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# RESEARCH ARTICLE

# NEOTECTONIC AND MORPHOSEDIMENTARY PROFILE OF ILDIR BAY AND CURRENT SEABED STRUCTURES IN AQUACULTURE AREAS

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## ABSTRACT

This article presents data from high-resolution shallow seismic profiles, side scan sonar, surficial sediment data for the sedimentary history, characterization and process-description of the Çeşme Ildır Bay. First, the effects of tectonism on the Gulf were examined from the literature. Tectonic and geological events occurring over the last 20000 years have been tried to be examined in the sea floor and in the water column. At the same time seagrass, coralligenous, marine habitats and abiotic structures (rock, mud, sand) were investigated. In addition, aquaculture activities are carried out in the region. In this study, the sea floor structure of Ildır Bay, an important aquacultural site around Karaburun Peninsula, was identified and mapped. The results of the neotectonism in the bay and the formations and differences in the seabed structures were analyzed and interpreted as a whole.

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## INTRODUCTION

Western Anatolia neotectonism is represented by tectonic regime (McKenzie, 1972; Şengör, 1979; Şengör, 1980). The regionally tectonic regime in the N-S direction is the result of neotectonism throughout Anatolia. During the West, Anatolian block was pushed on the African plate along the Hellenic arc in the Aegean Sea with a of rotation counterclockwise in Western Anatolia (Dewey and Şengör, 1979; Şengör, 1979; Şengör, 1980; Şengör *et al.,* 1985). Opened tectonic regime in Western Anatolia is the result of rotation in the region (Emre, *et al.,* 2005). Consequently, this rotation is effective on the change of coastal geological structure, water column and seabed structures. The habitat in the region starts to differentiate due to the current tectonic activity (Renema, *et al.,* 2008). Marine habitat distribution along the coastal zone has a great importance for biodiversity. Coastal areas are very complex ecosystems covering many different habitats and productive resources in the world (de Groot, 1987; Costanza and Hannon 1989). Coastal resources are extremely valuable for natural, social, environmental and economic benefits (Berkes, *et al.,* 2003; MA (Millennium Ecosystem Assessment), 2005).

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Over the last decade, numerous works has been carried out on sedimentary coastal wedges in order to portray their pattern and evolution in relation to the last post-glacial sea level rise, and to estimate their future behavior (Foley, *et al.,* 2005; Finlayson and D'Cruz, 2005; Bennett, *et al.,* 2004). The existing literature, due to lack of research on the marine habitat mapping in Turkey's western coast is not sufficient. Such detailed studies have been limited around the Turkish coastal areas of Eastern Mediterranean, especially in the Ildır Bay needs more representative work (Fig 1). The quaternary growth of Gediz delta in Karaburun Peninsula particularly Ildır Bay is described and its relationship to tectonic and sea level change is interpreted (ten Veen, *et al.,* 2009). Ildır Bay is located to the southwest of the Karaburun Peninsula and to the northeast of Cesme. The marine area is approximately 193 $km^2$ and has a coastline of about 68 km long. The purpose of this study is to determine and mapped the seabed features of Ildır Bay by using acoustic technology, underwater photos, geomorphological and sedimentological evaluation.

## MATERIALS AND METHODS

The seismic studies, side scan sonar and underwater photo data that constitute the basis of this work were collected from Research Vessel Dokuz Eylül 3 of the Institute of Marine Sciences and Technology in 2015-2017. Seismic transects were seen in Fig. 2a and aquaculture areas were located at Fig. 2b. Morphosedimentary seabed features were investigated with

sonar and photo validations. Data were recorded and processed using Strata-Box 3510 Dual Frequency Seismic System with Cmax CM2 Side Scan Sonar. Seismic profiles are divided seismic stratigraphic units, using the technique that described in Allen and Posamentier, 1993.Side Scan Sonar (SSS) records, Sub Bottom Profiler (SBP) data were collected to provide full coverage and high resolution benthic habitat maps with high discrimination capacity between different sea-bed features. Data were collected along 180 $km^2$ coastal area for Ildır Bay, up to 65 m water depth. Validation of seabed structures were done by underwater photos of Go-pro Hero 5. According to acoustic data, each anomaly in the sea bed was validated with go-pro and its boundaries were tried to be determined. Those results were used to upgrade traditional mapping methods (e.g. satellite-image and ground-truthing) for developing a new habitat map of study area. During the study, the speed of the research vessel was chosen as 3-3,5 knots. This is because acoustic systems receive data with maximum efficiency at these speeds. The reason for keeping the speed within this range is the acoustic systems used to record data with maximum efficiency at these speeds. However, the recorded data can only be taken under appropriate sea conditions. With the strong wind and the sea wavelength exceeding 1.5 meters, the work was interrupted and the appropriate time was expected.

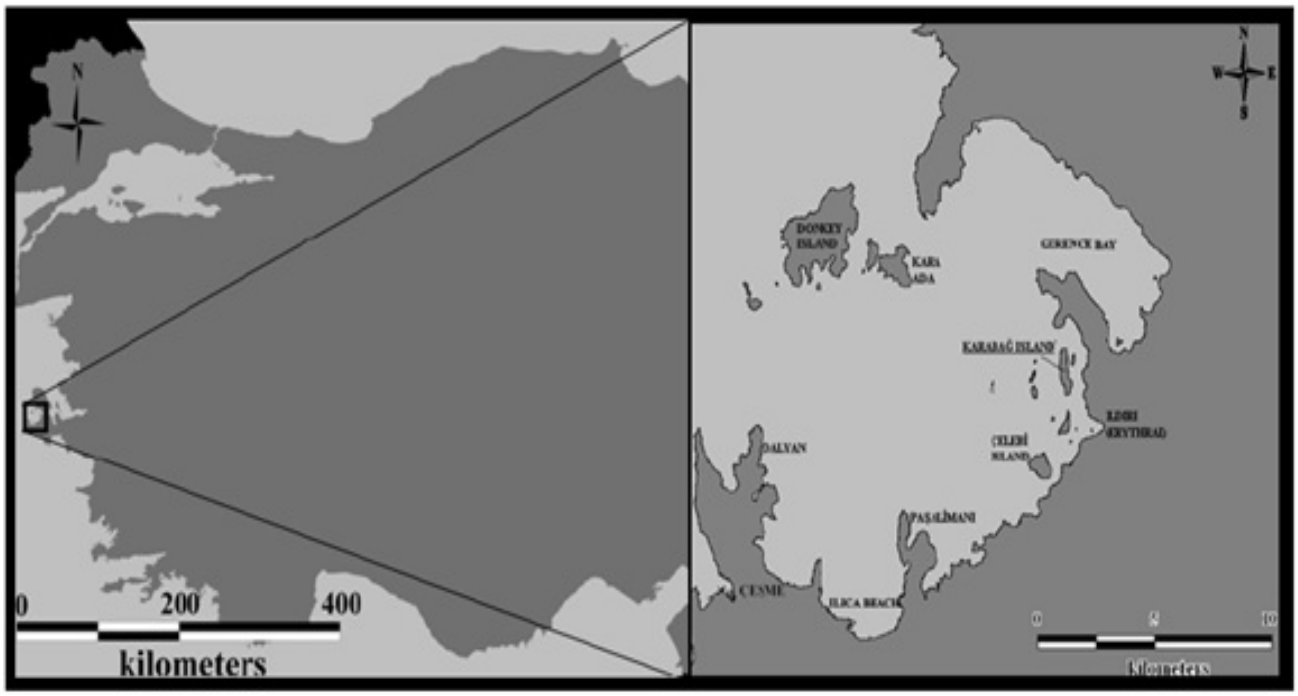



**Figure 1. Location of the study area and locations in the study area**

## RESULTS

Data were collected on 425 km lines for 11 days in the study area. Firstly, the present bathymetry map of the Gulf of Ildır was revealed (Fig.3). According to the depth map, the deepest point of the Gulf is around 65 meters. The depths of fish farms range from 35 to 62 meters. According to ADCP (Acoustic Doppler Current Profiler) data, the flow rates had diminished through the centre of the Gulf. However, a high currents observed at outside of the Gulf. Two seagrasses species were determined in the region: *Posidonia oceanica* (L) Delile and *Cymodocea nodosa* (Ucria) Ascherson. The *C. nodosa* was spread over the coastline from 9 to 10 meters, where *P. oceanica* was generally 30 meters and a maximum of 36 meters (Fig.4). *Caulerpa cylindracea* Sonder in the south of the study area and *Stypopodium schimperi* (Kützing) Verlaque & Boudouresque in the north were observed by alien invasive plants. The distribution of seagrasses in the Gulf of Ildır shaped by the present bathymetric structure. Due to the rapid increase of depths on high slopes, it is seen that the seagrasses have a narrow distribution along the coast. After evaluating the side scan sonar Fig.5a and the shallow seismic data Fig.5b together with (Fig.6) the underwater photographs, detailed results were obtained. The shelf and basin slope area of Ildır Bay is underlain by superimposed deltaic sequences. Following the Holocene post glacial transgression, deltas were re-established deep in ancestral bays and little sedimentation took place on the shelf. The main architecture change occurred at ca. 7000 BP, i.e. when the sea-level rise slowed down comparably. Rate of sea-level rise, sediment supply, basement hypsometry and hydrodynamic regime appear therefore as key-factors controlling the general geometry, preservation and nature of the sedimentary infilling. It appears in particular, that wave and current dominated bodies could be preserved in the infill of micro tidal bay settings characterized by erosional seabed morphology especially in southern part of the bay. Besides seagrasses, coralligenous and maërl habitats were seen in the study area (Fig.7). These habitats are complex bioconstructed structures which are symbolic for Mediterranean Sea. The main species of those habitats are coraline red algae additionally the other invertebrates, bryozoans and sponges (De Jode *et al.,* 2019). These habitats are threatened by anthropogenic activities. The distribution of coralligenous habitat and maërl beds are not well known. There is a lack of knowledge about the cartographical data for them UNEP-MAP-RAC/SPA. 2008).

## DISCUSSION

According to Aksu *et al.,* 1987, the pre-Miocene tectonic framework of the area around Izmir is characterized by north-northeast trending faults. Processed high resolution seismic profiling data show that there is no indication of active faulting

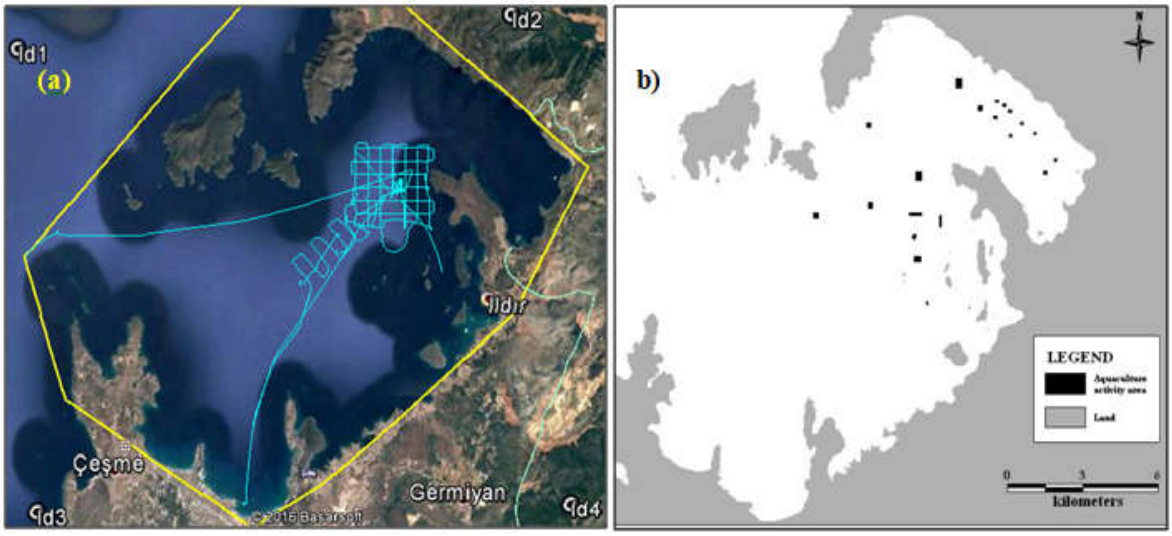



**Figure 2. a) Study area with working lines, b) Aquaculture activity area of Ildır Bay**

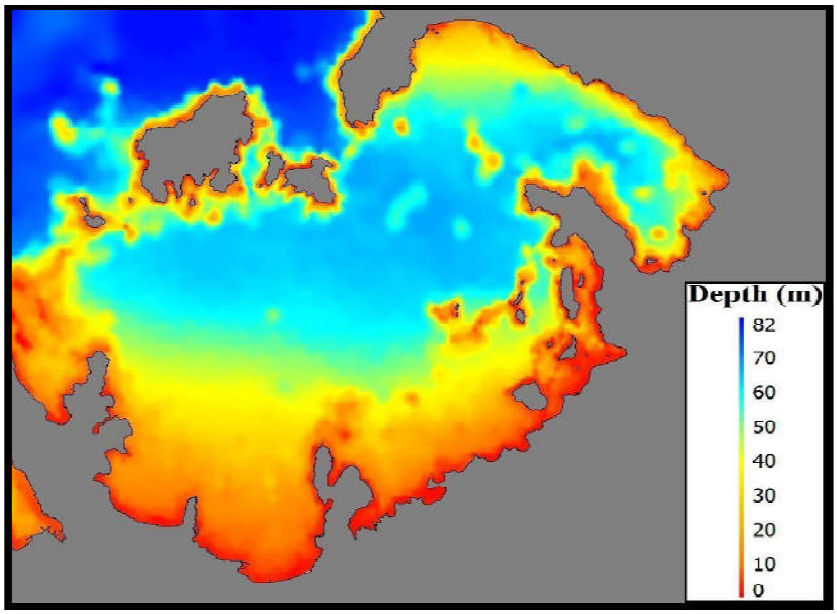



**Figure 3. Bathymetry map of Ildır Bay (It has been drawn from ONHO (Turkish Naval Forces Office of Navigation, Hydrography and Oceanography data until 2011)**

**Figure 4. Spatial distribution of seagrass detected in Ildır Bay (Red line shallow border, green line deep limit)**

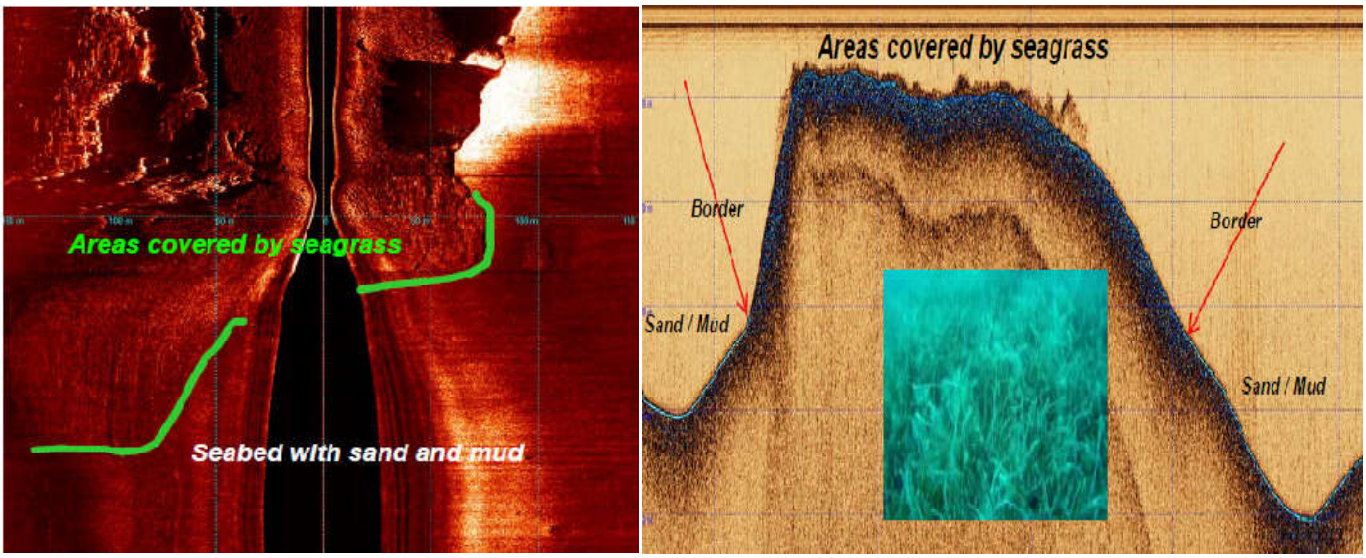



**Figure 5. (a) Side scan sonar image obtained from NE-SW(N:North, S: South, E: East, W:West) direction, (b) Shallow seismic data obtained from N-S direction and the seagrass detected in the area (Duman *et al*, 2019)**

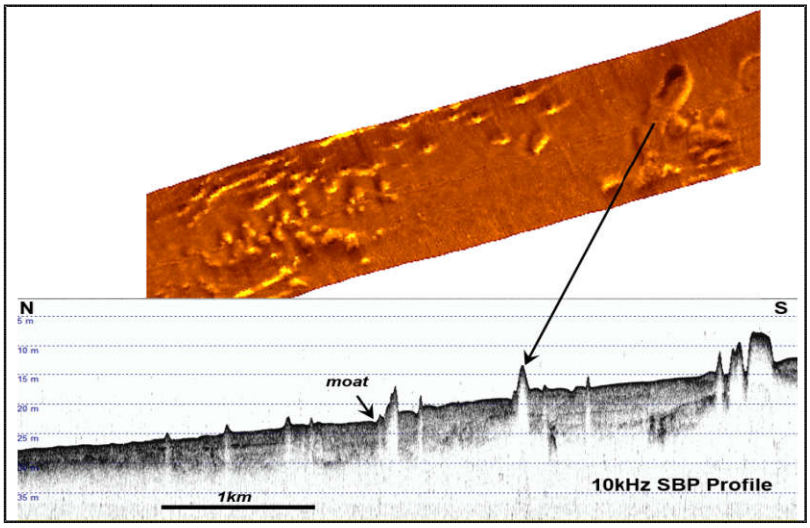
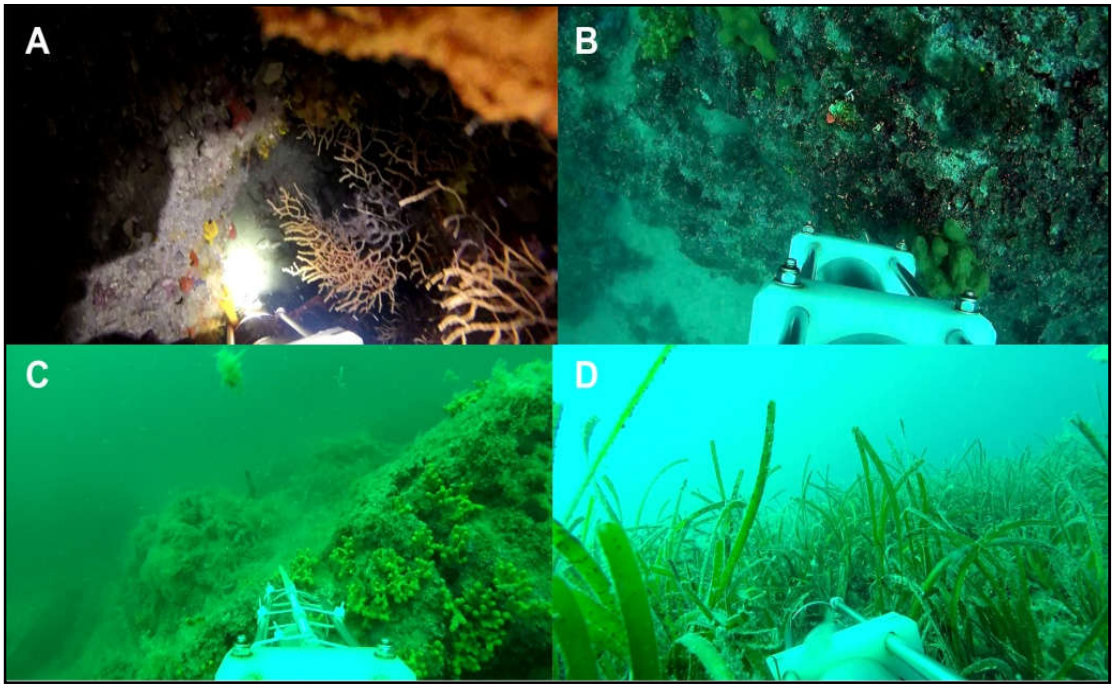



**Figure 6. Shallow Ridge-Reef Image of Side Scan Sonar and Subbottom Profile Images taken from Ildır Bay**



and all fault like structures are related with acoustic basement morphology. This pattern is contrary the proposed tectonic models of recent works for Ildır Bay (Ocakoğlu *et al.,* 2005; Uzel *et al.,* 2013). After analysing the high frequency shallow seismic data taken from the North East (Gerence) of the Ildır Bay, it was seen that the strike-slip faulting of the Urla-Seferihisar Fault Zone towards the north creates current tectonics within the Gulf. Moreover, considering the whole study, it was pointed out that more special and detailed studies should be done about the effects of tectonism on the sea floor structures (for example; the positive and negative effects of hot water outlets in the Gulf on both the abiotic and biological structure on the sea floor).

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