# DANUBE WATER QUALITY IN BULGARIA

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The Danube is the longest - 2,850 km - and deepest river in Europe, after the Volga, and it represents a main waterway between Central and Eastern Europe. The total catchment area of 817,000 km$^2$ is characterised by a dense and deep river system, consisting of 120 tributaries, 34 of which are navigable.[1] The Danube River Basin is intersected by two mountain chains and divided into three parts: the Upper Danube- up to the 1,880th km, the Middle Danube- up to the 981th km, and the Lower Danube- up to the delta in Sulina, including the Bulgarian stretch of the river. The Danube forms the northern boundary of Bul-garia with Romania. The total catchment area - from the 845.5th to the 375.5th km - is 104,800 km$^2$, of which only 46,930 km$^2$ are in the Bulgarian territory.

The catchment area in the Bulgarian section of the river is relatively poor in surface, as well as groundwater, and the contribution of the inflow waters from the Bulgarian territory to the river is only 3%, averaging 150 l/s.[1,2] The Bulgarian economy consumes approximately 1 billion m$^3$ of Danube water annually: about 100 m$^3$/s for irrigation; 150 m$^3$/s for cooling in Nuclear Power Plants; 6 m$^3$/s for water supply; 260 million m3 for industry.[2] For the year 2010, the "North-East Bulgaria" water supply system will provide 3,053 l/s of water from the Danube, in addition to the 756 l/s of surface water regulated by the Stevrek dam. Thus, in 2010, up to 600 l/inh/day of potable water will be provided.

**Policy**

The first agreement between the Danube countries for joint actions in the environmental protection of the river was signed in 1985, as the Declaration for the Danube River Water Management. In 1991, the countries of the Danube river basin and interested international institutions drew up an initiative to support and reinforce national actions for the restoration and protection of the Danube river, known as the Danube Environmental Programme.

The Danube Emissions Management Decision Support System (DEMDESS), consisting of a data base and software, has been developed and applied to a pilot river basin in Bulgaria, the former Czechoslovakia, Hungary and Romania. The Danube countries and the European Union signed the Convention on Co-operation for the Protection and Sustainable Use of the River Danube in 1994.

The development of the Strategic Action Plan for the Danube River Basin 1995-2005 has been the major task of the Danube Environmental Programme.[3] It supports and complements the Convention on Co-operation for the Protection and Sustainable Use of the River Danube and contributes to the implementation of the Environmental Action Programme for Central and Eastern Europe.

The Strategic Action Plan describes a framework for regional action which will be implemented through National Action Plans. It contains three goals for the environment of the Danube river basin: strategic directions; short- medium- and long-term targets; and a phased programme of action to meet those targets.

**Sources of pollution**

According to the Bulgarian National Ecological Programme for the Danube River2, two main groups of problems determine the ecological conditions along the Bulgarian-Romanian sector: First, the construction and operation of the "Iron Gate" hydro-station, situated at a distance of 100 km and 17 km above the Bulgarian stretch and directly influenced by the hydrology of the downstream section of the Danube River; and, second, point and non-point sources of pollution - cities, industry, rural towns and villages, water transportation and agriculture - along the river bank and its tributaries. It is essential to point out again that the Bulgarian sector of the Danube is situated in the downstream section of the river and its water quality is strongly influenced by the Upper and Middle water streams carrying the pollution load from Germany, Austria, the Czech and Slovak Republic, Hungary, Croatia and Yugoslavia.4

Systematic monitoring of the Danube water quality along the Bulgarian stretch was performed for many years, at 21 locations uniformly situated along the coastal line and near to settlements and tributary discharges in the river.1 The main locations are: before the Timoc river; near the Novoselo settlement; before the town of Vidin; after the town of Vidin; before the Archar settlement; after the town of Lom; after the town of Kozloduj; after the Orijahovo settlement; after the Sviloza chemical plant; after the town of Svishtov; before the town of Russe; after the town of Russe; near the town of Tutracan; and near the town of Silistra. In execution of the Danube Environmental Programme, the pollution of the four main Danube tributaries - Iskar, Vit, Osam, Yantra - has been studied.

According to Bulgarian legislation, Regulation 7 from 1986 determines the parameters and rates for flowing surface water quality. The parameters are divided into 5 groups: (a) general, physical and inorganic chemical parameters; (b) general, parameters for organic contaminants; (c) parameters for inorganic substances from industrial origin; (d) parameters for organic substances from industrial origin; (e) biological parameters.

Surface waters are separated into three categories according to the possibility for their use: (I) water supply, (II) agriculture, recreation and fishery, and (III) irrigation and industrial supply. The categorisation of the flowing surface waters is made for all essential parameters. The parameter with the most unfavourable value within three monthly measurements is accepted as normal, and determines the category of the receiving body in a given point.

**Table 1**. Rates of changes in mg/l for some essential parameters during 1995

| Sampling points | | | Parameters | | |
|---|---|---|---|---|---|
| | $BOD_5$ | Oxidisability | NDS[a] | Ammonium N | Nitrate N |
| PDK (Category II)[b] | 15 | 30 | 50 | 2.0 | 10 |
| PDK (Category III) | 25 | 40 | 100 | 5.0 | 20 |
| before Timok | 1.2-5.0 | 3.5-8.8 | 29-96 | 0-0.13 | 0.40-2.20 |
| before Novoselo | 1.4-6.2 | 2.9-10.2 | 28-98 | 0-0.21 | 0.30-2.10 |
| before Vidin | 1.2-4.4 | 3.3-10.6 | 30-80 | 0-0.24 | 0.27-2.00 |
| after Vidin | 2.2-6.0 | 4.0-11.4 | 28-94 | 0.06-0.66 | 0.25-2.60 |
| before Archar | 1.2-4.2 | 2.8-9.8 | 39-112 | 0-0.30 | 0.23-1.55 |
| after Lom | 1.9-3.9 | 3.2-10.7 | 28-116 | 0-0.14 | 0.27-0.52 |
| after Kozloduj | 2.1-4.7 | 1.0-3.6 | 6.7-73 | 0.04-0.54 | 10 |
| after Orjahono | 1.1-4.9 | 1.3-3.8 | 27-87 | 0.16-0.95 | 8 |
| after Sviloza | 1.3-14.7 | 3.7-16 | 26-190 | 0.12-0.70 | 0.03-2.30 |
| after Svishtov | 2.9-5.7 | 7.2-14.6 | 32-82 | 0.43-0.98 | 0.31-1.04 |
| before Russe | 2.5-3.3 | 3.4-3.6 | 8-28 | 0.07-0.15 | 1.40-2.70 |
| after Russe | 2.6-3.5 | 3.6-4.2 | 16-40 | 0.06-0.15 | 1.40-2.40 |
| near Tutracan | 2.4-2.8 | 3.3-3.5 | 12-32 | 0.03-0.18 | 1.14-2.60 |
| near Silistra | 2.0-3.2 | 3.2-3.6 | 10-38 | 0.07-0.18 | 1.12-3.00 |

a) NDS: non-dissoluble substances
b) PDK: Limited Allowable Concentration
c) The Sviloza Chemical Plant

*Physico-chemical monitoring*

Measurements show that the quality of the Danube water entering Bulgaria, near Novoselo, falls under Category III. Because the water flow in the downstream section of the Danube is very large - 6,550 m3/s at the entrance of the delta3 - determining high self-purification capacity, the pollution contribu-tion from the Bulgarian stretch is not significant (Table 1).[4]

Summarising the data available from 1980 to 1995, the following conclusions can be drawn:[5,6] The most serious pollution in the period 1980-1991 was found in the central part of the Bulgarian stretch, coinciding with the discharge of the largest tributaries: Iskar, Vit, Osam, Yantra and Russenski Lom. The highest pollution was observed in 1982, 1984 and 1986, and from 1989 onwards a tendency towards stable reduction of pollution was found. Despite the unfavourable, drought conditions in Bulgaria in 1990-1995, a tendency towards improving the water quality in the basins of the main tributaries was found, leading to the reduction of the degree of pollution in discharging points. One of the main reasons for these positive tendencies is the significant decrease of industrial and agricultural production. As a result, the total pollution load of the receiving body, i.e. the Danube and the Black Sea as a final recipient, decreased.

From the analysis of the mean annual results for water quality in 1995 in comparison with 1994, a general conclusion towards preserving and improving water quality can be made (Table 1).[7,8,9] As for the main parameters, water quality in most sampling points corresponds to Category II.

According to the Bulgarian National Statistics Institute, a reduction of about 2% of the wastewater discharged in the Danube river basin, without treatment, from the main tributaries Ogosta, Iskar, Vit, Osam, Yantra and Russenski Lom, was observed in 1995, in comparison with 1994.

*Radiological monitoring*

Monitoring of the radiological conditions of the Danube water is performed in three monthly periods, according to the Bulgarian-Romanian Programme for the Low Danube, and results are compared with the Bulgarian State Drinking Water Standards. The rate of total â-radioactivity in drinking water should not exceed 0.75 Bq/l. For the year 1995, the minimum value, 0.06 Bq/l, was observed near Belene and the maximum value, 0.197 Bq/l, near the towns of Nikopol and Zagrajden. Monthly monitoring of the radiological conditions of the Danube is performed at two sites: at the inflow of the river in Bulgaria, near Novoselo, and at the outflow to the Black Sea, near Silistra.

A number of sampling points, within a 30 km radius of the Kozloduj Atomic Power Plant are analysed monthly. From the data obtained so far,[7,8,9] it can be concluded that the total â-radioactivity of the Danube River in the inflow and in the outflow of Bulgarian territory is much below the Limited Allowable Concentration for potable water, 0.75 Bq/l.

*Biological monitoring*

The last complete investigation of Danube water quality, including biological parameters, was performed in 1991.[2] In a joint Bulgarian-Dutch expedition, a study was conducted into the water quality of the Danube on the Bulgarian-Romanian stretch of the river. Measurements were made at 22 different locations and parameters included macrozoobenthos, zooplankton and phytoplankton.

A total of 57 taxa of benthic micro-organisms were established, mainly from the groups of: Oligochaeta - 27 species or 47% of the total species found; Mollusca - 14 species, 25% total; Amphipoda - 7 species, 12% total and others2. Water quality from a saprobiological point of view seemed to be optimal, Category II, in only a few points, and unsatisfactory, Category III, for most of the profiles under study.

A total of 31 zooplankton taxa were established in the water samples under study. 15 species of Rotatoria - 48% of total species present - and 14 species of Copepoda, 45% of total species present - were the most abundant. Species included, among others, Kerratella quadrata, Brachionus calyciflorus, Asplanchna sp., Bosmina Longirostris, and Chydorus sphaericus. The saprobi-ological situation, estimated by means of the zooplankton indicative capacity, was quite different from the macrozoobenthos one. It should be emphasised that in all cases under study the level of saprobity was measured as â-mesosaprobic, close to oligosaprobity.

Photosynthetic pigment can provide information about the trophic state, as well as about the biological sufficiency of water. The basic photosynthetic pigment - chlorophyll-a (CHLA) - tended to increase downstream in the stretch under study. Being non-specific in their nature, however, the biotic responses of the monitored communities have revealed the joint effect of the total impact upon the living environment, and thus have made possible an integral estimation of the ecological situation as a whole.

Two zones of different ecological states were distinguished in the study:[2] the first, heavily affected by impacts from tributaries and local sources, is situated in relatively narrow strips along the banks, and the second embraces almost the entire water body of the Danube River. By means of altercation of their living strategy - as expressed in changes of species composition, abundance and structural parameters - the communities being monitored indicated, in general that the L-sided points were more heavily affected by impacts than R-sided ones.

The reaction of a biological system is often connected to the interaction of many factors. The responses of biological parameters to the same physico-chemical parameters may also differ. However, the results of the biological research carried out so far corresponds in general terms with those of the physico-chemical research.

*Priorities*

As a result of the completion of the WASH Project, in 1992 [10,11] the following information concerning the Danube river basin has been studied: industrial waste water and pollution loads from main industries; waste water from settlements; treatment plants in operation and wastewater from feedlots.

**Table 2**. High priority "hot spots"

| River Basin | Critical Pollution Section | Polluter |
|---|---|---|
| Ogosta | Bukovetz river to Montana damDubnika river - the point of joining the Leva river<br>Skat river | Ore-dressing plant at ChiprovtchiChemical factory and Stockbreading farms at VratzaPaper factory, industrial wastewater, stock-breading farms |
| Iskar | Downstream of SamokovDownstream of Novi IskarMalak Iskar RiverDownstream of Eliseina | WWTP of Samokiv and BorovetzWWTP of Sofia and KremikovtsiDownstream Etropole heavy metalsOre-dressing plant |
| Vit | Downstream Dolna Mitropolia | Pleven WWTP, paper, sugar factories, stock-breeding farms |
| Osam | Downstream Trojan | Domestic and industrial wastewater |
| Yantra | Downstream GabrovoDownstream Gorna OrjahovitzaRossitza River, downstream SevlievoRossitza River, downstream Pavlikeni | Domestic and industrial wastewaterDomestic and industrial wastewaterDomestic and industrial wastewaterDomestic and industrial wastewater |
| Russenski Lom | Beli Lom River, downstream RazgradTeherni Lom RiverRussenski Lom river | Razgrad WWTP, wastewater from Antibiotics FactoryDomestic and industrial wastewaterDomestic, industrial wastewater and stock-breeding farms |

A list of "hot spots," which are subject to excessive pollution from an identifiable source and require particular action to prevent or reduce the degradation caused, is shown in Table 2.[10,11]

**Conclusion**

The data presented in this paper show that the quality of the Danube river water, entering Bulgaria near Novoselo, can be classified under Category III -according to Bulgarian Regulation 7/86 - as a result of the pollution load from the Upper and Middle courses. From the information available from 1980-1995, a general tendency towards preserving and improving the quality of the Danube water can be found. The main pollutants are: non-dissoluble substances, nitrates and ammonium, and microbiological organisms.

In order to prevent further pollution from the Bulgarian stretch, full treatment of domestic and industrial wastewaters, before the river discharge, has to be achieved. This includes all objects situated on river banks, as well as all tributaries along the river.

The following points have to be developed in accordance with the fulfilment of the four Strategic Action Plan goals for the Danube River Basin:

- Policy and Regulation - The adoption and harmonisation of EU standards and regulations with similar Bulgarian documents and with all Danube related countries. Due attention should be given to the full integration of environmental considerations. The equalisation of standards, methodology and equipment, as well as staff education on monitoring water quality, will lead to the successful implementation of the DEMDESS system and will provide useful tools for integrated management of the Danube River Basin. With this progress, an ecosystem approach can be reached.
- Sources of pollution - The National Technical Reports, Bulgarian and others prepared thus far about the primary problems of water pollution control, can be used as a base for preparing the Detailed Action Programmes for reducing and removing pollutants. This can include the change in existing laws and regulations, the necessary investments and the possible ways to achieve success.
- Institutional development - In governmental policy, changes towards the free market in the role of different institutions, ministries, local authorities, human resources and NGOs will increase. The participation of all institutions in developing a new institutional structure and system of taxes and fines will give a much larger role to those institutions in water pollution control. Institutional development will have to include the possible changes in approach and methodology for promoting international co-operation among the Danube countries. Let us combine our efforts and use the experience of the Rhine river to achieve a "Blue Danube," as the river was called in the not so distant past.

**Acknowledgement**

This paper has been prepared with the materials kindly provided by the Ministry of Environment and the National Centre for Environment and Sustainable Development.

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