INFLUENCE OF DAM BUILDING ON SURFACE WATER QUALITY. CASE STUDY

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Abstract

Since ancient times people have tried to control the surface water flow. Most often this could be achieved by building of storage lakes. In the twentieth century alone, more than 800,000 dams were built in the world. They aim to change the temporal regime of the surface flowing waters by retaining a part of the tributary flows in certain periods, and by increasing the defluent flows in other periods. (Ilie A., C., 2007) The usefulness of dams is obvious: they facilitate the use of the available freshwater, store water in times of drought or excess, regulate flows for various uses, increase safety in case of floods, generate electricity, etc

Dams disrupt the free water flow though, the transport of sediments and the free movement of aquatic species. If we only view the construction of dams ecologically, we might think that it has negative connotations. It is just too simple, considering the benefits dams bring (Yang Q. et al., 2015, Heine I. et al., 2015).

The present paper aims to analyze the effect the construction of Suplacul de Barcău dam lake has on the water quality supplied to its beneficiaries, city dwellers of Marghita and rural settlements between Suplacu de Barcau and Marghita.

Key words: permanent storage, indicators of oxygen regime, electrical conductivity, suspensions

INTRODUCTION

Suplacu de Barcau permanent storage is located on the river Barcau, approx. 400 m upstream from the national road DN 19 B which connects the settlements Suplacu de Barcau and Port, in Bihor County. The storage was built to reduce the risk of flooding downstream, by reducing the maximum flows of floods, as well as to supplement the flow of drinking and industrial water for the town of Marghita, and drinking water take off for waterworks in rural communities pertaining to the communes Suplacu de Barcau, Balc, Abram and Abramut.

According to calculations the gross volume of the lake is 10.2 mil. m^3, the dam is made of local materials, sealed in a mask of reinforced concrete and a concrete screen to the upstream foot. The crest of wave was set at 174.50 mdMB. The height above the foundation level is about 11 m. The unloader is a frontal concrete spillway with three 12 m openings, each provided with energy dispersion works. The bottom outlet is located between the high waters discharger and the left escarpment and it has an access channel, intake and control tower, drainage gallery, energy disperser. The accumulation dam was classified as class II of importance, according to

STAS 4273-83. The work importance category under GD 261/1994 and Law 10/1995 on quality in constructions is B - high.

The construction of a reservoir has beneficial effects on water quality because the sedimentation process of substances in suspension accentuates, thus reducing water turbidity, along with the microbial load. However, in the early years after flooding, water quality slightly worsens due to the entrainment of the organic material, iron and manganese compounds and humic compounds. These entries alter the organoleptic properties of water and indicators such as oxidability and biochemical oxygen demand (Romocea, 2009, Wang, et al., 2008, Wang et al., 2012).

MATERIAL AND METHOD

By water quality we understand all of the physical, chemical, biological and bacteriological characteristics, quantifiably expressed, which admit the water sample to fall into a certain category, thus acquiring the attribute of serving a particular purpose. The quantified expression is made by means of quality indicators (Romocea, 2011).

The present study focuses on the interpretation of water quality expressed through some physical and chemical indicators, with values provided by Crisuri Water Basin Administration. Of all the indicators with determined values, we chose: indicators of oxygen rate (dissolved oxygen, BOD5, COD), electrical conductivity and suspensions. The years chosen for comparison are 2010 (before the lake started to operate), 2014 and 2015. The sampling places are: upstream of the dam in 2010, upstream and downstream of the dam in 2014, upstream, downstream and the storage in 2015. The mean values of the indicators were compared. The measured values of the parameters were compared to their permitted values. In accordance with the regulations in force (HG 567 / 2006 on amending quality standards that must be met by surface waters used for drinking), the admissible values of the parameters taken into consideration by the present study, for the three quality classes A1, A2 and A3, are shown in table 1.

Table 1

The admissible values of the parameters

Parameter	Unit. of measurement	A1	A2	A3
oxygen deficit	%	70	50	30
CBO_5	mgO_2/l	<3	<5	<7
CCO-Cr	mgO_2/l	10	20	30
electrical conductivity	µ/cm	1000	1000	1000
total suspensions	Mg/l	25		

The relevance of the chosen indicators is presented briefly.

The most important parameter that characterizes the quality of surface waters is dissolved oxygen, which is vital to aquatic ecosystems. The most important processes in which oxygen is consumed are biochemical and chemical oxidation processes and breathing of creatures (Patrick M.et al. 1998) Biochemical oxygen demand is the most representative indicator of the consumption rate of oxygen and it consists of determining the quantity of oxygen used by bacteria in the water to decompose the organic substances, in a certain period of time. Biochemical oxygen demand is determined at a temperature of 20 ° C in intervals of 5 or 20 days. The biochemical oxygen demand in five days is a relative assessment of the amount of biodegradable substances in the water. The individual determination of organic substances in the water is very difficult therefore an overall assessment of their content is needed, to determine their "oxidizability". This means to determine the amount of oxidant, potassium permanganate or potassium dichromate used for the oxidation of organic substances: COD Mn or COD. By chemical oxidation methods, a great part of non-biodegradable organic substances are mineralized as well (Dasgupta, Yildiz, 2016).

The higher the water mineralization degree is, the higher the valueof the electrical conductivity. Certain quality requirement documents stipulate the maximum admissible water electrical conductivity others give the permanent residue value at exactly 105 ^{o}C. Both of these parameters refer to the amount of dissolved substances in the water (Lee, et al., 2012)

Solids may be present in water both in dissolved and undissolved forms. Solids with dimensions under 1 nm are dissolved, those between 1nm and 1μm are colloidal and solids larger than 1μm are in the form of suspensions. Undissolved solids give water turbidity. The amount of suspension is a gravimetric property while transparency and turbidity are optical properties (Huey, Meyer, 2010, Byun, et al., 2015) , Any insoluble substance can persist more or less time suspended according to the weight of the particle.

Suspended matters represent the amount of water-insoluble substances that can be separated by filtration, centrifugation or sedimentation. In terms of water supply are important: gravimetric suspensions (sedimentable) and colloidal suspensions (non-sedimentable). Gravimetric suspensions represent all insoluble materials that can settle naturally in a limited time. Determining the total suspension is important for the characterization of natural waters and dimensioning of objects in water treatment plants for potabilization process. The amount of gravimetric suspensions helps dimensioning the pre-clarifiers and desanders.

RESULTS AND DISCUSSION

1. The variation the oxygen regime indicators (dissolved oxygen, CBO5, CCO-Cr)

As regards the dissolved oxygen concentration, it is higher in the upstream sampling sections (maximum of 11.12 mg / l in 2014), getting lower in the lake water (7.47 mg / l) and reaches minimum values for the sections downstream (4.93 mg / l in 2014). The temporal and spatial variation of this parameter is shown in Figure 1**.**

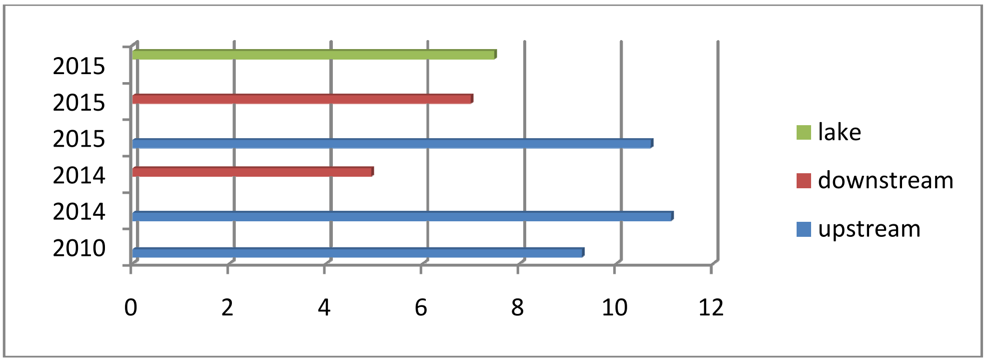

Fig. 1. Space-time variation of the concentration of dissolved oxygen (mg / l)

The variation of oxygen consumption indicators - biochemical and chemical oxygen demand - is opposite to the variation of dissolved oxygen. The biochemical oxygen demand is low in the upstream sections and large in the storage waters and downstream. The CBO5 value in the lake water (5.75 mg / l), allows the class II classification of water quality-A2. Temporal and spatial variation of this parameter is shown in Figure 2

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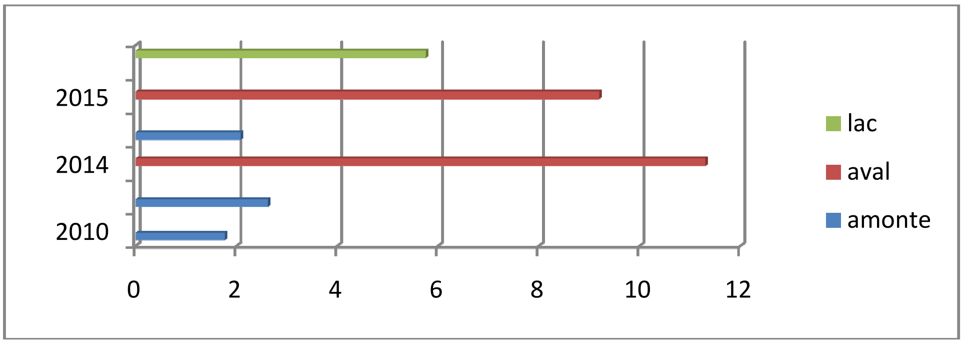

Fig. 2. Space-time variation of biochemical oxygen demand (CBO5) (mg / l)

Chemical consumption of oxygen varies proportionally to biochemical consumption. Lower values are recorded in upstream sections and higher values in the storage waters and downstream. The value of this parameter for the storage water is 19.7 mg / l. The maximum value admissible by the reference regulatory document for quality class II is 20 mg / l, and we considered the average values of parameters, therefore the punctual values frequently exceed that limit. Temporal and spatial variation of this parameter is shown in Figure 3.

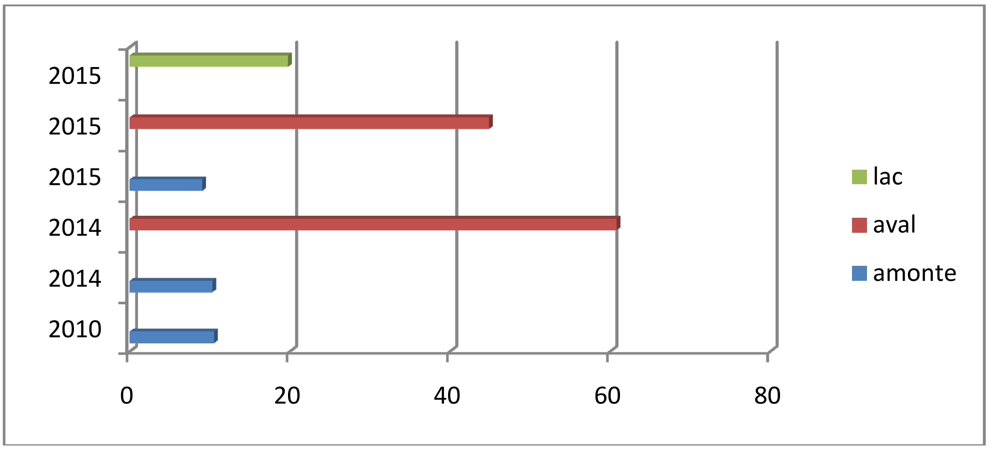

Fig. 3. Space-time variation of chemical oxygen demand (CCOCr), (mgO2 / l)

The biochemical process of organic matter decomposition (especially the leaves when the flooded land has not been sufficiently cleared), consumes dissolved oxygen and leads to anaerobic decomposition processes, accompanied by inherent phenomena: the emergence of hydrogen sulphide and methane. This is why chemical and biochemical oxygen consumption increase in the storage water and downstream. Decomposition causes the increase of the amount of nutrients in the water. Fertilizers used on the agricultural land upstream are also added to this phenomenon (Mida et al., 2010).

2. Physical and chemical indicators variation: electrical conductivity and suspensions.

Water storage land flooding favors a series of processes which mobilize soluble salts which are present in the geologic substratum. They are most solubilized salts are in particular iron, manganese, silicon, aluminum. Along with ions resulting from organic matter mineralization, they increase the water mineralization and electrical conductivity is the most faithful parameter of this development. In our case, as shown in Figure 4, conductivities are smaller (around 200 µS// cm) in the upstream sections and slightly grow in the lake water (273.75 µS// cm). The samples are average and not profile samples. Probably conductivity is higher in samples taken at depth.

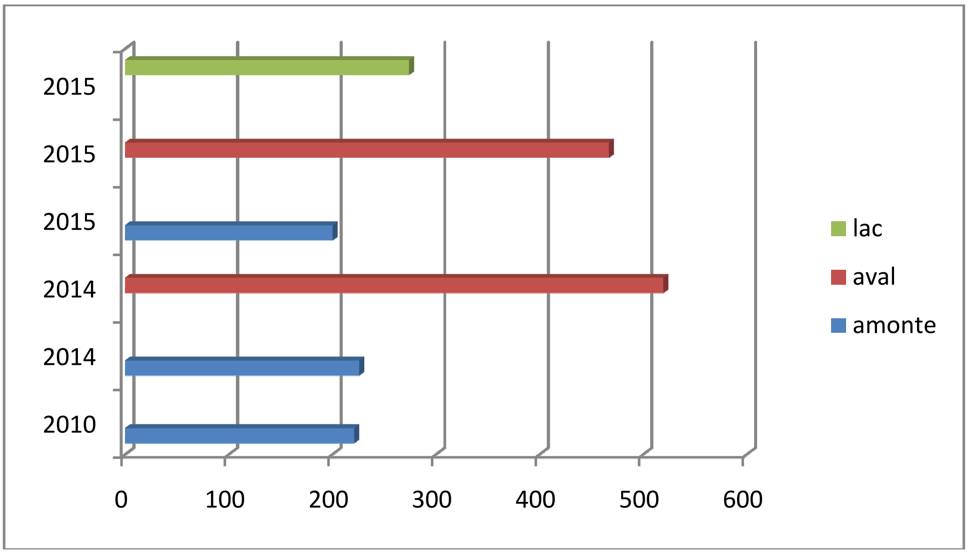

Fig. 4. Space-time variation of electrical conductivity (µS / cm)

Particles in suspension, transported by water from upstream are deposited in time on the bottom. Suspensions deposited on the bottom of the waters form, together with vegetal and animal debris, sludge or sediment. The sediment is the place where certain physical phenomena and chemical and biochemical reactions that influence water quality, produce. The construction of the reservoir has beneficial implications on water quality because the process of sedimentation of suspended substances is increasing and thus reduces water turbidity, reducing microbial load at the same time.

The settling process the lake water is obvious. The amount of suspended matters is in 2015, 19 mg / l upstream lake and 2 mg / l in the lake. Also in 2015 there is a large increase in the amount of suspended particles in the downstream section of the storage. The average recorded value is 53.25 mg / l. This is due to the forces of erosion that confront the riverbed downstream (Sharma, Capoor, 2010). The temporal and spatial variation of the total quantity of suspension is shown in Figure 5.

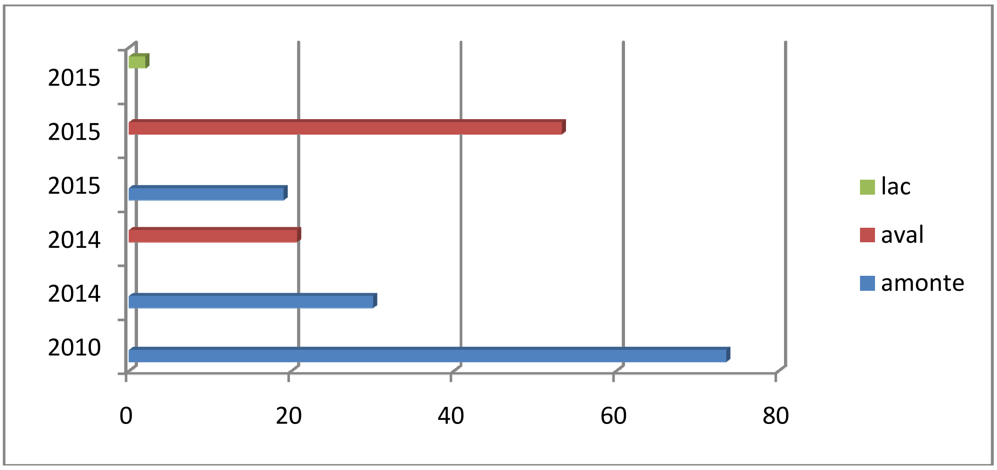

Fig. 5. Space-time variation of the total suspension amount (mg / l)

CONCLUSIONS

The support and guarantee for the proper functioning of aquatic ecosystems are the physico-chemical qualities of water and morphological qualities of natural aquatic environments. The artificial creation of a water retention alter water quality, the life of aquatic organisms and influence the sedimentation process of suspended particles.

The main changes in water quality after filling the lake are related to turbidity reduction due to lower quantity of suspended substances, decomposition of organic matter on the bottom and mobilization of soluble organic and inorganic substances. The current decline in the amount of dissolved oxygen can be balanced within a short time, by intensification of photosynthesis, due to lower stagnant water turbidity. The electrical conductivity, expression of mineralization may decline in the coming period due to the decreased solubilization phenomena and become mainly dependent on rainfall. Changes in water quality can be induced by hydraulic processes related to the management of the dam, which can cause water mixing layers in the vertical section.

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