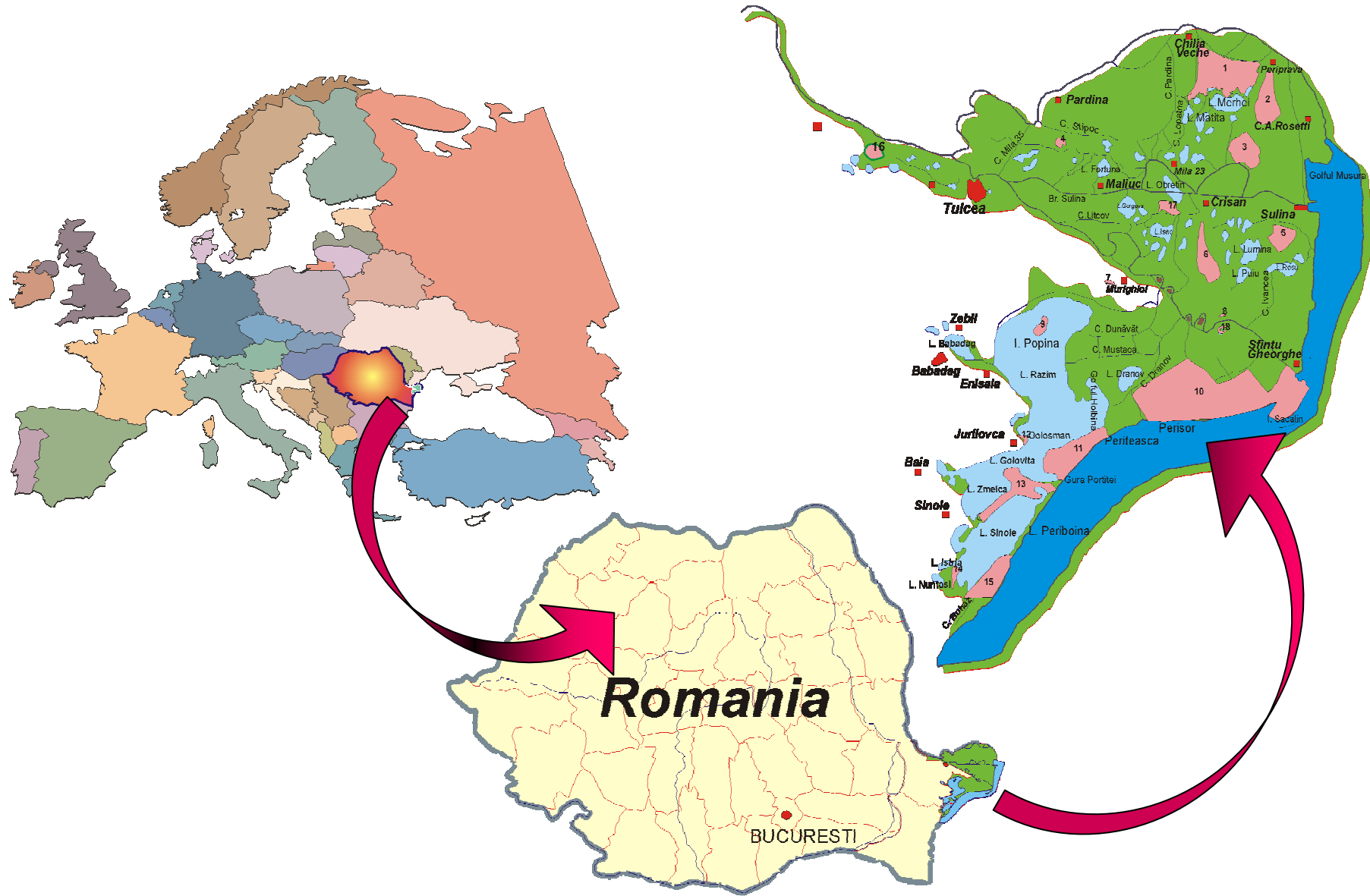


Human interventions and related impacts in the Danube Delta

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Geoecology – GEOECOMAR,
Bucharest, Romania



The Danube-River-Basin

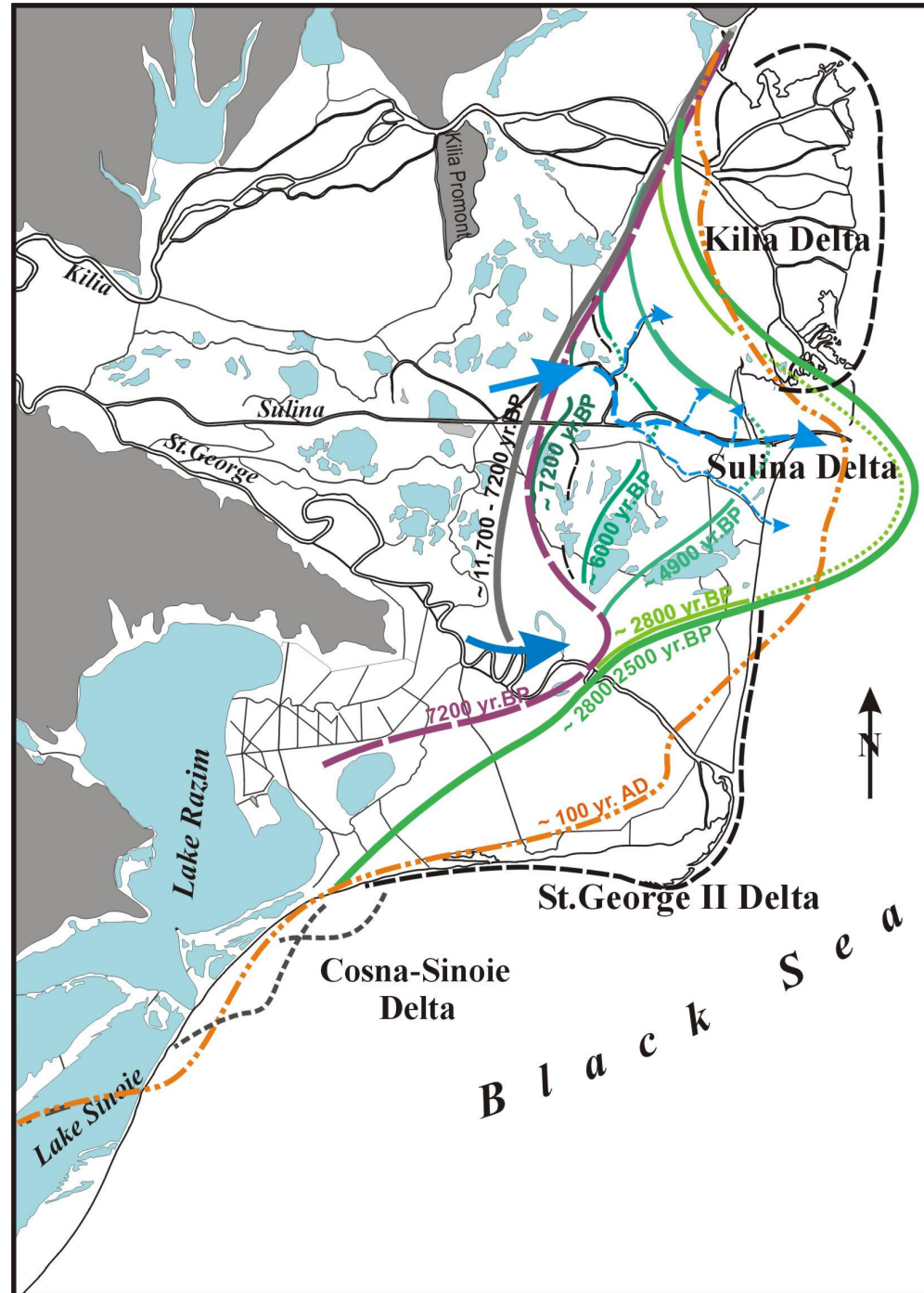
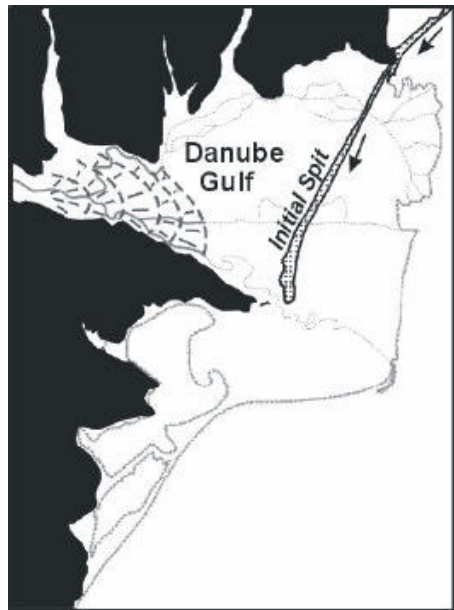


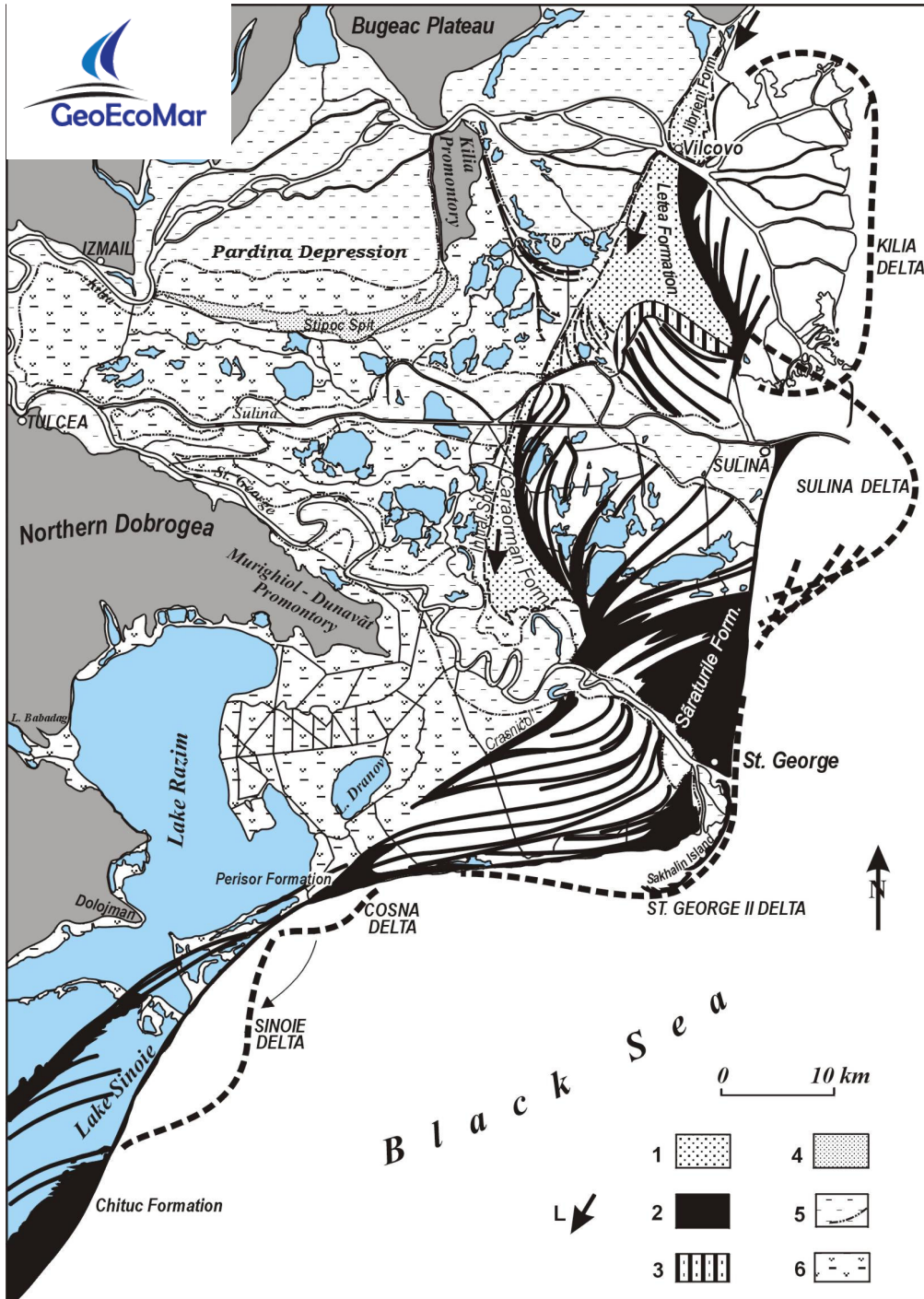
Natural evolution of the Danube Delta

The Danube Delta evolution



Evolution of the coastline during the last 12,000 years (Panin, 1997, 1998, 1999)





Areal distribution of the main types of deposits in the Danube Delta

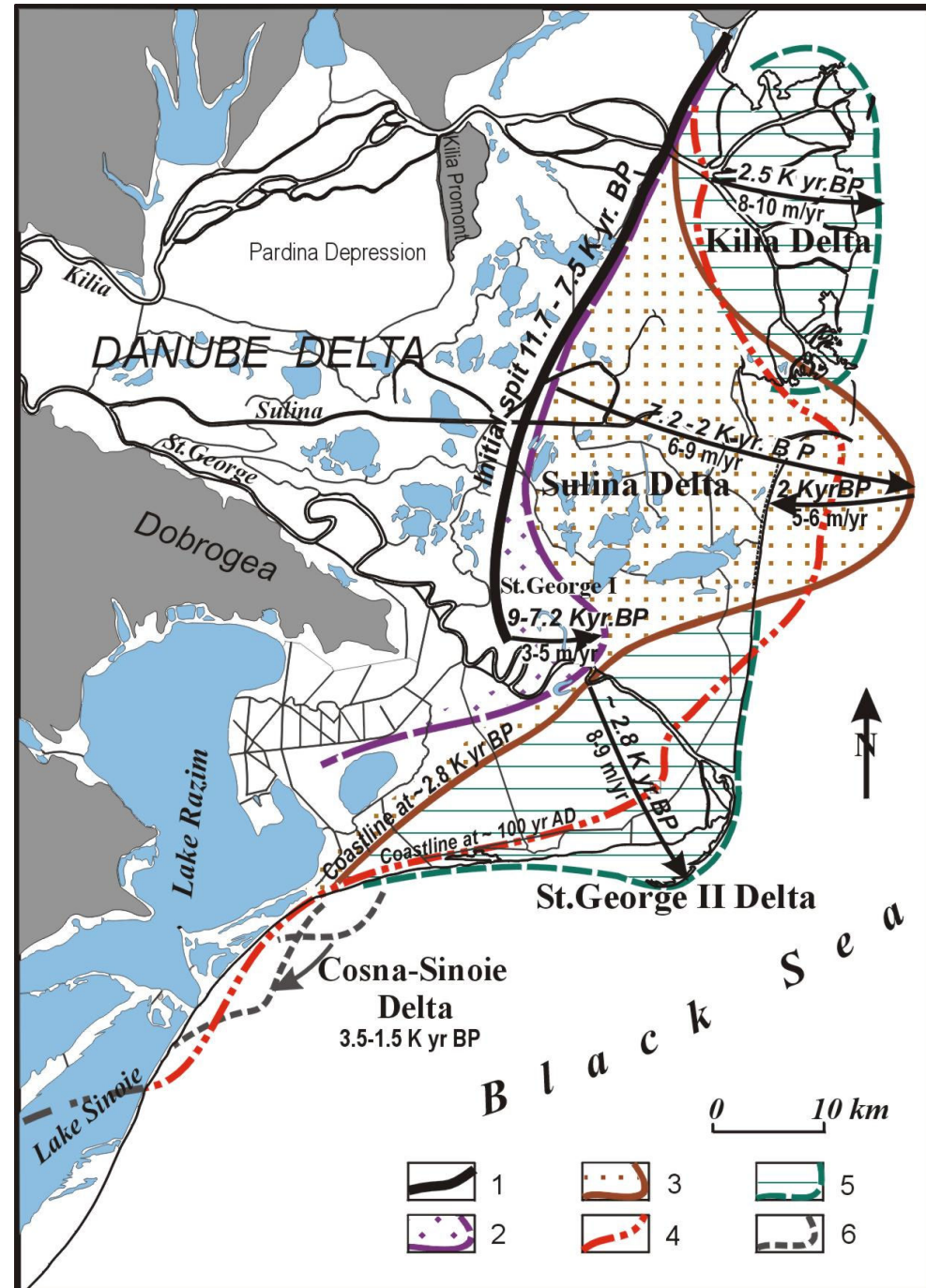
1. Marine littoral deposits:
 - a, type “a” - of littoral drift from the Ukrainian rivers;
 - b, type “b”- of Danubian origin;
 - c, littoral diffusion (mixed “a” and “b” types);
 2. Lacustrine littoral deposits;
 3. Fluvial deposits:
 - a, meander belt deposits;
 - b, interdistributary depression deposits;
 4. Læss-like deposits;
- L** - longshore sediment drift;
D - main sediment supplies.

The Danube Delta evolution

Evolution of the coastline during the last 12,000 years

(Panin, 1997, 1998, 1999)

1. Initial spit: 11.7 – 7.5 K yr. BP
2. St. George I Delta: 9.0 – 7.2 K yr. BP
3. Sulina Delta: 7.2 – 2.0 K yr. BP
4. Coastline position at ~ 100 yr. AD
5. St. George II Delta and Kilia Delta: 2.8 K yr. BP – Present
6. Cosna – Sinoie Delta: 3.5 – 1.5 K yr. BP



Danube Delta Lobes Volumes

Lobe name/time of development	Total volume of deposits (m ³)	Rate of deposition Danubian sedim. (m ³ /yr)
St. George I/ 2200 yr.	2,105,342,923	383,063
Sulina/ 4500 yr.	9,236,857,413	1,653,150
St. George II/ 2800 yr.	5,294,475,401	1,436,884
Kilia/ 2500 yr.	3,982,737,489	1,593,095
Total, without Cosna-Sinoie	20,619,413,226	

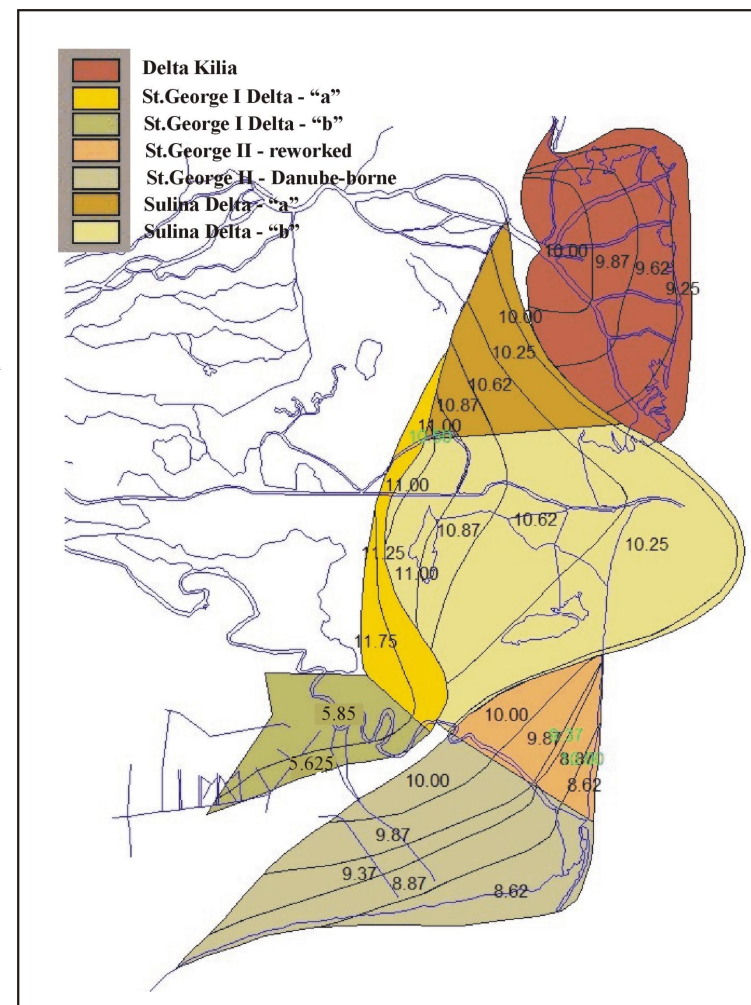
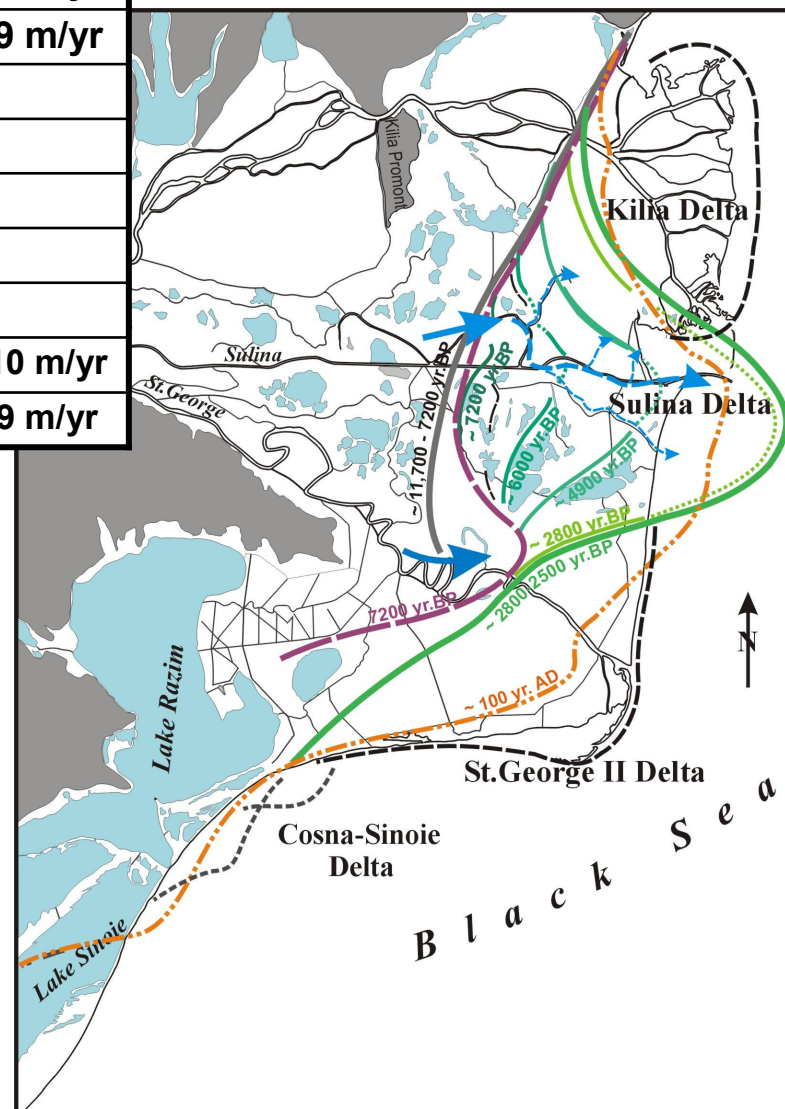


Fig. 5 - Area and thickness for different delta lobes

Main lobe name	Absolute dating years BP	Number channels	Prograd Rate
Initial Spit	11,700 - 7200	1	
Blocked Delta	11,700 – 7200	2-3	
St.George I Delta	~9000 – 7200	1	3-5 m/yr
Sulina	~7200 - 2 000	1 – 5	6-9 m/yr
<i>Sulina Delta - phase 1</i>	<i>7200</i>	<i>1</i>	
<i>Sulina Delta - phase 2</i>	<i>~ 6000</i>	<i>3</i>	
<i>Sulina Delta - phase 3</i>	<i>~ 4900</i>	<i>5</i>	
<i>Sulina Delta - phase 4</i>	<i>~ 2800 – 2000</i>	<i>2</i>	
Cosna - Sinoie Delta	3500 – 1500	1	
Kilia Delta	2500 - present	1 to 19	8-10 m/yr
St. George II Delta	~ 2800 - present	1 to 3	8-9 m/yr

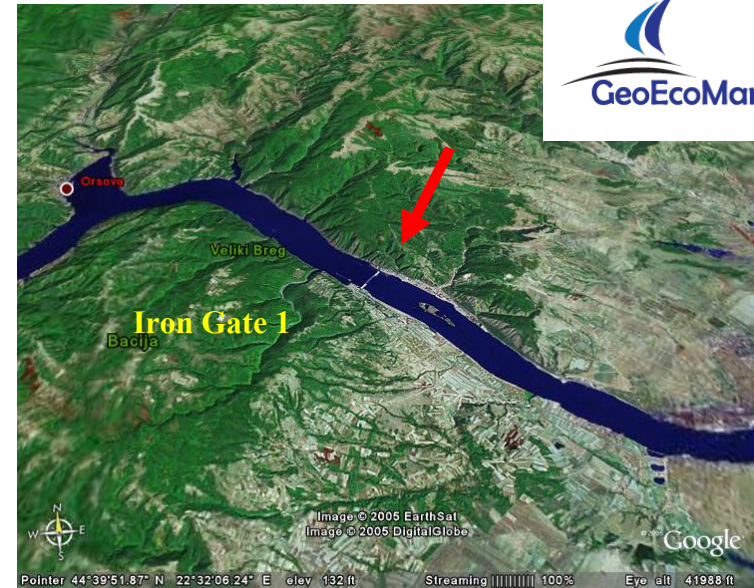


Human interventions affecting the Danube Delta



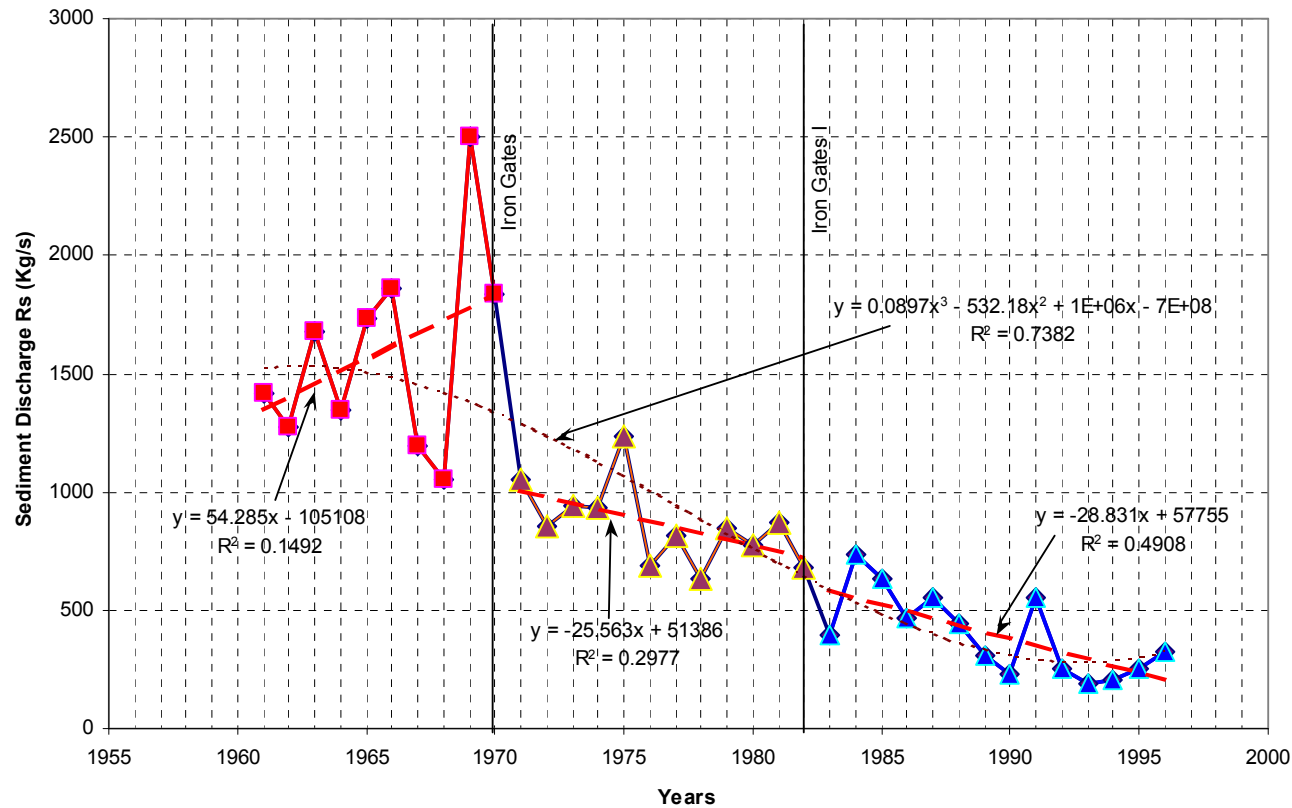
After 1970, following the building of Iron Gates I dam (942.95 km from the Black Sea) and the hydrotechnical works along the Danube tributaries, the sediment discharge decreased by approximately 10-20%.

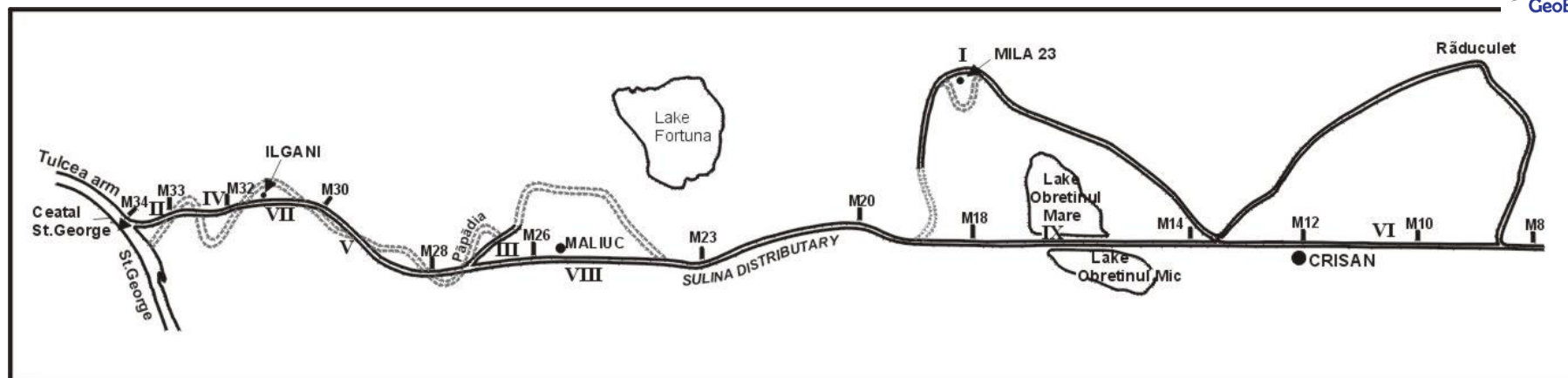
In 1983, the second barrage, at Ostrovul Mare (864 km), was built up and this new closing of the Danube induced a really catastrophic decrease in the sediment discharge: in all the stations the measured sediment discharge dropped by 35-50 % compared to the mean value of pre-damming sediment flux regime.



Decreasing of the River Danube sediment discharge after damming

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





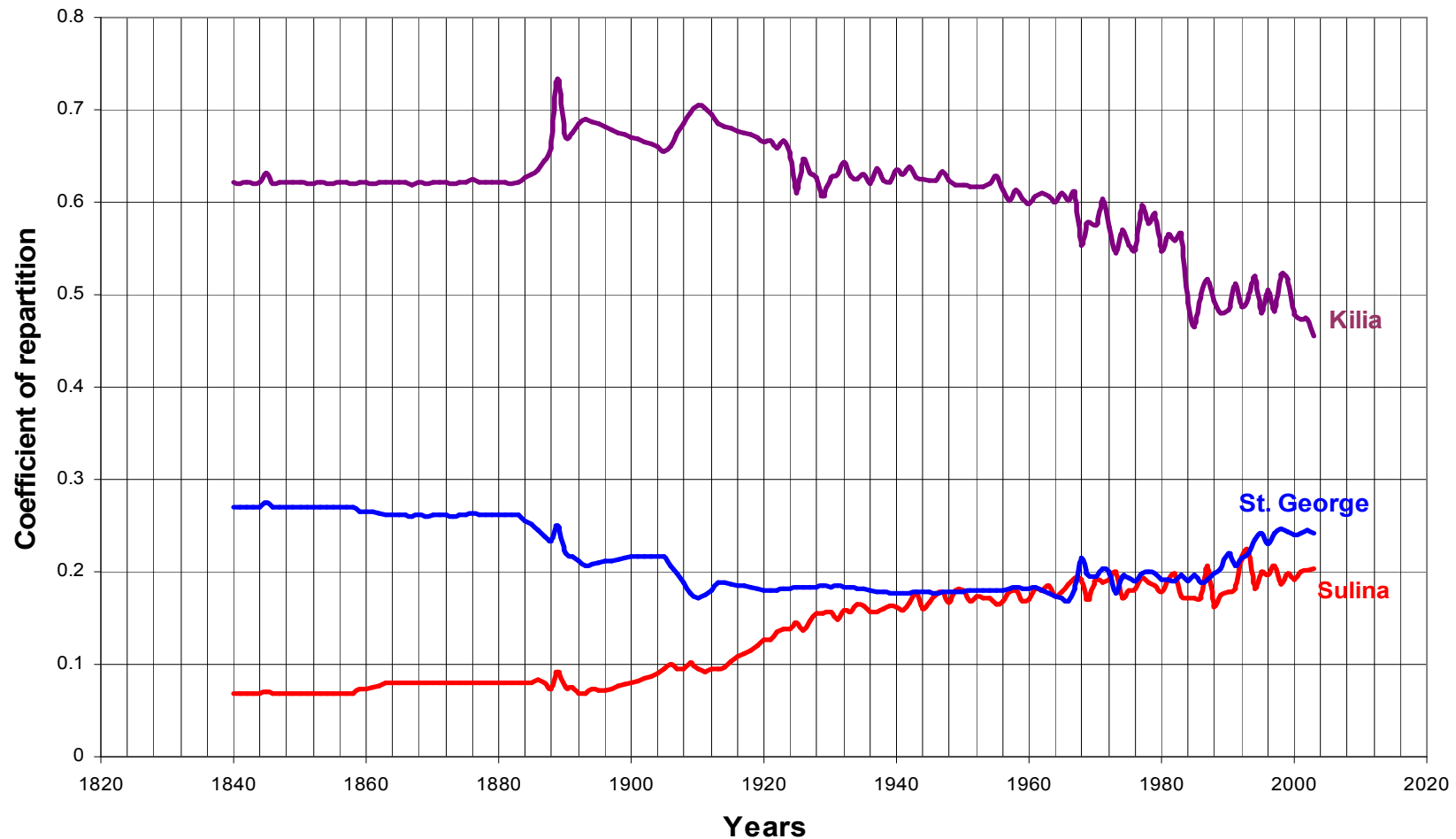
The Sulina distributary meander belts cut-offs (EDC, 1868 – 1902)

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

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



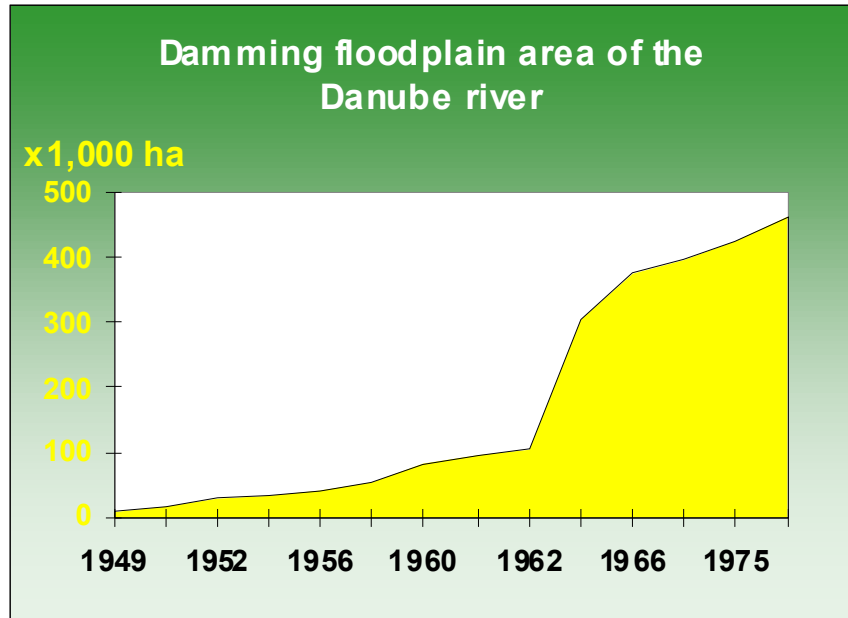
Changes in the suspended load distribution among the main Danube Delta distributaries at the mouth zones for the 1840-2003 period



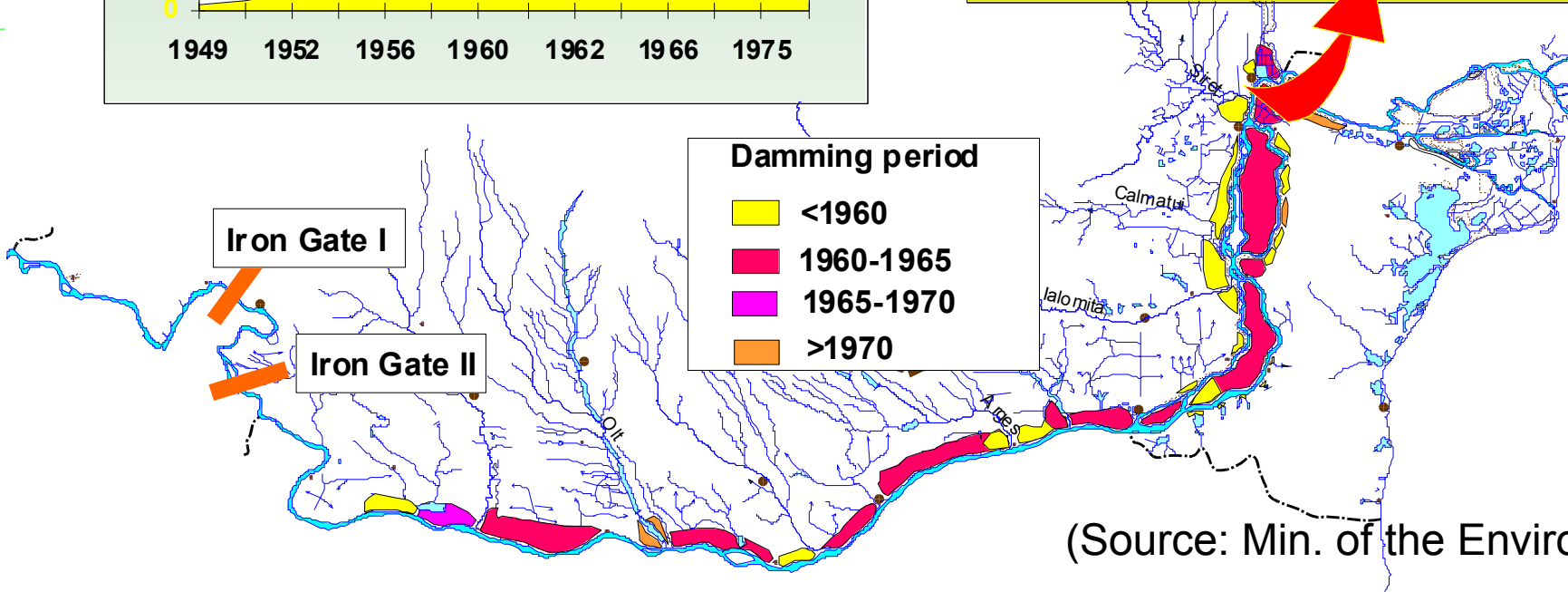
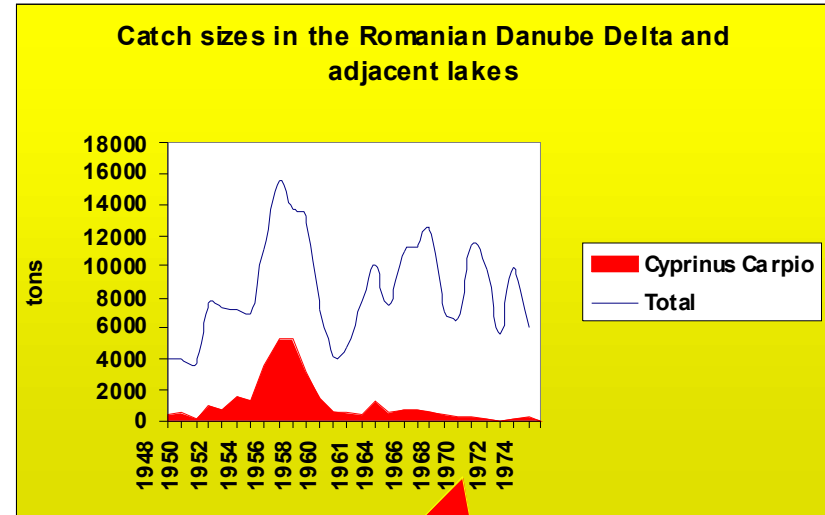
After Bondar, 2003

Embankment of the floodplain upstream the Danube Delta

DAMMING OF DANUBE RIVER FLOODPLAIN



IMPACT ON DANUBE DELTA'S FISHERY



(Source: Min. of the Environment)

SULINA JETTIES

Between the second half of the XIX-th Century (first plan for the Sulina Navigation Canal – Sir Charles Hartley) and mid 1900`s, the Sulina mouth was protected by 2 parallel jetties, which were extended in several steps, up to the present-day dimensions (kms. offshore)



Late XIXth Century



New lighthouse and jetties

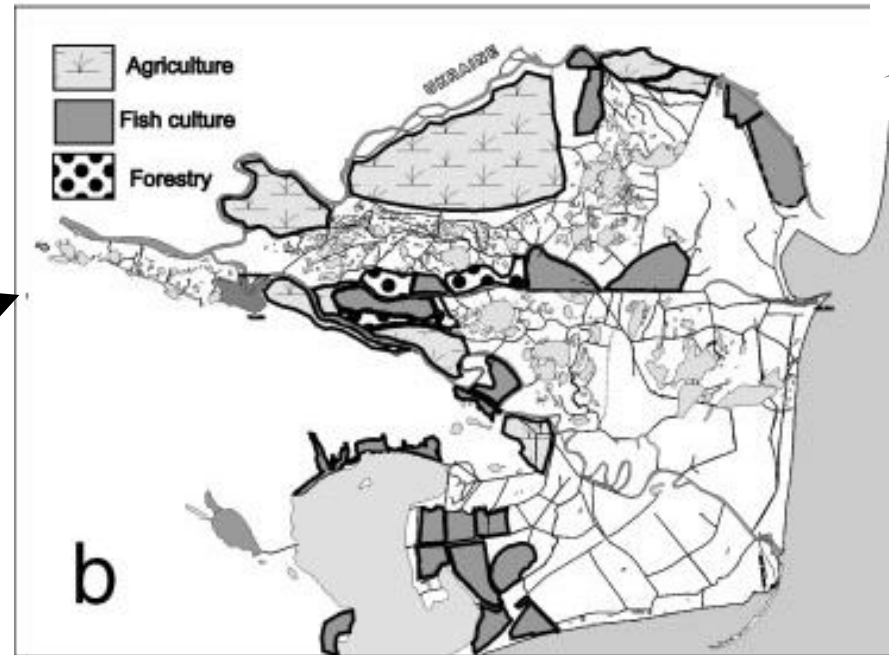
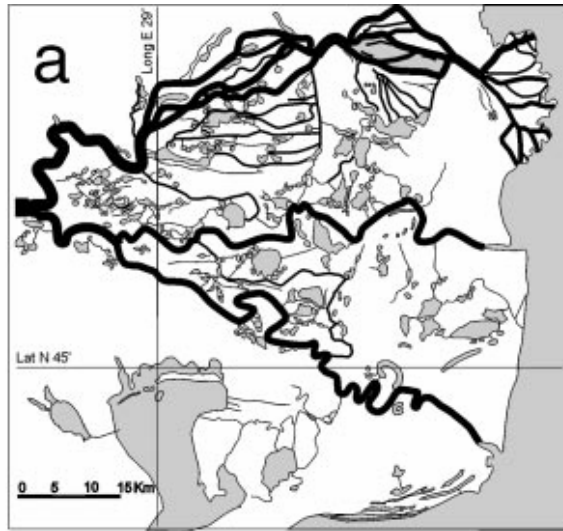


Human interventions within the Danube Delta



These can be divided into:

- a) The so called “reed period” (1960-1970): changes in the natural circulation pattern by digging canals;
- b) The “fish-period”: 1970 – 1980: changes in land uses : creation of large fish ponds;
- c) The “agriculture period” (1980 – 1990): transforming wetlands into agricultural polders (more than 35,000 ha).
- d) “Back to nature” – restoration policies (after 1990 – present time). Renaturation of polders, blocking of human – made canals)

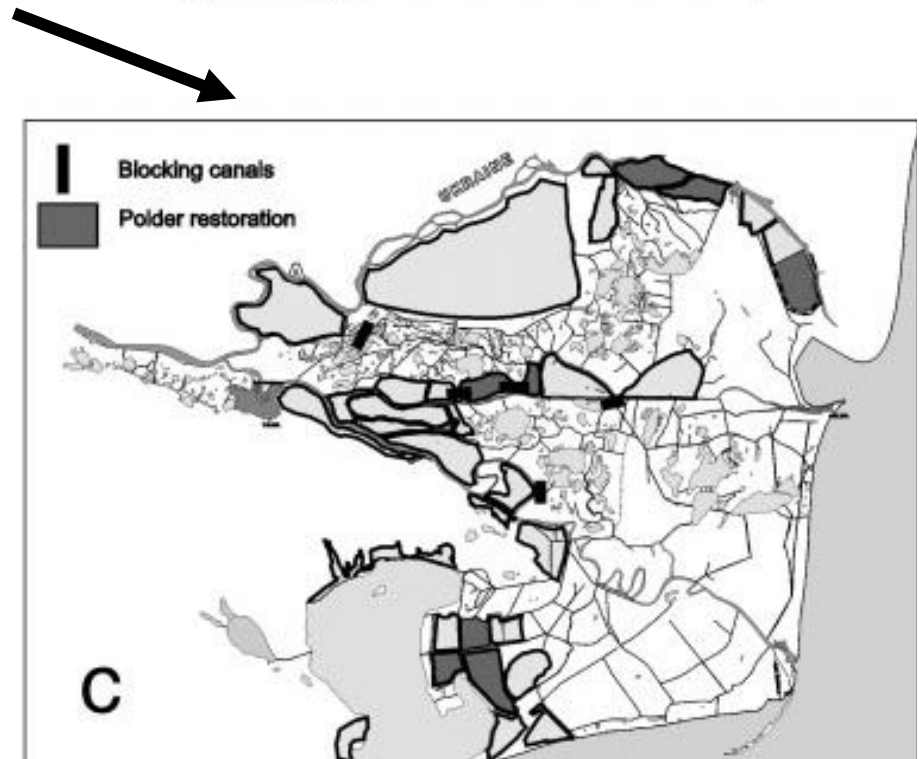


Danube Delta changes generated by humans (only for Romanian Territory)

a = “pristine” phase (1880)

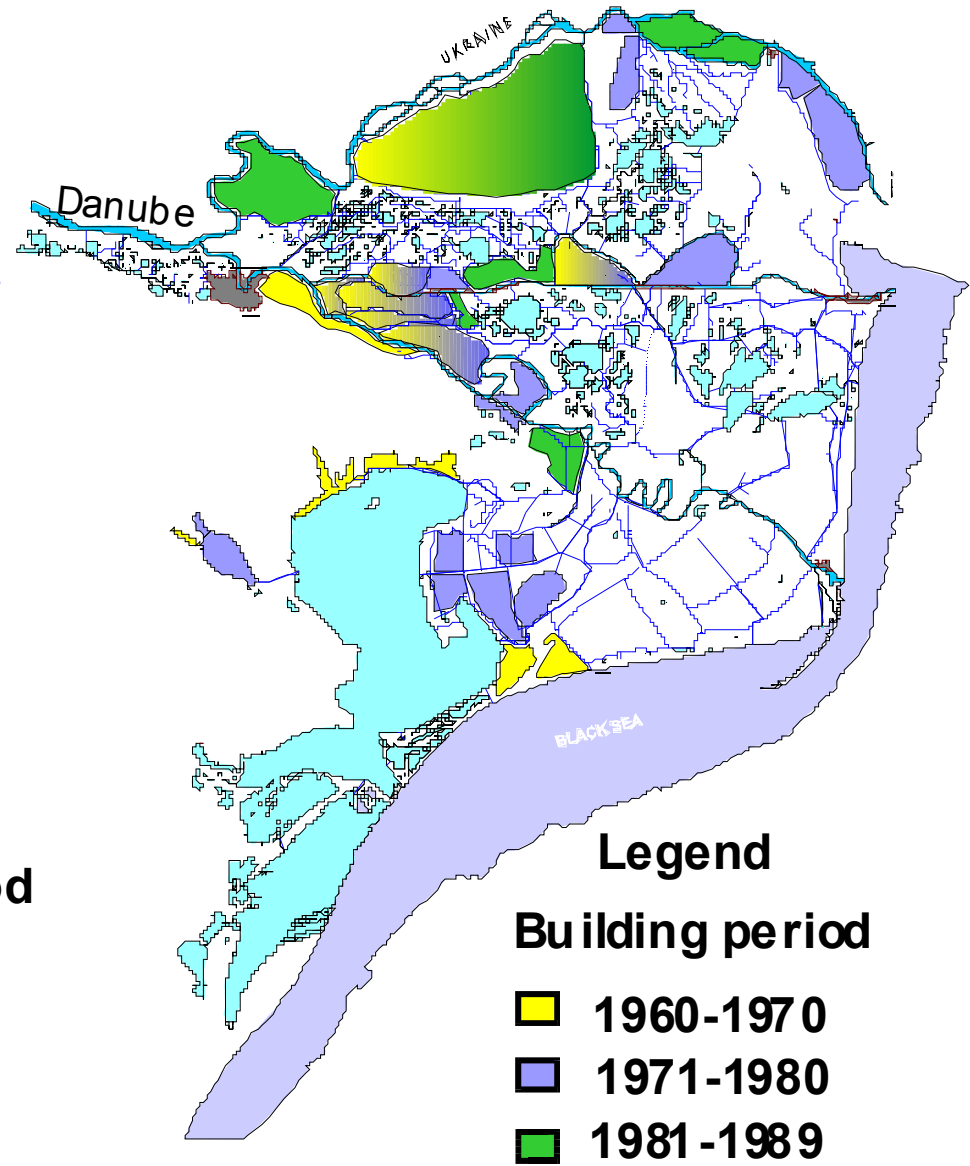
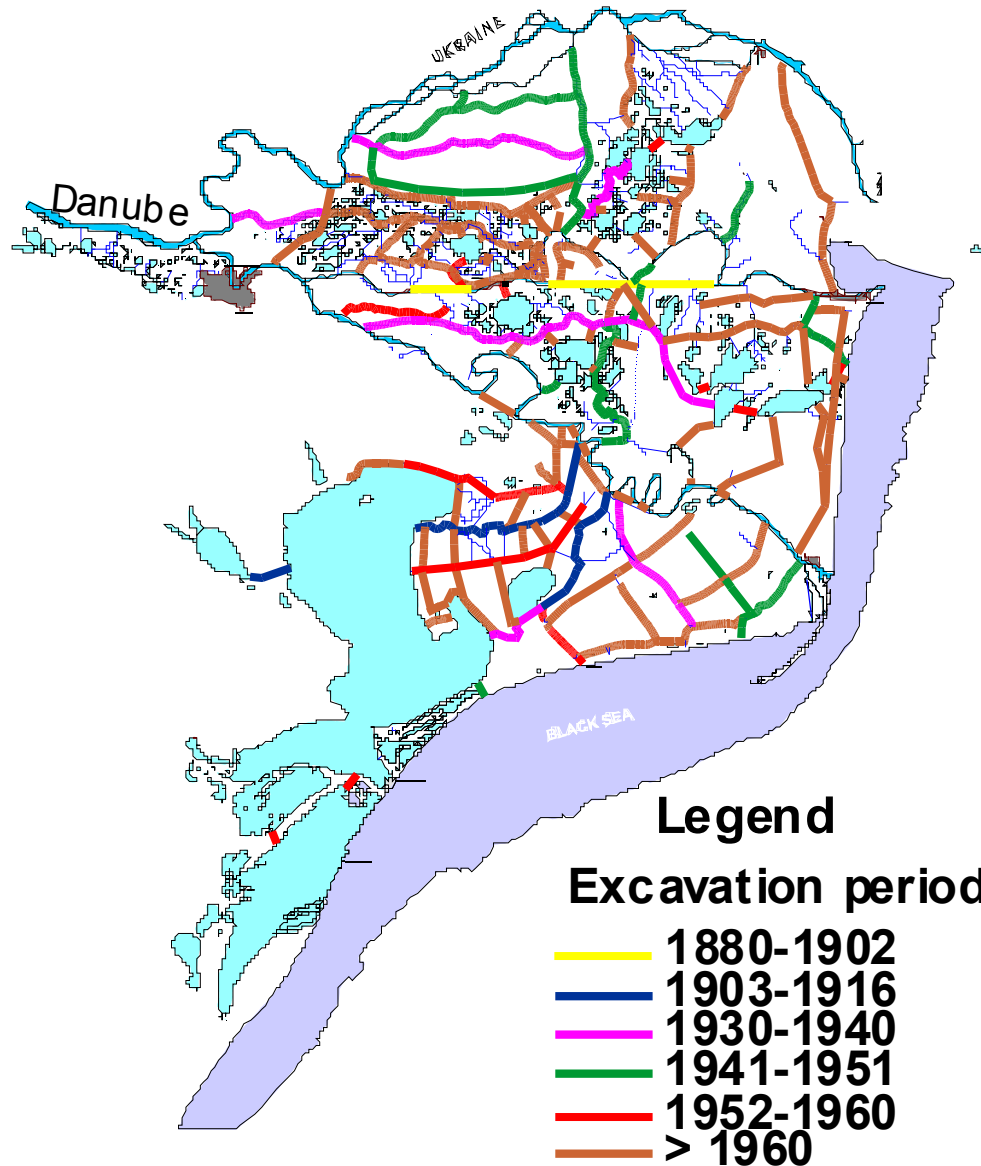
b = Reclaimed land for agriculture, fish culture and forestry (1890 –1989) and location of artificial canals

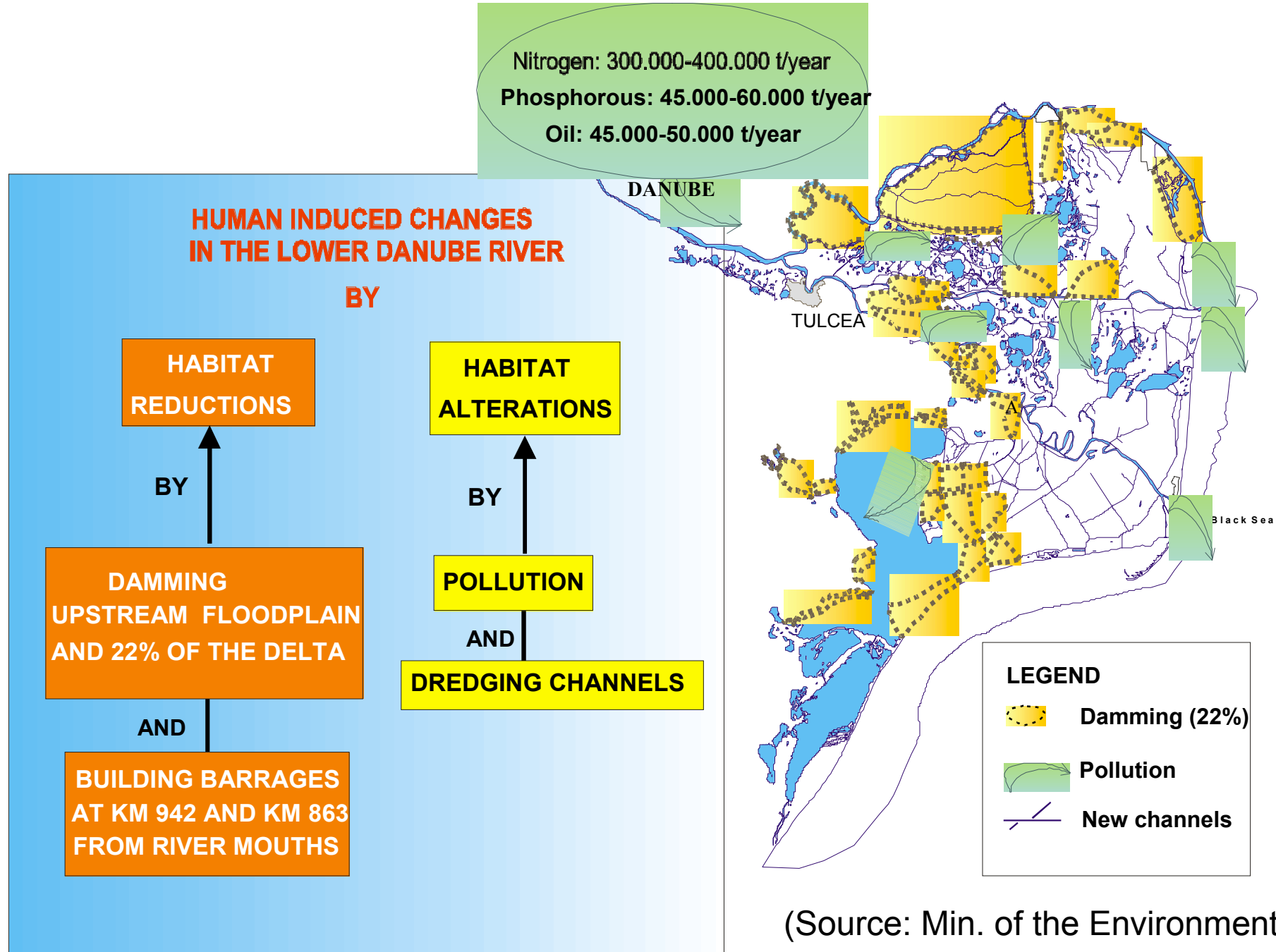
c = restoration activities since 1994 including re-opening of polders and blocking of man-made canals (images and text from Buijse et al., 2002)



(Source:
Min. of the
Environment)

Damming and channel excavations

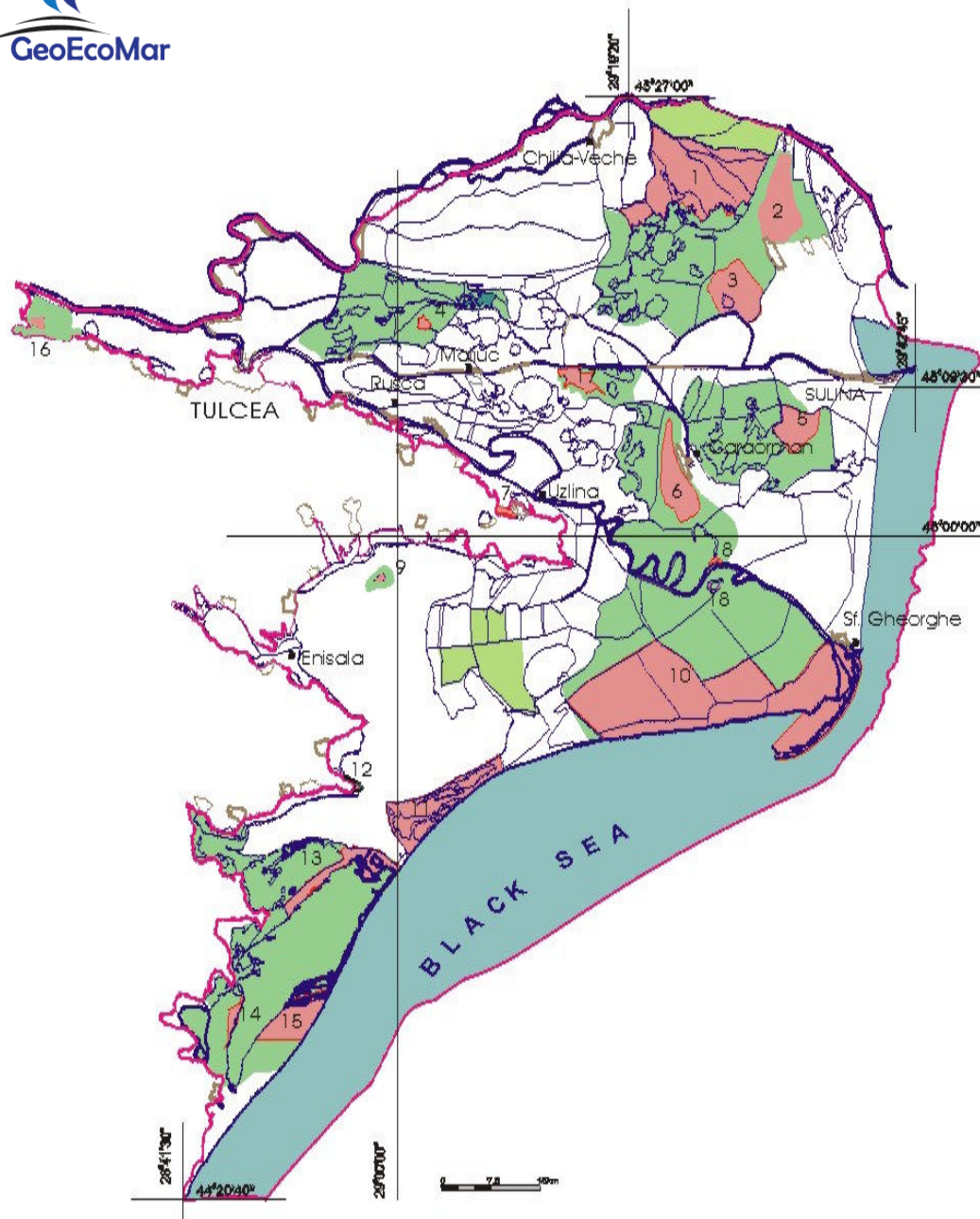




(Source: Min. of the Environment)

Back to Nature (after 1989)





DANUBE DELTA BIOSPHERE RESERVE

Total surface: 580,000 ha

Strictly protected areas: 50,600 ha

Buffer zones: 223,300 ha

Economic zones 306,100 ha

- **ecological restoration: 11,425 ha**
- **agriculture polders 39,974 ha**
- **fish ponds: 39,567 ha**
- **forests: 6,442 ha**

INTERNATIONAL CONVENTIONS

- Convention on Wetlands of International Importance Especially as Waterfowl Habitat (*Ramsar, 1971*)
- Bern Convention on Protection of European Wild Flora and Fauna and Natural Habitats (*Bern, 1979*)
- Convention on Protection of Migratory Species of Wild Animals (*Bonn, 1979*)
- Convention on Biological Diversity (*Rio de Janeiro, 1992*)
- Convention on the Protection of the Black Sea Against Pollution (*Bucharest 1992*)

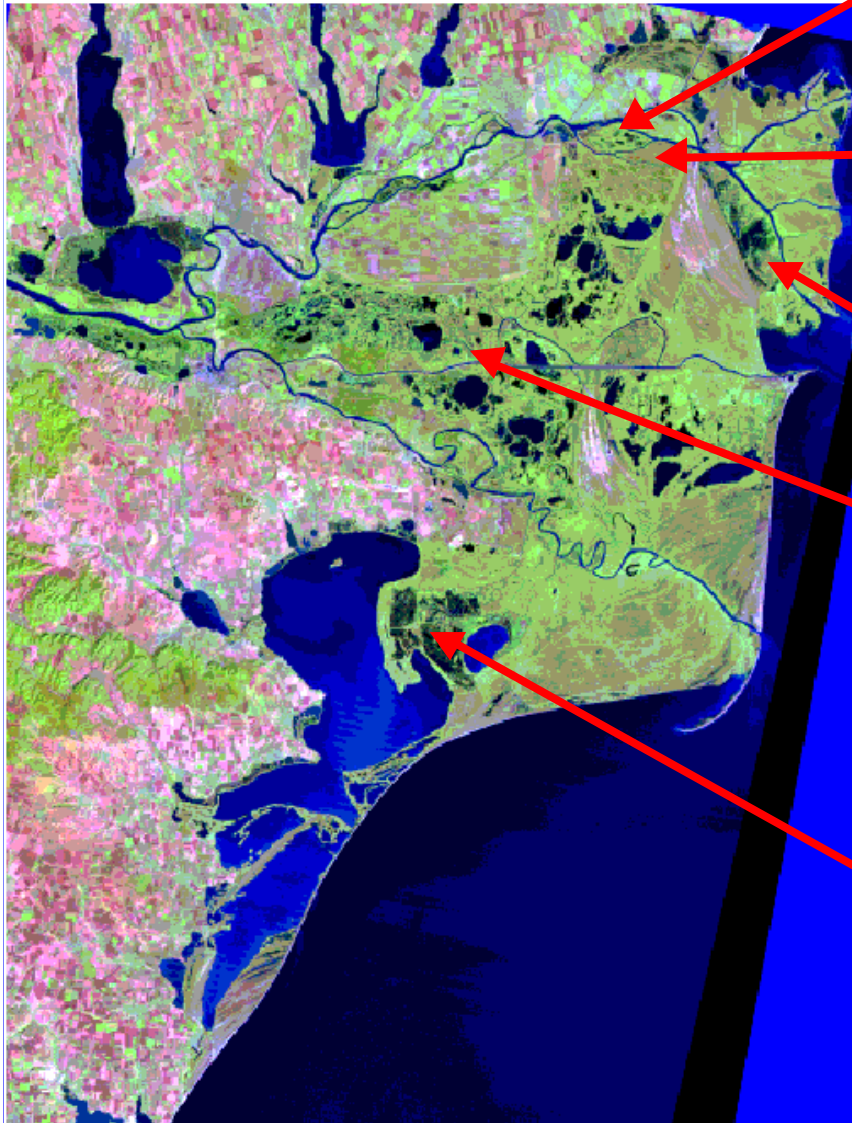
INTERNATIONAL CONVENTIONS

- Convention on the protection the world natural and cultural heritage.
- The UNESCO Man and Biosphere Programme
- Convention concerning the international trade with endangered flora and fauna species – CITES (*Washington, 1973*)
- Agreement between Ministers of Ecology of Romania, Ukraine and Moldova on Trans-boundary Co-operation in the Protected Areas of the Danube Delta and Lower Prut (*Bucharest, 2000*)

INTERNATIONAL CONVENTIONS

- European Framework Directive 79/409/EEC/1979, concerning the protection of birds
- European Framework Directive 92/43/EEC/1992, concerning the protection of habitats The UNESCO Man and Biosphere Programme
- Convention concerning the international trade with endangered flora and fauna species – CITES (*Washington, 1973*)

Implemented and ongoing Restoration Works in the Danube Delta



◆ In 1994 Babina (2,100 ha),

- agricultural polder -

◆ in 1996 Cernovca(1,580 ha)

- agricultural polder -

◆ in 2000 Popina(3,600 ha)

- fishpond -

◆ in 2002 Fortuna (2,115 ha) -

- agricultural polder -

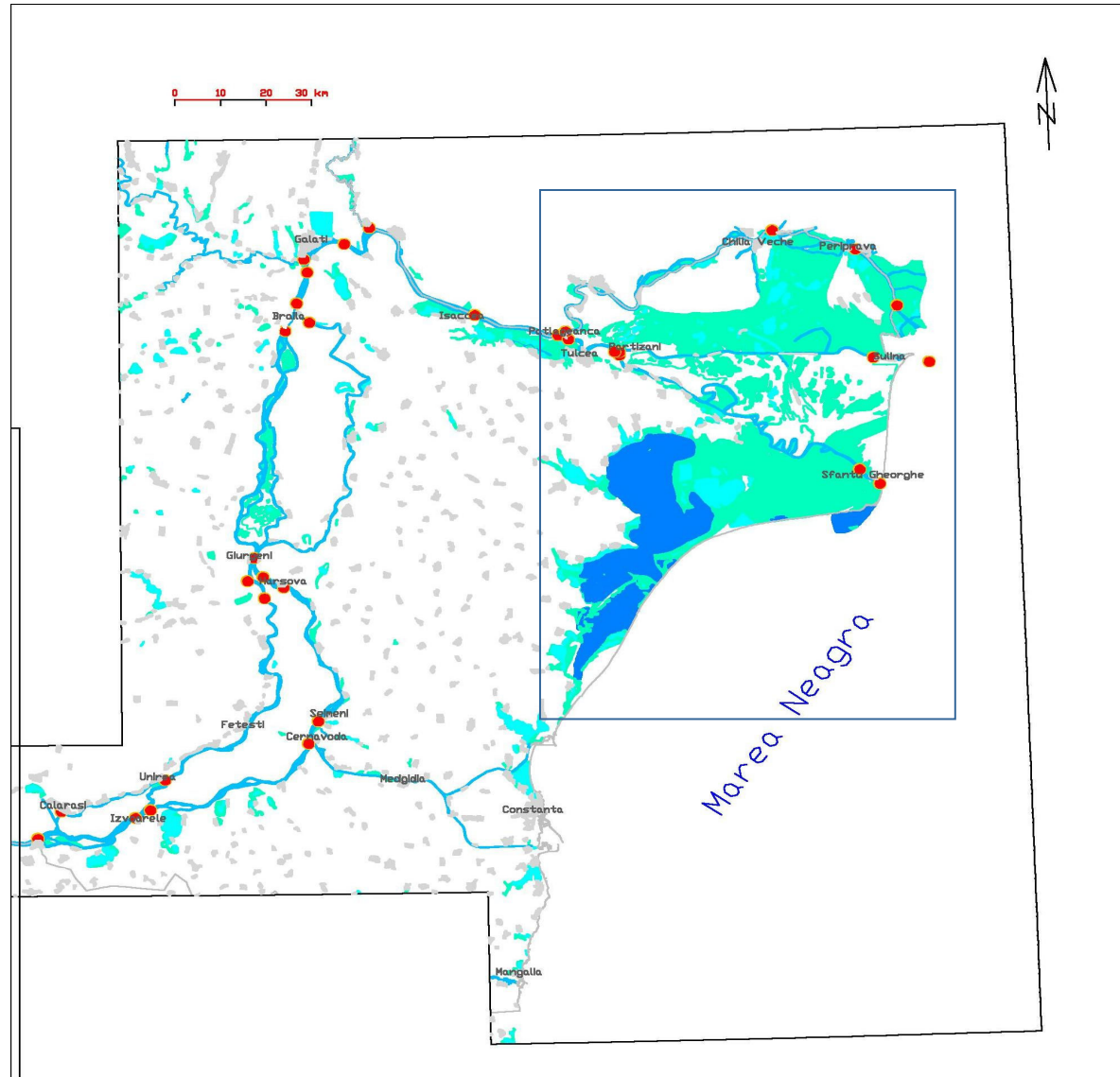
◆ Prospective areas to be restored

◆ Holbina - Dunavat(5,630 ha)

- fishponds -

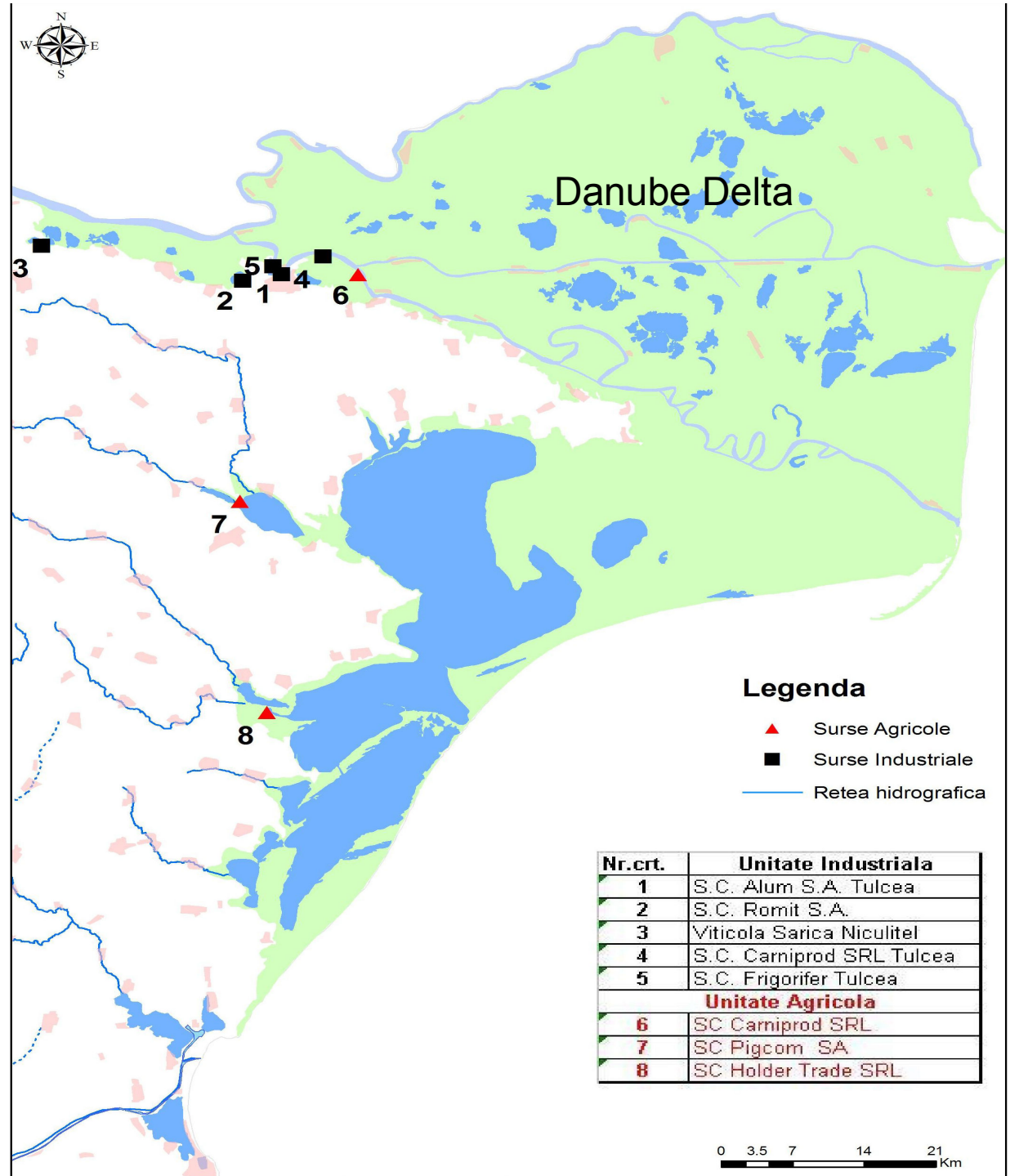
TOTAL: 15,025 ha

The Danube Delta Sector monitoring stations



DANUBE DELTA AREA

Local sources of anthropic activities



NAEP Report on the state of the Environment

Dispersal of trace metals in water:

Fe and Cr – increase in areas controlled by riverine inputs

Mn, Zn, Pb – irregular distribution

Mn, Zn and Cu decrease from the fluvial delta plain to the marine delta plain

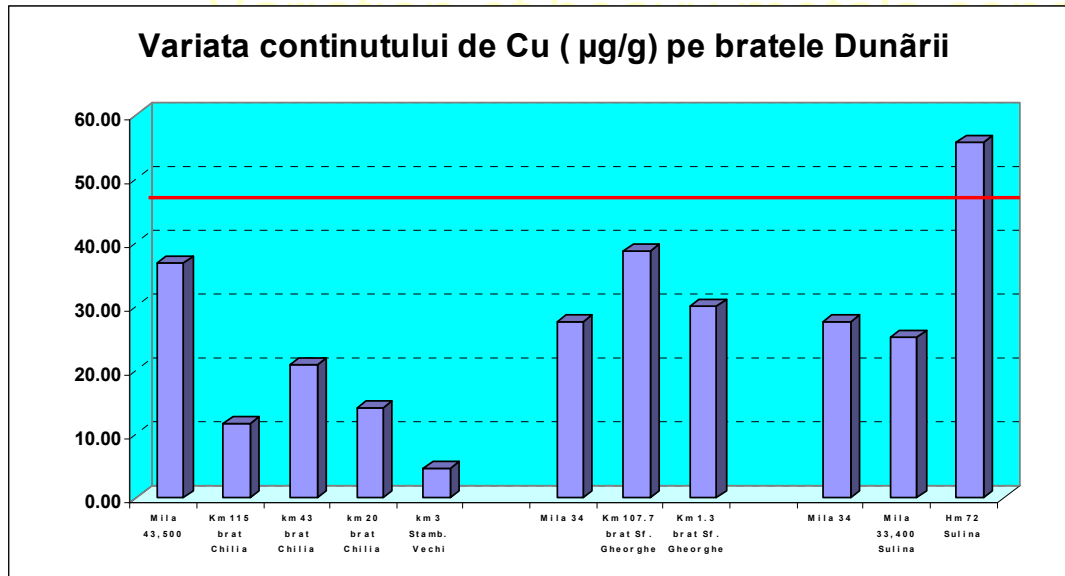
Razelm – Sinoie Lagoon Complex:

As and Mn - lower concentrations than in the deltaic lakes

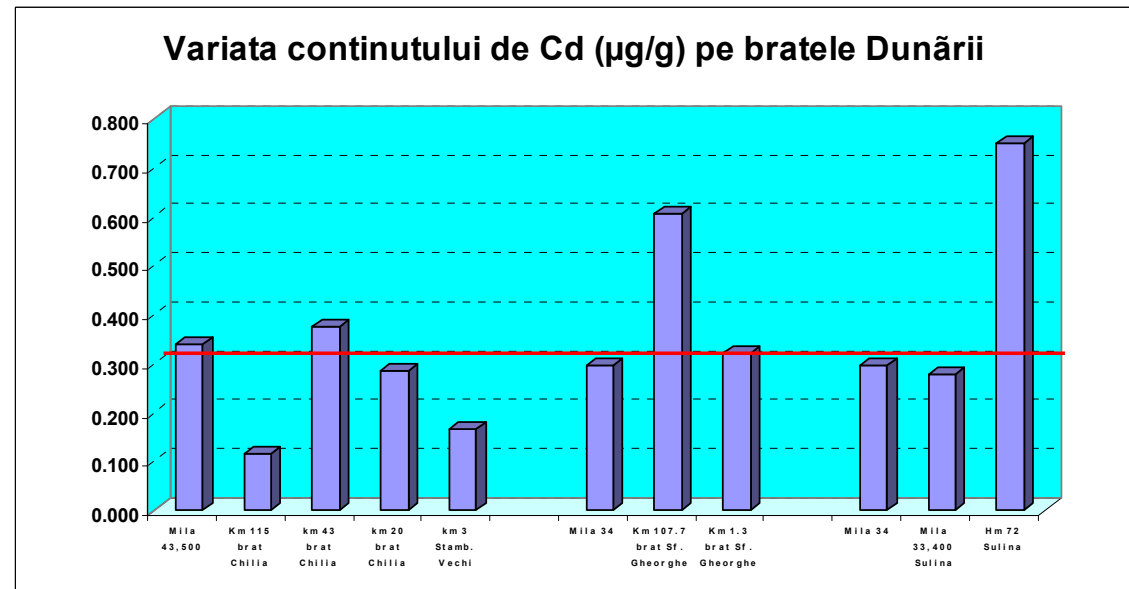
Cr, Fe, Ni, Pb and Zn - more abundant, can manifest increasing trends from north to south

Cu contents in sediments in the Danube Delta arms

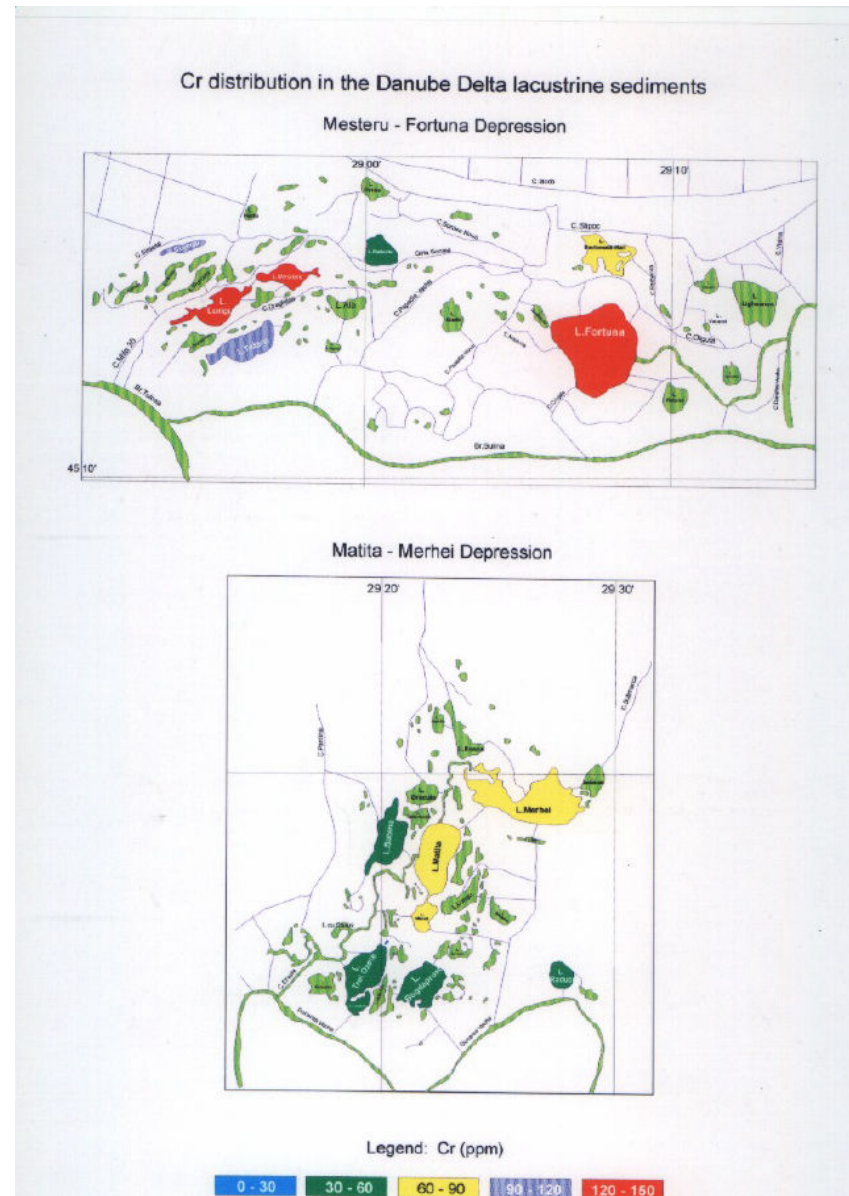
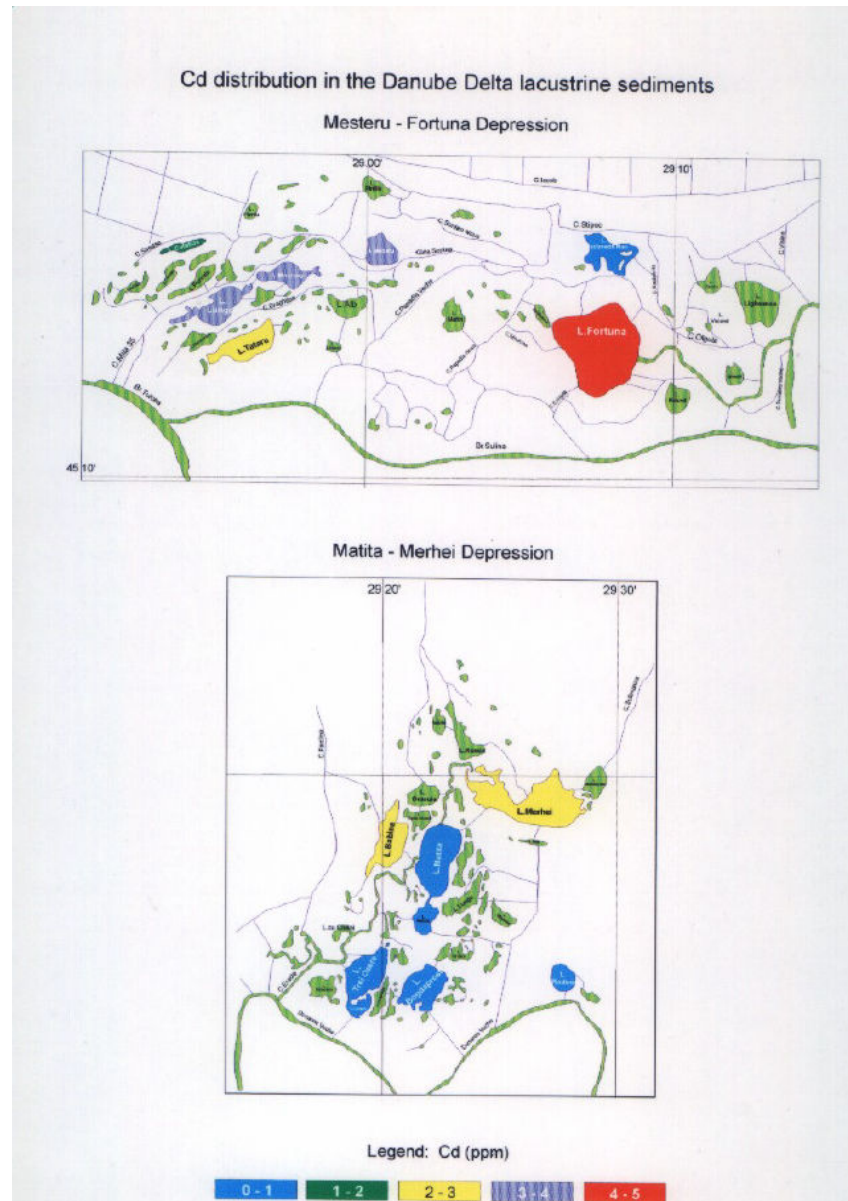
Concentrations along the
Mila, Sulina and St. George



Cd contents in sediments in the Danube Delta arms



Maps of sediment quality in Mesteru-Fortuna and Matita-Merhei depressions (Cd and Cr)



Pollutant contents in bottom sediments of the River Danube in front of the Black Sea basin

Km 3 – Stambulul Vechi section - Chilia branch

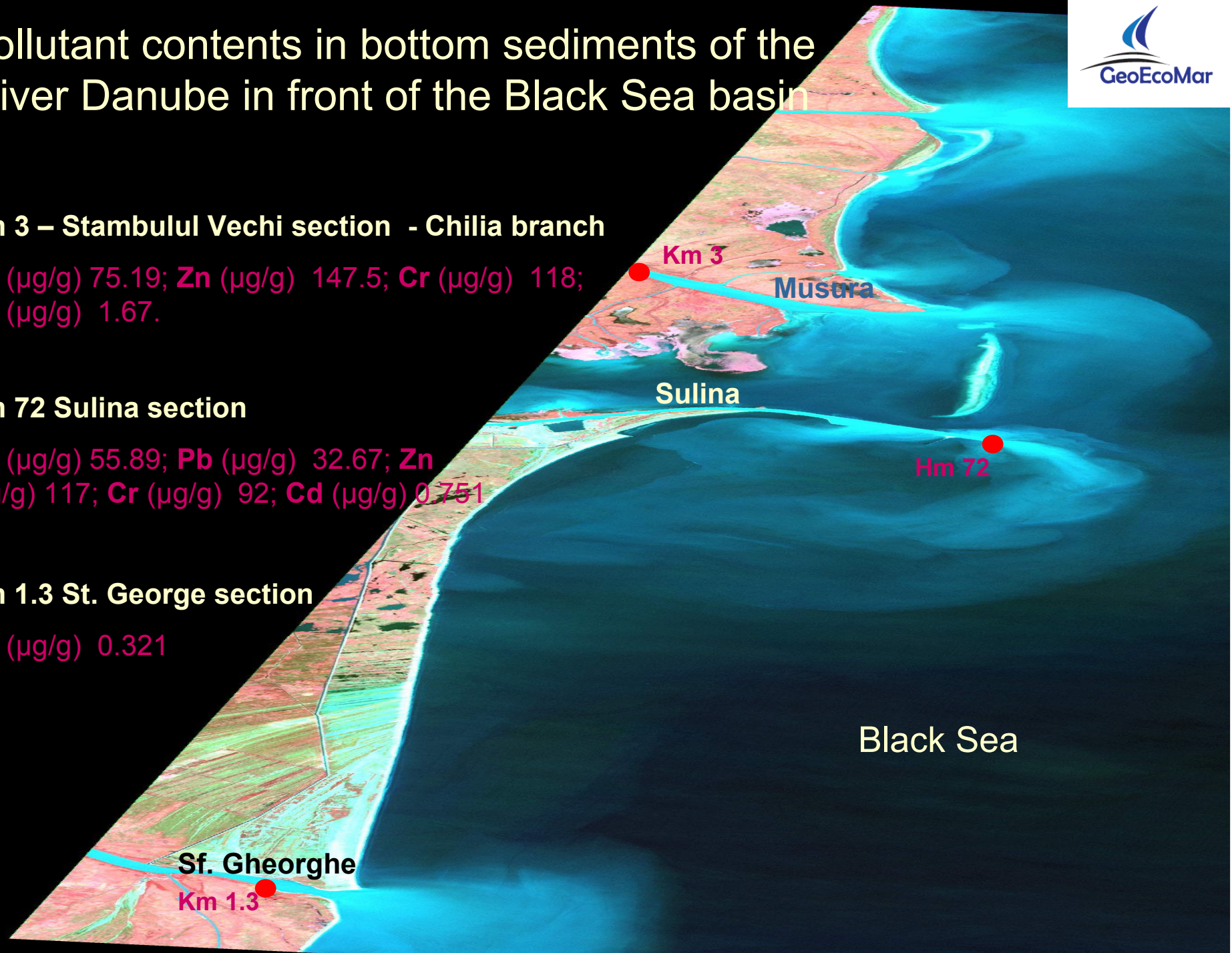
Cu ($\mu\text{g/g}$) 75.19; **Zn** ($\mu\text{g/g}$) 147.5; **Cr** ($\mu\text{g/g}$) 118;
Cd ($\mu\text{g/g}$) 1.67.

Hm 72 Sulina section

Cu ($\mu\text{g/g}$) 55.89; **Pb** ($\mu\text{g/g}$) 32.67; **Zn** ($\mu\text{g/g}$) 117; **Cr** ($\mu\text{g/g}$) 92; **Cd** ($\mu\text{g/g}$) 0.751

Km 1.3 St. George section

Cd ($\mu\text{g/g}$) 0.321



Heavy metals and other trace elements - Conclusions

-Lakes from River Danube influenced areas: generally high contents in almost all trace elements; suspect situations for As, Cr, Ni, Mn - adsorbed on clay minerals and Fe-oxides and hydroxides

- Confined lakes: lower contents; enrichment tendency in Ni, Cr, Mn, Pb - affinity for organic matter and/or atmospheric inputs (Pb)

- Distribution patterns: gradual increase from north to south within Razim-Sinoie Lagoonal Complex (Ni, Cr, Zn, Cu, Cd); influences of differential transport and sedimentation, leaching of the tailing dumps of the flotation plant from Baia, atmospheric inputs

Conclusion: not polluted sediments; slight local tendencies

Greenhouse gas fluxes distribution in the Lake Razelm (nmol/m²s)

