ASSESSMENT OF THE ANTHROPOGENIC IMPACT ON THE TATLAGEAC LAKE AND MODALITIES TO MITIGATE IT

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ABSTRACT

In 1986, lake Tatlageac (sea-river liman origin) started to be used for aquaculture and fishery purposes. This activities, along with other factors – anthropogenic and natural – caused major changes in lake's ecosystem.
The paper presents morphological, physic-chemical and biological aspects reflecting human impact on Tatlageac Lake and proposes some measures for its sustainable future exploitation. The analysis of the environmental data was performed in order to assess the „health state" of the Tatlageac Lake in 2004 and 2005 and its evolution until the above-mentioned moment.
The scope of this work is to disseminate some information regarding the ecological state of the Tatlageac Lake and faculties for it's rehabilitation, to encourage the long term quality monitoring of this lake, and at last but not least, to recommend the education regarding the environmental protection of all those factors involved in different activities with possible negative impact in this area.

KEY WORDS: aquaculture, lake ecosystem, anthropogenic impact, sustainable exploitation

INTRODUCTION

Intense exploitation for different purposes (irrigation, tourism, aquaculture and fishing) has led major changes in structure and functioning of coastal lake ecosystems.

River-sea liman Tatlageac was described as an unique area of 178 ha and a volume of approx. 21.5 million m3 (BREIER, 1976). It is now divided into several pools with fisheries purposes, all totaling 178 hectares, but has a smaller volume of water - 14 million m3 (SECARĂ, 2003).

The main water sources of Tatlageac are surface waters of Lake Dulcesti and 23 August, and groundwater sources in itself, L4 (Fig. 1).

Reducing water volume besides large quantity of pollutants discharged by sources Dulcesti and 23 August led to installation and intensification process of lake eutrophication (PORA, 1973, GODEANU, 1994). Under these conditions a set of ideas seeking to improve water quality and sustainable exploitation of its resources began to take shape (VASILESCU and DUMITRESCU, 1994, VĂDINEANU, 1998, PRIMACK, 2002).

In this paper the influence of anthropogenic factors (past and present) on lake ecosystems, issues of quality aquatic biotopes and biocenoses state, degree of eutrophication and trends of their evolution for an accurate assessment of the environmental status of Lake Tatlageac developments has been approached.

Having identified the sources of pollutants and their impacts on the aquatic environment at the end of the paper, some recommendations to mitigate environmental impacts and improve the condition of default are presented.

Fig. 1 - Tatlageac fish farm

MATERIAL AND METHOD

For the presentation of the ecological status of Tatlageac Lake between 2004 and 2005, the physical, chemical and biological parameters based on Dobrogea-Litoral Water Directorate Constanta (ANAR) data determination were analyzed.

Analysis of physical, chemical and biological parameters was performed for the period March – November of each year taken into consideration. Sampling was undertaken in three areas considered representative: connection with the Black Sea, the lake center (L4) and the lake tail.

Lake quality class between 2004 and 2005 was updated according to the Order of the Ministry of Environment and Water No.161/2006 for approval of Norms for classification of surface waters to determine the ecological status of water bodies.

Based on own observations and the analysis of statistical fish catches data (provided by the companies that operated during analysis period), the status of representative resources was assessed. In the same time the opportunities for recovery of populations of economically valuable species characteristic for Tatlageac Lake and the introduction of new suitable species for aquaculture were identified.

RESULTS AND DISCUSSIONS

Anthropogenic impact factors

Until 1989 human activities occurring in Tatlageac adjacent areas were numerous.

Agriculture practiced had a great influence on the lake, hundreds of hectares of farmland being irrigated with water from the lake. In addition, used fertilizers and pesticides in agriculture practiced at that time were driven in the lake by water flow, enriching it with nutrients and harmful substances.

Duck farm, *sheep farm* and *wine cellar* that worked near the lake were also impact factors, because the specific waste resulting from their activities were directly discharged into the lake.

Between 1989 and 2000 many of these activities have stopped, or significantly reduced (agriculture), so their influence on the lake is now being considerably reduced.

23 August locality is situated in the northwest of the lake. Its influence is evident through household waste discharged into Tatlageac by main surface water source which is crossing the locality (Fig. 2).

Fig. 2 - Household waste discharged in Tatlageac from 23 August source

Fish farm which came into operation in 1986 was the most important human action that caused major changes on the lake.

Initially fish farm involved creating ponds (breeding, parking, growth of different species) with smaller areas, which led to fragmentation of the ecosystem. After start of its activity some influences occurred on the ecosystem, some of them currently is maintaining but less intensively, the exploatation being reduced.

All these human activities led to changes of physic-chemical factors of water, aquatic flora and fauna, affecting also morphological and morphometric characteristics of the lake.

Ecology state of Tatlageac Lake between 2004 and 2005 and its general tendency

Physical characteristics

Total suspended matter (TSM) in 2004 showed higher average values (75.3 mg / l), with maximum up to 372 mg / l, decreasing the transparency of water. In following year values did not exceed 53.0 mg / l. TSM level was closely related to the hydric regime of the lake area, maximum values being recorded after the floods.

pH value it is a very important physical indicator influencing chemical and biological aquatic specific processes. As for most aquatic organisms the optimal values ranged between 6.5 and 8.5. It is estimated that the recorded average values, although high (8 in 2004 and 8.4 in 2005, respectively) had no negative impact on aquatic organisms.

Oxygen regime

The minimum *dissolved oxygen (DO)* that allows most aquatic organisms (including fish) to survive is 4 mg/l. Under this value an extensive series of negative events to mass mortality appeared. DO values below the limit of 2.83 mg/l were observed only for a very short period in the summer of 2004, under conditions of high temperatures and maximum values up to 18.10 mg O/l *biochemical* and 30.96 mg O/l *chemical consumption,* respectively (Table 1, Fig. 3).

The values of these parameters between 2000 and 2005 have registered different variations, such as: from 2000 to 2002 a gradual growth, in 2003 a significant reduction and between 2004 and 2005 an increase again to around the mentioned early years (Fig. 4).

Table 1 - Main chemical characteristics of oxygen regime in Tatlageac Lake between 2004 and 2005

Characteristics	***2004***			***2005***		
Values	***min.***	***max.***	***med.***	***min.***	***max.***	***med.***
Dissolved oxygen- mg O/l	2,83	11,40	**7,05**	5,30	16,37	**13,67**
Quality class	V	I	**I**	II	I	**I**
CBO5 – mg O/l	2,50	18,10	**6,81**	2,00	7,80	**4,53**
Quality class	I	IV	**III**	I	IV	**III**
CCO-Mn –mg O/l	2,91	30,96	**20,23**	1,90	27,93	**11,00**
Quality class	I	IV	**IV**	I	IV	**III**

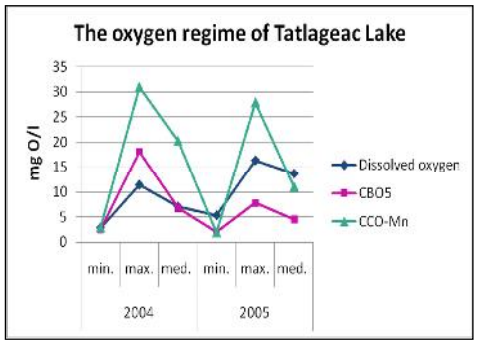

Fig. 3-Tatlageac Lake oxygen regime between 2004 and 2005

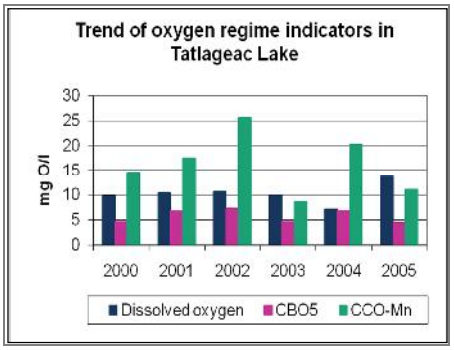

Fig. 4-Trend of oxygen regime indicators (average values) between 2000 and 2005

Intensification of chemical and biochemical processes that consume large quantities of oxygen demonstrates the existence of significant accumulation of inorganic and organic substances, particularly in lake sediments.

If in 2004 water quality indicators of oxygen regime corresponded to quality class IV (low) in 2005 it was within class III (moderate).

Ionic composition

Tatlageac Lake waters have changed ionic composition to increase the salt content until 2000 and 2001. After this period a slight decline has occurred due to the massive reduction of activities in this area. The values between 2004 and 2005 are still higher than those recorded before 2000 (Fig. 5).

Large quantities of *chlorine* due to contribution from the Tuzla salt water (in Lake Techirghiol) source to the lake via 23 August source and communication with the sea was evinced (Table 2).

According to the recorded values, the lake fits into oligohaline category. Although high values, chlorides do not cause adverse effects on fish populations, and no danger to the lake ecosystem.

While not indicators of pollution *calcium and magnesium* are crucial elements for ensuring the aquatic life. For fish breeding it is recommended that water content ranges between 50 and 220 mg / l calcium, between 8 and 80 mg / l magnesium, and the ratio of these two elements Mg: Ca 1:3,7. In 2005 the values of these substances with natural origin and their relationship cannot categorize water as "good for fish growth" (Fig. 6).

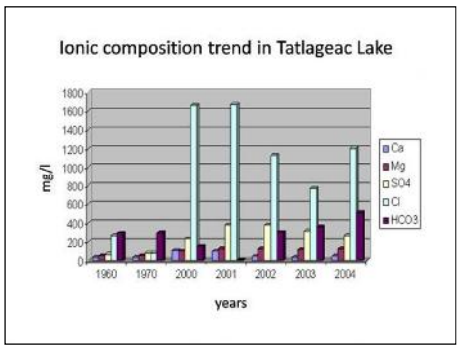

Fig. 5 - Trend of ionic composition in Tatlageac Lake

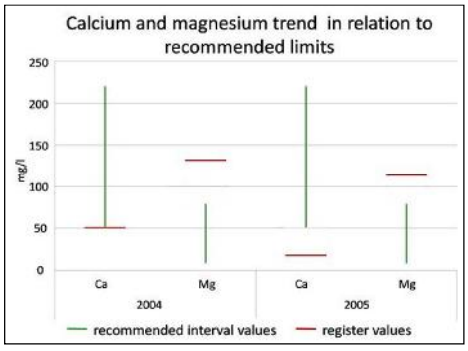

Fig. 6 - Ionic composition trend between 2004 and 2005 in Tatlageac Lake (average values)

Between 2000 and 2004 Ca and Mg concentrations were slightly above those in 1960 and 1970, while *sulphates and carbonates* had three to four times higher values.

In terms of indicators of mineralization, water quality fits into class V (bad) between 2004 and 2005.

Table 2 - Ionic composition of Tatlageac Lake water between 2004 and 2005

Characteristics	***2004***			***2005***		
Values	***min.***	***max.***	***med.***	***min.***	***max.***	***med.***
Chlorines (Cl) –mg/l	861,5	2769,0	**1207,8**	275,7	3965,0	**887,6**
Quality class	V	V	**V**	IV	V	**V**
Sulphates (SO4)–mg/l	161,6	417,9	**264,3**	119,7	190,0	**152,6**
Quality class	V	V	**IV**	II	III	**III**
Calcium (Ca) –mg/l	29,2	73,2	**50,7**	16,0	20,0	**17,3**
Quality class	I	II	**II**	I	I	**I**
Magnesium (Mg)-mg/l	98,7	274,0	**131,6**	109,4	116,7	**113,5**
Quality class	III	V	**IV**	IV	IV	**IV**

Nutrients

In the studied years, *phosphates* were present in relatively small quantities, averages not exceeding 0.2 mg / l, which fits lake into quality class I (very good) (Table 3).

Table 3 - Main nutrients composition in Tatlageac Lake between 2004 and 2005

Characteristics	**2004**			**2005**		
Values	***min.***	***max.***	***med.***	***min.***	***max.***	***med.***
Nitrates (N-NO3)-mg/l	0,072	3,47	**1,420**	2,154	7,926	**4,252**
Quality class	I	III	**II**	II	IV	**III**
Nitrites (N-NO2-mg/l	0,002	0,070	**0,032**	0,013	0,097	**0,044**
Quality class	I	IV	**III**	II	IV	**III**
Amonium (N-NH4)-mg/l	0,093	1,478	**0,536**	0,091	0,988	**0,570**
Quality class	I	IV	**II**	I	III	**II**
Orthophosphates (P-PO4) –mg/l	0,0030	0,1187	**0,0417**	0,000	0,0197	**0,0062**
Quality class	I	I	**I**	I	I	**I**

The *nitrate* average values recorded in 2004 and 2005 fit the lake into quality class II (good) and class III (moderate), respectively (Table 3, Fig. 7).

The trend is improving, given that between 2001 and 2003 nitrate concentration reached maximum values above 14 mg / L corresponding to the fifth class quality.

Significant reductions were recorded for values of *nitrites*, *amonium* and *orthophosphates* (Fig. 8).

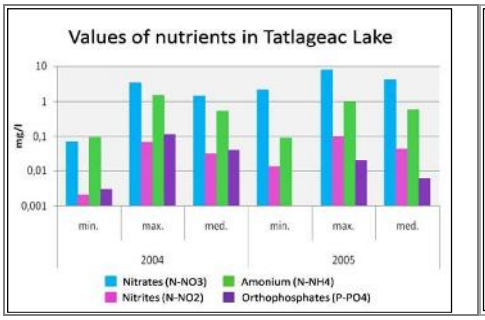

Fig. 7 - Content of nutrients in Tatlageac Lake between 2004 and 2005

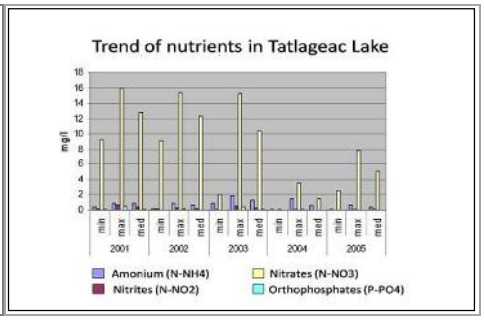

Fig. 8 - Changes in nutrient content during 2001 and 2005 in Tatlageac Lake

Water quality according to nutrients corresponds to quality class III (moderate).

Eutrophication level

Main indicators which indicate level of eutrophication are load of waters with nutrients (total nitrogen and total phosphorus) that pursue the development of phytoplankton density and biomass values (Fig. 9).

Mass development of the phytoplankton occurs due to nutrients. This leads to reductions in oxygen content, with serious consequences for the survival of other aquatic aerobic organisms.

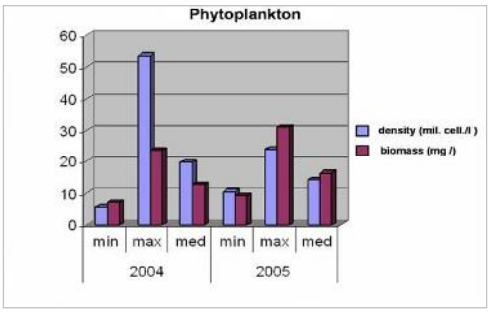

Fig. 9 - Density and biomass of phytoplankton in Tatlageac Lake between 2004 and 2005

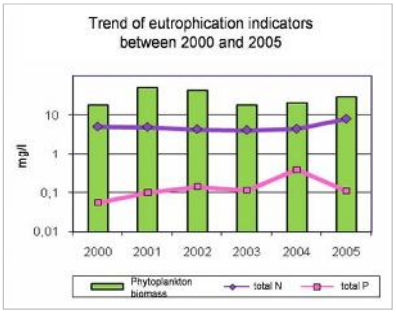

Fig.10 - Trend of eutrophication indicators in Tatlageac Lake between 2000 and 2005

The accumulation of nutrient coming from sources Dulcesti and 23 August as well as degradation of organic matter in the lake have supported the development of phytoplankton biomass to maximum values over 20 mg / l (2004) and 29 mg / l (2005), almost half the value recorded in 2001.

Values of indicators of eutrophication registered between 2004 and 2005 still characterizes the lake as hypertroph (Fig. 10).

Biota - fish stocks

The main activity carried out in the Lake Tatlageac is aquaculture and fishing.

The analysis of historical data and own observations in 2004 and 2005 showed changes in the last decades of fish stocks structure. After the start of exploitation an increase of Asian cyprinids dominance at the same time with decrease of native fish species has been noticed (Fig. 11).

Intense exploitation of natural food resources, wrong fish restocking and failure to ensure living conditions for fish led to the installation of unsuitable conditions for fish growth and to the degradation of breeding sites of native species (carp, catfish, zander).

Since 2001, the practice of mixed farming systems (intensive in small basins and extensive in the lake) and appropiate fish stocking depending on lake ecology have been adapted. These measures led to the installation of a trend of balancing the ratio between native and introduced species in the ecosystem.

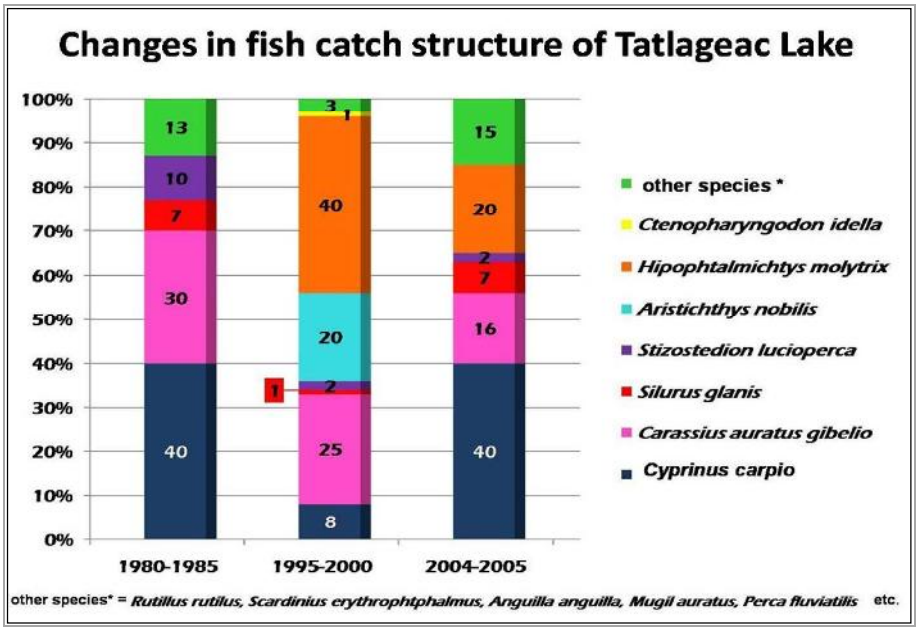

Fig. 11 - Structure of fish catches in natural system (1980-1985), intensive farming system (1995 -2000) and mixed farming system (2004-2005)

Recommendations for sustainable exploitation of Tatlageac Lake

Given the described condition of Tatlageac Lake it is necessary to undertake actions to improve its environmental quality, recovery and fish structure enhancement, respectively.

Actions to improve environmental quality should cover:

- improving the quality of power supply, by reducing nutrient loading, organic matter etc. (identify places of waste entry and stopping them);
- developing a protection plan in case of floods (to avoid polluting the water flow and silt);
- actions to restore and improve the structure of the bottom (sludge removal, the administration of amendments and disinfectants in appropriate proportions).

Restoring and improving fish fauna requires enrichment with native juvenile fish (carp, catfish, zander) but also with Asian cyprinids. Stocking material can be obtained in small basins of the lake.

Intensive system requires a supplementary fish feeding, regular application of fertilizers, disinfectants, which under some circumstances can

lead to degradation of the environment, so we recommend practicing of extensive system in the lake (L4).

Farming can be done in small basins, near the lake - L4, easily manageable.

The fish quantity for stocking must be established depending on the natural food supply, the existing fish stock and ecology of each species.

It is recommended to apply and also to maintain long-term principles of sustainable exploitation of bioaquatic resurces: optimal harvesting of living resources, aquaculture practices / adequate fishing precaution approach, appropriate scientific and technological research.

Sustainable exploitation of the ecosystem as a whole should consider permanent changes of climate factors, anthropogenic influences and exploitation practiced nowadays.

CONCLUSIONS AND FUTURE DIRECTIONS

Tatlageac Lake, especially in the past decades has undergone significant anthropogenic pressure leading to major changes, manifested by:

- natural ecosystem fragmentation;
- reduction of shoreline and degree of convolution;
- increased clogging process;
- depth change;
- changes in physico-chemical factors;
- qualitative and quantitative changes of biota.

Based on main physical and chemical parameters the values of Tatlageac Lake ranged, between 2004 and 2005, in surface water category with a poor environmental status. This condition is characterized by low values of oxygen content, especially during the summer, excess of organic substances, nitrates, nitrites, ammonium sulfate, magnesium in large quantities, imbalance between N: P and Ca: Mg.

Nutrients discharged from different human activities and microbial decomposition of organic matter accumulated in the lake waters, especially in sediments defines the lake as hypertrophic.

Fishing in 2005 indicated a significant reduction in quality and quantity, so that restocking is absolutely necessary.

Causes for the reduction and change in structure of natural fishery resources are: the introduction of suitable aquaculture species (Asian cyprinids), over-exploitation, wrong restocking, increased eutrophication and pollution of the lake.

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