International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Estimation of Quality of Water of Lake Virua (Albania) based on Analysis of Diatoma

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Abstract: ***The main objective of this paper is to investigate the genera of diatoms, which were identified in the Viroi lake in the period 2011-2012 in the Gjirokastër region. We also carried out a classification of the quality of the water through the bio-indicator diatoms. The presence of polysaprobic species in the Virua lake, such as, Gomphonema parvulum,G.olivaceum, Nitzschia palea, is a clear indication of the pollution of waters coming from a variety of source. According to the bio-indicator saprobic species investigated the waters in the Virua lake Is classified as II class of bonity, i. e. from oligomesosaprob to betamesosaprob level.***

Keywords: diatoms, bio-indicator species, Virua lake, Gjirokastër, Albania**.**

1. Introduction

Lake are the most important water resource. In Albania are many natural lake which are not used to supply with water the citizens. The lake Virua are one of them which are not used for drinking. Viroi lake has a surface area of 17 ha and is located in the north-west of Gjirokastra district and 3 km distance from the town itself in the south part of Albania, on the left side of national road Gjirokaster – Tepelene. It has a karstic water source called "Mother of Viroi", In the lake Virua did't spill any river, but the waters of lake are spill in the river Drinos. Around the lake the are some restorants which spill the effluent waters in the lake. Water is a prerequisite for life and a key factor in virtually all human economic activities. Freshwater rivers are crucial sources of water and it is necessary to study, protect, and improve their ecological status (Zalewski 2000). Self-purification of water bodies depends on marine life of which algae serve as the primary producers and form the basis of the food chain. In addition to this, algae diversity is a clear indicator of the ecological and hygienic (health) status of the river as well as of the self-purification capabilities (Janauer and Dokulil, 2006). Our approach is based on the bio-indication of algal habitats, which includes not only the biodiversity but also the density of each bio-indicator species. The assessment of aquatic ecosystems is based on algal indicators which are widely used (Whitton and Rott, 1995; WFD, 2000), in particular, the assessment of water quality based on the saprobity indicator, obtained from the analysis of algal communities, (Sumita, 1986; Watanabe et al., 1986), but their capabilities are not yet fully understood. Albania is a country rich in waters, which being near urban centres are under constant risk of being polluted by household and industrial waste. These waters are rich in diatoms many species of which serve as bio-indicators due to their capabilities. Periphytic diatoms are an excellent indicator of the ecological condition of rivers and streams, due to their ability to react fast to changes in nutrient concentration. Rivers abound with diatoms which are primary producers and are found in all habitats (Round 1991). Based on the work of Kolkwitz & Marsson (1908) autoecological indicies were developed to indicate levels of pollution from the ecological preferences and tolerance of the species assemblages (Lange – Bertalot 1979).

2. Material and Methods

The samples were collected from 3 sampling sites, edge of lake (1), middle of lake (2) and near aqueous (3) along the Virua lake during the four seasons: spring 2011, summer 2011, autumn 2012 and winter 2012. Water samples were collected in 500 ml glass bottles, 10 cm beneath the water surface, using standard methods (Hindak, 1978). Conductivity, pH, salts, TDS (Total Dissolved Salts), were measured on site using portable instruments (HACH), O_2 was measured with portable instruments, such as, oxygenometer (Hana Instrument) and nutrients (N, P, Si) were analyzed by standard methods (DEV, 1981). Epilithon was brushed from the stones using a toothbrush and the upper layer of epipelon was drawn up via a vacuum suction system and then pipetted (Sladeckova, 1962). Epiphyton was sampled from the substrate and placed in the plastic bottles. The diatoms were examined using a Leica microscope, with a digital camera Fujifilm, which photographed the algae directly from the sample.

Diatoms Cleaning

Cleaning of diatoms' frustules and the preparation of slides and their determination was done according to Krammer & Lange-Bertalot (1986-2001). Diatoms' identification was done according to the keys: *Bacillariophyta*: Kramer & Lange-Bertalot (1986, 1988, 1991a, 1991b).

3. Results and Discussion

A total of species of diatoms were identified from the quantitative analysis of the samples taken during the four seasons (spring, summer, autumn and winter) (Table 1). We present them according to the seasons in which they were identified: spring 2011, 64 species (Table 2); summer 2011, 83 species (Table 3); winter 2012, 71 species (Table 4) and autumn 2012, 51 species (Table 5).

Table 5: Determined diatom in the lake Virua, during four season: spring, summer, autumn and winter

			Season			
97	**Total number of diatoma**	Level of Saprobity	spring	summer	autumn	winter
1	**Achnanthes** hungarica (Grunow) Grunow	o	+	+	+	+
2	Achnanthes ventralis (Krasske) Lange-Bertalot		+			+
3	A.clevei var.clevei Grunow		+			+
4	A. coarctata (Brébisson) Grunow	x			+	
5	**Achnanthidium** minutissimum (Kützing) Czarneck			+	+	
6	**Amphora** lybica Ehrenberg	β	+	+	+	+
7	A. normani Rabenhorst	o	+	+	+	+
8	**Aneumastus** stroesei (Ostrup) Mann			+	+	
9	**Cocconeis** pediculus Ehrenberg	o- β	+	+	+	+
10	C. placentula Ehrenberg	β	+	+		
11	C.placentula var.lineata (Ehrenberg) Cleve	β	+	+	+	+
12	**Craticula** accomoda (Hustedt) Mann	o- β	+	+	+	+
13	C. cuspidata (Kützing) Mann	o		+	+	
14	**Centronella** reichelti (Voigt)		+			+
15	**Cyclotella** ocellata Pantocsek		+	+	+	
16	**Cymatopleura** solea (Brébisson) W.Smith	β - α	+	+	+	
17	**Cymbella** affinis Kützing	o- β	+	+	+	+
18	C. helvetica Kützing	o	+	+	+	+
19	C.minuta Hilse ex Rabenhorst			+	+	
20	C. naviculiformis (Auerswald) Cleve	β	+	+		
21	**Diatoma** ehrenbergii Kützing		+	+	+	+
22	D. moniliforme Kützing		+	+	+	+
23	D. vulgaris Bory	β	+	+		
24	**Epithemia** adnata (Kützing) Brébisson		+	+	+	+
25	**Fragilaria** capucina Desmazières	o- β		+	+	
26	F. ulna (Nitzsch) Lange-Bertalot		+	+	+	+
27	F.ulna complex oxyrhynchus Lange-Bertalot		+	+	+	+
28	**Frustulia** vulgaris (Thwaites) De Toni	o	+	+	+	+
29	**Gomphonema** carolinense Hagelstein			+	+	
30	G.grovei M.Schmidt			+	+	
31	G.microporus *Kützing*		+	+	+	+
32	G.minutum (C.Agardh)		+	+	+	
33	G.olivaceum Hornemann) Brebisson	β	+	+		+
34	G.longiceps var.subclavatum Grunow		+			+
35	G.parvulum (Kützing) Kützing	β		+		
36	G.parvaulum var.parvulius lange-Bertalot&Rechardt		+			
37	G.parvaulum var.exlissimum Grunow		+			
38	G.tenue Fricke		+			
39	**Gyrosigma** acuminatum (Kützing) Rabenhorst	β	+	+	+	+
40	G. attenuatum (Kützing) Rabenhorst	β	+	+		
41	G. scalproides (Rabenhorst) Cleve		+	+	+	+
42	**Hantzschia** amphioxys (Ehrenberg) Grunow	α	+	+		+
43	H.elongata (Hantzch) Grunow		+			+
44	**Hippodonta** capitata (Ehrenberg) Lange-Bertalot		+	+	+	+
45	**Luticola** geoppertiana (Bleish) Mann		+	+	+	+
46	L.mutica (Kützing) D.G.Mann			+	+	
47	**Melosira** varians Agardh	β	+	+		
48	**Meridion** circulare (Grev.) C. Agardh	o	+	+	+	+
59	Meridion circulare var. constrictum (Ralfs) **V.Heurck**			+		
50	**Navicula** capitatoradiata Germain			+	+	
51	N.cryptotenella Lange-Bertalot		+	+	+	+
52	N. lanceolata (Agardh) Ehrenberg		+	+	+	+
53	N. radiosa Kützing	o- β	+	+	+	+
54	N.recens (Lange-Bertalot)	o- β			+	
55	N. rhynchocephala Kützing	α		+		
56	N. species aff radisafallax Lange-Bertalot			+	+	
57	N. tripunctata (O.F.Müller) Bory		+	+	+	+
58	N. trivialis Lange-Bertalot		+	+	+	+
69	N.tuscula Ehrenberg	o- β			+	
60	N. viridula (Kützing) Ehrenberg	α	+	+		
61	N. viridula var.rostellata(Kützing) Cleve		+	+	+	+
62	**Nitzschia** acula Hantzsch in Rabenhorst	α	+	+	+	

63	N.capitellata Hustedt		+	+	+	+
64	N.closterium (Ehrenberg) W.Sm.			+	+	
65	N.constricta (Kützing) Ralfs		+	+		+
66	N. dissipata (Kützing) Grunow	o- β	+	+	+	+
67	N. elegantula Grunow in Van Heurck			+	+	
68	N. eglei Lange-Bertalot			+	+	
79	N.exilis Kützing		+			+
70	N. fonticola Grunow	o- β		+	+	
71	N. levidensis (W.Smith) Grunow			+	+	
72	N. litoralis Grunow			+	+	
73	N. linearis (Agardh) W.Smith	o- β		+	+	
74	N.palea (Kützing) W.Smith	α		+		
75	N.pusilla Grunow			+	+	
76	N. recta Hantzsch	β -α		+		
77	N. sigmoidea (Nitzsch) W.Smith	β		+	+	
78	N.umbonata (Ehrenberg) Lange-Bertalot			+		
79	**Pinnularia** microstauron (Ehrenberg) Cleve	o	+	+	+	+
80	P.microstauron var. brebisonii (Kützing) Mayer	β	+	+	+	+
81	**Planothidium** ellipticum (Cleve) Round		+	+	+	+
82	P. lanceolatum (Brébisson) Round		+		+	+
83	**Reimeria** sinuata (Greg.) Kociolek & Stoermer		+	+	+	+
84	**Rhoicosphaenia** abbreviata (Agardh) Lange-Bertalot	β	+	+	+	+
85	**Sellaphora** pupula (Kützing) Mjereschowsky	α	+	+	+	+
86	S. pupula fo. rostrata (Hustedt) Bukhtiyarova		+	+		+
87	**Stauroneis** smithii Grunow	x-o	+	+	+	
88	**Surirella** angusta Kützing	β	+	+	+	+
99	S. brebissonii var. kuetzingii Krammer & Lange-Bertalot		+	+	+	+
90	S.linearis W.Smith	β	+	+		+
91	S.minuta Brébisson in Kützing	o	+	+	+	+
92	S. ovalis Brébisson	o			+	
93	S.patella Kützing			+	+	
94	S. robusta Ehrenberg			+	+	
95	**Synedra** acus Hustedt			+	+	
96	S. nana Meister			+	+	
97	S. ulna Kützing	β	+	+	+	+
	Total number of species for season		64	83	71	51

During spring we identified 64 species within 29 genera, where 7 species within the genera *Navicula* and *Gomphonema* were dominant, followed by 5 species within the genera *Nitzchia,* 4 species within the genus *Surirella*, we also identified 3, 2 or 1 species within their respective genera (table 2). The highest number of algae was identified on site 1 and 3 site during spring, with 50 species, followed by the 2 site with 44 species. There were 32 bio-indicator species, where 14 species within the genus betamesosaprob were dominant, followed by 7 species within the genus oligosaprob, 5 species within the genus oligo-betamesosaprob, 4 species within the genus alphamesosaprob, 1 species within the genus beta-alphamesosaprob and genus oligo-xenosaprob.

Table 2: Determined diatoma in the lake Virua, during spring season 2011

			STATIONS		
	Division BACILLARIOPHYTA	*Saprobity level*	*I*	*II*	*III*
64	**Total number of diatoma**				
1	**Achnanthes** hungarica (Grunow) Grunow	o	1		
2	Achnantes clevei var.clevei Grunow		1		1
3	Achnantes ventralis (Krasske) Lange-Bertalot		1	1	
4	**Amphora** lybica Ehrenberg	β	1	3	3
5	Amphora normani Rabenhorst	o		1	1
6	**Cocconeis** pediculus Ehrenberg	o- β	3	3	3
7	Cocconeis placentula Ehrenberg	β	3	5	1
8	Cocconeis placentula var.lineata (Ehrenberg) Cleve	β	3		
9	**Craticula** accomoda (Hustedt) Mann	o- β		1	1
10	**Centronella** reichelti (Voigt)		1		1
11	**Cyclotella** ocellata Pantocsek			1	
12	**Cymatopleura** solea (Brébisson) W.Smith	β- α	1	1	1
13	**Cymbella** affinis Kützing	o- β	5	3	3
14	Cymbella helvetica Kützing	o	1	1	

15	Cymbella naviculiformis (Auerswald) Cleve	β	3	3	3
16	**Diatoma** ehrenbergii Kützing		3	1	1
17	Diatoma moniliforme Kützing		1	3	1
18	Diatoma vulgaris Bory	β	3	3	3
19	**Epithemia** adnata (Kützing) Brébisson		1		1
20	**Fragilaria** ulna (Nitzsch) Lange-Bertalot		1	3	1
21	Fragilaria ulna complex oxyrhynchus lange-Bertalot			1	
22	**Frustulia** vulgaris (Thwaites) De Toni	o	1		1
23	**Gomphonema** microporus Kützing		1	1	
24	Gomphonema minutum (C.Agardh)		1	3	1
25	Gomphonema olivaceum Hornemann) Brebisson	β	1	1	1
26	Gomphonema longiceps var.subclavatum Grunow		1		1
27	Gomphonema tenue Fricke		1	1	
28	Gomphonema parvaulum var.exilissimum Grunow		1		
29	Gomphonema parvulumvar. parvulius Lange-Bertalot&Reichardt			1	1
30	**Gyrosigma** acuminatum (Kützing) Rabenhorst	β	1	1	1
31	Gyrosigma attenuatum (Kützing) Rabenhorst	β	1	1	1
32	Gyrosigma scalproides (Rabenhorst) Cleve		1	1	
33	**Hantzschia** amphioxys (Ehrenberg) Grunow	α	1	1	1
34	Hantzschia elongata (Hantxch) Grunow				1
35	**Hippodonta** capitata (Ehrenberg) Lange-Bertalot		1		1
36	**Luticola** goeppertiana (Bleish) Mann		1		1
37	**Melosira** varians Agardh	β	1		1
38	**Meridion** circolare (Agardh)	o	1	1	1
39	**Navicula** cryptotenella Lange-Bertalot			3	3
40	Navicula lanceolata (Agardh) Ehrenberg		3	5	3
41	Navicula radiosa Kützing	o- β	3	3	
42	Navicula tripunctata (O.F.Müller) Bory		3		3
43	Navicula trivialis Lange-Bertalot		1		3
44	Navicula viridula (Kützing) Ehrenberg	α	5	3	3
45	Navicula viridula var.rostellata(Kützing) Cleve		3	3	
46	**Nitzschia** acula Hantzsch in Rabenhorst	α	3	3	3
47	Nitzschia capitellata Hustedt			3	3
48	Nitzschia constricta (Kützing) Ralfs		3	3	3
49	Nitzschia dissipata (Kützing) Grunow	o- β	1		3
50	Nitzschia exilis Kützing			1	
51	**Pinnularia** microstauron (Ehrenberg) Cleve	o			1
52	Pinnularia microstauron var. Brebisonii (Kützing) Mayer	β	3	3	3
53	**Planothidium** ellipticum (Cleve) Round				1
54	Planothidium lanceolatum (Brébisson) Round		1	3	1
55	**Reimeria** sinuata (Greg.) Kociolek & Stoermer		3		3
56	**Rhoicosphaenia** abbreviata (Ag.)Lange-Bertalot	β	1	1	1
57	**Sellaphora** pupula [Kützing] Mjereschowsky	α	3	3	1
58	Sellaphora pupula fo. rostrata (Hustedt) Bukhtiyarova		1		1
59	**Stauroneis** smithii Grunow	x-o		1	1
60	**Surirella** angusta Kützing	β	3	3	3
61	Surirela brebissonii var. kuetzingii Krammer & L-B.			3	3
62	Surirela linearis W.Smith	β	1		
63	Surirela minuta Brébisson in Kützing	o		1	1
64	**Synedra** ulna (Kützing) Ehrenberg	β	3	5	3
	Total number of species for stations		50	44	50

83 species within 30 genera were identified during summer, where 16 species within the *Nitzchia* genus were dominant, followed by 10 species within the genus *Navicula*, 6 species within the genus *Surirella* and *Gomphonema*; 4, 3, 2, and 1 species within their respective genera were also identified (table 3). The highest number of algae during summer was found on sites 2 with 51 species, followed by site 3 with 45 species, site 1 with 35 species. There were 40 bio-indicator species, where 16 species within the genus betamesosaprob were dominant, followed by 8 species within the genus oligo-betamesosaprob, 7 species within the genus oligosaprob, 6 species within the genus alphamesosaprob, 2 species within the genus beta-alfamesosaprob and 1 species within the genus xeno-oligomesosaprob.

Table 3: Determined diatoma in the lake Virua, during summer season 2011

			STATIONS		
	Division BACILLARIOPHYTA	**Saprobity Level**	**I**	**II**	**III**
83	**Total number of diatoma**				

1	**Achnanthes** hungarica (Grunow) Grunow	o			1
2	**Achnanthidium** minutissimum (Kütz.) Czarneck		1	1	1
3	**Amphora** lybica Ehrenberg	β	1		
4	Amphora normani Rabenhorst	o	1	3	3
5	**Aneumastus** stroesei (Ostrup) Mann			1	
6	**Cocconeis** pediculus Ehrenberg	o- β			3
7	Cocconeis placentula Ehrenberg	β	3		
8	Cocconeis placentula var.lineata (Ehrenberg) Cleve	β	3	5	3
9	**Craticula** accomoda (Hustedt) Mann	o- β			3
10	Craticula cuspidata (Kützing) Mann	o		3	
11	**Cyclotella** ocellata Pantocsek				1
12	**Cymatopleura** solea (Brébisson) W.Smith	β- α		1	1
13	**Cymbella** affinis Kützing	o- β	3	3	3
14	Cymbella helvetica Kützing	o	3	3	3
15	Cymbella minuta Hilse ex Rabenhorst		1	3	
16	Cymbella naviculiformis (Auerswald) Cleve	β	3	3	
17	**Diatoma** ehrenbergii Kützing		3	5	3
18	Diatoma moniliforme Kützing			3	
19	Diatoma vulgaris Bory	β		3	3
20	**Epithemia** adnata (Kützing) Brébisson			3	
21	**Fragilaria** capucina Desmazières	o- β	3		
22	Fragilaria ulna (Nitzsch) Lange-Bertalot		1		
23	Fragilaria ulna complex oxyrhynchus lange-Bertalot			1	
24	**Frustulia** vulgaris (Thwaites) De Toni	o	1	1	
25	**Gomphonema** carolinense Hagelstein			1	
26	Gomphonema grovei M.Schmidt			1	1
27	Gomphonema microporus Kützing			1	
28	Gomphonema minutum (C.Agardh)			1	1
29	Gomphonema olivaceum Hornemann) Brebisson	β	1	1	1
30	Gomphonema parvulum (Kützing) Kützing	β	1		
31	**Gyrosigma** acuminatum (Kützing) Rabenhorst	β	1	1	
32	Gyrosigma attenuatum (Kützing) Rabenhorst	β	1	1	1
33	Gyrosigma scalproides (Rabenhorst) Cleve			1	1
34	**Hantzschia** amphioxys (Ehrenberg) Grunow	α	1		
35	**Hippodonta** capitata (Ehrenberg) Lange-Bertalot				1
36	**Luticola** goeppertiana (Bleish) Mann			1	
37	Luticola mutica (Kützing) D.G.Mann			1	
38	**Melosira** varians Agardh	β		1	1
39	**Meridion** circulare var.constrictum (Ralfs)V.Heurck			1	
40	**Navicula** capitatoradiata Germain				1
41	Navicula cryptotenella Lange-Bertalot			3	3
42	Navicula lanceolata (Agardh) Ehrenberg		3	3	3
43	Navicula radiosa Kützing	o- β			3
44	Navicula rhynchocephala Kützing	α		3	
45	Navicula species aff radisafallax Lange-Bertalot		1		
46	Navicula tripunctata (O.F.Müller) Bory		3		3
47	Navicula trivialis Lange-Bertalot		3	3	
48	Navicula viridula (Kützing) Ehrenberg	α	3	5	3
49	Navicula viridula var.rostellata(Kützing) Cleve		3	3	
50	**Nitzschia** acula Hantzsch in Rabenhorst	α		1	
51	Nitzschia capitellata Hustedt		3	3	
52	Nitzschia closterium (Ehrenberg) W.Sm.				3
53	Nitzschia constricta (Kützing) Ralfs				1
54	Nitzschia dissipata (Kützing) Grunow	o- β		3	3
55	Nitzschia elegantula Grunow in Van Heurck				3
56	Nitzschia eglei Lange- Bertalot			1	
57	Nitzschia fonticola Grunow	o- β		3	
58	Nitzschia levidensis (W.Smith) Grunow		3		
59	Nitzschia litoralis Gruow			1	1
60	Nitzschia linearis (Agardh) W.Smith	o- β	1		
61	Nitzschia palea (Kützing) W.Smith	α			3
62	Nitzschia pusilla Grunow				1
63	Nitzschia recta Hantzsch	β -α		3	3
64	Nitzschia sigmoidea (Nitzsch) W.Smith	β			3
65	Nitzschia numbonata (Ehrenberg) Lange-Bertalot				3

66	**Pinnularia** microstauron (Ehrenberg) Cleve	o	3		
67	Pinnularia microstauron var. Brebisonii (Kützing) Mayer	β	3		
68	**Planothidium** ellipticum (Cleve) Round		3		
69	Planothidium lanceolatum (Brébisson) Round		3		
70	**Reimeria** sinuata (Greg.) Kociolek & Stoermer				3
71	**Rhoicosphaenia** abbreviata (Ag.)Lange-Bertalot	β	1	1	1
72	**Sellaphora** pupula [Kützing] Mjereschowsky	α		3	3
73	Sellaphora pupula fo. rostrata (Hustedt) Bukhtiyarova			3	
74	**Stauroneis** smithii Grunow	x-o	1		1
75	**Surirella** angusta Kützing	β		1	
76	Surirela brebissonii var. kuetzingii Krammer & L-B.				3
77	Surirela linearis W.Smith	β		3	3
78	Surirela minuta Brébisson in Kützing	o		3	3
79	Surirela patella Kützing			1	
80	Surirela robusta Ehrenberg			1	1
81	**Synedra** acus Hustedt		1		1
82	Synedra nana Meister			1	
83	Synedra ulna Kützing	β	1		1
	Total number of species for stations		34	50	45

During autumn we identified 71 species within 28 genera, where 12 species within the genus *Nitzchia* were dominant, followed by 10 species within the genus *Navicula*, 6 species within the genus *Surirella*; , 4 species within the genus *Gomphonema;* we also identified 3, 2, 1 species within their respective genera (table 4). The highest number of algae during autumn was found on site 1 with 36 species, site 2 with 26 species, site 3 with 40 species. There were 30 bio-indicator species, where 10 species within the genus oligo-betamesosaprob where dominant, followed by 9 species within the genus oligosaprob, 8 species within the genus betamesosaprob, 1 species within the genus xeno-oligosaprob, the genus xeno-saprob and the genus beta-alfamesosaprob.

Table 4: Determined diatoma in the lake Virua, during autumn season 2012

			STATIONS		
	Division BACILLARIOPHYTA	**Saprobity level**	**I**	**II**	**III**
71	**Total number of diatoma**				
1	**Achnanthes** hungarica (Grunow) Grunow	o	1		1
2	Achnanthes corctata **(**Brébisson) Grunow	x	1	1	
3	**Achnanthidium** minutissimum (Kütz.) Czarneck		1		1
4	**Amphora** lybica Ehrenberg	β	1	1	
5	Amphora normani Rabenhorst	o	1		3
6	**Aneumastus** stroesei (Ostrup) Mann			1	
7	**Cocconeis** pediculus Ehrenberg	o- β		1	
8	Cocconeis placentula var.lineata (Ehrenberg) Cleve	β	3	1	5
9	**Craticula** accomoda (Hustedt) Mann	o- β	1		
10	Craticula cuspidata (Kützing) Mann	o			3
11	**Cyclotella** ocellata Pantocsek			1	
12	**Cymatopleura** solea (Brébisson) W.Smith	β -α			1
13	**Cymbella** affinis Kützing	o- β	3		3
14	Cymbella helvetica Kützing	o	3	1	3
15	Cymbella minuta Hilse ex Rabenhorst		1		3
16	**Diatoma** ehrenbergii Kützing		3		5
17	Diatoma moniliforme Kützing				3
18	**Epithemia** adnata (Kützing) Brébisson				3
19	**Fragilaria** capucina Desmazières	o- β	3	1	
20	Fragilaria ulna (Nitzsch) Lange-Bertalot				1
21	Fragilaria ulna complex oxyrhynchus lange-Bertalot		1		
22	**Frustulia** vulgaris (Thwaites) De Toni	o	1	1	1
23	**Gomphonema** carolinense Hagelstein				1
24	Gomphonema grovei M.Schmidt		1		1
25	Gomphonema microporus Kützing			1	1
26	Gomphonema minutum (C.Agardh) C.Agardh				1
27	**Gyrosigma** acuminatum (Kützing) Rabenhorst	β	1		1
28	Gyrosigma scalproides (Rabenhorst) Cleve				1
29	**Hippodonta** capitata (Ehrenberg) Lange-Bertalot				1
30	**Luticola** goeppertiana (Bleish) Mann		1		
31	Luticola mutica (Kützing) D.G.Mann				1

32	**Meridion** circulare (Grev.) C.Agardh	o	1		1
33	**Navicula** capitatoradiata Germain			1	
34	Navicula cryptotenella Lange-Bertalot				3
35	Navicula lanceolata (Agardh) Ehrenberg		3		3
36	Navicula radiosa Kützing	o- β		1	
37	Navicula recens (Lange-Bertalot) Lange-Bertalot	o- β	1		
38	Navicula species aff radisafallax Lange-Bertalot		1		
39	Navicula tripunctata (O.F.Müller) Bory		3		
40	Navicula trivialis Lange-Bertalot		3		3
41	Navicula tuscula Ehrenberg	o- β		1	
42	Navicula viridula var.rostellata(Kützing) Cleve		3		3
43	**Nitzschia** acula Hantzsch in Rabenhorst			1	
44	Nitzschia capitellata Hustedt		3		3
45	Nitzschia closterium (Ehrenberg) W.Sm.			3	
46	Nitzschia dissipata (Kützing) Grunow	o- β			3
47	Nitzschia elegantula Grunow in Van Heurck				3
48	Nitzschia eglei Lange- Bertalot			1	
49	Nitzschia fonticola Grunow	o- β			3
50	Nitzschia levidensis (W.Smith) Grunow		3		
51	Nitzschia litoralis Gruow			1	1
52	Nitzschia linearis (Agardh) W.Smith	o- β	1		
53	Nitzschia pusilla Grunow				1
54	Nitzschia sigmoidea (Nitzsch) W.Smith	β		3	
55	**Pinnularia** microstauron (Ehrenberg) Cleve	o	3	1	
56	Pinnularia microstauron var. Brebisonii (Kützing) Mayer	β	3	1	
57	**Planothidium** ellipticum (Cleve) Round		3	1	
58	Planothidium lanceolatum (Brébisson) Round		3		
59	**Reimeria** sinuata (Greg.) Kociolek & Stoermer			1	
60	**Rhoicosphaenia** abbreviata (Ag.)Lange-Bertalot	β	1		1
61	**Sellaphora** pupula fo. rostrata (Hustedt) Bukhtiyarova				1
62	**Stauroneis** smithii Grunow	x- o	1		
63	**Surirella** angusta Kützing	β		1	
64	Surirela brebissonii var. kuetzingii Krammer & L-B.			1	
65	Surirela munuta Brébisson in Kützing	o	1		3
66	Surirela ovalis Brébisson	o	1		1
67	Surirela patella Kützing			1	1
68	Surirela robusta Ehrenberg				1
69	**Synedra** acus Hustedt		1	1	
70	Synedra nana Meister				1
71	Synedra ulna Kützing	β	1		
	Total number of species for stations		36	26	40

51 species within 26 genera were identified during winter, where 6 species within the genus *Navicula* were dominant, followed by 4 species within the genus *Nitzchia* and *Surirella;* we also identified 3, 2, 1 species within their respective genera (table 5). The highest number of algae during winter was identified on site 3 with 40 species; site 1 with 39 species and site 2 with 34. There were 24 bio-indicator species, where 10 species within the genus betamesosaprob were dominant, followed by 7 species within the genus oligosaprob, 5 species within the genus oligo-betamesosaprob and 2 species within the genus alphamesosaprob.

Table 5: Determined diatoma in the lake Virua, during winter season 2012

			STATIONS		
	Division BACILLARIOPHYTA	*Saprobity level*	*I*	*II*	*III*
51	**Total number of diatoma**				
1	**Achnanthes** hungarica (Grunow) Grunow	o	1		
2	Achnanthes clevei var.clevei Grunow		1		1
3	**Achnanthes ventralis (Krasske) Lange-Bertalot**		1	1	
4	**Amphora** lybica Ehrenberg	β	1	3	3
5	Amphora normani Rabenhorst	o		1	1
6	**Cocconeis** pediculus Ehrenberg	o- β	3	3	3
7	Cocconeis placentula var.lineata (Ehrenberg) Cleve	β	3		
8	**Craticula** accomoda (Hustedt) Mann	o- β		1	1
9	**Centronella** reichelti (Voigt)		1		1
10	**Cymbella** affinis Kützing	o- β	5	3	3

11	Cymbella helvetica Kützing	o	1	1	
12	**Diatoma** ehrenbergii Kützing		3	1	1
13	Diatoma moniliforme Kützing		1	3	1
14	**Epithemia** adnata (Kützing) Brébisson		1		1
15	**Fragilaria** ulna (Nitzsch) Lange-Bertalot		1	3	1
16	Fragilaria ulna complex oxyrhynchus lange-Bertalot			1	
17	**Frustulia** vulgaris (Thwaites) De Toni	o	1		1
18	**Gomphonema** microporus Kützing		1	1	
19	Gomphonema longiceps var.subclavatum Grunow		1		1
20	Gomphonema olivaceum Hornemann) Brebisson	β	1	1	1
21	**Gyrosigma** acuminatum (Kützing) Rabenhorst	β	1	1	1
22	Gyrosigma attenuatum (Kützing) Rabenhorst	β	1	1	1
23	Gyrosigma scalproides (Rabenhorst) Cleve		1	1	
24	**Hantzschia** amphioxys (Ehrenberg) Grunow	α	1	1	1
25	Hantzschia elongata (Hantzch) Grunow				1
26	**Hippodonta** capitata (Ehrenberg) Lange-Bertalot		1		1
27	**Luticola** goeppertiana (Bleish) Mann		1		1
28	**Meridion** circulare (Agardh)	o	1	1	1
29	**Navicula** cryptotenella Lange-Bertalot			3	3
30	Navicula lanceolata (Agardh) Ehrenberg		3	5	3
31	Navicula radiosa Kützing	o- β	3	3	
32	Navicula tripunctata (O.F.Müller) Bory			3	3
33	Navicula trivialis Lange-Bertalot		1		3
34	Navicula viridula var.rostellata(Kützing) Cleve		3	3	
35	**Nitzschia** capitellata Hustedt			3	3
36	Nitzschia constricta (Kützing) Ralfs		3	3	3
37	Nitzschia dissipata (Kützing) Grunow	o- β	1		3
38	Nitzschia exilis Kützing			1	
39	**Pinnularia** microstauron (Ehrenberg) Cleve	o			1
40	Pinnularia microstauron var. Brebisonii (Kützing) Mayer	β	3	3	3
41	**Planothidium** ellipticum (Cleve) Round				1
42	Planothidium lanceolatum (Brébisson) Round		1	3	1
43	**Reimeria** sinuata (Greg.) Kociolek & Stoermer		3		3
44	**Rhoicosphaenia** abbreviata (Ag.)Lange-Bertalot	β	1	1	1
45	**Sellaphora** pupula [Kützing] Mjereschowsky	α	3	3	1
46	Sellaphora pupula fo. rostrata (Hustedt) Bukhtiyarova		1		1
47	**Surirella** angusta Kützing	β	3	3	3
48	Surirela brebissonii var. kuetzingii Krammer & L-B.			3	3
49	Surirela linearis W.Smith	β	1		
50	Surirela minuta Brébisson in Kützing	o		1	1
51	**Synedra** ulna (Nitzsch) Kützing	β	3	5	3
	Total number of species for stations		39	34	40

Benthic algal communities are usually rich species and therefore provide a lot of information which is ideal for the monitoring of the environment because of their relatively short life cycle, allowing for a rapid response to environmental changes. At the same time they also reveal the cumulative effect that the environmental changes has had over a longer time period (Janauer and Dokulil, 2006). Because of this, bio-indicator algae are included in the EC-Water Framework Directive (WFD, 2000) for the assessment and monitoring of water quality. The complete database includes taxa of 97 diatoms, but only 38 diatoms species within 24 genera are found in all seasons (Table 1).

The most common species were *Cocconeis placentula var. lineata, Nitzschia acula, Gomphonema parvulum, Rhoicosphenia abbreviata, Navicula lanceolata, Nitzschia dissipat* and *Navicula radiosa*. These diatoms are known as cosmopolitan, widely distributed in inland waters, and considered as indicators of eutrophic conditions (Van Dam et al., 1994).

In our study during the period 2011-2012 we identified 97 species of diatoms within 31 genera; 17 species within the genus *Nitzschia* were dominant, while the other genera are represented with a smaller number of species; 13 species within the genus *Navicula*, 10 species within the genus *Gomphonema*, 7 species within the genus *Surirella*, 4 species within the genus *Cymbella*. We also recognized 45 bio-indicator species which belong to the xenosaprobic till alphamesosaprobic level of saprobity. 16 species belong to the Betamesosaprobic level, and dominate the other level of saprobity. The other levels of saprobity have the lowest number of bio indicator species, such as, oligo-betamesosaprobic level of saprobity have 10 species, oligosaprobic level of saprobity has 9 species,alfamesosaprob level of saprobity has 6 species, beta-alphamesosaprobic level of saprobity has 2 species, xeno-oligosaprobic level of saprobity has 1 species, xenosaprobic level of saprobity has 1 species.

4. Conclusions

During the study period (2011-2012) we identified 97 diatoma species of plankton and periphyton within 31 genera. 17 species within the genus *Nitzschia* dominated the algal flora, followed by 13 species within the genus *Navicula*, 10 species within the genus *Gomphonema*, 7 species within the genus *Surirella*. We also identified 4, 3, 2 or 1 species within their respective genera.
Furthermore, there is a high diversity of diatoms in each season. There are 45 bio-indicator species. The betamesosaprobic bio-indicator (16 bio-indicator species) were dominant. 10 species which belong to oligo-betamesaprob (o- β) level of saprobity were found, followed by oligosaprob bio-indicator (9 species), alfamesosaprob bio-indicator (6 species), beta-alfamesosaprob bio-indicator (2 species), xeno-oligosaprobic bio-indicator (1 specie) and xenosaprob bio-indicator (1 species).

We did not find any bio-indicator species which belong to polisaprob (ρ) level of saprobity.

According to the bio-indicator saprobic species investigated the waters in the Virua lake. Is classified as II class of bonity, i.e. from oligomesosaprob to betamesosaprob level.

References

[1] M. Zalewski, M. Ecohydrology – the scientifi c background to use ecosystem properties as management tools towards sustainability of water resources. Ecological Engineering 165 (2000), 1-8.
[2] G. Janauer, M. Dokulil, Mactophytes and algae in running waters. – Ziglio, G.,Siligardi, M., Flaim, G. (eds). Biological monitoring of rivers. John Willey and Sons, Ltd, Chichester, England (2006).
[3] B.A. Whitton, E. Rott, (eds). Use of algae for monitoring rivers II. – Institute für Botanik Univ. Press, Innsbruck (1995).
[4] WFD Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for community action in the field of water policy. – Official J. Eur. Communities L327,Brussels, Belgium: (2000), 1-72.
[5] M. Sumita, A numerical water quality assessment of rivers in Hokuriku District using epilithic diatom assemblage in riverbed as a biological indicator (II). The values of RPId in surveyed rivers. - Diatom, Japan J. Diatomology 2(1986), 9-18.
[6] T. Watanabe, K. Asai, A. Houki, Numerical estimation to organic pollution of flowing water by using the epilithic diatom assemblage – Diatom Assemblage Index (DAIpo). – Sci. Total Environ. 55(1986), 209-218.
[7] F.E. Round, Diatoms in river water - monitoring studies. Journal of Applied Phycologica 3(1991), 129–145.
[8] R. Kolkwitz and M. Marsson, Okologic der pflanzlichen Saprobien. Ber. Dt. Bot. Ges., 26(1908), 505-519.
[9] H. Lange-Bertalot. Pollution tolerance of diatoms as a criterion for water quality estimation. Nova Hedwigia, 64(1979), 285-304.
[10] F. Hindak, The genus Lagerheimia Chod. and Lager Hinda´k, F., 1978b. The genus Lagerheimia Chod. and Lager heimia-like unicells in the genus Scenedesmus Meyen (Chlorophyceae). Biologia 33(1978), 795–808
[11] DEV Deutsche Einheitsverfahren zur Wasser-, Abwasser und Schlamm-Untersuchung. Physikalische, chemische, biologische und bakteriologische Verfahren. 1. Aufl., Loseblatt-Samm lung (1981).
[12] A. Sladeckova, Limnological investigation methods for the periphyton (Awfwuch) community. Botanical Review, 28(1962), 286-350. Wiley-VCH, Weinheim.
[13] K. Krammer, H. Lange-Bertalot 1986-2001. Suesswasserflora von Mitteleuropa. 2/1: pp. 876; 2/2: pp. 596; 2/3: pp. 576; 2/4: pp. 437; 2/5: Fischer, Stuttgart.
[14] K. Krammer, H. Lange-Bertalot, Bacillariophyceae, 1. Naviculaceae. In: Ettil, H., Gerloff, J., Heynig, H., Mollenhuer, D. (eds), Süsswasserflora von Mitteleuropa, 2, 1, 1–876. Gustav Fischer Verlag. Jena (1986).
[15] K. Krammer, H. Lange-Bertalot, Bacillariophyceae, 2. Bacillariaceae, Epithemiaceae, Surirellaceae. In: Ettil, H.,Gerloff,, J.,Heynig, H.,Mollenhuer, D. (eds), Süsswasserflora von Mitteleuropa, 2, 2, 1–596. Gustav Fischer Verlag. Stuttgart (1988).
[16] K. Krammer, H. Lange-Bertalot, Bacillariophyceae, 3. Centrales Fragilariaceae, Eunotiaceae. In: Ettil, H., Gerloff, J., Heynig, H., Mollenhuer, D. (eds),Süsswasserflora von Mitteleuropa, 2, 3, 1–576. Gustav Fischer Verlag. Stuttgart (1991a).
[17] K. Krammer, H. Lange-Bertalot. Bacillariophyceae, 4. Achnanthaceae Kritische Ergänzungen zu Navicula (Lineolatae) und Gomphonema. In: Ettil, H., Gerloff, J., Heynig, H., Mollenhuer, D. (eds), Süsswasserflora von Mitteleuropa, 2, 4, 1–437. Gustav Fischer Verlag. Stuttgart (1991b).
[18] H. Van Dam, A. Mertens, I. Simkeldon. Acoded cheklist and ecological indicatorvalues offreshwater diatoms from the Nehterlands Neth,I. Ag. Ecol. 8(1) (1994), 117-133.
[19] R.H. Whittaker. Gradient analysis of vegetation. Biological Reviews 49(1967), 207–264.