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# Active Shoreline Changes of Büyük Menderes River Delta in Last 50 Years

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**Abstract**

The coastal face of Büyük Menderes River is characterized by a complex system of lagoons, inlets, lakes, natural levees, beach ridges and river promontories. The geomorphological aspects of this complex system had been studied by means of aerial photographs and archive topographical maps. Three different periods of dataset is used where the earliest set is dated as 1956-1963, the next as 1977-1980 and the most recent one as 1996. In addition to aerial photographic studies, field observations have been made in 77 different locations in summer of 2004. It is observed that the most active parts of this shoreline are the promontories of Büyük Menderes River. One active and one relict promontory (northern and southern deltas) are observed with two different river courses. Two large lagoons are located behind the beach ridges of the shoreline. The so called Dil Lake -a large Lagoon- lies in the north part of the active promontory and joined with 2 inlets to the Aegean Sea as observed on aerial photographs and in field surveys done in 2004. The other one known as Akköy Lagoon is located on the south of the active promontory and also contiguous to the relict one. In year 2004, the Akköy Lagoon has 3 main inlets. The major changes detected in the shoreline between the observed dates are concentrated in the closure of inlets, formation of new sand barriers, slight changes in the course of the sand beaches and in the shape of promontories. It is expectably observed that the active promontory continues to aggrade since 1956 to 2004 for 50 years. However, on the other hand, the ceased promontory after a certain aggradation until 1963 is degrading continuously as a result of the human control and change in the southern course of Büyük Menderes River.

**Key words:** shoreline change, geomorphology, Büyük Menderes River, Büyük Menderes Delta, Turkey



## Introduction

Not very different from the modern cities, through the recorded history of seaside civilizations the instability of the shoreline either in favor of sea (erosion and land loss) or in favor of land (deposition and land gain) happens to act as one of the major threats for development. The existence of such instabilities whether human induced or naturally occurring, whether sudden or spread over very long time, whether catastrophic or predictable do immensely affect the living stock of both humans and associated living forms. Not only the instabilities but certain strong trends are also generally not desired, such that many ancient harbor cities in Aegean coasts of Turkey and Greece had left inland for many kilometers just because of aggregation of deltaic plains with river sediments.

The purpose of this study is to introduce the coastal morphological units of Büyük Menderes River's delta while demonstrating the shoreline changes with associated landform changes that have been occurring since 1950's.

## The Study Area

Büyük Menderes Delta is located in the Büyük Menderes River Catchment at the west of Aydın in South-Western Anatolia and is bounded by Dilek Peninsula at the north, Aegean Sea at west and Didim highlands at south. The size of the catchment is 24,976 $km^2$ with an annual river discharge of approximately 3.03 $km^3$ water. The Büyük Menderes delta is formed by the sediment discharge of Büyük Menderes River (400 km. in length), in Aegean Region. It rises in three branches from west of Afyonkarahisar and flows generally westwards into the Aegean Sea.

At the southern reaches of the delta there are abandoned meandering channels. By the construction of irrigation canal network (back from 1960's) (Aksu et al., 1987) the flow regime of the river is regulated and the present active delta mouth Deringöl promontory is being formed by a single channel flowing through the north of the Lala Karakol Hills, whereas the previous delta mouth had been flowing through the south of the basin forming Akköy lagoon and Tuz promontory (Fig. 1).

Büyük Menderes Delta is dominated by Northerly and North-Northwesterly waves. The most frequently-occurring wave heights are less than 2 meters but waves with a significant wave heights of up to 4 m can occur. In the winter times, the southwesterly waves got dominant with a frequent wave height of 1-2 meters and a maximum height of 4m. The dominant winds acting on the shore of the study area are north-northwesterly winds with a frequently-occurring wind speed ranging from 12.5m/s to 15m/s. Also northerly and north-northeasterly winds can be dominant with speeds more than 15m/s can be seen in winter and spring times. The seasonal variations of the winds and waves acting on the shore of Büyük Menderes Delta can be examined in the rose diagrams in the Fig. 1.

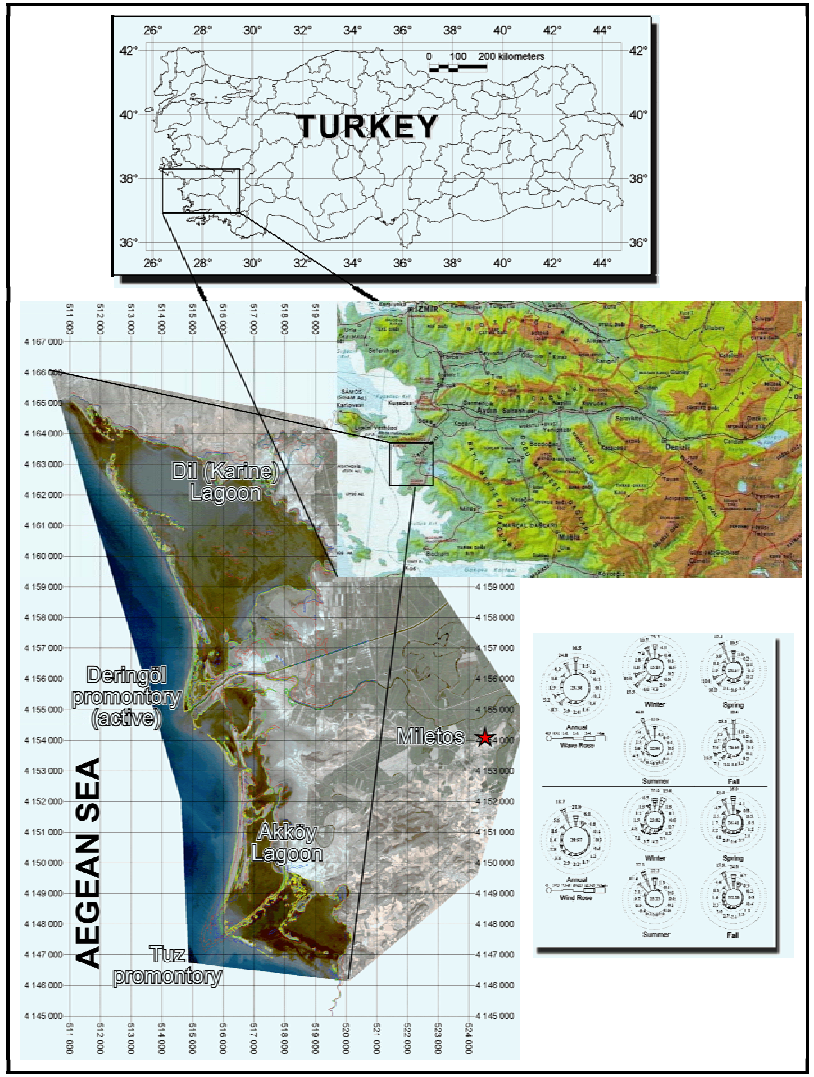


**Fig. 1**: Geographic location of the study area in multi scales and rose diagrams of the annual and seasonal waves and winds acting on the shore (Rose diagrams are taken from Özhan, E. and Abdalla, S., 2002).



## Methods and Data sets used

The data sets used in this study is mainly composed of multitemporal stereoscopic aerial photographs taken for the purpose of topographic surveying and their resultant topographical maps that have been produced by the General Command of Mapping. Three different periods were available. The oldest period is photographs of 1957 and 1964 with topographical base maps of 1:25.000 scale produced at 1964. The preceding set is photographs of 1977 and base maps produced at 1980 and the newest dataset is formed from 1993 photographs and 1996 base maps. In addition to these spatial datasets field observations at the summer of 2004 had been done with the help of GPS. Nearly 100 observation stations were established on the shoreline and detailed coordinates of shoreline is recorded.

The stereoscopic aerial photographs have been interpreted and geomorphological features are mapped. The maps of different periods are scanned then registered to real earth coordinates with national datum information. Following this in all of the periods the position of the shoreline is digitized and then stored. The point information provided by the field observation stations are also used to create a continuous shoreline of 2004. All of the produced shorelines are then overlaid to observe the changes (Fig 3).

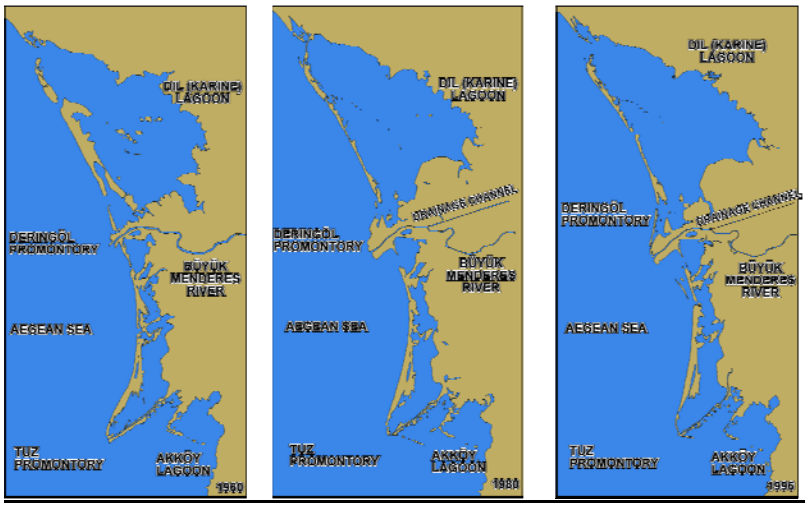


Fig 2. Multitemporal shorelines of 1957 (1960 map date), 1977 (1980 map date) and 1993 (1996 map date).

**Results and Conclusions**

In order to understand the evolution of the Büyük Menderes Delta, the contribution of human presence in the area should have to be well recognized. The activation of water works and irrigation projects for higher agricultural yields had made great effect on the geomorphological features and the shoreline of the delta since early 1970's. As it can be seen in figure 2 a drainage channel is added to Büyük Menderes River which is acting as the major collector, disabled the flow of southern branch which resulted in the degradation of Tuz promontory (Figure 3).

Since 1957 to 2004, it is well seen that the derivation of the water to northern channel had resulted in continuous erosion of the southern promontory in coherence with the field observations from GPS measurements (Fig 4). The degradation of the shoreline also affects the Akköy Lagoon fisheries, as the shoreline looses its barrier task the lagoons are silting up.

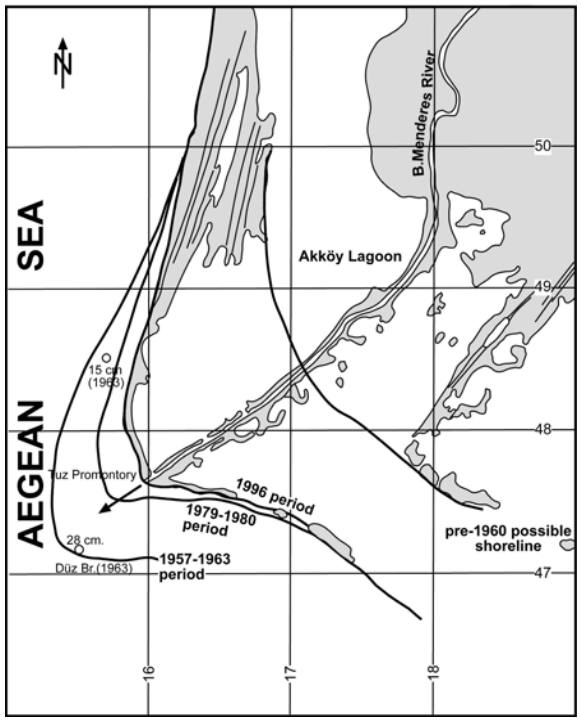


Fig 3. Multitemporal shoreline positions of Tuz promontory.



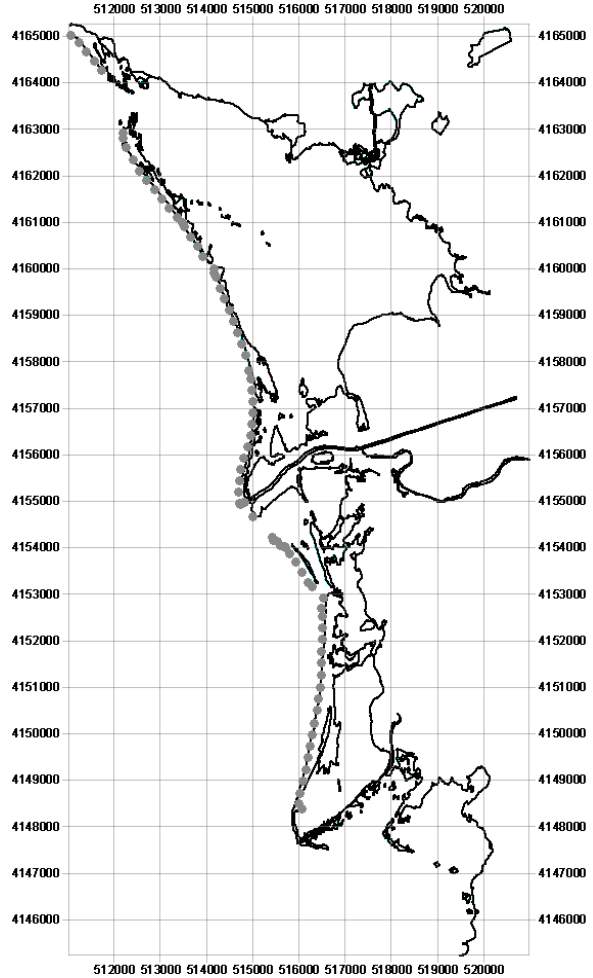


Fig. 4. GPS observation stations in summer 2004

On the other hand in the northern promontory where the water is diverted by channels an aggrading pattern and trend is observed (Fig. 5). However in summer times the channel is blocked by small scale dams (Fig. 6) to store fresh water for irrigation of cotton which completely cuts down the discharge of Büyük Menderes River to Aegean Sea.

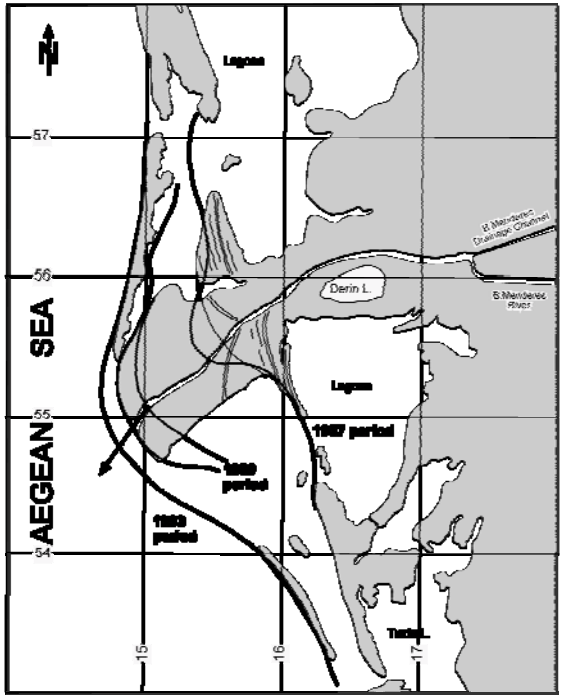


Fig 5. Multitemporal shoreline positions of Deringöl promontory.


Fig 6. a) Small scale freshwater Dam on Büyük Menderes River, b) cotton field irrigation.



Although the irrigation channels do not let Buyuk Menderes River flow to Aegean Sea, field observations show that there is still aggradation in the northern promontory (Fig 5). The rest of the shoreline nearly remains stable but continuously new sand barrier islands are forming on both sides of the northern promontory. Many inlets are temporarily opening but as an overall figure in time the sand barriers are tending to aggrade and form a flatter shoreline.

To conclude Büyük Menderes River has two promontories, the southern one is continuously degrading, and the northern one is aggrading. The main reason for this is claimed to be the construction of drainage channels for irrigation. This net shift in the sediment source is also recorded in other minor features such as the locations of sand barrier islands have been shifted near to Northern promontory and on meandering course of the Büyük Menderes River.

## Acknowledgements

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