PRECIPITATION AND RIVER QUALITY AT THE HIGHEST PART OF THE VITOSHA MOUNTAIN

S.Blaskova, L. Iordanova

CAH/NIMH-BAS, Sofia, Bulgaria
E-mail: Stefka.Blaskova@meteo.bg

Abstract: The Vitosha mountain has volcanic origin and its slopes are covered with granite and syenite rocks. At Cherni vruh (2290 m) is situated a synoptic station. The results of the precipitation and river water quality analysis in the highest part of the mountain are presented.
The findings present the background levels of the studied hydrochemical parameters. The predominant anions in river water are hydrocarbonates (HCO_3^-) and sulfates (SO_4^{2-}) while the predominant cations are calcium (Ca^{2+}) and sodium (Na^+). The measured pH values suggest the pure precipitation's influence on river water in terms of acidity. It is perceivable that the majority of the nitrate concentrations in river water originate in the precipitations.

Keywords: *ICAM, precipitation quality, water quality*

1. INTRODUCTION, DATA AND METHODS

The Vitosha mountain has volcanic origin. Series of slow bendings have formed its present character. The slopes are covered with granite and syenite rocks. The Vitosha mountain consist of four main parts which get together at the highest peak Cherni vruh (2290m). The turfed mountain-meadow soils, screes and stone rivers have considerable effects on the water regulation.

The presented results are obtained through a complex investigation on the water and precipitation quality in the highest parts of the mountain. A temporary local monitoring network for surface water quality was establish in the examined period (2004-2006). The investigation focused on the main rivers in the central part of the mountain. The monitoring points are situated near the peak of Cherni vruh, where operates the synoptic station of NIMH-BAS (Fig. 1).

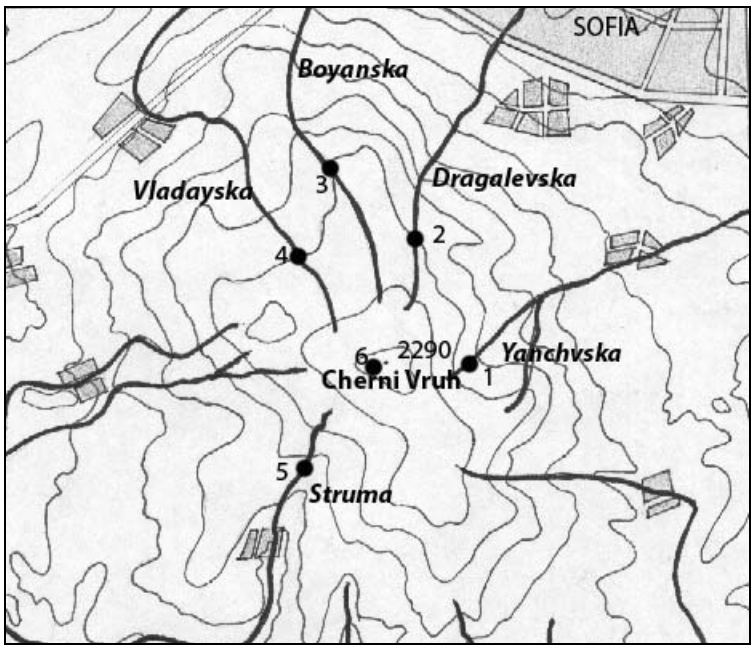

Figure 1: Monitoring points distribution: 1 – Yanchovska river; 2 – Dragalevska river; 3 – Boyanska river; 4 – Vladaiska river; 5 – Struma river; 6 – Synoptic station.

The river water quality was sampled through 4 yearly seasonal expeditions (seasonal monitoring). The following parameters were subject to the investigation: parameters of oxygen regime and organic content - dissolved oxygen (O_2), permanganate oxidation; biogenic parameters: nitrate (NO_3^-), nitrite (NO_2^-), ammonium (NH_4^+), phosphate (PO_4^{3-}) ions and total iron (Fe); parameters of mineral content - hydrocarbonate (HCO_3^-), sulphate (SO_4^{2-}), chloride (Cl^-), calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium and pottassium (Na^++K^+) ions. The river water samples are analyzed at Water quality laboratory- Sofia, CAH/NIMH-BAS.

The 6-hour precipitation samples are collected in the synoptic station on peak Cherni vruh in the primary synoptic hours (00, 06, 12, 18 UTC) when the precipitation amount is measured. The pH is measured at the moment of sample obtainment by a portable pH-meter and transmitted with a special code in the synoptic telegram. The rest of the sample is sent for additional analysis to the NIMH's quality precipitation laboratory. In the laboratory samples are analyzed for nitrates (NO_3^-), sulphates (SO_4^{2-}) and conductivity.

2. RESULTS AND DISCUSSION

The registered concentrations show a similarity between the dissolved oxygen and permanganate oxidation regimes for the studied river sections. The dissolved oxygen content is high (Tab1, 2). It is due to aeration, low water mineralisation, low temperatures and the lack of direct pollution sources. Higher concentrations are observed in the winter period. The maximum values of the organic content, assessed by permanganate oxidation are registered during the summer (Tab.1, 2).

Table 1: Average values for the studied parameters during 2004-2006. (concerning the period of rainfall)

parameter	River monitoring					Precipitation monitoring
	Yanchovska	Dragalevska	Boyanska	Vladaiska	Struma	Cherni vruh
pH	6.5	6.5	6.6	6.6	6,4	5.39
O_2, mg/l	9,8	9,9	9.7	9.8	10.0	-
Permanganate oxidation, mg/l	4.22	4.16	4.85	4.91	4.37	-
NO_3^-, mg/l	1.18	1.24	0.71	0.66	0.78	1,85
NH_4^+, mg/l	0.08	0.04	0.05	0.05	0.04	-
PO_4^{3-}, mg/l	0.01	0.01	0.02	0.02	0.01	
total Fe, mg/l	0.20	0.19	0.17	0.14	0,14	-
HCO_3^-, mg/l	19.52	19.30	19.52	20.13	20.74	-
SO_4^{2-}, mg/l	15.84	14.4	12.96	16.84	14.21	4,99
Cl^-, mg/l	7.44	4.61	4.96	4.61	3.90	-
Ca^{2+}, mg/l	6.40	6.40	7.00	6.20	5.00	-
Mg^{2+}, mg/l	2.67	0.85	1.46	2.79	2.92	-
Na^++K^+mg/l	7.75	8.25	6.25	6.75	5.75	-

The content of the studied biogenic parametes (nitrate (NO_3^-), nitrite (NO_2^-), ammonium (NH_4^+), phosphate (PO_4^{3-}) ions and the total iron (Fe)) is lower in the warmer part of the year (Таб. 1, 2). For acidity ranging between pH=5.9-7.3, such as in the investigated river parts, the phosphorus acid derivates exist mainly as $H_2PO_4^-$ and HPO_4^{2-} (Dobrevski, 1986). In the presence on enough dissolved oxygen, like in the river upstreams, the conditions are favorable for nitrification. The nitrate ions as a final product of this process are presented in higher concentrations (Tab.1, 2). In this aerobic medium (O_2 >90%) denitrification is inhibited from taking place.

Table 2: : Average values of studied parameters for surface water and precipitation quality during 2004-2006. (concerning the period of snow)

parameter	River monitoring					Precipitation monitoring
	Yanchovska	Dragalevska	Boyanska	Vladaiska	Struma	Cherni vruh
pH	7,0	6.9	6,8	7.1	6.6	5.77
O_2, mg/l	10,4	10.3	10,2	10,1	10,3	-
Permanganate oxidation, mg/l	3.04	3,58	3,21	3,25	3,02	-
NO_3^-, mg/l	2,54	1,93	1,85	1,68	2,08	1,89
NH_4^+, mg/l	0,25	0.14	0.09	0,10	0.12	-
PO_4^{3-}, mg/l	0.01	0.02	0.04	0.03	0.01	
total Fe, mg/l	0,21	0,26	0.23	0.16	0.22	-
HCO_3^-, mg/l	19,02	19,88	19,13	20,53	19.82	-
SO_4^{2-}, mg/l	15,9	14,63	12,70	17,01	12.48	2,30
Cl^-, mg/l	7,12	4,84	4,87	4,63	3,15	-
Ca^{2+}, mg/l	6,11	6,52	6,86	6.26	4,8	-
Mg^{2+}, mg/l	2,72	0,87	1,40	2.82	2,72	-
Na^++K^+mg/l	7,48	8,61	6,12	6.82	5.01	-

The average values for the registered concentrations of nitrates in the river waters are similar to the observed nitrate concentrations in the precipitations samples from the synoptic station at peak Cherni vruh, for the respective period. The above is true for the warm as well as the cold half of the year. The average value for the nitrate concentration in the precipitations at the Cherni vruh station is 1.85 mg/l for the liquid and 1.89 mg/l for the solid ones. Those results clearly show that the atmospheric waters are a major source for the enrichment of the rivers with nitrates. The presence of nitrate ions in the river water during the rainfall is lower than the nitrate concentrations in the precipitation itself (Tab.1). This is a result of the water organism's life activities.

The studied main ions (hydrocarbonate (HCO_3^-), sulphate (SO_4^{2-}), chloride (Cl^-), calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium and pottassium (Na^++K^+) ions) characterize the water mineral content, however, it is to be noted that some of them take part in the life processes of water organisms (Ca^{2+}, Mg^{2+}, K^+). The average values of these parameter's concentrations are presented in Table 1, 2.

The water mineral content according to Kurlov's formula (Posohov, 1985) can be seen in Table3. The anions and cations sums, in terms of mg-equiv/l are accepted to be 100% for cations and anions respectively. Only the ions with concentrations greater than 5% mg-equivalent are included. The main ions contents in percents are written as coefficients before the ion symbols. The numerator represent the main anions and the denominator- the main cations, respectively.

Table 3: Main ions content in % mg-equivalent

Yanchovska river	$\frac{38.4SO_4\,37.2HCO_3\,24.4Cl}{37.6Ca36.5(Na+K)25.9Mg}$
Dragalevska river	$\frac{41.1HCO_3\,41.1SO_4\,17.8Cl}{45.8(Na+K)44.4Ca9.7Mg}$

Boyanska river	$\frac{43.8HCO_3\,37SO_4\,19.2Cl}{46.8Ca\,34.7(Na+K)\,16.7Mg}$
Vladaiska river	$\frac{43.2SO_4\,40.7HCO_3\,16Cl}{38.3Ca\,33.3(Na+K)\,28.4Mg}$
Struma river	$\frac{47.9HCO_3\,36.6SO_4\,15Cl}{34.7Ca\,33.3(Na+K)\,28.4Mg}$

The local monitoring results show changes in the proportions of the main ion concentrations. In spite of this it is established that the rivers Struma and Boyanska are hydrocarbonate type with prevailing calcium cation; the rivers Yanchovska and Dragalevska are sulphate type with prevailing calcium cation and the Dragalevska river is hydrocarbonate-sulphate type.

The pH values for the river water are in the same range as the pH values for the precipitations and also have a similar regime (Tab.1, 2). The minimal measured pH values of the river water are under the limit established by the Bulgarian legislation as the first class water (pH<6.5) (Ordinance No7, 1986). These values are not the result of pollution but rather that of a pure precipitation influence.

3. CONCLUSION

1. The investigated parameters are in low concentrations and characterize the background conditions in the Vitosha mountain surface and precipitation water.

2. The river water nitrate concentrations are commensurate to the nitrate concentrations in precipitations samples obtained at the Cherni vruh synoptic station. It is perceivable that the majority of the nitrate concentrations in river water originate from the precipitations.

3. The minimal measured pH values of the river water are under the limit established by the Bulgarian legislation for first class waters (pH<6.5) (Ordinance No7, 1986). These values are not the result of pollution but of pure precipitation influence.

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