DETERMINATION OF SOME FACTORS INFLUENCING EROSION BY USING REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEMS IN THE VICINITY OF ANKARA ÇUBUK DAM LAKE

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Due to stimulating topographic structure, erosion is a crucial problem in Turkey. In this study, the objective was to determine some factors influencing erosion by using RS and GIS techniques. Materials used in the study include aerial photos of 1969 and 1995 at scales of 1:21000 and 1:4000 respectively, topographic, soil and geological maps of 1:25000 scale, Landsat 7 images, camera and triangulation information of the aerial photos.
To obtain erosion map digital elevation points produced by means of photogrammetric digitization of aerial photographs were transformed into grid model with grid interval of 0.5 meter. Changes took place on land surface were calculated by extracting digital elevation classes produced from DTM (digital terrain model) of 1995 from the DTM of 1969. Areas become eroded and subjected to accumulation were classified according to erosion criterion of National Soil Map Legend, then mapped with different levels of erosion and accumulation.
From the digitized soil map, some layers have been formed by taking into consideration the characteristics such as soil characteristics combination - SCC, land use capability class – LUC.

A TIN model was composed using point data of 1969, then slope map was recreated. By statistical analysis done between the slope map being recreated and land use capability, slope and depth classes of available soil map and erosion classes corresponding to the obtained erosion values, factors influencing land with regard to erosion were examined. The sample file in ArcInfo has been established and finally by using this file have been performed by the use of SPSS program.

Analysis have disclosed that an outstanding erosional phenomenon occured on VI. class lands, soils having slope degree of 20-30 % and deep soils.

Key Words: Erosion, gully, modelling, geographical information systems, remote sensing, Çubuk dam, and image analysis

1.INTRODUCTION

The data collection studies realised for the purpose of modelling the soil erosion aims at the determination of the methods that can be used for the prevention of erosion and together with these methods can be adopted for the designation of the best model of land use. This can sometimes be in the form of defining the degree of erosion and sometimes in the form of constituting a model on the basin by having theoretically collected the factors that are controlling erosion. The high rate of resolution possessed by the remote sensing data and the developed data processing technologies have rendered possible the collection and evaluation of the partial data.

The unwanted collection of the eroded material is a very general explanation for the sedimentation problem. At the basin areas, the problem regarding the general condition of sediment control initiates with the erosion of the soil by the effect of water or wind. Within the scope of the basin protection projects, the reduction of the amount of erosion and the improvement of sediment problems constitute the basic objectives. For this purpose, it is necessary to acquire information including the intensity of the problems encountered. This information that are necessary can be achieved within a short period of time with the help of Geographical Information Systems (GIS) and the Remote Sensing (RS) techniques. The GIS and RS techniques are gaining a significant importance in the recent years from the viewpoint of obtaining the data used in relation with the erosion and sediment estimation

models and the model studies that are operated or formed at GIS environment with the adoption of these models. The data such as the cover of vegetation, the length of the dip, the characteristics of the soil, the hydraulic parameters and the land use are providing numerous conveniences for the transactions regarding the transfer of the present maps to a digitised medium, the processing and storage of the acquired data, the obtaining of new data from the present data via cross – examinations and for the intensive and costly field studies lasting for long periods of time.

This study has been handled for the purpose of designating the change that has been formed by erosion from the environmental viewpoint at the areas surrounding the Çubuk Dam Lake by benefiting from the quantitative modelling for reasons as dictated above and to determine the dimensions of the erosion and to find out some factors which influencing erosion at this region.

2. MATERIAL AND METHOD

2.1. Material

2.1.1. Definition of the Study Area

The investigation area is approximately 1000 hectares and covers the Çubuk 1 Dam Lake and the area surrounding it. The investigation area is situated at the North of Ankara and lies in the North – South direction. The distance of the Çubuk County that gives its name to the plain, to Ankara is 40 kilometres. The area lies between the 32° 68' - 32° 88' Western longitudes and the 40° 00' - 40° 03' Northern latitudes (Çinkaya 1993).

2.1.2. Materials Used in the Study

In this study, the 1:21000 scaled aerial photographs for the year 1969 and the 1:4000 scaled aerial photographs for the year 1995 in relation to the area of study and obtained from the General Directorate of Land Registration and Ownership and the General Directorate of Ankara Water and Sewer Administration, the elevation data obtained by the digitisation of these aerial photographs by the adoption of photogrammetric methods, the triangulation information regarding the aerial photographs and the camera calibration information, the satellite images, the geological, topographical and soil maps and the studies realised by other institutions regarding the subject have been used. Within the scope of the study, TNTmips 6.2, Intergraph MicroStation 95, ArcInfo 7.2.1, Erdas Imagine 8.1 and ArcView 3.1 softwares have been used. On the other hand, the base materials used in the digitisation of the aerial photographs were the 1:25000 scaled topographic maps, 1:21000 scaled aerial photographs for the year 1969, 1:4000 scaled aerial photographs for the year 1995, the coordinates of the ground control points regarding this project and the camera calibration information.

2.2. Method

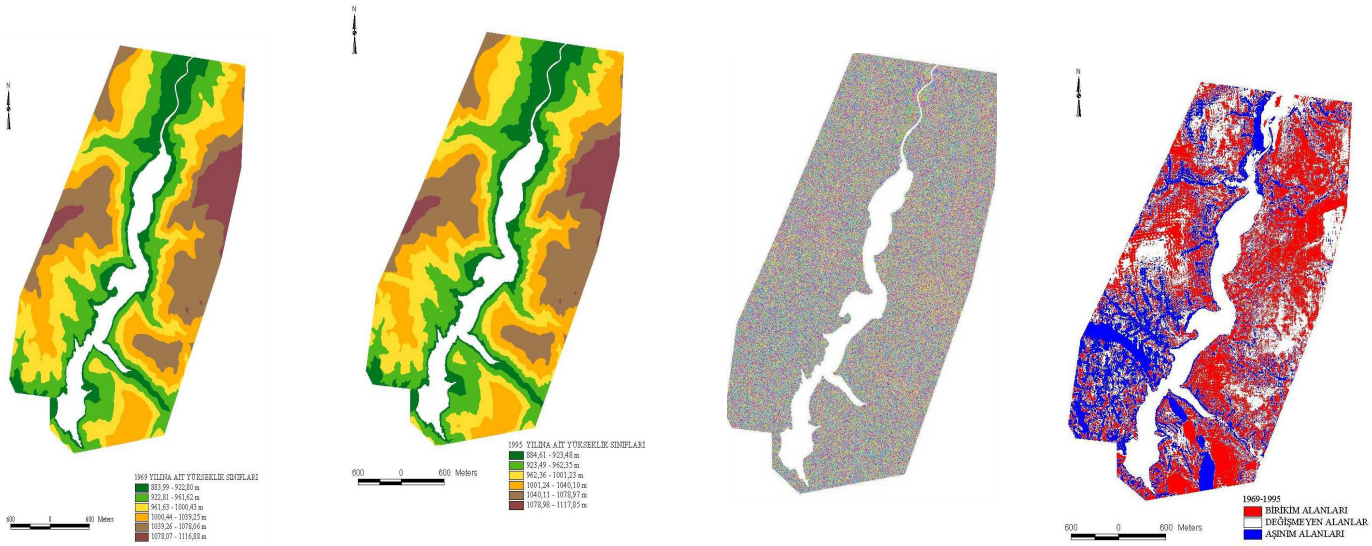
Within the scope of the study, the digital terrain models obtained by using the elevation data acquired from the digitised aerial photographs have been used as a base. The taking of horizontal cross – sections and the realisation of the volume analyses and erosion determination transactions on these bases constitute the method of the study (Welch et al. 1984, Dymond et al. 1986). To obtain erosion map digital elevation points produced by means of photogrammetric digitization of aerial photographs were transformed into grid model with grid interval of 0.5 meter. Changes took place on land surface were calculated by extracting digital elevation classes produced from DTM (digital terrain model) of 1995 from the DTM of 1969. Areas become eroded and subjected to accumulation were classified according to erosion criterion of National Soil Map Legend, then mapped with different levels of erosion and accumulation.

The soil data has been added to the soil database by the digitising of the 1:25000 scaled soil map (h29c3 section), that has been prepared as a result of the soil surveys realised by the General Directorate of Soil and Water (TOPRAKSU) during the years of 1960 - 1970. The Land Use Capability Classes (LUC) produced from the soil map with 0.5 m grid intervals, the slope and depth classes produced from the Soil Combination Map (SCM), and the erosion maps obtained by the subtraction of the slope map produced by the use of digital elevation points for the year 1969 and the digital elevation classes from each other and including only the erosion values are overlapped and the pixel values are transformed to the ASCII

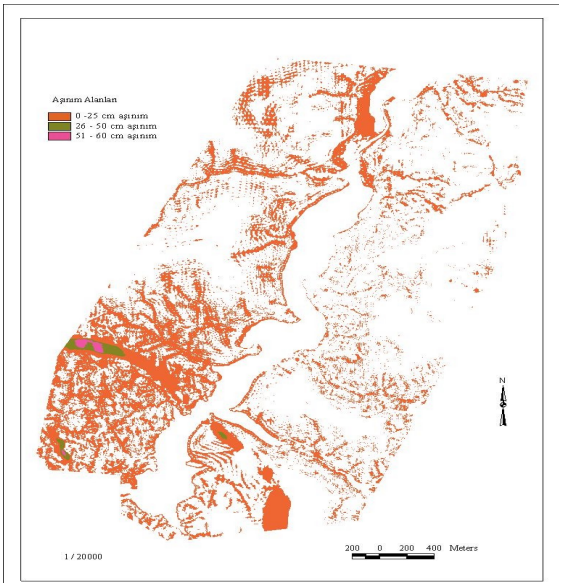
codes. Due to the problems encountered regarding the size of the data, the pixel size is re-gridded to 2m and by masking the remaining areas, the sample file in ArcInfo medium has been established and finally by using this file obtained the statistical analyses have been performed by the use of SPSS program. By the increase of the pixel size to 2 m, a difference was observed in the classes within the thematic layers. For example, the four classes taking place within the depth layer dropped down to three classes. While the depth classes according to a pixel size of 0.5 m was deep, medium deep, shallow and extra shallow; the medium deep class was transferred into the other classes by the program when the pixel size was increased to 2 m.
From the digitised soil map, new layers have been formed by taking into consideration the characteristics such as and slope and depth maps which produced from soil characteristics combination – SCC layer , land use capability class – LUC and new slope map produced from digital terrain model (TIN) belong to 1969 year. Each of these layers has been divided into 0.50 m interval grids by adopting the ArcView 3D module and by transferring the newly obtained layers into the ArcInfo program, they have been masked according to the lake boundaries for the year 1969.

The erosion map and some layers which produced soil map are overlapped and the pixel values are transformed to the ASCII codes. The sample file in ArcInfo medium has been established and finally by using this file obtained the statistical analyses have been performed by the use of SPSS program.

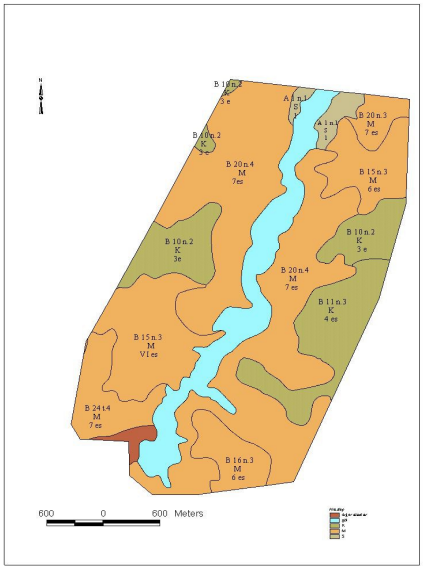
While realising the statistical analyses, erosion was taken as the dependent variable and the land use capability classes and slope map obtained 1969 TIN model, slope and depth classes obtained from the soil characteristic combination map were regarded as the independent variables. In order to be able to designate the effects of the soil depth, soil slope and the land use capability classes on erosion, the factors were separately evaluated.



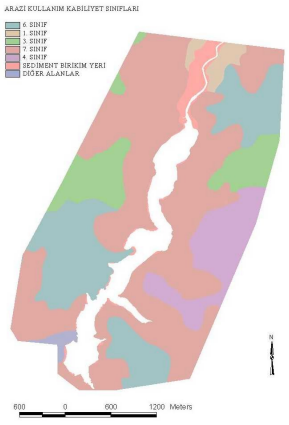
Digital Elevation Classes –1969 Digital Elevation Classes –1994 Changes Map Classifed Changes Map



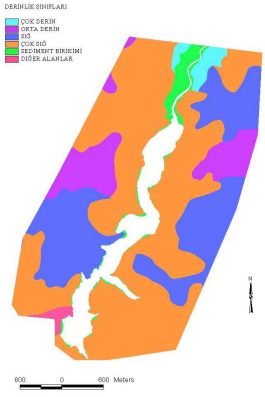
Classifed Erosion map



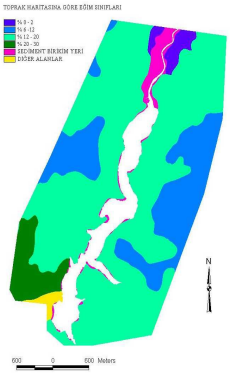
Soil Map



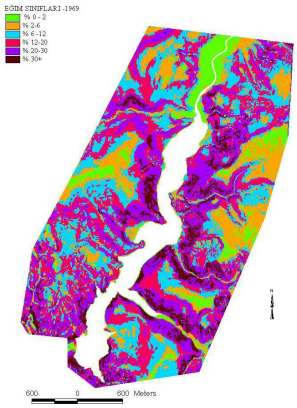
Land Use Cabability Map



Slope Map and Depth Map



Produced Soil Map



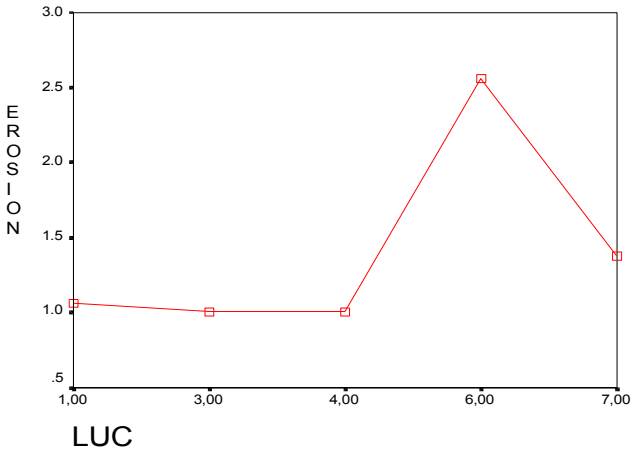
Slope Map Produced TIN_1969

3. INVESTIGATION FINDINGS AND DISCUSSION

3.1. Relation between Land Use Capability Classes (LUC) and Erosion

For the purpose of designating whether or not there exists a difference between the amounts of erosion of different land use capability classes, one-way anova analysis has been realised. As a result of the variance analysis, it was found out that the differences between the group averages were significant ($P<0.01$). Under such circumstances, it can be said that there exists significant difference between the land use capability classes, from the viewpoint of erosion.

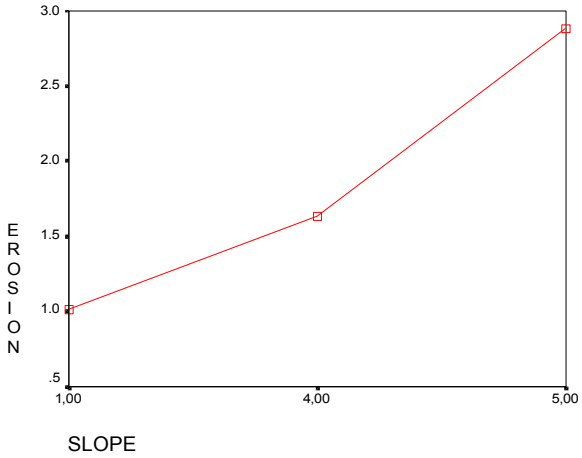
The average values of erosion for each group were compared according to the new variation width control method (Duncan). The highest rate of erosion average occurred at Class 6 lands and Class 7 and Class 1 followed. The averages regarding all three of these groups displayed significant differences from each other at levels of 1 %.



Relation between Land Use Capability Classes (LUC) and Erosion

3.2 Relation between the Slope Established from the Soil Map and Erosion

When the amounts of erosion that has occurred in relation to different slope groups are studied, it was found out that the erosion has increased as slope increased and the average amount of erosion at an slope value of 20-30 % was observed to be 2.8858 cm. The amount of erosion at the lowest value of slope, on the other hand, was found to be 1.012 cm. Despite the fact that the highest amount of erosion observed in these areas was 5 cm, the amounts of erosion went up as high as 60 cm at slope values of 12-20 % and 20-30 %. As a result of the analysis realised, it was determined that the differences between the erosion averages belonging to the slope groups were indeed significant ($P<0.01$). Upon the comparison of the slope groups by the use of Duncan method, it was as well found out that the averages of the three groups were different from each other at 1 % significance level.



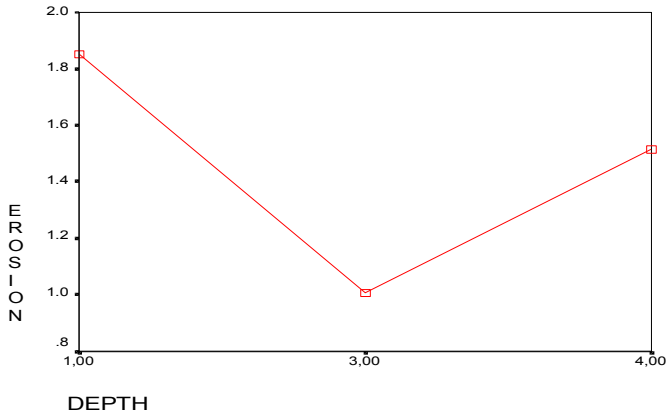
Relation between the Slope Established from the Soil Map and Erosion

3.3. Relation Between Depth and Erosion

According to the results of the variance analyses, it was observed that the difference between the erosion groups in relation to different soil depths was significant. The lowest amount of erosion was found to have occurred within the 3rd depth group, in which the maximum amount of erosion happened to be 5 cm.

As a result of the Duncan grouping, it was designated that the erosion average belonging to the 1st depth group displayed a significant difference when compared with the erosion averages of the other two depth groups at a level

of 1 %. The fact that the amount of erosion was high at the depth classes and especially at the Class 1 depth group arises from the abrasion characteristic of the soils within this depth group.



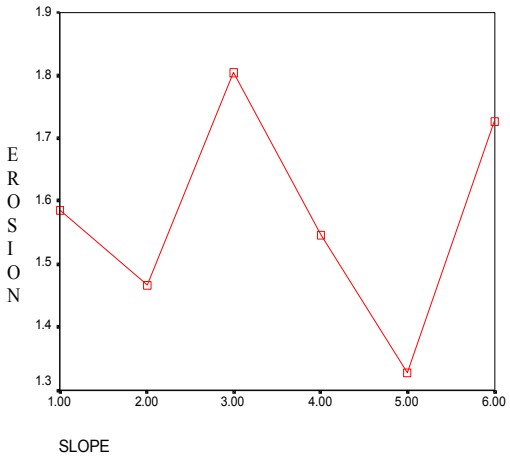
Relation between Depth and Erosion

3.4. Relation Between the Slope Values Established From the Digital Terrain Model and Erosion

According to the brief statistical data regarding the slope values designated by two different methods within the scope of this study, the average amount of erosion found out to be 3.6745 ± 0.00085 cm in accordance with the slope degrees obtained from the digital elevation model, while the average amount of erosion in accordance with the slope map established from the soil map was found out to be 3.3710 ± 0.00084 cm

According to the variance analysis results in relation to the slope groups, it was observed that the differences between the amounts of erosion belonging to the slope groups established from the digital land model were significant ($P<0.01$).

It was also observed that the respective 3rd, 6th and 1st group averages, where the highest amount of erosion was observed as a result of the variance analysis, entered into the same group and also that there exists no difference among themselves from the statistical viewpoint. However, the 3rd, 5th and 6th slope groups displayed a difference at a rate of 1 % sense when compared with the other groups.



Relation between the Slope Values Established from the Digital Land Model and Erosion

4. RECOMMENDATIONS

Of the necessary bases within the scope of the study, the soil maps were not up-to-date and they do not include the information at the level of sub-units as necessitated from the viewpoint of the parameters affecting erosion. By taking into consideration the soil maps of a serial basis for the methodology studies to be executed or developed in the future, significant facilities shall be rendered regarding the interpretation of the results. The immediate initiation of the basic soil survey studies all over the country shall get rid of the difficulties encountered on this subject.

It is also necessary to evaluate the other parameters affecting erosion, such as erosivity, vegetal cover, inclination length, etc.

Regarding the explanation of the area erosion and accumulation points depending on the supply of photographs, the evaluation of the entire parameters is rendered difficult. From the viewpoint of better evaluation of the erosion and accumulation results, it is necessary to handle these studies on the basis of the basins bounded by the water separation line. Therefore, the source of the incoming soil can be better explained and this situation shall also render the better interpretation of the parameters affecting erosion.

Since the grid interval is too low, the volume of data had increased enormously and subsequent difficulties were encountered regarding the processing of the data, despite the significantly high capacity of the computers used (2 X 500 Mhz Dual Processor, 2 X 18 GB Hard Disc, 1 GB RAM). In order not to encounter with such difficulties, more convenient grid intervals should be designated.

5.REFERENCES

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