



ASSESSMENT OF WATER QUALITY IN BUVILLA RESERVOIR BASED IN PHYTOPLANKTON

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SYNOPSIS

Consideration about water quality in Buvilla reservoir are presented here, based in phytoplankton composition. Depth profiles of physic-chemical and biological parameters were carried on during two years period from May 2006 - May 2008 with two months frequency. The data were the complementary part of the whole study, focused on the drinking water, since the reservoir is the main water supplier for Tirana city.

The most productive layers extend down up to 15 m of depth, and the maximum of productivity was observed in 10 m depth.

INTRODUCTION

Buvilla watershed extends in the Eastern to Northeastern side of the capital, Tirana. The reservoir was constructed in 1998, located about 15 km North-East of Tirana city. It has a surface of 4575 km², maximum volume of 80 x 10⁶ m³, and average depth of 18 m (max. 60 m, near the dam) (Figure 1). Residence time of the water is 4.23 years. It drains an area of approximately 98 km²; the main source is river Tërkuza with total discharge about 105 x 10⁶ m³/year.

The relief of the region is mainly hilly to mountainous, mountains mainly in the periphery. Buvilla territory belongs to subhilly Mediterranean climate, with heavy precipitations (1200-1300 mm/yr), mainly during the end of the winter and end of the autumn. Average temperatures oscillate: min 7.6, max 18.2 and average 12.9 °C. Since year 1998, Buvilla is the main water supplier of Tirana Capital (more than 700'000 inhabitants); its waters are treated by Treatment Plant of Buvilla, with a capacity up to 1800 l/s, through standard treatment: pre-disinfection, coagulation, clariflocculation, decantation, filtration, post-disinfection; in case of extreme

emergency a powdered activated carbon at clariflocculation step, is added, using a PAD Dosing System with a silo storage.



Figure 1: Watershed of Buvilla basin with three sampling stations (S1-S3) and several villages (Image © Terremetrics, Europa Technologies and DigitalGlobe, from GoogleEarth)

The study was initiated in response to concern over the deteriorating water quality manifesting by an unpleasant smell and taste first detected on September 2001. The purpose of the study was to collect sufficient baseline quality data to define current limnological conditions at Buvilla reservoir and provide a basis for future water quality protection and monitoring. Our data highlights the floristic richness in water, its trophic and pollution state. An important role has the human impact in the nearby basin giving recommendation aiming to prevent environment impact regarding water quality.

MATERIALS AND METHODS

Depth profile (1m, 3m, 5m, 10m, 15m, 20m, 30m, 40m) using a Niskin bottle (2 l) with the aid of a hand-winch mounted in the boat at three sites (S1, S2, S3) with a frequency of two months, during May 2006 – May 2008, were carried on. It was evaluated the water temperature, pH, dissolved oxygen (Winkler method), conductivity, alkalinity, total dissolved solids, turbidity, permanganate index, UV

absorbance and Secchi disk transparency (with a black and white quadrant disk, of 20 cm of diameter), nutrients (nitrogen and phosphor), photosynthetic pigments, phytoplankton, zooplankton and microbiology (total coli, coli-faecal and streptococcus-faecal). Only the phytoplankton data will be discussed here, compared with other physical-chemical data that will be discussed elsewhere.

Qualitative and quantitative (cell/ml) phytoplankton was carried on following Utermöhl method [1] and EU Guidance Standard (prEN 1524:2005) [2]. Samples were conserved and transported in the glass bottles (250 ml); fixation was done with Lugol at sampling time. Counting was made by selecting occasionally field using inverse microscope with zoom objective 40x and zoom ocular 40x, 10x using an inverse microscope, XDS-1R, mainly by the Institute of Food Control and Veterinary, Tirana. To get a reliable data (confidence >95%) more than 400 cells were counted. Species determination was made following the keys of *Krammer & Lange-Bertalot* [3] with a normal microscope Leica DLMB.

RESULTS AND DISCUSSIONS

More than 20 species of microscopic algae were dominant in phytoplankton, belonging to *diatoms* (*Centricae* and *Pennate*) and *Dinoflagellates*. Other groups like: *Chlorophyceae*, *Chrysophyceae*, *Euglenophyceae* and *Cyanophyceae* were in small quantity. The most common species dominating the phytoplankton were centric diatoms of *Cyclotella* sp. *diverse*, composed mainly from *C. commensis*, a typical species in reservoirs throughout the region; its abundance goes even higher than 90% of the total phytoplankton. *Cyclotella* representatives are known mainly as oligotraphent species [4] that grows in the clean habitats. From pennatae diatoms we can cite: *Fragilaria* sp. *diverse*, *Navicula* sp. *diverse*, *Nitzschia acicularis*, *Nitzschia dissipata*, *Cymbella affinis*, *C. microcephala*, *Cocconeis placentula*, etc. *Fragilaria* sp. *diverse* have the highest density, mainly during May, July and September. From the dinoflagellates, *Peridinium* sp. *diverse*, *Ceratium hirundinella* were more abundant at the end of spring and beginning of summer, showing the stressing conditions and the concurrence for nutrients mass. *Dinoflagellates* are more favorites in an environment with high temperature, circulated water and lack of nutrients.

Average values of phytoplankton growth (cell/ml) are given in Table 1, while the phytoplankton growth in the whole water column, taking into consideration the average values were reported in figures 2. The plots on figure 3 report the absolute values of phytoplankton growth (cells/ml) in each depth. The highest density was found in 15m of depth (Table 1 and Figure 3). The maximum of productivity was observed between 5-10 m depth. It seems that the reservoir presents main growth peak in late spring and another in autumn. The lowest productivity was observed in January, when isotherm of the waters was observed. There were no significant differences between the three sampling stations meaning that the main part close to the dam and the two big arms of the reservoir were more or less continuously mixed with each other. The biomass given by *Cyclotella* sp. *diverse* was calculated; as the most abundant species (often

more than 90%) it would be closer to the phytoplankton biomass of the whole system. After the classification given by Willen [5], the waters can be considered mainly oligotrophic, with some trends to mesotrophy in late spring or autumn. But, it is in contrast with trophic state index (TSI) based in transparency (Table 3) [6] that correspond to a mesotroph state.

Table 1: Average values of phytoplankton (cell/ml) in Buvilla reservoir during May 2006 – May 2008

Depth, m	Mean values of stations S1, S2 and S3					
	May-06	July-06	Spet-06	Nov-06	Jan-07	March-07
-1	114.88	172.88	91.71	184.17	15.63	285.00
-3	66.83	126.42	67.13	190.71	15.54	252.33
-5	67.71	271.58	60.75	213.29	12.33	243.33
-10	36.25	463.83	521.46	189.88	14.83	188.67
-15	4.44	185.13	168.25	98.25	19.38	56.00
-20	7.13	76.33	52.96	90.92	11.88	15.33
-30	2.63	35.63	11.50	86.19	11.44	11.50
-40	3.63	19.63	-	58.13	11.25	9.00
Mean	37.93	168.93	139.11	138.94	14.03	132.65

Depth, m	Only station S1						
	May-07	July-07	Sept-07	Nov-07	Jan-08	March-08	May-08
-1	9688.56	1604.98	848.42	107.35	330.37	80.19	555.42
-3	9300.20	1529.66	874.99	130.59	305.87	95.51	411.00
-5	9341.08	907.57	1461.65	116.44	345.31	79.94	482.50
-10	5003.71	3349.12	452.66	106.74	337.62	128.12	243.11
-15	4521.33	956.41	1564.16	111.27	332.88	174.53	193.04
-20	3327.63	450.82	418.35	82.82	157.08	98.97	85.75
-30	239.03	174.13	211.68	45.80	23.30	72.24	101.43
-40	169.91	141.44	107.53	30.30	2.19	22.63	21.62
Mean	5198.93	1139.27	742.43	91.41	229.33	94.01	261.73

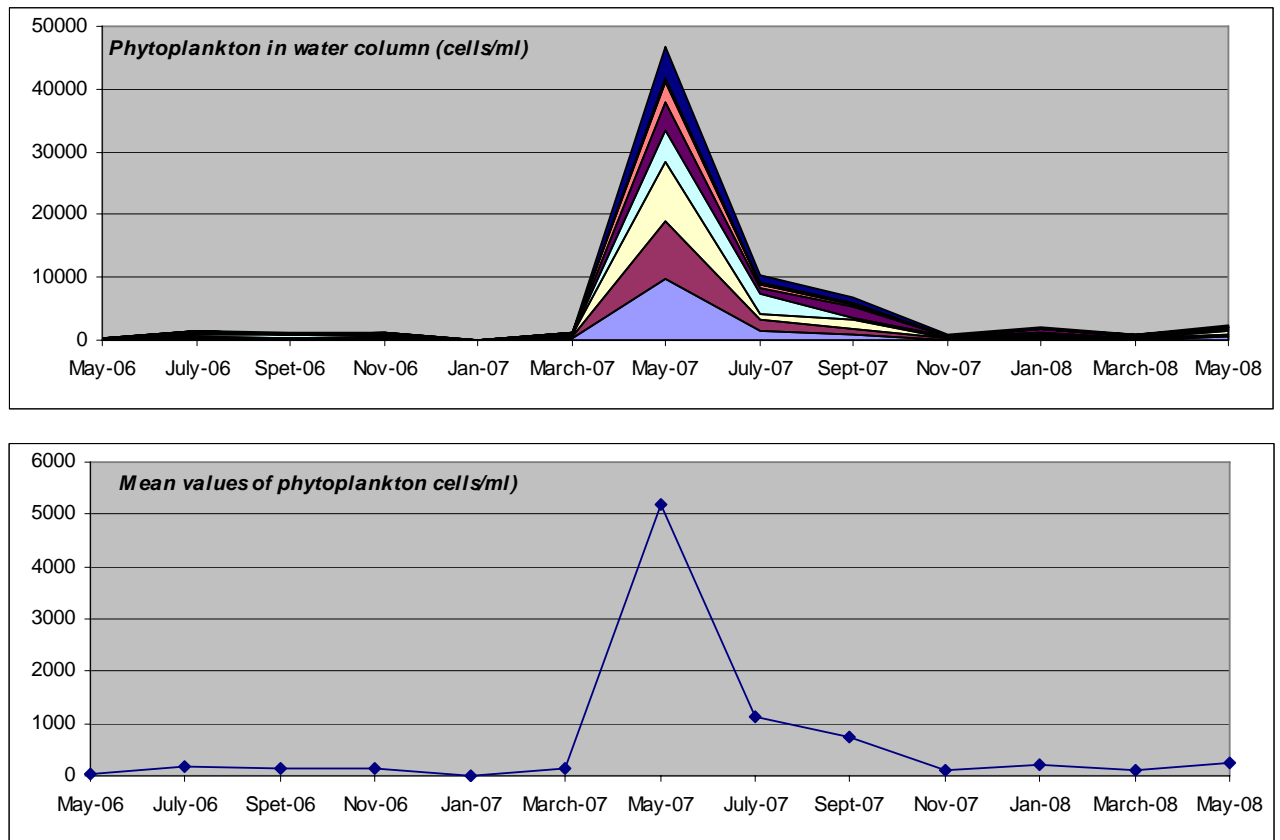


Figure 2. Progress in time of phytoplankton in water column (above) and of average value (below).

Seasonal dynamics is expected for a relatively deep reservoir like Buvilla. Due to climate condition, in winter happens mixing and homogenization of layers, affecting appearance in surface of nutrients (P, N, Fe, Si, etc.) from the bottom; most important here are phosphates and nitrites, which favor the phytoplankton growth mainly in surface light layers (1-10m depth) during next coming season, spring and summer. The water mixing is also shown in figure 3 by the relatively uniform growth of phytoplankton during November and January.

Dominant species of microscopic algae present in phytoplankton were not considered as harmful and dangerous for human health also not known for any toxic action. Density of phytoplankton in surface layers (1-10 m) showed uniform distribution for all months (*Fig. 3*), except of January, where density of phytoplankton in all depth was lowest and a high peak in July. Density decrease of phytoplankton was probably due to the low temperatures during winter period.

From the data obtained will it can be concluded that the water quality comply the norms of class A1 for raw drinking water quality standards of EC Directive 75/440:1975 [7]. After the trophic state based on Secchi disk transparency [6] the waters were mainly mesotrophic, with a trend to eutrophy only during wet period (Table 2). But it was not confirmed from the nutrients and plankton growth, where the

water quality was mainly oligotrophic with slight trend to mesotrophy in May or September. This evident contradiction between relatively low transparency and low

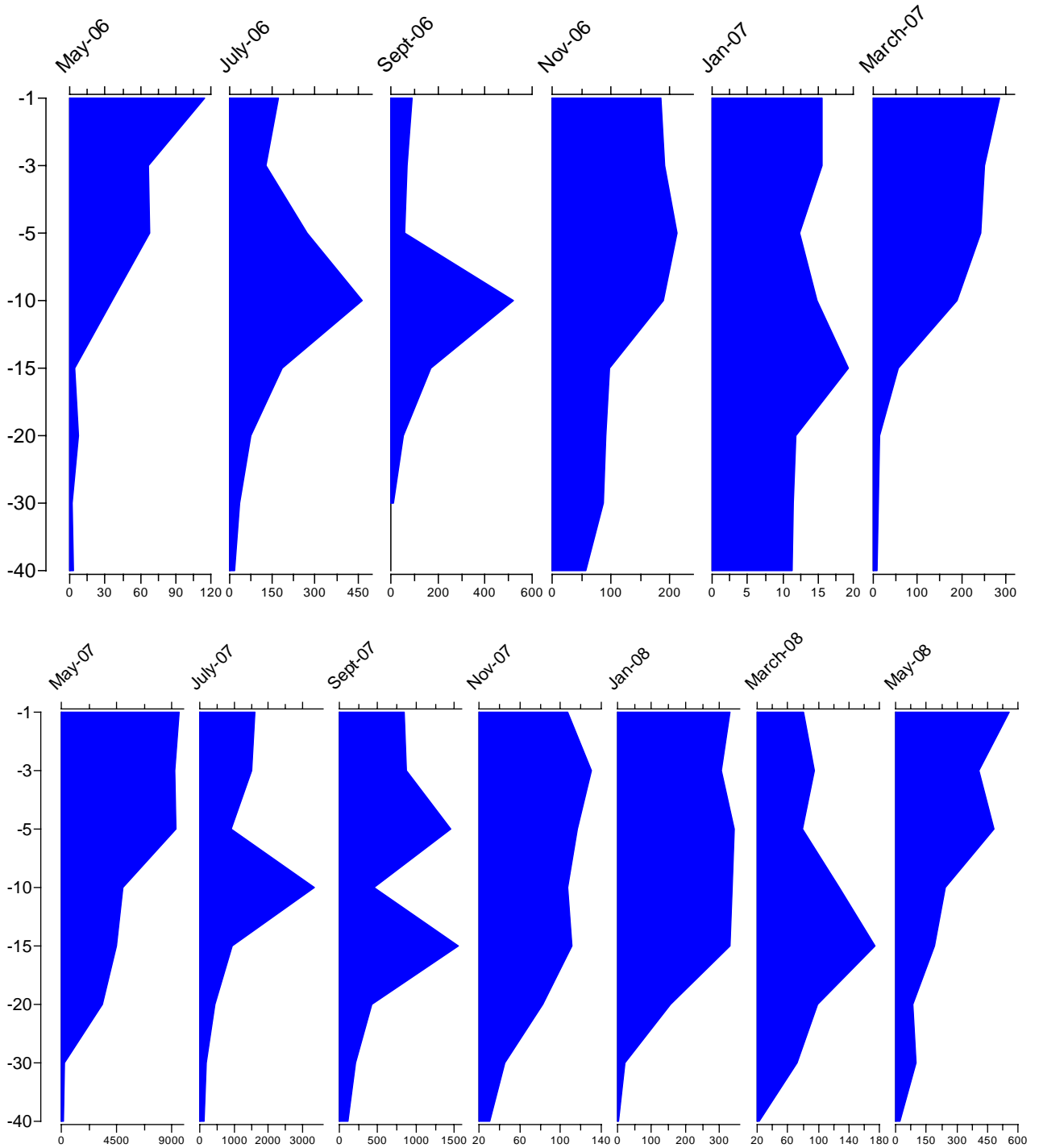


Figure 3. Phytoplankton growth (average values, cell/ml) in water column (m).

level of biological trophy (phytoplankton, zooplankton, photosynthetic pigments) is probably caused by the high rate of total suspended solids (TSS) in water; as matter of the fact only TSS exceed 25 mg/L of EC Directive standard for the quality of raw drinking water. Erosive formations of surrounding hills, woodcutting and denuding from vegetation, and intense rainfall favor and strengthen clayey torrents, erosion spots, erosion of slopes, and landslides, mainly during wet season, that end in and fill continuously the reservoir.

Table 2. Values of transparency (Secchi disk, m) and trophic state index (TSI) [6] in Buvilla (May 06 - May 08)

Depth, m	Mean values of stations S1, S2 and S3						Assessed only station S1						
	May -06	July -06	Spet -06	Nov -06	Jan -07	March -07	May -07	July -07	Sept -07	Nov -07	Jan -08	March -08	May -08
Mean	2.6	2.4	3.0	2.3	2.1	3.1	2.5	3.1	2.6	1.3	2.0	3.1	3.2
TSI	46	47	44	48	49	44	47	44	46	56	50	44	43
Trophy	Mesotrophic									Eutrophic		Mesotrophic	

Since year 2001 Buvilla is facing time after time with taste and odor problems, sporadically present mainly during late autumn. From our data it can be confirmed that it cannot be originated from the microscopic algae present in phytoplankton. Assessment made in two water samples taken in March 2008, in Zurich University showed an unusual gas chromatograph-pattern, with a sum of monoterpenes, from which Carvon dominated, that probably forms the smell. Nevertheless, the most common compounds in other similar systems (geosmine and 2-MIB) were definitively not present [7]. The most common opinion is that the decaying of the remaining stems and roots underwater may produce terpenes for many years. It can be enhanced also from terrestrial bordering areas that are regularly flooded with water as the lake level varies to about 10 m in altitude.

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