage density of the Zeytinli Stream was calculated by dividing the total canal length to the drainage area. The aim here was to define the river length for the unit area. Obtained result gives us information about the drainage system of the Zeytinli Stream [6].

The measurement of the Zeytinli Stream canal length was done on topographic maps scaled 1:25,000 by using contours. According to the measurement, the length of the Zeytinli Stream and its side branches were found to be 281 km.

During calculations of drainage area, watershed that defines the basin was taken into consideration. However, in the opening width of the stream coastline completes the basin borders. Total catchment area was determined to be 138 km2.

When the total calculated canal length and catchment area of Zeytinli Stream is taken into consideration together, we have the total of 2,04 km/km^2.

Number of beds of Zeytinli Stream and its branches per unit area shows its drainage density value. This value can be obtained by counting from the map but it can also be determined with the help of a formula (Scheidegger, 1961). According to the formula;

F: Drainage density squared (D^2) * 0,694 (constant)

F: (2,04) * 0,694 = 2,88 (in km^2)

This value shows how often the basin is drained together with Zeytinli stream and its branches with the drainage network. The frequency level of a Stream depends firstly on the time that has passed since its formation and also on precipitation, slope and permeability of the area. The drainage frequency value of Zeytinli Stream characterizes the enlargement phase dependent on parameters cited [1],[7].

3.2.4. Length and Longitudinal Profile

The length of the Zeytinli Stream measured between the source and the river mouth shows that the actual breadth of the Stream is 28 km whereas the direct distance is 22 km. The difference of 6 km originates from the meander character of the Stream (Figure 3).

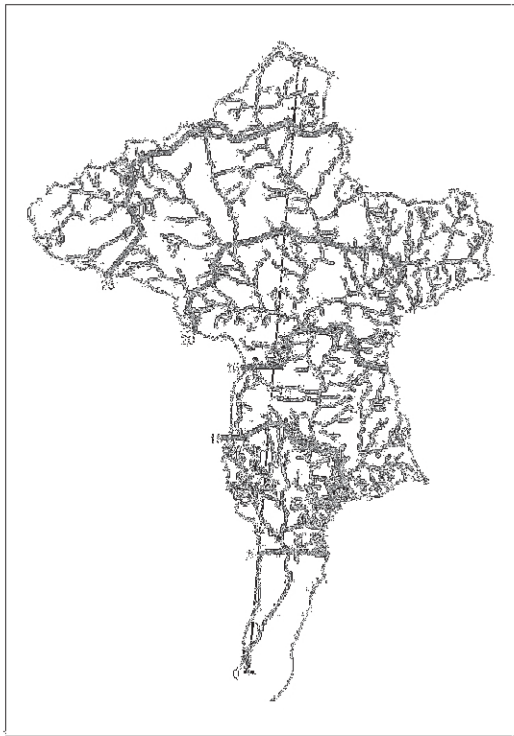

Figure 15. Length and longitudinal

3.3. Tectonic

3.3.1. SL Index, Bed Length Gradient and Thalveg Reconstruction

Bed length-Gradient Index is related to the power of the Stream. Total watercourse power of a specific branch of the Stream is a variable that determines the erosion and the capacity of the Stream to carry the eroded materials [4]. When SL values increase, the proclivity of the Stream bed also increases and erosion gains speed. Mean SL value of Zeytinli stream is 507 and the SL value of the section between the 15th km and 20th km of the stream reaches a high number of 1047 (Figure 16).

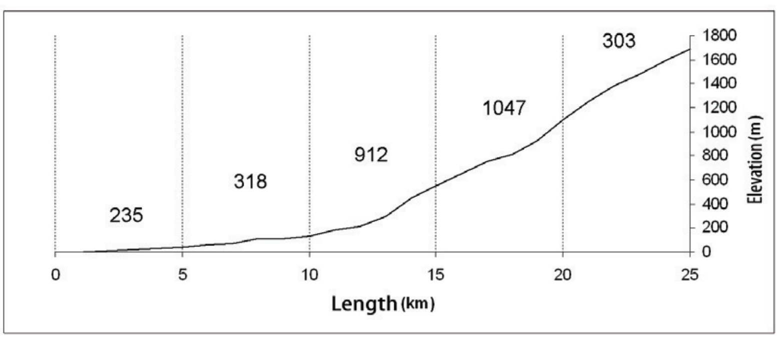

Figure 16. Talveg Reconstruction

3.3.2. Factor of Asymmetry

When the formula T = DaDd as asymmetry index was used (where Da: is mid basin axis that is run through the center of the basin or the distance from the stream line to active meandering zone; Dd is the distance from the mid basin axis to catchment area) (Keller & Pinter, 1996) an average symmetry of Dd: 2385, Da: 721; T = 721/2385 = 0,3023 was calculated. The value hat falls between full symmetry of "0" and strong asymmetry of "1" shows the mathematical value of the basin asymmetry.

4. Conclusion

Different erosion processes and tectonic activities are effective in the shaping of geomorphologic characteristics of the Zeytinli Stream Basin. Features such as amplitude of the comparative altitude difference in the basin, elevation levels, and drainage network and valley forms support this view.

Proportional distribution of elevation zones in the basin and the form of the hypsographic curve show that the area is elevating. The areal values that are lower than the mean in the steps show that the basin is undergoing a speedy elevation and during this phase, rivers are buried in the basin and form narrow and deep valleys. Concave and convex appearance in the hypsometric curve also supports this idea.

The high hypsometric integral value of the basin proves the existence of a young topography cleft by deep valleys. A specific asymmetry rate in the total basin area was calculated. This asymmetry value proves that the basin section in the east of thalveg develop faster regardless of the variables dependent on the lithology. The faulted and sinuous structures in and around the basin provides support for the development in this regard. According to Stream's length-gradient index values, it is apparent that Zeytinli Stream erodes its basin profoundly. Identification of mean SL values and high SL values taken from most of the sampled valley sections contribute to this view.

According to "Ratio of Valley-floor Width to Valley Height Index", the Stream has been corroding the Zeytinli stream Basin profoundly to great depths. It is apparent in the light of the basic parameters that are assessed in the study field that Zeytinli Stream Basin is a young basin in terms of geomorphologic development that has been intensively affected from tectonic activities. The various rock groups with varying age and properties inside the basin have caused the effects of the fluvial process effective in the basin to surface in different manners. The faults that are equivalent of the development of E-W directional horst and grabens forming the common morphology of West Anatolia still control the geomorphologic development of the Zeytinli Stream Basin in the north of Edremit Gulf and cause rejuvenation in the valley network. In this process, the elevation that develops dependent on Stream erosion shows increase towards the north in steps.

References

[1] Bilgin, T. (2001), Genel Kartoğrafya II, Filiz Kitapevi, İstanbul.
[2] Cürebal, İ. (2004), Madra Çayı Havzasının Hidrografik Özelliklerine Sayısal Yaklaşım, Balıkesir Üniversitesi - Sosyal Bilimler Enstitüsü Dergisi, Sayı 11, s.11-24, Balıkesir.
[3] Cürebal, İ.(2006), Strahler Yöntemiyle Komşu Akarsu Havzalarının Karşılaştırmalı Analizi: Mıhlı ve Şahin Dereleri, Trakya Üniversitesi, Sosyal Bilimler Dergisi, Cilt 8, Sayı 2, s.71-84, Edirne.
[4] Cürebal, İ., Erginal, A. E. (2007), Mıhlı Çayı Havzası'nın Jeomorfolojik Özelliklerinin Jeomorfik İndislerle Analizi, Elektronik Sosyal Bilimler Dergisi (www.e-sosder.com), Sayı 19, s.126-135, Diyarbakır .
[5] Efe, R.; Ekinci, d.; Curebal, I. (2007) Erosion Analysis of Şahin Creek Watershed (NW of Turkey) Using GIS Based on RUSLE (3d) Method. Journal of Applied Science. 8 (1): 49-58.
[6] Efe, R.; Ekinci, D.; Curebal, I. (2008) Erosion Analysis of Fındıklı Creek Catchment (NW of Turkey) Using GIS Based on RUSLE (3d) Method. Fresenius Environmental Bulletin, Vol.17; No.5 pp, 586-576.
[7] Erinç, S., (2000), Jeomorfoloji I (Güncelleştirenler: Ahmet ERTEK - Cem GÜNEYSU), Der Yayınları, No:284, İstanbul.
[8] Erginal, A. E.,Öztürk, B. -Cürebal, İ. (2002), Kepez Deresi Havzasının Jeomorfolojik Özelliklerinin Morfometrik Açıdan İncelenmesi, Türk Coğrafya Dergisi, Sayı 39, s.23-43, İstanbul.
[9] Erginal, A. E.,Cürebal, İ., (2007), Soldere Havzasının Jeomorfolojik Özelliklerine Morfometrik Yaklaşım: Jeomorfik İndisler ile Bir Uygulama, Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, Sayı 17, s.203-210, Konya.
[10] Hoşgören, Y. (2004), Hidrografya'nın Ana Çizgileri I, Çantay Kitapevi, İstanbul.