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# ASSESSMENT OF WATER QUALITY OF LAKE VIROI AFTER THE RECONSTRUCTION OF THE PARK

## SUMMARY

Albania is a reach country in water natural resource and one of them is "Mëma e Viroit" in the region of Gjirokastra. This is a karstic water source and it is approved as natural monument. The Lake Viroi is an important water ecosystem, with ecological, economic and environmental values. The anthropogenic and natural impacts are very significant indicators for eutrophication process of this lake. There is a good database for the environmental indicators and eutrophication of this ecosystem, which were assessed during the years 2011-2015. The park was under restoration during the year 2016 and it was a demand to assess water quality of lake after its restoration. The main objective of this study was to compare water quality of the lake before and after lake restoration and to propose the measures for water quality improvement. Water samples were collected during the year 2018, in accordance with the standard methods and were analyzed for chemical parameters by using ISO standard methods. The analyzed parameters were estimated according to the Water Framework Directive (WFD 2000/60 /EC) on the quality of surface waters. The values of trophic index (TSI) for Lake Viroi was calculated based on the total Phosphorus and total Nitrogen. The results showed that the amount of main nutrients as Nitrogen and Phosphorus continues to be at "High" and "Good" level. The trophic status of the lake varies from "oligotrophic" based on total Phosphorus values, to oligo-mesotrophic based on total Nitrogen values.

Key words: Lake Viroi, park restoration, water quality, eutrophication, trophic index.

## INTRODUCTION

The Lake Viroi is situated in the NW of Gjirokastra district. It has a surface area of 17 ha and about 11.13 ha of surrounding hilly area with a diverse and rich flora and fauna**.** It is an artificial lake fed by a karstic water source called "Mëma e Viroit". The flow is 17 $m^3$/s and its yearly average temperature is 13-14°C. The waters of this source are originated from the Blue Eye in Saranda (Alikaj, 2015)**.** The source has a funnel-shaped cave 6-8 m long, 3-4 m wide and 22 m deep while the maximum depth of the lake is about 4 m.

The lake and the surrounding area are rich in biodiversity counting around 250 plant species, 72 invertebrates and 16 vertebrate species **(**Gjini and Demaj, 2007; 2009; Hasani and Oruçi, 2007). It is distinguished for the growth of cyprinid fishes and frogs, where their growth and fishing constitute economic development in this area (Shkurti, 2013). Further, the Lake Viroi is rich in aquatic plants and phytoplankton, becoming a good food source for fishes. Another reason for the excessive number of fishes in the lake is the suitable habitat for their reproduction. Some of the fish move from the Drino river to the lake during reproduction period through a bio-corridor which joins the two ecosystems. Based on ecological, economic and recreational values of the lake, environmental assessment at different times is an important issue. Former studies about this area, were performed in the relation to its biodiversity.

During the years from 2011 to 2015,a detailed study was performed in this artificial lake to assess the water quality based on chemical parameters and biomonitoring (Alikaj, 2015; Alikaj, et al., 2019). During this period the lake were under the different natural and human impacts. In 2016 the park was under the restoration for touristic purposes. The restoration consisted in the arrangements of the source avoiding solid and liquid deposits from erosion of the surrounding areas, construction of the roads and barriers, as well as planting trees around the lake, thus avoiding the numerous influences from runoff and anthropogenic impacts. Although, the presence of the business activities at the entrance of the park continue to be a concern for their impacts in water pollution.

The current study aims to assess the environmental state of the aquatic ecosystem after the reconstruction of the park and to compare it with the environmental state before the interventions, in order to determine the necessary measures for water quality improvement of this ecosystem.

## MATERIAL AND METHODS

### *The study site*

The study site was water ecosystem of Lake Viroi (Figure 1). This lake is located in Gjirokastra district in the south of Albania.


Fig. 1. The study site and sampling stations of the Lake Viroi.

### *Sampling methods and sample analysis*

The water samples were collected during the year 2018, 4 expeditions were performed and water samples were collected in the 5 sampling points for each expedition. Samples were taken in 1.5-L plastic containers and transported in a cool box at a temperature of 4ºC.

The water analyses were performed within 24h at scientific laboratory of the Department of Environment and Natural Resources, Agricultural University of Tirana. The samples were analyzed for chemical parameters as $N\text{-}NO_2^-$, $N\text{-}NO_3^-$, $N\text{-}NH_4^+$and $P\text{-}PO_4^{3-}$using ISO standard methods (ISO 7150:1984; ISO 7890/1:1988; SSHEN 26777:1993; ISO 6878:2004;). *In situ* were measured pH, DO and temperature using portable multi-parameter device. The trophic index (TSI) for total Phosphorus and total Nitrogen were calculated by using Carlson and (Kratzer and Brezonik, 1981) equations, as follow:

TSI (TP) = 4.15 + 14.42 ln (TP) (total Phosphorus, in µg/L);

TSI(TN) = 54.45 + 14.43 ln (TN) (total Nitrogen, in mg/L).

The obtained data of this study were compared with the data of the study performed before the year 2015 (Alikaj, 2015).The computer program Excel 2019 was used for statistical analysis as average and STDev of parameters and the values of indexes based in the aforementioned equations.

## RESULTS AND DISCUSSION

In the Table 1 are presented the average values of physico-chemical parameters for each station. Temperatures varied from 8.66°C in station S1 to 12.1°C in station S3. pH values varied from 7.68 in source of lake (S1) to 8.02 in station S5, showing a slightly alkaline water status. Regarding to dissolved Oxygen the values ranged from 7.6 mg/l in station S3 to 8.3 in station S5.Based on these obtained data and according to WFD, for the assessed indicators, the water quality in the Lake Viroi can be classified of high quality. The current values of physico-chemical parameters were comparable with the previous obtained values during the years 2011-2015.

Tab. 1. Physico-chemical parameters of the Lake Viroi, in average values, during 2018.

| Stations | **S1** | | **S2** | | **S3** | | **S4** | | **S5** | |
|---|---|---|---|---|---|---|---|---|---|---|
| Parameters | Average | STDev | Average | STDev | Average | STDev | Average | STDev | Average | STDev |
| **pH** | 7,6 | ± 0.32 | 7,9 | ± 0.5 | 8 | ± 0.35 | 7,9 | ± 0.32 | 8,0 | ± 0.29 |
| **Temp°C** | 8,6 | ± 5.8 | 11,9 | ± 9.2 | 12,1 | ± 9.5 | 11,7 | ± 9.1 | 10,6 | ± 7.8 |
| **DO mg/l** | 7,8 | ± 2.3 | 7,9 | ± 1.9 | 7,6 | ± 2.2 | 8,1 | ± 2.2 | 8,3 | ± 1.9 |

Nitrogen and Phosphorus salts are two important chemical elements that indicate water eutrophication. In the Table 2 and 3 are presented the average obtained values of these nutrients for the performed studies during 2011-2015 and 2018,respectively.

Tab. 2. Average values of nutrients in lake Viroi during 2011-2015.

| **Parameters** | **$P\text{-}PO_4^{3-}$(mg/l)** | **TP (mg/l)** | **$N\text{-}NO_3^-$(mg/l)** | **$N\text{-}NO_2^-$(mg/l)** | **$N\text{-}NH_4^+$(mg/l)** | **TN (mg/l)** |
|---|---|---|---|---|---|---|
| **Stations** | **Ave. STDev** | **Ave. STDev** | **Ave. STDev** | **Ave STDev** | **Ave STDev** | **Ave. STDev** |
| **S1** | 0,036 ± 0.048 | 0,037 ± 0.049 | 0,487 ± 0.35 | 0,021 ± 0.013 | 0,031 ± 0 .046 | 0,568 ± 0.34 |
| **S2** | 0,025 ± 0.012 | 0,025 ± 0.012 | 0,205 ± 0.31 | 0,012 ± 0.009 | 0,050 ± 0.037 | 0,265 ± 0.32 |
| **S3** | 0,026 ± 0.029 | 0,026 ± 0.029 | 0,375 ± 0.38 | 0,031 ± 0.048 | 0,07 ± 0.071 | 0,402 ± 0.4 |
| **S4** | 0,021 ± 0.013 | 0,029 ± 0.034 | 0,314 ± 0.4 | 0,013 ± 0.008 | 0,089 ± 0.1 | 0,418 ± 0.43 |
| **S5** | 0,017 ± 0.01 | 0,031 ± 0.04 | 0,382 ± 0.36 | 0,015 ± 0.008 | 0,022 ± 0.023 | 0,45 ± 0.35 |

Tab. 3. Average values of nutrients in lake Viroi during 2018.

| Parameters | $P\text{-}PO_4^{-3}$ (mg/l) | | TP (mg/l) | | $N\_NO_3^-$(mg/l) | | $N\text{-}NO_2^-$(mg/l) | | $N\text{-}NH_4^-$ (mg/l) | | TN (mg/l) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stations | Ave. | STDev | Ave. | STDev | Ave. | STDev | Ave. | STDev | Ave. | STDev | Ave. | STDev |
| S 1 | 0.0021 | ± 0.0011 | 0.0021 | ± 0.0011 | 0.32 | ± 0.20 | 0.22 | ± 0.45 | 0.007 | ± 0.0055 | 0.56 | ± 0.39 |
| S 2 | 0.0029 | ± 0.001 | 0.0029 | ± 0.001 | 0.57 | ± 0.26 | 0.39 | ± 0.74 | 0.013 | ± 0.009 | 0.97 | ± 0.58 |
| S 3 | 0.0024 | ± 0.0008 | 0.0024 | ± 0.0008 | 0.83 | ± 0.28 | 0.42 | ± 0.76 | 0.019 | ± 0.0015 | 1.15 | ± 0.69 |
| S 4 | 0.0033 | ± 0.0013 | 0.0033 | ± 0.0013 | 0.8 | ± 0.46 | 0.41 | ± 0.74 | 0.019 | ± 0.003 | 1.22 | ± 0.60 |
| S 5 | 0.0026 | ± 0.0006 | 0.0026 | ± 0.0006 | 0.66 | ± 0.28 | 0.38 | ± 0.67 | 0.019 | ± 0.005 | 1.06 | ± 0.48 |

Ammonium in Lake Viroi varied in average values from 0.0077mg/l to 0.019mg/l. According to WFD for this parameter, waters are of High quality (where 0.2mg/l is 'average' background concentration level, for class I of waters, according to the Directive 78/659/EEC.) Compared to these values, with those of 2015, the amount of Ammonium is significantly reduced.

Based on the type of fish that grows, the waters of the Lake Viroi are classified as cyprinids waters. For these waters the recommended level of nitrites must be <0.03mg/l, the values that classified waters as of high quality. The values of $N\text{-}NO_2^-$ in Lake Viroi in average values varied from 0.22 mg/l in station S1 to 0.42 mg/l in station S3. These values classified waters quality from Poor to Bad quality.

Before restoration the average values for nitrites were from 0.012 mg/l to 0.031mg/l (Table 2). The deterioration of water quality of the Lake Viroi can be explained with the impact of anthropogenic factors during the restoration process and with the low temperatures of waters during water samples collection. Because with the decrease of temperatures below 17°C, mainly 12-14°C, the oxidation ratio of nitrites to nitrates decreases and thus the nitrification process can be controlled (Randall and Buth, 1984). In average values the temperature of the samples were lower than the above interval.

The average values of nitrates varied from 0.32 mg/l to 0.83 mg/l. The maximum values of nitrates were 1.2 mg/l. Taking into consideration the maximum values of nitrates the waters of Lake Viroi according to WFD were from high to good quality. Even if, the waters before 2016were at the same quality, after the restoration the situation for nitrates in lake is much better if we refer to the maximum values for each station. However, when the nitrate concentration in the water is higher than 0.2mg/l, it indicates the tendency of the water for eutrophication (Alikaj, 2015). Thus, the waters of Lake Viroi are under the eutrophication process.

Comparing the two studies for the Phosphorus level, the waters are classified as high quality according to WFD (<0.05mg/l), with values that varied from 0.0021mg/l in S1 to 0.0033 mg/l in S4 in 2018 and 0.017mg/l to 0.036

mg/l before 2016. The amount of phosphates decreased more than 10 times, especially in the water source of the Lake Viroi.

Restoration of the park has led the improvement of lake waters quality, for some reasons: (i) the reduction of fluvial sediments in "Mëma e Viroit" source has brought the decrease of phosphates, and (ii) has been avoided livestock waste leaks from soils around the lake. Thus, the anthropogenic and natural impacts have been reduced significantly.

In the Figure 2 is presented the trophic status of lake before and after its restoration. In average values for total Nitrogen and Phosphorus were calculated trophic indexes and trophic status. Before 2016 the relation of trophic index was TSI(TP)>TSI(TN), with trophic status mesotrophic and oligo-mesotrophic, respectively.

In the year 2018 the situation was TSI(TN) > TSI(TP), the trophic status of lake varied from oligotrophic for total Phosphorus to oligo-mesotrophic for total Nitrogen. The values of Phosphorus are lower than natural values for eutrophication process. Based on these results can be concluded that Phosphorus is a limited nutrient for algae growth and aquatic plants productivity. Nitrogen is the main nutrient in eutrophication process. The improvement of trophic status of lake shows the impact that the restoration in the area of the Lake Viroi has had in aquatic ecosystem.

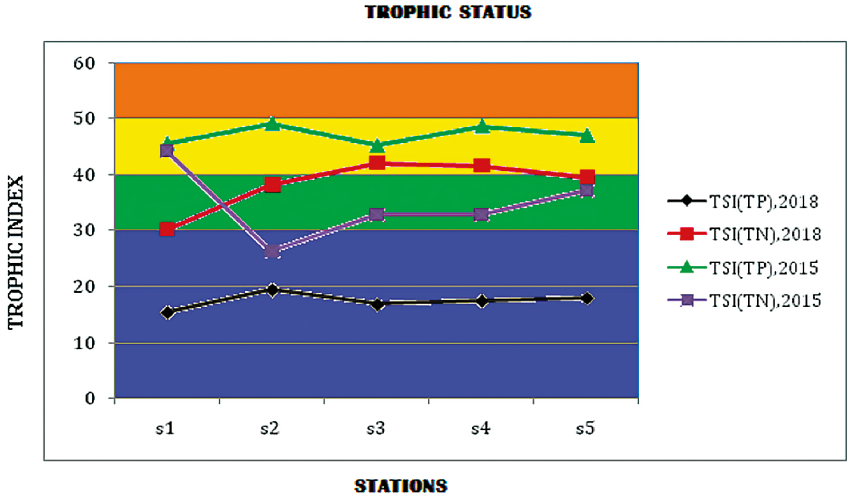


Fig. 2.Trophic indexes for Lake Viroi and the assessment of trophic status.

## CONCLUSIONS

Viroilake is the only artificial lake in Gjirokastra district and the most important for its rich biodiversity. In terms of water quality after the restoration

of park, this water ecosystem was somewhat better than before. The nitrates and phosphates were in the level of class I (high), whereas nitrites resulted in class IV and V (poor to bad). This situation was not only from different pollution impacts, but also due to the low temperature in water in the time of sampling. The assessed trophic status of waters was mainly oligo-mesotrophic for total nitrogen level and oligrotrophic for total Phosphorus. The trophic status of the Viroi lake was improved after the restoration, especially based on the presence of the total Phosphorus.

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