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Water flow and sediment transport in the Lower Danube River

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A comprehensive hydrologic study has been recently carried out in INHGA Bucharest, aiming to determine the main characteristics of water flow and sediment transport in the Lower Danube River in Romania, for the period of time from 1931 to 2003.

The hydrologic study was conducted by making use of a large amount of field data collected at a number of 15 hydrometric stations located along the Lower Danube River, from the Bazias Village (rkm 1072.5) where the river enters into the Romanian territory to the Ceatal Izmail bifurcation (rkm 80.5) where the river enters into the Danube Delta.

The main hydro-morphological parameters collected regularly at various hydrometric stations (six to eight times every year) and occasionally during some field campaigns, referred to:

- The water flow: level, velocity, discharge,
- The sediment transport: discharges for suspended-load and bed-load,
- The river channel and bathymetry: wetted width and area, depth, slope, cross-sectional and longitudinal profiles,
- The water quality: temperature, turbidity, pollution, mineralization,
- The sediment quality: size distribution and characteristic diameters of suspended and bed materials, contamination, and others.

Primary analyses of long-term time series of measurement data (from 1931 to 2003) showed that:

- At the Bazias station, where the Danube River enters into the Romanian territory:
  - The multi-annual discharge of flow is about 5460 m^3/s, with an average volume of 172.24 km^3 per year (the maxim of 251.03 km^3 per year recorded in 1941 while the minim of 118.89 km^3 per year recorded in 1990).
  - The multi-annual discharge of suspended materials is about 738 kg/s, with an average volume of 23.28 million tones per year (the maxim of 64.46 million tones per year recorded in 1940 while the minim of 1.92 million tones per year recorded in 1990).
- At the Ceatal Izmail station, where the Danube River enters into the Danube Delta:
  - The multi-annual discharge of flow is about 6460 m^3/s, with an average volume of 203.74 km^3 per year (the maxim of 297.07 km^3 per year recorded in 1941 while the minim of 134.03 km^3 per year recorded in 1990).
  - The multi-annual discharge of suspended materials is about 1279 kg/s, with an average volume of 40.34 million tones per year (the maxim of 106.31 million tones per year recorded in 1940 while the minim of 7.25 million tones per year recorded in 1990).

- The annual runoff in the Lower Danube River between the Bazias and Ceatal Izmail stations is strongly influenced by the Romanian tributaries (Jiu, Olt, Arges, Ialomita, Siret and Prut rivers) which contribute with about 1000 m^3/s, while contribution of the Bulgarian tributaries (Lom, Ogosta, Isker and Yantra rivers) is very small, 100-150 m^3/s in total.

Three different hydrologic regimes one can identify for water flow and sediment transport in the Lower Danube River:

- The *natural regime*, undisturbed, that occurred from 1931 to 1965,
- The *transitional regime*, from natural to current, that occurred from 1966 to 1985, and
- The *current regime*, disturbed, that occurred from 1986 to 2003.

The natural regime corresponds to "reference" conditions in the Lower Danube River. The transitional and current regimes are determined by the great hydrotechnical systems Iron Gates 1 (completed in 1972) and Iron Gates 2 (completed in 1985), as well as by the large water management schemes with dams and reservoirs-in-cascade, realized from 1965 to 1985 in the major Romanian tributaries (Olt, Arges, Siret and Prut rivers).

A thorough investigation on these hydrologic regimes concluded that in comparison with the natural regime, due to various natural causes (climate changes) and anthropogenic causes (damming of the main river and tributaries, silting of reservoirs, sand mining), the current water flow regime is slightly reduced (3 to 8%), while the current sediment transport regime is drastically reduced (65 to 80%).

These changes in water flow and sediment transport regimes in the Lower Danube River have significant impact on wider environment in the region (e.g. riverbed morphological changes, bank erosion, water quality, current, wave action and coastal erosion in the western Black Sea, and others).

Several depth-discharge curves, flow profiles, and sediment transport relationships have been derived for various engineering and environmental purposes in the region, at different locations along the Lower Danube River.

Station	rkm	Natural regime (1931-1965)		Current regime
		Water volume (km^3/year)	Sediment volume (mil. tones/year)	Water volume (km^3/year)
Bazias	1072.5	172.82	33.93	162.19
Orsova	953.3	176.63	33.93	162.63
Gruia	851.0	176.07	34.00	162.76
Calafat	794.6	181.87	44.40	166.95
Bechet	679.0	177.77	51.59	170.74
Corabia	629.5	180.39	53.04	172.53
Zimnicea	553.5	190.64	41.56	177.83
Giurgiu	492.8	191.33	46.14	179.66
Chiciu-Calarasi	364.5	191.99	53.77	182.09
Vadu Oii	238.0	195.27	53.01	184.52
Braila	169.4	190.04	51.69	184.55
Grindu	139.6	197.92	53.87	190.70
Ceatal Izmail	80.5	201.07	53.30	193.98