

## DETERMINATION OF GEOMORPHOLOGICAL CHARACTERISTICS AROUND OF THE ISIKLAR MOUNTAIN BY USING REMOTE SENSED DATA AND DEM.

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### ABSTRACT

Joint use of remote sensing data with digital elevation model has facilitated solution of many problems in geological sciences. Remote sensing data, in particular, have certain advantages such as easiness in working in large areas , ability to display ground features in colours by recording different reflectance values, availability of synoptic vision, mapping possibility of inaccessible areas and ability to process obtained data by means of computers. As the remote sensing data are images obtained multispectrally, they display the morphological structure of the surface characteristics very well. By looking at this morphological structure, evaluation of the structural characteristics among the surface formations can be done. In this study, composition of slope maps by means of digital elevation model , analysis of terraces occasioned in the course of time and definability of geomorphological features from satellite data have been examined.

### 1 INTRODUCTION

Geomorphological maps are drawn on topographic maps. Topographic maps have to be analyzed to see whether they are suitable for geomorphological works or not. It is essential that topographic maps should carry certain standards and be scaled and have the features to be integrated with other data. In the regionally made geomorphological studies usually 1/25 000 scale topographic maps are used. As these maps are not digitally at computer media , it is rather difficult to work in large areas, to make interpretations and carry out actual field controls. Furthermore, since producing such maps requires a lengthy period of time, they do not possess up to date information.

Remote sensing data and aerial photographs offer such information to the science of geomorphology that can not be obtained from any other source (Goudie, 1990, Cooke and Doornkamp, 1990). Because the information which would otherwise necessitate long time through classical methods are quickly obtained and collected. As data could be obtained within short time intervals, changes in the morphological structure of earth's surface can be observed. This information consists of fast, economical, current digital etc. data (Richards, 1993, Sabins, 1997). Remote sensing data which are radiometrically and geometrically enhanced at present have geometrical characteristics close to aerial photographs. However, the following have to be noted about aerial photographs :

- They cover a small area on the ground ,
- They are difficult to interpreted as they are black and white and do not display well the morphological structure of earth's surface ,
- It is sometimes impossible to watch the continuous structural features on land,
- They might be at different scale and conversion ,
- They are not recorded digitally therefore it is difficult to process data ,
- As working in large areas takes a long time, spread of light is not homogeneous ,
- Working in large areas is costly and time consuming .

Therefore , use of remote sensing data in geological sciences has an advantage against the aerial photographs.

Geomorphological studies made in the region of Isiklar Mountain previously ( by using only maps of 1/25 000 scale ) have been utilized (Altin, 1992, Eldeniz, 1996, Erol, 1979, 1983b, Erol and Cetin, 1995). In this method, analysis of the geomorphological surfaces (terrace) is based on slope classification among the contour lines. In this study, digital

elevation model of the area was made and the analysis of the slope groups was carried out rapidly in computer media. Again by utilizing the previously made studies, 5 geomorphological surfaces have been determined according to elevations (Figure 5). Furthermore, these assessments were also evaluated by means of joint use of remote sensing data and digital elevation model (Kaya, 1999a).

## 2 DATA ANALYSIS

### 2.1 Digital Elevation Model

In the study, first of all contour lines were digitized on topographic maps of 1/25000 scale. Each map was individually digitized and arranged by using Auto CAD programme. Digital elevation model was made by using grid method and bilinear interpolation method was used in Z elevation interpolation. All data which have been used to jointly evaluate all data have been transformed into UTM (Universal Transfer Mercator) projection co-ordinate system. When used alone, digital elevation models do not display the morphological structure of the surface of earth. Therefore, it is impossible to interpreted the surface of earth three-dimensionally or to evaluate the surface formations three-dimensionally. Remote sensing data express the formations of the earth's surface in colours. Therefore, they very well show the features of the earth's surface (Kaya and Muftuoglu, 1999b).

### 2.2 Remote Sensed Data

Landsat 5 Thematic Mapper data have been used in the study. These data have been transformed into UTM coordinate system. Data have been analyzed at various band combinations. Images have been enhanced by using Principal Components Analysis (Figure 2, 3). Enhanced remote sensing data used with digital elevation model express the features of earth's surface three-dimensionally. This makes it possible to analyze the geomorphological characteristics (Kaya and Muftuoglu, 2000).



Figure 1. Digital Elevation Model



Figure 2. Landsat 5 TM Image

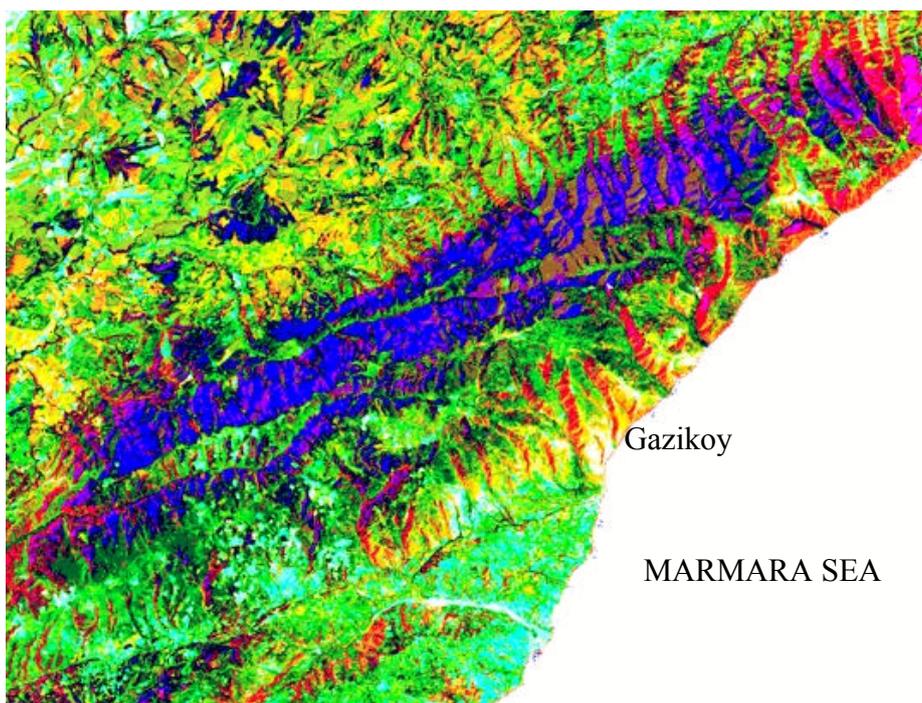


Figure 3. Enhanced Landsat 5 TM Image (PCA)

### 3 METOT

#### 3.1 Slope Maps

Slope maps are formed on all digital elevation models made in the raster data group. The purpose is to analyze the terraces ( flat terrains formed erosionally) by finding the slope groups in all the surface. In this study, zones with slopes between 0 –5 % have been considered as flat terrain (Figure 4). Slope maps have been classified and allocated into 5 groups (Erol, 1993b) .

- 0-5 % Flat terrains (Yellow)
- 5-10 % Slightly sloped hills (Orange)
- 10-20 % Sloped hills (Green)
- 20-40 % Steep hills (Red)
- 40+ % Very steep hills (Cyan)

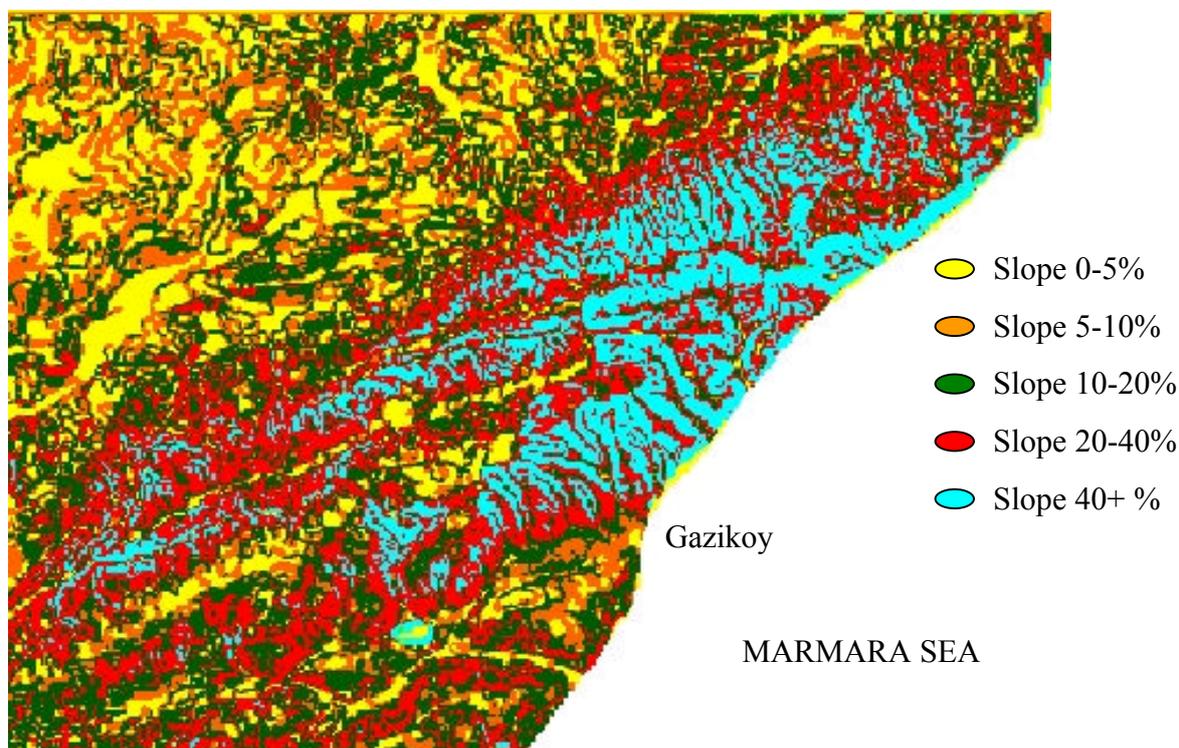


Figure 4. Classified Slope Map

### 3.2 Determination of Erosion Surfaces ( Surface-Slope Relation)

Erosion formations are the formations that are shaped as a result of the erosion of cumulative formations at various phases by external forces (Erol, 1993b). Where the structure of the earth is the dominant factor in cumulative formations, in erosion formations the dominant factor appears to be the stage of the process of formation. Generally development of a surface formation starts with its formation as a result of the impact of internal forces or volcanic activity and the erosion becomes effective in the subsequent stages. In times when the erosion is effective, surface formations start to change shape, to crumble or even disappear during this course. In geomorphology; formation of surface features, their relations and interrelations, age of the events and the formations and the units of surface formations have to be determined and found out. That is to say, units of earth's surface have to be determined. One has to evaluate as a whole the tectonic movements affected by the systems of erosion surfaces and reflection of these movements upon the formations of the earth which are formed under the morphoclimatic conditions pertaining to the same period composing the geomorphological units and considered as generations of earth formations. In the system developed by Erol for the purpose of determining the erosion surfaces which forms the basis of this study, joint evaluation of erosion surfaces and their correlating sediments will make it possible to differentiate generations of earth formations which have been formed under the same morphoclimatic conditions (Erol, 1979, 1983a). In this study, relief generations are listed and named from the old ones to the new ones and from the peaks to the troughs (Erol, 1983a, 1991, 1993a).

<b>RELIEF GENERATIONS ( REGION OF ISIKLAR MOUNTAIN)</b>	
<b>SYMBOL</b>	<b>MORPHOCLIMATIC CAHARCTERISTICS</b>
DI Erosion Surface System	Lower-Middle Miocene Period Hot-Humid Conditions, Between 470-924 m.
DII Erosion Surface System	Upper Miocene Period Dry-Semi Dry Conditions, Between 270-470 m.
DIII Erosion Surface System	Upper Pliocene Period Subtropical-Humid Conditions, Between 130-270 m.
SY High Terrace Systems	Lowest-Middle Pleistocene Period Subtropical-Humid Conditions, Between 50-130 m.
SA Low Terrace Systems	Upper Pleistocene Period Cool-Humid Conditions, Between 10-50 m.

Table 1. Relief Generations of Isýklar Mountain (Erol and Cetin, 1995, Altin, 1992, Eldeniz, 1996).

Grouping was made among the contour lines, which have been digitized and transferred to computer media at each 20 m. for the purpose of determining the surfaces according to their elevations. Based on the geomorphological studies previously made in the region and the groups of contour lines made from these studies, such groupings have been assessed according to the surfaces to be selected. The purpose is to analyze the erosion surfaces according to elevations by querying jointly this grouped map with slope map. Joint evaluation of the entire surface with all the information would create confusion in large areas. Therefore, in order to obtain the required information from the data evaluated in the information system, interrelating the data with each other has become essentially dependent on the computer technology today. In the study, relief formation generations have been queried as SA, SY, DIII, DII and DI systems according to their elevations and slope values (as in Table 1).

Slope map was merged with the map made up of contour lines queried according to elevations of erosion surfaces. The purpose is to display all the flat terrain lying among these elevations over the entire area of study. It has been made possible to reach information quickly by querying only the surfaces which are to be analyzed.

As a result of the analyses made in the whole area of study, erosion surfaces have been found out. For this purpose, slope map in raster form and the topographic map with contour lines in vector form were queried in ArcView programme. Therefore, first of all, erosion surfaces have been queried according to their minimum elevation on the topographic map and then they were merged with the slope map. Flat areas lying among these elevations were attributed by means of PhotoShop programme to the colours of erosion surfaces used by Erol. Erosion surfaces analyzed in the entire area of study show the tectonic and climatic process.

Enhanced remote sensing data have been merged with digital elevation model and it was tried to analyze the region through the newly obtained image. In this image, flat areas on the heights of Isiklar Mountain were seen clearly and other flat areas were interpreted. Different band combinations reflect different morphological characteristics of the surface of earth. Therefore, the area has to be analyzed in different band combinations too. By looking at the image through different angles, formations in the area can be evaluated. According to geological data, Isiklar Mountain is semi-anticlines. It is considered that the flat areas in the heights of the mountain are of upper-Miocene age (>5.5 Ma), corresponding to DI and/or DII erosion surfaces of Erol (Kaya, 1999a), (Figure 6).

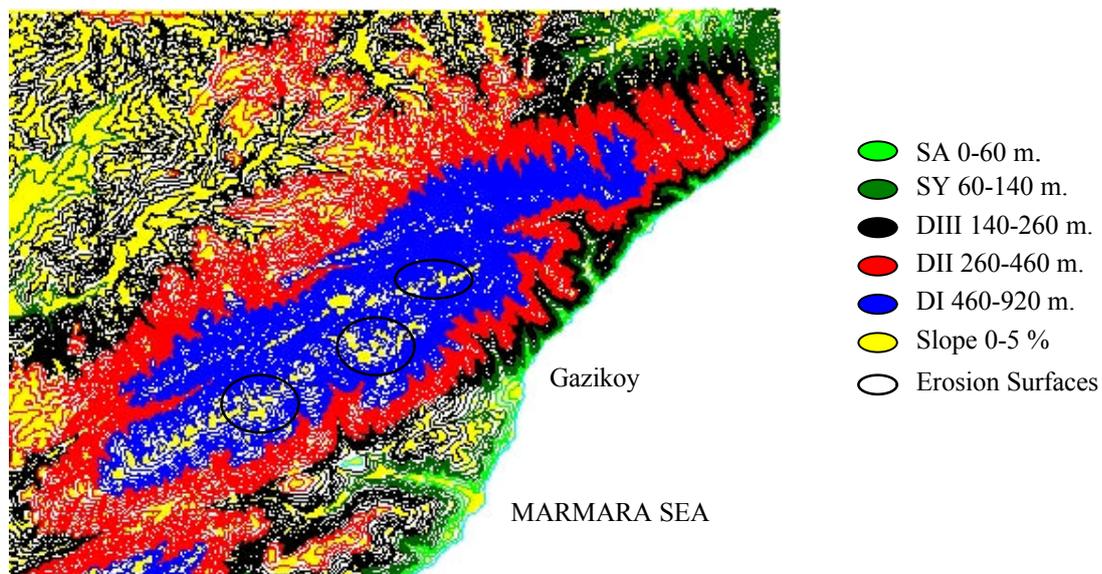


Figure 5. Display of the flat areas on the map grouped according to erosion surface elevations

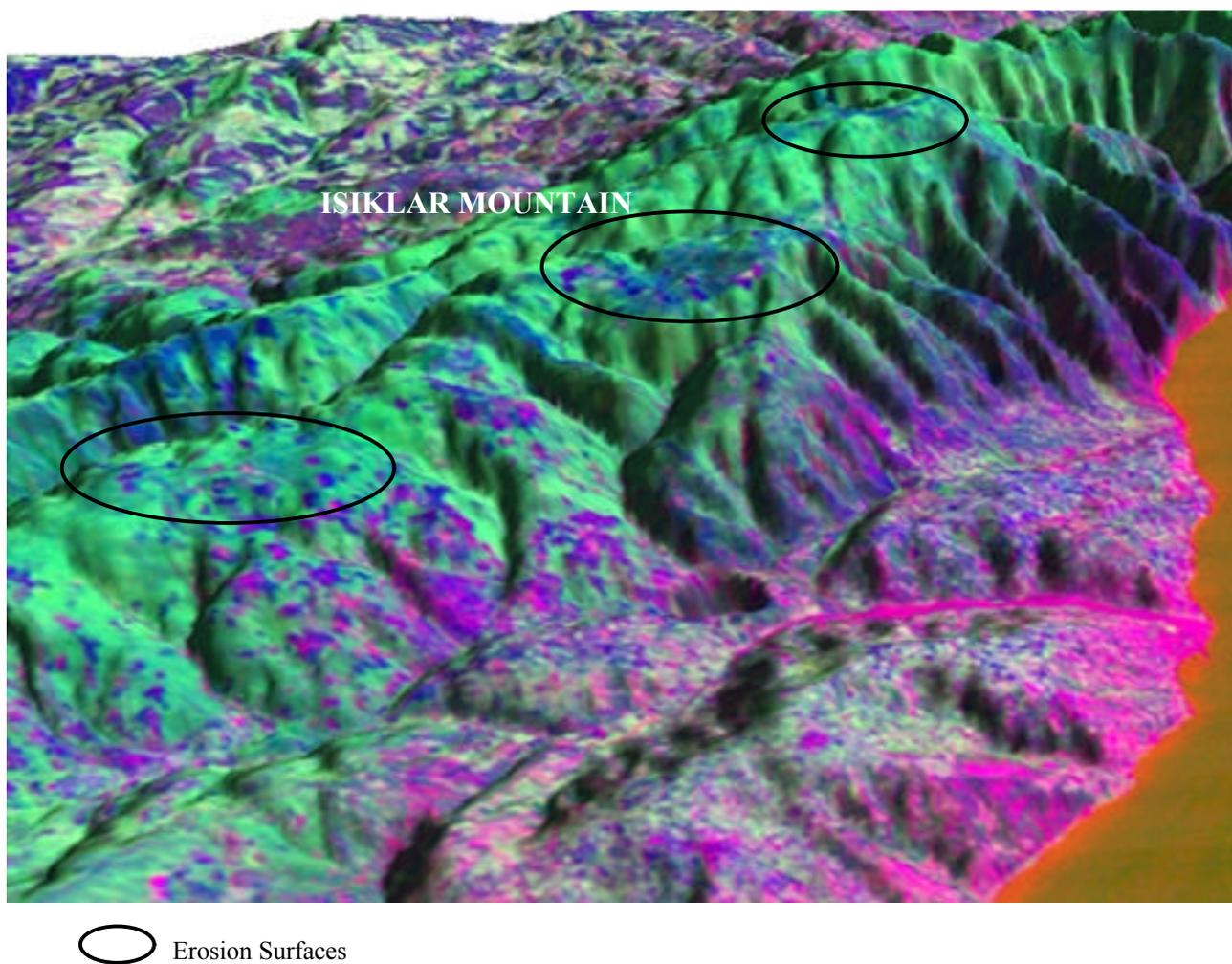


Figure 6. Erosion Surfaces of Isiklar Mountain

#### 4 CONCLUSIONS

In the region of Isiklar Mountain that was selected as the area of study, geomorphological works done by means of classical methods have been carried out by using digital elevation model. A slope map was produced from the digital elevation model that was prepared and the flat areas (with slope of  $< 5\%$ ) and hills (with slope of  $> 5\%$ ) have been quickly distinguished according to slope groups. The hills were determined according to slope groups as low-sloped (with slope of  $5-10\%$ ), sloped (with slope of  $10-20\%$ ), steep (with slope of  $20-40\%$ ) and very steep (with slope of  $40\%+$ ). Furthermore, it is very easy to obtain surface profiles through this model.

By putting forward the surface-hill relations through the digital elevation model, 5 erosion surfaces have been found out parallel to the previous studies in the area. These are, D-I (Lower-Middle Miocene), D-II (Upper Miocene), D-III (Upper Pleistocene), SY (Lowest-Middle Pleistocene) and SA (Upper Pleistocene) surfaces and they have been obtained in quicker and more accurate way than the classical geomorphological methods.

Innovations brought to geomorphology by remote sensing data obtained at different scales and resolutions from different satellites have been compared with aerial photographs and discussions have been made. It has been observed that the remote sensing data had superiority over the aerial photographs in a way that they display the characteristic structures of the terrain in colours and show large areas in one model. It has been established that by using digital elevation model produced as raster data group and high-resolution remote sensing data, geomorphological studies could be achieved much faster and more accurate in larger areas.

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