The Water Quality Assessment of Jiu River by Analyzing Physico-chemical Indicators

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This paper presents the assessment of the quality of Jiu river in the period of 2011-2013, through analysis and determinations on some physico-chemical indicators of water quality. Water sampling was conducted upstream and downstream of Tg. Jiu to highlight the influence of industrial and domestic wastewater of the city on the quality of Jiu river. The results of experimental measurements allowed assessment of regime acidification, oxygen and nutrient regime and water salinity on section of the studied river.

Keywords: water quality, physico-chemical indicators

Surface water quality is variable in time due to natural or anthropogenic sources of contamination, which requires permanent monitoring of parameters that define water quality. Surface waters are receptors of the wastewater tributaries and pluvial water that significantly influence the chemical composition. In most cases, domestic and industrial wastewater is treated in wastewater treatment plants more or less modernized. In these conditions, the degree of purification is insufficient and in natural waters penetrate about one third of the pollutants contained in wastewater [1-3]. Depending on the quantity and nature of pollutants that enter the natural receptors, changes and quality of natural waters, influenced by the composition of atmospheric deposition and stormwater. Given that atmospheric precipitations are low quantity becomes specific the pollution with wastewater untreated or insufficiently treated. Natural water quality is largely influenced also of the self-purification capacity of all natural processes given hydrodynamic, chemical, biochemical, occurring in natural waters polluted that aims to improve water quality characteristics and properties of natural waters unpolluted [4-6]. As a result of mixing the waste water discharged into the natural environment of the concentration of pollutants is reduced by the action of chemical agents (oxidants, reductants), micro-organisms (biochemical oxidation) and photochemical processes leading to the decomposition of organic and inorganic substances. In case of low self-purification capacity of water it requires oxygen enrichment of atmospheric aeration [7-10]. Surface waters receiving wastewater effluents as industrial (mining industry, energetic industry, food and chemical industry) and domestic wastewater are polluted with organic matter, nitrogen compounds (N), phosphorus compounds (P), metals heavy, persistent organic micropollutants, certain pathogens and other non-biodegradable substances. Wastewater discharge into natural manifests itself in different ways, from harm to human health, to complex issues such as environmental, technical and economic [11-13]. The presence in the water of nitrates, nitrites and phosphate in quantities beyond normal, causing adverse effects on aquatic balance mainly water eutrophication process that consists in the development of accelerated and massive microplancton and aquatic vegetation. Compounds of nitrogen and phosphorus are nutrients for algae and microplancton because they assimilate and use them in the cellular structure. Eutrophic waters have damaged qualitative characteristics, color contrast, low transparency and low oxygen [14-17].

Experimental part

To assess the quality of Jiu river in 2011-2013, were determined the following physico-chemical water qualities: *p*H, dissolved oxygen, nitrates, nitrites, ammonium, phosphates, chlorides and sulphates. The study was conducted on a section of Jiu river having a length of 25 Km. Samples were taken upstream and downstream of the city of Tg. Jiu aiming to influence the waste water from the industrial area of the city and the household have on the quality of emissary. Sampling points were chosen on both sides of the river, so that to allow appreciation of the influence of pollution sources in the city of Tg. Jiu, and the sampling was done every two months in total 72 samples were collected. Sampling was done according to current regulations, the new polyethylene receptacles, each recipient being washed at the place of sampling with the Jiu river water to reduce the possibility of contamination with impurities from the manufacturing material of the recipient. The receptacles were completely filled with water and tightly closed during immersion to prevent oxidative processes in oxygen-water interface [18]. Physico-chemical indicators of water quality were analyzed by in situ measurement methods using specialized portable and by laboratory methods. Standardized analytical methods and equipment used to measure water quality indicators were:

- determination of *p*H and dissolved oxygen in water was achieved using specific standard portable multiparameter model Consort by electrochemical method [19, 20].
- determination of nitrate, nitrite, ammonium and phosphates ions was performed by spectrophotometric method with UV-VIS spectrophotometer - T70 [21 -24].
- determination of chlorides was performed volumetric method by titration with silver nitrate using chromate as indicator (Mohr method) [25].
- sulphates determination was carried by precipitated in an acetic acid medium with barium chloride resulting barium sulphate crystals. The absorbance suspension is measured photometrically using portable photometer model Orbeco-Hellige (turbidimetric method) [26].

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Indicator	2011		2012		2013	
	Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
pH (pH units)	7.78	7.69	7.99	7.83	7.88	7.82
Dissolved oxygen (mg/L)	8.16	8.51	8.24	8.32	9.15	9.26
Nitrates (mgN/L)	4.88	4.46	4.4	4.29	1.02	0.82
Nitrites (mgN/L)	0.062	0.033	0.114	0.126	0.047	0.037
Ammonium (mgN/L)	0.167	0.154	0.18	0.151	0.076	0.063
Phosphates (mgP/L)	0.287	0.264	0.168	0.153	0.054	0.05
Chlorides (mg/L)	9.324	8.905	5.237	4.608	9.635	8.090
Sulphates (mg/L)	28.41	24.82	36.62	32.84	20.72	19.25

Table 1
AVERAGE VALUES OF WATER QUALITY INDICATORS (2011-2013)

Indicator	2011		2012		2013	
	Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
pH (pH units)	7.93	7.89	8.24	8.14	8.12	8.02
Dissolved oxygen (mg/L)	9.15	9.51	9.24	9.82	11.67	11.98
Nitrates (mgN/L)	6.24	6.12	5.98	5.39	3.89	3.82
Nitrites (mgN/L)	0.148	0.125	0.280	0.285	0.182	0.167
Ammonium (mgN/L)	0.572	0.654	0.384	0.351	0.174	0.162
Phosphates (mgP/L)	0.559	0.524	0.348	0,318	0.149	0.135
Chlorides (mg/L)	12.408	11.344	7.475	6.842	12.642	11.986
Sulphates (mg/L)	32.16	30.72	46.82	42.49	30.98	29.12

Table 2
MAXIMUM VALUES OF WATER QUALITY INDICATORS (2011-2013)

The results of measurements carried out during the period 2011-2013 to monitor indicators are presented in table 1 and 2.

Results and disscusions

To determine the physico-chemical quality of Jiu river, evaluation of quality indicators of water samples was performed in accordance with Order 161 of 16 February 2006 approving the normative concerning the classification of surface water quality in order to determine the ecological status of water bodies [27]. After the value of hydro-chemical indices, the water of Jiu river corresponds to an average of class II quality (good condition).

Jiu acidification status was assessed by analyzes carried out to determine the *p*H of the water. The results of these measurements for the studied section shows that this parameter is within the limit values of water quality standards (*p*H = 6.5-8.5), ranging between 7.69 - 7.99 *p*H units.

Oxygen regime of the river Jiu on the studied section was evaluated by analyzing the results of dissolved oxygen indicator. Average values recorded for this indicator upstream and downstream of Tg. Jiu, for the period 2011-2013 (fig. 1) indicates a value beyond the limit value (LV) for class II quality under Order 161/16 February 2006 (LV = 7mg/L) in which it is employed Jiu river. Maximum value was recorded in 2013, in the downstream section, and this was 1.32 LV. It can be observed an increasing trend of average and maximum oxygen content downstream of the upstream, indicating good self-purification capacity of water in the analyzed section (fig.1).

Nutrient regime of the river Jiu indicators was evaluated by determining nitrate ($N\text{-}NO_3^-$) nitrite ($N\text{-}NO_2^-$), ammonium ($N\text{-}NH_4^+$), phosphate ($P\text{-}PO_4^{3-}$). Determined average content of nitrate ranged between 0.82 mg/L and 4.88 mg/L. Variation of average nitrate concentrations (fig. 1) has a downward trend by 2013. In 2011 and 2012, average values recorded exceeded the limit value (LV) for class II quality of this indicator.

Overcoming average nitrate concentrations from LV = 3mg/L in Class II quality are between 1.43 LV and 1.62 LV. From figure 1 it is noted that average values of downstream of nitrate ion of Tg. Jiu slightly decreases than those upstream, indicating good water self-cleaning process. Maximum values recorded exceeded the limit value by 1.27 LV in downstream section (2013), respectively 2.08 LV in upstream (2011).

Variation of average nitrite content is between 0.033 mg/L and 0.126 mg/L, which indicates all samples analyzed exceeded the limit value for class II quality (LV = 0.03 mg/L). Average values nitrite ion concentration in water Jiu indicates that water quality deterioration was more pronounced in 2012, exceeding the 4.2 LV recorded downstream and 3.8 LV upstream (fig. 2). In 2012 the

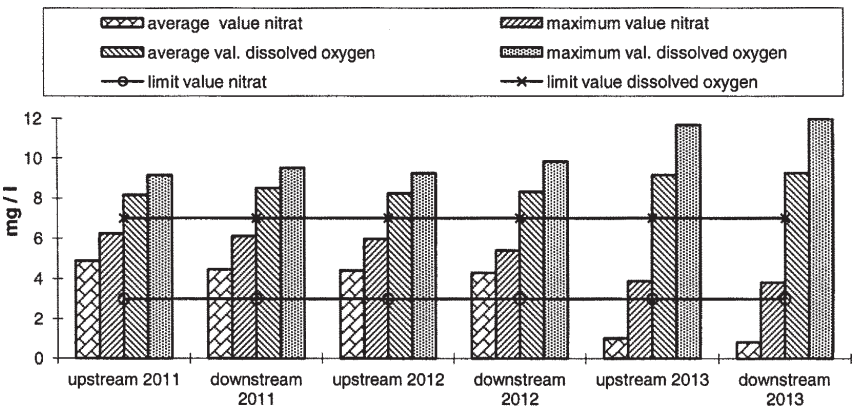

Fig.1. Concentration values of dissolved oxygen and nitrate in Jiu river

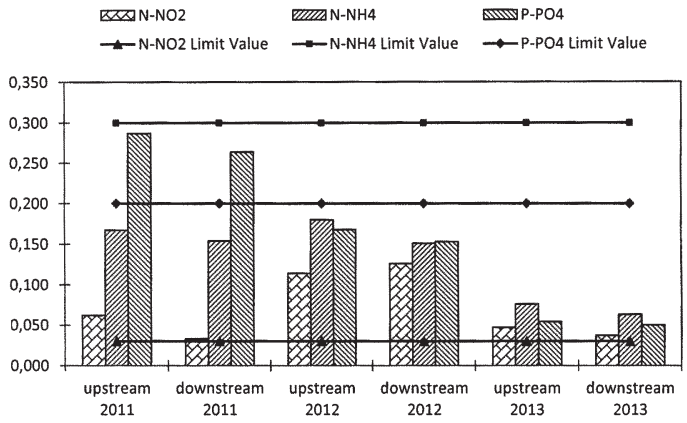

Fig. 2. Average values of nitrite, ammonium and phosphate concentration in Jiu river

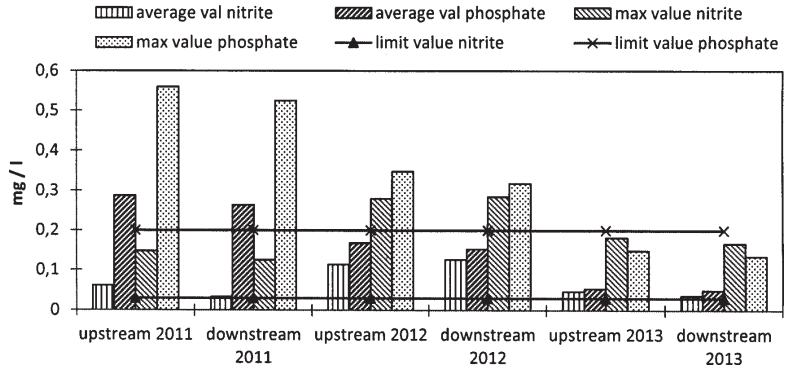

Fig.3. Concentration values of nitrite and phosphate in Jiu river

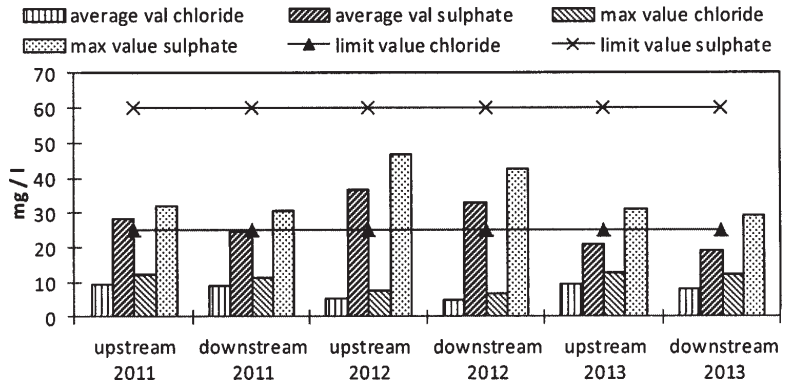

Fig. 4. Concentration values of sulphates and chlorides in Jiu river

average value exceeds the same indicator downstream of nitrite determined upstream, indicating a moderate pollution of Jiu river due to nitrogen compounds derived from the city wastewater discharged into the river.

Analyzing the evolution of the average concentration of ammonium ion, it can be seen that this had values in the range 0.063 mg/L and 0.18 mg/L. By reporting the measured limit value for class II quality (LV = 0.3 mg/L), all determinations is within the allowable value of the regulations in force (fig. 2). Every year the average values of ammonium downstream of Tg. Jiu are lower than those upstream which indicates a process of self-purification of water during the analyzed area.

From determinations it was found that the indicator recorded two averages phosphate surplus in 2011, as shown in figure 2. Exceeding the limit value of 0.2 mg/L for class II quality indicator phosphate was the 1.435 LV upstream and 1.32 LV downstream. The registered values upstream are lower than those in downstream, which mean the existence of a good self-cleaning process regarding phosphorus compounds. Variation of maximum nitrite content is between 4.16 LV (upstream section, in 2011) and 9.5 LV (downstream section, in 2012). Analyzing the evolution of the maximum concentration of phosphate ion, it can be seen that maximum value was recorded in 2011, in the upstream section, and this was 2.795 LV (fig.3).

Salinity regime of Jiu river was evaluated by analyzing the average values of indicators: chlorides and sulphates. Both upstream and downstream of Tg. Jiu average values recorded for these indicators are below the corresponding limit surface water quality classified in class I under Order 161/16 February 2006. In figure 4 is shown the evolution of upstream and downstream sulphate and chloride indicator of Tg. Jiu for the period of 2011-2013.

From the physico-chemical analyzes performed for Jiu river, upstream and downstream of Tg. Jiu, in 2011 it may be established that the average values of most indicators determined situate Jiu waters in the second category surface waters (according to Order 161/2006). Exceptions are indicators of nitrate and nitrite, whose average values exceed the limit values, which leads to a classification of the water of Jiu river in report with registered quality to these nutrients in the category of grade III (moderate condition). Indicator values recorded for phosphate are relatively small. In 2012, for the physico-chemical indicators of Jiu river in Tg. Jiu, we find that the average values are maintained close to 2011. The values fall the water of river Jiu in the category of II quality. Average values nitrite and nitrate indicators remain above the limit values, which fall Jiu in the category III of quality in relation to the arrangements of these nutrients. Evolution of water quality of river Jiu in 2013, compared to previous years, is much

improved and leads to the location of the watercourse within class II quality. It remains one exception due to its average nitrite that remains over the limit due to anthropogenic activities undertaken in the city of Tg. Jiu.

Conclusions

The aim of this work was to achieve the quality assessment of water Jiu in 2011-2013. For this were measured and analyzed the following physico-chemical quality parameters of the water: *p*H, dissolved oxygen, nitrates, nitrites, ammonia, phosphates, chlorides and sulphates. Deterioration of water quality of Jiu river is due wastewater discharges industrial wastewater and to a lesser extent of the pluvial. The mentioned effluents, mixed with water receiver, change the composition and characteristics of its quality. From the experimental data of physico-chemical analysis, we can say that the Jiu river pollution is moderate. The *p*H indicator is within the limit values of water quality standards. Indicators chlorides and sulfates both upstream and downstream of Tg. Jiu, have average values below the corresponding limit surface waters in first class quality framed under Order 161/2006. The average values are higher oxygen content limit corresponding for class II quality, which shows a good self-purification capacity of the river Jiu studied section. Average values concentration of nitrate ions (during 2011-2012), nitrite (2011-2013) and phosphate (2011) exceeds the limit value for class II quality, according to Order 161/2006. The cause of exceedances of nutrient content may be mainly due to insufficient purification of wastewater from Tg. Jiu as well from industrial activities conducted in the city. Evolutionary trend for nitrate for the period analyzed is one descending. In 2013 measurements values for the nutrient regime indicators are within the limit values for class II quality indicator except nitrites. Physico-chemical indicators of quality analyzes have lower values downstream than upstream, which means that, on the one hand, Tg. Jiu cause moderate pollution of the Jiu river due to the fact that many of the polluting industrial units were closed or operating at reduced capacity, and on the other hand, self-purification capacity of water is carried in parameters.

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