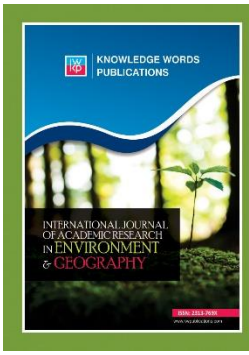

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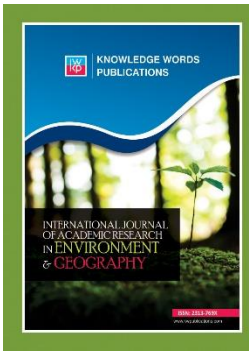
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Evaluation of the Physico-Chemical Water Quality Parameters of Lake Branesti, Romania.

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Abstract

Lake Branesti is situated in the East of Bucharest and it is an integrant part of the reaches of Pasarea River. The purpose of this study is the analysis the abiotic factors: water and soil, in order to observe if the water of lake is still within the current quality norms and if the anthropogenic pressure caused major changes in this areal between 1960 and 2015.

The drawing of water and soil samples was carried out in March of 2015 at the Lake Branesti. The physico-chemical parameters of 12 samples were analysed, 8 for water and 4 for sail. The interpretation of the analysis bulletins has proven that 11 parameters were within the current legal norms, the only value that exceeded them being that of nitrates in the water as well as in the soil, geochemical explanations using the cycle of nitrogen of these parameters.

Keywords: Lake Branesti, Soil and Water Analysis, Physico-Chemical Parameters, The Cycle of Nitrogen, Anthropogenic Influence.

Introduction

Recent studies concerning the hydrochemistry of rivers and/or lakes have brought to light the fact that the socio-economic development and the extension of the human habitat are making their mark more and more aggressively upon the planet`s vital resource: water. Following this realisation, a number of articles and specialized writings have emerged. Of these we mention: Biljana Gicevski si Salvco Hrisrtovski for the hydrological study of the Slatinski waters from the Republic of Macedonia (2015); Aniekan Edet, Aniediobong Ukpong and Therese Ngange for Cross River Basin from Nigeria where the parameters of the quality indicators of water (2013); Ebelin Sampah G., Sombo Abé P., Soro Gbombélé, Aka Natchia, Kambiré Ollo, Soro Nagnin for the evaluation of the physico-chemical quality of water from the Adiaké region belonging to the Ivory Coast (2014); Klisarova Daniela, Gerdzhikov Dimitar Borisov for the chemical proprieties of Varna Lake (2007).

The purpose of this study is of comparative nature, the obtained analysis aiming to show how much the water quality parameters have changed during the course of 50 years (confirmed through existing data) and correlated with the anthropogenic pressure which put pressure throughout the last two decades in this space.

At the same time, it was also observed of the results of the natural resources of water and soil belonging to lake Branesti adhere to the current norms regarding quality Order MMGA no.161/2006 and "The decree regarding soil quality" 2006/0496/N and how much the anthropogenic activity has changed this lacustrine environment, seeing as how there has been spatial extension of the perimeter fit for construction afferent to the Branesti village.

Study Area

From the source- from the North of Bucharest- to the river mouth, Pasarea stream crosses from north to south the villages: Tunari, Stefanesti, Afumati, Ganeasa, Pasarea, Branesti and Fundeni. In a strongly bend lowland areal, it has formed a cluster of lakes with physico-chemical characteristics specific to the development of rich aquatic fauna which is strongly exploited through organized fishing.

The hydrographic basin of Pasarea river is situated within lowland landform with reduced altitudes between 65 and 70 meters and low slope (fig. 1) (Ieleniez M, 1984). As far as climate goes, according to the measurements of the National meteorological administration which were taken for the Bucuresti-Afumati station, the average annual values for climate indicators single out: the average annual temperatures fall within 10,5°C and 11,0°C with slight overtakings (ex. 12,5°C in the year 2010 – the accentuation of the drying phenomenon), average annual rainfall 555 mm and 580 mm – the climate norm being 579,7 l/m^2 (the value of rainfall in the year 2010 was 494,6 l/m^2 – shortage of rainfall, thus the draught phenomenon is accentuated). The eolian regime has particularities when it comes to the movement of dominant masses of air: the NE wind - 20,8%, the Eastern wind - 18,4%, the Western wind - 14,7%, and the South wind - 3,1%.

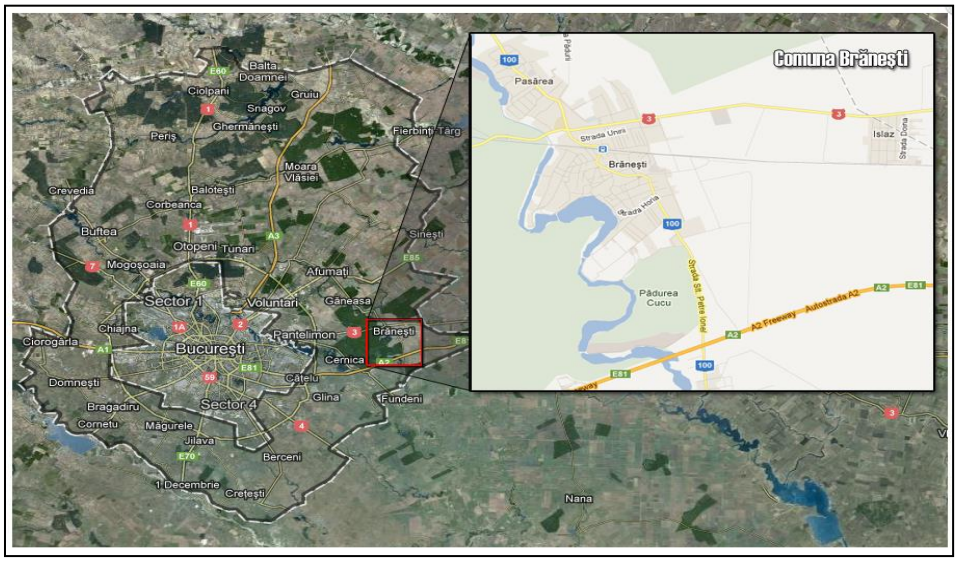

Figure 1. Study area

Source: https://www.google.ro/maps/place//@44.4577653,26.3378039

The hydrology of the areal is represented by Dambovita river which crosses the territory of the county with the same name on a distance of approximately 35 Km, the river being regularized, set up and enclosed for the most part; and the river Pasarea (tributary in the left side if the Dambovita river which is itself tributary to the river Arges, in Budesti) (Gâstescu, Iordan, 1970). Initially, these facilities had good quality of surface waters where fishing for economic purposes is practiced, because of this the number of permanent facilities for fishing has been permanently increasing. Ichtyofauna of economic interest belonging to Branesti lake is varied by the multitude of species that inhabit it: Romanian carp (*Cyprinus carpio*), zander (*Sander lucioperca*), catfish (*Silurus glanis*), crucian carp (*Carassius gibelio*), bream (*Abramis Brama*), chub (*Squalius cephalus*), bleak (*Alburnus Alburnus*), roach (*Rutilus rutilus*), pike (*Exos lucius*).

Pedologically, the studied area has soils specific to an original forest vegetation, which favoured the accumulation of large amounts of humus derived from the foliage of deciduous forests (Ielenicz, 1984). Later, massive deforestation of forested area and the application of a policy to practice intensive agriculture has made the yield of lowland soils in this area to fall. This was mainly due to partial loss of fertility by reducing the amount of organic matter which accumulates annually on the soil layer and contributes to enriching and preserving its quality (Benciu, Shacks, Galdean & al., 2011).

Integrating with water quality standards for surface water from Lake Balta Branesti

Water quality is determined by: organoleptic characteristics (taste and odor), physical (turbidity, colour, temperature, electrical conductivity, radioactivity), chemical (fixed residue, water reaction, water hardness, organic substances: Fe, Mn, Mg, NH_3, Cl, Cu + Pb + Zn, CO_2 and H_2S), biological and bacteriological (bacteria) (Benciu, 2012).

According to statistics of Enviromental Raports 2005-2010 Section WATER there has been a constant decrease in its quality in reservoirs on the river Pasarea (cf. NSCC - National Surveillance System for Water Quality for basins Arges, Ialomita and Mostistea, SGA Ilfov-Bucharest / monitoring water quality in standing fresh water (natural or artificial lakes).

Measurements taken during 2005-2010 showed that in the Branesti Lake, water quality decreased. For the period 2005 - 2010 water quality was monitored by the laboratory Service of Water-Bucharest Ilfov, finding changes occurring within a 5 years interval (the framing of the water quality grades is presented in Table 1).

Table 1 The framing of the water quality grades (2005-2010)

	2005	2006	2007	2008	2009	2010
Lake Branesti III	**V**	**IV**	**III**	**IV**	**IV**	**IV**

Source: Report on the status of environmental factors, 2005-2010 in Bucharest-Ilfov region (Chapter W*ater), 2011*

As classified by the degree of trophic for natural lakes and storage lakes mentioned in *Normative no.161/2006*, from the data analysis for the period 2005-2010 in the table above we conclude that for the studied period, water quality in Lake Branesti III recorded low ratings - quality class IV specific for eutrophic lakes is dominant (cf. Law 310/2004, annex 11).

It also notes how water quality has changed from year to year: if in 2005 the water quality was classified as V - hypertrophic lake, in the next year 2006 water quality has improved, the

measured parameters framing Balta Branesti in category III and category IV, which was thereafter sustained so that in 2007, water quality had improved, falling within category III of mesotrophic lakes. After 2008, the situation was constant until 2010 (cf. data obtained) water quality for Branesti Marsh dropped from category III to category IV.

Methodology of Analysis

Starting from the intended purpose - to check that the area adjacent to Lake Branesti - in eastern Bucharest - water and soil related to anthropogenic use zone, falls within the current quality standards under *Order MoEWM no.161/2006* and the *Decree on soil quality 2006/0496/N*; It was desired to correlate the theoretical side to the empirical part of the *Global Biogeochemical Cycles*; Practical observation of the quality of abiotic environmental factors for water and soil and the framing of lake Branesti within the rules of proper quality of surface waters. Sampling was carried out by a well-established sampling program, 8 water samples were taken and 4 samples soil, in order to eliminate possible errors (Fig. 2).

Figure 2. The results of the water sample analysis

Water samples were studied in *The Ecological Research of Polluted Areas Laboratory, belonging to the Department of Ecology and Environmental Protection of the Ecological University of Bucharest*.

Water samples were measured *in situ* parameters: pH, electrical conductivity χ, TDS dissolved salts (pH meter), NTU turbidity (turbimetru) and for the nutrients, the water samples were analysed in the laboratory through spectrophotometry (spectrophotometer CECIL 4004): nitrites, nitrates, ammonia and phosphates; Also, soil samples were analysed in the laboratory with the kit *La Motte* for the following parameters: pH, nitrogen, phosphorus and potassium.

Samples of soil and water from Lake Branesti (Figure 2) were performed on the left bank of the lake in the morning (March 2015) at an air temperature of +7°C, under conditions conforming to the requirements for laboratory analysis: Sterile water and soil containers

(samples collected from a depth of 15 cm). Working in the laboratory occurred within 2 hours of collection.

In Table 2 presents data results performed within parameters set for the abiotic environmental factor - water, compared with data previous to our research, statistical data from 1964 to 1967 carried out under the The Management of Romanian Waters - Institute for Hydrotechnical Studies and Research between 1960-1971 (cf. STAS 470 688) at the hydrometric station Branesti III (after the Romanian Rivers, hydrometric station Branesti III, NIMH, 1971 test report ECOIND Bucharest, 2015).

The statistics, together with the evaluated STAS of the parameters (listed in the graphic representations of each analysed and measured parameter) were taken as reference systems in order to be able to see if the waters fall within the same class quality or if they comply with the maximum admissible concentration (MAC) mentioned by legal norms provided for current use. At the same time, this study proposes an assessment of the physical and chemical parameters changes over the 50 years of the creasing anthropogenic impact around Lake Branesti III.

Table 2 Data results performed within parameters set for the abiotic environmental factor - water, compared with data statistical from 1964 to 1967

Measured Parameter	UM	Year 1964	Year 1967	Year* Jan.2015	Year Mar.2015
pH		6,5	8,5	8,13	**7,94**
χ – Electric conductivity	µS/cm	-	-	380	**660**
TDS (Total dissolved salts)	mg/l	216	354	-	**442**
NTU (Turbidity)	kg/mc	0,133	0,125	<1	**0,681**
NO_3^- (Nitrates)	mg/l	1,911	2,084	-	**4,060**
NH_4^+ (Ammonium)	mg/l	0,932	1,003	0,09	**1,876**
PO_4^{3-} (phosphor)	mg/l	-	-	-	**0,120**
NO_2^- (Nitrates)	mg/l	0,021	0,089	<0,006	**0,057**

1. **Water pH** of lake Branesti III - 7,94 (Figure 3)
   Result - water of slight alkalin nature

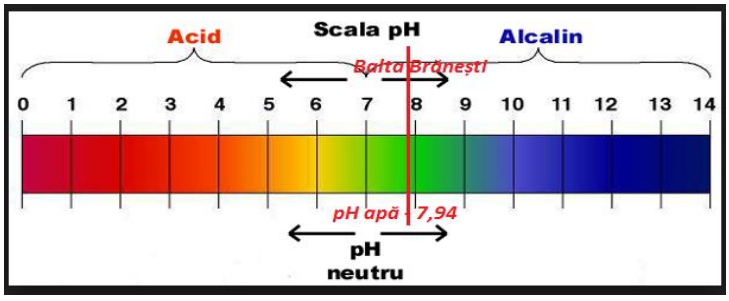

Figure 3. The pH for Lake Branesti III

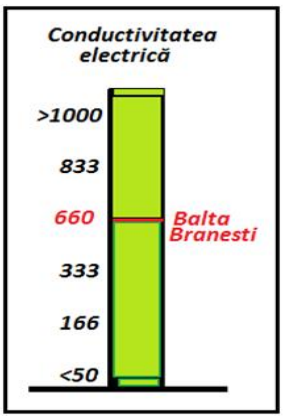

Figure 4. Electric conductivity χ For Lake Branesti III

2. The electrical conductivity χ is governed by the current legislation by STAS 7722-84, ISO 7888-1983, it is the indicator of the degree of water mineralization. The measured value χ = 660 µS/cm (fig. 4) electrical conductivity is within normal limits.

3. TDS (total dissolved salts). The quantity of dissolved salts that are present in the water have a very important role in the function osmoregulation of aquatic living things, regardless of trophic level they are on, it equally influences algal development, and the development of plants specific to upper lake areas.

The measured value TDS = 442 mg/l (fig. 5) is within the normal range of use.

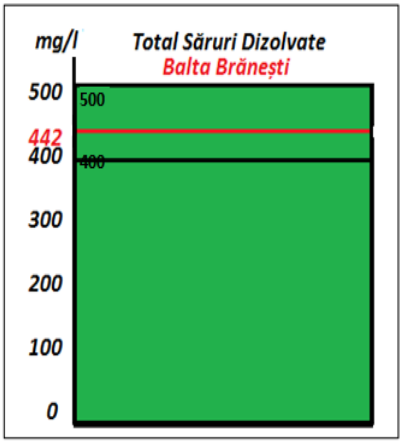

Figure 5. Turbidity for Lake Branesti III

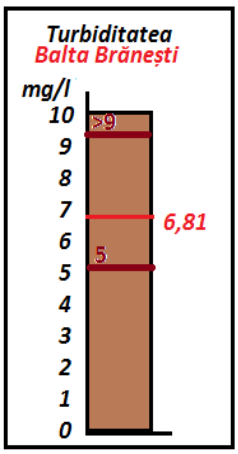

Figure 6. TDS for Lake Branesti III

4. Turbidity or opacity directly affects transparency of the water is determined by the solid particles of very small sizes (microscopic) that are in suspension. Values c.m.a. of the content of suspended sediment are between 5 and 10 mg/l NTU (nephelometric turbidity units), with 10 being a value allowed in exceptional cases. The value of the measured turbidity (NTU) = 6.81 mg/L (fig. 6).

5. Nutrients in the water in Lake Branesti. In the surface waters, the N azote is in the reduced form as ammonium ion NH_4^+ and in oxidized form as nitrates / nitrites ions NO_3^- and NO_2^-.

• ammonium NH_4^+ content: 1,876 mg/l (fig. 7),falls within c.m.a. of quality III to be used with 1.2 mg/N /l to 3.2 mg/ N/l IV quality water with the analysis method SR ISO 7150-1/2001.

Quantitatively it appears more because the lake is in late winter/early spring when the oxidative processes of nitrogen begins.

• The content of nitrates NO_3^-: 4.060 mg/l (fig. 8), falls within c.m.a. usage limit - 3 mg/N/l II quality compared to 6 mg/N/l III quality water (method of analysis SR ISO 7890-3/2000).

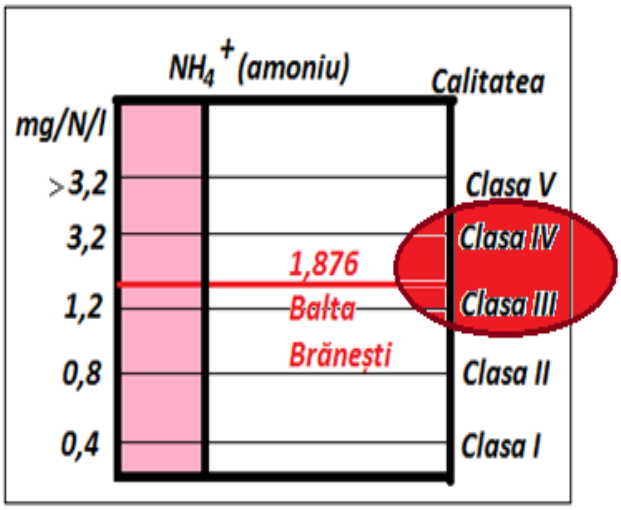

Figure 7. The NH_4^+ ion for Lake Branesti III

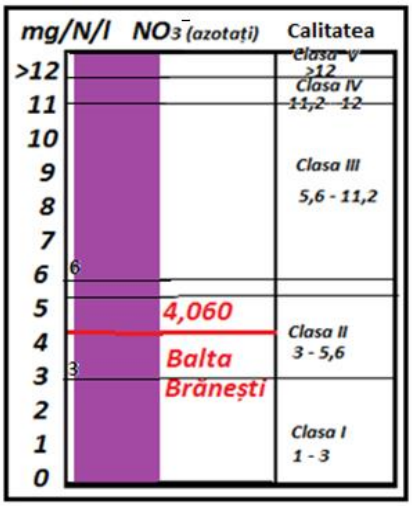

Figure 8. The NO_3^- ion for Lake Branesti III

• The content of nitrites **NO_2^-**: 0.057 (mg/l) (fig. 9) falls within c.m.a. usage limit - 0.060 mg/N/l II quality water SR ISO 26777/C91/2006. Nitrite ion is an intermediate step in the oxidation of nitrogen from ammonium NH_4^+ ion to the nitrate NO_3^-, so it is natural that it does not present high values in terms of quantity.

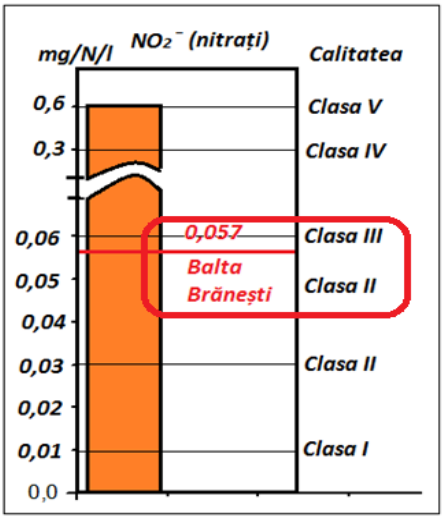

Figure 9. The NO_2^- ion for Lake Branesti III

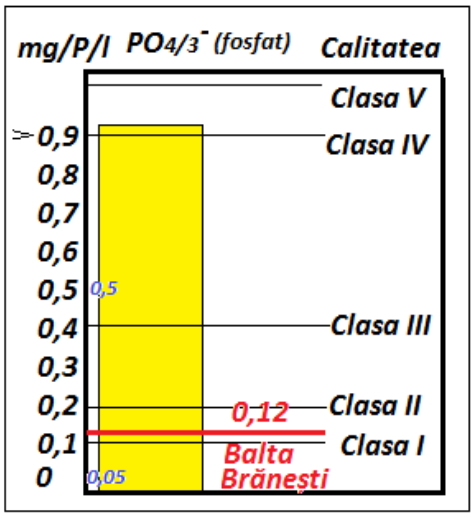

Figure 10. The PO_4^{3-} ion for Lake Branesti III

• Phosphorus in surface waters Is found as **PO_4^{3-}** phosphate ion (0, 05-0,5 mg/l). Higher concentrations 0.05-5 -> 0.5 mg/l **PO_4^{3-}** constitute a clue regarding the pollution of surface waters, the causes being generally of animal origin (linked to developing microbial fauna) as a result the progressive eutrophication of lake water by promoting the development of excess algae, or algal bloom. This phenomenon is known as eutrophication.

Phosphates PO_4^{3-}: 0.120 mg/l (fig. 10) falls within c.m.a. usage - 0.1 mg/l quality water II EN ISO 6878/2005.

The Results of Analysis of Soil Samples

The periodical analysis and evaluation of soil quality constitutes of the identification and characterization of the factors that limit their productive capacity (table no. 3).

Table 3 Physico-chemical parameters for the SOL environmental factor

Parameter	**UM**	
N (azote)	lb/a - kg/ha	10 - 4.53592
P (phosphor)	lb/a - kg/ha	100 - 45.3592
K (potasium)	lb/a - kg/ha	350 - 158.7572
pH	-	6

1. The pH value is given by the alkalinity or acidity of the soil which means identifying the pH firstly, parameter which gives it the properties and quality for agriculture. Fertility is undeniable feature of the soil, it depends on the presence of organic matter. But the extremes of the pH, organic matter will be totally absent, fertile soils having the beach of minimum values between 4 and 8 maximum (acid soil pH = 4.5 - 6; weak acid soils: pH =6 to 6.5; neutral soil pH = 6.5 to 7.2 and salty-alkaline soils, pH =7.5 - 8), beyond these values below 4 and above 8, plants dry quickly.

Most cultivated crops prefer slightly acidic and neutral soils to alkaline soils. Soil pH from the Branesti area is 6, that is slightly acidic soil, being in the normal range of use of agricultural land (fig. 11).

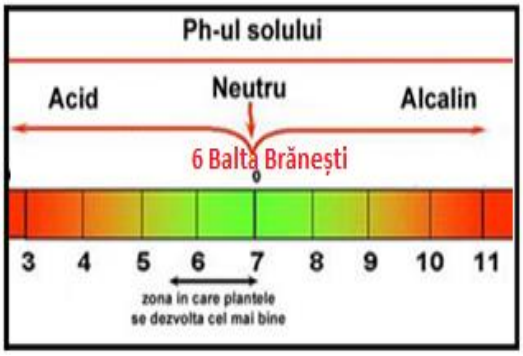

Figure 11. pH for Lake Branesti III

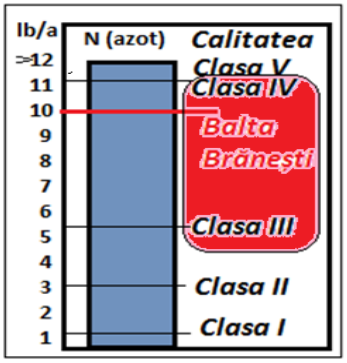

Figure 12. Azote for Lake Branesti III

2. Nitrogen is a chemical element essential to plant growth, it can be found in molecules of biological significance. According to the nitrogen cycle, nitrogen's main tank is the atmosphere (78%), but because of the very weak reactivity of the molecule (N_2), it is fixed to the microorganisms that live on plant roots, the molecule converting into the form of reduced ammonia and further, being oxidized, it is converted into nitrites and nitrates, as oxidized forms.

The value resulting from the soil analysis for nitrogen is 10 lb N/a - 4.53592 kg/ha (fig. 12) therefore it falls within classes III and IV of use (the loading of soil with nitrogen) so that it is

suitable for a particular type of agriculture (without using the amendments to improve the nitrogen).

3. P (phosphorus) is another essential chemical element necessary for plant growth. From the soil the plants take phosphorus in a proportion of 1-5% in soluble form. The phosphorus content is expressed in ppm P_2O_5 as follows: weak soils <20 ppm, 40-80 ppm for medium soils and very good soils with > 160 ppm. The amount resulting from soil analysis of phosphorus P 100 lb/a - 45.359.2 kg/ha (fig. 13). Analyses of soil samples carried out at the pond Branesti shows that P (phosphorus) has a value of 100 ppm, falling within the quality of good to very good soil, optimal for agricultural use.

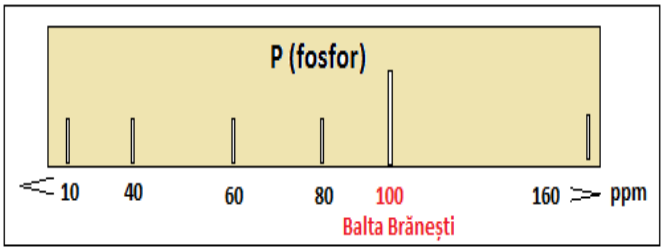

Figure 13. Phosphot for Lake Branesti III

4. K (potassium) has a major role in plant development, and the lack of it causes major disturbances in biological functionality of the whole plant so that for the correction of the lack of potassium in the soil amendments such as potassium and sulphate apply. Although potassium is widespread in soil, only 1-3% of the existing total is in a soluble state, the rest being under the form of clay minerals.

The amount resulting from the analysis of soil potassium (K) is 350 lb/a - 158.7572 kg/ha (fig. 14) fits within the class of very good soils for agricultural use (> 200 lb/a).

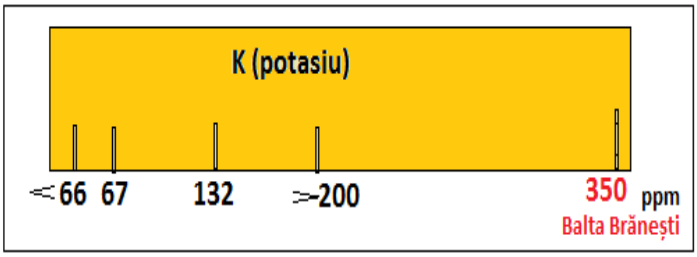

Figure 14. Potasium for Lake Branesti III

Conclusions

The evaluation of chemical and physico-chemical elements of quality for Lake Branesti: January to March 2015, according to Water Quality Standards MEWM Order no. 161/2006 and according to the Decree regrading soil quality 2006/0496/NL reveals the following:

From the perspective of the European Parliament and Council Directive 60/2000/EC regarding establishing a framework for Community action in the field of water policy, the Water Framework Directive, "the environmental status of Lake Branesti and River Pasarea is considered good, falling within grade II- so that the values of the general physico-chemical elements are

characterized by slight deviations from the values characteristic to unspoiled areas (reference) or anthropogenic minor alterations".

Analysis reports for water and soil from January and March 2015 for Lake Branesti (located in a meander of the River Pasarea), revealed that 11 parameters were within legal norms for both water and soil. From the interpretation of results we are dealing with a quality class III which is exceeded only in nitrogen compounds, respectively (NH_4^+, N ammonia in water and soil nitrogen). These two parameters (NH_4^+, N) reflect the state of moderate quality/mesotrophic lake. At the same time, it appears that water values approach fourth grade quality of waters, considered for poor quality waters - eutrophic lake, so it can be concluded that Lake Branesti shows slight eutrophication tendencies.

Matching the current data about water with existing data for a period of 50 years (range 1964-2015) has drawn the following conclusions:

- pH increased by two units from 6.5 to 8.5 within three years, the value is found approximately (pH 8.13 and pH 7.94) and measurements made in 2015, which shows the trend of water alkalinity.

- χ - electrical conductivity varies considerably in the two measurements made in January and March, nearly doubling the January value 380 respectively 660 µS/cm. For comparative analysis, there is no statistical data.

- **TDS** (total dissolved salts) – for this parameter there is a doubling of the net quantity of the salts dissolved within 50 years, from the amount of 216 mg/l in 1964 to the 442 mg/l in 2015.

- **NTU** (turbidity) increased six times in value in the studied historical interval. Knowing that the risk of water infestation is directly proportional to its degree of turbidity, this proves that the degree of water purity of Lake Branesti dropped considerably. The minimum value was 0,125 (1967) and the maximum 1,681 (2015)

- **NO_3^-** nitrate concentration increased progressively, within 50 years it exceeded twice the value of the first measurement level (1.911 to 1964 4060 to 2015). Increasing the amount of ammonium NH_4^+ follows the same ascending line, the value virtually doubling (from 0.932 to 1964 to 1,876 in 2015). NO_2^- nitrate values registered the same upward swing and within the range of analysis is observed an almost a tripling of the initial measurement value (Table no. 2). These forms of nitrogen (anionic and cationic) are found in large quantities in dissolved salts (TDS) because they are highly soluble, this feature being characteristic of them. Definitely this increase in TDS value is directly proportional to the increase turbidity and the eutrophication of the lake Branesti fence.

- For phosphorus **PO¾⁻** there is no data to make an estimate assessment, its value being 0.120 according to the current measurements.

- **NO_2^-** nitrate values registered increases on an upward swing and from the range of analysis there is an approximate tripling from the initial measurement value (Table no. 2).

In conclusion, for every physical parameter and chemical parameter continuous growth was registered for most parameters, the doubling of initial values measurements is representative, proving that within 50 years water chemistry changed constantly and permanently, in connection with the expansion of the PUG of the Branesti commune. So, there was increase in the number of households/inhabitants-animal species combined with increased quantities of chemical nitrogen for both water and soil (fig. 15) from domestic human activity (NO_2^-, NO_3^-, NH_4^+), according to the nitrogen cycle (Benciu F., 2012). By uncontrollable domestic

human activity, it appears that the biogeochemical cycles of the elements can no longer take naturally quantitatively anthropogenic chemical species.

According to the current legislation, in terms of water quality, lake Branesti has not kept its` group II quality according to the Water Framework Directive of the European Parliament and the European Council 60/2000/EC, but has passed to the group III, even IV from the point of view of nitrogen compounds.

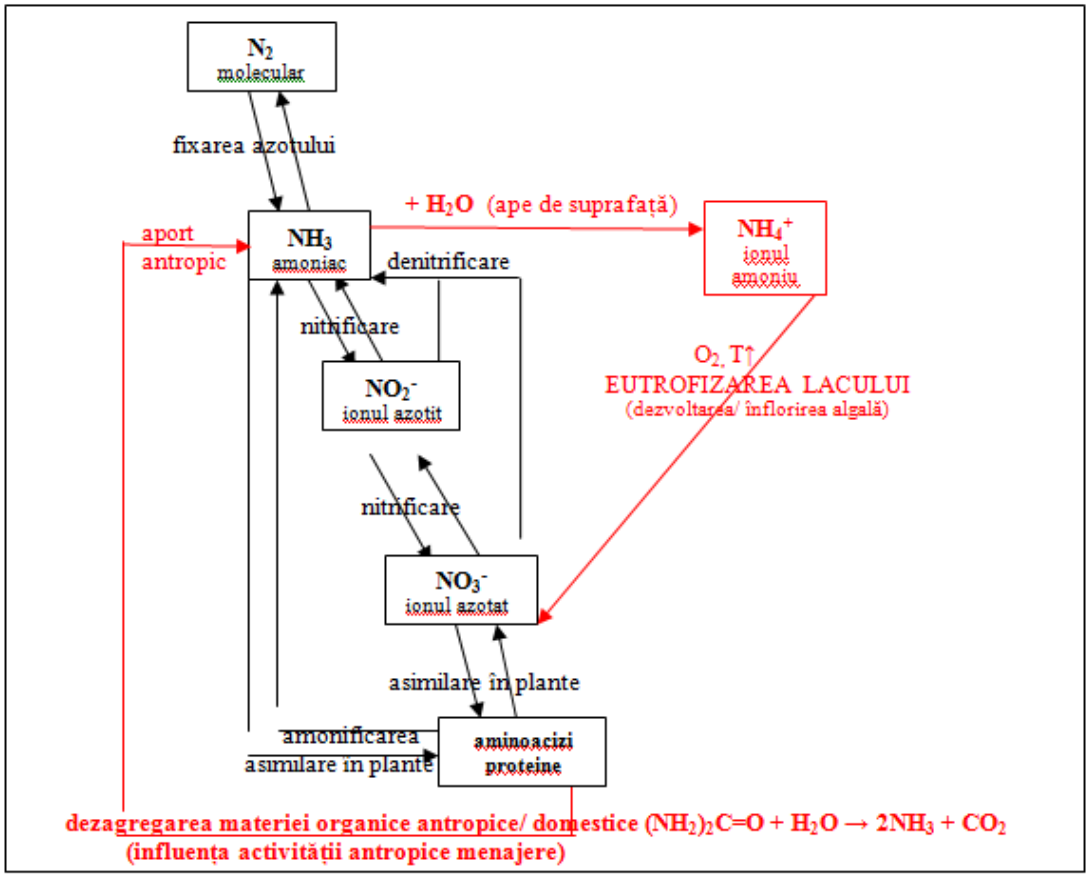

Figure 15. The influence of anthropic activity to the biochemical cycle of azote (Benciu F., 2015)

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