RESEARCH ARTICLE **(Open Access)**

Assessment of the Water Quality from the Sitnica River as a Result of Urban Discharges

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Abstract

According to the Ministry of Environment and Spatial Planning, Kosovo is facing problems related not only to the limited amount of water, but also when it comes to its quality, as a result of discharge of contaminated wastewater into the surface and groundwater, without any prior treatment. The longest river (90km) and at the same time the most polluted river in Kosovo is the Sitnica River. All the wastewater from the towns and villages washed by this river during its entire watercourse from its source until its mouth into the Ibar River is discharged into this river.

In order to have a more accurate overview of the impact of urban discharge into the quality of the Sitnica River water and to assess the impact of the pollutants discharged into this river, we conducted a research at five monitoring stations: the first station representing a reference station not being subjected (untouched) to anthropogenic pollution pressure while the other four represent monitoring stations situated at water area affected by this discharge of urban wastewater. The purpose of this study is to assess the quality of the Sitnica River water and to analyze the pollution scale level throughout its course caused by urban discharge.

Some of the parameters of the water qualityanalyzed are: temperature, turbidity, electrical conductivity, pH, DO, COD, BOD, P total, nitrates, detergents and ammonium ions.Analysis of the physical – chemical parameters of the water quality was conducted at the laboratory of the Hydro-meteorological Institute of Kosovo. Based on experimental results, various readings of the majority of the studied parameters were obtained at different stations with a tendency of deteriorated quality of water with the growing distance from the source of the Sitnica River, as a result of continuous impact of pollution. From our findings we can conclude that continuous discharge of urban wastewater has a considerable impact on the quality of the Sitnica River water.

Keywords: assessment, urban discharge, pollution, parameters, Sitnica River.

1. Introduction

Water quality, resulting badly, is a threat to the ecosystem itself and for human health. This is a particularly serious problem and displays a great interest for solutions to developing countries, where environmental management practices cannot ensure compliance with the economic development [2] [3] .

In the recent decades, the quality of the running river water has deteriorated in our country due to continuous discharge of urban, agricultural and industrial wastewater. All these discharges of wastewater pose indeed a threat to the water quality and they are considered as constant (permanent) threats to the human health.

Such serious problems related to amount of water as well as its quality in Kosovo appear as a result of all the wastewater ending up into the surface and groundwater as well as discharge of the contaminated wastewater into the recipient river without any prior treatment, resulting in significant decrease of the water quality, contributing thus to the alarming situation on the ground. Kosovo has limited resources of water, both surface and underground water, hence its protection and rational use is of vital importance for a sustainable economic growth of the country [6].

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(Accepted for publication on September 20, 2015)
***ISSN**: 2218-2020,*

The Sitnica River, starting from Ferizaj through Mitrovica, is the most polluted river in Kosovo. Deposits are present in it and their amounts exceed the maximal permissible values. This occurs as a result of the following tributaries flowing into this river: a part of the Nerodime River along with the rivers of Shtime, Graqanka, Prishtina, Drenica, Llapi and Trepça. In addition to these, other smaller streams end up in the Sitnica River carrying with themselves discharge of both urban and industrial wastewater [5].

Historically, Sitnica River has been surrounded by many residential areas and has been an important factor of regional development. Until recently, this river's water was an important source for the neighboring settlements and was used for different purposes, such as water supply, irrigation, fishing, and recreation. In recent times, the Sitnica River has been converted into a natural recipient of wastewaters, like those coming from Kosovo power plants in Obiliq, waters from bigger and smaller central urban sewage systems and those which have increased the contamination of the water due to waste water discharges [1].

In other words, the biggest impact comes as a result of anthropogenic activities, such as urban discharge and pollutants of the wastewater as well as agriculture infiltrations, discharges from the light industries, which carry out their activity along these water basins [4].

Taking into account urban discharge into this river from many towns and villages washed by this river, which still lack wastewater treatment plants of their own, the purpose of this study is to assess the impact of urban discharge on the water quality from the Sitnica River via monitoring and analyzing some of the water quality parameters, indicating the scale of the water pollution as well as the current water quality of this river.

To achieve the research objectives, water samples were taken at five monitoring stations along the flow of the Sitnica River and physical and chemical parameters have been analysed at the Hydrometeorology Laboratory of Kosovo.

2. Materials and Methods

The aim of the experimental part of this research was to determine the presence of contaminants caused by urban discharges in the Sitnica River through defining the values of selected parameters for monitoring. The survey was carried out in 2014 in three periods (spring, summer and autumn) in order to see the impact of climate (seasonal) changes while the parameters were analysed in the Laboratory of the Hydro-Meteorological Institute of Kosovo.

Sampling was carried out based on standard ISO 5667-6: 2014 which sets out the principles to be applied to the design of sampling programmes, sampling techniques, and the handling of water samples from rivers and streams for physical and chemical assessment (URL 1). To reflect the impact of urban discharges water quality in the Sitnica River, sampling points included two types of aquatic areas, as follows:

1. water area unaffected by the pressures of anthropogenic pollution (reference station: Devetak).

2. Aquatic areas affected by urbanwastewater discharges (stations: Vojnovc, Small Hallaq, Vragoli and Kuzmin).

The first monitoring station Devetak is located in the spring of the SitnicaRiver, the station Vojnovc and Small Hallaqbelongs to the upstream, while Vragoli and Kuzmin stations are located in the middle flow of the river. Water samples were taken in glassbottle for organic parameters and in polyethylene bottles for inorganic parameters. Sample bottles were labelled including time, date and source of sampling. They were preserved in the refrigerator at 4 °C and transported according to respective procedure.

Some of the parameters were measured directly in the ground (mainly physical parameters). At each sampling point, the following parameters were measured: temperature, electrical conductivity, pH, dissolved oxygen, while chemical analyses were carried out in the analytical laboratory ofHydrometeorological Institute of Kosovo.

Analysis of physical and chemical parameters of water samples taken from the Sitnica River was conducted using the following tools: Multi 340i thermometer – used to measure temperature; turbidity was measured with Turbid meter AQUALITIC / PC COMPACT – ISO 7027 (photometry); electrical conductivity was measured using conduct meter WTW 315i; pH values were measured using the HI 98130 pH meter (DIN 38404 – C5); levels of dissolved oxygen were determined by the HI 9146 – ISO 5814 (Electrochemical); BOD – ISO 5815-2 and COD – ISO 15705; P-total – ISO 15681-2, SO4 2- – ISO 15923, $NO3^-$ ISO 7890/1, $NH4^+$ ISO 7150/1 with SECOMAN PRIM-LIGHT UV–VIS Spectro-photometer. Calibration and evaluation of analytical

methods and estimation of performance characteristics, Part 2: Calibration strategy for non-linear second-order calibration functions – ISO 8466-2.

3. Results and Discussion

Results for the analysed parameters are presented in Table 1 with sampling stations are represented by codes, parameters of monitoring, their measuring units, values recorded in three monitoring periods (spring, summer and autumn) for each analysed parameter. The comparison between the three periods is reflected in the diagrams presented in Figures 1 to 10.

Table1. Results of physical and chemical parameters

Parameters	Units	Devetak (S1)			Vojnovc (S2)			Small Hallaq (S3)			Vragoli (S4)			Kuzmin (S5)		
		Sp	Su	A	Sp	Su	A	Sp	Su	A	Sp	Su	A	Sp	Su	A
Temperature	*˚C*	6.4	14.9	10.2	10.1	20.1	13.2	13	21.9	15.2	12.5	23.5	15.0	14	22.2	16.5
Turbidity	*NTU*	9.5	61	9.2	5.7	31	19.7	5.9	10.9	5.5	9.8	7.5	7.5	64	31	8.2
Conduct.	*µScm-1*	262	280	270	532	530	540	708	540	710	720	670	770	884	770	760
pH	*0 - 14*	7.99	7.85	8.2	7.76	7.30	7.61	7.69	7.31	7.62	7.71	7.32	7.66	7.69	7.48	7.77
Dissol. O_2	*mg/L*	10.51	7.4	9.37	5.73	1.9	4.02	4.01	1.7	2.49	6.18	2.8	3.15	2.81	1.9	3.31
COD	*mg/L*	18	4.2	nd	3.8	28.8	36.2	24.4	48	57.5	27.2	20.6	33.8	60.5	83	106
BOD	*mg/L*	8.5	1.9	<0.1	2	9.2	18.8	11.3	25.2	23.8	12.5	8.4	11.4	29.2	26.2	34.9
P total	*mg/L*	nd	0.05	<0.1	0.31	0.33	0.43	0.71	0.70	0.56	0.70	0.93	0.50	1.16	1.23	0.57
Nitrates	*mg/L*	nd	nd	nd	nd	nd	2.4	1.8	nd	nd	8.0	5.6	9.0	nd	nd	3.5
Ammonium ion	*mg/L*	0.56	0.21	0.09	4.54	6.87	1.44	5.54	10.1	4.82	4.45	10.1	3.26	5.67	21.5	5.58

***Sp**-Spring; **Su**-Summer; **A**- Autumn; nd – below the threshold of detection of used method*

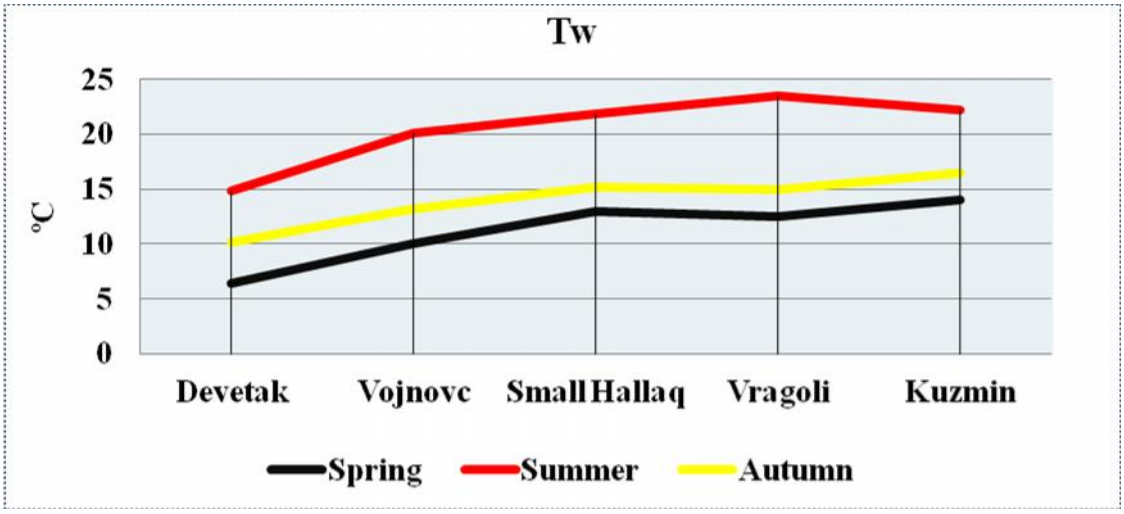

Figure 1. Water temperature according to monitoring stations and seasonal variations

Temperature had variations in three monitoring periods. During spring variations were from 6.4 (S1) to 14 °C (S5), in summer from 14.9 (S1) to 23.5 °C (S4), whereas in autumn it water temperature varied from 10.2 (S1) to 16.5 °C (S5). The biggest change of temperatures was between seasons of spring and summer, while between autumn and summer changes were smaller. The rising of the temperatures was influenced by air temperatures which increase in summer and especially during midday, in addition to that, urban discharges also contributed to the increase of temperatures.

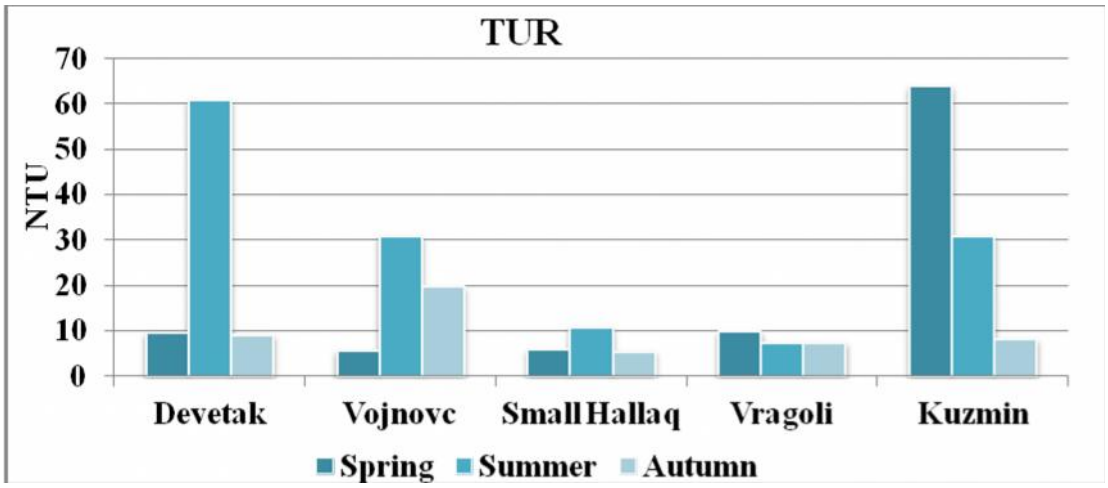

Figure 2. Turbidity for every station and the values by seasonal variation

Turbidity was present throughout the course of the three monitoring periods, the highest valueswere recorded when it had rained shortly before measurements took place, as it happened in the summer season in the sampling point S1 where turbidity reached the value in 61 NTU, while at other stations the turbidity had lower values, because while doing the sampling there was no rain, and turbidity was caused by consecutive polluting pressures, at S3 we have the case of a slight increase which was caused by the Pristina River, known as collector of all wastewaters of the capital Prishtina which permanently has high turbulence (from the data of KHMI – 31 NTU asVMV–2014).

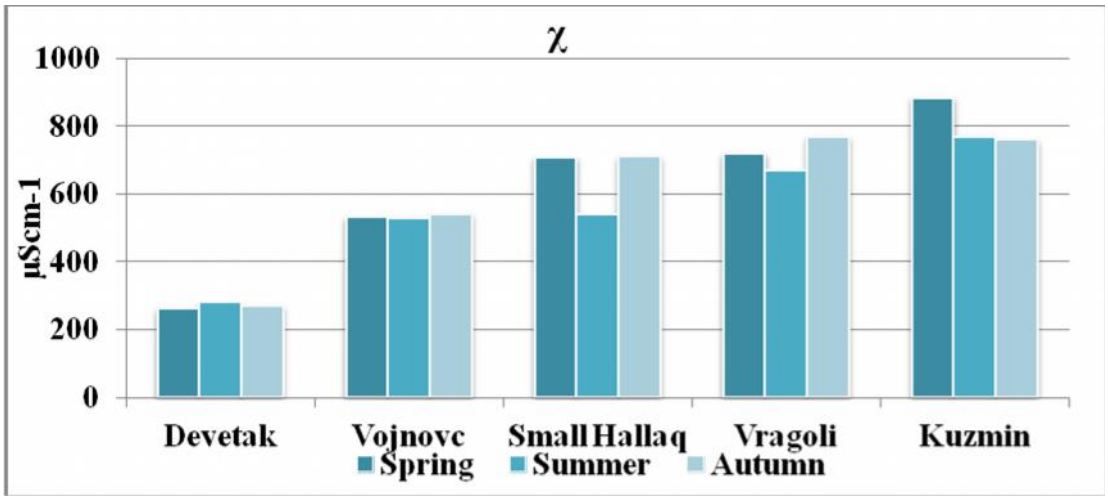

Figure 3. Electrical conductivity according to monitoring stations and seasonal variations

From the presentation of data on Table 1 and Figure 3, it can be seen that the electrical conductivityat sampling site S1 in three cases was lower (below 300 µScm-1) that leads to the conclusion that water had high purity and was without polluting pressures. From the station S2 and on, we may note an increase of electrical conductivity along the whole river flow down to S5 where the maximum value reached (831 µScm-1).

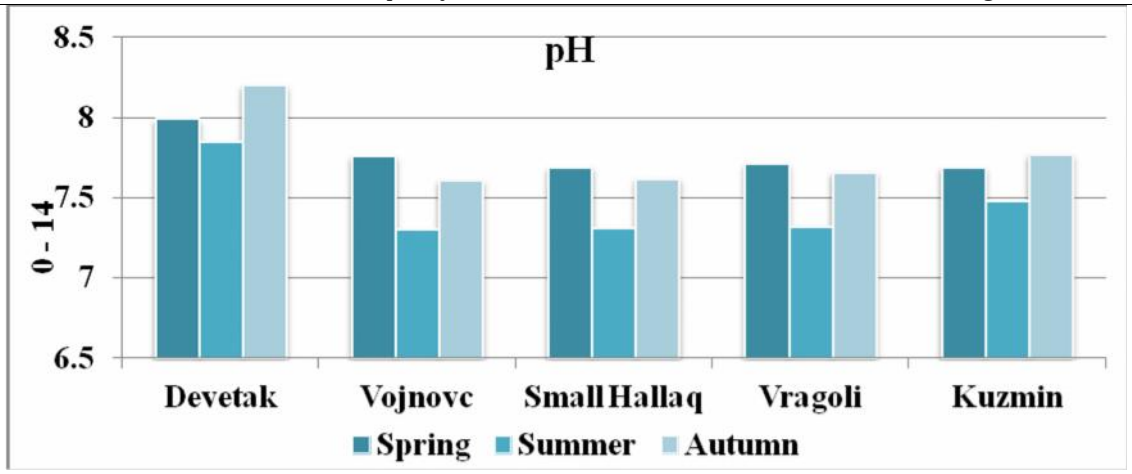

Figure 4. pH according to monitoring stations and seasonal variations

In the water samples that we analyzed, the pHfigures recorded do not present a high variability, not more than 1 measurement unit. All pH values are noted to be higher than 7, they range from 7.69-7.99 during the spring season, 7.30-7.85during the summer and 7.61-8.2 in autumn, slightly alkaline and are generally stable in the region of stable values for all seasons.

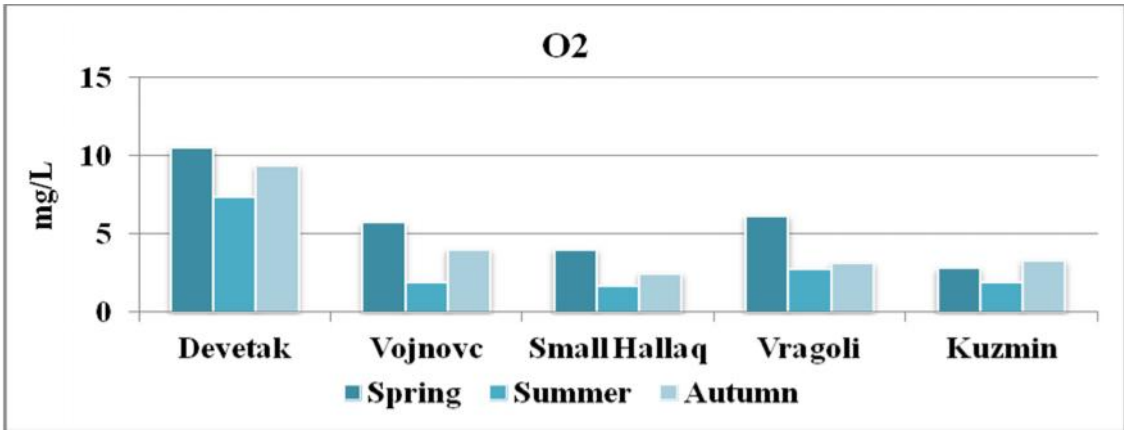

Figure 5. O_2 according to monitoring stations and seasonal variations

Our measurements showed that the values of dissolved oxygen in the monitored stations weredifferent. Highest values during the three periods were at S1 station (reference station), whereas the lowest from the performed measurements was 2.81 mg/L in S5 in spring, S3 with 1.7 mg/L in summer and in S3 with 2.49 mg/L in autumn. It is clear from the diagram that at all stations the quantity of DO is very small and especially during the summer season was significantly lower which confirms the impact of temperature on this parameter.

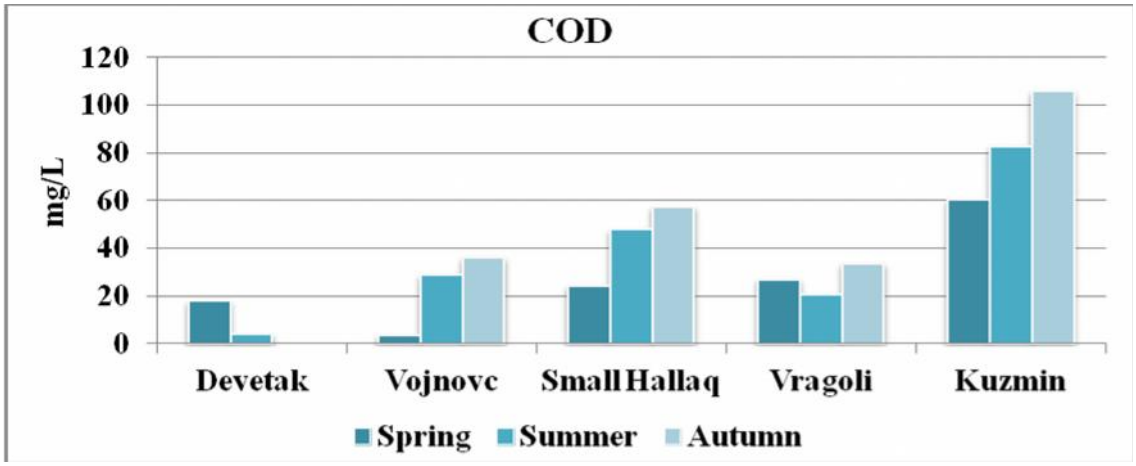

Figure 6. The performance of the values of COD for each station according to seasonal variations

Chemical oxygen demand values during the spring vary from 3.8 (S2) to 60.5 (S5) mg/L, insummer from 4.2 (S1) to 93.0 (S5) mg/L, while during autumn they vary from 0.1 (S1) to 106 (S5) mg/L. This leads to the conclusion that during all the seasons the Sitnica River is subjected to all pollution types from organic materials in considerable amount where the values are above 100 mg/L.

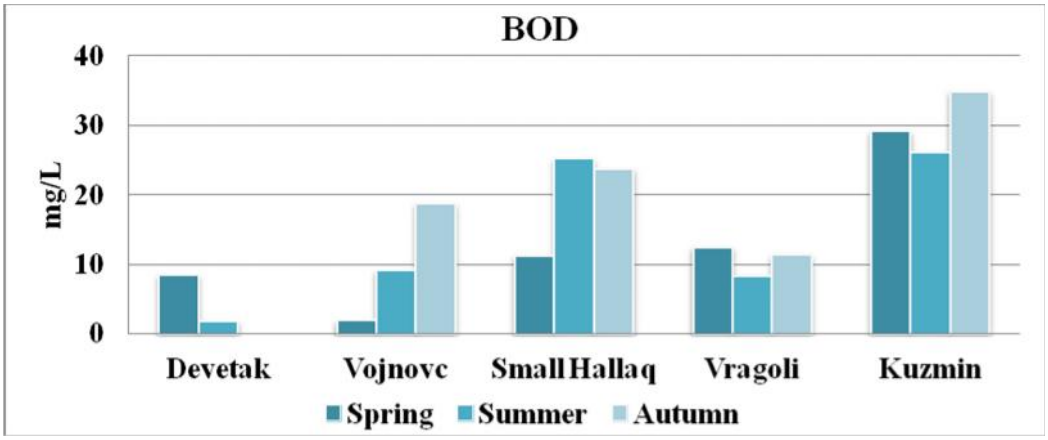

Figure 7. The performance of the values of BOD for each station according to seasonal variations

In the analysed water samples of the SitnicaRiver, the values of bio–chemical oxygen demand during spring varied from 2 (S2) to 29.2 (S5)mg/L, in summer from 1.9 (S1) to 26.2 (S5) mg/L and during monitoring in autumn to 34.9(S5) mg/L. So it is noted that the quantities were considerably higher during summer and autumn because the river's volume was smaller, while the impact of discharge of water in terms of pollution is higher.

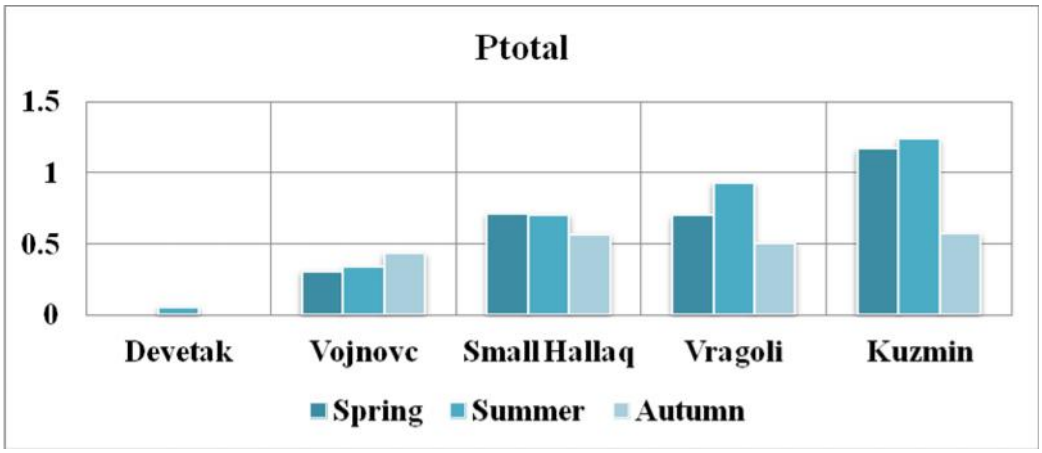

Figure 8. Total phosphorus (mg/l) according to sampling stations and seasonal variations

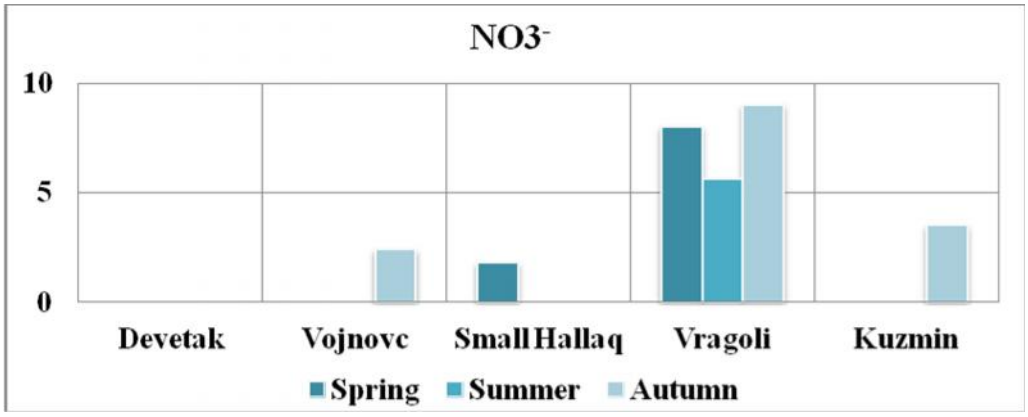

Figure 9. Concentration of nitrates (mg/l) for each station and seasonal variation

Lowest values of total phosphorus during three periods were recorded in S1, while its highest values were recorded in spring 1.168 mg/L in S(5) station, in summer 1.238 (S5) mg/L and in autumn with 0.572 mg/L (S5).

Highest values of nitrates during the three monitoring periods were recorded in thestation S4, in spring with 8 mg/L, in summer with 5.6 mg/L and higher in autumn with 9 mg/L. The lowest values of nitrates during three periods were recorded in S1 that had values below the threshold of detection of analytical method referred to above. We think that the nitrates in the water of rivers are mainly of urban origin.

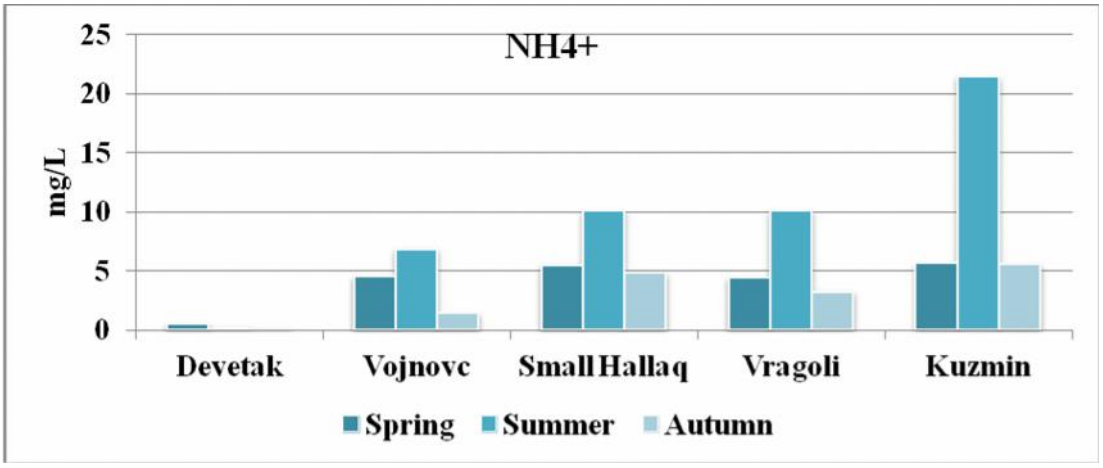

Figure 10. The performance of ammonium ion values according to seasonal variations

Ammonium ions were present in all three stations and during the three monitoring seasons which according to the findings during analysis shows that a smaller quantity was in S1 – 0.097 mg/L and higher quantities in S – 21.5 mg/L.

4. Conclusions

The study gives a description of the data related to examination and assessment of the impact of the urban discharge on the water quality from the Sitnica River as well as measures that should be taken in order to improve and rehabilitate this water environment.

- Examined physical and chemical parameters of the Sitnica River water have shown that the greater distance between the source of the river (reference point) and the last monitoring station (S5/Kuzmin) the worse quality of water is noted during the three time periods. Therefore, we can conclude that there is a significant pollution of the Sitnica River at these four monitoring stations (Vojnovc, SmaliHallaq, Vragoli and Kuzmin).
- Higher values of the monitored parameters such as: turbidity, electrical conductivity, COD,

BOD, the total phosphorus, detergents and ammonium ions were recorded at the monitoring station S5.

- This can be explained by the fact that the Sitnica River at this segment collects the biggest amount of urban discharge from the towns and villages washed by this river. The main pressure from urban pollution at this station comes from the Prishtina River, which is a collector of the wastewater discharged from the entire city of Pristina as well as from the wastewater discharged from the town of FushëKosovë.
- Constant increase of the water quality parameters with an increase of the distance from the river source confirms the impact of pollution pressure due to the discharge of wastewater from many towns and villages washed by this river. As a result of such impact we also have a reduced amount of dissolved oxygen.
- Results of this study reveal a large scale of pollution of the Sitnica River water. In order to prevent further pollution of water and enhance the water quality in this river, urgent measures are required such as construction of the urban wastewater treatment plants prior to its discharge into this river as well as keeping up with the monitoring of the water quality from the Sitnica River at specific stations of its watercourse.

5. References

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