



**D 4.2: Assessment of hazards and threats on the coastal zone, arising either from Global Change or from regional variability due to either natural or anthropogenic forcing.**

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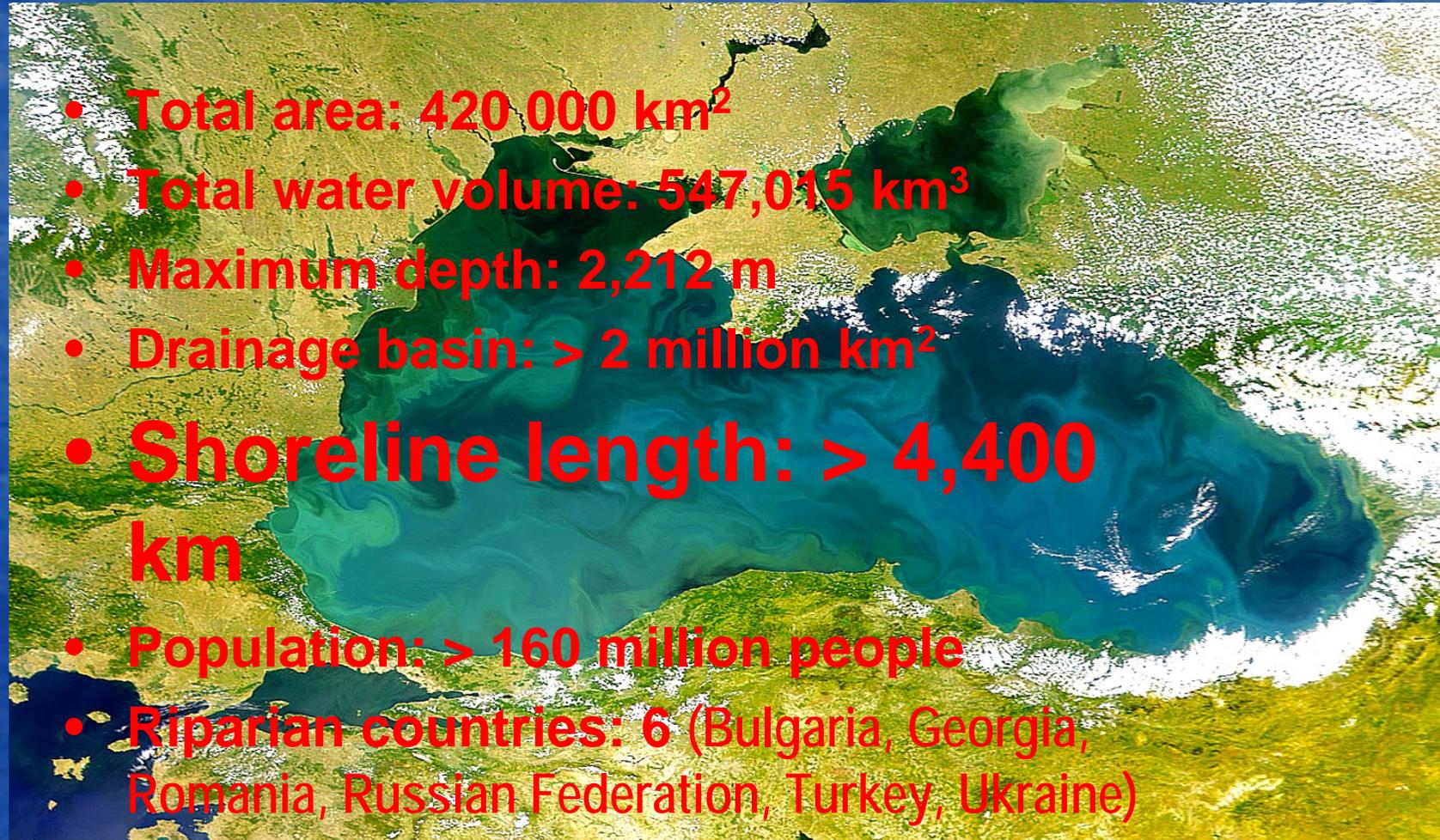
# The Mediterranean

- Total area: 2,5 million km<sup>2</sup>
- Total water volume: 4,249,020 km<sup>3</sup>
- Maximum depth: 5 150 m
- Shoreline length: ~ 50 000 km
- Population: > 460 million inhabitants
- Bordering Countries: 22
  - Europe: Spain, France, Monaco, Italy, Malta, Slovenia, Croatia, Bosnia and Hertzegovina, Serbia and Montenegro, Albania, Greece, Turkey, Cyprus.
  - Asia: Turkey, Syria, Lebanon, Israel.
  - Africa: Egypt, Lybia, Tunisia, Algeria, Morocco.





# The Black Sea





# Mediterranean Sea

**Natural causes of long term coastal erosion  
(Ozhan, 2001) :**

- **Sea level rise**
- **Coastal subsidence due to tectonic events**
- **Climatic changes**
- **Sediment sinks (presence of offshore canyons, movement to great depths at steep slopes, wind transport of sand to inland areas)**
- **Changing of river courses and mouths in deltas**





# Mediterranean Sea

- Anthropogenic causes of long term coastal erosion (Ozhan, 2001):
- Decreasing sediment supply by rivers to the coastal physiographic unit (cutting of the sediment transport by damming the rivers, sand and gravel mining along the river beds, decreasing the sediment transport efficiency by lowering water discharges due to increased fresh water use or due to river works such as bank and bed erosion control)
- Decreasing the volume of sand in the physiographic unit (sand mining from the beach and dunes, offshore sand mining)
- Alteration of the usual pattern of coastal currents and the associated sediment transport along and across the shoreline, due to man-made coastal structures and urban development too close to the shoreline
- Anthropogenic changes made to river courses and mouths in deltas
- Maintenance dredging of approach channels and estuarine inlets;
- Land subsidence due to anthropogenic effects





# Black Sea

Natural factors

and

Global changes

- Geomorphology and bathymetry of coastal zone;
- Geology, litology of coasts, grain size of beach material;
- Meteorological regime;
- Wave energy regime;
- Sediment supply, sedimentary littoral budget;
- Water and sediment littoral circulation;
- Subsidence or/and neotectonic regime etc.
- **Modification of energetic level of the coastal sea;**
- **Modifications of hydrologic regime (river water and sediment supplies);**
- **General sea level rise.**

Anthropogenic factors

- Anthropogenic changes of large rivers hydrology: damming – decreasing of sediment supply, regularisation of floods, channalisation, over-use of river water for irrigation etc;
- Men-made littoral structures: breakwaters, seawalls, bulkheads, revetments, groins, jetties etc.;
- Removal of material from beaches, uncontrolled dredging of river mouth bars and too close to the beaches etc.





## Shoreline syntethic classification

- **Low, accumulative coasts, mostly related to the main rivers mouth zones:**
- **Erosive coasts with low standing plateaux and plains, with active cliffs and sometimes narrow beaches in front of the cliffs:**
- **Mountainous coasts, with cliffs, marine terraces, land-slides, sometimes with small sandy and/or gravely beaches**





# The Danube Delta section or Northern Zone of Romanian Coastal Zone

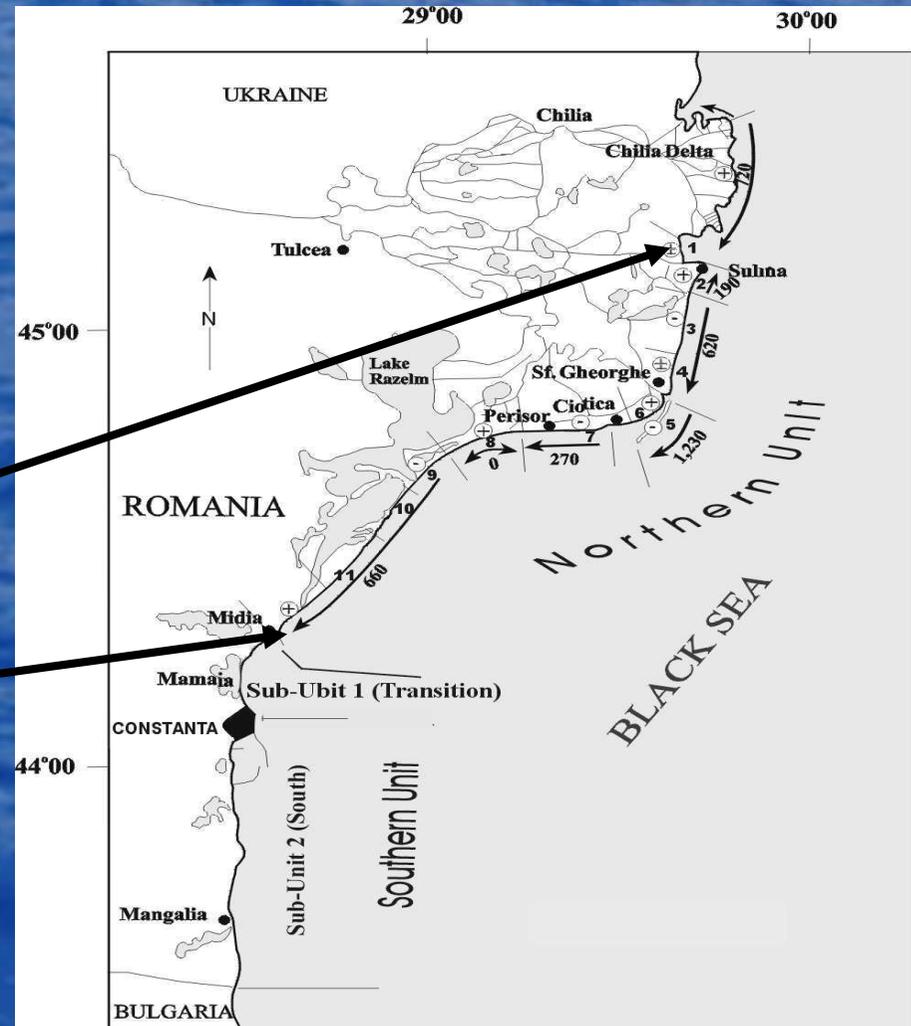
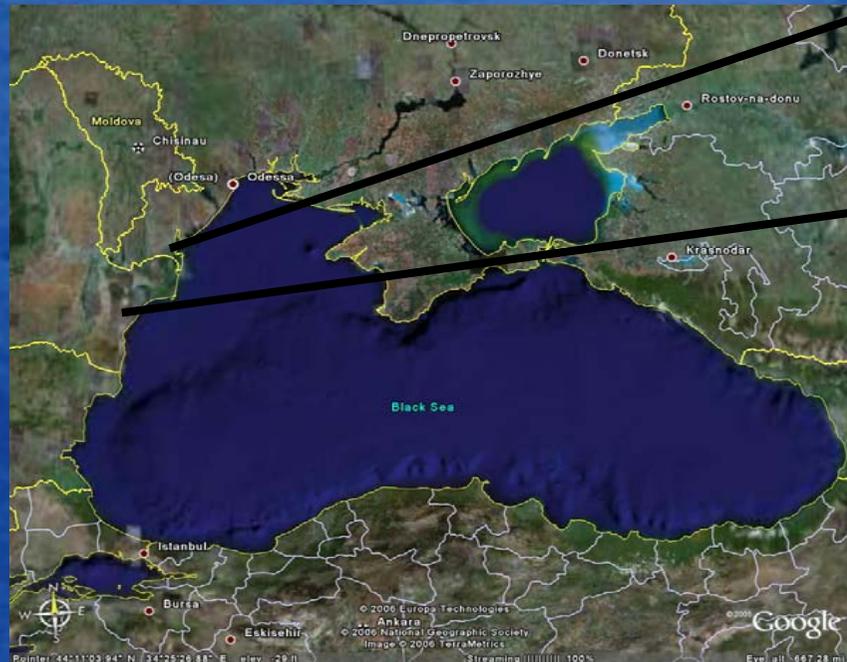
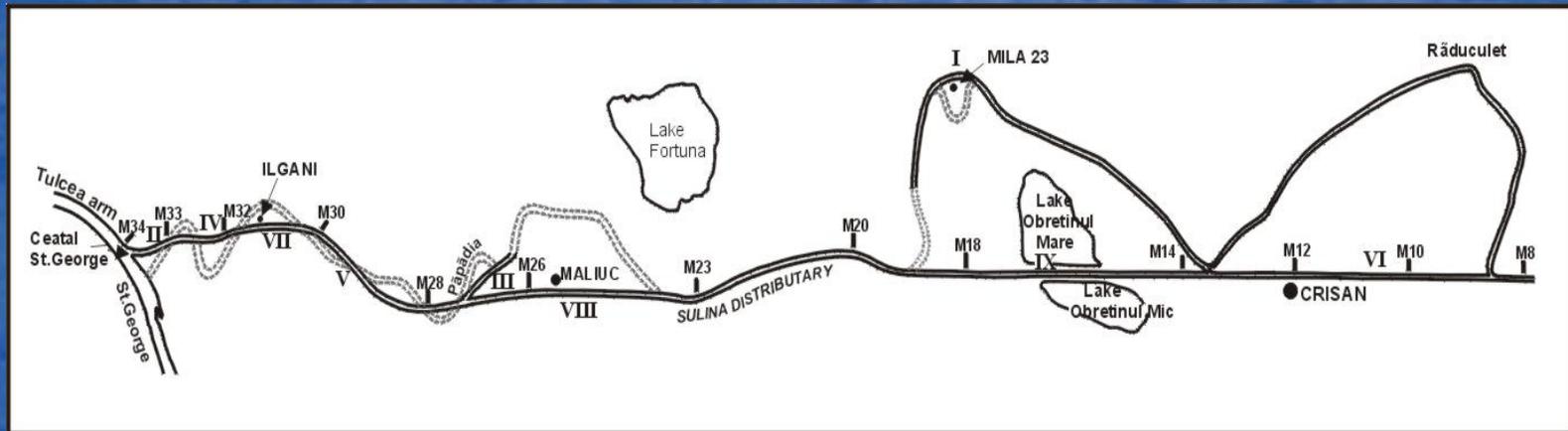


Fig. - Romanian Black Sea coast and the longshore sediment transport model (for the Danube Delta coast zone - Northern Unit)

Sediment drift (arrows) and transport rates in thousand of cubic meters per year (figures by the arrows). Circled + and - represent advancing and retreating sections respectively (after Giosan et al., 1997)





*The Sulina distributary meander belts cut-offs (EDC, 1868 – 1902)*

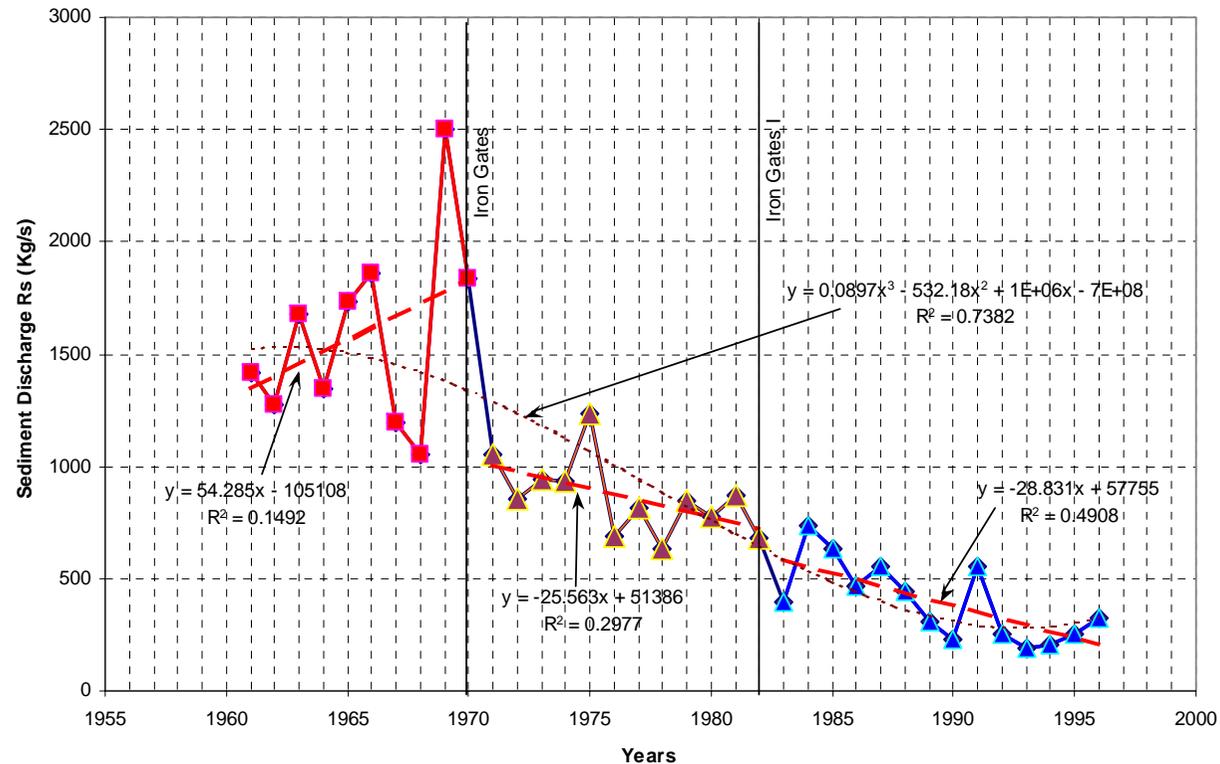
Order of digging channels	Period	Length of cut-off channel (Km)	Channel location
I	1868 - 1869	0.6	The "Little M" meander bend, "Mila 23"
II	1880 - 1882	1.0	Ceatal St. George
III	1883 - 1884	0.9	The "Păpădia" meander bend
IV	1885 - 1886	2.0	Miles 32 – 33
V	1886 - 1889	2.1	Miles 28 – 30
VI	1890 - 1893	9.7	Downstream half of the "Big M" meander
VII	1894 - 1897	5.5	The "Maliuc" meander bend
VIII	1897 - 1898	1.7	The "Ilgani" meander bend
IX	1898 - 1902	9.2	Upstream half of the "Big M" meander





# Decreasing of the River Danube sediment discharge after damming

Danube Sediment Discharge at Vadu Oii hydrographic station - Km.247 (1961-1996)





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## St. George cut-off channels (Dunavat meander belt)

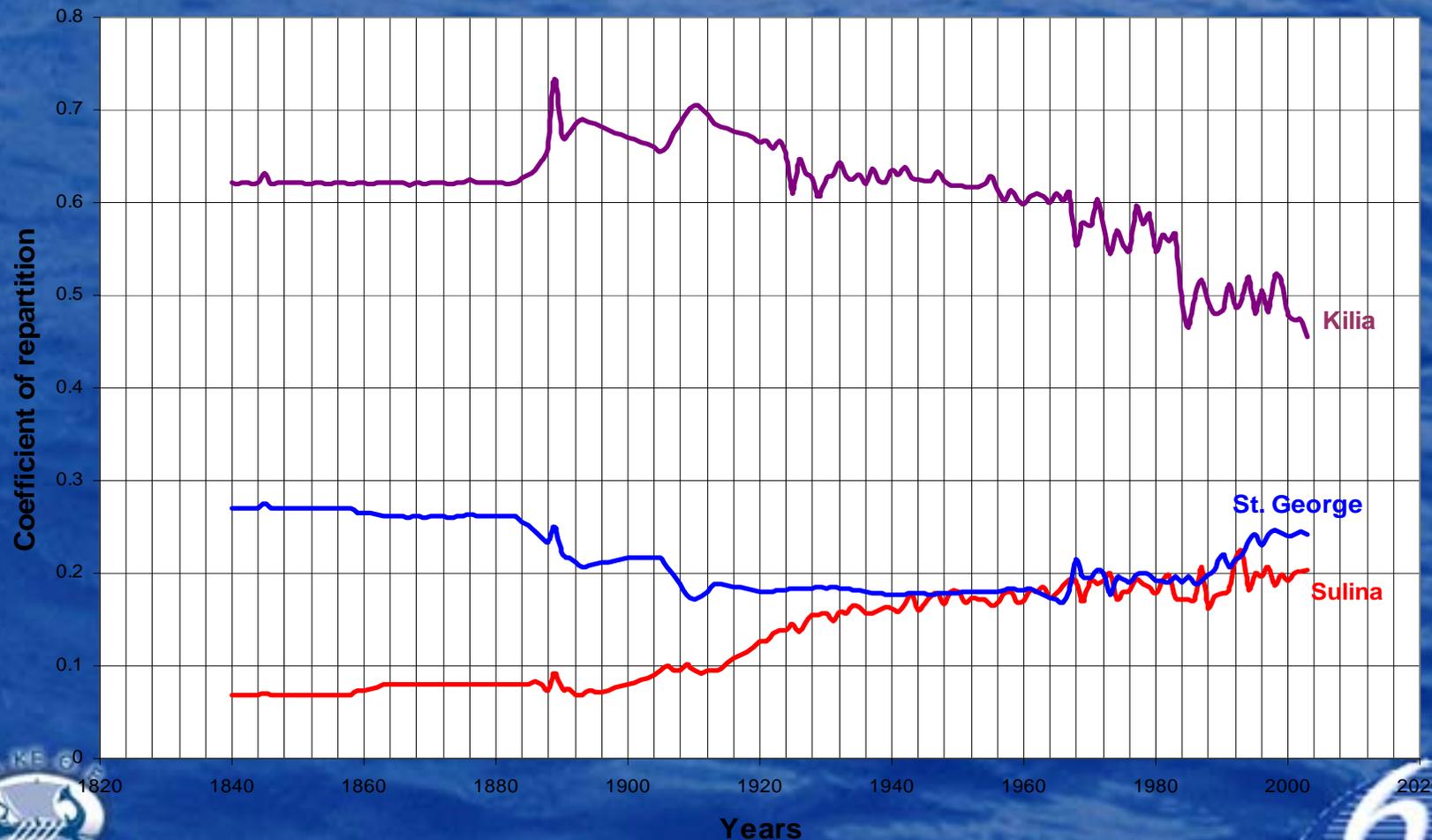


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# Changes in the suspended load distribution among the main Danube Delta distributaries at the mouth zones for the 1840-2003 period





Geomorphologic changes in the Danube Delta Coastal Zone

- Historic cartographic documents consisting of 15 hydrographic and bathymetric maps of Danube Commission and of the Romanian Service for Navigation have been assessed.
- The map of 1857 was taken as reference document.

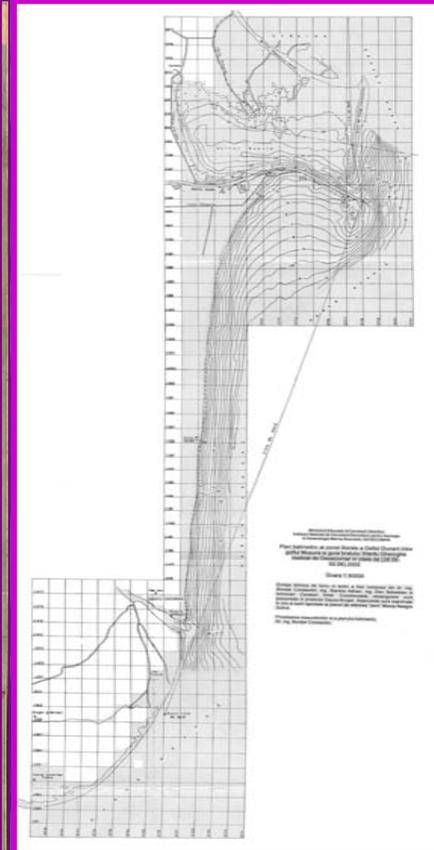
1857



1909



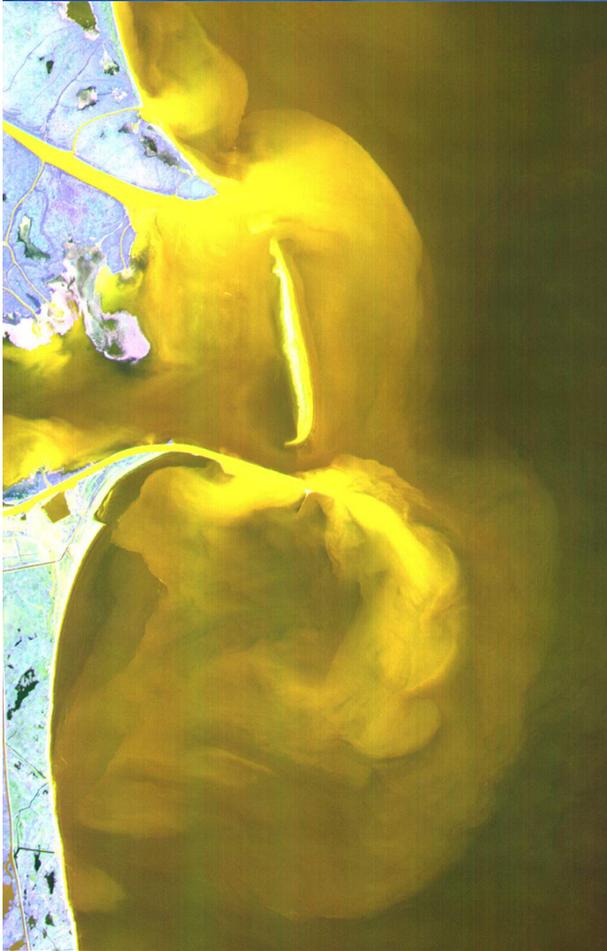
2003





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The lateral mouth bar at the Stambulul Vechi  
distributary mouth  
(Kilia Delta), northward Sulina



The bar has emerged (in the early 80') and reaches at present time about 10 km in length, its southern end being at less than 1.2 km from Sulina distributary.

This bar almost closes the Musura bay, which is gradually transformed into a lagoon.

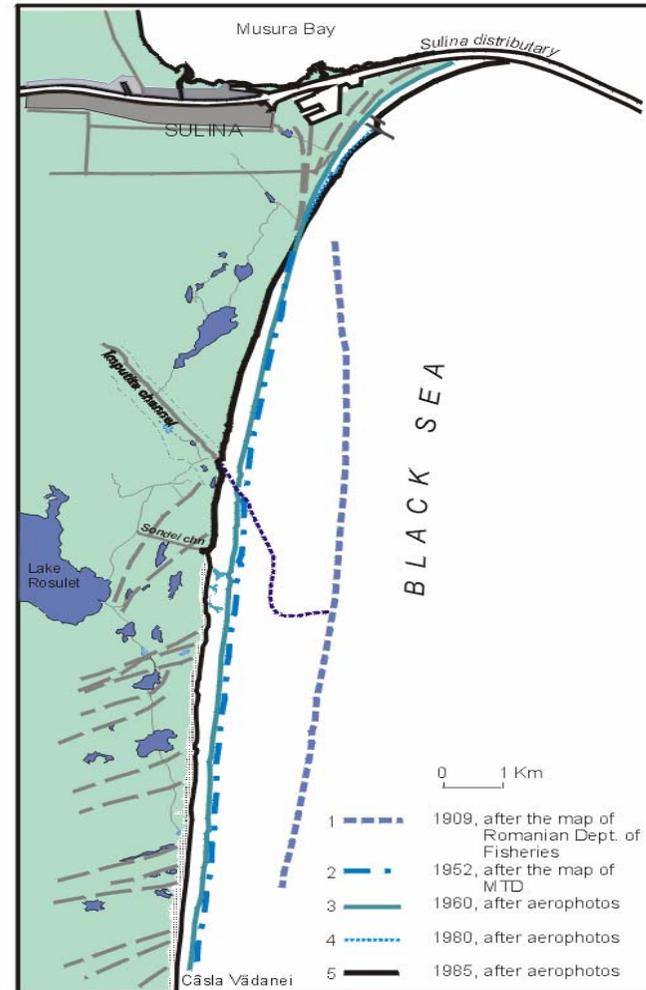


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# The Danube Delta coastline erosion in the last century

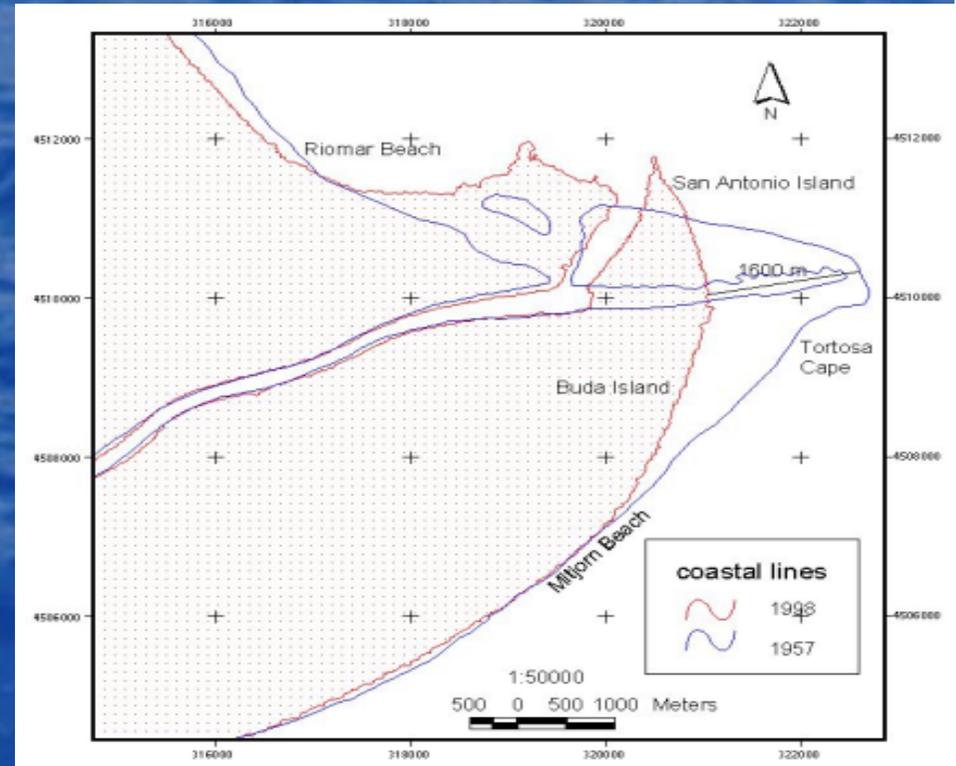
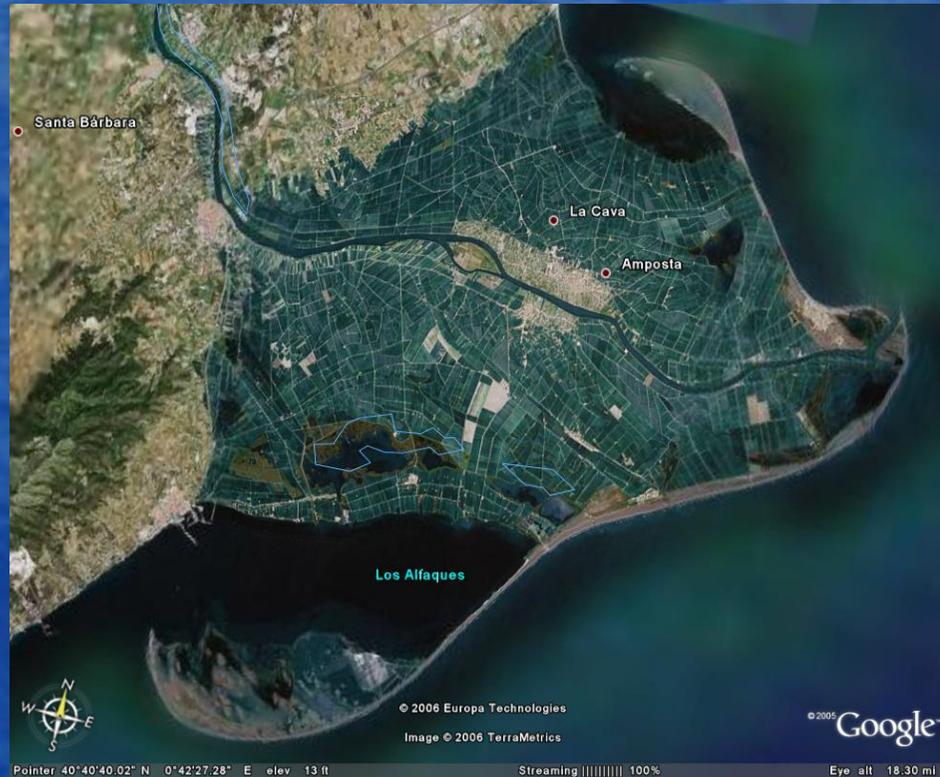




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# Ebro Delta coastline retreat

(Rodríguez, 1999)

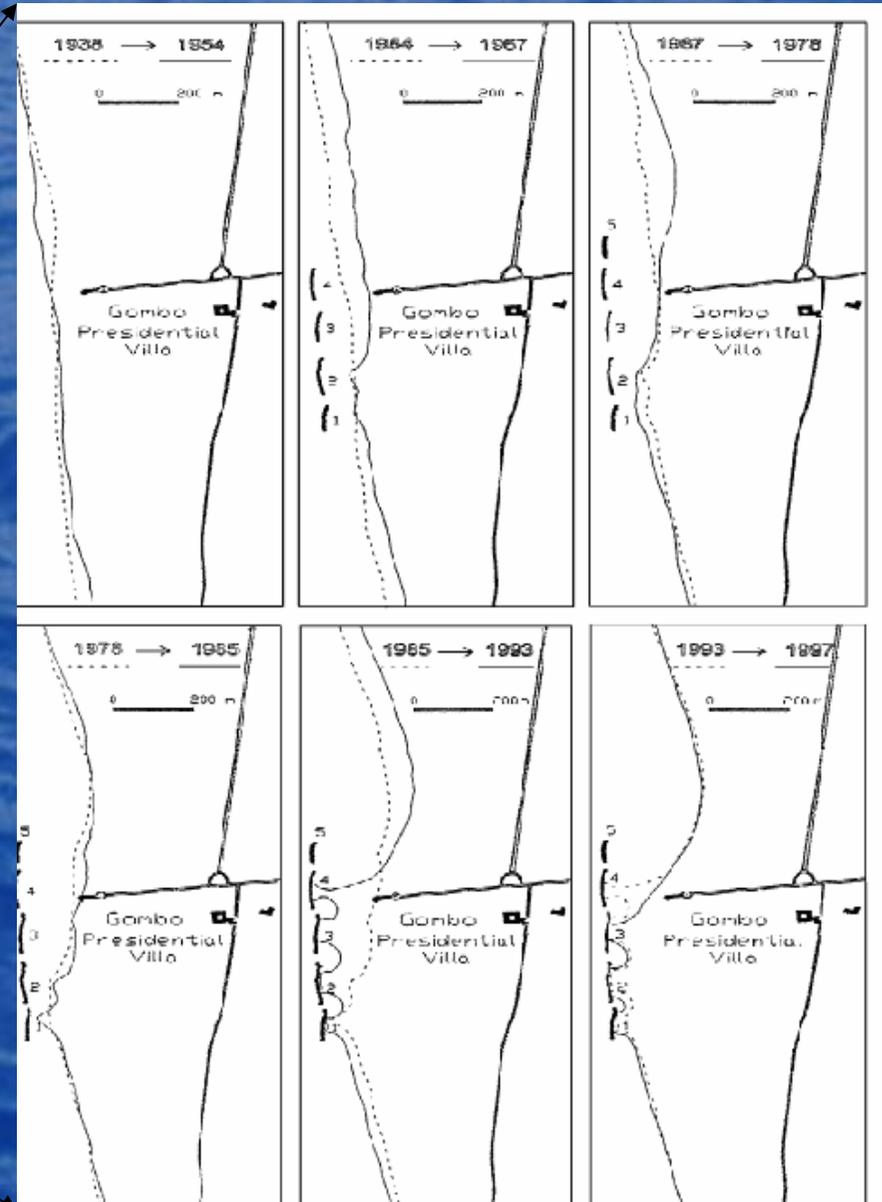


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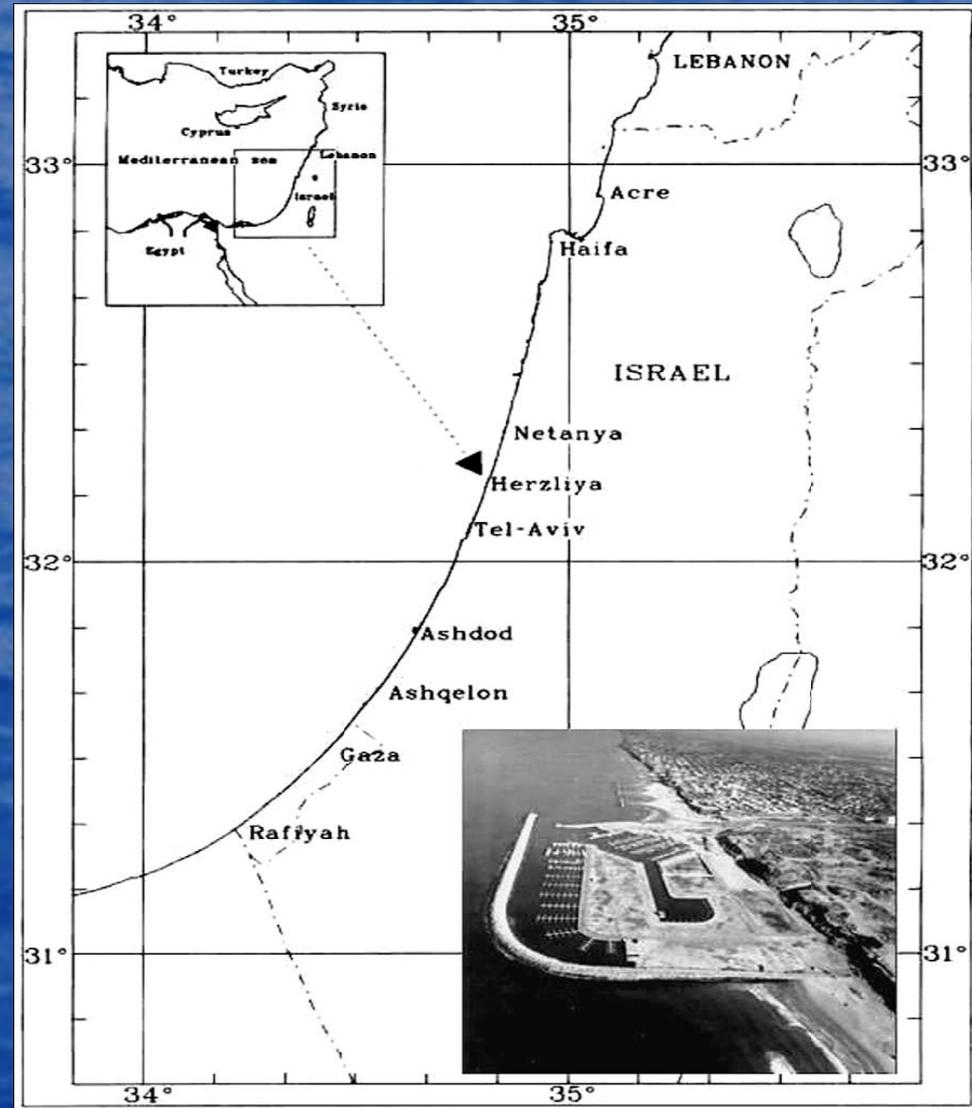


# Shoreline changes induced by coastal structures Gombo Beach, Italy, Ligurian Sea (Bowman & Pranzini, 2003)





# Coastal erosion induced by marina piers - Herzliya coast, Israel (Klein & Zviely, 2001)





## Most vulnerable coasts – Mediterranean

### EXAMPLES:

- Nile, Ebro, Po, Rhone deltas littorals;
- Italy - Northern Adriatic
- Morocco, Algeria, Tunisia, Spain, Israel





## Most vulnerable coasts – Black Sea

### EXAMPLES:

- the Danube Delta with a very exposed to erosion littoral of about 240 Km.
- the unit River Dnieper liman - Karkinit Bay (total length of about 618 Km). specifically the Kinburn spit - Dolgyi Island section (~ 20 Km) and Tendra spit - Dzharylgatch Island section (~137 Km).
- the Taman - Anapa section of about 200 Km long (of which 66 Km are the Anapa spit).
- the Kolkhida (Rioni) Lowland where the rivers Chobi, Rioni, Inguri and Supsa have built up their deltas.
- on the Turkish coast: the deltas of Kizilirmak, Yesilirmak and Sakaraya rivers.
- in Bulgaria, sandy accumulative beaches related to the rivers Diavolska, Kamchya, Provadyiska and Batova, summing about 100 Km.





## Soft solutions for limiting coastline erosion effects

- The Coastal Zone should be protected as much as it is possible by soft, environmentally clean measures.
- These measures should take into consideration the most efficient use of sandy sediments already existent or supplied by rivers into the Coastal Zone.
- **Objectives to be performed:**
- **Detailed assessment of geodynamic, sedimentological and hydraulic processes in the CZ zone for improving the knowledge about water and sediment behaviour in the nearshore zone;**
- **New models for the sediment supply in the CZ, for a better planning of coastal zone sediment budgets;**
- **New innovative soft solutions for protecting the CZ mainly by sustainable use of the sediment budgets.**

