Macro Invertebrates as Indicators of Anthropogenic Pollution of the River Mirusha in Kosovo

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Abstract: *The sensitivity of macro invertebrates to changes in environmental quality made them an integral part of any bio-monitoring program. In our research macro invertebrates were used to evaluate the anthropogenic pollution in the river Mirusha. The samples were collected during January to April 2015 in three locations along the river.Based on the values of physic-chemical parameters, total taxa number, Hilsenhoff Biotic index (HBI) and Shannon Winner diversity index (H), the water of the river is fair to fairly poor quality as a result of disturbances caused by anthropogenic activities.*

Keyëords: *Macro invertebrates, anthropogenic pollution, Mirusha, disturbance*

1. Introduction

Today, water pollution has become a very serious problem, and it includes the chemical, physical and biological components of waters. As the main sources of water pollution in Kosovo in the recent years are waste waters, agriculture and industrial activities which discharges directly into the water collection channels and go into the rivers. Animals, starting from the simplest (invertebrates) and to those with more complex body structure, can be used in bio-monitoring programs. Benthic macro-invertebrates, are doubtless the most frequently used organisms for bioindication in standard water management (De Pauw*et al*., 1992; Rosenberg and Resh, 1993; Metcalfe- Smith, 1994; Hering*et al*., 2004).Evaluating the abundance and diversity of benthic macroinvertebrates in a waterbody gives us an indication of the biological condition of that waterbody.

Macro-invertebrates react against the physical and chemical changes of the environment, therefore, their composition should represent different events which took place in the water during every phase of their development (Cairns and Pratt, 1993). Water pollution affects the biodiversity of water environment, thus the species composition changes from natural to tolerant species against different pollutants. The use of macro-invertebrates in biological evaluation of water bodies have some advantages such as: they can be found in most aquatic habitats, they are sensitive to changes of physical and chemical conditions of the water, they are the food source for many species of fish, they have limited mobility, so they cannot escape pollution events,they are small, they are easy to collect and identify.

Considering the requirements of the EU WFD, the composition and abundance of macroinvertebrate fauna, apart from aquatic flora or fish fauna, constitutes one of the quality elements for the classification of the ecological status of streams (WFD, 2000).

River Mirusha is the left tributary of the Drini I Bardhë basin. It is one of the most beautiful rivers in Kosovo.Due to hydrological, geomorphologic and landscape importance, in 1983 this river has been put under protection by the National authorities as a third category monument according to IUCN.

Mirusha derives in the mountains of Carraleva, it has a length of 37 km, and flows in an altitude from 795-360 meters. The average flow is 1.2 m^3/s, while the average water level is 0.65 cm. The river covers an area of 336.7 km^2, around 3.1% of the total land area of Kosovo

In its middle and down stream, river Mirush acreates a canyon around 2 km long, where 16 lakes of different shapes and sizes have been created, connected to each other with 12 spectacular waterfalls. Due to the canyon beauty, the waterfalls of Mirusha attract many tourists, affecting positively in the development of tourisms in this area,unfortunately this resulted with increased anthropogenic impact and disturbance in the river.

2. Materials and Methods

2.1. Study area

Samples of macro invertebrates were collected in three localities (table 1.) along the river with different antropogenic impact.

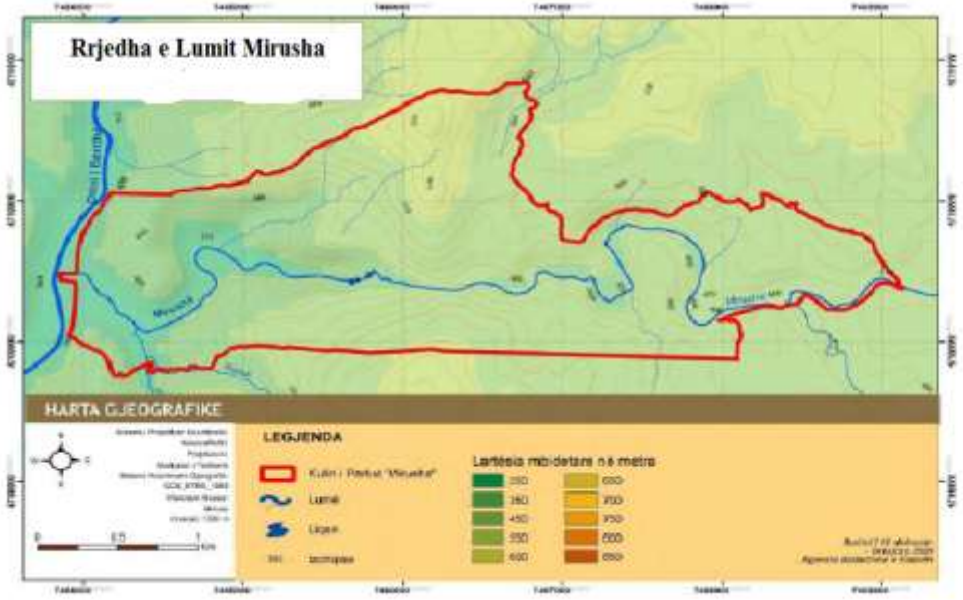

Fig. 1. River Mirusha Flow

The first sampling locality of macro invertebrates is in the upstream in the river spring, where a branch of thermal water deriving from the therme of Banja e Malisheves joins the river. The substrate of the river consists of stone, grit and silt.

The second sampling locality was in the center of the town of Malisheva. It this locality the untreated waste waters from the municipality as well as used waters from the hospitality and other economic operators discharge directly into the river.

It should be mentioned that the river bed in this area is cemented as an action of municipal authorities to maintain it.

TABLE I. Macro invertebrate sampling localities

Locality	X	Y	Altitude
L1- Banja e Malisheves(upstream of the river)	42°28'4.52"N	20°46'3.42"E	538m
L2-Malisheva (middle stream)	42°29'7.87"N	20°43'59.13"E	521m
L3-Mirusha waterfalls-downstream	42°31'24.80"N	20°34'55.84"E	428m

The third sampling locality was at the first waterfall in the park of Mirusha. The width of this locality is about 5.50-10m, while the altitude is 428m. The substrate of the river is composed from stones, gravel and silt but also from the garbage deposited by the visitors of this monument and from two improvised restaurants operating in this area. The depth of the river is different from place to place and it goes up to 90.5cm. In both sides of the river, the vegetation is quite developed, composed of grass, bushes and woods dominated by willow.

Macroinvertebrates were collected with a net, depending on the river depth and substrate structure, the Surber's net and D frame net with 500 µm mesh size have been used. In each sampling locality multihabitat sampling technique was used (Hering, 2004). Samples were preserved in 75% alcohol and transported to the laboratory of Zoology at the Department of Biology of the University of Prishtina. In the laboratory the macroinvertebrate samples were sorted and identified to the taxonomic level with the help of binocular stereomicroscope and adequate keys. (Tachet at al.,2010; Merritt and Cummins,1984)

Parallel to biological sampling, the measurement of physical and chemical parameters of water was done. In order to assess the pollution from the anthropogenic impact, we have calculated the total number of taxa as well as two indexes: Hilsenhoff Biotic Index -BI (Bode et al. 1988; Hilsenhoff, 1997), which is used to measure the organic pollution and is based on the tolerance value of taxons against the oxygen level in the water, and the Shannon-Wiener diversity index -H, which represents the diversity of the species in a sample.

3. Results

Values of the physical and chemical parameters have been shown below on the Table 2.

TABLE II. The values of physical and chemical parameters in surveyed localities

			January 2015			February 2015			March 2015			April 2015		
Parametri		measure	L1	L2	L2	L1	L2	L3	L1	L2	L3	L1	L2	L3
Water temperature	Wt	^{0}C	18	8.5	6.5	19.2	10.3	8.5	20	11	8	24.5	15.5	13.2
Total suspended matter	TSM	mg/l	251	239	206	271	298	200	319	312	290	332	318	298
pH	pH	0-14	7.21	7.99	7.61	7.29	8.32	7.46	7.22	8.52	8.04	7.15	8.63	8.11
ParametratKimik														
Dissolved oxygen	DO	mg/l	8.50	7.10	9.80	8.90	6.60	10.50	9.00	6.50	8.70	8.90	6.30	9.48
Oxygen Saturity	OS	%	89.76	60.68	79.74	96.32	58.88	89.74	99.01	58.93	88.60	99.70	65.80	94.42
Total suspended matter	TSM	mg/l	0.30	22.50	8.90	0.80	19.80	11.9	<0.1	55.20	35.50	<0.1	26.70	15.30
Chemical Oxygen Demand	COD	mg/l	1.80	28.60	10.50	3.10	80.00	44.50	7.30	77.60	49.50	8.70	40.40	12.00
Biochemical Oxygen Demand	BOD	mg/l	0.95	15.12	5.55	1.89	37.00	23.53	4.10	1.89	12.30	4.60	17.80	5.70
Detergents	DET	mg/l	<0.1	0.10	<0.1	<0.1	0.20	0.10	<0.1	0.40	0.15	<0.1	0.30	0.10
Nitrites	NI_3^-	mg/l	5.80	6.20	5.20	6.20	14.10	7.30	4.80	8.60	6.30	5.40	5.40	4.50
Chlorides	Cl^-	mg/l	11.60	15.80	13.80	10.90	20.60	14.40	12.80	19.60	16.20	13.50	21.40	16.60

Phosphates	PO_4^{3-}	mg/l	0.02	0.32	0.12	0.02	0.98	0.13	0.04	0.34	0.26	0.16	0.43	0.28
Total phosphorus	P_{tot}	mg/l	0.06	0.91	0.33	0.09	2.56	1.29	0.22	2.28	1.47	0.30	1.27	0.43
Sulphates	SO_4^{2-}	mg/l	4.45	9.12	7.23	4.87	9.99	7.35	5.15	18.60	13.08	5.37	11.35	9.22
ammonia	NH_4^+	mg/l	0.005	0.098	0.056	0.005	0.397	0.128	0.009	0.389	0.141	0.006	0.212	0.086

TABLE III: The macro invertebrate composition in the river Mirusha

	Taxonomic category			Localities		
Nr.	Order	Family	Species	L1	L2	L3
1	Trichoptera	Hydropsychidae	Hydropsyche instabilis	+	+	+
2		Hydropsychidae	Hydropsych eannguistipenis	-	+	-
3		Rhyacophilidae	Rhyacophila fasciata	-		+
4	Ephemeroptera	Baetidae	Baetis muticus	-	+	+
5		Baetidae	Centroptilum luteolum	-	-	+
6		Ephemerellidae	Ephemerellaignita	-	+	+
7		Heptagenidae	Heptageniasulphurea	+	-	+
8	Plecoptera	Perlodidae	Isoperla gramatica	-	-	+
9	Odonata	Calopterygidae	Calpoteryx splendens	-	+	-
10		Gomphidae	Orychogomphus forcipatus	-	+	+
11		Libellulidae	Libellula depressa	-	+	+
12	Diptera	Simulidae	Simulium sp.	-	+	+
13		Tipulidae	Tipula sp.	-	+	+
14		Tipulidae	Dicranota sp.	-	-	+
15		Tabanidae	Tabanus sp.	-	-	+
16	Oligochaeta			-	-	+
17	Amhipoda	Gamaridae	Gammarus roeseli	+	-	-
18	Amhipoda	Gamaridae	Gammarus fossarum	-	+	+
19	Isopoda	Asellidae	Asellus aquaticus	+	-	-
20	Gastropoda	Physidae	Physa acuta	+	-	-
21	Gastropoda	Lymnaeidae	Lymnea peregna	+	-	
22	Hirudinea	Erpobdellidae	Erpobdella octoculata	-	+	+
23	Hirudinea	Hirudinidae	Haemopis sanguisuga	-	+	+
	Species number			6	12	17

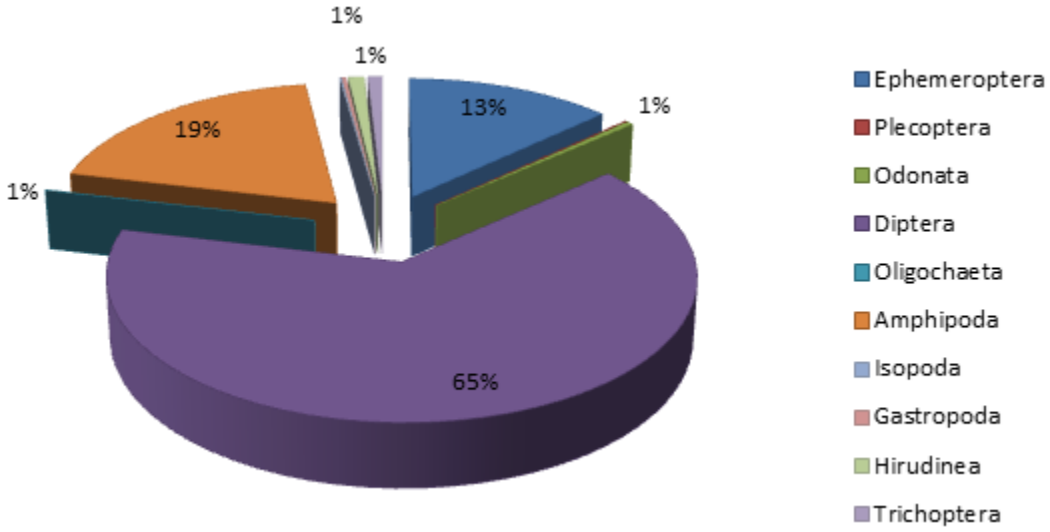

Fig 2. Pariticipation of animal groups in macroinvertebrate samples

TABLE IV.Hilsenhoff biotic index (HBI) in three surveyed localities

Localities	*HBI*	*Water quality*
L1	5.58	Fair
L2	5.80	Fairly poor
L3	5.89	Fairly poor

TABLE V. Shannon- Wiener Diversity Index (H) in the surveyed localities

	L1-Banja e Malisheves	***L2-Malishevo***	***L3-Mirusha waterfalls***
Nr of taxa	***6***	***12***	***17***
Nr of specimen/individuals	***557***	***1267***	***1393***
Shannon Wiener-diversity index -H	***0.06***	***1.11***	***0.88***

During our research 3217 macro invertebrate organisms were collected, belonging to 18 families and to 10 taxonomic groups. Insect orders Ephemeroptera, Odonata and Diptera are the richest and have been represented by three families each, while the other groups such as Gastropods, Hirudinea and Trichoptera by two families each. Groups such as Plecoptera, Oligochaetes, Amphipoda and Isopoda were represented by only one family. Regarding the number of taxons in localities, from table 2, it can be seen that the first locality, Banja e Malisheves, is poorer with spices, only six, while on the second locality the number of spices increases in 12, to continue with the third one with 17 species. In the first locality, representatives of Amphipoda dominated with a single species Grammarus roeseli, which was quite representative in numbers. In this locality tolerant spices are dominant with about 82%

In the second locality in the middle flow of the river in Malisheva town, the river bed is cemented and represents a highly modified environment for the water organisms. However, in this locality a highly rich bental fauna used to be present. In this part of the river the order Diptera dominated with highly abundant Simulium sp., followed by Ephemeroptera comprised with three species, among which Baetis muticus dominated, while the number of other species was smaller. In the third locality the diversity of taxonomic groups increased and again order Diptera comprised 83% of macroinvertebrate sample, represented only by Simulium sp. with 1153 individuals. In this locality semi-tolerant species have dominated by about 97%. With regards to values of Biotic index– BI, they variate from 5.58 in L1, 5.80 in L2 and 5.89 in L3.The Shannon- Wiener Diversity Index (H), is very low in L1, only 0.06, in L2 increases to 1.11, to decrease again in L3 to 0.88.

4. Discussions

The values of Hilsenhoff biotic index (BI) and the values of the Shannon- Wiener Diversity Index H, suggest a deterioration of waters of MirushaRiver with organic pollution. According to the Biotic Index, the water in the first locality in Banja e Malisheva is of a fair quality, while regarding the two other localities belonging to the middle and downstream of the river, the quality of water is even worse. The diversity index in the first locality is very low and indicates a poor fauna. This can be justified by the fact that in this locality the river is joined by the thermal water source, which highly increases the temperature of water, reaching the values of 19.5-24° C, which is not favorable forthe most sensitive benthic organisms, and particularly can affect the trophic structures of ecosystem.

The situation improves in L2 and L3, expressed as the registered number of families (11-15) which is connected to the stability of the environment (Wynes and Wissing, 1981). During this research, a

decreasing number of macroinvertebrate families along the downstream of the river Mirusha is registered, which suggest the presence of environmental pressure.

The evidenced change of the macro invertebrate's structure does not only suggest the presence of pollution, but also the change of the water flow types.The change of type, position and structure of the river bed corresponds with the changes in the structure of macro invertebrates, therefore, the third locality is characterized by the presence of Ephemeroptera, Diptera, Trichoptera, etc, and other groups which are typical for the middle and downstreams. This state of the Mirusha river is quite similar to the middle and downstreams of other rivers in Kosovo (Gashi, 2006, Zhushi – Etemi 2005, Grapci 2002), as a result of anthropogenic pollution from discharges of untrated waste waters as well as from agriculture, industry and other activities.

5. Conclusions

Based on the findings of this research, we consider that the benthic macroinvertebrate community of the Mirusha river is poor and reflects the level of pollution of the river. The findings also suggest the endangerement of the benthic fauna of the Mirusha river, which is a continuous threat from the anthropogenic factor. In the future, measures need to be taken in favor of protection of this river with special values not only to the area of Mirusha, but also to the entire territory of Kosovo, by applying different methods of monitoring aming to prevent various forms of anthropogenic pollution.

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