Water Quality Control of Aposelemis Dam Reservoir

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Abstract
The aim of this study is to check the vertical water quality profile of Aposelemis Reservoir. The water quality was studied in nine (9) different water reservoir depth points: S9: 0 m, S8: 02 m, S7: 03 m, S6: 05 m, S5: 07 m, S4: 09 m, S3: 10 m, S2: 13 m and S1: 15 m. A sudden change in the temperature of the water was observed at the water depth of 7 m (thermocline phenomenon) and a change in pH (from pH> 8 to pH <7.5) at the depth of 3 m. A sharp increase in metal concentration was identified in greater water depth, as well as prevalent the soluble form of them (Mn, Fe, etc.). Relating to microbial load, it was much lower in water depth > 2m, compared to 0-2 m. As the water sampling depth was increasing, the Total Organic Carbon (TOC) was decreasing, in contrary with the nutrient concentration (N, P) which was increasing. Color and odor values appear elevated in water depth greater than 5 m.
Keywords: water, quality, thermocline, reservoir stratification

1. Introduction

In a reservoir, wind-induced currents and the structure of the thermocline mainly control the vertical distribution of heat, dissolved substances, and nutrients in the water column. Thermal structure and stratification in lake ecosystems are physical features that exert important control on vertical fluxes of dissolved and particulate material.

Thermal stratification in reservoirs leads to forming of three layers. The upper one is called the epilimnion. There the water is relatively warm and it is sensitive to the changes of external factors (like mixing by the wind). The water of the lowest layer – the hypolimnion – is colder (about 10–14°C) and it does not move for most of the time in a year (spring – autumn). The middle layer – the thermocline (metalimnion) – is the area of rapid temperature decrease and it constitutes the border between layers sensitive and insensitive to the changes of external parameters.

Aposelemis Reservoir has a water surface area of 1,6 km^2, a mean depth of 35 m, a water volume of 25,3 million m^3, and a basin area of 143 km^2, when the maximum water storage water level is at +216 m. On August 21, 2017, when the vertical water sampling took place, the reservoir contained 4.5 million m^3 water.

2. Methodology and Equipment

The methodology followed for the water sampling at different water depth points of Aposelemis reservoir included the use of a boat to the deepest point of the reservoir and the use of a special sampler with thermometer (Ruttner Water Sampler, 1.5 L, KC Denmark special sampler). The water sampling was carried out during the summer period, in particular on 21st August 2017, when reservoir stratification was evident. The water samples were analyzed in the Water Quality Control Laboratory of Aposelemis WTP according to Standard Methods for the Examination of Water and Wastewater (22nd edition, 2012).

3. Results

3.1. Physico-chemical analyzes

The results of physico-chemical analysis of the nine (9) samples taken from the Apeselemis reservoir, as carried out at the Water Quality Control Laboratory of Aposelemis Water Treatment Plant (WTP), are shown in Table 01 and Table 02.

Table 1. Physico-chemical analysis (I)

Parameter	Unit	S9	S8	S7	S6	S5	S4	S3	S2	S1
T	°C	26	25	25	20	12	11	11	11	10,5
Turbidity	NTU	1,96	2,51	2,39	5,82	5,46	12,10	17,10	18,80	18,7
Colour	Pt/Co	17	24	26	87	98	108	123	132	124
Odour	TON	0	0	0	0	4	6	6	7	8
pH		8,27	8,27	8,20	7,46	7,45	7,38	7,38	7,37	7,44
Conductivity 20°C	μS/cm	389	390	390	407	414	409	413	414	409
TOC	mg/L	3,7	3,6	3,4	3,0	2,6	2,3	2,4	2,3	2,4
SS	mg/L	1,76	3,26	2,57	7,16	4,48	3,09	4,20	4,95	3,92
Al	μg/L	-	16	-	-	-	-	14	-	-
Fe	mg/L	0,029	0,040	0,036	0,045	0,068	0,445	0,500	0,522	0,474
Mn	mg/L	0,035	0,040	0,042	0,513	1,557	1,407	1,395	1,395	1,398
Mn (soluble)	mg/L	-	0,039	-	-	-	-	1,233	-	-

Table 2. Physico-chemical analysis (II)

Parameter	Unit	S9	S8	S7	S6	S5	S4	S3	S2	S1
NH_4^+	mg/L	0,027	0,022	0,023	0,03	0,063	0,39	0,612	0,657	0,691
NO_3^-	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1
NO_2^-	mg/L	0,008	0,007	0,007	0,023	0,03	0,018	0,022	0,029	0,022
SO_4^{2-}	mg/L	20	21	22	16	14	12	9	9	8
CN^-	mg/L	-	0,002	-	-	-	-	0,004	-	-
PO_4^{3-}	mg P_2O_5/L	-	0,149	-	-	-	-	1,054	-	-
Hardness	(dHo)	-	9,89	-	-	-	-	11,5	-	-
Mg^{+2}	mg/L	-	12,6	-	-	-	-	10,8	-	-
Ca^{+2}	mg/L	-	49,5	-	-	-	-	64,2	-	-
F^-	mg/L	-	0,214	-	-	-	-	0,102	-	-
Cl^-	mg/L	-	37,4	-	-	-	-	30,4	-	-

Figures 1 and 2 show the results of the physicochemical analyzes of the nine (9) water samples taken from the Aposelemis reservoir at different sampling depths.

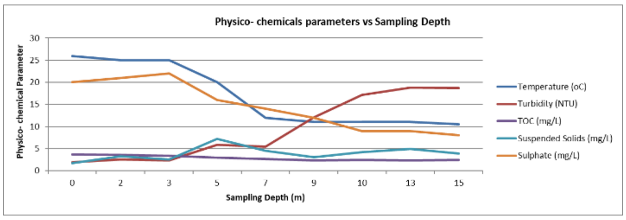

Figure 1. Physico-chemical parameters at different sampling depths

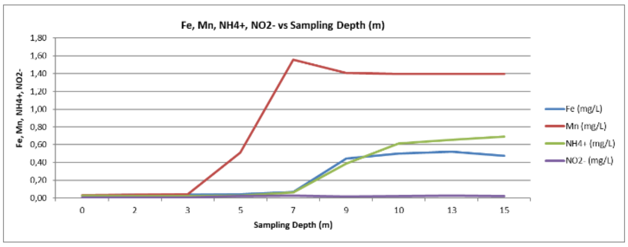

Figure 2. Concentration of Fe, Mn, NH_4^+, NO_2^- at different sampling depths

3.2. Microbiological analysis

The results of microbiological analysis of the nine (9) samples are shown in Table 03.

Table 3. Microbiological analysis

Parameter	Unit	S9	S8	S7	S6	S5	S4	S3	S2	S1
Coliform bacteria	colonies /100 mL	3340	13000	2000	800	1400	800	4400	2500	2000
Escherichia coli (E. coli)	colonies /100 mL	0	0	0	3	58	31	37	42	34
Clostridium perfringens	colonies /100 mL	1	0	2	2	5	5	4	7	2
Enterococci	colonies /100 mL	0	0	0	1	84	116	124	90	88
Colony count 37 °C	colonies /mL	39	12	31	62	24	32	22	38	33
Colony count 22 °C	number/ml	170	142	67	26	21	49	70	56	40

Figures 3 shows the results of the microbiological analyzes of the nine (9) water samples taken from the Aposelemis reservoir in different sampling depth.

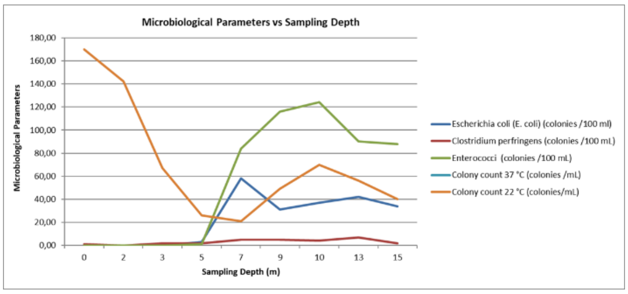

Figure 3. Microbiological parameters in different sampling depth

4. Conclusions

In the Aposelemis reservoir the thermocline phenomenon was in progress, based on the observed temperature change which occurred at a depth of 7 m from the surface of the water (Reservoir Stratification). Almost at the same depth (7-9 m), there was a sharp rise of water turbidity, which stabilized at high values (> 18 NTU) at greater depths. The color and odor values appeared to be elevated at depths > 5 m. Total Organic Carbon (TOC) decreased as the depth of sampling increased, suggesting the existence of anaerobic conditions at larger depths. ThepH value decreased (pH<7,5) to higher sampling depths (> 5m). A sharp increase of metal concentrations and the predominance of their soluble form (Mn, Fe, etc.) was observed at greater depths (H> 5 m). The concentration of nutrients (N, P) increased with increasing sampling depth (H> 9 m). The increased microbial load on surface water samples (0-2 m) was probably due to increased temperature (T), to increased dissolved oxygen concentration (DO) and to surface contamination. The most resistant microorganisms (e.g. Enterococci, E. coli) grew more at water samples > 7m deep, where there was a decrease in dissolved oxygen.

References

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