

CENTENNIAL EVOLUTION OF A RECURVED SPIT : A CASE STUDY FROM THE SPIT OF THE GORO LAGOON, PO DELTA (ITALY)

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Abstract

The evolution of the Scanno di Goro, a spit delimiting the Goro Lagoon in the southern Po Delta, during the last 100 years is described. The main evolutionary phases and mechanisms were identified by comparing historical maps, aerial photography and field mapping. The study found out that in the last 50 years the spit grew in length despite the sedimentary deficit that affected the nearby Po di Goro. It is forecasted that this process will continue in the future.

Key-words : Shoreline evolution, geomorphology, coastal processes, Po Delta

Introduction

The Goro Lagoon is part of the Po Delta and its historical evolution is strictly connected with the development of the main delta complex. The Po River has an average yearly water discharge of 1441 m³/sec (calculated over the period 1980-1992) and in its delta areas is branched into five main channels (Fig. 1): Po di Maistra, Po di Pila, Po di Tolle, Po di Gnocca and Po di Goro. The Goro Lagoon is found southwards of this last river branch.

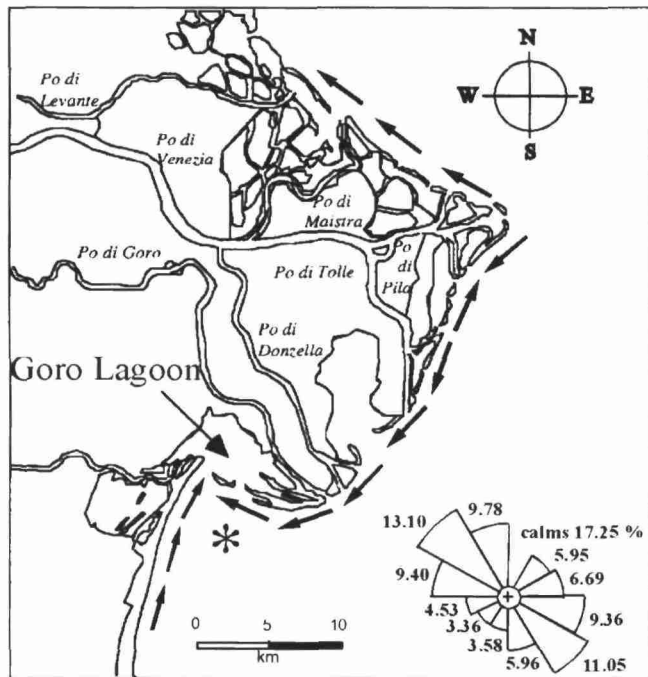


Fig. 1. Index map of the Po Delta, directional distributions of waves (referred to the point marked by the asterisk) and patterns of longshore drift.

Studies on the development of the delta found that historical reconstructions are difficult because of the variable quality of data and due to the dynamic environment together with man-made effects. Cartographic sources and previous studies indicate a continuous growth of the delta plain until the 1940s that was followed by an erosive trend [1, 2] triggered by a reduction in the sediment load of the Po River, caused by man activities such as engineering works and quarrying of river beds [3, 4]. The consequence of these events is that the delta is now controlled by wave action [5] and not by river discharge as indicated previously [6, 7].

Evolution of the Goro Lagoon

The lagoon covers a surface of 2000 hectares, it has an average depth of about one metre and a maximum tidal range of 120 cm is observed during the largest spring tides. Its geomorphology is complex, since the present landscape results from the overlapping between morphologies of medieval age and more recent ones, particularly the man-made interventions of the last fifty years. The area is affected by natural subsidence, exacerbated by anthropogenic activities. The rate of downward ground movement is considerable: recent studies [8] calculated a rate of 1.63-3.61 cm/year for the period 1984-1993.

Due to the sheltering effect of the delta itself (Fig. 1), the coastline is exposed to waves coming from a direction between 60°N and 120°N (75% of occurrences) with small heights (68% of occurrences have a height smaller than 0.5 m). Longshore drift is mainly controlled by the predominance of waves with a direction between E and SE.

Sedimentary inputs are provided mainly by the load of the Po di Goro and to a smaller extent by the other river branches southward of the Po di Pila. The lagoon has acted as a natural sediment sink throughout the present century, even in the period of sedimentary crisis of the Po (1960s-1980s), presenting a net positive sediment budget. Between 1984 and 1993 about 8 x 10⁶ m³ of sediment have been deposited on the sea bed in front of the Goro Spit (area marked by the asterisk in fig. 1). Estimates of net longshore drift along the spit [8] indicate a progressive decrease from the mouth of the Po di Goro towards the lagoon's inlet: transport varies from 120 x 10³ m³/year at the river mouth to 46 x 10³ m³/year at the spit's end. Estimates of northward drift along the coast at the southern boarder of the Sacca are between 27 and 30 x 10³ m³/year.

Evolution of the Goro spit

The spit has always been an element of control on the physical, biological and sedimentary environments of the lagoon. Cartographic sources prove that the spit formed between the end of the 19th century and the beginning of the present one (Fig. 2). Until the 1930s a group of spits and linear islands was stretching from the Po di Goro towards the NW for about 3.5 km, at a position further inland than the present one. A series of small islands was present at the spit's end (Fig. 3), producing a system with a total length of about 6 km. On the inner side of the system a large sandy island, 2.5 km in length and 200 m wide, was present. Part of this system is still visible at the present time in the eastern part of the lagoon, despite having been reduced in extension because submerged due to the subsidence and/or eroded.

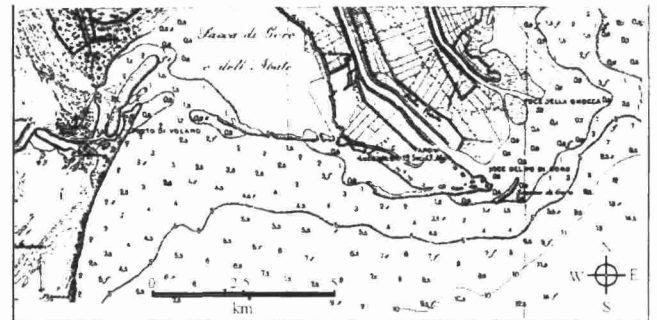


Fig. 2. Hydrographic chart of 1905.

The spit in its present configuration starts to take shape in the 1940s, whilst the old one was eroded and submerged, developing in a W-NW direction and rotating anticlockwise with reference to the previous one. In 1950 the spit was already 5 km long, growing other 1.7 km in the following 14 years, but between 1964 and 1971 its growth stopped and it became 500 m shorter (Fig. 3). In the 1970s there is a new phase of accretion and by 1977 the peninsula is already 7.8 km long.

It is interesting to notice that in the period 1954-1977 the mouth of the Po di Goro started to be eroded, due to a decrease in river sand input, despite the fact that the spit grows for 3 km, hinting that for many years the main input for the spit's sediment budget came from