# PHYSICO-CHEMICAL AND BIOLOGICAL ANALYSES FOR DANUBE WATER

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**abstract:** This paper compares the results of the biological and physico-chemical analyses of the Danube's waters upstream and downstream of Braila. The Biological Monitoring Working Party Score (BMWP) was calculated using the existence of the macro invertebrates in the Danube's water. The pollution of the Danube by the town Braila is minors, the quality of the waters being medium.

## Introduction

The Danube waters transport annually huge quantities of nitrogen, phosphorus, lead, chrome, copper, and mercury [1]. Moreover, dams construction has a serious influence on ecosystems, sometimes leading to certain species extinction.

This work presents the Danube water quality evaluation results in Braila, between 2003 and 2005, by analyzing and determining certain general quality and specific impurification parameters for samples taken upstream (before Chiscani plant), and downstream (at Lippovan beach). The distance between the two points is approximately 24 km, and within this distance, the Danube is the tributary stream for all the waste waters of the town and industrial areas.

The length of the hydrographic network, in Braila County, of the Danube River is 222.5 km, having an average flow of 8400 $m^3$ per second, the water being used for river and maritime navigation, population water supply, industry, animal breeding and irrigation.

Pollution sources for the Danube in Braila are some industrial, agricultural and animal breeding units, as well as the town's sewage system which does not have a waste water managing station. Due to this, at exit points, there are exceeding in the limits for total suspensions, ammonium, extractible substances, $CBO_5$ [2].

The nitrates in the water come from the soil, but especially as a result of demineralization of the proteic polluting substances, or from fertilizers and pesticides that contain nitrogen. Nitrates can become a growing factor for algae or other water plants. Determining nitrates in the water sources is very important for evaluating their drinkability conditions [3].

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The ammoniac appears in water as a result of incomplete organic substances degradation or it may also come from the soil. It presents the first decomposing stage of organic substances containing nitrogen, therefore it indicates a recent pollution (hours-days), and consequently very dangerous [4].

The nitrites in the water come from the incomplete oxidizing of the ammoniac in the presence of the nitrification bacteria. They represent a more advanced level of decomposing process gore the organic substances, and, as a result, their presence or a concentration increase in the water shows us a past pollution (days-weeks). A source of drinkable water must not contain nitrites and their concentration should not vary with time [4].

## Experimental

Sample gathering points have been placed so as to allow pollution sources appreciation in Braila town and they have been preserved as much as possible.

Gathering took place once a month for three consecutive years, 2003-2005, except for the winter months.

Since the microbial activity can alter the ammoniac-nitrites-nitrates balance, in order to preserve the nitrogen forms, 2 mL of $H_2SO_4$ 1:3 per water litter were introduced in every sample recipient [3].

Physico-chemical analyses for nitrate, ammonium, and nitrite ions were made according to standards [5÷7].

Nitrate and ammonium ions ($NO_3^-$, $NH_4$+) were determined using a UV-VIS CECIL 6100 spectrophotometer, and the nitrite ion was determined with the help of a Spekol spectrometer.

The water quality determination using the aquatic macro invertebrates is based on the fact that tolerance to environment conditions varies from one species to another. Species with low tolerance are good indicators of water quality, because the presence of polluting factors, directly or indirectly leads to an oxygen quantity decrease.

The macro invertebrates were sampled with a colonization sampler, preservated in the field by adding 70% denatured ethanol or 4% formaldehyde until the animals are completely immersed. For identification we used a microscope and identification keys for macro invertebrates [8÷11].

Biological analyses focused on determining the biotic score – the value of BMWP (Biological Monitoring Working Party Score). The BMWP value was first used in Great Britain in 1978 [12].

This biotic score is efficient in highlighting small changes of water quality. The method is based on the number of macro invertebrate families that appear in water.

Depending on their sensibility to pollution, the families have a certain attributed value between 1 and 10. The more sensible to pollution a group is, the higher the number. Because more groups can appear in water, the BMWP index value does not have a maximum limit, although values over 150 are rare.

In order to calculate the BMWP biotic score, multiple sample collecting is needed, including significant ecological basket funnels (both banks, water ground) followed by adding the numeric values of the considered groups.

For a more accurate calculation, the water BMWP value is divided to the number of macro invertebrates groups identified in samples. Thus, the BMWP biotic score value for a taxonomic group is found [13].

**Table 1 BMWP index interpretation**

| BMWP index | Water quality |
|---|---|
| > 150 | Very high |
| 101 – 150 | High |
| 51 – 100 | Average |
| 26 – 50 | Tolerable |
| 10 – 25 | Low |
| 0 - 9 | Very low |

## Results and discussion

Quality, as applied to water as a natural material resource, is more difficult to define subjectively and can only satisfactorily be defined objectively in terms of specific uses. Although different natural waters, e. g. soft and hard waters, may best serve different uses, any deterioration in the environmental quality of a water source results in a lowering of the quality of the water for most purposes.

In Table 2, there are the average and maximum values of the 3 chemical indicators – nitrate, ammonium and nitrite – which characterize Danube pollution in Braila between 2003 and 2005. It can be noticed that the average value of the nitrate ion do not exceed half of the allowed maximum limit, and in 2004 and 2005 the average value of the nitrate concentration downstream Braila decreases in comparison to upstream Braila, but not significantly.

**Table 2. Average and maximum values of the chemical indicators for the Danube in Braila between 2003 and 2005**

| Year | Indicator | nitrate | ammonium | nitrite |
|---|---|---|---|---|
| 2003 | downstream average values | 1,3 | 0,249 | 0,022 |
| | downstream maximum values | 2,16 | 0,56 | 0,026 |
| | upstream average values | 1,232 | 0,325 | 0,027 |

| Year | Indicator | nitrate | ammonium | nitrite |
|---|---|---|---|---|
| | upstream maximum values | 1,98 | 0,63 | 0,032 |
| 2004 | downstream average values | 1,34 | 0,15 | 0,032 |
| | downstream maximum values | 1,77 | 0,25 | 0,049 |
| | upstream average values | 1,421 | 0,26 | 0,028 |
| | upstream maximum values | 1,8 | 0,4 | 0,041 |
| 2005 | downstream average values | 1,36 | 0,1899 | 0,026 |
| | downstream maximum values | 1,98 | 0,34 | 0,032 |
| | upstream average values | 1,54 | 0,293 | 0,027 |
| | upstream maximum values | 2,01 | 0,513 | 0,038 |
| CMA (mg/L) | | 3 | 0.3 | 0.06 |

If we compare the average ammonium concentration value in the Danube at Braila, between 2003 and 2005, we can notice that only in 2003 does the average value of the ammonium ion concentration upstream Braila exceed the maximum concentration allowed, but every year the average ammonium value downstream Braila are lower than upstream, which indicates a water self cleansing process along the study zone.

The average values of the nitrite ion concentration in Danube waters at Braila during the study are about half of CMA, except 2004 when downstream nitrite average value is higher than upstream, which indicates a slight Danube pollution because of the nitrogen compounds originating in waste waters from the town.

The macro invertebrate's evidence was gathered from the Danube upstream and downstream Braila at the same time and in the same place as the water samples for the physico-chemical analyses.

The macro invertebrate's determinations (Table 3) were done on site while they were still alive, because their behavior and the environment features help the determination process, but for such cases, conservation was necessary for a microscope study.

**Table 3. Macro invertebrate categories identified in Danube at Braila between 2003 and 2005.**

| No. | Family | Species number | Upstream | Downstream |
|---|---|---|---|---|
| 1. | Planariidae | 2 | ✓ | ✓ |
| 2. | Dendrocoelidae | 1 | ✓ | ✓ |
| 3. | Diplogasteridae | 1 | ✓ | ✓ |
| 4. | Ampharetidae | 2 | ✓ | ✓ |
| 5. | Naididae | 7 | ✓ | ✓ |
| 6. | Tubificidae | 4 | ✓ | ✓ |
| 7. | Enchytraeidae | 1 | ✓ | ✓ |
| 8. | Glossiphoniidae | 1 | ✓ | ✓ |
| 9. | Piscicolidae | 1 | ✓ | ✓ |
| 10. | Hirudinidae | 1 | ✓ | ✓ |
| 11. | Neritidae | 2 | ✓ | ✓ |
| 12. | Viviparidae | 1 | ✓ | ✓ |
| 13. | Valvatidae | 2 | ✓ | ✓ |
| 14. | Acroloxidae | 1 | ✓ | ✓ |
| 15. | Sphaeriidae | 2 | ✓ | ✓ |
| 16. | Mysididae | 1 | ✓ | ✓ |
| 17. | Astacidae | 1 | ✓ | ✓ |
| 18. | Asellidae | 1 | ✓ | ✓ |
| 19. | Gammaridae | 2 | ✓ | ✓ |
| 20. | Palingeniidae | 1 | ✓ | ✓ |
| 21. | Potamanthidae | 1 | ✓ | ✓ |
| 22. | Oligoneuridae | 2 | ✓ | ✓ |
| 23. | Polymitarcidae | 1 | ✓ | ✓ |
| 24. | Heptageniidae | 4 | ✓ | ✓ |
| 25. | Baëtidae | 1 | ✓ | ✓ |
| 26. | Agrionidae | 1 | ✓ | ✓ |
| 27. | Aeschnidae | 1 | ✓ | ✓ |
| 28. | Libellulidae | 1 | ✓ | ✓ |
| 29. | Hydroptilidae | 1 | ✓ | ✓ |
| 30. | Chironomidae | 3 | ✓ | ✓ |
| 31. | Culicidae | 2 | ✓ | ✓ |
| 32. | Tabanidae | 1 | ✓ | ✓ |
| 33. | Simuliidae | 1 | ✓ | ✓ |

In order to evaluate water quality at Braila using two macro invertebrates-based methods, samples of macro invertebrates were taken monthly for three years, 2003-2005, between

March and November. I will enumerate below all the species determined at the two data collecting locations, upstream and downstream Braila, from the same locations used to collect data for the physico-chemical analyses.

The macro invertebrates listed in the table above have been identified at both research locations.

In Fig. 1 and Table 4 the BMWP biotic score values are presented, the values for the Danube between 2003 and 2005 at Braila.

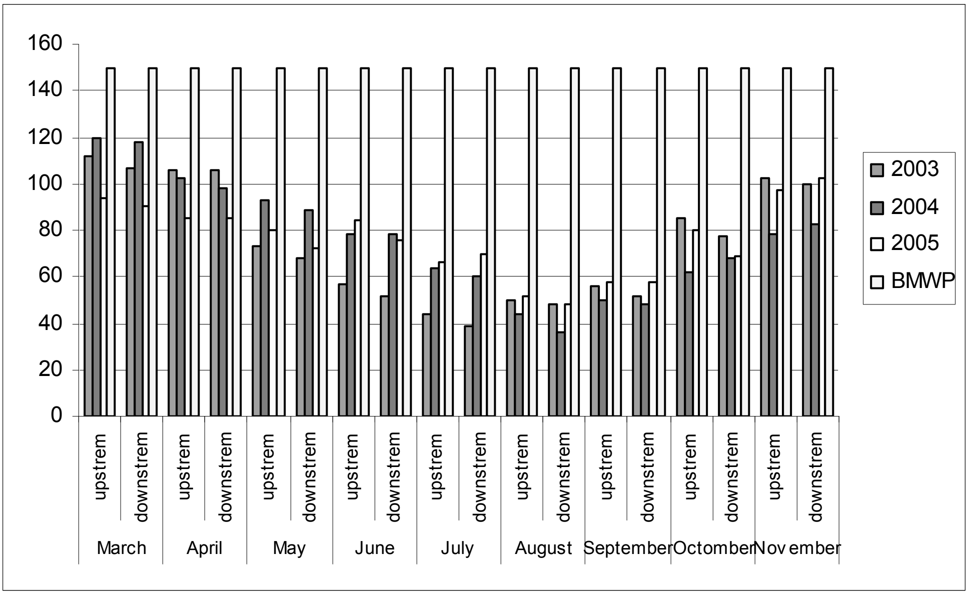


**Fig. 1** *The BMWP biotic score values for Danube in Braila between 2003 and 2005, in comparison to the maximum value of 150 specific to a high quality water*

**Table 4. The BMWP biotic score values/taxa for the Danube in Braila between 2003 and 2005**

| | March | | April | | May | | June | | July | | August | | Sept. | | Oct. | | Nov. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | up | down | up | down | up | down | up | down | up | down | up | down | up | down | up | down | up | down |
| 2003 | 8 | 8 | 8 | 7 | 7 | 6 | 6 | 6 | 6 | 5 | 6 | 6 | 7 | 6 | 7 | 6 | 8 | 7 |
| 2004 | 8 | 7 | 8 | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 5 | 6 | 6 | 7 | 6 | 7 | 7 |
| 2005 | 7 | 7 | 7 | 7 | 8 | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 6 | 7 | 6 | 7 | 6 |

Taking into consideration the physico – chemical analyses made for the Danube upstream and downstream Braila in 2003, it can be noticed that the average values for most of the determined indicators place the Danube water within the 1st category of the surface waters (according to Order OM 1146/2002) [14].

In the case of 2004, we have a decrease in average values in comparison to 2003, except the nitrate ion. The obtained values place the Danube waters in the $2^{nd}$ quality category. Danube water evolution is no different in 2005 and leads to placing the Danube water in the same $2^{nd}$ quality class.

Due to quick polluter's dispersion and self-purification capacity, permanent pollution for the Danube is within normal limits.

By comparing the results in Table 4 with the ones in Table 1, it is noticeable that the two biotic values (upstream and downstream) calculated for 2003-2005 situate the Danube in the low or average polluted category.

## Conclusions

The biological evaluation results were compared with those from the physico-chemical results. By comparing the two types of methods, they had the same result, which Braila does not significantly contribute to Danube pollution. Similar results [15] led to similar conclusions.

Results that assessments of water via a chemical analysis and via a biological analysis give as two different sets of information. Physico-chemical analysis yields information about the possible physico-chemical causes that may influence the quality status of the natural resource "water". Biological analyses yields information of the effects of physico-chemical, structural, biological and hydrodynamic causes that influence the quality of the ecosystem "water".

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