# THE PO RIVER DELTA (ITALY) AND THE YELLOW RIVER DELTA (CHINA): THE STUDY AREA OF THE PROJECT

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The deltaic coastal zone is clearly of major ecologic, economic, and social importance, and characterized by its sensitive, fragile, and unique natural resources and habitats (IPCC, 2001).

Coastal geomorphologic systems, ad hoc large scale, used to be attributed to natural processes. In essence, however some large-scale coastal geomorphologic systems are human-induced. A delta can be defined as a coastal sedimentary deposit with both sub-aerial and sub-aqueous expression. During the last few decades, due to the impact of human activities and natural factors, most deltas in the world have been experiencing shoreline retreat and land loss. For instance, the wetlands and salt marshes in the Mississippi delta lost at a rate of 100 $km^2$ $yr^{-1}$ (GAGLIANO *et al.*, 1981), and shoreline erosion in the north-eastern Nile delta was 0.044 km $yr^{-1}$(FRIHY *et al.*, 1998), caused by damming, channelization, water and soil conservation in the upper and middle reaches of the rivers, and sea-level rise, land subsidence. The Huanghe (Yellow) River delta is one of the most typical examples whose area is losing severely in the development processing of the delta during the last century (WANG *et al.*, 2003).

The Huanghe (Yellow) River is the second longest river in China and the vital water source for north and northwest of China. Originating from the northern foot of the Bayankela Mountain in Qinghai Province, China, it runs through nine provinces and autonomous regions and flows into the Bohai Sea in Shandong Province. It is 5,464 km long with a basin area of 752,000 $km^2$ (YRCC, 2003). The annual mean runoff volume at the Lijin Hydraulic Station is about 36.6 billion $m^3$ during the period of 1950-1995 (LI *et al.*, 2002).

The present Huanghe (Yellow) River delta is located north Shandong

Peninsula, on the northern east coast of China (Figure 1). It was formed by sediment siltation since an avulsion initially occurred at Tongwaxiang (Henan province, China), and later the lower Huanghe (Yellow) River migrated from the south to the Daqing River course, where it emptied into the Bohai Sea in 1855. With its apex near Ninghai (118°24 E, 37°36 N), it covered an area of 5,212 km$^2$ in 1984 (SPSTC, 1991) and expanded to 5,800 km$^2$ by 1994 (YANG *et* al., 1999), ranging from Taoer River estuary in the north to Zimaigou River estuary in the south. Thanks to its huge sediment discharge, the Huanghe (Yellow) River is world famous for its avulsions and instability. On average, the main channel has shifted once in every 10 years (PANG and SI, 1979).

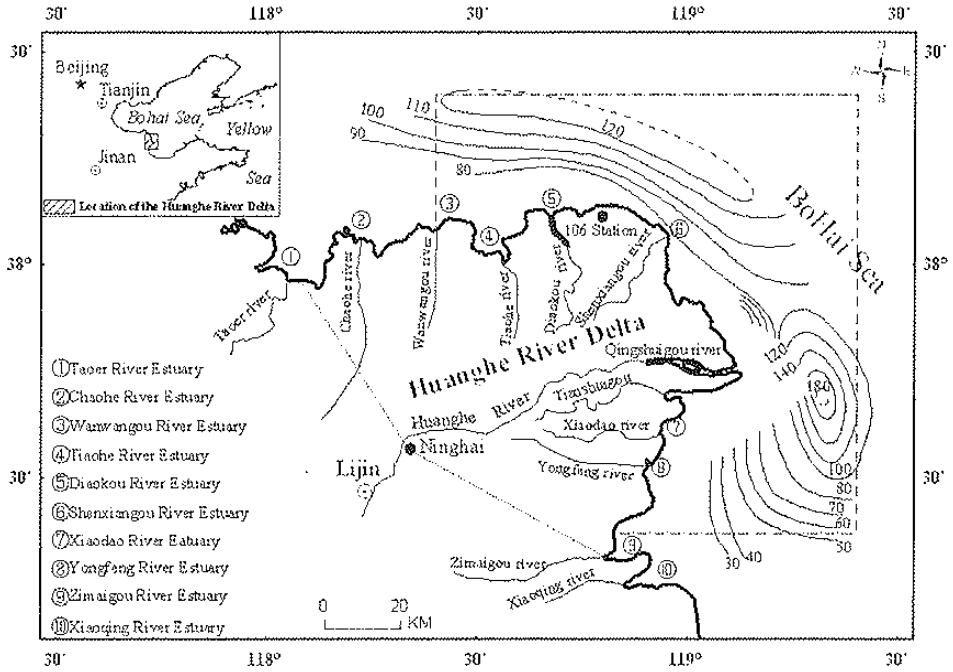


**Fig. 1**. Location of study area and maximum tide-current amplitude (cm/s) off the modern Yellow River Delta in August,1985

Prior to the 1950s, channel migration in the lower Huanghe (Yellow) River was triggered by overflow and levee breaches. Since 1950, the shift of the channel has been partly controlled by human intervention and so far, the river course was artificially shifted three times. In May 1976, the river shifted to Qingshuigou River and the major part of the channel has been stable until now.

## GEOLOGIC SETTING

The modern Huanghe (Yellow) River delta is located on the Mesozoic and Cenozoic tectonic shrinking zone (REN, 1990) and is characterized by Holocene marine sediments deposited during the postglacial transgression. Owing to the special climate conditions, geography, tectonic setting in the river mouth area and the hydrodynamic factors within its catchments basin, the Huanghe (Yellow) River delta is high-constructive fan-like delta, which can be divided into delta plain, delta front and pro-delta. Eight delta lobes have been constructed in the modern Huanghe (Yellow) River delta since 1855, as a consequence of frequent shifting of the distributary channels (XUE, 1994).

## NEARSHORE DYNAMIC CONDITIONS

The coastal zone off the Huanghe (Yellow) River mouth is microtidal (tidal range <1 m) or low mesotidal (tidal range 1-2 m), and is influenced by the amphidromic point (region) of $M_2$ tide offshore and south of the abandoned Shenxiangou River course. There is a diurnal tide zone with tidal range 0.22-1.0 m on average between Shenxiangou River estuary and Wuhaozhuang. The south and north of this area are subject to irregular semi-diurnal tide, ranging 1.0-1.78 m and 1.84-2.88 m, respectively. The tidal current field offshore the Huanghe (Yellow) River delta is complex (Figure 1), with two high current velocity fields. One located in the amphidromic point (region) of $_{M2}$ tide, and the other off the Huanghe (Yellow) River mouth (SPSTC, 1991). With the river mouth protruding, tidal current on the delta frontal slope has been strengthened and its maximum velocity increased from 1.87m/s in 1984 to 2.2 m/s in 1990 (ZENG *et al.*, 1997). The tide current ellipticity is less than 0.1 and the principal axis is parabathic (SPSTC, 1991). The residual current is mainly driven by wind, and its velocity is 10-25 cm/s. The surface residual current is subject to the monsoon and generally moves southward in winter and northward in summer. The wave direction rests mostly with the prevailing wind, i.e., southward in winter and northward in

summer; the wave height is generally below 0.8m under normal weather conditions (SPSTC, 1991; CHEN, 2001).

The Huanghe (Yellow) River is well-known worldwide for not only its high sediment concentration (PANG and SI, 1979; REN and SHI, 1986), frequent floods and shifts in course, but also its showcase of human impacts on rivers. The present Huanghe (Yellow) River delta has been developed over the past 149 years as a consequence of siltation and avulsions of its channel, flooding, and sedimentation since 1855. In the last few decades, the dramatic decrease of water and sediment discharge in the downstream of the Huanghe (Yellow) River and the increases in human activities have resulted in significant changes in the delta (REN, 1989a; Mc LAUGHLIN, 2001; EO-NASA, 2000). The focus of this project is on land erosion/deposition processes, deltaic ground subsidence, salt water intrusion, etc., in order to better understand the evolution of the modern Huanghe (Yellow) River delta by integrating river discharge data, field survey, satellite remote sensing, and bathymetric charts.

The Po River, delta which developed out of the Adriatic Sea, is surrounded by the Venice lagoon in the North and the sandy littoral of the Romagna (Ravenna) with the Po plain on the back, at the South up to the promontory of Gabicce, where the Apennines mountains meet the Adriatic Sea (fig. 2).

The Po River delta covers a surface of 73.000 hectares of which 60.000 are reclaimed land and the remainder are brackish lagoons, with dams or open foreshores and emerging sandy banks. In ancient times, the uncontrolled river system, subject to periodical ruinous floods, caused serious problems to the first man settlements on the Po plain. Periodical breaches, caused by floods during periods of bad weather, modified the hydrology and morphology of the Po plain and the configuration of the Po delta.

The dynamic advancement of the Po River delta is quite simple. The sediments carried by, the river to the sea are discharged at the river mouths, where they are reworked by wave action to form sand bars both at the front and at the sides of the mouths. If the supply of sediment is great and constant the bars tend to grow and emerge, they are fixed by marsh vegetation and join the mainland. Therefore we obtain an area of lagoons and small pockets of water behind the

delta system. Such a process can be cyclical.

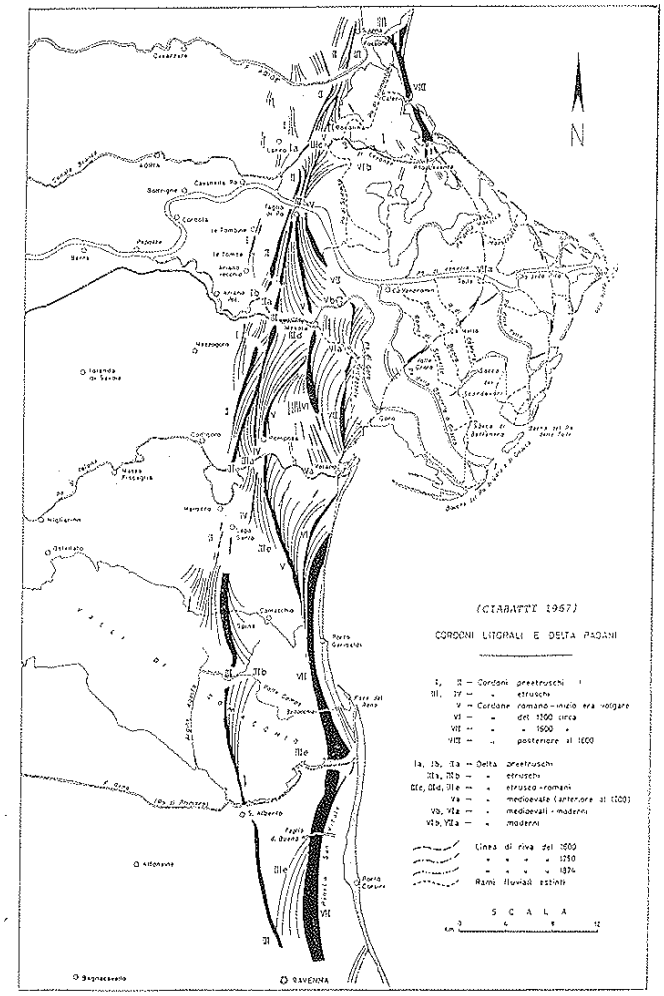


**Fig. 2** – The Po river delta evolution (Ciabatti, 1967).

If we consider the evolutional trend of the Po river delta, in the Adriatic Sea, from 1600 up to the present time we note that the coastline is continuously growing seaward, mainly in the past times.

We have a lower rate of growth in the earliest years of the 20$^{th}$ Century. This low increase is continuous as it is testified by the 1953 survey. Then we have in the 1964 survey an inversion in the trend. This means that the coastline moved back toward the land in the external area of the delta.

If we examine the evolution of the river before 1600 A.D., we note, from historical sources, some natural and artificial events changing, the hydrography of the Po River and its delta in the coastal zone.