

Coastal changes at the Sulina mouth of the Danube River as a result of human activities

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Abstract

Sulina, the middle distributary of the Danube Delta, has been significantly changed by human activities over the past 150 yr. These include engineering works in the second half of the 19th century, when the channel was transformed for navigation and the construction of jetties which nowadays extend 8 km seawards.

These interventions have strongly affected the natural processes of the Black Sea coast near the Sulina mouth. To the south of the Sulina mouth, the natural mild erosion has been reversed in the area close to the jetties where accretion is occurring, while southwards the greatest erosion rate along the entire Romanian coast, of more than 20 m/yr, has been recorded.

Sediment accumulation in the northern part of the mouth is also huge and has brought to the creation and swift elongation of a sediment spit in several decades. Thus, the bay located here suffers from a rapid transformation into a lagoon.

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1. Introduction

During recent years, many researchers have attempted to assess the impact of human development on coastal areas worldwide demonstrating the often harmful and irreversible changes that have occurred. Delta beaches have been considered to be amongst the frailest coastal systems worldwide. In the Mediterranean, such studies have been undertaken on the Rhone (Bird, 1988), Ebro (Jimenez et al., 1997), Nile (Fanos, 1995), and Po (Simeoni and Bondesan, 1997) deltaic coasts. Results of these studies indicate the important role of river damming in changing the coastal sedimentary budget (Poulos and Collins, 2002). However human activity has influenced coastal processes in other ways. Harbor protection jetties and coastal engineering works have caused extended

shoreline displacements by altering nearshore sediment transport and/or by modifying littoral sediment budget (e.g. Komar, 1998; Finkl, 1994; Anfuso and Martinez del Pozo, 2005).

The Danube Delta is no exception from this rule. Here, the first significant human interventions were completed about 150 yr ago. Jetties were extended almost continuously for almost a 100 yr. Furthermore, the damming of the Danube River for hydroelectric purposes has drastically reduced sediment discharge to the coast.

The main purpose of this paper is to describe morphological changes in the coastal area of the Sulina mouth of the Danube River. Recent decades have witnessed an abrupt change in the pattern of evolution of this area. Thus, a range of coastal processes are encountered here, ranging from swift coastline accumulation and silting up to erosion. The paper also considers resulting changes in sediment transport capacity of longshore currents using numerical modeling.

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2. Study area

2.1. Geographical setting

The study area represents the terminal component of the Danube River's course of about 2857 km, which extends from the Schwarzwald Mountains in Germany before discharging into the Black Sea.

The Danube Delta, is the final major section of the Danube River, and has three main depositional units. These units are: the delta plain (total area of about 5800 km², the marine delta plain having a width of 1800 km²), the delta front (total area of ~1300 km²) and the prodelta, with an area of more than 6000 km² (Panin, 1998).

Currently, the Danube discharges into the Black Sea through three main distributaries. The northern distributary is Chilia, which, near the coast, is further divided into a series of smaller branches forming the Chilia Secondary Delta, which is located mainly in the Ukraine. The Chilia Distributary also represents the border between Ukraine and Romania. The middle branch is the Sulina Distributary, while the southern one is Sfantu Gheorghe (Fig. 1).

The study area is the Sulina mouth, which can be divided into two sections:

- (a) The northern section (Musura Bay) is situated between Sulina and the southernmost arm of the Chilia Distributary, Stary Stambul. It has a length

of about 12 km and is crossed by the border between Romania and Ukraine.

- (b) The southern section is to the south of the Sulina mouth. It consists of a sandy beach with a total length of about 12 km, with a southern limit located in the Canalul cu Sonda area (a former secondary distributary of the Danube Delta which was closed in 1995). This section is divided into three smaller subsections, according to coastline dynamics: (i) Sulina – which is accumulating sediment – with a length of about 5 km, (ii) South Sulina – stable – with a length of about 2 km and (iii) Canalul cu Sonda, which is eroding, with a length of about 5 km.

2.2. Genesis and natural evolution of the Danube Delta

The Holocene genesis and evolution of the Danube Delta includes the following main phases (Panin, 1976, 1999): (A) the formation of the Jibrieni – Letea – Caraorman initial spit, consisting of sands transported by the southwards longshore current from the present-day Ukrainian rivers – 11,700–7500 yr BP. (B) the Sf. Gheorghe I Delta (9000–7200 yr BP) – representing the first deltaic pulse on the southernmost arm of the Danube. (C) The Sulina Delta developed between 7200–2000 yr BP. (D) the Cosna – Sinoie Delta (3500–1500 yr BP). (E) The Sf. Gheorghe II and Chilia deltas (2000 yr BP – present) (Fig. 2).



Fig. 1. The Danube Delta and beach sectors in the Sulina mouth area.

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