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FOREWORD

The view of humanity on the environment has grown in recent times in different dimensions. His relationship with the environment has led to different echo in the strata of society. Since the destruction of the environment on the one hand caused the emergence of the environmental crisis, on the other hand leads to reducing the chance of survival of future generations. To avoid this, each individual must look at life in our environment, and protect the creatures bear any responsibility.

This matter needs to be seriously discussed and solutions need to be found both on universal and local level. International meetings have also the duty to keep such environmental problems before the eye, and allow the exchange of expert opinion scientists. The 7th International Symposium On Ecology And Environmental Problems will forward the following topics in the Symposium:

Environmental Education; -Environmental Law and Philosophy;- Chemical and physical contamination and measures to be taken in the ecosystem; -Tourism and Environment; -Alternative and Green Energy; -Biodiversity; -Environment and Settlement;- Ecology and Economy Dilemma; -Energy and Environment; -Health, Nutrition and Environment; -Art and Environment:

What should be done to create a platform for climate change. A certain consensus has to be made between the economic thinking and ecological thinking. The relationship between human health and pollution should be thoroughly demonstrated. The impact of genetically modified foods on the environment and not least on the health of humanity is discussed. To protect against the import of genetics-modified organism (GMO) must be made on a legal basis. The protection of the air, water and soil should be placed on the agenda and discussed in the context of ecological thinking. Some issues should be directed to the protection of biodiversity and nature protection. In addition, the method of using the optimal form of alternative energy sources must be carried forward.

The 7th International Symposium On Ecology And Environmental Problems was organized by the Hacettepe, Akdeniz and Mehmet Akif Ersoy University with the Ministry of Forestry and Water Affairs in Turkey and 65 national-and international organisations in Manavgat/Antalya/Turkey from Dezember 18-21, 2013.

The main results of the 7th Symposium are included in this issue of the international journal "Fresenius Environmental Bulletin"(FEB) and they will contribute undoubtedly to the advancement of the environmental scientific knowledge and hence, to the improvement of the environment.

Prof. Dr. Ilhami KİZİROĞLU
Chairman of the Symposium

DETERMINING OF AREAS WITH HIGH EROSION RISK IN KÜÇÜK MENDERES RIVER BASIN (WEST ANATOLIA, TURKEY) BY USING MULTI-CRITERIA DECISION MAKING METHOD

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Presented at the 7th International Symposium on Ecology and Environmental Problems (ISEEP2013), December 18-21, 2013, Antalya, Turkey

ABSTRACT

The objective of this study was to determine the current situation of erosion in Küçük Menderes River Basin which is a site rich in natural environment potential, and to semtinize possible dangers which the erosion would create in the future, from a geographical-ecological point of view. In the research, Landsat satellite images were utilized to determine the relationship of the current land use-erosion, and "Multi-criteria analysis method" was used in the process of these images. Beside this, parameters such as slope, exposure, lithology etc., which are influential in erosion, were created on GIS software. Finally, areas with high erosion risk in Küçük Menderes River Basin were determined by overlaying each parameter. There is an inconsistency between the land capability classes and their usage in the basin. While the area occupied by Ist, IInd, IIIrd and IVth class lands which should be used as agricultural fields covers 32%, the area occupied by the agricultural fields covers currently 40%. This situation shows that, in the area, lands have not been used according to their capability classes. In other words, 4% of IIIrd class lands is used as the agricultural area; 16% of IVth class lands as forest; 38% of VIth class lands as the agricultural; 44% as forest-maquis; 11% of VIIth class lands as the agricultural, and 46% of VIIIth class lands as settlement area. The said situation leads to aggravation exacerbation of erosion in the area. As a matter of fact, severe erosion being seen at 30% of the basin affects the lands that are inclined and devoid of vegetation cover. As a result of land degradation and erosion, the basin lands become unuseable losing their natural feature. To prevent this loss is possible by establishing a pattern of land use which is suitable for natural environment potentials of the lands (land capability classes).

KEYWORDS: Küçük Menderes River Basin, Erosion, GIS-Remote sensing, Basin Planning.

* Corresponding author

1. INTRODUCTION

Soil, pedogenesis of which has occurred over thousands of years, is in danger of disappearing in a lot of regions in the World today [1, 2]. Soil erosion is one of the most important environmental problems in arid and semi-arid regions especially. For this reason, we also confront with the erosion as an important problem in Turkey where arid and semi-arid regions cover a wide area. A great part of Turkey is faced with the danger of erosion [3-6].

Since Geographic Information Systems (GIS) technology has various skills such as storing, producing, analyzing and visualizing spatial data, it possesses a great potential to solve and manage spatial problems [7]. Importance of Geographic Information Systems in planning and in protecting natural landscape is increasing day by day. Estimation of erosion in an area is a very large and effective method in workings for soil protecting and planning, and more effective and more correct data are obtained by using GIS technology. Both in Turkey and abroad, erosion risk analyses of many areas are carried out by ensuring integration of CBS and remote sensing data [8-13]. Used within this technology, Multi-Criteria Decision Making Method has features such as evaluating alternatives in solving the problem in line with the decision maker's priorities and selecting the most satisfying one, etc. For this reason, it provides the user with considerable flexibility (offers choices) in creating risk and sensitivity maps at planning works and thus giving a better and flexible response to the user's determinations. Considering the erosion's emergence depending on numerous reasons, Multi-Criteria Decision Making Method seems highly suitable for evaluating the emerging differences locally by so many alternatives in creating erosion risk maps. Therefore, this method was used while erosion risk map was being created in this study.

The objective of this study was to determine the current situation of erosion in Küçük Menderes River Basin which is a site rich in natural environment potential, and

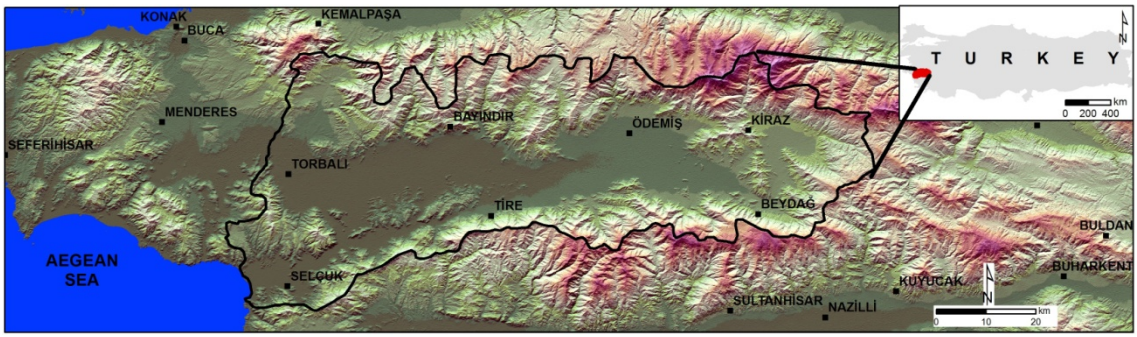


FIGURE 1 - Location map of study area.

to semtinize possible dangers which erosion would create in the future, from a geographic-ecologic point of view.

2. MATERIALS AND METHODS

Sometimes for economic purposes, different land-use policies within different administrative boundaries can be implemented, which causes different soil losses within the same ecosystems. In this study, Küçük Menderes River Basin was investigated. The objective of the study was to present erosion risk in Küçük Menderes River Basin and to emphasize factors (land cover, geology, topography etc.) having influence over spatial differences in soil loss. In this study, it was aimed to determine areas of potential and true erosion danger with the help of Geographic Information System (GIS) and Remote sensing methodologies.

To determine erosion risk of the study area, parameters of slope, lithology, vegetation cover, rainfall and exposure were used. Topography maps of 1/25.000 belonging to the study area were digitized on ArcGIS 10.x programme for the purpose of producing slope and exposure maps which were used as a parameter in the study, and databases of these parameters were established. The similar method was also used to establish database of lithological features which is an-other parameter that was utilized in presenting the erosion risk of the study area. In determining lithological features, "Geology and Lithology Map of Küçük Menderes River Basin" prepared by Gozenc (1978) was used as underlay [14].

Another influential factor used in the study is rainfall. For establishing database related to this data, annual average precipitation data belonging to the study area were obtained from Turkish State Meteorological Service. Distribution map of precipitation for the area was created via Inverse Distance Weighted (IDW) method by considering altitude factor, as well. Beside this, MODIS satellite image dated August 23, 2012 was used to present land cover density of Küçük Menderes River Basin. NDVI (Normalized Difference Vegetation Index) image was created to measure closure status of land cover by utilizing from satellite image of the year 2012. Clearance or closure of the land in the study area in terms of vegetation cover was addressed within three different categories: a) Bare surfaces, b) Fewer vegetation cover, c) Areas with dense vegetation cover.

3. RESULTS AND DISCUSSION

There is an inconsistency between the land capability classes and their usage in the basin. While the area occupied by Ist, IInd, IIIrd and IVth class lands which should be used as agricultural fields covers 32%, the area occupied by the agricultural fields covers currently 40%. This situation shows that, in the area, lands have not been used according to their capability classes. In other words, 4% of IIIrd class lands is used as the agricultural area; 16% of IVth class lands as forest; 38% of VIth class lands as the agricultural; %44 as forest-maquis; 11% of VIIth class lands as the agricultural, and %46 of VIIIth class lands as settlement area. The said situation increases erosion risk in the research area.

3.1. Slope

In the research area, the erosion risk is high on the south slopes of Bozdağlar Mountains and the north slopes of Aydın Mountains, where the cleavage degree geomorphologically and the plain density have increased, and

TABLE 1 - The Slope classes and reclassify values in the study area.

Slope Classification	Reclassify Value	GIS Value
Level-Very low slope (% 0-3)	20	
Moderate slope (% 3-12)	40	
Steep slope (% 12-25)	60	10
Very steep slope (% 25-40)	80	
Sheer (> % 40)	100	

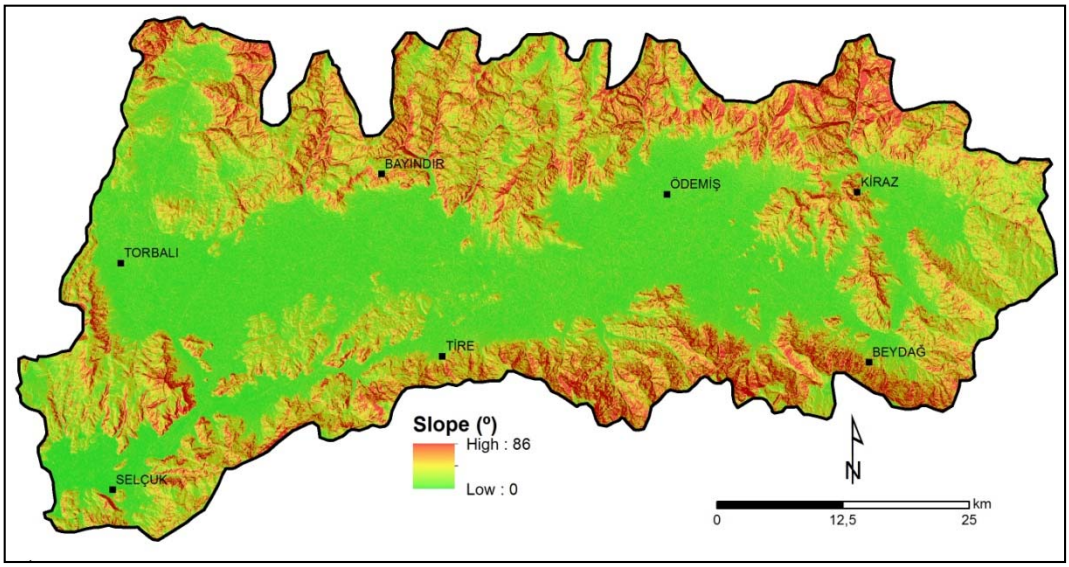


FIGURE 2 - The Slope map of the study area.

TABLE 2 - Elevation zones and reclassify values in the study area.

Elevation (m)	Reclassify Value	GIS Value
0-185	20	
185-450	40	
450-750	60	9
750-1150	80	
> 1150	100	

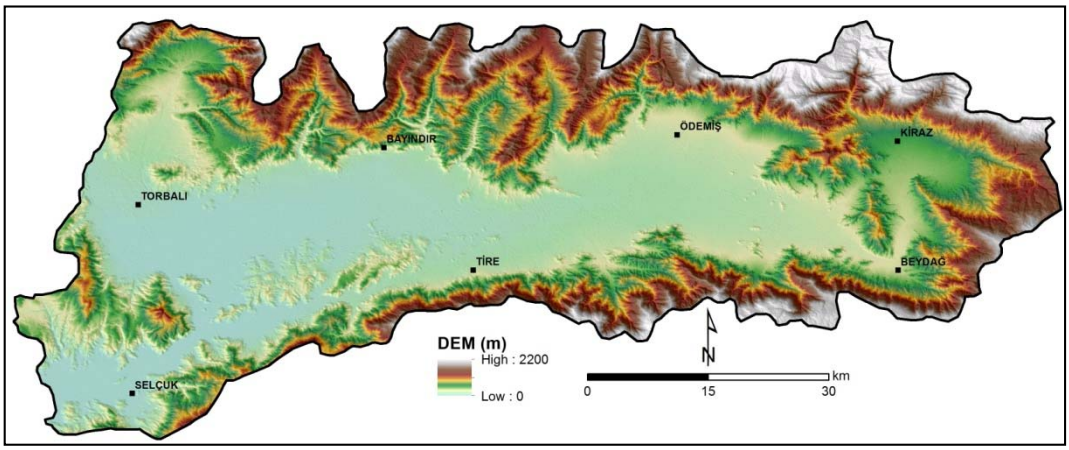


FIGURE 3 - DEM (Digital Elevation Model) map of the study area.

which have the slope above 10-12%. It is moderate along the alluvial deposits, lower hilly areas and the erosional surfaces, where the slope is below 10-12%. The erosion risk is rather low on the basin bottom where the slope is less and the deposition is in the forefront.

3.2. Elevation

In the basin, the erosion risk is high on the areas that are inclined, the average elevation of which is above 750 m. and the vegetation cover density is low, while it is moderate on the areas which are at altitudes between 450-750 m. The erosion poses a serious threat on these areas, which are cleaved narrowly and deeply by rivers, and the basin densities of which are high. It is low on the areas with an elevation below 450 m. in the research area.

3.3. Vegetation

While, in Küçük Menderes River Basin, the erosion risk is high around residential areas where the vegetation cover has been destroyed, and on the areas which are de-

TABLE 3 - NDVI classes and reclassify values in the study area.

NDVI	Reclassify Value	GIS Value
Dense vegetation	25	
Vegetation	50	7
Non-vegetation	100	

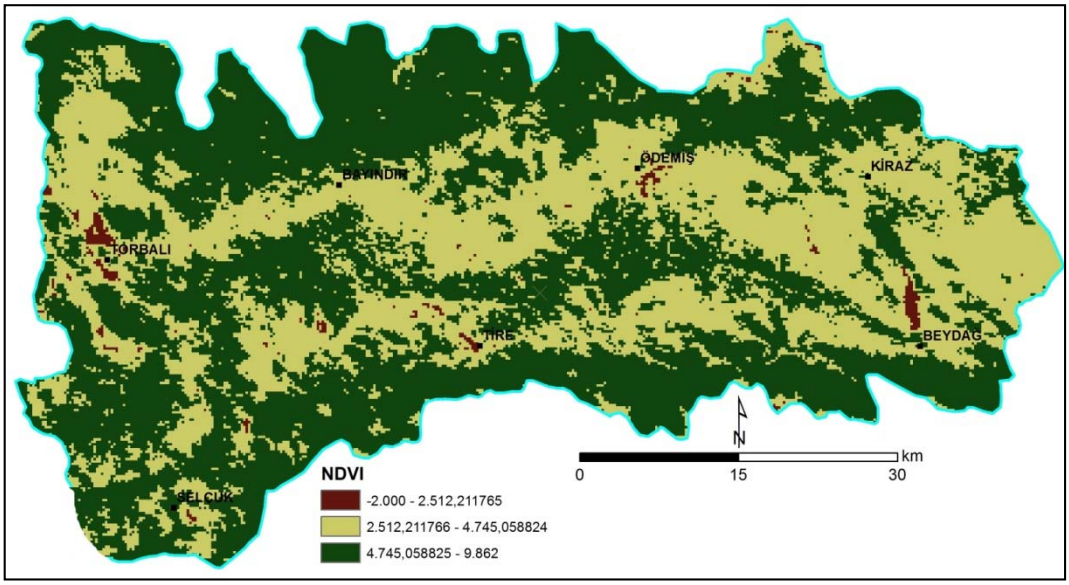


FIGURE 4 - NDVI map of the study area

TABLE 4 - Geological elements in the study area and their reclassify values

Geology	Reclassify Value	GIS Value
Alluvion	25	
Limestone-Conglomerate	50	5
Rhyolite-Andesite-Granite-Quartzite	75	
Gneiss-Mica schist-Marble	100	

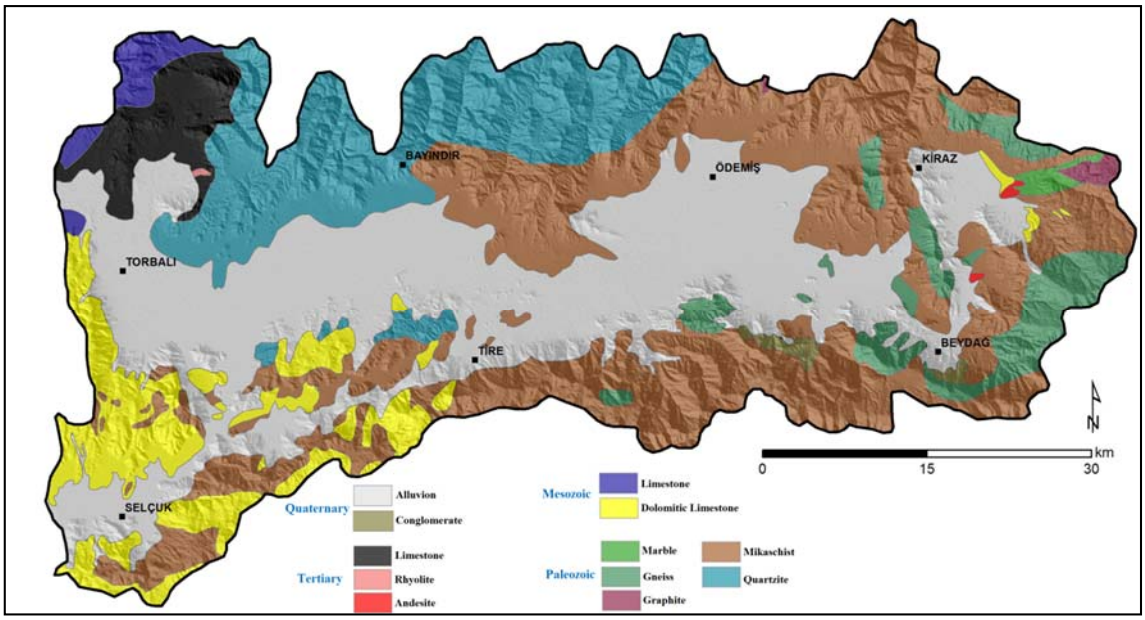


FIGURE 5 - Geology map of study area.

void of vegetation cover and where the slope is in excess of 10 %, it is moderate in the areas which are free from destruction, and the closure of vegetation cover of which is at an intermediate level. The erosion risk is low on the areas where there is a respectively high rainfall and density of vegetation cover.

3.4. Geology

While, in the research area, the erosion risk is very high on slopes that are inclined and devoid of vegetation cover, which consist of metamorphic elements (gneiss, mica schist and marble), it is high on slopes which are inclined and consist of volcanic rocks (rhyolite, andesite, granite) and quartzites. The erosion risk is moderate over sedimentary elements (limestone, conglomerate) which show a spreading on a narrow area whereas it is rather low on the basin bottom and banks, which consist of alluvions.

3.5. Rainfall

The research area receives an average rainfall around 724 mm. While north, northwest and west slopes of Aydın Mountains which are facing air masses coming from north, northwest and west receive higher rainfall (750-850 mm), the south and depression areas of Bozdağlar Mountains receive less rainfall (550-650 mm). Within this scope, erosion risk is high on the south of the basin on which the amount and density of precipitation are high (above 800 mm.) whereas it is moderate on the north of the basin receiving respectively less rainfall (below 750-800 mm.). The erosion risk is low on the areas receiving a rainfall below 700 mm.

3.6. Aspect

In the basin, the erosion risk is generally high on the inclined slopes which consist of metamorphic and volcanic elements which face south, the vegetation cover of which has been destroyed, and which receive respectively less rain, while it is at a moderate level on slopes that face east-west, which receive rainfall on the basin average (724 mm), and which the closure of vegetation cover of is moderate. On the other hand, it is low on north-facing slopes, where the rainfall is more (750-780 mm.) than the basin average and of which the closure of vegetation cover is high.

TABLE 5 - Rainfalls and reclassify values in the study area.

Rainfall (mm)	Reclassify Value	GIS Value
650-700	20	3
700-750	40	
750-800	60	
800-850	80	
> 850	100	

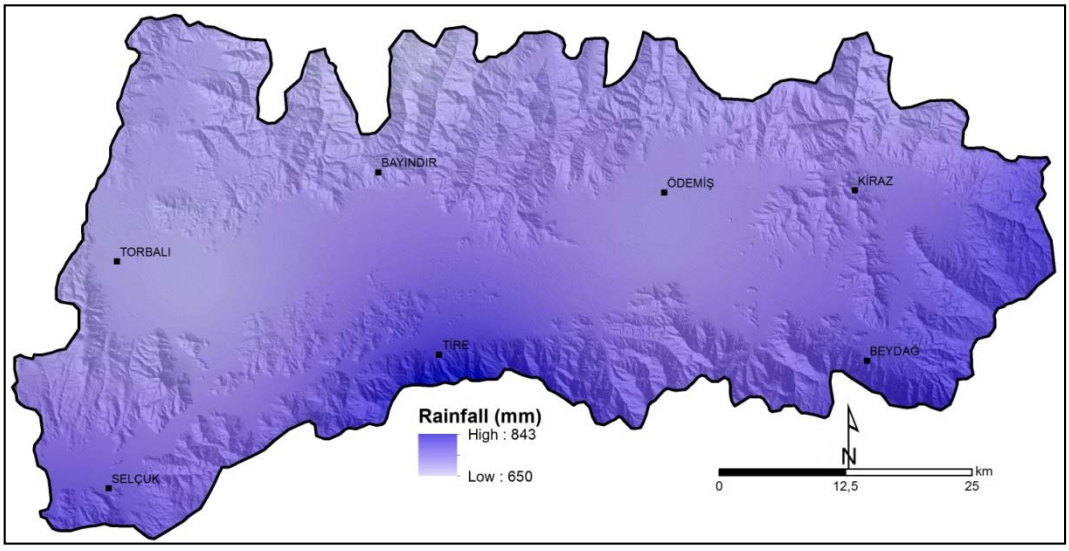


FIGURE 6 - Rainfall map of the study area.

TABLE 6 -Reclassify values according to the exposure in the study area.

Aspect	Reclassify Value	GIS Value
North	25	2
East-West	50	
South	100	

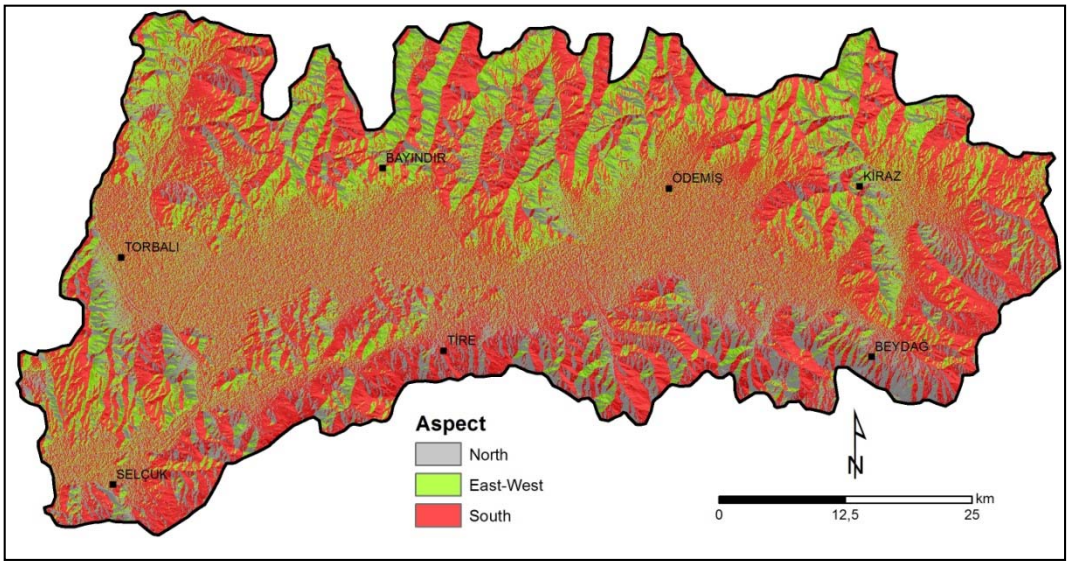


FIGURE 7 - Exposure map of the study area.

3.7. Erosion Risk Mapping

Erosion risk maps were determined according to variables of geology, exposure, vegetation, slope, elevation and rainfall in Küçük Menderes River Basin. The erosion risk is high on the areas with high slope, rainfall and elevation, which are devoid of vegetation cover, with south-facing, and consisting of metamorphic-volcanic elements. It is moderate over the sedimentary-volcanic elements, with the intermediate degree of slope, which receive a rainfall on the basin average and which are at altitudes between 450-750 m., with an intermediate degree of vegetation cover closure and with east-west-facing. The erosion risk is low on the areas consisting of alluvional-colluvial elements, with a low slope, which have an altitude below 450 m., where there is a respectively dense of vegetation cover, and with north-facing.

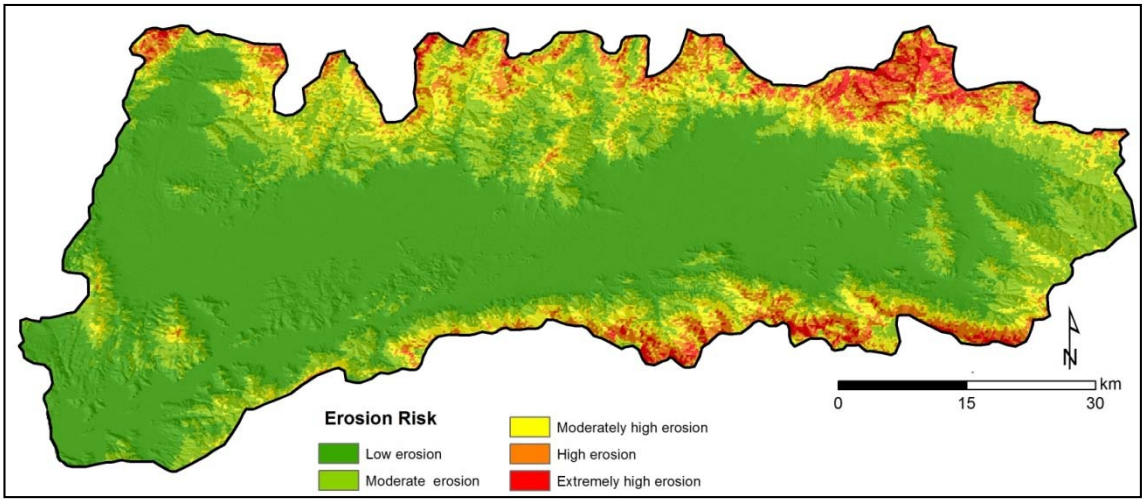


FIGURE 8 - Erosion risk map of the study area.

TABLE 7 - Areas (ha) and ratios (%) which are covered by erosion risk classes in the study area.

Erosion Risk	Area (ha)	%
Low erosion	140675,4	43,02
Moderate erosion	89826,9	27,47
Moderately high erosion	47938,2	14,66
High erosion	31620,9	9,67
Extremely high erosion	16938,6	5,18

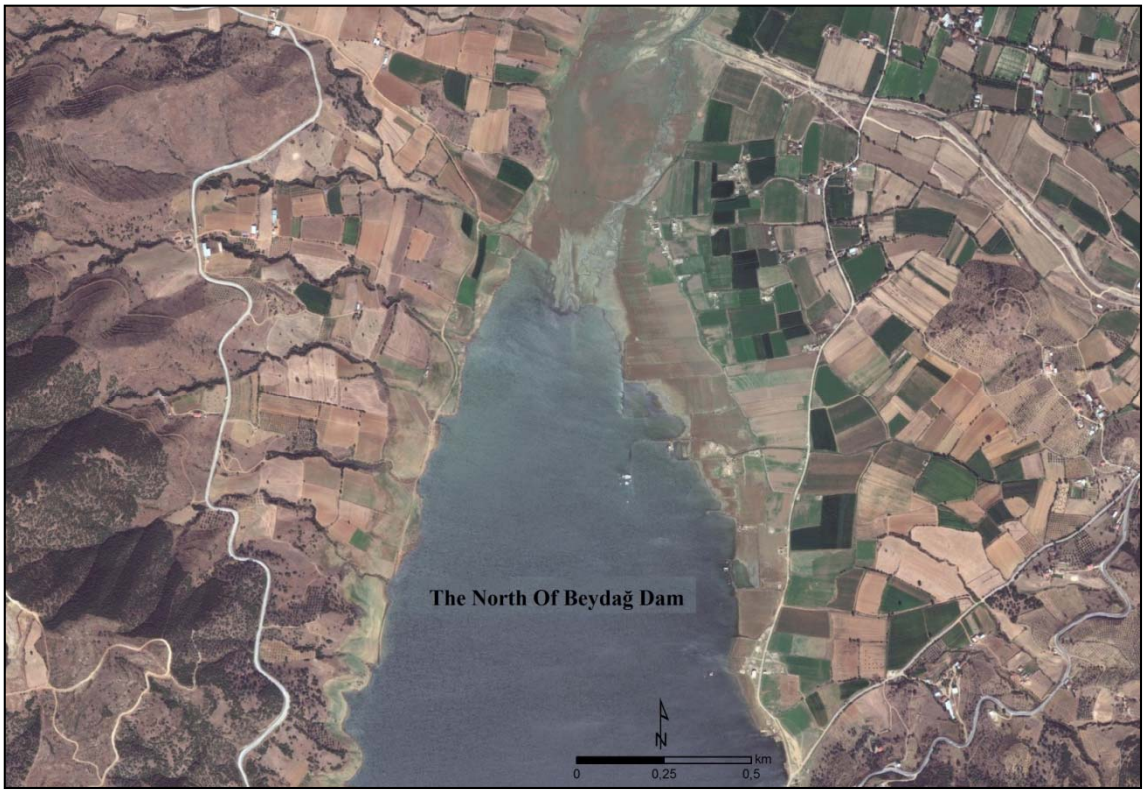


FIGURE 9 - Agricultural activities which are done around Beydağ Dam are increasing the erosion and siltation, and consequently lifetime of the dam is getting shorter.

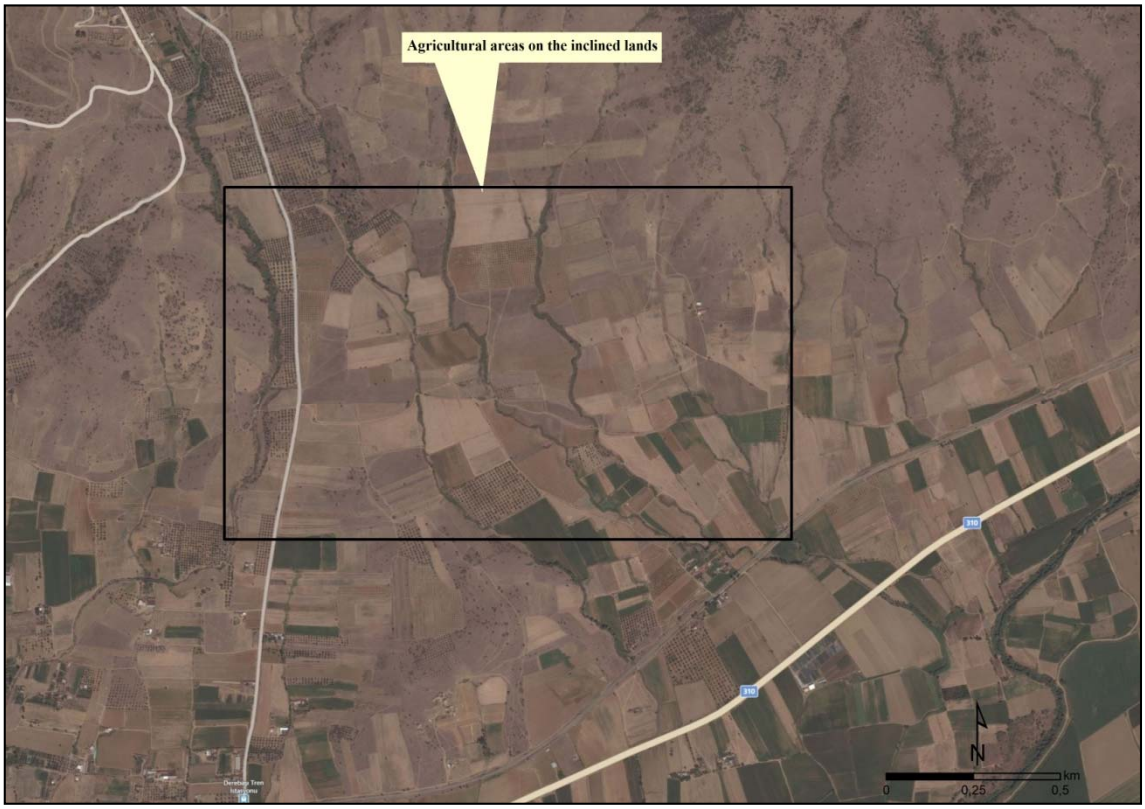


FIGURE 10 - Agricultural activities being done over the inclined lands, in the north of D310 State Highway, in the south of Derebaşı Village, Tire County lead the fertile soil to erode.

4. CONCLUSIONS

In this study, the areas the erosion risk of which is high in the Küçük Menderes River Basin were determined by using the multi-criteria (geology, exposure, vegetation, slope, elevation and rainfall) decision making method. The areas where the erosion risk is high are sites with high slope, rainfall and elevation, which are devoid of vegetation cover, with south-facing, and which consist of metamorphic-volcanic elements. The areas with moderate erosion risk are the sites, which have intermediate level of slope, which are at altitudes of 450-750 m., which have a moderate closure of vegetation cover, receive rainfall on the basin average, with east-west facing, and which consist of sedimentary-volcanic elements. As for the areas with low erosion risk are sites, where the slope is low, which have an altitude below 450 m., where there is a respectively dense of vegetation cover, with north-facing, and which consist of alluvial-colluvial elements.

In the research area, non-use of lands in a suitable way for their natural environment potential leads to the aggravation of erosion. As a matter of fact, severe erosion being seen at 30% of the basin affects lands that are inclined and devoid of vegetation cover. As a result of land degradation and erosion, the basin lands become unusable losing their natural feature. To prevent this loss is possible by establishing a pattern of land which is suitable for natural environment potentials (land capability classes) of the lands.

The authors have declared no conflict of interest.

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