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INVESTIGATION OF SOME ESSENTIAL POLLUTANTS IN 15 LOCATIONS THROUGHOUT THE JIU RIVER

INVESTIGAREA UNOR POLUANȚI ESENȚIALI ÎN 15 LOCAȚII DE PE TRAIECTUL RÂULUI JIU

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ABSTRACT | REZUMAT

For a long time, soil and water have been considered renewable and inexhaustible resources, but lately, they are proving to be some of the limiting factors, as water and soil pollution can have serious consequences on the biosphere. The main pollution-generating process is industrialization and technologicalization. Thus, the objective of this study was to investigate through a field study of some essential pollutants (nitrates/nitrites and heavy metals), using the portable spectrophotometer DR 1900 in 15 locations along the Jiu River, for two years with locations upstream and downstream of the largest polluters in Gorj and Dolj counties. Following this study, we can say that for the water samples taken from the Jiu River, the values of nitrates and nitrates in Gorj County in 2017 were higher in July compared to August for the Drăgușești-Ionești area, the values obtained including the Jiu water on this section in quality class I and II for the nitrogen indicator and class II and III for nitrates. The values of nitrates and nitrates in Dolj County were higher in July compared to August in the water samples taken downstream of Işalnița, values that include the Jiu water on this section in the third quality class. For the water samples collected from the Jiu River on the territory of Gorj county, high values were obtained for Mn, Cr, and Fe downstream of the Rovinari thermal power plant. Increased values of Pb in the Rovinari, Brebenei, and Ionești areas, which include water in the class V of greening. For the water samples collected from the Jiu River on the territory of Dolj County, high values were obtained for Mn (Işalnița-Podari area) as well as the presence of chromium in the water taken from Mihăița, Işalnița and Podari points. Increased values of lead were observed in the Işalnița area and for at least three points downstream, values that include water in class IV and V of greening.

Keywords: regional risk study, pollution, water, soil, nitrates/nitrites, heavy metals, Jiu River

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Multă vreme, solul și apa au fost considerate resurse regenerabile și inepuizabile, dar în ultima perioadă se dovedește tot mai mult a fi unii dintre factorii limitativi, poluarea apei și a solului putând avea consecințe grave asupra biosferei. Principalul proces generator de poluare este industrializarea și tehnologizarea. Astfel, obiectivul acestui studiu a fost investigarea printr-un studiu de teren a unor poluanți esențiali (azotați/azotiți și metale grele), cu ajutorul spectrofotometrului portabil DR 1900, în 15 locații de pe traiectul râului Jiu, pe o perioadă de doi ani cu localizări în amonte și în aval de cei mai mari poluatori ai județelor Gorj și Dolj. Elementele și standardele de calitate pentru apa de râu au fost în conformitate cu legislația națională, standarde a căror valori le-am comparat cu valorile obținute de noi pentru parametrii studiați.

În urma prezentului studiu putem spune că pentru probele de apă prelevate din râul Jiu valorile azotaților și azotiților județului Gorj în anul 2017, au fost mai crescute în luna iulie comparativ cu luna august pentru zona Drăgușești-Ionești, valorile obținute încadrând apa Jiului pe acest tronson în clasa de calitate I și II pentru indicatorul azotiți și clasa II și III pentru azotați. Valorile azotaților și azotiților județului Dolj au fost mai crescute în luna iulie comparativ cu luna august în probele de apă prelevate în aval de Işalnița, valori care încadrează apa Jiului pe acest tronson în clasa a III-a de calitate.

Pentru probele de apă recoltate din râul Jiu pe teritoriul județului Gorj au fost obținute valori crescute pentru Mn, Cr și Fe în aval de termocentrala de la Rovinari. Valori crescute de Pb în zona Rovinari, Brebeni și Ionești care încadrează apa în clasa a V-a de ecologizare.

Pentru probele de apă recoltate din râul Jiu pe teritoriul județului Dolj au fost obținute valori crescute pentru Mn (zona Işalnița - Podari) precum și prezența cromului în apa prelevată din punctele Mihăița, Işalnița și Podari. Valori crescute de plumb s-au observat în zona Işalnița și pentru cel puțin trei puncte în aval, valori ce încadrează apa în clasa IV și V de ecologizare.

Cuvinte cheie: studiu de risc regional, parametri poluare, ape, sol, nitrați / nitriți, metale grele, Jiu

For a long time, soil and water have been considered renewable and inexhaustible resources, but lately, they are increasingly proving to be some of the cardinal limiting factors for socio-economic development (2, 4, 10, 12, 17, 19, 26, 29, 34).

Being an important factor in ecological balances, water and soil pollution can have serious consequences on the biosphere. The two essential components that led to the intensification of the use of natural resources were and remain the growth of the population, on the one hand, and the development of human society on the other, the anthropic activities of exploitation and capitalization of these resources, have also generated appreciable amounts of waste, polluting emissions that have degraded the quality of the environment (1, 7, 11, 18, 20, 27, 30).

The fact that man has conquered the entire planet and the rate of population growth is increasing has led to the emergence of large urban agglomerations. The main pollution-generating process is industrialization and technologicalization (10, 14, 29).

This process began in the eighteenth century in England and has reached an unprecedented scale today, the problems of environmental degradation and pollution attracting the need for general legislation and several specific regulations in the field of environmental protection.

These steps began in 1972, when the "Environmental Declaration" was launched in Stockholm and continued with the "United Nations Conference on Environment and Development" in Rio de Janeiro, Brazil in 1992, at which - added the annual meetings of developed countries where economic and social environmental issues were generated and addressed, those that formed the basis of the "Rio Declaration", which includes the fundamental principles on which states will base their future decisions and "Agenda 21", constituted as an action plan for the 21st century and which has as a basic principle sustainable development, this being followed by a great amount of legislation (8, 9, 15, 16, 23-25).

Unfortunately, comparing the *"strategy"* of nature with that of human society, we can see an essential contradiction between balance and harmony in nature vs. the human tendency to achieve maximum yields, replacing natural ecosystems with artificial ones, mostly labile, created and maintained artificially viable (6, 10, 12, 21, 22, 28, 31, 33).

The objective of this study was to investigate through a field study of some essential pollutants (nitrates / nitrites and heavy metals) in 15 locations along the Jiu River, for two years (2016 and 2017) in different climates winter/summer, with locations upstream and downstream of the largest polluters in Gorj and Dolj counties (respectively, Turceni and Iṣalnița thermal station).

MATERIALS AND METHODS

Collection of water samples

The water samples were collected in special plastic containers, opaque white, and stored in the refrigerator at 4 °C until the determinations were made.

In order to determine a possible threat of contamination or pollution of the sampling locations, it became dependent on the neighboring regions of Turceni Thermal Power Plant and Isalnița Thermal Power Plant, upstream and downstream on 15 locations on the Jiu River. The water samples were taken from five different locations in Gorj County and 10 locations in Dolj County. For each location, two samples were taken twice a year: the first samples were taken in January, February, July, and August 2016 and the following in the same months of 2017.

Analysis of chemical and physico-chemical parameters

To determine the chemical and physico-chemical parameters, in the present research was used the portable spectrophotometer model DR 1900 (Hach, Romania), by field method. It has the advantage of portability, compactness and low weight. The device is designed to withstand shocks and moisture in the field, as well as to accept the largest dimensional range of ampoules. A large number of pre-programmed methods (over 220 built-in water testing methods as well as the wide reading range of up to 800 nm) provide high technical accuracy results and for this reason, the data processing rate provides accuracy comparable to the one in the lab.

Sampling was done by recording GPS coordinates, hardness, pH, and dissolved oxygen.

Technical characteristics of the portable DR 1900 spectrophotometer:

- detector: silicon photodiode;
- set of 2 × 10 mL tanks;
- useful wavelength: 340-800 nm/± 2 nm;
- photometric accuracy: ±0.003% (0.0-0.5 Abs);
- photometric linearity: <0.5% (0.5-2.0 Abs);
- scattering light: <0.5% T at 340 nm, with $NaNO_2$.
- analytical tests for substances/detection limits for: Chromium (III and VI) (0.03-1.0 mg/L/Cr); Iron (II and III) (0.6-6.0 mg/L/Fe); Manganese (0.005-0.7 mg/L/Mn); Aluminium (0.02-0.5 mg/L/Al); Lead (0.001-0.5 mg/L/Pb); Sulphide (0.1-2.0 mg/L/S_2); Cyanides (0.01-0.6 mg/L/CN); Nitrates (1.0-15 mg /L /N-NO_3) Nitrites (0.01-0.5 mg/L/N-NO_2).

Statistical analysis

The statistical analysis of the results was performed in the Microsoft Excel program with the generation of comparative graphs.

RESULTS AND DISCUSSIONS

Determination of nitrites and nitrates from water samples taken from the Jiu River in Gorj and Dolj County

According to Directive 98/83/EC of 3.10.1998 and Order no. 161/16.02/2006 "for the approval of the Norm on the classification of surface water quality in order to establish the ecological status of water bodies" were established 5 ecological states for rivers and natural lakes (9, 23):

- very good ecological status (I)
- good ecological status (II)
- moderate ecological status (III)
- poor ecological status (IV)
- poor ecological status (V)

Table 1 shows the elements and quality standards for river water in accordance with Order 161 of February 16, 2006, standards whose values we will compare with the values obtained by us for the chemical and physico-chemical parameters studied.

According to Order 743/2008 (approving the list of localities by counties where there are sources of nitrates from agricultural activities) (24), Dolj County is identified as a vulnerable area to nitrate pollution for 78 localities, including Bradesti, Coțofenii din Dos, Drănic, Işalnița, and Bridges are areas from which water samples were taken for the present study. The values of nitrogen and nitrates in the water samples taken in January, February, July and August 2016, from the two areas, are presented in Tables 2 and 3.

From the water samples taken by us in the winter months of 2016, we could see that the values of nitrates and nitrates (mg/L) were higher in February compared to January, these being higher in the water sample taken from the Rovinari area. However, the values of nitrates and nitrates include the Jiu water on this Drăguțești-Ionești course, according to order 161/2006 (23), in quality classes I and II. For the water samples collected in January-February and July-August of 2016, on the section of Jiu (Schitu-Zăval), localities belonging to Dolj County, we could see that the values of nitrogen and nitrates were higher compared to the values obtained on the course of the Jiu between the localities of Drăguțești-Ionești. Increased values were determined in the water samples taken from the area of Işalnița, Podari and Secui localities. The values obtained include the Jiu water on the Schitu-Mihăița river (localities upstream of the Işalnița area) in quality class I and II according to order 161/2006 and on the Isalnița-Zăval river in quality class II and III (23).

Tables 4 and 5 show the values of nitrogen and nitrates in water samples taken in January, February, July and August 2017. Analysing the values from the tables presented above on the concentration of nitrates and nitrates (mg / L) of water samples taken from the Jiu River during Gorj County in 2017 we found that the values of nitrates and nitrates were higher in July compared to August for the Drăguțești - Ionești area, the values obtained framing the Jiu water on this section in: quality class I and II for the nitrogen indicator and class II and III for nitrates. In the case of water samples collected from Jiu water on the territory of Dolj county, we could find that the values of nitrates were higher in July compared to August in the water samples taken downstream of Işalnița, values that include Jiu water on this section in quality class III.

Table 1

Values of quality standards for the evaluated chemical and physico-chemical parameters
(According to Ord. 161 of Feb. 16, 2006)

Parameter	I	II	III	IV	V
pH	6.0- 9.5				
O2 concentration (mg/L)	9.0	7.0	5.0	4.0	>4.0
Nitrites (N-NO2) (mg/L)	0.01	0.03	0.06	0.3	>0.30
Nitrates (N-NO3) (mg/L)	1.0	3.0	5.60	11.2	>11.2
Manganese (mg/L)	0.05	0.10	0.30	1.0	>1.0
Iron (mg/L)	0.30	0.50	1.0	2.0	>2.0
Chromium (mg/L)	0.025	0.05	0.10	0.25	>0.25
Cyanides (mg/L)	0.05				
Lead (mg/L)	0.005	0.01	0.025	0.05	>0.05
Aluminium (mg/L)	*				

* There is no standard value for running water for Aluminium

Table 2

Values of nitrates and nitrites for water samples taken upstream and downstream of the Turceni station (2016)

Water sample	GPS coordinates	Parameter analysed	Sampling 1 January	Sampling 2 February	Sampling 3 July	Sampling 4 August
P1 (upstream) Drăgușești	N 44º58'02.8 " E 23º12'54.1"	Nitrites ($N-NO_2$)	0.02 mg/L	0.02 mg/L	0.02 mg/L	0.02 mg/L
		Nitrates ($N-NO_3$)	1.0 mg/L	2.0 mg/L	2.0 mg/L	2.30 mg/L
P2 (downstream) Vîrț	N 44º56'55.0" E 23º07'57.3"	Nitrites ($N-NO_2$)	0.03 mg/L	0.03 mg/L	0.03 mg/L	0.02 mg/L
		Nitrates ($N-NO_3$)	3.0 mg/L	3.0 mg/L	3.0 mg/L	3.0 mg/L
P3 (downstream) Rovinari	N 44º54'11.6" E 26º09'29.1"	Nitrites ($N-NO_2$)	0.04 mg/L	0.06 mg/L	0.03 mg/L	0.04 mg/L
		Nitrates ($N-NO_3$)	3.80 mg/L	4.20 mg/L	3.70 mg/L	4.0 mg/L
P4 (upstream) Brebenei	N 44º38'37.6" E 23º26'21.8"	Nitrites ($N-NO_2$)	0.03 mg/L	0.04 mg/L	0.04 mg/L	0.06 mg/L
		Nitrates ($N-NO_3$)	3.20 mg/L	2.70 mg/L	4.0 mg/L	3.80 mg/L
P5 (downstream) Ionești	N 44º37'11.00" E 23º27'1.12"	Nitrites ($N-NO_2$)	0.03 mg/L	0.04 mg/L	0.04 mg/L	0.02 mg/L
		Nitrates ($N-NO_3$)	3.0 mg/L	2.70 mg/L	3.20 mg/L	2.80 mg/L

Table 3

Values of nitrates and nitrites for water samples taken in the Işalnita area (upstream and downstream 2016)

Water sample	GPS coordinates	Parameter analysed	Sampling 1 January	Sampling 2 February	Sampling 3 July	Sampling 4 August
P1 (upstream) Schitu	N 44º30'44.50" E 23º30'38.93"	Nitrites ($N-NO_2$)	0.03 mg/L	0.03 mg/L	0.02 mg/L	0.02 mg/L
		Nitrates ($N-NO_3$)	3.0 mg/L	2.0 mg/L	2.0 mg/L	2.0 mg/L
P2 (upstream) Brădești	N 44º29'27.86" E 23º35'52.27"	Nitrites ($N-NO_2$)	0.02 mg/L	0.02 mg/L	0.02 mg/L	0.01 mg/L
		Nitrates ($N-NO_3$)	3.0 mg/L	2.0 mg/L	2.0 mg/L	2.0 mg/L
P3 (upstream) Coțofenii din Dos	N 44º24'40.11" E 23º40'57.86"	Nitrites ($N-NO_2$)	0.02 mg/L	0.02 mg/L	0.03 mg/L	0.03 mg/L
		Nitrates ($N-NO_3$)	3.0 mg/L	2.0 mg/L	3.0 mg/L	3.60 mg/L
P4 (upstream) Mihăița	N 44º21'58.85" E 23º42'34.97"	Nitrites ($N-NO_2$)	0.04 mg/L	0.03 mg/L	0.04 mg/L	0.04 mg/L
		Nitrates ($N-NO_3$)	4.0 mg/L	3.0 mg/L	4.20 mg/L	4.0 mg/L
P5 (downstream) Işalnița	N 44º15'38.40" E 23º47'6.23"	Nitrites ($N-NO_2$)	0.05 mg/L	0.03 mg/L	0.05 mg/L	0.06 mg/L
		Nitrates ($N-NO_3$)	8.20 mg/L	9.0 mg/L	6.80 mg/L	7.20 mg/L
P6 (downstream Podari	N 44º11'8.62" E 23º50'55.37"	Nitrites ($N-NO_2$)	0.09 mg/L	0.07 mg/L	0.07 mg/L	0.07 mg/L
		Nitrates ($N-NO_3$)	9.20 mg/L	9.0 mg/L	10.6 mg/L	11.0 mg/L
P7 (downstream) Secui	N 44º 1'21.82" E 23º52'41.83	Nitrites ($N-NO_2$)	0.06 mg/L	0.06 mg/L	0.05 mg/L	0.06 mg/L
		Nitrates ($N-NO_3$)	7.0 mg/L	6.50 mg/L	9.0 mg/L	7.10 mg/L
P8 (downstream) Drănic	N 43º49'3.45" E 23º49'36.68"	Nitrites ($N-NO_2$)	0.05 mg/L	0.06 mg/L	0.04 mg/L	0.03 mg/L
		Nitrates ($N-NO_3$)	4.20 mg/L	4.0 mg/L	5.0 mg/L	4.20 mg/L
P9 (downstream) Valea Stanciului	N 43º58'42.3" E 23º52'43.2"	Nitrites ($N-NO_2$)	0.05 mg/L	0.04 mg/L	0.03 mg/L	0.03 mg/L
		Nitrates ($N-NO_3$)	4.0 mg/L	3.60 mg/L	4.0 mg/L	3.20 mg/L
P10 (downstream) Zăval	N 43º85'12.19" E 23º84'83.37"	Nitrites ($N-NO_2$)	0.03 mg/L	0.03 mg/L	0.03 mg/L	0.02 mg/L
		Nitrates ($N-NO_3$)	3.60 mg/L	3.20 mg/L	3.50 mg/L	3.0 mg/L

Table 4

Values of nitrates and nitrites for water samples taken upstream and downstream of the Turceni station (2017)

Water sample	GPS coordinates	Parameter analysed	Sampling 1 January	Sampling 2 February	Sampling 3 July	Sampling 4 August
P1 (upstream) Drăgușești	N 44º58'02.8" E 23º12'54.1"	Nitrites ($N\text{-}NO_2$)	0.01 mg/L	0.02 mg/L	0.03 mg/L	0.04 mg/L
		Nitrates ($N\text{-}NO_3$)	3.0 mg/L	2.0 mg/L	3.0 mg/L	3.0 mg/L
P2 (upstream) Vîrț	N 44º56'55.0" E 23º07'57.3"	Nitrites ($N\text{-}NO_2$)	0.02 mg/L	0.02 mg/L	0.03 mg/L	0.04 mg/L
		Nitrates ($N\text{-}NO_3$)	3.0 mg/L	3.40 mg/L	3.20 mg/L	3.50 mg/L
P3 (downstream) Rovinari	N 44º54'11.6" E 26º09'29.1"	Nitrites ($N\text{-}NO_2$)	0.02 mg/L	0.02 mg/L	0.05 mg/L	0.07 mg/L
		Nitrates ($N\text{-}NO_3$)	3.60 mg/L	4.0 mg/L	4.0 mg/L	4.20 mg/L
P4 (downstream) Brebenei	N 44º38'37.6" E 23º26'21.8"	Nitrites ($N\text{-}NO_2$)	0.03 mg/L	0.04 mg/L	0.06 mg/L	0.09 mg/L
		Nitrates ($N\text{-}NO_3$)	4.0 mg/L	4.80 mg/L	4.80 mg/L	5.20 mg/L
P5 (downstream) Ionești	N 44º37'11.00" E 23º27'1.12"	Nitrites ($N\text{-}NO_2$)	0.04mg/L	0.04 mg/L	0.08 mg/L	0.09 mg/L
		Nitrates ($N\text{-}NO_3$)	5.20 mg/L	5.50 mg/L	5.0 mg/L	6.0 mg/L

Table 5

Values of nitrates and nitrites for water samples taken in the Işalnita area (upstream and downstream, 2017)

Water sample	GPS coordinates	Parameter analysed	Sampling 1 January	Sampling 2 February	Sampling 3 July	Sampling 4 August
P1 (upstream) Schitu	N 44º30'44.50" E 23º30'38.93"	Nitrites ($N\text{-}NO_2$)	0.03 mg/L	0.02 mg/L	0.02 mg/L	0.02 mg/L
		Nitrates ($N\text{-}NO_3$)	3.20 mg/L	2.0 mg/L	3.0 mg/L	3.0 mg/L
P2 (upstream) Brădești	N 44º29'27.86" E 23º35'52.27"	Nitrites ($N\text{-}NO_2$)	0.02 mg/L	0.02 mg/L	0.03 mg/L	0.02 mg/L
		Nitrates ($N\text{-}NO_3$)	3.0 mg/L	2.20 mg/L	3.0 mg/L	3.0 mg/L
P3 (upstream) Coțofenii din Dos	N 44º24'40.11" E 23º40'57.86"	Nitrites ($N\text{-}NO_2$)	0.03 mg/L	0.03 mg/L	0.03 mg/L	0.03 mg/L
		Nitrates ($N\text{-}NO_3$)	4.0 mg/L	3.0 mg/L	3.0 mg/L	3.20 mg/L
P4 (upstream) Mihăița	N 44º21'58.85" E 23º42'34.97"	Nitrites ($N\text{-}NO_2$)	0.04 mg/L	0.03 mg/L	0.05 mg/L	0.04 mg/L
		Nitrates ($N\text{-}NO_3$)	3.50 mg/L	3.0 mg/L	3.0 mg/L	3.50 mg/L
P5 (downstream) Işalnița	N 44º15'38.40" E 23º47'6.23"	Nitrites ($N\text{-}NO_2$)	0.06 mg/L	0.08 mg/L	0.06 mg/L	0.06 mg/L
		Nitrates ($N\text{-}NO_3$)	5.20 mg/L	5.0 mg/L	5.40 mg/L	6.0 mg/L
P6 (downstream) Podari	N 44º11'8.62" E 23º50'55.37"	Nitrites ($N\text{-}NO_2$)	0.09 mg/L	0.08 mg/L	0.09 mg/L	0.08 mg/L
		Nitrates ($N\text{-}NO_3$)	8.50 mg/L	7.0 mg/L	8.0 mg/L	7.0 mg/L
P7 (downstream) Secui	N 44º 1'21.82" E 23º52'41.83	Nitrites ($N\text{-}NO_2$)	0.07 mg/L	0.06 mg/L	0.07 mg/L	0.07 mg/L
		Nitrates ($N\text{-}NO_3$)	8.0 mg/L	6.50 mg/L	8.60 mg/L	7.0 mg/L
P8 (downstream) Drănic	N 43º49'3.45" E 23º49'36.68"	Nitrites ($N\text{-}NO_2$)	0.07 mg/L	0.06 mg/L	0.05 mg/L	0.03 mg/L
		Nitrates ($N\text{-}NO_3$)	6.20 mg/L	5.0 mg/L	6.0 mg/L	5.8 mg/L
P9 (downstream) Valea Stanciului	N 43º58'42.3" E 23º52'43.2"	Nitrites ($N\text{-}NO_2$)	0.05 mg/L	0.05 mg/L	0.03 mg/L	0.02 mg/L
		Nitrates ($N\text{-}NO_3$)	4.0 mg/L	3.0 mg/L	5.20 mg/L	4.0 mg/L
P10 (downstream) Zăval	N 43º85'12.19" E 23º84'83.37"	Nitrites ($N\text{-}NO_2$)	0.05 mg/L	0.03 mg/L	0.03 mg/L	0.03 mg/L
		Nitrates ($N\text{-}NO_3$)	4.0 mg/L	3.0 mg/L	4.0 mg/L	4.0 mg/L

Table 6

The values of the determined chemical elements (mg/L) from the water samples taken from the Turceni station area (2016)

Water sample	Period	Mn mg/L	S mg/L	Cr mg/L	Fe mg/L	Cyanide mg/L	Al mg/L	Pb mg/L
P1 (upstream) Drăgușești	January	0.02	0.0	0.0	0.20	0.01	0.0	0.0
	February	0.02	0.0	0.0	0.20	0.01	0.0	0.0
	July	0.02	0.10	0.0	0.20	0.01	0.01	0.0
	August	0.03	0.10	0.0	0.30	0.01	0.02	0.0
P2 (upstream) Vîrț	January	0.05	0.10	0.0	0.20	0.01	0.02	0.01
	February	0.06	0.10	0.0	0.20	0.01	0.02	0.01
	July	0.05	0.10	0.0	0.40	0.01	0.02	0.02
	August	0.05	0.10	0.0	0.30	0.01	0.01	0.03
P3 (downstream) Rovinari	January	0.07	0.10	0.0	0.30	0.01	0.02	0.05
	February	0.07	0.20	0.0	0.40	0.01	0.02	0.08
	July	0.07	0.10	0.01	0.40	0.01	0.01	0.05
	August	0.10	0.20	0.02	0.30	0.01	0.02	0.08
P4 (downstream) Brebenei	January	0.10	0.10	0.0	0.40	0.01	0.03	0.10
	February	0.20	0.20	0.0	0.50	0.0	0.03	0.20
	July	0.10	0.20	0.01	0.30	0.01	0.02	0.10
	August	0.20	0.30	0.01	0.30	0.0	0.01	0.10
P5 (downstream) Ionești	January	0.20	0.10	0.0	0.50	0.0	0.03	0.25
	February	0.20	0.20	0.0	0.50	0.0	0.03	0.20
	July	0.20	0.30	0.01	0.30	0.0	0.02	0.30
	August	0.10	0.20	0.0	0.02	0.0	0.02	0.20

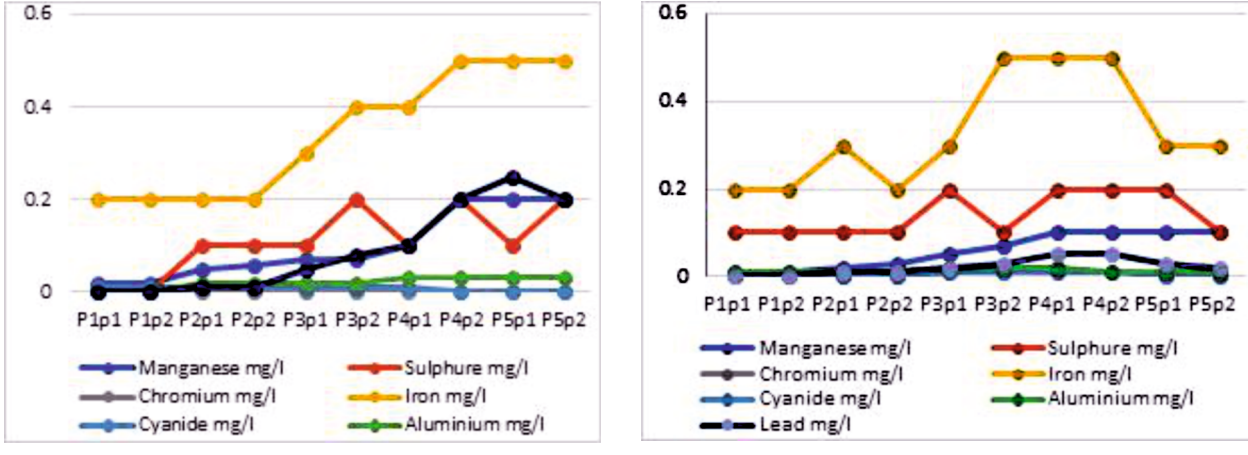

Fig. 1. Dynamics of the values of the chemical elements determined from the water samples taken from the Turceni station area during January-February (left), July-August (right), 2016

Detection of the presence of chemical elements in the Jiu water

Five water samples were taken from the Turceni station area (two upstream and three downstream) and, from the Ișalnița area, 10 water samples were taken (two upstream and six downstream). The values of the chemical elements determined in the water samples taken from the course of the Jiu on the territory of Gorj county, in January, February, July and August of 2016 are shown in Table 6 and Fig. 1.

Analysing the values of chemical pollution indicators for water samples collected from the Jiu River downstream and upstream of the Rovinari thermal power plant, we found that the values obtained for manganese were higher downstream of the Rovinari thermal power plant, values which, according to Ord 161/2006, classifies the water taken from these points in the second class of greening. Also, the values obtained for iron were higher downstream of the Rovinari thermal power plant and, for the values obtained from the water samples taken from these areas, we are talking about a classification of water in the second class of greening (23). In the case of lead, very high values were obtained, especially downstream of the thermal power plant, values that include water from the Rovinari, Brebenei, and Ionești areas in quality class V.

Table 7

The values of the determined chemical elements (mg/L) from the water samples taken from Iṣalnița (2016)

Water sample	Period	Mn mg/L	S mg/L	Cr mg/L	Fe mg/L	Cyanide mg/L	Al mg/L	Pb mg/L
P1 (upstream) Schitu	January	0.10	0.0	0.0	0.20	0.01	0.01	0.02
	February	0.10	0.0	0.0	0.20	0.01	0.02	0.02
	July	0.01	0.10	0.01	0.20	0.0	0.0	0.008
	August	0.01	0.10	0.01	0.30	0.0	0.01	0.01
P2 (upstream) Brădești	January	0.05	0.10	0.0	0.30	0.01	0.02	0.03
	February	0.05	0.10	0.0	0.20	0.01	0.02	0.02
	July	0.02	0.10	0.02	0.30	0.01	0.02	0.02
	August	0.07	0.20	0.01	0.40	0.01	0.02	0.02
P3 (upstream) Coțofenii din Dos	January	0.02	0.10	0.0	0.20	0.01	0.02	0.01
	February	0.02	0.10	0.0	0.10	0.01	0.03	0.01
	July	0.10	0.20	0.01	0.30	0.01	0.02	0.01
	August	0.10	0.10	0.01	0.30	0.01	0.01	0.02
P4 (upstream) Mihăița	January	0.02	0.10	0.01	0.10	0.01	0.02	0.01
	February	0.03	0.10	0.01	0.20	0.01	0.02	0.02
	July	0.10	0.10	0.0	0.40	0.01	0.02	0.04
	August	0.20	0.20	0.01	0.30	0.0	0.02	0.03
P5 (downstream) Iṣalnița	January	0.10	0.30	0.01	0.30	0.02	0.02	0.02
	February	0.20	0.30	0.02	0.40	0.02	0.02	0.05
	July	0.20	0.20	0.02	0.40	0.01	0.03	0.05
	August	0.30	0.40	0.03	0.70	0.02	0.02	0.06
P6 (downstream) Podari	January	0.40	0.40	0.02	0.50	0.03	0.03	0.08
	February	0.30	0.40	0.01	0.50	0.02	0.02	0.10
	July	0.30	0.40	0.02	0.90	0.02	0.02	0.10
	August	0.40	0.50	0.02	1.0	0.01	0.01	0.20
P7 (downstream) Secui	January	0.20	0.30	0.0	0.40	0.02	0.02	0.10
	February	0.10	0.20	0.0	0.30	0.01	0.01	0.10
	July	0.20	0.30	0.01	1.20	0.01	0.01	0.10
	August	0.20	0.10	0.01	1.0	0.01	0.01	0.05
P8 (downstream) Drănic	January	0.07	0.10	0.0	0.30	0.01	0.02	0.05
	February	0.07	0.10	0.0	0.20	0.01	0.02	0.03
	July	0.20	0.10	0.0	0.80	0.01	0.01	0.03
	August	0.10	0.10	0.0	0.80	0.01	0.02	0.05
P9 (downstream) Valea Stanciului	January	0.05	0.10	0.0	0.20	0.01	0.02	0.03
	February	0.05	0.10	0.0	0.20	0.01	0.02	0.02
	July	0.08	0.10	0.0	0.50	0.01	0.02	0.02
	August	0.05	0.10	0.0	0.50	0.01	0.02	0.03
P10 (downstream) Zăval	January	0.03	0.10	0.0	0.20	0.01	0.02	0.01
	February	0.03	0.10	0.0	0.20	0.01	0.01	0.01
	July	0.05	0.10	0.0	0.30	0.01	0.02	0.02
	August	0.05	0.10	0.0	0.30	0.01	0.02	0.01

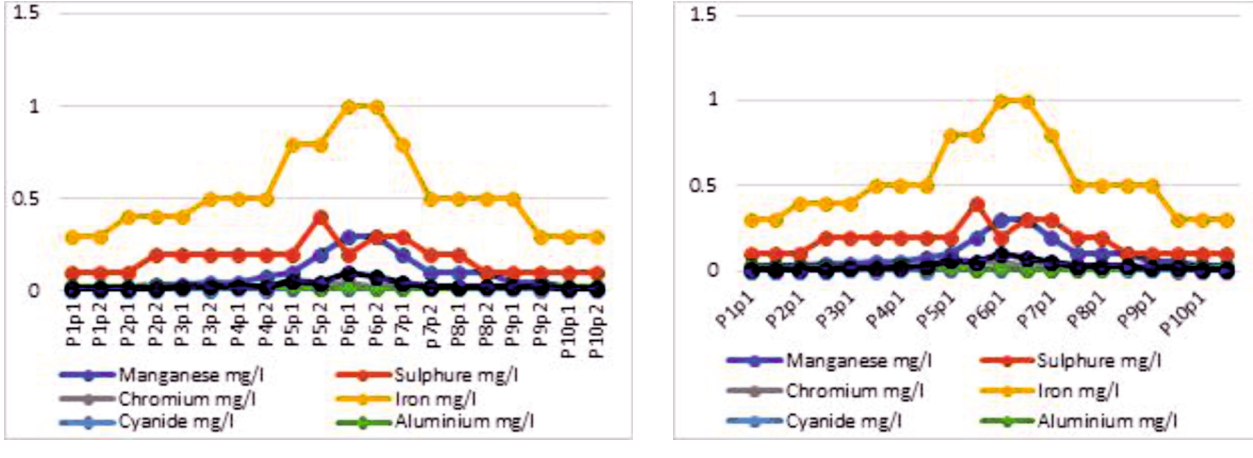

Fig. 2. Dynamics of the values of the chemical elements determined from the water samples taken from the Iṣalnița area during January-February (left), July-August (right) 2016

Table 8

The values of the determined chemical elements (mg/L) from the water samples taken from the Turceni station area (2017)

Water sample	Period	Mn mg/L	S mg/L	Cr mg/L	Fe mg/L	Cyanide mg/L	Al mg/L	Pb mg/L
P1 (upstream) Drăgușești	January	0.04	0.10	0	0.3	0.0	0.02	0.0
	February	0.04	0.10	0	0.30	0.0	0.01	0.0
	July	0.01	0.10	0.0	0.20	0.0	0.01	0.0
	August	0.01	0.10	0.0	0.20	0.0	0.01	0.0
P2 (upstream) Vîrț	January	0.03	0.20	0.01	0.20	0.0	0.02	0.01
	February	0.05	0.20	0.01	0.30	0.01	0.02	0.01
	July	0.02	0.10	0.0	0.30	0.0	0.01	0.01
	August	0.03	0.10	0.0	0.20	0.0	0.01	0.01
P3 (downstream) Rovinari	January	0.08	0.20	0.02	0.50	0.01	0.02	0.02
	February	0.08	0.30	0.02	0.50	0.01	0.03	0.03
	July	0.05	0.20	0.01	0.30	0.01	0.02	0.02
	August	0.07	0.10	0.01	0.50	0.01	0.02	0.03
P4 (downstream) Brebenei	January	0.20	0.30	0.01	0.70	0.02	0.03	0.05
	February	0.30	0.20	0.02	0.70	0.01	0.03	0.03
	July	0.10	0.20	0.02	0.50	0.01	0.02	0.05
	August	0.10	0.20	0.01	0.50	0.01	0.01	0.05
P5 (downstream) Ionești	January	0.30	0.20	0.01	0.50	0.01	0.02	0.02
	February	0.20	0.20	0.0	0.50	0.0	0.02	0.02
	July	0.10	0.20	0.01	0.30	0.0	0.01	0.03
	August	0.10	0.10	0.01	0.30	0.0	0.01	0.02

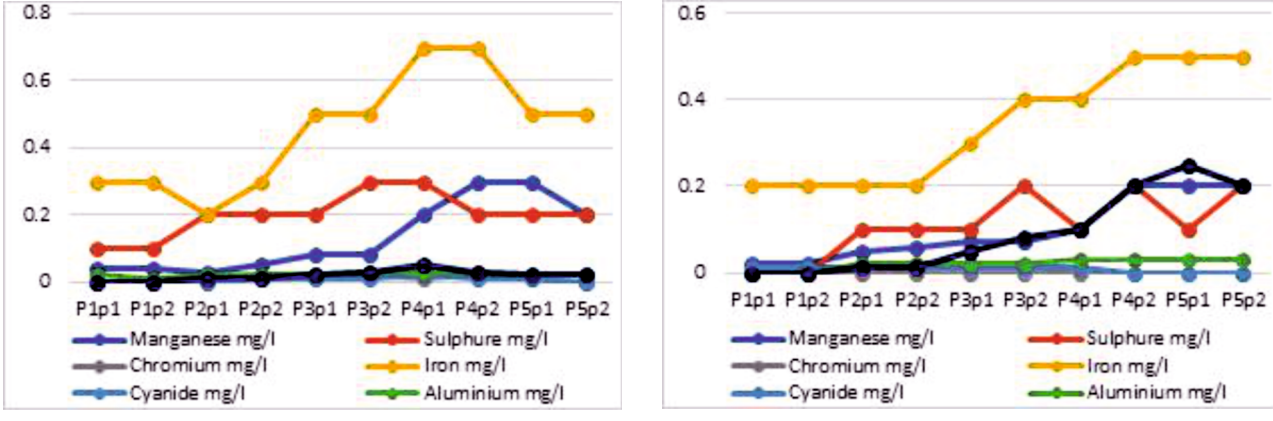

Fig. 3. Dynamics of the values of the chemical elements determined from the water samples taken from the Turceni station area during January-February (left) July-August (right) 2017

The values of the chemical elements determined in the water samples taken from the Jiu River on the Dolj County in January, February, July, and August of 2016 are shown in Table 7 and Fig. 2.

For the water samples taken from the Jiu River on the territory of Dolj County in January and February 2016, we found high values for manganese in the area of Işalnița and Podari, values that include the water in these areas in the second and third class. Also, in the water samples P4, P5 and P6 we identified low values of chromium that include water from these areas in the I class of greening. In samples P7, P8, P9, and P10 (downstream), this element has not been identified.

For iron, the values obtained allowed the classification of water on this section in class I and II. Unfortunately, along the Jiu River, during Dolj County, it was identified in water and lead samples, especially in the Işalnița area and at least in three points downstream of it, values that include water from these areas in quality class IV and V.

Analysing the results obtained for lead, on the two investigated areas, it can be seen that water is part of quality class IV and V (23).

The values of the chemical elements determined in the water samples taken from the Jiu River on the territory of Gorj County, in January, February, July, and August of 2017 are shown in Table 8 and Fig. 3.

Among the determined elements, for sulphide and aluminium we can say that they are not relevant elements for surface water pollution.

Table 9

The values of the determined chemical elements (mg/L) from the water samples taken from Iṣalnița (2017)

Water sample	Period	Mn mg/L	S mg/L	Cr mg/L	Fe mg/L	Cyanide mg/L	Al mg/L	Pb mg/L
P1 (upstream) Schitu	January	0.05	0.0	0.0	0.30	0.0	0.01	0.01
	February	0.05	0.0	0.0	0.20	0.0	0.01	0.01
	July	0.03	0.10	0.0	0.30	0.0	0.03	0.01
	August	0.03	0.10	0.0	0.30	0.0	0.02	0.01
P2 (upstream) Brădești	January	0.10	0.0	0.0	0.30	0.0	0.01	0.005
	February	0.10	0.10	0.01	0.30	0.01	0.02	0.003
	July	0.03	0.10	0.01	0.40	0.0	0.02	0.01
	August	0.04	0.20	0.01	0.40	0.0	0.02	0.01
P3 (upstream) Coțofenii din Dos	January	0.10	0.10	0.01	0.30	0.0	0.01	0.005
	February	0.10	0.20	0.01	0.20	0.01	0.02	0.002
	July	0.04	0.20	0.01	0.40	0.01	0.02	0.02
	August	0.05	0.20	0.01	0.50	0.0	0.02	0.02
P4 (upstream) Mihăița	January	0.10	0.20	0.01	0.20	0.01	0.01	0.005
	February	0.20	0.10	0.01	0.40	0.01	0.01	0.008
	July	0.05	0.20	0.02	0.50	0.01	0.03	0.02
	August	0.08	0.20	0.02	0.50	0.0	0.02	0.03
P5 (downstream) Iṣalnița	January	0.10	0.20	0.02	0.50	0.01	0.02	0.01
	February	0.30	0.30	0.02	0.70	0.02	0.03	0.02
	July	0.10	0.20	0.03	0.80	0.01	0.02	0.06
	August	0.20	0.40	0.04	0.80	0.01	0.01	0.05
P6 (downstream) Podari	January	0.30	0.30	0.03	0.90	0.02	0.03	0.02
	February	0.30	0.30	0.02	0.60	0.02	0.03	0.05
	July	0.30	0.20	0.05	1.0	0.01	0.02	0.10
	August	0.30	0.30	0.03	1.0	0.01	0.01	0.08
P7 (downstream) Secui	January	0.10	0.20	0.01	0.50	0.01	0.02	0.08
	February	0.10	0.20	0.01	0.30	0.01	0.02	0.05
	July	0.20	0.30	0.05	0.80	0.01	0.01	0.05
	August	0.10	0.20	0.03	0.50	0.01	0.01	0.03
P8 (downstream) Drănic	January	0.05	0.20	0.01	0.30	0.01	0.02	0.03
	February	0.05	0.10	0.0	0.30	0.0	0.02	0.03
	July	0.10	0.20	0.02	0.50	0.01	0.01	0.03
	August	0.10	0.10	0.02	0.50	0.01	0.02	0.03
P9 (downstream) Valea Stanciului	January	0.05	0.10	0.0	0.30	0.0	0.01	0.02
	February	0.05	0.10	0.0	0.20	0.0	0.01	0.02
	July	0.05	0.10	0.01	0.50	0.01	0.02	0.02
	August	0.05	0.10	0.0	0.30	0.01	0.02	0.02
P10 (downstream) Zăvald	January	0.02	0.10	0.0	0.20	0.0	0.01	0.02
	February	0.02	0.10	0.0	0.20	0.0	0.01	0.01
	July	0.03	0.10	0.0	0.30	0.01	0.02	0.01
	August	0.03	0.10	0.0	0.30	0.01	0.02	0.01

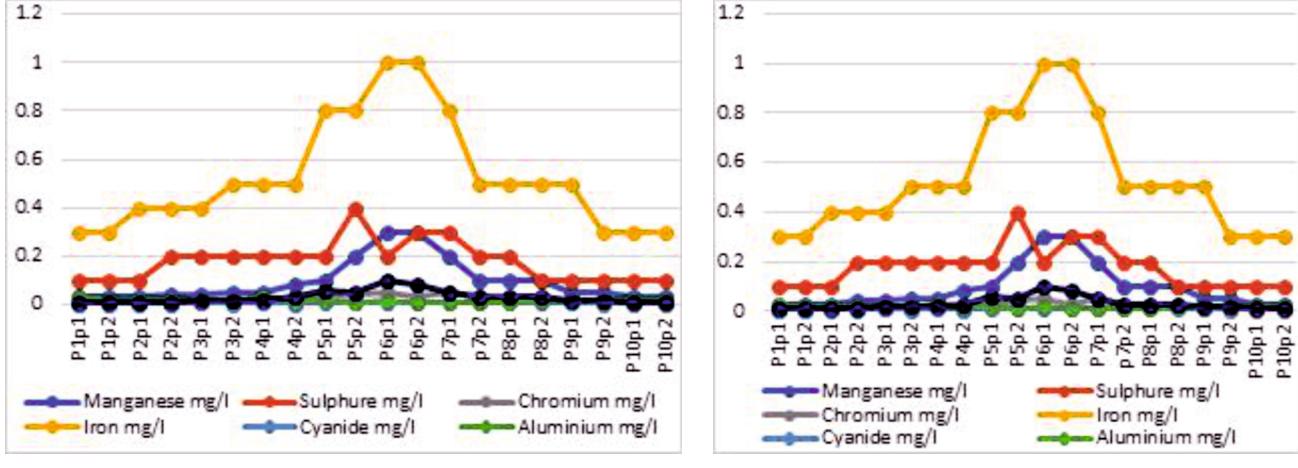

Fig. 4. Dynamics of the values of the chemical elements determined from the water samples taken from the Iṣalnița area during January-February (left), July-August (right), 2017

The presence of sulphides in the water highlights the fact that wastewater is discharged into the Jiu water and the presence of aluminium in the water does not alter the ecological / physiological state of the bioindicators / molluscs.

The values obtained for the chemical elements determined in the water samples taken from the Jiu River on the territory of Gorj County, in January and February 2017 showed the increase of values for manganese, especially in the Brebeni and Ionești area downstream of the Rovinari thermal power-plant, values that include the water in these areas in II and III class of greening. The values obtained for chromium and iron include water from Rovinari and Brebeni points in the first and second class of greening. For lead we could observe that the values obtained in January and February of 2017 were lower than those obtained in the same period of 2016.

For the values obtained from water samples collected around the Rovinari thermal power plant and downstream, the classification is for the third and fourth class of greening. In the case of water samples collected in July and August of 2017, we could see that in terms of the values obtained for chromium, the water taken from these points falls into the first greening class, for manganese and iron in the first class. and the second grade of greening and, for lead in III and IV class of greening.

The values of the chemical elements for the water samples taken during January, February, July and August 2017 on the Jiu River, downstream and upstream of the Işalnița power plant are shown in Table 9 and Fig. 4. The values obtained for the chemical elements determined on this section in 2017 show, at least for lead, much lower values compared to the same period in 2016. According to the values obtained in 2017 we can classify the water in this area in class I and II of greening compared to the IV and V class from 2016. The values obtained during this period include water in the second and third class of greening for the chemical element manganese in the Isalnița area and downstream of it, for chromium in the second class of greening in the Podari and Secui area, for iron in the III class of greening in the Podari area and for lead in the IV and V class of greening in the Işalnița, Podari, and Secui area.

When we talk about surface and groundwater pollution, we think that its effects affect organisms, ecosystems and the anthroposphere. Among the pollutants of water, we can talk about natural organic substances, those that consume oxygen from water, either for the development of the living organism or for the decomposition of dead matter. Aerobic self-cleaning processes, aerobic bacteria that oxidize organic substances need oxygen. The normal concentration of dissolved O_2 is between 34-36 mg × dm^{-1}, and its decrease below this limit will be followed by the cessation of aerobic processes, with very serious consequences (1, 3, 5, 13, 14, 27, 33, 34).

The concentration of dissolved oxygen decreases when the water temperature rises, at which point the life of aquatic organisms is endangered. Wastewater treatment plants, mining, manufacturing, and agriculture are the terrestrial sources that generate heavy metals in the environment. They are transported in dissolved forms in watercourses or as an integral part of sediments (1, 4, 6, 10, 19, 20, 22, 29, 31, 33, 34).

Metals are also generated as a result of natural rock erosion processes. Substantial amounts of metals in water resources come from tailings ponds and tailings dumps (12, 17, 18, 31).

Also, inorganic substances (heavy metals -Pb, Cd, Hg, Cu, Zn, Cr), chlorides, sulphates, dissolved or in suspension, frequently found in industrial wastewater, are important sources of pollution. Inorganic salts of these metals increase salinity and increase water hardness (3, 5, 14, 22).

Biological or chemical processes do not create or destroy heavy metals. These processes, either biological or chemical, have the ability to facilitate the transition of the metal from one valence to another or from an organic to an inorganic form (12, 17, 18, 31).

It seems that the main problem associated with the persistence of heavy metals in the environment is related to the capacity of bioaccumulation and bioamplification, phenomena that can cause an increase of the metal in the ecosystem. Heavy metals, through the process of bioaccumulation, have toxic effects on aquatic organisms, but at the same time inhibit the self-purification processes (12, 18, 31).

There are also substances that at very low levels are essential for life (arsenic, chromium, copper, beryllium, iron, boron, fluorine, iodine, molybdenum, lead, manganese, mercury, selenium), but which become toxic and carcinogenic with an increase in concentration (2, 7, 12, 17, 18). Many of the substances listed above have an increased affinity for sulphur thus disrupting the activity of sulphur-containing enzymes. Heavy metals precipitate or break down phosphorus-containing biological compounds. Substances such as lead, cadmium, copper, and mercury, in their ionic form, bind to cell membrane receptors thus preventing membrane transport. Among the inorganic, polluting, common compounds are aluminium fluoride, chromium-containing pigments, copper sulphate, nickel sulphate, sodium sulphate, hydrocyanic acid, and cyanides (12, 17, 18).

CONCLUSIONS

Following this study, we can conclude that for the water samples taken from the Jiu River the values of

nitrates and nitrates of Gorj County in 2017 were higher in July compared to August for the Drăguțești-Ionești area, the values obtained framing the Jiu water on this section in quality class I and II for the nitrogen indicator and class II and III for nitrates. The values of nitrogen and nitrogen in Dolj County were higher in July compared to August in the water samples taken downstream of Işalnița, values that include the Jiu water on this section in class III of quality. For the water samples collected from the Jiu River on the territory of Gorj county, high values were obtained for Mn, Cr, and Fe downstream of the Rovinari thermal power plant. Increased values of Pb in the Rovinari, Brebenei, and Ionești area, which include water in class V of greening. For the water samples collected from the Jiu River on the territory of Dolj county, high values were obtained for Mn (Işalnița-Podari area). The presence of chromium in the water from points P4, P5, and P6. Increased values of lead in the Işalnița area and for at least three points downstream, values that include water in class IV and V of greening.

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