European Water 58: 245-250, 2017.

Water quality in Osumi, Devolli and Shkumbini rivers, using benthic invertebrates

B. Pepa[1*], A. Paparisto[2], E. Keci[3] and E. Halimi[2]
[1] *Faculty of Technical Sciences, "Ismail Qemali" University, Vlore, Albania*
[2] *Faculty of Natural Sciences, Tirana University, Albania*
[3] *Faculty of Professional Studies, "Aleksander Moisi" University, Durres, Albania*
[*] *e-mail: bled_pepa@hotmail.com*

Abstract: Anthropogenic activities have increased recently affecting among others, the ecological integrity within the aquatic ecosystems in the river waters in Albania. This paper promotes the biological monitoring of water quality, using macro invertebrates as bio indicators and definition of biological indices as a useful method of evaluating the ecological health status of rivers. Water Frame Directive (2000) implementation requires the use of benthic macro invertebrates as biological indicators for monitoring of water quality. The study presents the relation between benthic macro-invertebrate quantity, and the water quality status in Osumi, Devolli and Shkumbini Rivers, south Albania, during the Summer of 2011 through the Spring of 2013. The results obtained from the study refer to a total number of individuals of 4845 (42 families) in Osumi River, 3469 individuals (31 families) in Devolli River and 5991 individuals (34 families) in Shkumbini River. Based on the SWRC-Biotic Index calculations the following results have been obtained: Osumi River; St.1 (4.31; 5.39; 4.20; 4.61; 4.37; 4.26; 4.23; 4.15): St.2 (4.77; 5.52; 3.85; 4.12; 4.76; 4.04; 4.03; 4.07): St.3 (5.57; 5.15; 3.85; 3.99; 5.42; 5.29; 5.09; 4.91). Water quality bio classification has been carried out as well during the study. Based on the results of this study the two first sampling stations at Osumi River are classified as "good" water quality, while the third sampling station is qualified as "fair" water quality. Generally we can conclude that the water quality of the three Rivers in Albania is still good and slightly impacted..

Key words: Macro-invertebrates, WFD, bio classification, SWRC-Biotic Index

1. INTRODUCTION

Along with the physical-chemical approaches, currently the biological monitoring is recognized as one of the most valuable tools in the assessment of water quality (Bode, 2002).

Many years ago, in 1972 the NY State undertook bio-monitoring as an alternative method of monitoring and assessing its streams and rivers. For this reason, in 1977 CLEAN WATER ACT was committed to observe and save the chemical, physical and biological parameters of many rivers. After this, many countries developed different monitoring methods, to assess the water quality (Arscott et al., 2006; EEA 200696-107, 2007). Water Frame Directive implementation also requires the use of benthic macro invertebrates as part of biological monitoring of surface waters as biological indicators for monitoring of water quality (Directive 2000/60/EC).

Benthic macro-invertebrate species are differentially sensitive to many biotic and abiotic factors in their environment.The presence of numerous families of highly tolerant organisms usually indicates poor water quality Some river's organisms have a high variety, or they can be under the threat of water quality conditions (Lenz and Rheaume, 1995).

A high number of macro-invertebrates are very sensitive to the pollution (0-10). The short circle of life and the fast change of the species' number can ensure us a clear evidence of the returning of favorable water quality after water pollution state (McGonigle, 2000; Bouchard, 2004; S.W.R.C, 2007).

2. MATERIALS AND METHODS

Material has been collected based on method proposed by Campaioli et al. (1994), Bode et al. (1997) and Bailey et al. (2001).

The macro invertebrates were sampled from the bottom of the river at the depth 30-50 cm, using a kick-net. This net was put vertically in the river's bed, while from a one meter distance we stirred up the river bed with our feet for 30 seconds (Herbst and Silldorff, 2009).

The sampled macro-invertebrates were stored and preserved with an alcohol solution (95 %) (Beatty et al., 2006).

In the laboratory the samples were poured into a large watch glass. Approximately one teaspoon of materials was removed from the sample and processed in a white enamel pan. Macro-invertebrates were placed in a smaller watch glass for identification under a dissecting microscope. Organisms in order EPT were identified at least at family level (Tachet et al., 1980; Campaioli et al., 1994; Taxonomic Key to Macro-invertebrates Families of Maryland Streams, 2004).

The results were used to determine parameter S.W.R.C. - BI (Stround Water Research Center – Biotic Index, 2007). Biotic index calculations coming from this study were taken into consideration to determine the water quality of each river for two years from summer 2011 to spring 2013.

2.1 The study area

Osumi River: The Osumi river is a main branch of *Semani* River that originates from the Vithkuqi Mountain located in the South Western Part of Albania. Some of the morphmetric parameters of *Osumi* River are: length 161 km, watershed surfaces 2150 km^2, average altitude 828 m. At the both sides of *Osumi* River there are located three urban area regions, Çorovode city, Berati city, Ura Vaj-Gurore city. Most of the waste of the urban areas is released in this river.

Devolli River: The Devolli river originates from Gramozi Mountains located also in the Western Part of Albania. Its length is 196 km. This river is also a branch of *Semani* River with the following morphometric parameters: a watershed surfaces of 3139 km^2 and an average altitude of 960 m. Part of its watershed are three urban area regions including Gramshi, Cerrik, Kuçova cities which were used as well as sampling sites for this study.

Shkumbini River: The Shkumbini river has a length of 181,4 km. Its average flow is 61 m^3/sec, with a flowing module from 25, 21l sec/km^2 to 27,3l sec/km^2. At the both sides of *Shkumbini* River there are located three urban regions including Librazhd, Peqini cities and Elbasani industrial zone (Pano, 1984).

Sampling stations are situated in representative areas of the three rivers; within one sampling station samples were taken randomly (Beatty et al. 2006). The sampling stations and their respective codes are indicated in the following (Figure 1): *Osumi* River: Os.1 - Poliçan; Os.2 - Gorica bridge (Berat); Os.3 - Ura Vajgurore. *Devolli* River: D.1 - Gramsh; D.2 - Gostime bridge (Cerrik); D.3 - Kucovë. *Shkumbini* River: S.1 - Librazhd; S.2 - Paper bridge (Elbasan); S.3 - Peqini bridge (Peqin).

3. RESULTS AND DISCUSSION

Results obtained from the study refer to a total number of 4845 (42 families) individuals in Osumi River, 3469 individuals (31 families) in Devolli River and 5991 individuals (34 families) in Shkumbini River. Water quality bio-classification of *Osumi, Devolli* and *Shkumbini* Rivers was carried out based in biological parameter SWRC - Biotic Index. The relation between water quality and the value of the SWRC – Biotic Index is described and documented by McGonigle (2000), S.W.R.C (2007). Values of SWRC – Biotic Index are: (0-3.75) - *Exellent*; (3.76-5.0) - *Good*; (5.10-6.50) - *Fair*; (6.60-10.0) - *Poor*.

SWRC - Biotic Index is calculated for all the sampling stations for the 3 rivers, *Osumi, Devolli* and *Shkumbini* River (Table 2) by the following eq. (1) (SWRC, 2003; McGonigle 2000):

$$[\textit{SWRC - Biotic Index}\,] = \frac{\sum (TV)*d}{D} \tag{1}$$

where TV is given tolerance values for all the families found during our study (McGonigle 2000), *d* is the density of each family and *D*, the total amount of densities. Bio-classification was based on the data of Tables 1 and 2, where are presented Biotic Index Parameter, Stroud Water Research Centre, of organic water pollution and its quality for all the sampling stations of *Osumi, Devolli* and *Shkumbin* Rivers.

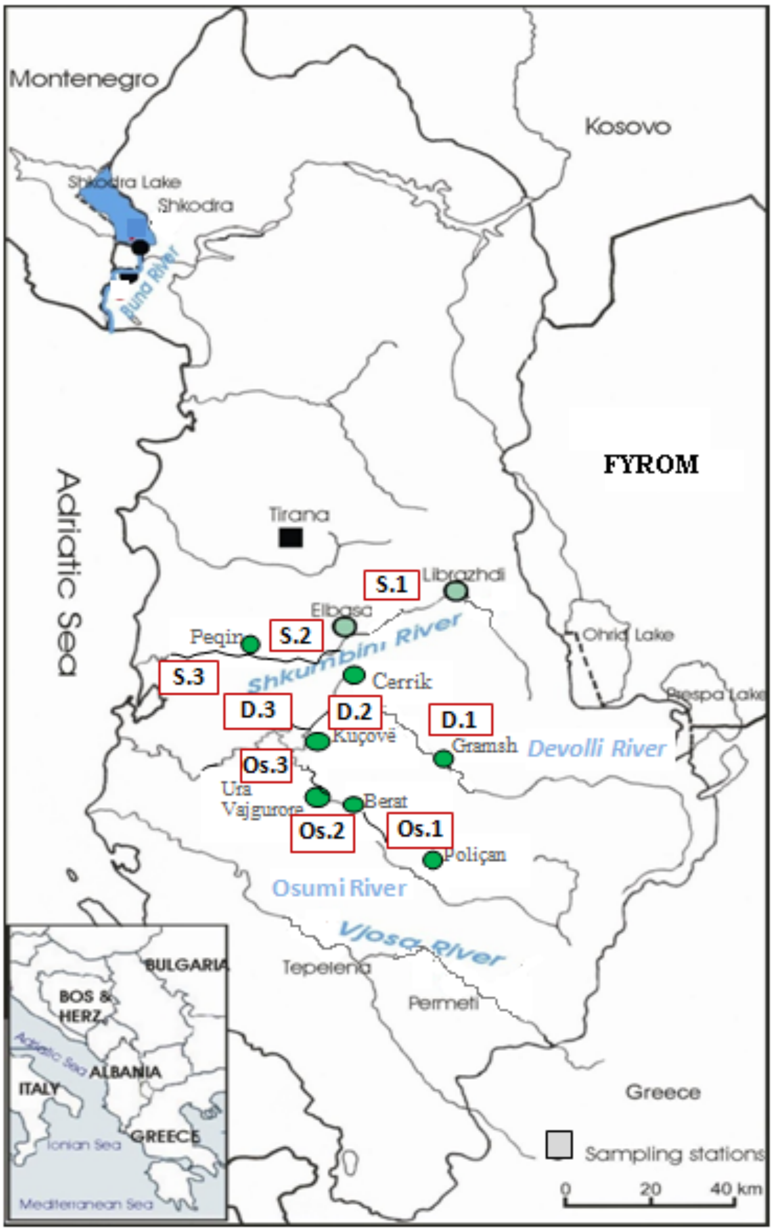

Figure 1. The stations and their codes: Osumi River, Os.1 - Poliçan; Os.2 - Gorica bridge (Berat); Os.3 - Ura Vajgurore. Devolli River, D.1 - Gramsh; D.2- Gostime bridge (Cerrik); D.3 - Kucovë. Shkumbini River, S.1 - Librazhd; S.2 - Paper bridge (Elbasan); S.3 - Peqini bridge (Peqin).

Herewith we are giving water quality bio-classification of each river, based on S.W.R.C - Biotic Index:

Table 1. Bioclassification of water quality of Osumi, Devolli and Shkumbini River according to the SWRC - Biotic Index

River	Station	Session	Summer 2011	Autumn 2011	Winter 2011	Spring 2012	Summer 2012	Autumn 2012	Winter 2012	Spring 2013
Osumi river	St. 1	SWRC- Index	4.31	5.39	4.20	4.61	4.37	4.26	4.23	4.15
		Bio-classification	*(good)*	*(fair)*	*(good)*	*(good)*	*(good)*	*(good)*	*(good)*	*(good)*
	St. 2	SWRC- Index	4.77	5.52	3.85	4.12	4.76	4.04	4.03	4.07
		Bio- classification	*(good)*	*(fair)*	*(good)*	*(good)*	*(good)*	*(good)*	*(good)*	*(good)*
	St .3	SWRC- Index	5.57	5.15	3.85	3.99	5.42	5.29	5.09	4.91
		Bio- classification	*(fair)*	*(fair)*	*(good)*	*(good)*	*(fair)*	*(fair)*	*(fair)*	*(good)*
Devolli river	St. 1	SWRC- Index	5.0	5.76	4.57	4.50	4.92	4.61	4.25	4.32
		Bio-classification	*(good)*	*(fair)*	*(good)*	*(good)*	*(good)*	*(good)*	*(good)*	*(good)*
	St. 2	SWRC- Index	4.90	5.56	4.74	4.73	4.82	4.69	4.72	4.45
		Bio-classification	*(good)*	*(fair)*	*(good)*	*(good)*	*(good)*	*(good)*	*(good)*	*(good)*
	St. 3	SWRC- Index	5.25	4.68	4.27	4.70	5.32	4.44	3.96	4.16
		Bio-classification	*(fair)*	*(good)*	*(good)*	*(good)*	*(fair)*	*(good)*	*(good)*	*(good)*
Shkumbini river	St. 1	SWRC- Index	4.37	5.18	4.22	4.85	4.31	5.0	4.98	4.84
		Bio classification	*(good)*	*(fair)*	*(good)*	*(good)*	*(good)*	*(good)*	*(good)*	*(good)*
	St. 2	SWRC- Index	5.95	5.50	4.58	5.26	5.88	5.55	5.28	5.44
		Bio classification	(fair)	*(fair)*	*(good)*	*(fair)*	*(fair)*	*(fair)*	*(fair)*	*(fair)*
	St. 3	SWRC- Index	4.91	5.50	3.78	4.71	4.88	4.35	4.59	4.36
		Bio classification	*(good)*	*(fair)*	*(good)*	*(good)*	*(good)*	*(good)*	*(good)*	*(good)*

Table 2. S.W.R.C. - Biotic Index calculated for all the sampling stations on Spring, 2013

Spring 2013			Osumi River						Devolli River						Shkumbini River					
		TV	St. 1	St. 2	St. 3	St. 1	St. 2	St. 3	St. 1	St. 2	St. 3	St. 1	St. 2	St. 3	St. 1	St. 2	St. 3	St. 1	St. 2	St. 3
Nr	**Taxon**		**D**			**TV*D**			**D**			**TV*D**			**D**			**TV*D**		
1	Ephemeroptera	**3.6**	205	87	79	738	313.2	284.4	54	41	19	194.4	147.6	68.4	60	97	92	216	349.2	331.2
	Plecoptera	**1**	12		6	12	0	6	2	1		2	1	0	2	1	13	2	1	13
3	Trich/ Hydropsychidae	**5**	175	28	31	875	140	155	34	56	7	170	280	35	18	5	85	90	25	425
4	Trichoptera (others)	**2.8**	4		1	11.2	0	2.8				0	0	0	1	0	0	2.8	0	0
5	Odonata/ Anisoptera	**4**			1	0	0	4	0	0	1	0	0	4	0	0	1	0	0	4
6	Odonata/ Zigoptera	**7**				0	0	0				0	0	0				0	0	0
7	Megaloptera/ Corydalidae	**3**				0	0	0				0	0	0				0	0	0
8	Megaloptera/ Sialidae	**4**				0	0	0				0	0	0				0	0	0
9	Diptera					0	0	0				0	0	0				0	0	0
10	Diptera/ Athericidae	**2**				0	0	0				0	0	0				0	0	0
11	Diptera/ Chironomidae	**6**	2	2	87	12	12	522	5	2	1	30	12	6	55	262	21	330	1572	126
12	Diptera/ Simliidae	**6**		2		0	12	0	2	3	1	12	18	6				0	0	0
13	Diptera / Tipulidae	**3**				0	0	0				0	0	0	2	0	0	6	0	0
14	Diptera (others)	**6**	1	4	27	6	24	162	6	0	0	36	0	0	18	70	15	108	420	90
15	Coleoptera	**4.6**				0	0	0	0	1	3	0	4.6	13.8	0	5	0	0	23	0
16	Oligochaeta	**8**			1	0	0	8				0	0	0	0	1	0	0	8	0
17	Hirudinea	**8**				0	0	0				0	0	0				0	0	0
18	Gastropoda	**8**				0	0	0				0	0	0				0	0	0
19	Amphipoda	**6**				0	0	0				0	0	0				0	0	0
20	Isopoda	**8**				0	0	0				0	0	0				0	0	0
21	Decapoda	**5**				0	0	0				0	0	0				0	0	0
22	Turbellaria	**8**				0	0	0				0	0	0				0	0	0
Total			**399**	**123**	**233**	**1654**	**501.2**	**1144**	**103**	**104**	**32**	**444.4**	**463.2**	**133.2**	**156**	**441**	**227**	**754.8**	**2398**	**989.2**
SWRC - Biotic Index = [Σ (TV*d)]: D						**4.15**	**4.07**	**4.91**				**4.32**	**4.45**	**4.16**				**4.84**	**5.44**	**4.36**

3.1 Osumi River

Based on the results of SWRC-Biotic Index shown on Table 1 the water quality in the first station (Poliçan - Os.1) and the second station (Berat - Os.2) of the *Osumi* River where most of sampling too place, is "*Good"* as the index is within (3.75 – 5.00). While in the third station (Ura Vajgurore - Os.3), bio classification of water quality is "*Fair"* the index is within (5.10 - 6.50) throughout five sampling sessions. The worst water quality in the third station (Ura Vajgurore - Os.3), is during the summer and the autumn (2011, 2012). This station is located in downstream part of the *Osumi* River nearby the urban area, thus it's affected continuously by the presence of non pointed resources of organic pollution.

3.2 Devolli River

The results of Table 1 based on SWRC-Biotic Index for *Devolli* River show a better water quality in the two first stations (Gramsh – D.1 and Gostima bridge/Cerrik – D.2). The water quality is remaining in the bio-classification class "*Good*" with the index of (3.75 – 5.00), during the study period except the session of autumn 2011, where the water quality on those stations belong to the bio-classification class "*Fair"with index of* (5.10 - 6.50). Meanwhile in the third station of this river (Kuçovë - D.3) the bio-classification of water quality shows alternation values between "*Fair"* in summer and "*Good"* in all other sessions, due to the summer income of waste. Based on the values of the biotic index it is obvious shown a tendency of water quality improving in the last period of this study.

3.3 Shkumbini River

Based on the S.W.R.C - Index values (Table 1) in the first and third monitoring station (Librazhd – S.1, Peqin – S.3) of *Shkumbini* River the water quality for all sampling sessions was "*Good*" (3.75-5.00). Only during autumn 2011 the water quality was "Fair" (5.10 - 6.50).

The second station (Elbasan – S.2) shows considerable differences in its bio-classification values compared to the station S.1 (Librazhd) and station S.3 (Peqin). The water quality of the station (S.2 -Elbasan) during all the study period except winter 2011, belongs to the bio- class "*Fair*". The station (S.2-Elbasan) is impacted directly by pollution of sewage and other discharges from the industrial area (Miho et al., 2005).

Based on the results of this study, the first station (Librazhd S.1) and the third station (Peqin S.3) show a better water quality with a slight impact, while station (Elbasan S.2) shows poorer water quality with a moderate impact.

3. CONCLUSIONS

This study presents biological monitoring data based on macro-invertebrate compositions collected during the summer of 2011 through the spring of 2013 from three principal Rivers of the South Central Albania (*Osumi*, *Devolli* and *Shkumbini*). Data analyzing shows that only the second station of *Shkumbini* River (S.2 -Elbasan) and third station of *Osumi* River (Os.3 - Ura Vajgurore) have a moderate pollution impact. This situation can be explained with the position of both stations in the downstream part of the rivers, nearby urban and industrial areas where the level of point and nonpoint organic pollution is higher. All other stations analyzed on those rivers during this period represent a bio-classification of "*Good",* indicating a slight impact in water quality. Differences between values of bio-indexes in different periods of the year can be explained by the presence of changes in sensitive macro-invertebrate populations and level of flow. Those changes are reflected directly in the water quality.

Based on the values of S.W.R.C. – Biotic Index calculated on this study, we can say that for the three Albanian rivers the situation of water quality is still good with a slight impact.

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