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HUMAN POLLUTION OF GROUNDWATER IN THE REGION OF BURIMI

Ahmet Tmava[1], **Sabri Avdullahi**[1*], **Islam Fejza**[1],

[1] Faculty of Geosciences and Technology, Str. Parku Industrial, Mitrovic, Republic of Kosovo.

*Corresponding author: sabri.avdullahi@uni-pr.edu

ABSTRACT

Groundwater pollution is a worldwide phenomenon with potentially disastrous consequences. Most of the Earth's liquid freshwater is found, not in lakes and rivers, but is stored underground in aquifers. Indeed, these aquifers provide a valuable base flow supplying water to rivers during periods of no rainfall.

This paper presents a comprehensive study on the quality of surface and groundwater in an environmentally sensitive aquifer watershed strongly pressed by urban growth. The objective of the study was to assess the integrated effects of human activities and natural characteristics of aquifer environments on the quality of surface and groundwater using multivariate statistical techniques. Data from 15 physical and chemical water quality variables obtained throughout a hydrological year were analyzed using principal components analysis (PCA).

The principal components analysis (PCA) was carried out individually for surface water and groundwater. In order to evaluate the impacts of anthropogenic activities on the water quality at the monitoring locations, the analysis was applied to the 22 sampling points. The results suggest the existence of specific contamination sources in many points, in surface water and groundwater, and highlight the natural vulnerability of the aquifer environments.

Keywords: human activities, surface and groundwater, water quality

INTRODUCTION

Globally, water dependent terrestrial ecosystems are receiving increased attention due to growing recognition that water must be available for ever to meet the fast growing urbanization and industrialization (Münch, and Conrad, 2007; Krause, *et al.*, 2007).

In the recent years, there has been an apparent tendency for the quality of groundwater to deteriorate, which has been caused by human contamination. The most intensive contamination occurs on rapidly urbanized areas where the intensive exploitation of groundwater for industrial and domestic purposes takes place, thus contributing to a high downward gradient

Much groundwater is of good quality water because of natural purification processes, and its typically modest treatment requirements make it a valuable source of potable water which can be developed cheaply and easily, if necessary in a piecemeal fashion

Generally, the quality of water is controlled by many factors that include composition of recharge water, geological structure and mineralogy of the watersheds and aquifers as well as the residence time and reactions that take place within the aquifer and anthropogenic factors (Derver, 1988, Fetter, 1994, Appelo 2005).

Water is polluted not only by industries but also by households. Both industries and household wastewater contain chemicals and biological matter that impose high demands on the oxygen present in water. Surface and groundwater have been associated with water quality problems and the practice of discharging untreated domestic and industrial waste into the water course has emerged to an alarming level (Hall, 1984).

The most intensive contamination occurs on rapidly urbanized areas where the intensive exploitation of groundwater for industrial and domestic purposes takes place, thus contributing to a high downward gradient. These conditions may accelerate the migration of contaminants from the land surface to the aquifer (Lawrence et al., 2000; Jeong 2001).

The contamination of groundwater may appear even if the aquifer is overlain by a thick confining layer (Simpkins and Bradbury, 1992).

This is particularly the case in long-term sources of contamination influence, which date back even as far as previous centuries, where contaminants may appear in deep groundwater.

2. MATERIALS AND METHOD

2.1. Study area

The study area is located in the western part of Kosova. The Burimi River is located in Western part of Kosova and belongs to the Drini i Bardhe basin (Avdullahi *et al.*, 2008). Drini i Bardhe basin discharges its water to Albania and finally to the Adriatic Sea (figure 1).

Fig. 1. Study area location

Burimi river sub basin – the total surface of this sub basin is 446,7 km^2 and during the year the average of rainfalls is around 335.2 m^3 10^6. The quantities of rainfalls are changeable depending from the seasons of the year.

The highest quantities of rainfalls are in November $95.0m^3$ 10^6. In river basin average during the year flow around $139.5m^3$ 10^6 of water; the highest quantity is during spring while during August lowest quantity. From the total quantity of rainfalls 195.7 m^3 10^6 or 58.4% isn't included in flow. The highest coefficient of evaporation is in the month of June 68.3% up to March 74%, while the evaporation is smallest from April 18.6% up to July 32.5%. In the Burimi River sub basin the average of rainfalls is around 855 mm per year, from which 317mm flows, while 538mm evaporates (Avdullahi *et al.*, 2007).

2.2. Sample Collection and Data Analysis

In order to investigate the groundwater chemistry of the aquifer, the results of physic-chemical analyses of water sampled from 20 drilled wells and surface water from two rivers Burim and Vrella (figure 2).

Only continuously pumped productive wells were chosen for the analyses, which helped to obtain representative samples. The wells chosen were continuously pumped for at least several hours prior to examination.

3. RESULTS AND DISCUSSION

In Table 1 & 2 are presented results of physical-chemical analyzes obtained during the study of water in wells in the region of Burimi, where most of the limits of indicators in these tables refers to the EU 98/83 directive for drinking water.

In the table 1 & 2 some fields are marked with dark colour (gray) that means exceed values of in water compared with the limit values allowed.

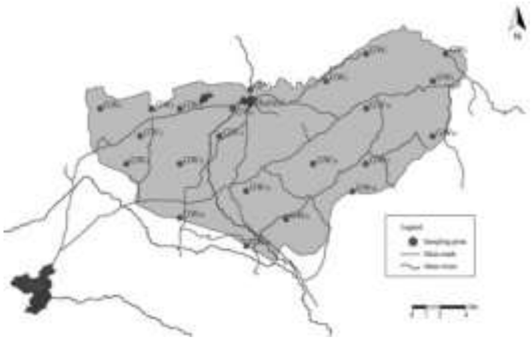

Fig. 2 Locations of the sampling points

Variable	**Unit**	GW_1	GW_2	GW_3	GW_4	GW_5	GW_6	GW_7	GW_8	GW_9	GW_{10}	GW_{11}
pH		7.36	7.18	8.09	6.90	7.03	6.45	7.75	6.97	7.13	7.50	6.87
T	oC		16.2	14.5	20.9	20.0	19.0	13.1	18.0	22.1	18.2	20
EC	µS/cm	1.294	860	440	590	1.360	1.000	670	930	540	640	350
Alk	$mgCaCO_3/L$	55.6	63.0	19.6	32.1	56.9	53.5	20	27.9	28.3	18.2	20.4
Har	d^{o}H	70.42	38.10	16.30	26.10	48.62	48.11	16.5	21.55	22.05	23.55	17.54
Fe^{2+}	mg/L		0.19	0.05	-	0.03	0.06	0.05	0.05	0.05	0.05	0.07
HCO^-_3	mg/L	442.3	506.3	161.7	292.8	463	481.9	189.1	259.3	262.3	179.9	195.2
Cl^-	mg/L	5.1	19.6	13.8	18.8	41.0	134.0	2.5	2.8	5.1	19.2	5.7
SO_4^{2-}	mg/L	138.80	13.71	0.80	7.71	212.0	12.66	0.30	0.26	1.33	16.26	3.16
NH_4^+	mg/L	0.34	0.64	0.29	0.56	0.31	0.30	0.29	0.39	0.48	0.43	0.29
PO_4-P	mg/L	0.15	3.55		0.00	0.02	0.07	0.06	0.07	0.07	0.07	0.02
NO_3^-	mg/L	96.00	1.20	3.30	2.00	15	62.00	0.30	0.30	17.80	52.50	-
NO_2^-	mg/L	0.09	0.09	0.02	0.16	0.16	0.02		-	-	0.06	0.02
COD	mg/L	24.50	22.80	3.00	5.30	7.80	6.50	2.9	56	42.50	33.50	26.40
BOD	mg/L	3.50	13.30	1.00	1.30	0.60	-	1.3	26.20	20.00	15.80	12.40

Table 1 Summary statistics for water quality data at the groundwater sampling points

Table 2 Summary statistics for water quality data at the groundwater sampling points

Variable	**Unit**	GW_{12}	GW_{13}	GW_{14}	GW_{15}	GW_{16}	GW_{17}	GW_{18}	GW_{19}	GW_{20}	GW_{21}	GW_{22}
pH		7.12	7.15	8.01	7.29	6.36	7.02	7.04	7.29	7.49	7.16	7.18
T	oC	14.6	16.6	18.0	21.9	19.7	23.3	16.9	23.3	15.7	18.1	18.9
EC	µS/cm	8.00	940	160	610	670	710	7.00	1.180	1.270	1.710	1.000
Alk	$mgCaCO_3/L$	63.5	52.3	11.2	28.9	17.2	40.1	31.8	84.9	55.5	103.9	283.8
Har	d^{o}H	27.11	47.61	8.01	25.06	29.60	127.57	16.11	46.20	36.15	60.14	36.50
Fe^{2+}	mg/L	4.55	0.05	0.09	0.38	0.12	0.35	0.18	0.35	0.07	5.28	-
HCO^-_3	mg/L	524.6	494.1	24.4	219.0	186.0	375.2	295.8	771.7	305.0	126.0	344.8
Cl^-	mg/L	72.1	19.3	6.9	23.0	31.0	11.0	38.0	121.0	27.8	36.6	13.6
SO_4^{2-}	mg/L	9.90	20.26	3.33	0.05	95.62	15.05	19.46	1.31	54.77	43.13	-
NH_4^+	mg/L	27.64	0.41	0.39	3.17	0.35	0.47	0.37	0.22	0.55	15.57	0.59
PO_4-P	mg/L	1.96	0.05	0.06	0.04	0.01	0.05	0.08	0.13	0.00	0.12	0.05
NO_3^-	mg/L		30.50	4.60	0.50	0.80	1.80	40.50	230.0	20.80	-	56
NO_2^-	mg/L	0.06	-	0.03	0.02	0.10	0.07	0.10	0.16	0.13	0.13	0.00
COD	mg/L	9.00	10.50	13.20	27.80	1.80	4.20	5.90	15.60	8.10	11.50	3.60
BOD	mg/L	20.00	4.90	7.80	25.80	0.40	1.80	2.70	0.80	1.70	2.50	2.50

In table 1 is the case of nitrate content (NO3-), for two sampling points (GW1, GW6), that results with very high values of the nitrate ion from 96mg/L NO_3^- and 62 mg/L for the following item.

If we analyze the results in hydrochemical terms of groundwater, will see that the content of ions of the main elements in groundwater is different, in this case are dominating the calcium ions (Ca_2^+) and hydro carbonate (HCO_3^-).

In Table 2, we see the increase of water contamination values. According to the results there is increase of nitrogen composition and oxygen consumption, where the value of ammonium ion (NH_4^+) has reached to 27.64mg/L NH_4^- and nitrate ions resulting highest value from 52.50 mg/L.

Content of ammonium ion (NH_4^+) in wells exceeds limits with amounts 27.64mg/L NH_4^-, while the value of biochemical oxygen consumption results raised at eight sampled points and reaches its maximum value in the range 26.20mg/L BOD, above the allowed limit for all natural waters.

At the same time as seen from Table 2, the value of the BOD is surpassed in other sampling points also; while in terms of hydrochemical aspects water type of these wells does not differ from those wells that belong to the areas around the sources.

Besides tabular form the results of physical-chemical research are presented in graphical form also in order to have a more rapid visual and analytical overview of main elements fluctuations, which express the mineralization of water in the wells of the region explored.

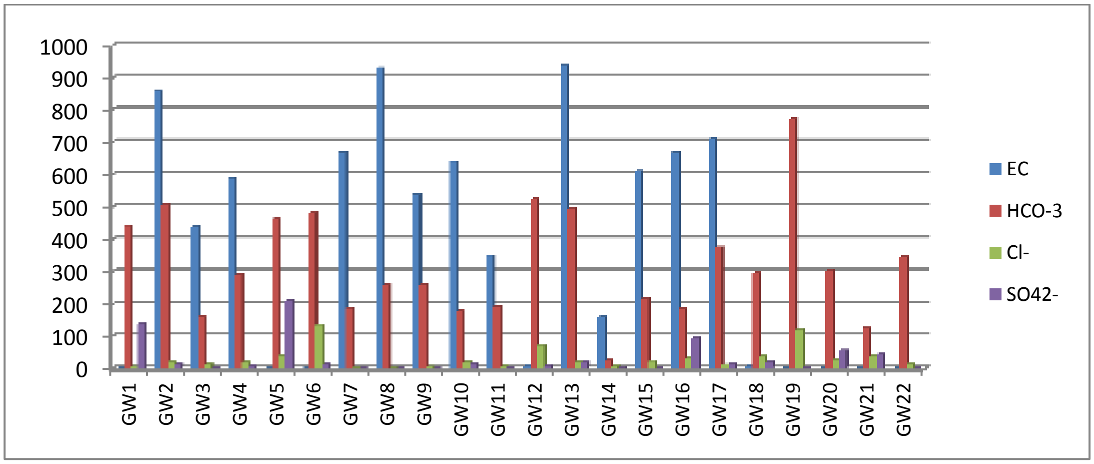

Fig 3. Oscillation of the values of major elements in natural waters

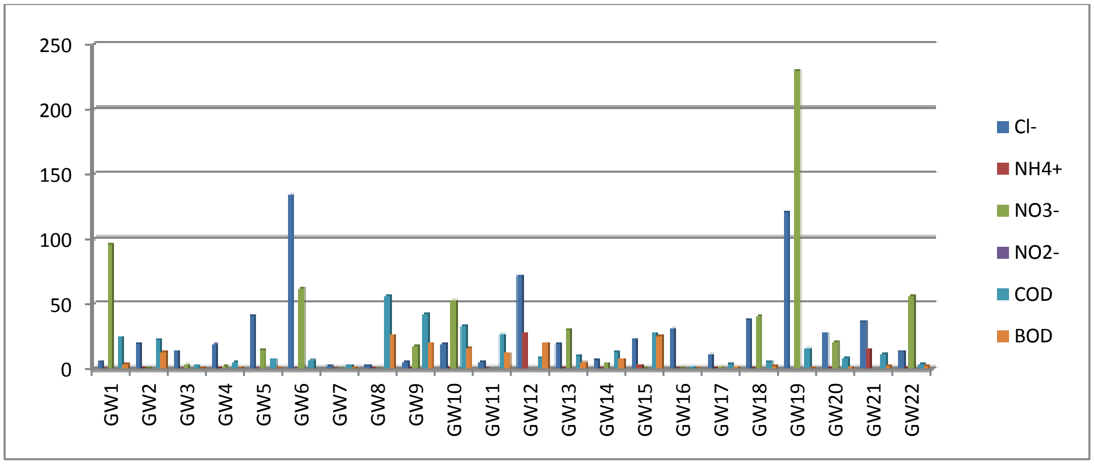

Fig 4 Oscillation of the values of water pollutions

Therefore, by analyzing fluctuations in the values of indicators in the chart is concluded that the ionic content results expressed as the indicator of conductivity of water in wells where high mineralization results consistent with increased values of electric conductivity (EC).

The highest point on the graph shown in sample point marked with GW19, which reaches the maximum value of 1620µS/cm, associated with a high value of chlorides and magnesium ions also, which at that point reaches the highest value of its presence up to 167.69 mg/L Mg^{2+} (figure 3).

In figure 4 the high content of chloride ions in point GW19 is up to 230mg/L and nitrate up to 230mg/L results by the high level of ionic content presented in the figure that gives us to understand that at this sampling point water results to be more contaminated.

CONCLUSIONS

Based on the achievements of research results for groundwater second zone of the water body Burimi, we can conclude that the groundwater is affected by anthropogenic impacts and water quality of wells is in decline.

In this case in table 3 is shown the presence of increased amonium with value of 27.64mg/L in sample GW10, while presence of nitrites results in the small from 0.06mg/L which tells us that has to do with a nearby source pollution and that happened newly. From table 3 the well sample GW10, the presence of nitrates in water results in a value of 52.50mg/L NO_3^- that indicates contamination from a remote source of pollution as well as in Table 2 samples GW1, is presented the increase of up to 96 mg/L NO_3^-

The presence of organic substance occurs as a result of municipal pollution, detergents and pesticides. In table 2 the values of organic substance results increased, where in a measured sample has maximum value up to 26.20mg/L.

For further protection of groundwater from anthropogenic impacts it is necessary that the population sewerage must be connected to the sewerage system and to construct the wastewater treatment plant in order to reduce pollution impacts in the groundwater.

REFERNCES

1. Appelo CAJ., Postma D. 2005. Geochemistry, groundwater and pollution (2nd ed., p. 321). Rotterdam: Balkema.
2. Avdullahi S., Fejza I., & Syla A., 2008. Water resources in Kosova. Journal of International Environmental Application & Science (JIEAS), 3 (6), 51-56,
3. Avdullahi S., Fejza I., Tmava A., & Syla A. 2007. Water resources in Drin i Bardh River Basin, Kosova, International Journal of Natural and Engineering Sciences 2 (3), 105-109.
4. Drever JI., 1988.The Geochemistry of Natural Waters. 2nd ed. Prentice Hall, Englewood Cliffs, NY, 437.
5. Fetter CW., 1994. Applied hydrogeology (3rd ed., p. 310). New York: Macmillan College Publication.
6. Hall MJ., 1984. Urban hydrology. Amsterdam, The Netherlands: Elsevier Applied Science P. 1–15, 227–244.
7. Jeong CH., 2001. Effect of land use and urbanization on hydrochemistry and contamination of groundwater from Taejon area, Korea. J. Hydrology 253, 194–210.
8. Krause S., Heathwaite AL., Miller F., Hulme P., & Crowe A. 2007. Groundwater dependent wetlands in the UK and Ireland: controls, functioning and assessing the likelihood of damage from human activities. Water Resourses Management. 21, 2015–2025.
9. Lawrence AR, Gooddy DC, Kanatharana P, Meesilp W, & Ramnarong V., 2000. Groundwater evolution beneath Hat Yai, a rapidly developing city in Thailand. Hydrogeol J 8(5), 564–575,
10. Münch, Z., & Conrad J. 2007. Remote sensing and GIS based determination of groundwater dependent ecosystems in the Western Cape, South Africa. Hydrogeology Journal 15, 19–28,
11. Simpkins WW, & Bradbury KR., 1992. Groundwater flow, velocity, and age in a thick, fine-grained till unit in southeastern Wisconsin. J Hydrology 132, 283–319.