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Study Regarding Hydrochemical Classification of the main Lakes from Fizeş Watershed (Romania)

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Abstract

Regarding to the importance of the ponds is noted an increasing interest in Europe, and also an increase of the awareness on the ponds contribution to biodiversity and proper functioning of the watersheds. Although significant progress was made in establishing generic methodologies of analysis in the purpose of implementing water directive, small water bodies, as lakes and ponds are still insufficient represented. The study area, Fizes watershed, is located in Transylvania Plain, in the northern part of Romania. A distinct characteristic of this watershed is the presence of lake units (natural and artificial). Natural lakes and ponds are a polarizing element, which provides identity for the landscape in Fizes watershed, concentrates the majority of settlements in their close vicinity and also represent a support of economical activities development, from agriculture to tourism.

The objective of the present work is to discuss the major ion chemistry of the main lakes from Fizes watershed. Chemical classification also throws light on the concentration of various predominant cations, anions and their interrelationships. Water lake samples were collected from 11 sampling points covering the area during the years 2007 and 2008 and were analyzed for physical-chemical characters. The system of lake units present distinctive physical-chemical characteristics, influenced by local natural conditions, main factors being climate, morphometric characteristics of lakes, vegetation by shadowing, factors which together with biological conditions and anthropic influences shape the quality conditions of the lake waters. Climatic, hydrological and substrate conditions are reflected in the resulting water quality. The lakes located in the upper part of the watershed can be included in the bicarbonate class, while lakes located in the lower part are closer to sulphate waters.

Keywords: Fizes watershed, lakes, ponds, ion chromatography, anions, cations

1. Introduction

Due to the major contribution to aquatic biodiversity, the ponds have to be considered as key aspects in strategic conservation biodiversity development plans at local and regional scale.

Such plans can be effective only if are based on a solid knowledge on the factors which influence the structure and diversity of aquatic communities.

Fizes catchment, part of Somes catchment tributary of Tisa watershed, is located in Transylvania Plain, in the northern part of Romania, with a surface of approx. 562 km^2. A distinctive feature of this area is the presence of ponds, mainly used for fishery.

Territorial favorability, the existence of broad floodplains with narrowing zones, determined the occurrence of cascading shallow lakes. Due to the genesis mode, damming of the main stream in narrowing areas, the lakes present similar morphometric features: elongated shape and shallow waters, generally less than 3 m. On the main stream of Fizes Valley from upstream to downstream, a

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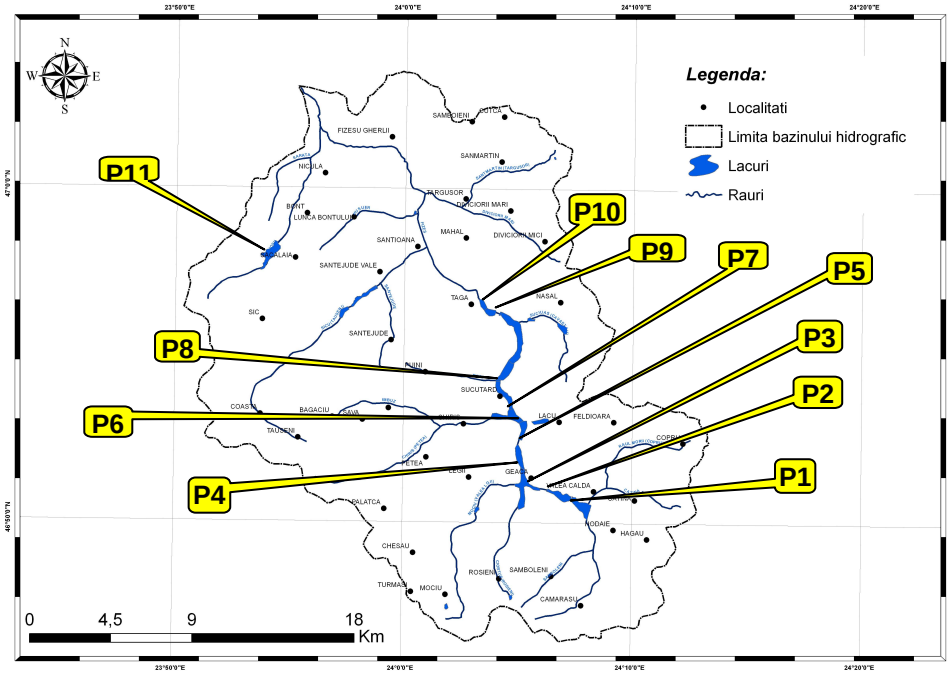
succession of lakes are developed: Cătina, Tăul Popii, Sf. Florian, Geaca I, Geaca II, Geaca III, Sucutard I, Sucutard II, Ţaga Mare, Ţaga Mică and Ghiolţ. Other lakes were created on the main tributaries: Roşieni on Ciortuş Valley, Năsal on Suciuaş Valley, Borzaş and Sântejude on Sic Valley. Ştiucii Lake on Bonţ Valley has a natural origin being formed as a result of tectonic phenomena followed by salt dissolution from the salt diaper which breeched the surface.

The major pollution sources [2] are represented by sediments (generated by erosional processes and transported in the water bodies) and diffuse pollution sources (originated from agricultural activities and the improper septic systems of the localities).

Fizes catchment, through its features of relatively low anthropic pressures and with little structural changes, represents a natural laboratory for designing and implementing programs of restorations of watersheds in agricultural landscapes. In such a context, chemical analysis is usually employed to identify the aquatic system characteristics including the assessment of inputs, distribution of various chemical species and characterization the outputs generated by the physical, chemical and biological processes developed within the water bodies. Among the specific chemical indicators, the inorganic species hold an important place, determining largely the behavior and evolution of the aquatic system [2].

2. Material and methods

The selection of the lakes to be sampled was made taking into account the geographic position within watershed. Lakes from the upper, middle and lower zone were selected in order to allow a general picture of the quality of standing water in the watershed. Water quality in Ştiucii Lake was also analyzed, the lake being located in a protected area, surrounded by a belt of wetland areas, with little supplementary pollutant inputs due to absence of localities in its watershed. On the main stream, Fizes Valley, 11 sampling points were selected (fig. 1).



P1-Cătina	N: 46°50′43,03″; E: 24°7′19,70″
P2-Tău Popii	N: 46°50′58,60″; E: 24°6′16,31″
P3-Sf. Florian	N: 46°51′7,77″; E: 24°5′29,18″
P4-Geaca I	N: 46°51′22,76″; E: 24°5′14,26″
P5-Geaca II	N: 46°52′2,63″; E: 24°4′55,97″
P6-Geaca III	N: 46°52′58,23″; E: 24°5′10,76″
P7- Sucutard I	N: 46°53′20,26″; E: 24°4′35,48″
P8-Sucutard II	N: 46°54′15,31″; E: 24°4′1,98″
P9- Ţaga Mare	N: 46°56′16,31″; E: 24°4′9,45″
P10-Ţaga Mică	N: 46°56′22,85″; E: 24°3′25,66″
P11-Ştiucii	N: 46°58′1,37″; E: 23°54′6,42″

Figure 1. Fizes Watershed and the position of sampling points

The physical-chemical characteristics of the waters in the studied area were assessed on the basis of chemical analysis and other measurement interpretation for the samples collected in several sampling campaigns in 2007 (March – June - September) and 2008 (March – June). Duplicate samples from all selected sampling points were taken and processed according to sampling/conserving methodology. Samples were passed through a 0.45 μm membrane filter (Millipore), and then were stored for 24 hours at 4ºC in 0.5 l polyethylene containers; each sample was analyzed in triplicates, the result being the average of the three measurements. The samples with ion

concentrations exceeding the calibration range were diluted accordingly and re-analyzed.

The method of analysis of the concentrations of major ions was ion chromatography accordingly to SR EN ISO 10304-1: 2003 and SR ISO 14911: 2003 [6, 7]. Analyses were performed on a Shimadzu system, consisting from: a Proeminence DGU 20As online degasser, a Proeminence LC-20AP solvent delivery module, an automatic sample injector SIL-10AF, a conductivity detector CDD-10Avp, a Proeminence CTO-20A column oven, a FCV-10AH$_2$ valve unit, an Allsep Anion 7u column (150 x 4.6 mm), an Universal Cation 7u (100 x 4.6 mm) and a Proeminence CBM-20A system controller. Chemicals for mobile phase preparation were of analytical grade: 4-hidroxybenzoic acid (Acros Organics), lithium hydroxide (Scharlau) and nitric acid (Merck). Ultrapure water with a specific resistance of 18.2 MΩ/cm was utilized for preparation of mobile phases as well as for sample dilution, being obtained from a Direct Q 3UV Smart (Millipore).

All solutions were stored in polyethylene bottles which had been thoroughly rinsed with ultrapure water. Mobile phases were filtered through a 0.45 μm membrane (Millipore), and then degassed using an Elmasonic S30 H ultrasonic bath before use. Standard working calibration solutions were prepared from a "six cation standard-II" (Dionex Corporation) and from "seven cation standard-II" (Dionex Corporation). The external standard method was used for quantification.

Instrument control, data acquisition and data analysis were accomplished by a computer running "LCsolution" ver. 1.2. software [3].

3. Results and Discussions

Salts content and prevailing ions in the lake units was determined by ion chromatography method with conductivity detection of the major cations and anions in samples during the 5 probing campaigns. Ionic balance of the parameters determined, shown as % is presented in fig. 2.

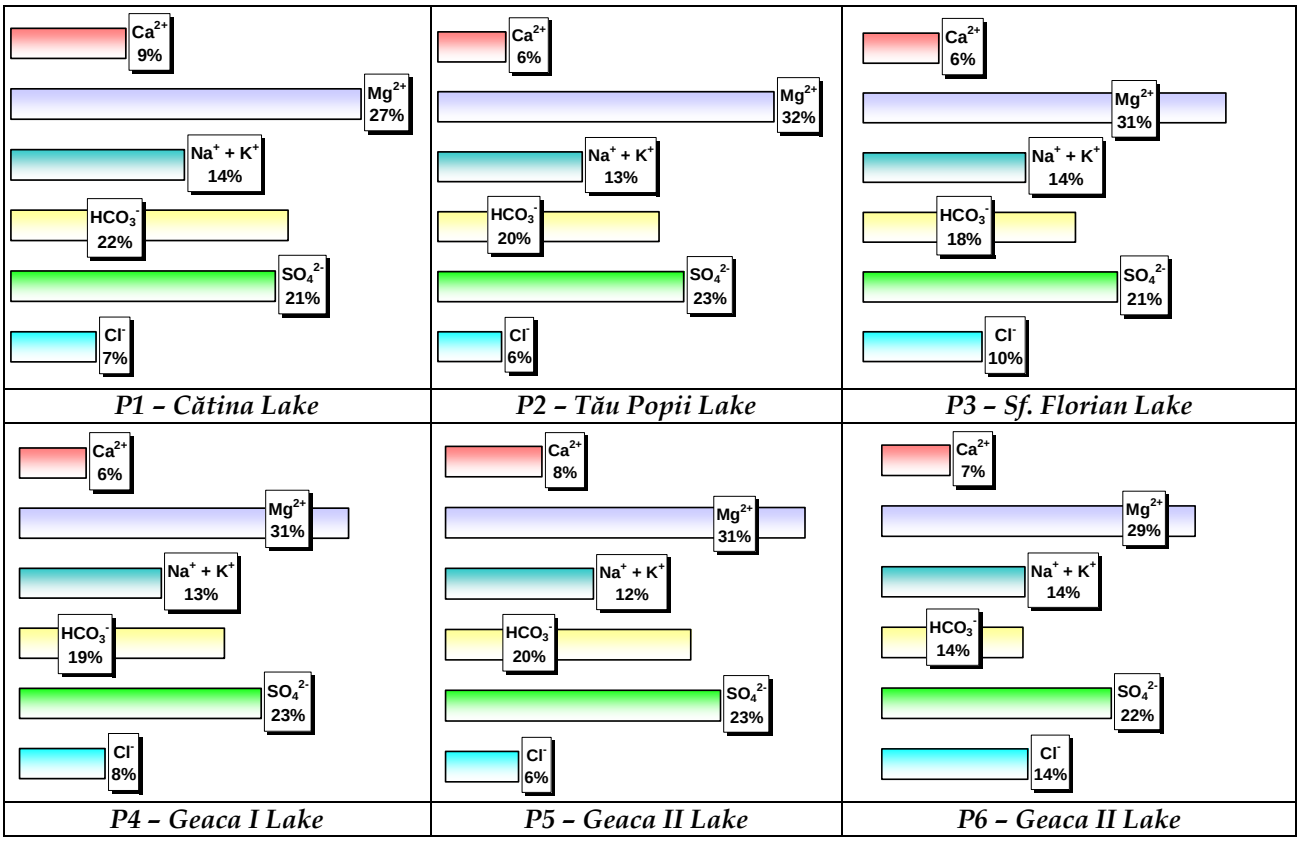


Figure 2. Ionic composition (%) in Fizes Watershed (average values 2007 – 2008)

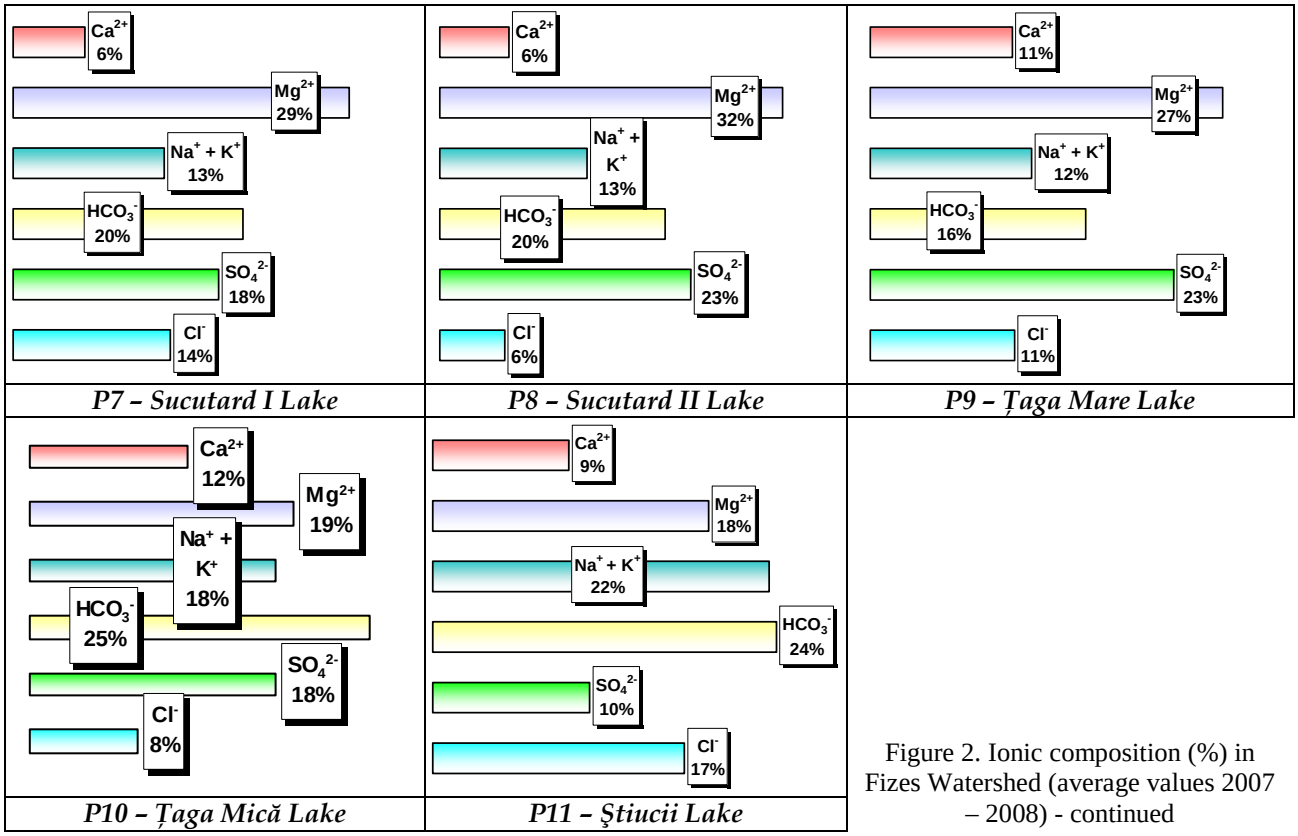


Figure 2. Ionic composition (%) in Fizes Watershed (average values 2007 – 2008) - continued

By analyzing the different ion equivalent percentage contribution (table 1), Fizes watershed lake waters were classified (classification scheme proposed O. A. Alekin [2]) in different classes (according to main anions) and groups (according to main cations).

Table 1.Lakes classification in Fizes Watershed (average values 2007 – 2008 campaigns)

Lake	*Anions (%)*			*Class*	*Cations (%)*			*Group*
	HCO_3^-	SO_4^{2-}	Cl^-		Na^+	Mg^{2+}	Ca^{2+}	
Cătina	44	42	14	Mixed bicarbonate-sulphate	26	55	19	Magnesium
Tău Popii	40	45	15	Mixed sulphate-bicarbonate	26	62	12	Magnesium
Sf. Florian	35	42	22	Mixed sulphate-bicarbonate	26	61	13	Magnesium
Geaca I	38	45	17	Mixed sulphate-bicarbonate	25	62	13	Magnesium
Geaca II	41	47	12	Mixed sulphate-bicarbonate	24	60	16	Magnesium
Geaca III	30	43	27	Mixed sulphate-bicarbonate	26	60	13	Magnesium
Sucutard I	33	36	30	Mixed sulphate-bicarbonate- chloride	22	62	16	Magnesium
Sucutard II	41	37	22	Mixed bicarbonate-sulphate	26	61	13	Magnesium
Ţaga Mare	33	47	20	Mixed sulphate-bicarbonate	24	54	22	Magnesium
Ţaga Mică	44	42	16	Mixed bicarbonate-sulphate	36	40	24	Mixed with Mg predominance
Ştiucii	46	21	33	Mixed bicarbonate-chloride	45	37	18	Mixed with Na predominance

Data analysis ascertains that the majority of lakes are included in the mixed class: bicarbonate-sulphate (Cătina, Sucutard II, Țaga Mică); sulphate-bicarbonate (Tău Popii, Sf. Florian, Geaca I, Geaca II, Geaca II, Țaga Mare); bicarbonate-chloride (Ştiucii). The mixed character can be explained taking into consideration the geological substrate characteristics of the watershed, mainly carbonate rock and sulphate containing rocks (Na and Mg as cations). Clay and marn clay (clays with $CaCO_3$ and $MgCO_3$) constitute prevailing components of the substrata and represent the major water ion sources.

During draught periods the phenomena of soil salinisation exposes salt efflorescence (with high sodium sulphate content) which are subsequently washed and drained into the lakes, thus contributing to the ionic content of the lake water. In the case of Stiucii Lake the presence of sodium and chloride ions is related to the salt presence in the geological substrate. Lake genesis is explain partially by salt dissolution, and also in the area are present underground salt waters. High percentage of sodium can be explained also by ionic exchange between sedimentary rocks which releases sodium and fix calcium [1, 2, 4, 5]. Results of several studies are shown in figure 3

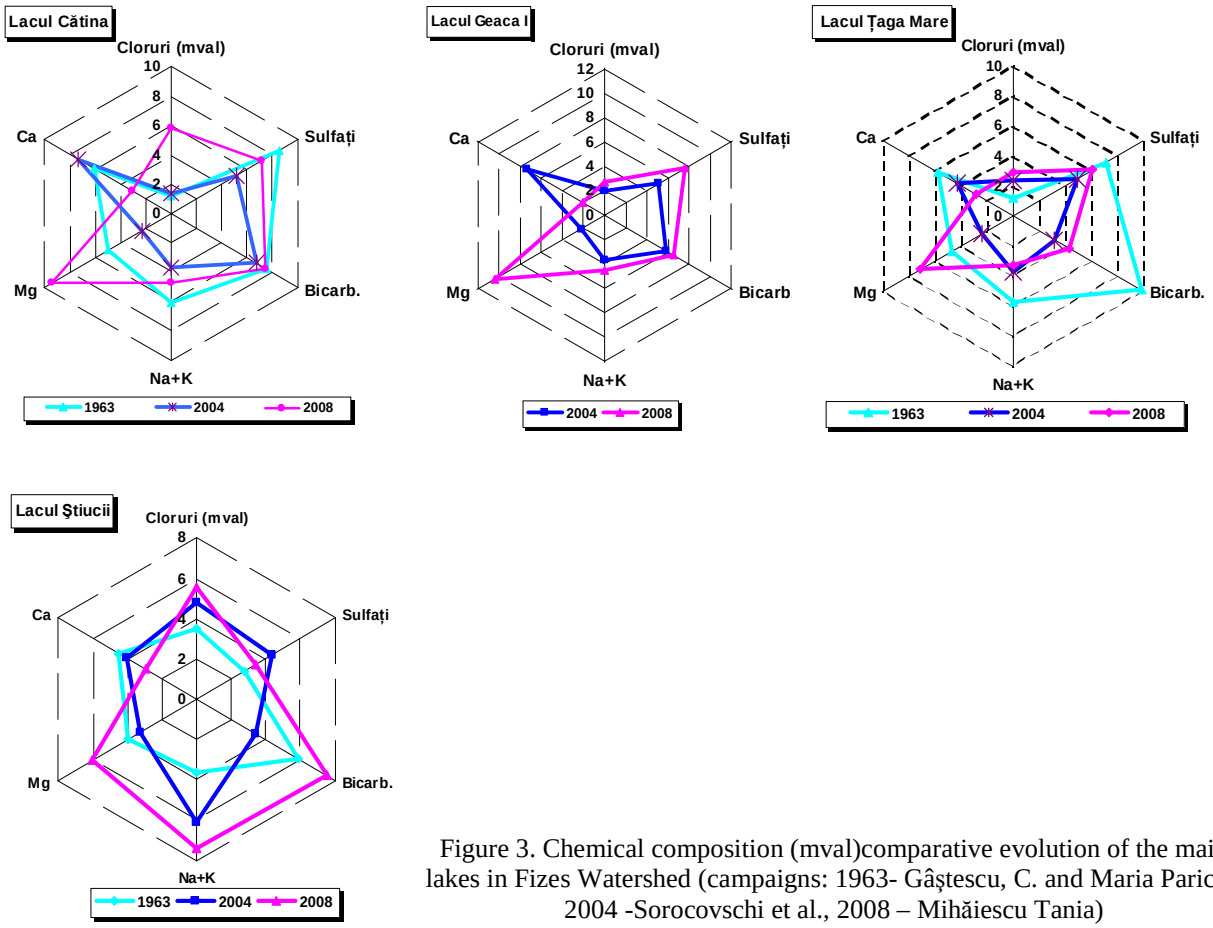


Figure 3. Chemical composition (mval)comparative evolution of the main lakes in Fizes Watershed (campaigns: 1963- Gâștescu, C. and Maria Parichi, 2004 -Sorocovschi et al., 2008 – Mihăiescu Tania)

According to the chemical analysis major differences can be observed, regarding ion content at different moments.

The main differences are observed in the case of magnesium and carbonates. Water composition depends on climatic and lake operation (water level, residence time) characteristics. Salt content is the cumulated result of salts carried by influents accumulation, sedimentation and remobilization processes from lake bottom sediments, and represents a distinctive characteristic of each analyzed lake.

4. Conclusions

Fizes watershed, through its characteristics can constitute a natural pilot laboratory for studying the complex interactions in a hilly landscape dominated by the presence of small water bodies.

The water quality in Fizes watershed is profoundly influenced by the characteristic of the catchment.

The lake units in Fizes watershed present differentiated physical-chemical characteristics imposed by the local natural conditions, being influenced by climate, morphometric parameters of lakes, vegetation, factors that together with biological conditions and anthropic influences decisively influence the water quality.

The climate, hydrological and geological substrate conditions are reflected both in the mineral and chemical content of lake water.

The lakes located in the upper part of the watershed can be included in the bicarbonate class, while lakes located in the lower part are closer to sulphate waters. The changing of the hydro chemical type was recently observed older studies considered that all the lakes were included in the bicarbonate class.

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