Web: www.witpress.com Email witpress@witpress.com
Paper from: *Coastal Environment*, CA Brebbia (Editor).
ISBN 1-85312-921-6

Geomorphic environmental changes at Uluabat and Manyas lakes (Southern Marmara region, Turkey) from neotectonics to present time

H.Turoglu[1],M. Uludag[2],B. Mater [1]
[1] *Istanbul University, Geography Dept., Turkey*
[2] *Balıkesir University, Geography Dept.,Turkey*

Abstract

Ulubat and Manyas Lakes (Southern Marmara Region, Turkey) and their close surroundings fall into one of the most active tectonic areas of Turkey due to their location on the Norther Anatolia Fault Zone. This location has been a primary reason for important geomorphic environmental changes at this area in Quaternary. This study consists a modelling of geomorphic environmental changes at Uluabat and Manyas Lakes and their close surroundings.

In modelling, paleoclimatic, paleomorphologic , paleobotanic, paleopedologic, and archeologic data have been evaluated together. Also, especially, boring data of Quaternary stratigraphy have been used. Lithological data, earthquake records of historical and instrumental eras, and contemporary geomorphological analysis results have contributed a great deal to this study

The study area was probably a lagoonary environment which was connected to Marmara Sea during upper Miocene. Tectonical movements which began at that time and continued up to now have caused horizontal and vertical displacements also affecting streams resulting in drainage deformations and base level changes, which conform with such an alteration. Accordingly, six basic stages can be diferentiated belonging to geomorphologic development of sutdy area.

In the last section, compare between 1965 and 2001 geomorphological features of area. As the factors and processes are still current at Uluabat and Manyas Lakes, geomorphic environmental changes that took place in a time span of 35 years are an indicator for extinction of these lakes in near future.

Paper from: *Coastal Environment*, CA Brebbia (Editor).
ISBN 1-85312-921-6

1. Introduction

The aim of the study is to try to foresee the future physical development of the project area by geomorphological modelling using data on physical development, paleogeographical conditions and present factors and processes that affect Uluabat and Manyas lakes. Both of these lakes are located within the South Marmara part of the Marmara region (Turkey). Mathematical coordinates are 27°45'00" - 28°45'00'' E langitudes and 40°00'00"- 40°23'30" N latituoes.

The office and field works have been conducted at the same time, parallel to each other, and analytical procedures have been especially utilized whenever possible. Satellite images of 1999 and 2000 besieds air photos have been interpreted by remote sensing technigues . 1:25000 scaled topographical maps, limited resolution satelitte images, previous studied, various computer equipment, G.P.S., digital planimeter, cameras are among the materials employed. Data about 46 borings made by Government waterworks have also been used in interpreting sedimentological sequences (1).

2. Findings:

Findings obtained as the result of office and field works can be summarized as follows (2):

2.1. Draniage data:

- Some displacement due to right lateral young faults have formed in parts of Manyas and Mürvetler creeks which take place in poject area.
- Although Mustafakemalpaşa creek was flowing towards the west emptying its waters to Hanife Creek, later changed its course as a result of a vertical component of a ruoghly East-West directed fault line, and reached Uluabat lake.
- Mustafakemalpaşa creek, after leaving the the Karacabey basin once flowed towards northwest, which could be seen from sedimentary features, later made a sharp turn towards the East and reached Uluabat lake
- The creeks that reach the Karacabey basin from the North have a parallel and/or subparallel drainage patterns that have evolved under the control of lithological character (Fig.1).
- If sedimentary features of the streams that empty their waters to the Karacabey basin are considered, their beds show alterages in accordance with areal shrinkage of the lake.
- Ulubat streem is an outlet of Uluabat lake which also feeds the lake with a reverse flow. The delta in the lake has formed as a result of this feature and it also verifies the situation geomorphologically.
- A rapid areal shrinkage can be seen in both of these lakes. The wide rushy-reedy areas around are very striking features.

Paper from: *Coastal Environment*, CA Brebbia (Editor).
ISBN 1-85312-921-6

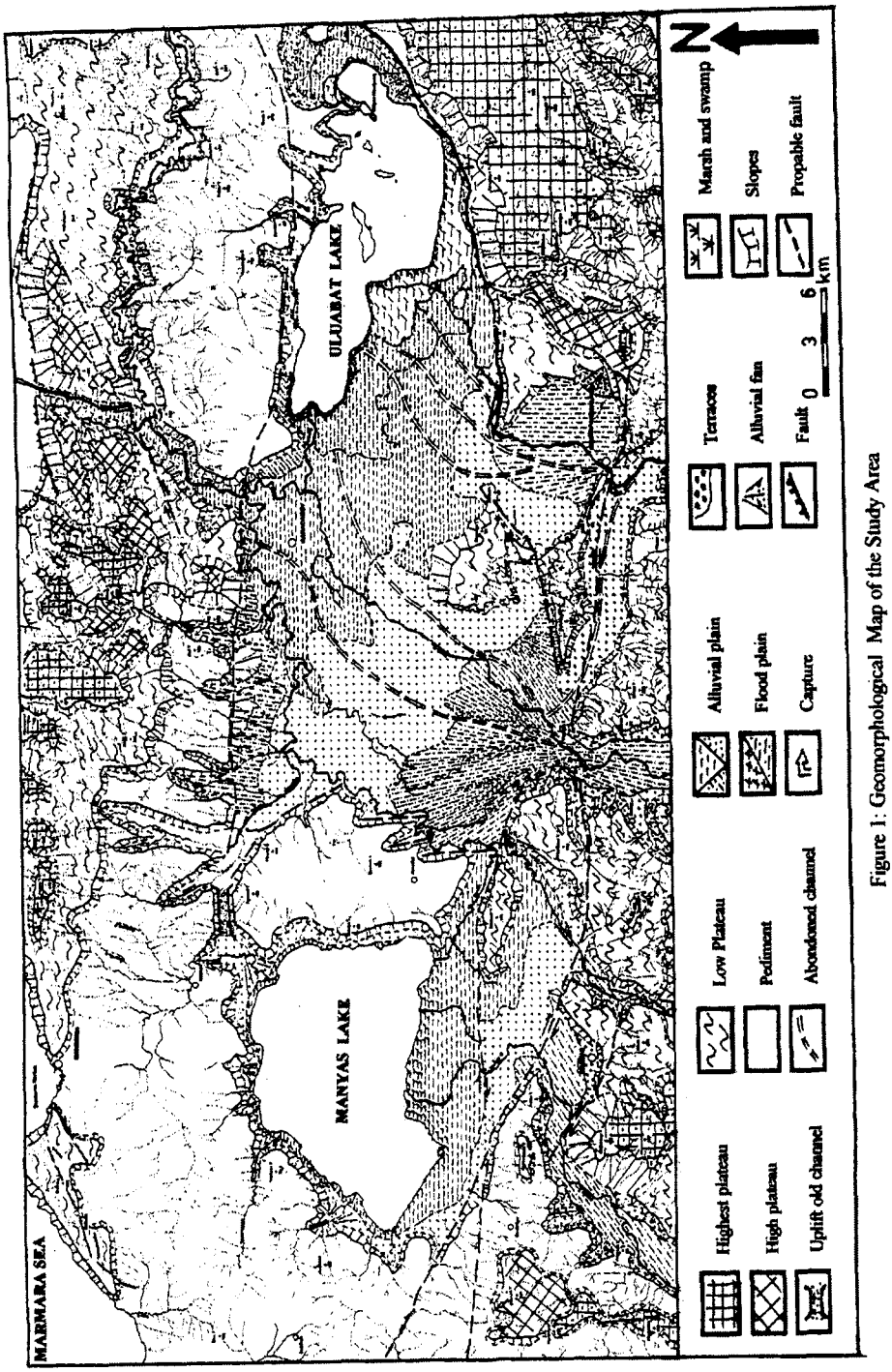

Figure 1: Geomorphological Map of the Study Area

Web: www.witpress.com Email witpress@witpress.com
Paper from: *Coastal Environment*, CA Brebbia (Editor).
ISBN 1-85312-921-6

2.2. Geomorphological Data

- The rise that forms a border at Uluabat lake from the south forming a topographical discordance is due to geomorphological effect of vertically displaced Uluabat fault.
- The Manyas fault which rougly begins from the east of Mustafakemalpaşa and continues up to Gönen is a right lateral fault with a vertical component. This fault is not formed of one line but has formed from a number of parallel fault lines together forming a budle shaped character. Earthquakes, hot water springs (Manyas, Kolağıltepe, Gönen, etc.), and swampy areas which were also present in the near past, can be considered among the evidence of active tectonics (3,4,5,6).
- Manyas lake has risen with the Aksakal massive at its East. At the present, Manyas lake is above 13 meters from the sea level whereas Uluabat lake in only 2 meters high. The elevation difference between these two very nearby lakes which are also related can not be though without taking tectonical land displacements into consideration.
- East-West directed trough at the North of the Aksakal massive is an old elevated stream bed. Later, by rising of Manyas Lake and Aksakal massive, the valley has been abandoned. (Fig.1).
- Samples to vertical displacements on some linear features can be seen in field observations and morphometrical studies on 1:25.000 scaled topograhical maps.
- In general, North facing slopes are more steeper than South facing ones. Such steep slopes can also be found as northwest and notheast facing ones.
- Some distortions in conjunction with parallel linearities have also formed in this project area (Fig.1). Lesser inclinations on South facing slopes have enabled them to form longer drainage patterns. Whereas on North facing slopes a shorter drainage patterns has evolved.
- Nilüfer creek has settled on one of these East-West directed linearities. Draniage features that belong to their tributaries are in conformation with the above explanations.
- The stream terraces especially at sides of Manyas and Hanife creeks have developed as a result of risings due to faults at the South of study area. Such rises have also played a part in Mustafakemalpaşa creek's ababdoning its old bed forming a new bed (7).
- Although strike-slip faults characterizes the tectonical lines, they have vertical components as well, thus sometime thrust faults come forward, which can be seen on profiles and traces observed in the field.
- Even if this area is tectonically very active with vertical and lateral displacements, nearness of the Karacabey basin (± 10m), Uluabat Lake (3m), and Manyas Lake (16m), to the sea level shows that not a rising but lowering of the land has taken place.
- Although fault lines partly dissect pre-neogene rocks, they have been influential in areas of neogene sediments in general. Thus, presence of

Paper from: *Coastal Environment*, CA Brebbia (Editor).
ISBN 1-85312-921-6

neogene outcrops at the South of Uluabat Lake in elevations between 150 to 200 meters are a result of this feature.

- While warping and collapsing at the Karacabey basin took place, the northern parts have stayed in a higheraltitude resulting in erosion of neogene sediments. By scraping of shallow neogene covers have outcropped lower palaeozoic and mesozoic rocks.
- It is reasonable that less inclined and mostly neogene areas have been subjected to pedimentation. Climatological conditions since upper pliocene have been suitable for pediment formation.Warped displacements as a result of tectonic movements have helped this development. However, when looked upon from the present climatic conditions, one can say that pediment formation has been interrupted. Therefore, here paleo-pediment term should be used in speaking of a poligenetic development in the area.
- Vertisols and redzinas cover a wide area in this region. Such soils, especially vertisols are characteristic soil of Neogene lake sediments (8, 9). Redzines are usually found alongside, even sometimes mixed. Such a situation is observed in the project area also. Their borders are mostly old lake floor areas.
- Brittle beachrock formations are found at the northern shores of Uluabat lake. However they have not been aged yet.
- Texture of beachrock at the northern shores of Uluabat lake is complex from the points of type, grain size and distributional features, and they show flood deposition character. This could also be considered as a proof to pediment formation and development at the North.
- It is unlikely that much changes have occurred in shorelines of northern Uluabat lake. Materials from East, West and Southwest which were carried by streams, and materials carried from pediment surfaces at the North with flood characterized waters have all played an important part in filling of the lake. Today, the deposits of these flood characterized waters are found together with beachrocks. So that one can see that, at least, some parts of Uluabat lake shores have been stable enough for making formation of beachrock possible. However, at the other parts of the lake's shores, changes are so rapid that one can easily follow them.

2.3. Sedimentological Data:

46 borings (1) made by D.S.İ. (Government Waterworks) in the study area were considered and evaluated. Although boring depths differ (max.344 m), important data about stratigraphic and origin characteristics have been obtainde and summarized as follows;

- 46 borings made in 28 different locations have been taken into consideration and their common characteristic are their being within the Quaternary material area or its close surroundings.
- Three different fascias come about when lithological characteristics of these material are considered. These are, base areas of pre-neogene rocks, lake-

Paper from: *Coastal Environment*, CA Brebbia (Editor).
ISBN 1-85312-921-6

swamp environments sediment types and stream sediments. Also, in some parts, igneous rocks have also been cut, nevertheless, they are very limited.

- In borings at the south, limestone, at the bottom, marly limestone and marl sequences take place. Series continue with base conglomerates and newer sediments show stream - lake sediment sequences in stratigraphical features. A thick stream sediment is followed by lacustrine sediments of similar thicness. Later, once again, river sediments take place. About a depth of 250 meters have been reached in these borings.
- Towards the inner parts, material variety and thicknesses differ. While thickness of river sediments at the lower parts increases, small grained sediments of calm waters decrease in thickness. Thus, towards the North, calm water environment (lake-swamp) have been effective for shorter periods.
- In borings made at the west of Kemalpaşa trough, stream sediments of 60 ko 125 meters in thickness have been cut. Although a linear flow is inexistent today, we can say that this trough belongs to a risen old stream bed.
- Neogene fascias are entered during the cuts in borings made at the southwest of Manyas lake. Very shallow clay layers are observed on them. Probably these clays are a part of Manyas lake deposits (Fig. 1).
- Two borings have been made at the North of Manyas lake. İn both, about 40 meters of stream-lake sediments have been cut.
- The boring made in the outlet of Manyas lake revealed tuffa and andesites following the clay layer of about 30 meters in depth. Absence of stream gravels is an indication for newness of this outlet.
- Two borings have been made near the outlet of Uluabat lake and only a thin layer (a few meters) of stream sediments at the top have been cut. The other sediments belong to stagnant water fascia.
- Two boring wells opened in the Karacabey basin mostly reach a depth of 200-250 meters. But some of them have reached to a depth of 300 meters. At the flanks of the basin, borings have entered limestone and marl formations, whereas in interion borings, lake stream deposits have continued in similar depths.

2.4. Archeological Data:

The time interval between paledlithic and Middle Ages (Paleolithic: 600000-12000/10000 B.C., Neolithic: 9000/8500 – 5500/5400 B.C., Calcolithic: 5500/5400 – 3200/3000 B.C., Bronze Age: 3200/3000 – 1200/1100 B.C., Middle Ages: 1200/1100 B.C. – 1000 A.D.) extends up to the middle of Pleistocene, that is 300 A.D. This time interval covers and important part of the period in protect area. There are 1 Paleolithic, 3 Neolithic, 5 Calcolithic, 4 Bronze Age and 3 Middle Age settlements in the study area (10). Distribution of these settlements from the oldest to new show a parallelism with shrinkage of lake areas.

Web: www.witpress.com Email witpress@witpress.com
Paper from: *Coastal Environment*, CA Brebbia (Editor).
ISBN 1-85312-921-6

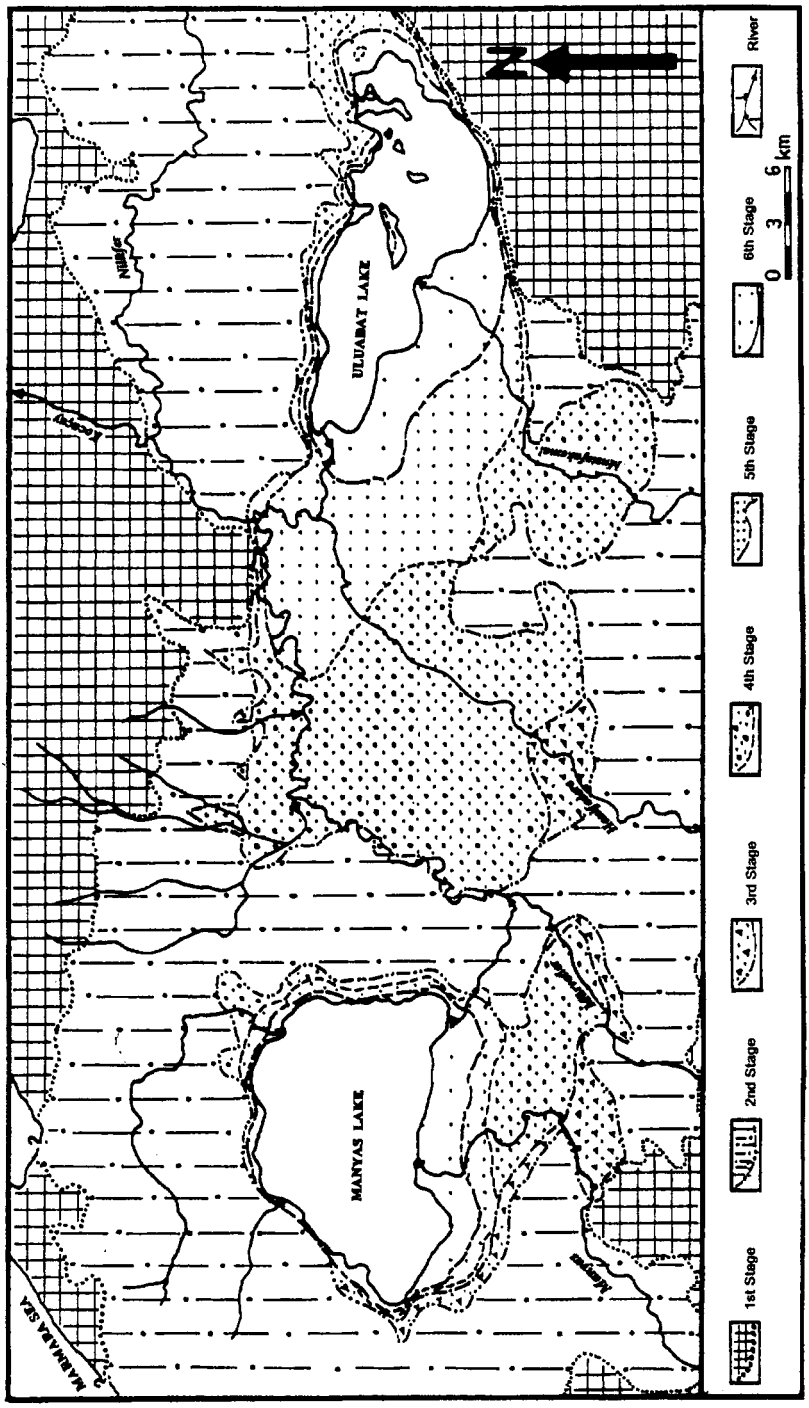

Figure 2: Geomorphological Evolution of the Study Area

Paper from: *Coastal Environment*, CA Brebbia (Editor).
ISBN 1-85312-921-6

3. Conclusion

A geomorphological evolution model of the study area, which is divided into 6 stages, has been prepared by taking all data into account (Fig.2).

1st Stage: Initiation of neotectonic era:

Almost all of the project area is under the influence of lagunar-lacustrine conditions of Pliocene. In this era, Paleozoic metamorphic rocks and Mesozoic sedimentary materials have played a part in moulding of this depression. It is being filled in stagnant water environment. This material consists of lake stream deposits of Miocene and Pliocene which are also considered as Neogene sediments in literature (Fig.1 and 2).

2nd Stage: Warped rising and outcropping of Neogene deposits.

Tectonic movements, propably at the end of Miocene, especially Upper Pliocene, have affected the study area with lateral and vertical displacements. Apart from these displacements, a lowering in warped form in suthern direction opposite to rising in northern direction have probably took place. Likewise, the Karacabey basin has been divided into two basic parts by these tectonic movements and western part of the Karacabey depression which includes Manyas lake, have risen to a greater degree.

In this stage, Manyas creek and Mürvetler stream emptied their waters to Manyas lake from the south, whereas Sığırcı stream flowed to the lake from the north. At that time the area of Manyas lake was larger than today. Probably the northern border have not changed much, but the southern parts including the present Manyas settlement area fell into the lake area. The outlet of manyas lake was connected to the Uluabat basin by a drainage channel from the north in the eastern direction. Also short creeks from the north and northwest and some flood water beds drained basin waters.

The area of Uluabat lake was much different from today. This lake which roughly resembles a rectangle is fed by Nilüfer stream from the North, Hanife stream (Susurluk) from the South and Mustafakemalpaşa stream. The south of this lake is bordered by a fault scarp. The northern part is represented by Neogene lake deposits lithologically which are slightly inclined towards the South. The drainage in this area was probably of flood character under which dynamic effects and processes a pediment formation has occurred.

The most striking feature of the drainage system is the flow of Sığırcık stream first from West to East than turning toward the south making a sharp bend and then empty its waters to Manyas lake, and also flow of Nilüfer creek first in East – West direction and reach Uluabat lake. Both of these streams are in conformity with the structure and as consecant streams have flowed in a course with less inclined northern slopes but very steep southerns slopes.

3rd Stage: Continuation of Tectonical activities and pediment development:

This stage roughly falls into the time of Pleistocene in which new systems began to take place in relavation to vertical displacements. Young, flood

Paper from: *Coastal Environment*, CA Brebbia (Editor).
ISBN 1-85312-921-6

charactered streams forming deep valleys are a striking feature on the north facing slopes. Probably the most important among these streams in Kocaçay which later captured Nilüfer creek. This flood charactered drainage system especially developed on slightly inclined Neogene lacustrine deposits which formed a pediment at the north of Uluabat and Manyas lakes. A dense and almost parallel drainage pattern, also fed by seasonal temporary creeks have accelerated pediment development. Paleolithic remains at the west of Eşenköy are attributed to a time gap of 600000 to 12000 years. At that time this place was a lake shore and that is why this place was chosen as a settling place.

4th Stage: Deltaic development and alterations in drainage systems:

Tectonic displacements which continued in Holocene also resulted in drainage pattern changes, and delta formation and development in streams.

Backward erosion and its effects still continue in younger streams which developed in connection with rising at the north, thus they send their waters to Marmara sea. One of these streams is Kocaçay, which probably captured Nilüfer creek likewise. Also, during water level rises in Uluabat lake, excess waters probably reached the Marmara sea by using the old bed of Nilüfer creek. In fact, another probabilitiy is that the outlet at the North of Manyas lake had to commence its flow due to rising and warping at the place, so a new outlet formed at the south of the lake. Another important stream channel has formed at Mustafakemalpaşa creek. East-West directed tectonic monvements at the south Karacabey basin caused Mustafakemalpaşa creek to change its course and flow towards northeast and empty into Uluabat lake.

Again during this stage advancing of deltas into Manyas lake by Manyas creek and Uluabat lake by Mustafakemalpaşa creek are also striking features. Hanife creek delta which advenced into Uluabat lake from the north and northeast has played an important part in formation af Karacabey plain by mixing floodwater alluvium that flowed into the basin from the north.

In project area, 3 locations about neolithic civilization have been determined. These are located on pediment surfaces which also form old lake shores. Their ages are almost go back to the beginning of Holocene (9000-5500 years).

5th Stage: Development of Karacabey Plain:

The alluvium carried by streams at the south resulted in rapid filling of Uluabat lake and expansion of Karacabey plain towards the lake. Similarly Manyas creek's delta also expanded towards Manyas lake. Tectonical movements and their influence on flüvial geomorphology have been very effective as determining-direting factor in the second half of Holocene. The level difference between Manyas and Uluabat lakes has become more pronounced during the last two stages reaching todays levels. Although located within the same basin, different tectonic movements as a block affected the lake areas which could be detected in erosional and depositional features that came about from descending by warps towards the south of Uluabat lake block. The remains df Calcolithic are observed on older alluvium. Thus, this attributes older alluvium to 5500-3000 B.C. in general.

Paper from: *Coastal Environment*, CA Brebbia (Editor).
ISBN 1-85312-921-6

6th Stage: Contemporary sturucturel features of the study area:

Location of bronze age (3200-1900 B.C.) and Middle Age (1000 A.D.) settlements on old and new alluvium areas have been a directive issue on their age determinations. At the same time, settlement places have changed according to the retreat of lake shores.

Geomorphological evolution is still continuing. In fact, the activities of the above mentioned factors and processes are still continuing. This means that geomorphological evolution of the Karacabey basin will continue in future also. Thus the following considerations could be made on Karacabey basin:

- Tectonic movements will continue in future as in the past. Their effects will be strongly felt on geomorphological features, drainage systems and human life.
- By such conservation activities like controlling of water that flows in or out and lowering sediment amound carried during areal changes could be reduced to a lesser degree.
- Flooding levels of lake and stream waters should conform with land use conditions and should also be selective in conservation – usage principles in all activities related to land use in the project area.

References

[1] D.S.İ. Genel Müdürlüğü, Aşağı Susurluk Havzası Hidrojeolojik Etüd Raporu, Jeoteknik Hizmetler ve Yeraltı Suları Dairesi Başkanlığı, Ankara, 1980

[2] Mater,B., Turoglu,H., Uludağ,M.,Yıldırım,C.,Cürebal,İ., *Manyas ve Uluabat Göllerinin Kuaternerdeki Evrimi ve Sonuçları*, 1186/070998 sayılı İ.Ü.Araştırma Fonu, Araştırma Projesi, İstanbul, 2001

[3] BARKA,A.A., *The north Anatolian fault zone, Annales Tectonica*, special issue, supplement to volume VI - 164-195, 1992.

[4] EMRE, Ö.-KAZANCI, N.-ERKAL, T., *Manyas ve Ulubat Göllerinin Kökeni ve Kuvaterner Jeomorfolojisi*, TÜBİTAK YDABÇAG 426/G, 1997.

[5] ŞENGÖR,A.M.C.,*Türkiye'nin Neotektoniğinin Esasları*, T.J.K.Konferanslar Dizisi, No:2, Ankara, 1980.

[6] ŞENGÖR,A.M.C.-YILMAZ,Y.,(1981), *Tethyan evolution of Turkey: A plat tectonic approach,* Tectonophysics, 75, 181-241, 1981

[7] EROL, O., *Neotectonic and Geomorphologic Evolution of Turkey*: in Fairbridge R.W. (Ed.), Neotectonics, Zeitschr. Für geom. Supp. Ed., s.193 -211,1980.

[8] Topraksu, *Susurluk Havzası Toprakları*, Topraksu Genel Müdürlüğü Yayınları, No:258, Raporlar Serisi: 46, Ankara, 1971.

[9] Topraksu, *Balıkesir İli Toprak Kaynağı Envanter Haritası*, Topraksu Genel Müdürlüğü Yayınları, No:234, Raporlar Serisi: 22, Ankara, 17-972.

[10] ÖZDOĞAN,M., *1989 Yılı Marmara Bölgesi Araştırmaları ve Toptepe Kazısı*, T.C.Kültür Bakanlığı, Anıtlar ve Müzeler Genel Müdürlüğü XII Kazı sonuçları toplantısı I, Ankara, 1990.