# THE WATER QUALITY FROM SAINT ANA LAKE

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**ABSTRACT. The water quality from Saint Ana Lake.** Inside the Ciomad Massive appears a unique lake in Romania, with an exclusive precipitations alimentation regime. The lake's origin and the morphometric elements, together with the touristic activity, determine the water's quality and characteristics. Water status evaluation was realized using random samples taken between the years 2005 and 2010. Qualitative parameters indicate the existence of a clear water lake, belonging to ultra-oligotrophic faze. This is because the crater is covered with forest and the surface erosion is very poor. Also the aquatic vegetation is rare. From all analyzed indicators, only ammonium and total mineral nitrogen have higher values during last years. In the future, the lake needs a higher protection against water quality degradation.

**Key words:** eutrophication, ultraoligotroph, nutrients, oxygen regime, space – time evaluation

## 1. INTRODUCTION

Ciomad Massive is the newest unit in the Carpathian volcanic range, and also in Europe. Its origin and belonging was always a highly disputed problem between numerous researchers and even today there are aspects that are not finally concluded. This problem appears also in the origin theories from Saint Ana Lake.

From the morphologic point of view, it is strong connected with Bodoc Mountains, but Olt Defile that separates it from Harghita Mountains, is a relative new limit, making such an association not justified. The Ciomadu Peak is delimitated by low depressions and valley from three parts. This is way it has this awfulness aspect, even though it is only 1300 m high. The two craters, Mohoş and Saint Ana, have total different ages and aspects. The latter is the smaller and newer crater, with the homonymous lake created by rainfalls accumulation.

The lake has small morphometric sizes. According to the measurements made by Pandi (2008), the water surface has 189,900 $m^2$ and the wetted perimeter has 1685 m. The small difference between its length (612 m) and its width (450 m), and also its very small bank sweeping coefficient (1.09) indicate a shape characteristic for crater lakes. The lake's water volume is of 580,150 $m^3$. Its average depth is of 3.1 m, with the deepest point at 6.1 m.

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The lake is supplied with water only from the inner crater areal flow. Surface erosion is small due to high forest extension inside the crater. Only the eastern slopes present some torrents with anthropogenic origin.

These crater and lake characteristics influence the lake water proprieties.

## 2. DATA AND METHODS

The samples were gathered mainly from the lake's middle and surface. Some samples were gathered from the lake's northern or southern part, respectively from the photic water layer in the middle of the lake. The samples were gathered when the lake was not covered with ice, between April and October. There is no regularity or unique frequency in gathering the samples, but the data are representative for space and time evaluations.

The samples were analyzed in a specialized laboratory, according to the legislations and directions of the European Union. They refer to eutrophication and physical – chemical indicators for the period 2005 – 2010. We will analyze only the most representative annual averages related with Saint Ana Lake water quality.

## 3. RESULTS

### 3.1. Temporal evaluation

For lake water quality analyze, the most relevant are biologic and physical processes. The eutrophication indicators reflect most accurate the water quality status from Saint Ana Lake, together with temperature and pH variations.

**Indicators for eutrophication process**

The most significant **nutrients** are nitrogen and phosphorus, both in terms of eutrophication, as well as on qualitative indicators. Total phosphorus present a general decrease trend determined by low quantities of organic and mineral substances dissolved into the lake. The decreasing values show an improvement of eutrophication degree, from mezotroph (0.03 mg/l) to oligotroph (0.005 mg/l). The last two years present values below 0.01 mg/l. The oscillations can come from the

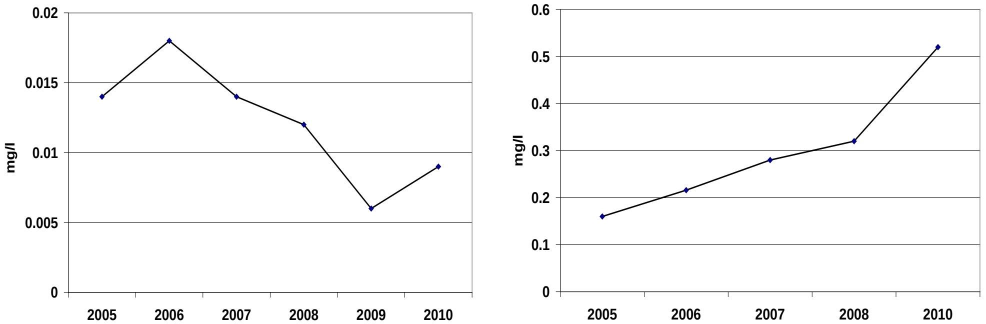


**Fig.1.** ***Total phosphorus and total mineral nitrogen***

last years temperature variations, increasing dissolution and facilitating bacteria activity. The presence of total phosphorus is the main cause for eutrophication.

On the other hand, the evolution of total mineral nitrogen has an increasing trend through all our study period, varying between 0.17 and 0.52 mg/l. Because the crater's slopes are well timbered, they increase nitrogen quantity. Another cause for this increase is the accumulation of physical and chemical sediments inside the crater. The trophic status of total mineral nitrogen still presented a relative degradation of lake water to mezotroph in 2010 (0.52 mg/l).

The different variation of the two main nutrients strengthens the degradation rule of lake water quality. The rainwater loaded with nitrogen and phosphorus compounds can also contribute, in a small part, to the accumulation of these nutrients into lake water.

**Phytoplankton biomass** was analyzed using phytoplankton number. In the first interval of our study, the number was low, but in 2007 it suddenly grew to 4-5 millions specimens. In 2010 we observed a comeback to the initial values. The consequence of this biomass expansion is the reduction of water oxygen quantity. The nutrients also determined the increase of phytoplankton biomass. The high temperatures, the water level decrease and the high photosynthesis can determine such an increase of phytoplankton density. No or scarce zooplankton slows down biomass reduction by not eating it. Because we use mg in standard weighing system, and the used method rests on the number of specimens, we cannot accurate tell the trophic status of this indicator. On the other hand, the bursting increase of phytoplankton biomass means an advanced eutrophication degree.

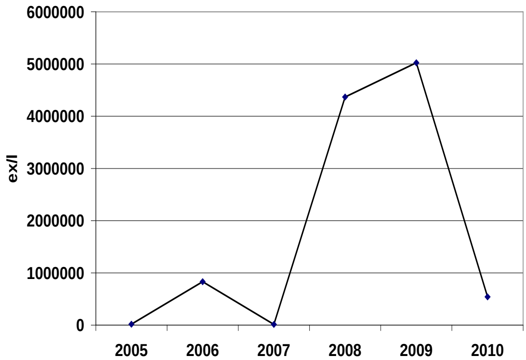


**Fig.2.** ***Phytoplankton density***

**Dissolved oxygen saturation** has been traced using oxygen quantity per volume unit. In the first two years, the average saturation with dissolved oxygen in the photic area has of 89.89%, representing a very good water quality. According to this indicator, the lake belongs to the best eutrophication phase – ultraoligotrophic.

**"A" chlorophyll** is the indicator for eutrophication process discovered only in two years, with very low values (0.01 µg/l). This very small quantity demonstrates the fact that, even according to this indicator, the lake has a very clean / of good quality water, belonging to the ultraoligotrophic phase.

From these four indicators types of eutrophication process in different trophic phases, only nutrients are not in the best quality class.

**Physic indicators**

**pH** had slightly acid values till 2008, followed by a powerful growth reaching 8.1. An under 7 pH means the presence of mineral acids or a human pollution during bathing. Passing over the neutral pH level is determined by the increase of bicarbonates in the second part of our analysis.

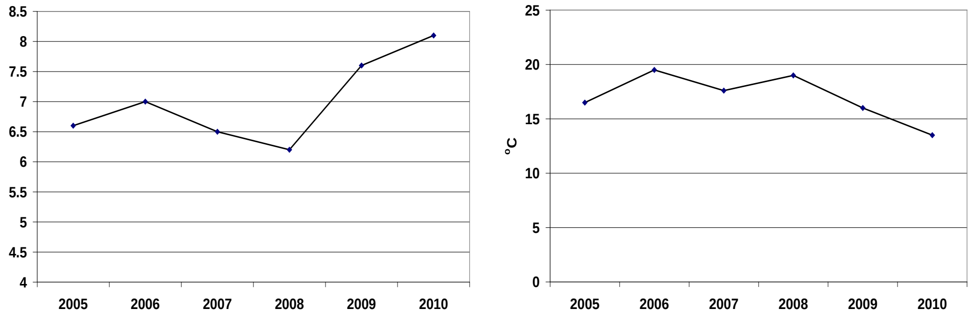


**Fig.3.** ***pH and temperature evolution***

**Temperature** varies between 16 and 20°C till 2008, followed by a decreasing trend, reaching 13°C. This decrease may be triggered by natural causes, such as climate change, or anthropogenic causes, such as bathing, determining the modification of normal water stratification.

**Other water quality indicators**

**Ammonium** reaches its maximum value of 0.25 mg/l, and then suddenly drops. The enhancement of eutrophication process since 2007 had also effects over water nutrients quantity.

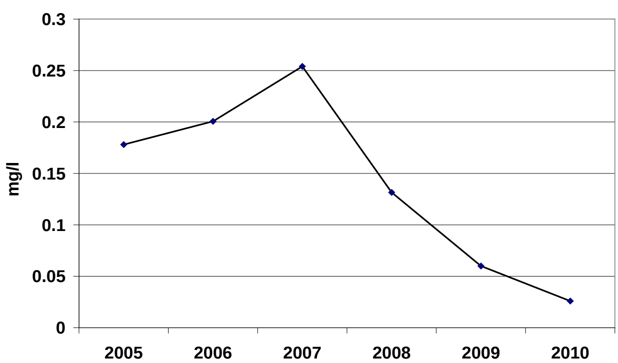


**Fig.4.** ***Ammonium variation***

**Dissolved oxygen** varies between two mg/l gap: between 7.5 – 9.5 mg/l. This variation is determined by the fluctuations of temperature and organic matter quantity, reducing through oxidation the oxygen saturation. The general increasing trend indicates an improvement of water quality and the existence of few water organisms.

**CBO5** varies a lot during the six years, reaching at the end an average number. The oscillation of oxygen quantity influences CBO5 evolution. Because of the low microorganisms’ number, the biodegradation process develops slowly. The average value of 2 mg/l is a relatively small one.

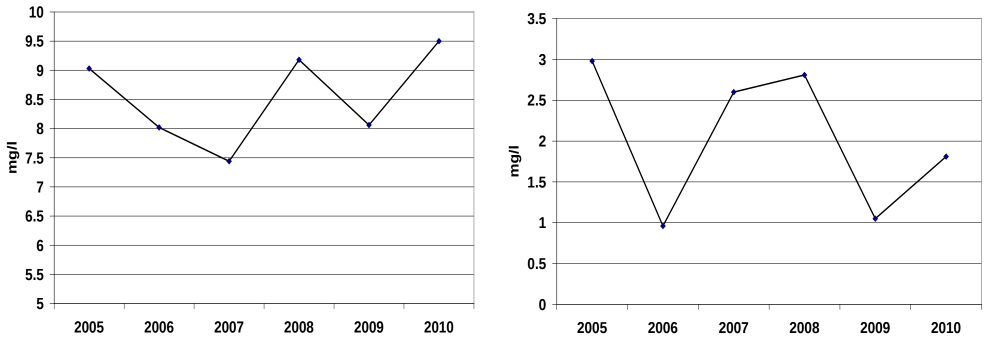


**Fig.5.** ***Dissolved oxigen and CBO5***

**Filterable residue** has a general increasing trend, from 13 to 20 mg/l. This is the consequence of organic matter discomposure after increasing eutrophication degree.

**Bicarbonates** have a more constant increasing trend, alternating different values of increase during these years. In these six years, bicarbonates concentration grew with four times.

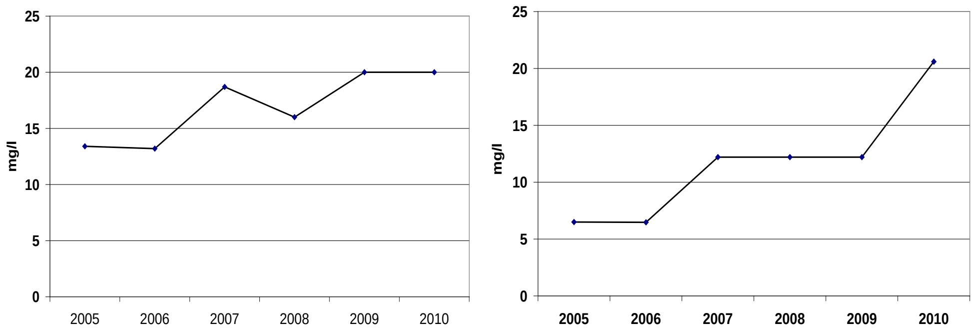


**Fig.6.** ***The concentration of filterable residue and bicarbonate***

The metals belonging to **specific toxic pollutants** are not represented in considerable quantities. This means that the metal oxides from crater surface do not reach water, nor the touristic activity has a strong polluting influence. But we can take notice that between 2007 and 2008 there appeared traces of metals, such as iron, chrome, zinc, lead, and copper, that it's a signal towards the need for lake protection.

These indicators were compared with the limits from European Union normative referring to surface waters. After this comparison, only ammonium exceeds maximum admissive concentrations – the first quality class in 2007. The other indicators do not exceed the values admitted by the European Union.

### 3.2. Evolution in space

In 2005 there were made some water surface determinations in three main points: the middle, the northern part and the southern part. Next year we added also the lake bottom point. So we can make an accurate evaluation of indicators variation.

The ones indicators that present an overall increase during 2006 are eutrophication degree, phytoplankton density and total phosphorus. The increase in higher in lake's southern part, where phosphorus values double and phytoplankton grows with 10 times.

Oxygen indicators are decreasing, as a normal reaction to eutrophication growth. This is way we cannot make an area differentiation between different lake parts.

Ammonium, that expresses nutrients concentration, stays constant in north and grows in center and south. Salinity, filterable residue and bicarbonate indicators have a random variation. For example, residue decreases in center and grows, and bicarbonates decrease in north and centre, and double there values in south.

**Table 1.** ***Indicators values at water surface***

| Indicator | Meas. Unit. | 2005 | | | 2006 | | |
|---|---|---|---|---|---|---|---|
| | | north | middle | south | north | middle | south |
| Phytoplankton | ex/l | 25858 | 12904 | 14330 | 94440 | 906420 | 1640100 |
| Total phosphorus | mg/l | 0.018 | 0.013 | 0.011 | 0.026 | 0.010 | 0.021 |
| Oxigen | mg/l | 9.1 | 8.9 | 9.1 | 8.1 | 8.1 | 7.8 |
| CBO5 | mg/l | 3.9 | 3.0 | 2.1 | 1.3 | 0.7 | 0.8 |
| Amoniu m | mg/l | 0.215 | 0.148 | 0.172 | 0.210 | 0.173 | 0.194 |
| Rezidue | mg/l | 14.5 | 13.1 | 12.7 | 14.4 | 11.3 | 15.7 |
| Bicarbonate | mg/l | 8.5 | 6.1 | 4.9 | 7.3 | 5.5 | 7.8 |

These space variations are determined by water dynamic, especially currents. Even though it is a small lake, surface waves and currents determined by air movement, can create strong space differentiations.

The highest space decrease is for phytoplankton that is normal because phytoplankton develops better in better light conditions. Also we observe a slight decrease of dissolved oxygen due to organisms concentration decrease. CBO5 and bicarbonate have almost the same values for surface as for the bottom. We observe higher values at the lake's bottom for residue, phosphorus and ammonium that have the ability to deposit.

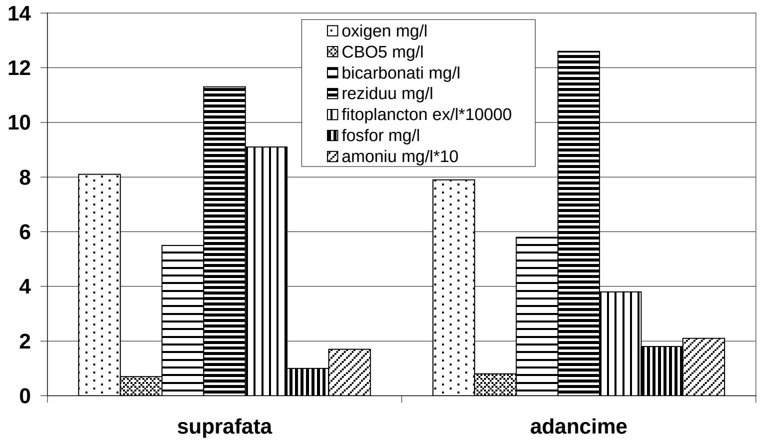


**Fig.7.** ***Indicators values at water surface and depth in 2006***

## 4. CONCLUSIONS

After comparing indicators values with the European Union normative, Saint Ana Lake belongs, from the eutrophication point of view, to ultraoligotroph phase. Some degradation signals of water lake quality according to nutrients till 2010 and the lake was brought to mezotroph phase.

According to other indicators, only ammonium has a higher concentration (0.25 mg/l in 2007).

Even though they appear in small quantities, metals (iron, chrome, zinc, lead, copper) appearance in lake water triggers some questions and alarming signals that can be resolved through regulation campaigns.

As a future prevention measure, it would be necessary a stricter analyze of lake water quality and a restriction of touristic traffic inside the Ciomadu crater and Saint Ana Lake. If we protect the lake in time, as a reaction to the smallest wrong changes of quality indicators, we will help preserve one of Romania's most unique hydro entity.

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