Hydromorphological balance of the Danube River Channel on the Sector between Bazias (km 1072.2) and Danube Delta Inlet (km 80.5)

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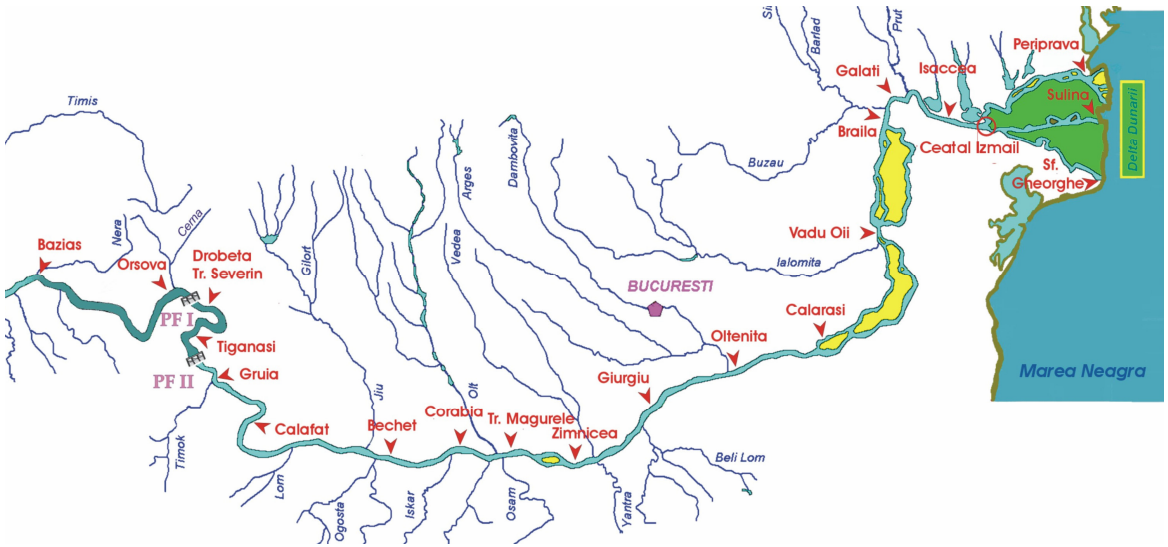
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1. Introduction.

- Channel perimeter (1300 km length).
- Channel physical degradation.
  - Cannel widening due to erosion.
  - Reduction of navigation depths due to formation of sandbars, islands and secondary branches.
- Hydrological components:
  - Danube water discharge between 1840 and 2006.
  - Danube sediment discharge between 1840 and 2006.
  - Channel morphologic regime between 1909 and 1992.
- Hydrological monitoring on the Romanian lower Danube.
  - 17 hydrometric sections (**figure 1**).

Figure 1.

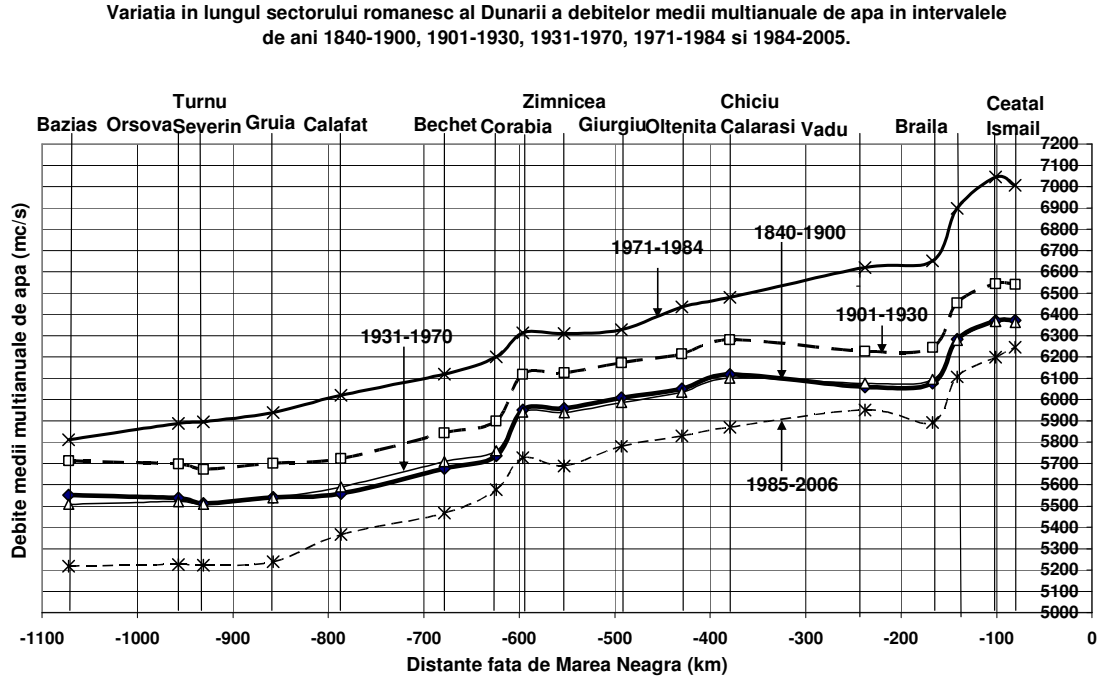


2. Engineering works influencing the water and sediment discharge on the Danube River.

- 1840-1900, natural river bed, no engineering works;
- 1901-1930, starting of the river embankment;
- 1931-1970, the river embankment almost finished;
- 1970-1984, the river embankment finished and the construction of Iron Gates I ;
- 1985-2006, the river embankment finished and the construction of Iron Gates I and II.

3. The balance of average water discharges

Figure 2.



Characteristics:

Relative uniform variation of water average discharges with increases at big affluent mouths Olt and Siret rivers.

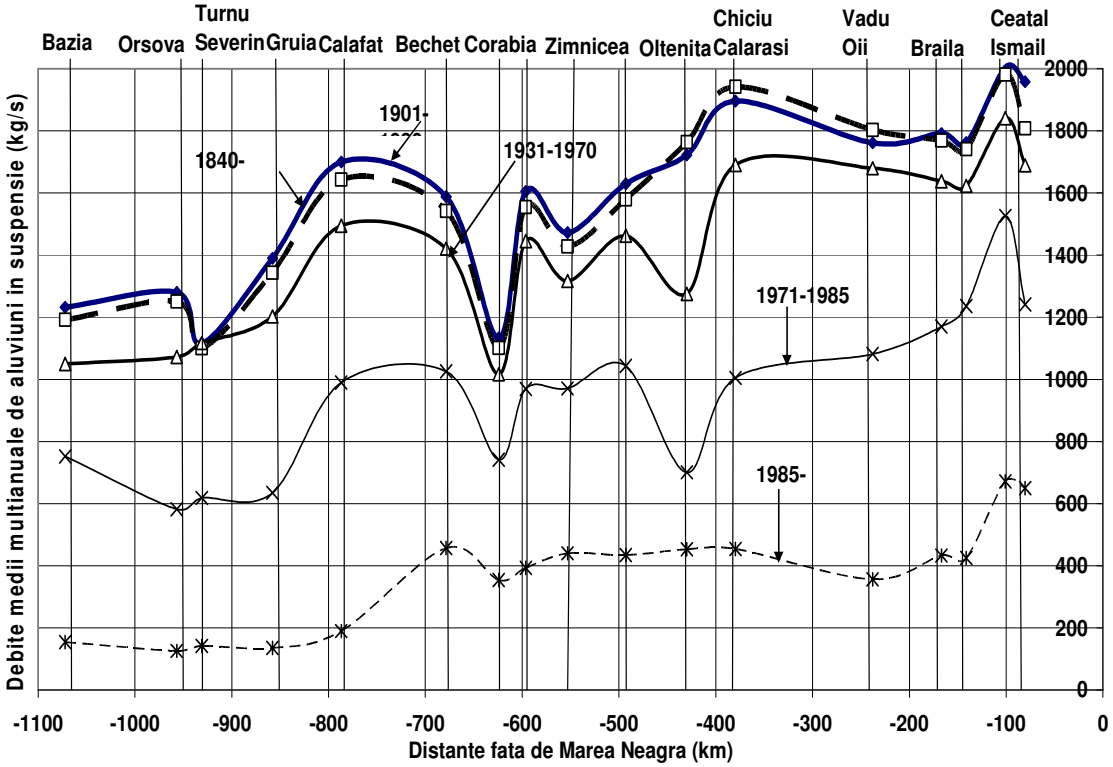
Linear time trends between 1840-2006 :

	Average	Trend
	mc/s	mc/s/yr
Bazias	5566	-0.951
Ceatal Ismail	6471	1.17

4. Sediments discharge balance.

Figure 3.

Variation of the multiannual average sediment discharges on the lower Danube in the periods 1840-1900, 1901-1930, 1931-1970, 1971-1984 and 1985-2006.



Characteristics:

Irregular variation of the average sediment discharges due to the morphologic processes.

Linear trend between 1840-2006 :

	Average	Trend
	kg/s	kg/s/an
Bazias	**988**	**-6.27**
Ceatal Ismail	**1619**	**-3.93**

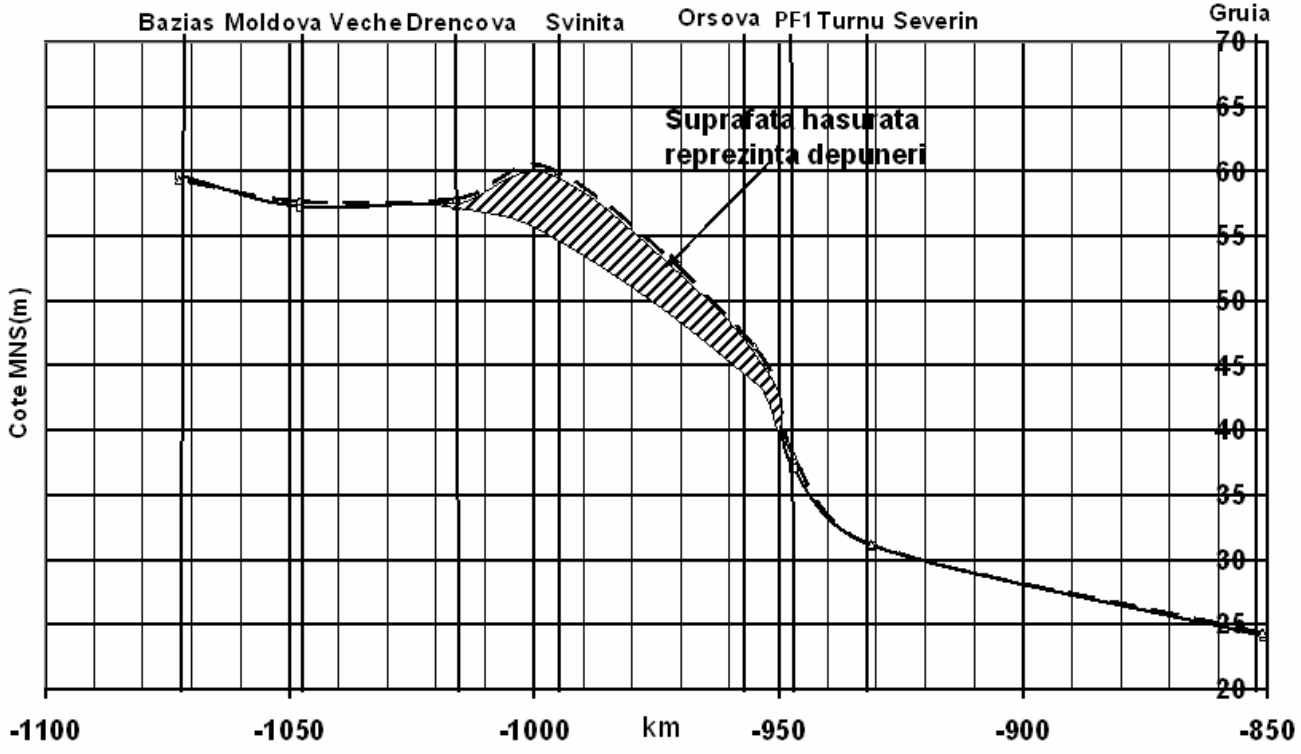
• **The sediment deposited in Iron Gates I and II lakes.**

Sediment discharge into Iron Gates I and II (1971-2005) is about 393 mil.t and depositing about 133 mil.t (34 %)

- o Masive deposition between Drencova (km 1016) and barrage (km 942.9) with thikness up to 5 m.
- o Grain size between 0.08 and 0.001 mm, mean diameter d50% = 0.025 mm.

Figure 4.

Variation of the river bed elevation for the Iron Gates lakes. Solid line corresponds to the river bed elevation in 1971 and the dashed line to year 2005.



• Sediment discharge on the lower Danube.

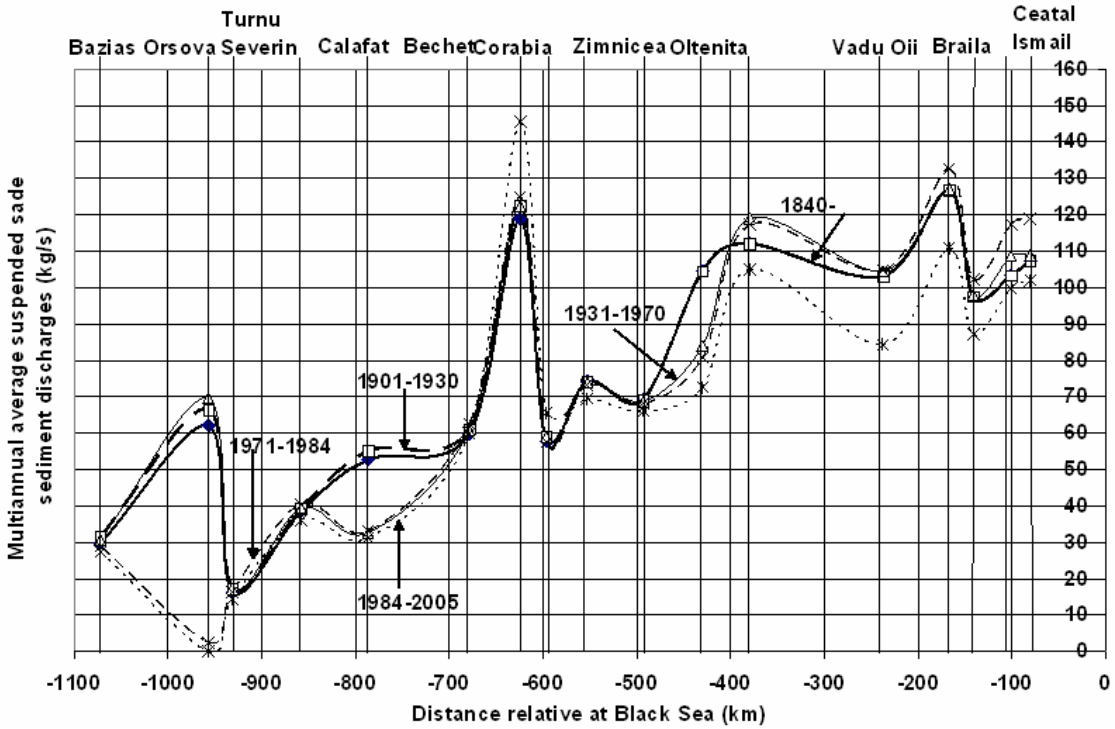
• It presents a great interest for Danube channel hydro morphological processes, the sand sediment (with fraction >0.08 mm) transport which comes in composition of the suspended sediment global transport.

• The experimental sediment discharge measurements for separation of sandy sediment discharge with particle large than 0.08 mm showed that the sandy sediment transport is dependent of water current kinetic energy.

• When the current average velocity decrease bellow a critical value, the transport stops.

• The multiannual average of the Danube sandy sediment discharge between 1840 and 2006:

o At Bazias section (Km 1072.2) about 30 kg/s (946730 t/y)



Characteristics:

• High irregularity of the trends.

• The majority of sediments retained at Iron Gates I

• The water regain much of the sediment due to erosion and contribution of the tributaries

Linear trend between 1840-2006 :

	Average kg/s	Tendency kg/s/yr
Bazias	**29.9**	**-0.0082**
Ceatal Ismail	**103.5**	**0.1237**

5. The characteristics of morphologic regime on the lower Danube low.

- **Hydrographical data fund used:**

o Bathymetric charts of Navigation National Authority from 1909, 1962 and 1992 at scales 1:25000, 1:10000 and 1:5000.

o Bathymetric profiles from hydrometrical sections of water and sediment discharge measurements between 1965 and 2005.

- **Results of bathymetric data processing.**

o Time variation of channel morphometric average data (width and depth) relative at low-water on the sectors:

Upper km	Lower km	Width (m/yr)	Depth (m/yr)	Vulnerable channel length (km/yr)
860	80	0.737	-0.076	1.39
860	375	1.04	-0.07	1.185
375	240	-0.073	-0.075	0.111
240	169	1.175	-0.127	0
169	80	0.877	-0.085	0.103

o The morphologic equilibrium of the river bed on the lower Danube stops when the water discharge drops bellow 2.8 m3/s.

o In order to keep the morphologic equilibrium of the river bed $B <= 146 \cdot h$; where B is the channel width and h is the channel depth.

o The vulnerable channel length increase from 120 km in 1909 to 244 km in 1988 .

o The annual periods with low waters (< 2.5 m) in critical points increase up to 50 days. .

o The number of islands on the sector Turnu Severin - Chiciu-Calarasi increase from 93 in 1934 (283 km total length) to 135 in 1992 (353 total length).

o To keep the navigation depths, between 1991 and 1990 was dredged a sandy sediment volume of 2.5 mil.t/yr.

- **The safety of navigation is strongly influenced by the processes previous describe and there is an urgent need to stop or diminish the effects of the hydromorphologic processes.**