Sediment related environmental problems at the Lower Danube

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1 Introduction

Hydrological monitoring and research has a long tradition in all of the Lower Danube countries. It is a necessary precondition for all studies directed to Danube sediment load and river morphology. The suspended sediment load and bed load transport depends on runoff and can only be understood together with the runoff regime characteristics.

In general, hydrological monitoring is in the responsibility of the Hydro-meteorological Institutions of the countries. Some additional monitoring and research work is performed by other institutions, such as water way authorities, universities etc.

The hydrometrical practice on the Lower Danube river is following the instructions for hydrological measurements and observations compiled and published by the Danube Commission in Budapest *(Danube Commission, 1979)*.

In **Romania**, along the Danube River between Bazias (km 1075) and the Danube Delta (km 80), the Romanian Hydrological Service has continuously maintained standard hydrological measurements in 20 cross-sections in the main river bed, and daily observations at 22 stations.

The **Bulgarian** section of the Danube River (km 843–km 375) is well studied from the hydrological point of view. There is a continuous information about the stages since 1908, and about the water discharge since 1935. The present hydrological network was built in the catchment area from 1948 to 1960, when more then 80 hydrologic and water stage stations came into operation but the 8 stations and 20 gauges are located on the main river.

In **Yugoslavia** regular analyses of the river morphology have been carried on since the beginning of design of Iron Gates I, i.e. since 1956. The impact assessment programmes were implemented regarding the flow regime and sediment transport within the area affected by the reservoir.

The common hydrometrical practice on the Lower Danube is following the instructions for hydrological measurements and observations compiled and published by the Danube Commission in Budapest (Danube Commission, 1979).

Within this report, a special focus is set on those uses, activities and hydrotechnical structures which influence the morphological processes, or which are affected by an adverse morphological development which influence on the environment at the Lower Danube.

2 Inventory of human activities along the Lower Danube main stream

After the Second World War, the economical development of the downstream riparian countries caused an increase of the water uses from the Lower Danube River reach and from the tributaries within the whole national territories from the catchment. Since that time, a significant number of hydraulic structures were built on the Danube river and on the tributaries as well. Among the most important hydraulic structures, the following are of main interest to be mentioned: the hydropower and navigation systems Iron Gates I and II on the Danube river, the Danube – Black Sea Channel, the levees for flood protection on the Danube river, the municipal water supply and the irrigation systems, ports and shipyards. Dredging, as a part of human activities, has an effect of major importance on the river bed and bank stability and therefore needs to be included. The wetlands and reserve territories are considered as a specific and important water use which deserves a special attention.

The Iron Gates Hydraulic System. The Iron Gates Water Power and Navigational System consists of two reservoirs built on the Yugoslav-Romanian section of the Danube river. The upstream dam "Iron Gates I", located at km 943 of the Danube river, was completed in 1972. The downstream dam "Iron Gates II" was completed in 1985 at km 862 + 800 of the Danube river. The aim of the dams is to make use of the considerable water energy potential and to improve the conditions of navigation.

The "Iron Gates I" reservoir extends on a complex river system, consisting of the Danube river and its tributaries. The total drainage area upstream of the dam is 577,000 km^2. The tributaries of the Danube river within the reservoir range are the Tisa river, the Sava river, the Morava river and a few minor rivers. The important characteristics of the reservoirs are the variable heights of water level and extent of the backwater zone, depending on the inflow and the power-plant operation. The average volume of the reservoir is $3.5*10^9 m^3$.

The average annual discharge on the upstream dam site, as well as on the downstream Danube reach, is about 5,400 m^3/s. Since the "Iron Gates I" reservoir volume is only 1.5–3 % of the average annual flow, its impounding effects cannot be significant. Actually, it provides only a daily and weekly flow regulation. The "Iron Gates II" reservoir is incomparably less in volume, thus its ability to produce impounding effects is negligible. The natural sediment transport regime of the Danube river is considerably influenced by the construction of the "Iron Gates I" reservoir *(Gutknecht, Modev, Bondar, 1998; Varga et al., 1996; Petchinov, Rainov et al., 1976.* Depending of the daily operational scheme of the hydropower plant, significant fluctuations of the water discharges and hence the water levels occur upstream as well as downstream. Downstream they are transmitted up to a distance of more 150 km.

Upstream of the hydropower and navigation systems Iron Gates I and II, between km 2357 and km 1820, the main bed of the Danube was dammed in 14 sections. On the 17 km long **Yugoslav Danube reach** downstream from the Iron Gates II Dam there exist a few hydraulic structures, which are insignificant in regard to the sediment transport.

The Danube-Black Sea Channel. The channel works started in 1949 in the variant of an unique line between the Danube river (Cernavoda harbour) and the Black Sea (Midia harbour). For economical reasons, the channel works were interrupted in 1953 and started again in 1975 in a more complete variant, with a unique line between the Danube (Cernavoda harbour) and Poarta Alba. The channel of 64.4 km length allows for the navigation between Cernavoda harbour, located at km 299.5 on the Danube river, and Constanta Sud Agigea as well as Midiathe, the sea harbours of the Black Sea. The channel is 90 m in width at the water surface, and 7 m in depth. By its specific operation under a dammed regime with locks, the Danube-Black Sea channel only insignificantly influences the water runoff of the Danube river. Besides the navigation facility, the channel provides also water for irrigation of the agricultural area of the central and southern districts of the Dobroudja department. As a result of diversions form the navigation channel to the irrigation canals, the mean water consumption approximately amounts to 68 m^3/s.

Dredging. The main goals of dredging are the maintenance of the navigation routes and the depths maintenance of approach channels to the ports, as well as production of sand and gravel. The two types of dredging differ considerably with respect to their disposal methods.

Table 1. Dredging at the common Bulgarian-Romanian section of the Danube river (km 843 – km 375)

		Romania			Bulgaria			Total		
Period	Dimension	1	2	total	1	2	total	1	2	total
1961–70 Mean annual	10^3 m^3 10^3 m^3 yr^{-1} %	4523 452.3 100	4943 494.3 100	9466 946.6 100	2753 275.3 100	2530 253.0 100	5283 528.3 100	7276 727.6 100	7473 747.3 100	14749 1474.9 100
1971–90	10^3 m^3	30608	23113	53721	9986	8639	18625	40594	31752	72346
Mean annual	10^3 m^3 yr^{-1} 1530.4 %	1156.6 338.4	2686.0 234.0	499.3 283.8	431.9 181.4	931.2 170.7	2029.7 176.3	1587.6 278.9	3617.3 212.4	245.2
1961–90	10^3 m^3	35131	28056	63187	12739	11169	23908	47870	39225	87095
Mean annual	10^3 m^3 yr^{-1}	1171.0	935.2	2106.2	424.6	372.3	796.9	1595.7	1307.5	2903.2

*1 Dredging for the maintenance of navigation
2 Dredging for sand and gravel production

Flood protection. Under natural conditions, the Danube river bed on the **Romanian Danube river bank** had a large floodplain, reaching from Gruia (km 851) downstream to the Black Sea, including the Danube Delta. The total floodable area of the Danube river downstream was of about 880,000 ha, out of which about 85,340 ha were on the right shore, belonging to Bulgaria. The Romanian surface area of the Danube river floodplain, up to the inflow into the Danube Delta, was of about 630,000 ha. After the Second World War, the old dikes were reconstructed and new dikes were built. From the total surface area of 530,000 ha of the floodable lowlands of the Danube bed along the Romanian shore, a surface of 438,000 ha (76.9 %) has been relieved from floods. The length of the defense dikes is of about 1,100 km. In Bassarabia belonging to Ukraine, about 166,000 ha have been embanked in the floodplains of the left bank of the Danube river downstream the mouth of the Prut river and along the left shore of the Chilia branch of the Danube Delta. The crest of the dikes surmounts the mean level of the natural bank of the river bed by about 2–3 m, depending on the local configuration of the dikes along the Danube river bed. The distance between the dikes and the banks of the main river-bed varies between 150 and 300 m, an area where also a tree protection curtain was planted. By their specific location and function the embankment structures have differently influenced the runoff regime of the floods in the Danube river.

The dikes on the right **Bulgarian Danube river bank** were built up between 1930–1950, at about 16 years earlier than on the left bank. The total length of the dikes is 264 km. The area protected from instead floods is 85,340 ha. The crest elevations are determined to prevent lowlands from floods with 1 % probability of exceedance of the peak discharge, in urban territories 0.1 %. The dikes have an influence on the streamflow during the flood-period and in the case when the discharges are greater than 9,500–10,200 m^3/s.

By these embankment works in the floodable plain of the Danube river, a significant water volume has been redirected to the main channel, thus influencing the runoff regime of water and sediments in the Danube river. By preventing the water exchange between the main course and the floodplains, the sediment transport within the bed has been almost entirely directed downstream towards the mouth, without major lateral losses. The increase of the total load of sediment transport is the main impact on the sediment transport and finally on the river morphology.

Bank protection structures on the right bank. Since historical time the right Lower Danube bank is most populated because of the more suitable conditions for the man activities. Bank protection is of a major importance on the steep Bulgarian bank. The bank revetment structures can be subdivided into "passive" and "active" structures. "Passive" structures are the retaining walls, some kinds of biological revetment – brush revetment etc., which do not affect the river-bed processes. "Active" structures are those which change the river bed morphological processes in their near vicinity but have local effects only, such as the spur dikes, rubble groins etc. The structures in use are retaining walls, spur dikes and rubble groins, embankment from dry-rubble masonry and brush or forest revetment. The total length of the protected bank is 77.7 km, or 16.5 % of the total length of the Bulgarian Danube river-bank.

Harbours and shipyards. Together with the development of the **Romanian** naval fleet and the communication lines like roads and railways, during the 19th century the Romanian Danube fluvial and maritime harbours were modernised. In Romania harbour structures have been built until the end of the 19th century in Moldova Veche, Drobeta Turnu Severin, Calafat, Corabia, Turnu Magurele, Zimnicea, Giurgiu, Oltenita, Calarasi, Cernavoda, Harsova, Braila, Galati, Isaccea, Tulcea and Sulina on the left bank. In **Bulgaria** the harbour structures have been built in Novo Selo, Vidin, Lom, Oriahovo, Nikopol, Svistov, Russe, Tutrakan and Silistra on the right riverbank. After the Second World War, together with the development of Romanian and

Bulgarian industry of naval construction, the facilities developed considerably, and new shipyards appeared were enlarged and modernised.

Draining and irrigation. In the **Romanian** Plain and the Dobroudja, agricultural areas of about 2,284,000 ha are arranged for irrigation. The irrigation systems are equipped with pumping stations, taking water from the Danube river and from the lagoon-complex Razelm-Zmeica. The total capacity for irrigation water extraction by the Romanian pumping stations amounts to about 1,570 m^3/s. In **Bulgaria**, about 128,000 ha are irrigated with water from the Danube river. In the Bulgarian Danube basin, an area of about 600,000 ha is irrigated, and the pumping stations reach a capacity of about 270 m^3/s.

The Danube water intakes for the irrigation systems and the return amounts from the drainage systems practically are equal.

Municipal and industrial water intakes. On the **Romanian** bank of the Danube river are located complexes emerged for technological and chemical plants, which use water from the Danube river. The development of some harbour towns as well the economical activities for the food industry are to be mentioned among others. For the great water intakes (with installed capacity greater than 1 m^3/s) water inlets have been built of a caisson type cylindrical form, placed directly in the river bed close to the banks. According to the records of the water management organisations, it results that the water uses from the Danube river for economical activities (industry, municipal supply and agriculture) sum up to a mean annual intake of about 140 m^3/s and a mean annual backflow of about 47 m^3/s. Headlong urbanisation commenced in **Bulgaria** after 1935. The relative share of the urban population increased from 22 % to 65 % and that process intensified after 1950. In 1995 water consumption went down by around 20–30 % basically at the expense of industry.

The irreversible losses of water in 1995 come up to $666 \cdot 10^6\ m^3$ *which is an insignificant quantity with respect to the Danube river runoff at Silistra.*

Hydraulic structures and systems in the main tributary catchments of the Danube river

Yugoslav tributaries of the Danube river. Considering the sediment input from Timok river into the Danube river, the impounding structures in the Timok river watershed are of the primary importance. During the past period, five reservoirs were constructed in the catchement area. During the period of 1960–1990, about 150 check dams were constructed in the Timok river basin.

Romanian tributaries of the Danube river. The dams on the Romanian tributaries of the Danube river, creating water reservoirs for hydropower use and water management (industry, water supply and tourism) are the most important structures. Dams were constructed on the rivers Cerna (2 dams until 1983), Jiu (a dam until 1968), Olt (25 dams until 1988), Arges (5 dams until 1987), Dambovita (2 dams until 1989), Ialomita (2 dams until 1987), Siret (8 dams until 1986) and Prut (a dam until 1980).

Bulgarian tributaries of the Danube river. The arable land under crop did not change in area during the period of 1935–1995. After 1992, agriculture was restructured within its parameters of 1935. 200,000 ha of land have been terraced since 1959. There are 819 large and small reservoirs in the Bulgarian part of the Danube catchment area with a total volume $2.311*10^9$ m^3. Most of the reservoirs were built between 1955 and 1982.

In the river basins of the Lower Danube tributaries, a number of dams tend to decrease or stop the river bed erosion processes. This man activities reduce the sediment transport and now it mainly occurs during floods. The bed load transport is practically stopped from the dams.

Afforestation. The forest reclamation is usual practice too. It is carried out on the appropriate programmes of the Committee of the Forests. Frequently forest belts or bands and clusters of trees are in use to prevent from surface erosion. Benching of slopes and other land reclamation and antierosion activities cover 4.3 % of the Bulgarian catchment area of the Danube river or about 200,000 ha (2,000 km^2). After 1955, great efforts were made in order to control and stop the erosion processes in small creeks and from the land surface. Among these works, there are anti-erosion works within torrents, slope offset works and re-afforestations.

The overall effect of these measures can be realised in a notable reduction of the sediment input to the tributaries.

The impact of human activities can be classified into two groups:

impacts within the catchment area (forestry, agriculture and related irrigation, water-supply and draining, urbanisation, open mines, gravel-pits sand-pits and so on);

impacts directly connected with the river network (construction works for water power plants, water-supply systems for municipal and industrial needs, irrigation and so on).

The total evaluation of the human activities impact on the river morphology can be dome on the base of the sediment load analysis. The main component of the analysis is the sediment balance assessment.

3 Summary sediment load balance and river morphology

The sediment balance has been studied on the base of existing time-series of the registered suspended sediment load and limited volume of the bed-load measurements.

The main suspended load time series on the Danube river from Romania and Bulgaria are shown in Figs. 1 and 2. In Fig. 3, the contribution of the Danube river and the tributaries to the suspended load total input to the downstream section is shown. It is important to note that the tributaries contribution is, roughly assessed, around the half of the total. All inputs, during the considered time, decreased approximately at the same rate. For 1983–1995 this results, finally, in almost the same relative input rates, but at a considerable lower rate.

There should be a precaution interpretation of the results, which are indicative in such a way that they do not take into account material exchange with the embankments, flood plains, side arms and islands, which might be important in some reaches.

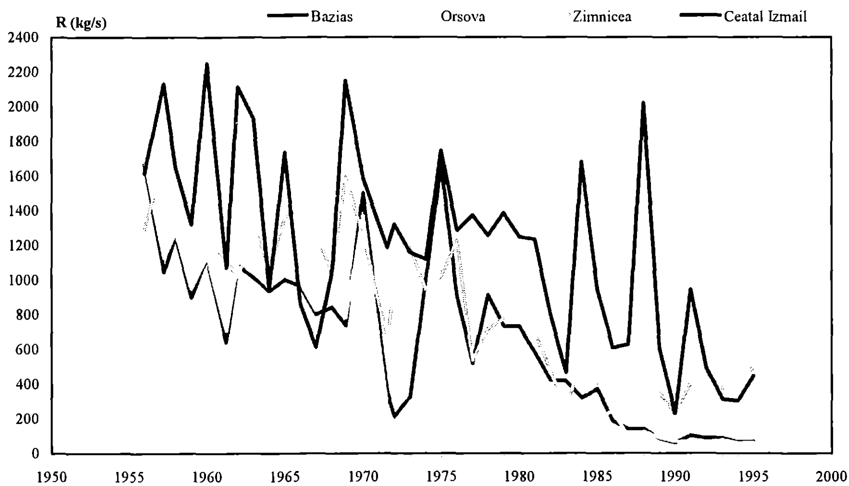

Fig. 1. Suspended sediment load hydrographs of the Danube river (Romanian stations) (Source: Morphological Changes and Abatement ..., Gutknecht, Modev, Bondar, 2000)

Further, no movement of materials on the river bed bottom has been accounted for. But the river practically is no more fed with coarse materials, except maybe from the embankments and the last downstream reaches of the tributaries where no dams exist. And finally, dredging has not be considered. There are data for dredging (see table 1), but it should be noted that they are not very accurate. What is more, it cannot be decided which part has been removed from the river, and which part only has been moved from one place to another. The latter part in any case is considerable.

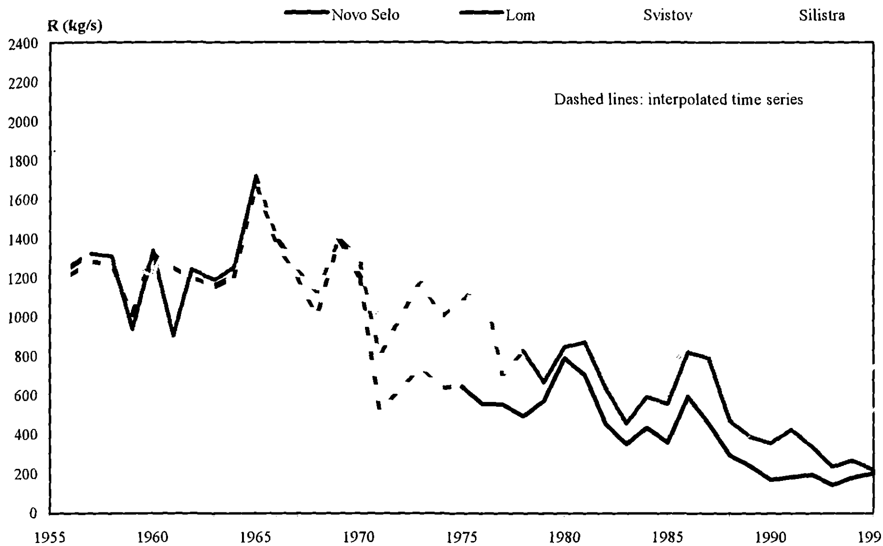

Fig. 2. Suspended sediment load hydrographs of the Danube river (Bulgarian stations) (Source: Morphological Changes and Abatement ..., Gutknecht, Modev, Bondar, 2000)

As conclusions the following can be stated about the main aspects of the morphological changes at the Lower Danube River:

The Danube river morphological process can be classified as a process in progress. In the upper part of the recognised section (km 845–km 730) the intensity of the erosion and accumulation is less then at the middle (km 730–km 500) or at the lower part of the section (km 500–km 375).

Hundreds of kilometers at the left and the right Bank of the Danube river are eroded;

- *A few crossings at the lower part of the section (km 375–km 500) have a tendency to become a limiting factor for the navigation during the following next years;*

The decreasing of the runoff, sediment load and water levels rise significant environmental impacts on the nature so on the future man activities in the different areas of the economic and social life on the Danube River Downstream.

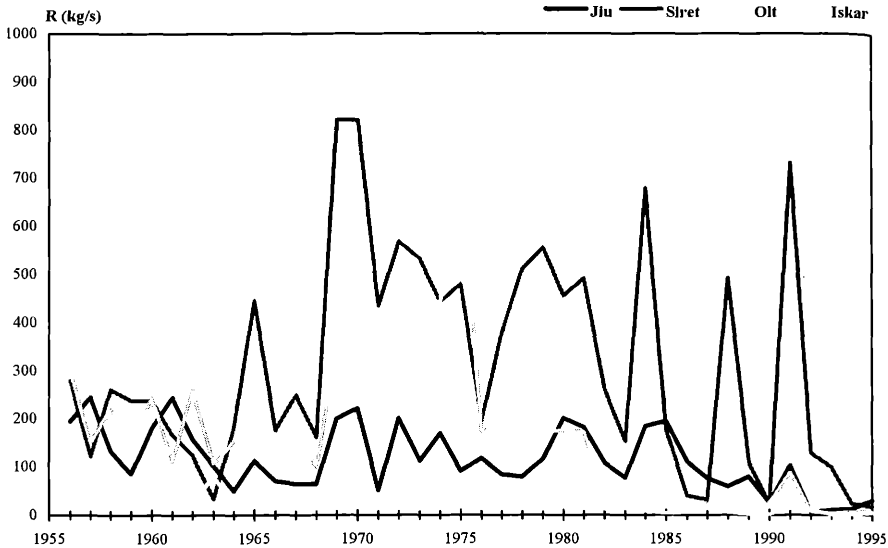

Fig. 3. Suspended sediment load hydrographs of the main downstream Danube river tributaries

Table 2. Summary of mean comparative river bottom elevation changes (Romanian and Bulgarian data)

	Common Romanian/Bulgarian reach		Whole reach
	Bulgarian data km 833.6–km 375.5 dh_m $cmyr^{-1}$	Romanian data km 786.9–km 379.6 dh_m $cmyr^{-1}$	Romanian data km 851–km 80 dh_m $cmyr^{-1}$
1956–1970	0.55	0.33	1.50
1971–1984	-0.12	0.68	1.04
1985–1995	-1.72	-0.84	-0.67

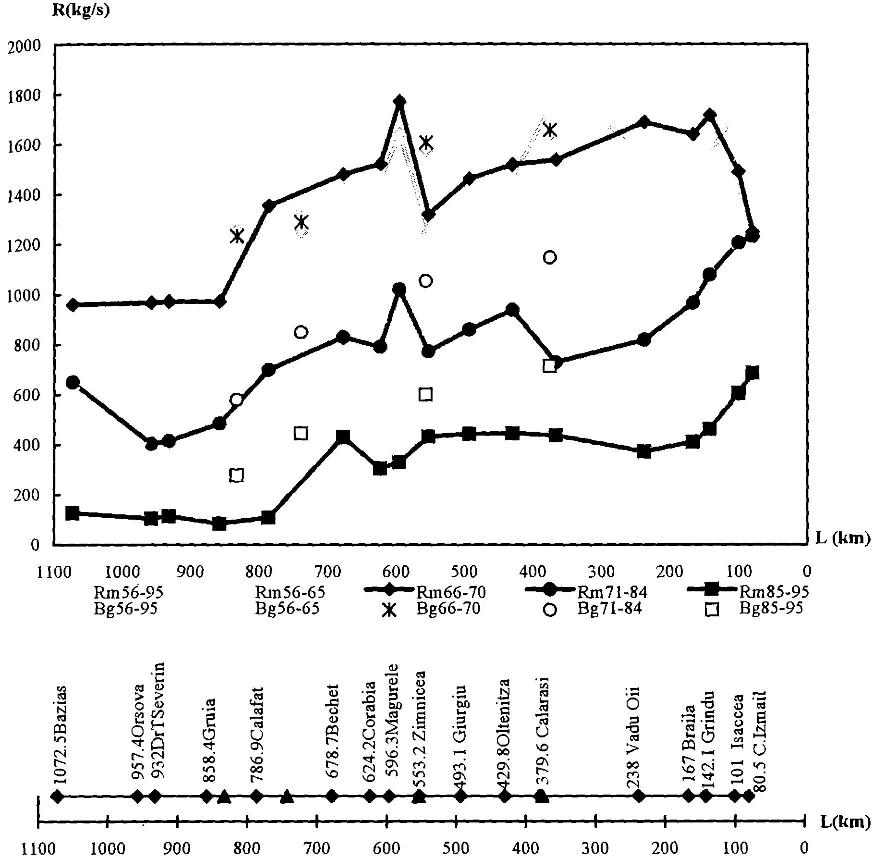

Fig. 4. Suspended sediment load along the Danube river for different time periods (Rm-Romanian data; Bg-Bulgarian data)

4 Environmental aspects of the morphological changes

The morphological Changes of the Lower Danube cause significant impact on the environment at the riparian territories and islands. Practically all of the characteristics of the riparian nature follow the morphological changes but in different way, power and sequence. The main impacts are related to the man activities already done to ensure the social and economy conditions on the reparian countries. The main activities under the morphological changes impact are as follow:

- Navigation conditions (maintenance and management of the navigation way)
- Water management activities (water supply, irrigation, power plants)
- Embankment/Slope stability
- Groundwater systems
- Wild life reserves and semi-aquatic habitats

Maintenance and management of the navigation. It depends from the crossings (bottlenecks) regime and space dimensions of the riverbed. The development of the negative impacts is well seen on fig. 5.

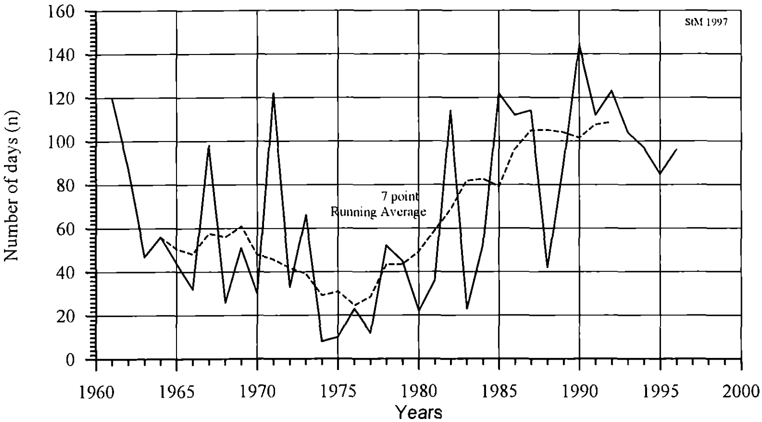

Fig. 5. Change of the annual number of days (n) with affected navigation conditions for the Danube river (common Bulgarian – Romanian Section).

The navigation conditions are of grate importance for the development of the riparion regions. During the last 30 Years the navigational conditions goes and stay heavier. The intensive morphological process reflect mainly on the bottlenecks regime. The Lower Danube developed to more critical for navigation in concern with the navigation conditions (table 3). The final conclusions about development of the navigation conditions can summarise as follow:

- Over the period 1947–1997 the slope of the water surface of the Danube river in the Svishtov-Russe and Russe-Silistra sections increased by 1,0–1,2 cm/km. The increase is from 18 % to 24 %;
- During the same period the flow capacity of the river bed went up by 12–18 %;
- The bottleneck crest elevations increased in average by 0,3–0,9 m;

- The amplitude of the change of the bottleneck crest elevations during the low-flow period is within 1,40–2,56 m and tends to increase downstream (from Svishtov to Silistra);
- New bottlenecks are formed in the close proximity of Silistra (km 375–404).
- The water level regime over the bottlenecks becomes aggravated. With all bottlenecks that have been surveyed (except the bottleneck at km 608), the water discharges that form the critical limit of 25 dm, increase.
- The volumes of the twenty-four-hour deformations of the bottlenecks change within broad limits: from 35000 to 150000 m^3/perday of accumulation and from 37000 to 230000 m^3/per day of erosion. There is a tendency toward higher intensity of the changes of the bottlenecks downstream.
- The improvement of the conditions for navigation along the Danube river by the help of systems of river training structures requires the application of a complex of structures and activities.
- Because of the high intensity of the processes of accumulation (up to 150000 m^3/perday), technical decisions that are based only on flow-directed dredging, will have low efficiency

The main reasons for creation of crossings are the river (energy) slope, the amount of suspended sediments and bed material. Better knowledge about the existing crossings would help to understand the reasons for the dramatic river bed changes, and to find the most appropriate measures for stabilising the river-bed, and also to improve the navigation on the Lower Danube.

From a navigational point of view a minimal floating depth (minimal navigation depth and width of the water way) is necessary over the Lower Danube stretch. Therefore the observations of crossings and necessary remedial actions (e.g. dredging, river training activities and so on) are of great importance. A minimum drought of 2,5 m has to be guaranteed during the low flow periods. The preliminary design of the river training structures, necessary to ensure the navigation conditions already done evaluate the necessary amount of financial resource at about 250 x 10^6 EURO (FHARE Project: Improvement of the navigation conditions in the Lower Danube, 2000–2001).

Water management activities (water supply, irrigation, power plants). Lowering of the water levels and decreasing of the river runoff cause significant changes on the energy potential of the Lower Danube.

Table 3. Characteristics of the main crossing (bottleneck) stretches along the Bulgarian-Romanian section of the Danube navigation way (period 1988–1997, low-flow season)

Bottleneck location/ Period	km 608 1988–1993	km 575 1988–1997	km 565 1988–1997	km 525 1988–1997	km 463 1988–1997	km 403 1990–1997
Maximum of the crest elevation Zd max * [m]	17.10	15.61	15.92	12.56	10.21	7.53
Minimum of the crest elevation Zd min [m]	16.23	14.05	13.36	11.16	7.79	5.17
Average elevation of the crest Zd aver [m]	16.64	14.92	14.28	11.82	8.59	5.85
Amplitude dZd = Zd max – Zd min [m]	0.87	1.56	2.56	1.40	2.42	2.36
Standard deviation of the crest elevation STDZd [m]	0.20	0.29	0.48	0.32	0.59	0.50
Maximum of the daily deformation dV max [m^3]	12150	56700	50760	74376	151340	56543
Minimum of the daily deformation dV min [m^3]	-38250	-63990	-54600	-77648	-250336	-116167
Average crest elevation by 25 dm depth at Year 1997 Zd aver [m]	16.52	14.94	14.30	11.96	9.16	5.32
Average crest elevation by 25 dm depth at Year 1947 Zd aver [m]	–	–	14.04	11.37	8.64	–

Table 4. Balance of the flow energy (KwH x 106/An)

Section/Period	833.6–554.3	554.3–375.5	Total
At1970	5844.66	4109.07	9953.73
1971–1984	5662.53	3868.77	9531.30
1985–1995	5155.70	3523.67	8679.37

Table 5. Balance of the flow energy change in %

Section/Period	km 833.6–554.3			km 554.3–375.5			Total for the section		
To 1970			100 %		100 %			100 %	
Change based on	Total	River morphology	Climate variability	Total	River morphology	Climate variability	Total	River morphology	Climate variability
1971–1984	3.12	1.14	4.26	5.85	-1.75	4.10	4.24	-0.06	4.18
1985–1995	-11.79	2.46	-14.25	-14.25	0.62	-14.87	-12.80	0.98	-13.87

It can be seen from table 4 that the flow energy of the Lower Danube stream decreased after the 1984. The main reasons are morphological changes and climate variability. The percentage ration of energy changes is done in table 5. The table 5 shows that the flow energy changes are significant on the Lower Danube. They reach total 12.80 % decreasing in compare with the period before 1970. It is of grate interest that on the base of the morphological changes the flow energy is increased by 0.98 % but because of the climate variability and upstream man-activities the energy decreased by 13.87 %.

Water delivery systems for domestic, agricultural and industrial purposes needed at about 40–50 x 10^9 m^3/Ann (including the Nuclear Power Plants). The water supply systems intake the water by pumping stations. The average head of the pump station is at about 20 m. The lowering of the water levels in the Danube river downstream by 0.6 m means that the necessary electrical energy have to increase by average 3 % or at about 50 x 10^6 KwH/Ann. The financial losses will reach 5 x 10^6 EURO/Ann.

Some of the pumping stations have to be reconstructed to ensure the necessary conditions to work during the low-flow period, because of the lowering of the riverbed and water levels.

Embankment/Slope stability. The bank erosion process can not be stopped. From the total length of 470 km Bulgarian bank is eroded in 95 km. The average intensity of erosion reach to 1.5 m/Ann. In some river sections the intensity is more then 3 m/Ann. Downstream of the town of Russe. The Danube River is change the river bed width with more then 600 m for the last 50 Years where the intensity of erosion is assessed to 12 m/Ann. Some of the Danube Downstream islands are partially or completely eroded (Tcibritza, Kamadinu etc.). The averaged losses of Bulgarian territory reach 130–250 dka/Ann.

Groundwater systems. The lowering of the river bad and water levels is followed consecutively by changes in the groundwater depression curves. The groundwater surface is of grate importance for the vegetation and habitat conditions of the aquatic spices. The lowering of the groundwater surface on the islands and the terrace of the main river course reach 0.5–0.7 m, in some cases even more. The ecological conditions on the wetland territories are changed significantly in concern with the water regime. The drying of the marshes is intensifying. The time-duration of the marsh overtopping is reduced not only during the flood period but all over the Year.

The lowering of the river bed is followed from dramatic dropping of the tributaries river bed. In some cases it reach 2.5 m (mouth section of the Iskar river). The lengths of the dropped riverbed reach some tens kilometer's. The decreasing of the groundwater surface covered thousand dka's arable lands. The stability of bridges and the different river structures is endangered too.

Wild life reserves and semi-aquatic habitats. Many reserve territories are under the UNESCO regulations. On the Lower Danube are located Danube Delta, Srebarna reserve territory, Belene, Kaikusha and Lalimok-Brashlian marshes and others. To ensure the necessary suitable conditions for the aquatic system on these territories special activities have to be directed for additional overtopping. The water regime of the territories needed special studies in the necessary complexity.

River flood plains form a green ribbon between the protecting dikes and the riverbanks. If these flood plains are in natural undisturbed conditions they represent a complex ecosystem with an enormous diversity of habitats, plants and animal species. But most of the river flood plains along the Romanian and Bulgarian Danube is vegetated by planted forests. It can be clearly seen that these trees where all planted at a particular point in time, are of a particular tree type and were planted with an absolute regular spacing. The most common planted tree is a rapidly growing hybrid poplar. It forms uniform forests on both sides of the lower Danube and stretches over hundreds of kilometer's. The width of these riparian forests varies from a few meter's to several kilometer's, but on the average about 200 to 500 meter's. T*hese forests form a habitat for a variety of plants and animals, but because of the nature of mono-culture with a very reduced diversity.*

The revering forests on both sides of the Danube are used intensively. Along the entire stretch mono-culture was by far predominant and even-aged stands as well as unnatural clear-cuttings could be observed. Sometimes on erosion prone shorelines they look like mangroves, the tree-trunk extending over washed-out roots. Wild forests and the flood plains normally form a unique habitat for endangered or often even almost extinct species of animals and plants. The existing uniform riparian forests do influence the type and probably also the rate of bank erosion. Because of the chosen uniform tree type up to the river-bank the natural balance of lower brushes between larger single trees is significantly disturbed.

5 Conclusion

As conclusions the following can be stated about the environmental impacts of the morphological changes in the Lower Danube:

- The Danube river morphological process can be classified as a process in progress. In the upper part of the section (km 845–km 730) the intensity of the erosion and accumulation is less then at the middle (km 730–km 500) or at the lower part of the section (km 500–km 375).
- Hundreds of kilometer's at the left and the right Bank of the Danube river are eroded;
- The crossings (bottlenecks) at the section (km 833.6–km 375) have a tendency to become a limiting factor for the navigation;
- The lowering of the water levels is followed by significant changes in there complexity on the riparian territories including the wetland zones;
- The environmental conditions in the Lower Danube have to be improved on the base of significant number scientific and applied-research works. Only on the base of complex studies is possible to choose the right and complex decisions to improve the Lower Danube environment.