# THE COAGULATION EFFECTS ON THE NEW SEDIMENT CHARACTERISTICS OF THE IRON GATE I RESERVOIR

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**Abstract :** Some interesting phenomena of generation and characteristics new sediment of the Iron Gate I Reservoir was analyzed in the paper. Differences between prognoses and generate type of sediments analyzed in context: effects of coagulation of natural and anthropogenic matters in the turbulent flow condition. High effects co deposition organic and pelite matter with high content different hazardous substances give to this sediment characteristic chemical time bomb.

**Key words:** coagulation, sediment, pollution, Iron Gate, Danube

## Sedimentation processes, composition and characteristics of the sediments

The Danube catchments area and tributaries that flow into the Iron Gate I Reservoir, at km 943, cover an area of 583,000 $km^2$ and drain parts or whole territories of several countries. Up to this profile over 72% of the total catchments area or 87% of the total inflow of the Danube into the Black Sea is encompassed.

The high organic loading of the Danube in the sector upstream this profile results high effects water quality changes after building the dam. The content of organic matter, intensity of biochemical decomposition accompanied with the consumption of dissolved $O_2$, reduction effects of: oxygenation, reaeration and primary organic production, with effects of deposition, elution, etc., defines the range of changes the content different matter in the water mass.

In the previous publications (4-7) we have shown the numerous previously non-emphasized phenomena which are characteristic for the run-of-the-river reservoirs,

which obtain during the many years of research changes water quality and sediment generation at the part of the flow under the backwater of the HEPP Iron Gate I.

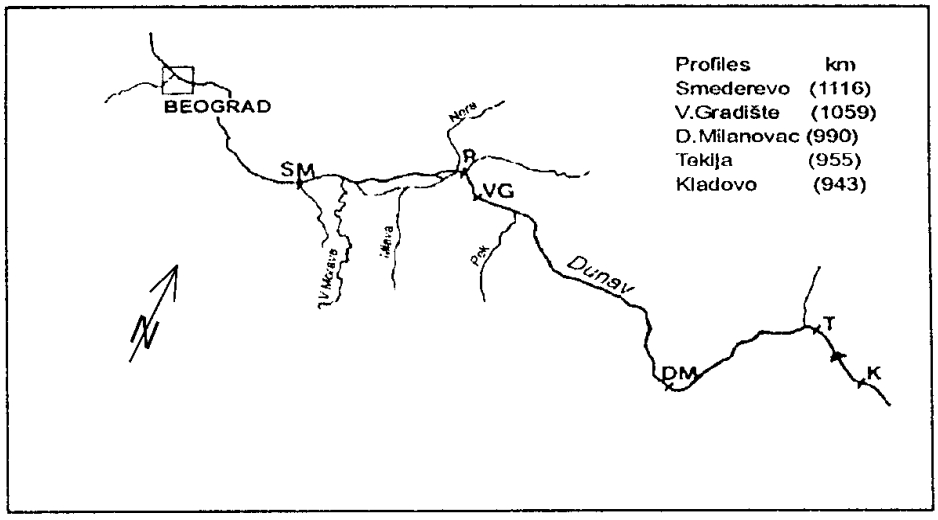


**Fig. 1.** The part of the Danube under the backwater effect of the HEPP Iron Gate I with the profiles of the control of water quality and of other environmental factors.

The coagulation under the conditions of high content of plankton mass creates conditions for the co-deposition of organic and allochtonous matters, with the creation of a new type of sediments. And just because of the exceptional effects of the coagulation, the enormous content of the finest particles of allochotonous and organic matter are removed from water body. This is one of the phenomena, which was not analyzed during the construction of the dam. The prediction model for the computation of the effects of the sedimentation included the model of Rosinski & Kuzmin, which linked together the concentration of suspended load and the hydraulic parameters of the flow (1).

In the prediction quantity of the sediment, they analyzed sedimentation of the particles without coagulation stage, which showed to be quite erroneous. This is the reason for the enormous differences between the predictions and the subsequent actual measurements (Fig. 2).

The predicted loading obtained at the basis of many years measurements of the content of suspension in the Danube and its tributaries, were grossly overestimated, but effects

of the sedimentation were underrate. The values obtained by measuring the loading and the effects of the sedimentation during the exploitation of the system present real state.

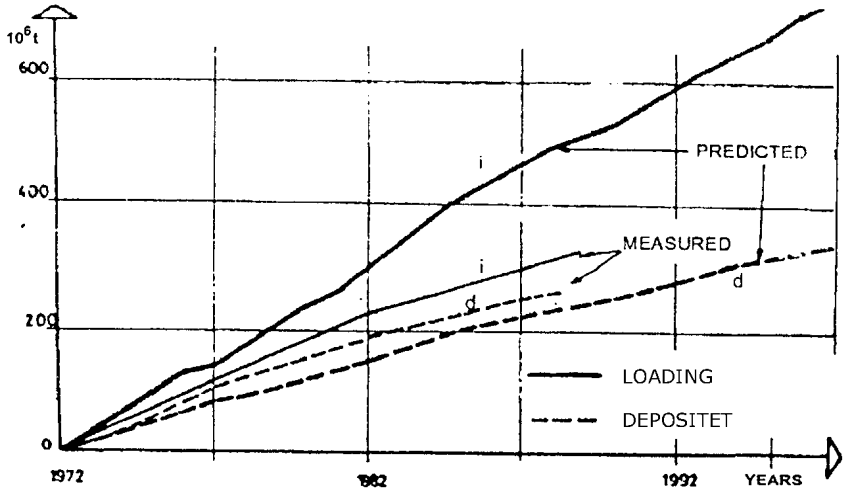


**Fig. 2.** The predicted loading (i) and deposited of suspended solids (d) of the HP Iron Gate I reservoir - in time.

According to the prediction in model, they envisaged the sedimentation of the material, of particles > 50 μm in the first phase; after the filling, the bigger particles only would be settled. By our measurements, we found out that even after 25 years of exploitation, the finest material is being settled (Fig. 3), which the important coagulation effects explain. Of course, all this depends very much on the load of plankton biomass, eutrophycation of the Danube at the upstream part of the reservoir which is in connection to the high over-border pollution and content of the other coagulants as dissolved Al.

Because of the coagulation processes an important part of the organic phase is settled already at the upstream part of the reservoir, together with the coarse particles of the allochtonous matter, which creates huge problems of the pollution of ground water. The great plankton production at the upstream part of the reservoir, due to the low degree of protection at the upstream catchments area, reflected on the important phenomena of co deposition of allochotonous and organic matter, with important consequences on the ecosystem under the existing conditions, but with important latent abrupt effects of degradation surrounding and downstream area.

Efficient sedimentation of plankton material in conditions of turbulent flow is one of the specific characteristics of the Danube in the run of the river zone. Phenomena manifested through high effects of the removal of suspended material, removal of degradable organic material, metal ions etc., represent phenomena that are possible only in conditions of extremely efficient coagulation and deposition of the created flock.

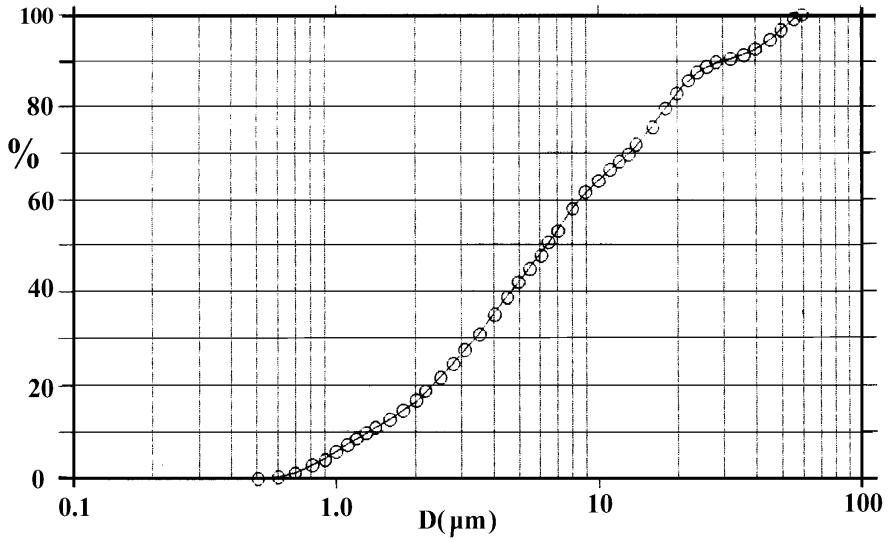


**Fig. 3.** The Granulometric properties of the sedimented material at the D. Milanovac site

The process of coagulation depends on non-organic and organic coagulants or their combinations. For the turbulent flow in the Iron Gate I Reservoir several types of coagulant are available: products of algae metabolism and decomposition of algae cell as well as relatively high concentrations of Al and Fe that are detected in sediments. The efficiency of concentration of toxic substances in the fine fractions of the suspension is indicated by the ratio of concentration of some metals on the suspended and sediment material in the Danube downstream of Budapest (Tab. 1).

**Table 1.** Average concentration of contaminants in Danube bottom and suspended sediment collected in 1994. (3)

| Pollution, µg/kg,*mg/kg | km.1852 | | km.1763 | | km.1709 | |
|---|---|---|---|---|---|---|
| | sediment | sus. mat. | sedim. | sus.mat. | sediment | sus.mat. |
| Hg* | 0.39 | 2.9 | 0.30 | 9.7 | 0.40 | 11.2 |
| Cd* | 0.12 | 3.5 | 0.05 | 4.2 | 0.08 | 2.4 |
| Fluoranten | 2 | 190 | 3.3 | 165 | 1.1 | 200 |
| Benzo(a)pyren | 190 | 60 | 4.0 | 65 | 49 | 100 |

The concentration toxic substances on the finest particle suspended material, as documented on the upstream sector by Literati et al. (3) represent state on the analyzed sediment of the Iron Gate I Reservoir.

Our investigations (4) showed specific characteristics of water purification in the run-of the river Iron Gate I Reservoir. Phenomena of co-deposition of plankton and allochtonous matter were analyzed in connection with the effects of coagulation of the latter with the cell content of phytoplankton in the phase of decomposition (5). This confirmed a high effect of removal of plankton from the water phase as well as the effects of this process on numerous composition parameters, especially the content of dissolved $O_2$ but also the high loading of the sediments with organic material and further processes in the sediment (7).

Data on the macro composition of the sediments (Tab. 2) give more complete picture about this material with an uncompleted process of mineralization. Data on the granulometric composition of the deposited material are in complete agreement with the model of suspended material from the Rhine with a high ratio of organic load.

**Tab. 2.** Sediment composition of the location D. Milanovac

| Depth (m) | $SiO_2$ (%) | $Al_2O_3$ (%) | Fe.ok. (%) | FeS (%) | MgO (%) | CaO (%) | $K_2O$ (%) | $Na_2O$ (%) | HPK ppm $O_2$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.3 | 49.60 | 16.55 | 7.32 | 1.13 | 2.71 | 6.55 | 2.12 | 0.79 | 87,500 |
| 1.4 | 48.10 | 18.10 | 5.21 | 2.83 | 2.90 | 7.24 | 2.47 | 0.74 | 78,000 |

Comparation of data for the content of this sediment with literature data for river and lake sediments formed through geological phases but also with new types of sediments

shows numerous specific characteristics of this system with pronounced anthropogenic influence.

The well-documented data the influence of HEPP Iron Gate I Reservoir on the ecosystem of the Black Sea (2) give an average reduction of $H_4SiO_4$ from over 50 to less then 20 μM. With this Si has become a limiting factor for the synthesis of algae and the reason for the change in species composition and water bloom of dinoflagelata and instead of silicate diatoms.

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