The Influence of the Air Thermal and Rainfall Regimes on Storage Lakes Water Turbidity

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Banat River Area specific climate is characterized by moderate temperature and high precipitation amounts, which affect the surface water quality. Since Secu Lake, located on Valley Bârzava provides drinking water to Re°iþa city, the raw water turbidity variation was analyzed depending on changes in climatic parameters. The study is based on monitored values of this quality indicator, within two years (December 2008-December 2010). Deviations from normal climatic limits are frequently caused by CO_2 concentration increasing in the atmosphere and massive deforestation determined during the analyzed period, increases in rainfall, with influences on the Lake Secu water turbidity. On the other hand, the works on the Bârzava River course, have contributed to changes in turbidity, by dislodging sand, gravel and various residues. Analysis of this indicator was performed in order to assess the water quality and the necessity of drinking water correction.

Keywords: water, turbidity, thermal regime, rainfall regime, storage lake, hydrographic basin

Banat hydrographic basin description

Banat hydrographical area (fig. 1), located in the extreme south-western Romania, occupies an area of 18320km^2 which corresponds to around 7.7% of total national area and includes hydrographic network located between the Mure° and Jiu, including Danube direct affluent between Bazias and Cerna.

From a climate perspective, Banat River area fall within the moderate temperate climate with Mediterranean influences, result of movement of air masses Atlantic overlap with invasions of Mediterranean air. This environment generates the thermal regime moderate nature, as heating in winter periods and average annual amounts of precipitation relatively high, ranging from 600-1400mm/year.

Average annual air temperature is between 10-11°C, except in western Banat Plain area, where temperatures are somewhat higher.

Average annual rainfall varies from 500mm in the plains, up to 1000-1200mm in the mountainous eastern Banat hydrographical area [1].

Fig. 1. Banat hydrographical area - hydrographic basins components (Source: www.rowater.ro)

Gozna, Valiug, Secu (on the Bârzava River) provides potable and industrial water requirements in Resita and contributes to the basin hydroelectric potential harness [2, 3, 12]. Secu Lake is located on Barzava Valley below Neman Mountain, at an altitude of 350m, behind a concrete dam that holds water at 30m height, at a distance of only 3km from Resita. Lake, which covers an area of 105.67ha and a volume of 15132000m^3, used to supply water to Resita, as protection against the city flooding, and recreation role in the Secu resort. The other two lakes are primarily used for hydropower purposes [1].

The main inlet is achieved through a concrete pipe, the water being transported by pumping up to the two feed pipes of the room junction (i.e. Secu and Grebla Lakes). Hence, raw water is transported to the ªamota I pumping station and feed the concrete absorption tank of Samota II pumping station [3].

Water temperatures variation closely follows the air temperature variation, so that the Barzava annual average water temperature is 9.9°C. Winter phenomena are rare, being more obvious in mountain stage sections [1].

The water chemistry shows bicarbonates with oxygen rich content predominance, with a medium to slightly alkaline in *p*H (6.8 to 7.4). Dissolved oxygen content varies depending on the relief stages, maintaining for all the mountain stage rivers over 10mg/L, Nera=10.2mg/L, Timis=10.3mg/L and decreasing to 9.3mg/L (Caras) in the plains, where leakage slopes do not allow a good water aeration [1].

The water mineralization is low in the mountain and sub-mountain and average in the plain, reaching values of 176mg/L (on the upper Timis River) in the mountain area and 381mg/L (on the inferior Caras River) in the plain area. Mineralization is average for rivers crossing the upper calcite area: 297mg/L on upper Caras River [1].

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Storage lakes overview

Achieving a storage lake on the water course involves a series of significant changes in both flow regime and morphology. Thus, depth and width of the bed local increases flow, velocity is more reduced, there are areas with stagnant water, changes in microclimate and groundwater flow groundwater, springs, etc. are produced [4].

These phenomena operate on turbidity which decreases more, but which can be modified by the planktonic organism development [5-7]. The dissolved oxygen content increases, exceeding sometimes the saturation limit. Water oxygenation favors the organic matter oxidation and mineralization.

At the lakes bottom appear sometimes specific substances such as iron, manganese, hydrogen sulfide, ammonia, etc. Organoleptic alterations frequently occur in water through the microorganism's vital activity or by their decomposition. Increased evaporation due to the solar heat increases the salts concentration in accumulated water [8].

Ecological state of water includes five categories: poor, weak, moderate, good and very good as the Romanian Water Law imposes [9]. Water conditions can be considered as very good, on the basis of biological, physicochemical and hydromorphological. If water state is analyzed only in terms of biological and physical-chemical elements, this will be appreciated as good [9].

Experimental part

The Secu Lake water quality evolution

Studies regarding the Secu Lake water quality evolution appreciate the climatic parameters influence on the physical and chemical characteristics of the storage lake water. Since the analyzed lake has a depth of 30m, a series of influences favorable to water quality are creating, such as: suspension contents substantial reduction, the insurance of a constant temperature, frost elimination and the ice and sludge danger.

Evaluation of the lake water turbidity parameters was based on their monitoring within two years (2009-2010). Qualitative determinations were performed in the SC Aquacaras SA Central Laboratory, Resita [3]. The study consists of analyzing the water quality parameter values depending on season specific temperature during the monitoring period [10, 11].

Turbidity monitoring between December 2008 and November 2009

In figure 2-5 are graphic presented turbidity variations during the four seasons, from December 2008 to November 2009, based on the Collaboration Protocol with SC Aquacaras SA.

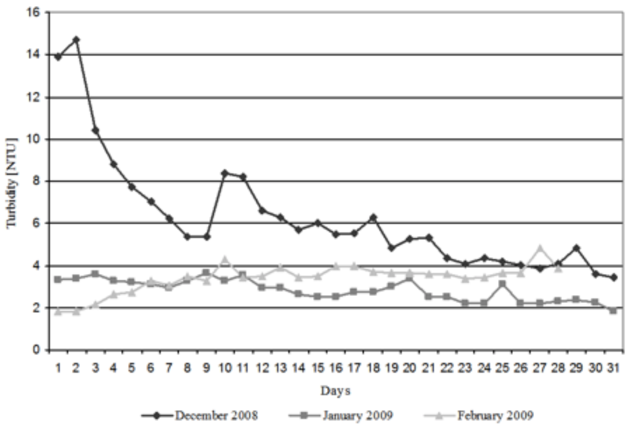

Fig. 2. Turbidity variation during winter 2009

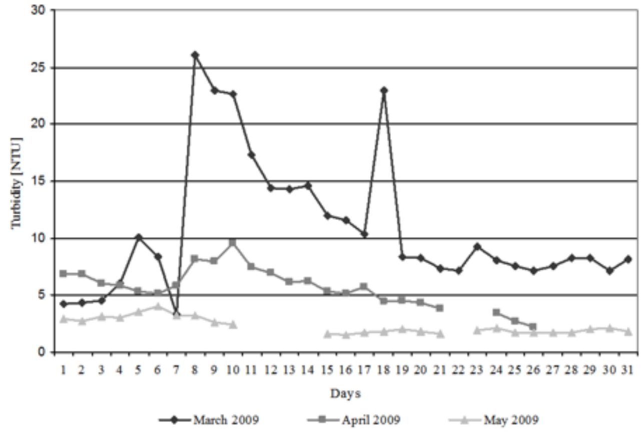

Fig. 3. Turbidity variation during spring 2009

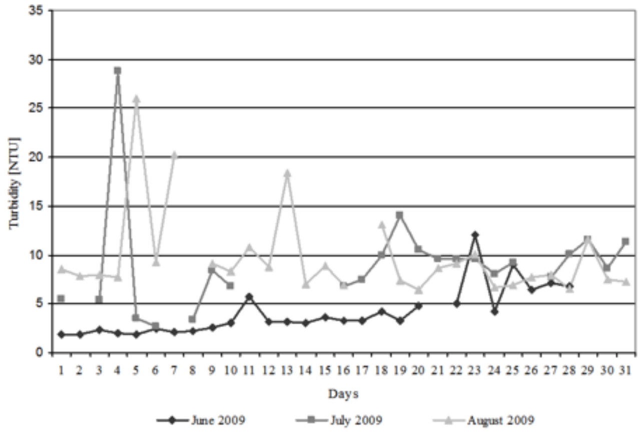

Fig. 4. Turbidity variation during summer 2009

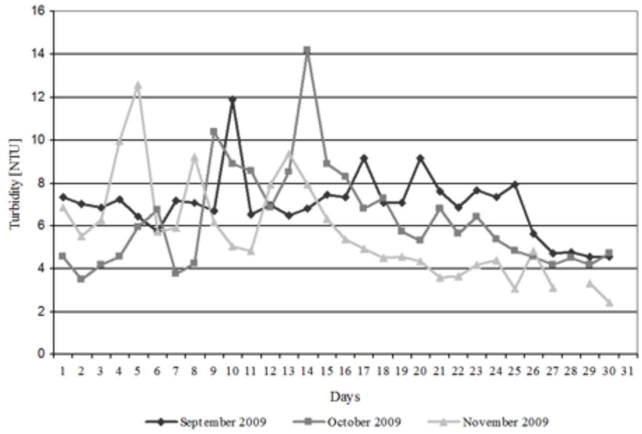

Fig. 5. Turbidity variation during autumn 2009

The turbidity variations monitored for each month between December 2009 and November 2010 in accordance with Collaboration Protocol with SC Aquacaras SA, are shown in figure 6-9.

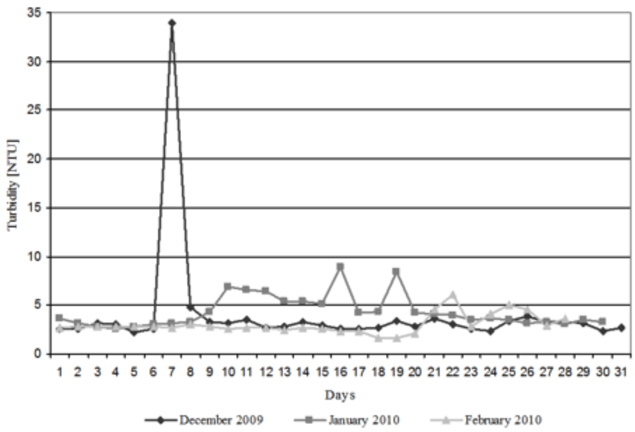

Fig. 6. Turbidity variation during winter 2010

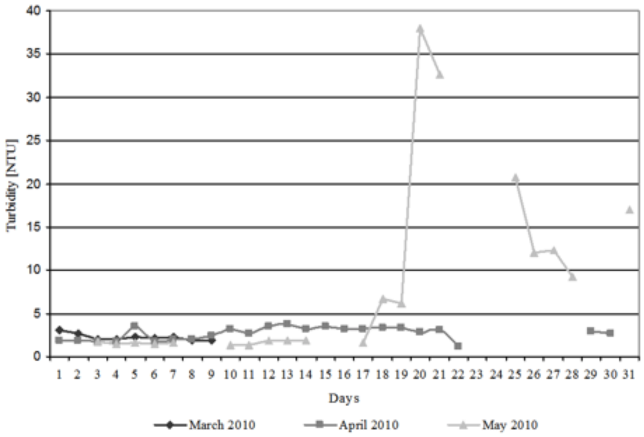

Fig. 7. Turbidity variation during spring 2010

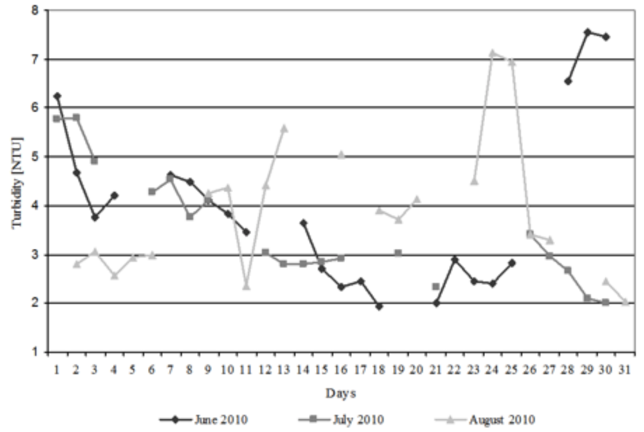

Fig. 8. Turbidity variation during summer 2010

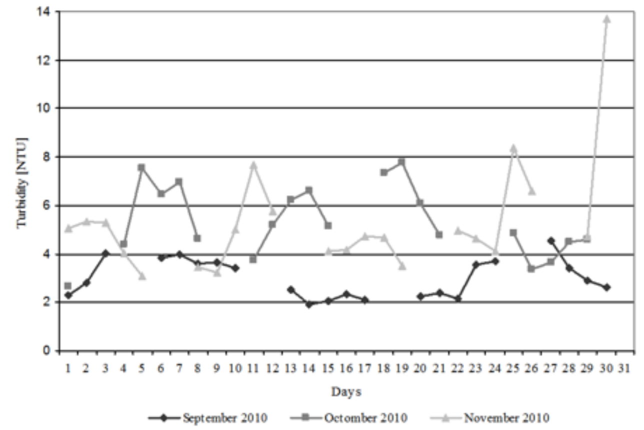

Fig. 9. Turbidity variation during autumn 2010

Results and discussions

In the first days of December 2008, the high turbidity values were influenced by the low thermal regime (fig. 2). Its variation has stabilized as temperature values were close to normal, on the specific months. At normal atmospheric temperature, in January 2009, turbidity remains approximately constant within the range 2 to 3.8NTU. In the first part of February, the normal thermal regime is maintained, so that turbidity values remain close to those in January. Since February 13, 2009, turbidity presents a slight increase in comparison with the values recorded in January, which can be explained by increased rainfall.

The beginning and the end of March was marked through a normal temperature, which is also observed from the constancy of turbidity variation (fig. 3). Between 7 to 19 March, high turbidity has been characterized by two maximum values of 26NTU on March 8 and 23NTU on March 18. The turbidity variation is due to high differences in day-night temperatures. The thermal regimes specific values in April and May were normal. For this reason it is noted that the turbidity variation shows a similar allure, the difference between the two intervals averaging 3NTU.

In the early summer of 2009, until June 23, atmospheric air temperatures, and therefore the turbidity, remain within normal limits, with a maximum of 5.71NTU on June 11. The end of June is manifested by daily variations in temperature with obvious effects on the turbidity, with a maximum of 9.26NTU on June 25.

The torrential rainfall recorded in June-July had an effect on turbidity, increasing. Exceeding the normal climatologically limit from 9July and the heavy rains accompanied by landslides have determined sudden variations in turbidity, the maximum values on certain days greatly exceeded the average in the rest of the month. Considering that August was characterized by the same temperature and precipitation, turbidity variation is similar to the one in July.

In the autumn months, high temperatures prevailed over the normal range, even hot, and large amounts of precipitation.

In figure 4, it is observed that the atmospheric conditions have determined frequent changes in turbidity values recorded during the three months. The minimum value of this parameter was 6.71NTU on September 13 and the maximum of 7.2NTU on November 7.

During the cold season (fig. 6), turbidity was maintained between 2-4NTU because the ambient air temperature was higher than normal limits. The maximum value of 4.85NTU was recorded on December 8 due to air cooling. The significant variation of the thermal regime in January 2010 strongly influenced the water turbidity. It is noted that the beginning and end of January are characterized by relatively constant values of this parameter, unlike the middle period when there were sudden variations (6.92NTU on January 10, 8.86NTU and 8.48NTU in January 16 19 January) due to changes in temperature.

The first half of February, is characterized by relatively constant atmospheric turbidity due to temperatures close to the stability limits. The rest of the monitored period generally shows large variations in turbidity influenced by the increasing temperature.

The analysis of monitored periods in March and April (fig. 7) shows that, since the temperatures were within normal limits, the lake water turbidity values are within the drinking water quality limits. This parameter has the same variation in the first half of May. Warm air from the second half of the month resulted in turbidity increase with a maximum of 38NTU.

Considering that the summer months of 2010 were characterized by an unstable temperature and rainfall, above the climatologically normal, the turbidity showed frequent variations from day to day, as it can be observed from figure 8.

In the autumn (fig. 9), the ambient air temperature varied from one month to another, causing frequent changes of the lake water turbidity.

Conclusions

From the study regarding the of ambient air temperature influence on the Secu Lake water turbidity, it can be observed that this water quality indicator shows annual and seasonal variations.

The most visible turbidity values disturbances were recorded as a result of changes in atmospheric temperature due to the climate change.

Even the water temperature may be an indirect indicator of pollution. Variations in air temperature, indicates communication with the outside and therefore the possibility of pollutants entering from outside into the water source.

The greenhouse effect caused by the increase in the atmosphere of CO_2 concentration causes the thermal anomalies that are manifested through higher than normal annual air temperatures. This contributes to the increase in precipitation with negative effects on the surface water quality. High precipitation regime, characteristic of the monitored period, contributed to lake water turbidity increase, involving the suspension of air and material contained in the soil. The increase of this indicator is also justified by dislodging waste from the river course as a result of the development work of Bârzava river course with negative environmental impact. Another cause of water negative changes in terms of turbidity is the deforestation during the analyzed period.

As Secu Lake water is used for Re°iþa drinking water supply, its quality parameters are very important in terms of substances doses used for the turbidity correction.

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