The Leading Role of the Turkish Straits System in Ocean Science and the Environmental Degradation Imposed on Unique Natural-Cultural Heritage by Canal İstanbul

Türk Boğazlar Sistemi'nin Denizbilim'deki Öncü Rolü ve Eşsiz Doğa-Kültür Mirası Karşısında Kanal İstanbul Çevre Katliamı

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Özet: Karadeniz ile Akdeniz arasında su, madde, enerji geçişlerini denetleyen Türk Boğazlar Sistemi (TBS), zıt özellikli iki-tabakalı akım yapısına ve hidrolik kontrol sonucunda oluşan tekil bir "maksimal değişim" rejimine sahiptir. Bu duyarlı sistem İstanbul'un ve bölgenin en değerli doğa hazinesi olarak çağlar boyunca fonksiyonunu sürdürmüşse de, çağımızda artan çevresel tehditlere maruz bırakılmış, adeta sessiz bir ölüme terkedilmiştir. Avrupa'nın halen tek megapolis'i olan İstanbul ve bölgesi, doğa ile barışık yaşama şansını giderek daha fazla yitirmektedir. Bu kapsamda Kanal İstanbul projesi denizlerimiz için en büyük risklerden birini oluşturmaya adaydır.
Anahtar Kelimeler: Boğazlar, değişim akımları, hidrolik kontrol, türbülans, katmanlaşma, deniz ekosistemi.

Abstract: The Turkish Straits System (TSS), which regulates the transports of water, material and energy between the Black Sea and the Mediterranean Sea has a two-layer flow with contrasting properties and a unique 'maximal exchange' regime resulting from hydraulic controls. This sensitive system in the present age has been subjected to increased environmental threats and literally has been abandoned for a silent death. The region centered around İstanbul, the only megapolis of Europe at present, currently are about to lose the chance to live in peace with nature. Within this context, the Canal İstanbul project is a candidate to pose one of the greatest risks for our seas.
Key Words: Straits, exchange flows, hydraulic control, turbulence, stratification, marine ecosystem.

1. INTRODUCTION

The Dardanelles (length 75 km, min. width 1.3 km) and Bosphorus (length 35 km, min. width 0.7 km) Straits and the Marmara Sea (surface area 11,500 m^2) make up the complex system of the Turkish Straits connecting two seas of extreme contrast, the Mediterranean and Black Seas. The region is also encircled with some of the widest continental shelves (max. depth 100m, width ~50 km) with adjacent deep basins (max. depth 1350 m in the Marmara Sea and 2350 m in the Black Sea).

The foundations of modern oceanography have been laid in İstanbul by Marsili [1], based on a series of first-time measurements in the Bosphorus [2-4]. In addition to the density driven currents, a net through-flow of about 350 km^3/yr is maintained through the Bosphorus due to the contrast in net water budget of the adjacent basins. A two-layer exchange results, with the component due for the Mediterranean about twice as large as the current flowing towards the Black Sea [5-12].

The rapid surface currents of the Bosphorus, forming recirculation cells near Beşiktaş north of the Sarayburnu (Byzantion Pt.) headland, trapping fish in the Golden Horn has provided the basis for fishing, a major source of income for the region since ancient times, quoted in *Anaplous Bosporou* by Byzantios, 5th century AD [1, 13-15]. The ancient settlement of Troy, located at the mouth of the Dardanelles is the other example of an ancient city thriving on fishing, trade and living peacefully with nature.

The hydrological regime, circulation, ecosystem and tectonics, all display extremes in the region. The great transformations of the system between fresh water lake and sea basin are well known [16], with projected impacts on human societies [17-19]. Climatic changes with rather short cycles of about 150-300 year periods are recorded in the bottom sediments of the Black Sea [20]. Large-scale climate patterns such as the NAO, NCP and Indian Monsoons have great regional importance [21-22], with impacts on ecosystems [23]. Yet it is not known what kind of risks are posed on the region by the present trend of global warming, combined with extreme weather, floods, earthquakes, especially as İstanbul, already a monster of a city, heads for further expansion, determined to destroy its remaining vital resources.

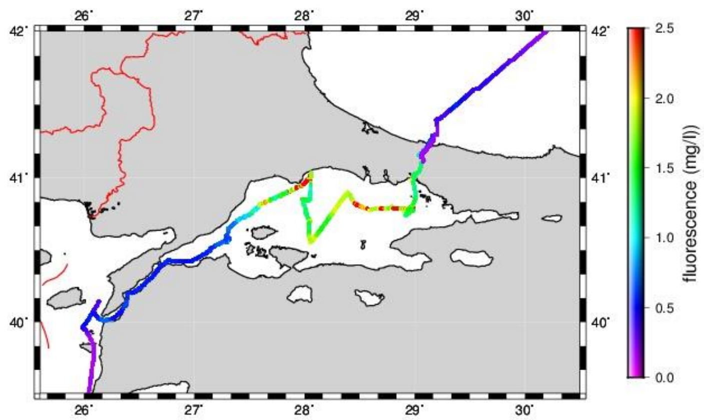

Figure 1. Chlorophyll concentration on the course of R/V BİLİM during April 2008.

Significant changes have occurred in our lifetime in the ecological status of the TSS, and mainly after the 1960's industrialization and population expansion. The eutrophic Marmara Sea waters fed by Black Sea nutrients [24], as well as the efficient jet induced local recycling makes this small basin a region of high productivity often far exceeding the Black Sea (Fig.1), with increasing occurrences of mucus and toxic algae (Fig. 2). The plans for what is often inappropriately called as 'development' pose increasing risks of ecosystem crises and failures in the TSS, with implied effects on adjacent basins, as many signs of deterioration are already easily discernible.

Figure 2. (a) Possible toxic plankton bloom near Tekirdağ; Milliyet, 24 April 2013 (b) from a jet flight over the Marmara Sea on 28 April 2013 (Photo: Dr. Bettina Fach, IMS-METU), (c) MODIS ocean colour image on 25 April 2013, showing the Bosphorus jet (black) surrounded by coccolith (green) and possible toxic plankton (orange) blooms.

2. MATERIAL AND METHODS

This review is based on about 30 years of experience on oceanographic field experiments, as well as the last 10 years of modeling development to understand and predict the complex physical behavior of the TSS. Modeling the exchange flows in the TSS has been a grand challenge because of the need for fine resolution and the ability to represent complex processes of stratified, turbulent, nonlinear flows through the complex geometry of the region. The challenge has been taken by a number of steps, using models of increasing complexity. A detailed study of the Bosphorus Strait [25] based on ROMS have revealed its basic hydrodynamics using both a hypothetical model domain of idealized geometry and a realistic one with the high-resolution representation of the strait geometry. A model based on MITgcm with identical geometry [26] has been shown to produce almost identical results, in harmony with measurements. A curvilinear grid MITgcm with extended features covering the entire TSS and fully resolving the narrow Bosphorus [27-28] further verified the results. A FEOM unstructured grid model of the entire TSS is under development, as well as an isopycnal coordinates model used for climatological predictions [29]. The detailed description of all the model development is beyond the presnt scope and will be presented in forthcoming papers. However a particular application to expose the simplest coupled behavior of Canal İstanbul [25] is in order here. This case was constructed with a simple straight canal of 25 m depth and 150 m width, aligned parallel to the Bosphorus and subjected to the same boundary and initial conditions.

3. RESULTS

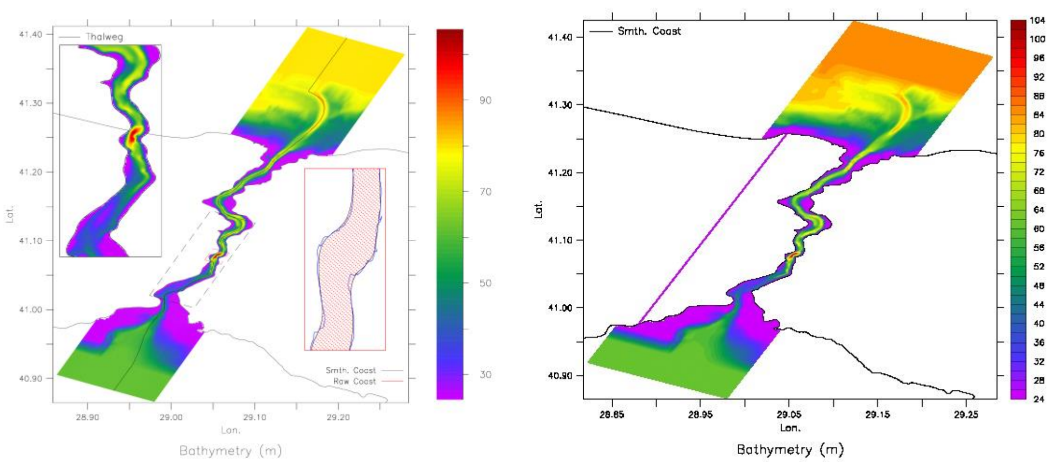

Figure 3. Model configurations and bathymetry for (a) Bosphorus Strait,
(b) Bosphorus + Canal İstanbul (Sözer 2013).

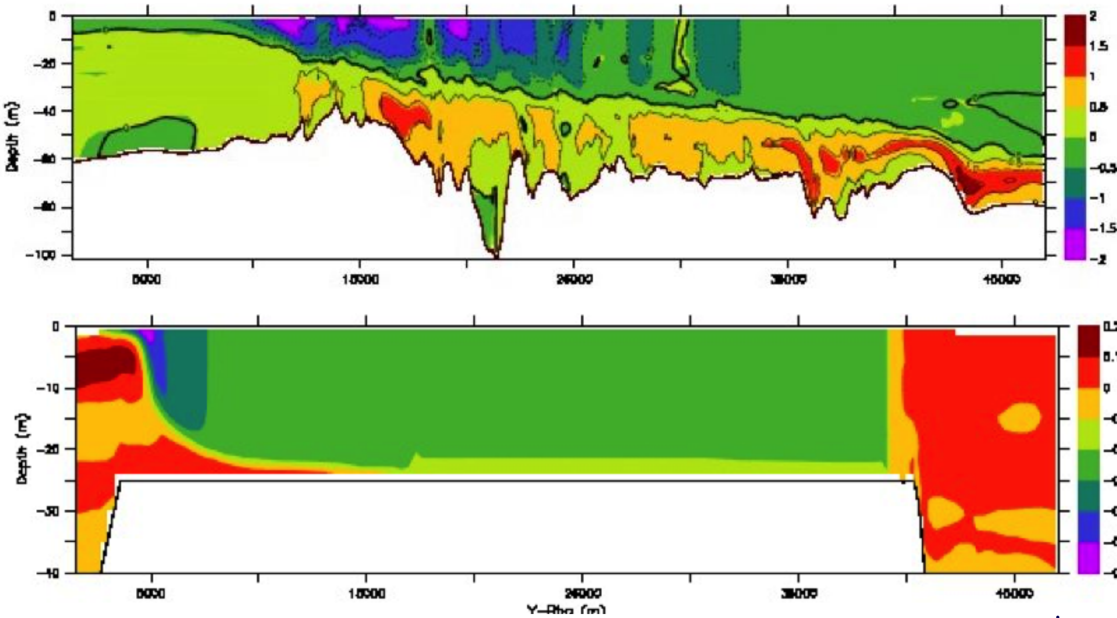

Figure 4. Model predicted currents in (a) the Bosphorus Strait, (b) the simple Canal İstanbul.

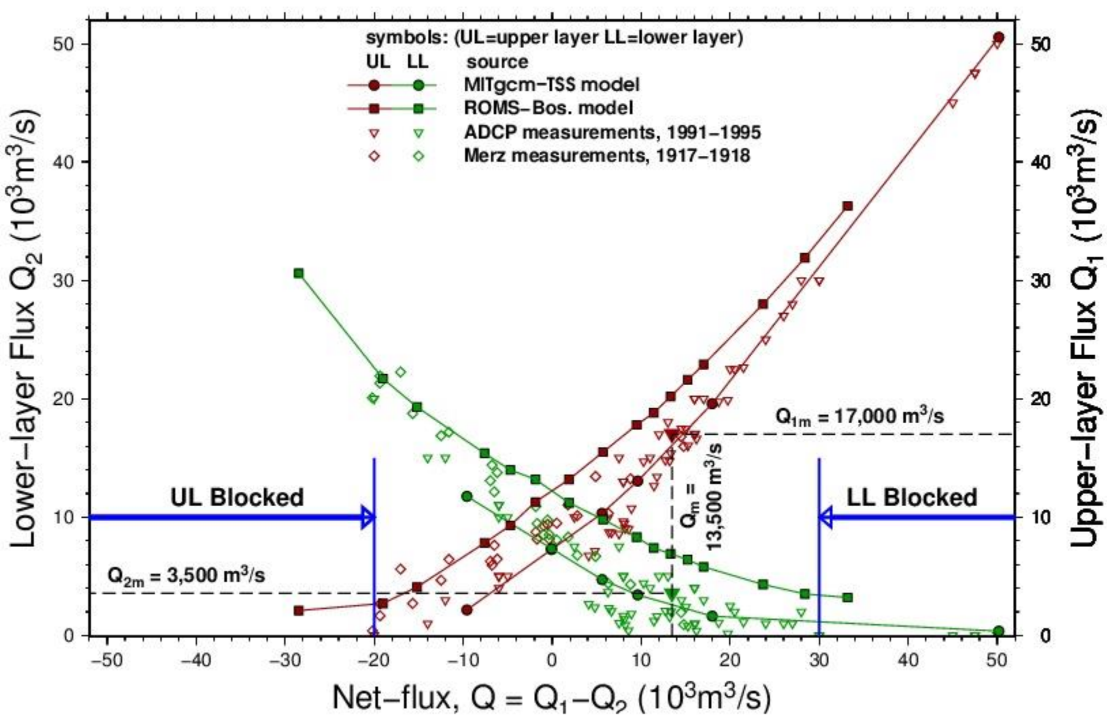

Figure 5. Upper-layer (Q_1) and lower-layer (Q_2) volume fluxes through the Boshorus as a function of the net flux ($Q=Q_1-Q_2$), based on observational data and compared with the results from the Bosphorus model (ROMS) of Sözer (2013) and the TSS (MITgcm) models.

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