INVENTORY OF PRESSURES ON SURFACE WATER BODIES AND THE ECOLOGICAL STATUS ALONG THE LOWER JIU RIVER

ZANFIR Cristina Georgiana, MITITELU-IONUȘ Oana, CIOBOIU Olivia

Abstract. This paper has as purpose the inventory of significant pressures of surface water bodies and the generated ecological status in the lower Jiu River. Three surface water bodies are analysed along the sector of interest (*Isalnița Reservoir, JIU: Isalnița Reservoir- Bratovoiești and JIU: Bratovoiești-Danube confluence*), and the delimitation of the water bodies was made according to the *Management Plan of the Jiu River Basin* (2016-2022). The Water Framework Directive provides that only significant pressures must be taken into account, i.e. pressures with a significant impact on water, resulting in the failure to meet environmental objectives for the studied water bodies. This approach, correlated with the list of pressures and the particular characteristics of the catchment, will lead to the identification of significant pressures. An alternative method is for the conceptual understanding to be summarized in a simple set of rules that indicates directly if a pressure is significant. Such an approach would be to compare the magnitude of the pressure with a relevant criterion or limit value for the water body. Therefore, the significant pressures identified in the study area are point, diffuse and hydro morphological pressures. For the pressure and impact analysis, the DPSIR (*Driver-Pressure-State-Impact-Response-Response*) concept is used, so for the inventory information must be included about anthropogenic activities and the changes in the state of the water body, and the response (measures taken to improve the condition of the water body). *The ecological status* of the water bodies is defined by the quality elements indicated in the Water Framework Directive (transposed in Romania by Water Law 107/1996 as subsequently amended and supplemented), respectively biological elements, hydro morphological elements, general physico-chemical elements and specific pollutants, applying the "worst case" principle among the quality elements. The analysis of these elements was done on monitoring sections, the results being relevant (moderate ecological status) for the three water bodies considered. The importance of this research consists in rising the awareness among communities about the reduction of pressures on water bodies along the Lower Jiu River, and in making local and regional authorities responsible for the importance and maintenance of *the good ecological status*.

Keywords: water body, human pressure, DPSIR, quality elements, Water Framework Directive, Jiu River.

Rezumat. Inventarierea presiunilor asupra corpurilor de apă de suprafață și starea ecologică de-a lungul cursului inferior al râului Jiu. Prezenta lucrare are ca scop inventarierea presiunilor semnificative a corpurilor de apă de suprafață și starea ecologică corespunzătoare de-a lungul cursului inferior al râului Jiu. Pe sectorul amintit sunt analizate trei corpuri de apă de suprafață (*Acumularea Isalnița, JIU: Ac. Isalnița- Bratovoiești și JIU: Bratovoiești-confluența Dunăre*), delimitarea copurilor de apă fiind realizată conform *Planului de Management al Bazinului Hidrografic Jiu* (2016 – 2022). Directiva Cadru Apă prevede luarea în considerare numai a presiunilor semnificative, și anume presiunile care produc un impact semnificativ asupra apelor, respectiv cele care au ca rezultat neatingerea obiectivelor de mediu pentru corpurile de apă studiate. Această abordare corelată cu lista tuturor presiunilor alături de caracteristicile particulare ale bazinului de recepție va conduce la identificarea presiunilor semnificative. O metodă alternativă este aceea că întelegerea conceptuală să fie sintetizată într-un set simplu de reguli care indică direct dacă o presiune este semnificativă. O abordare de acest tip este de a compara magnitudinea presiunii cu un criteriu sau o valoare limită relevantă pentru corpul de apă. Astfel, presiunile semnificative identificate pe sectorul analizat sunt surse de natură punctiformă, difuză și presiuni hidromorfologice. Pentru analiza presiunilor și a impactului se folosește conceptul DPSIR (*Activitate antropică-Presiune-Stare-Impact-Răspuns*), astfel în inventariere este necesar să se includă și informații despre activitățile antropice și schimbările la nivelul stării corpului de apă, cât și răspunsul (măsurile luate pentru a îmbunătăți starea corpului de apă). *Starea ecologică* este definită de elementele de calitate indicate în Directiva Cadru Apă (transpusă în România prin Legea Apelor 107/1996), respectiv elementele biologice, elementele hidromorfologice, elemente fizico-chimice generale şi poluanţii specifici cu aplicarea principiului „celei mai defavorabile situații" dintre elementele de calitate. Analiza acestor elemente s-a făcut pe secțiuni de monitorizare a corpurilor de apă de-a lungul Jiului, rezultatele fiind relevante (stare ecologică moderată) pentre cele trei corpuri de apă considerate. Importanța cercetării constă în conștientizarea comunităților cu privire la scăderea presiunilor asupra corpurilor de apă din cursul inferior al râului Jiu și în responzabilizarea autorităților locale și regionale asupra importanței și menținerii *stării ecologice bune.*

Cuvinte cheie: corp de apă, presiune umană, DPSIR, elemente de calitate, Directiva Cadru Apă, râul Jiu.

INTRODUCTION

Literature review. The identification, delimitation and classification of surface water bodies was made taking into account the physical characteristics of the hydrographic network analysed according to criterion B of the Water Framework Directive 2000/60/EC considering the ecoregions, the altitude of the basin, the geological characteristics and surface catchment as mandatory and optional criteria, the lithological structure of the riverbed, the specific multiannual average flow, the specific monthly minimum annual flow with 95% probability of manifestation, the climatic characteristics (the average multiannual precipitation and the multiannual average temperature) and the average slope of the watercourse.

The discrete and significant element, such as river, lake, channel, river sector, canal sector, transient waters, some of the coastal waters bear the name of surface water body (***. Water Framework Directive 2000/60 / EC, art. 2.10). The confluence of one section of river with another clearly marks both geographically and hydro morphologically

the boundaries of a body of water. Changing the quality classes of surface water is a very important criterion that is subject to analysis in order to delimit the water bodies (ȘERBAN, 2011; ȘERBAN & IONUȘ, 2011; CIOBOIU & CISMAȘIU, 2016; 2018).

Due to the fact that the qualitative state of the surface water is interconnected with the pressures and the anthropic impact on them (SCHINEGGER et al., 2012), the delimitation of the water bodies is a continuous process, which can undergo changes over time. Therefore, a body of water belongs to a single quality class.

The classification of surface water bodies is necessary in order to establish environmental objectives (KALLIS & BUTLER, 2001; BREZEANU et al., 2011; GAVRILESCU et al., 2017). The Water Framework Directive (DCA) requires the establishment of different environmental objectives for each water body type, as follows: a) Five classes of *ecological status* were established for natural water bodies (very good, good, moderate, low and bad); b) For heavily modified and artificial water bodies there are lower environmental objectives, quantified by three categories of *ecological potential* (maximum, good and moderate).

"Significant pressures" are those pressures which, either alone or in combination with other pressures, may prevent or contribute to the failure to meet environmental objectives in accordance with Article 4 (1) of the WFD. The environmental objectives are mainly to achieve the good state, not to deteriorate the current state, to prevent the significant and lasting increasing tendency of the groundwater pollution and to reach the DCA objectives for the protected areas.

Study area. The lower river basin of the Jiu river has an elongated and asymmetrical shape, with a generally west-east orientation, the main tributaries are on the right side and occupy an area of about 2214 km² (***. Atlas of the Romanian Water Cadastre, 1992) (Table 1; Fig. 1). The general tendency of the Jiu River is to build its floodplain on the left side and to destroy the right bank by lateral erosion (IONUȘ, 2014).

Table 1. Delimitation and classification of surface water bodies along the Lower Jiu River.

Water body category	Name of water body	Water category	(EU Surface Water Body Code PM)*	The global status (ecological and chemical) PM*	Water Body Typology Art.5**	EU Surface Water Body Code Art.5**	The global status (ecological and chemical)**
Ișalnița Reservoir	Isalnita Reservoir	LA/ HMWB	ROLW7.1_B120	2	ROLA01	ROLW7.1_B120	Yes
Jiu River	Jiu, Reservoir Ișalnița-Bratovoiești	RW	RORW7.1_B121	2	RO10*	RORW7.1_B121	Yes
Jiu River	Jiu Bratovoiesti-Danube confluence.	RW	RORW7.1_B148	3	RO11*	RORW7.1_B148	No

Legend: * Jiu river basin management plan ~ 2009-2015;
* Jiu river basin management plan ~ 2016-2022; LA – Reservoir; RW – River;
Ecological status / global potential: 2 – Good, 3 – Moderate;
ROLA01 - Lake located in the plain area, small depth, sand;
RO10 * - Watercourse sector located in the plain area with a surface area of more than 5000 km^2;
RO11 * - Watercourse sector with wetlands located in the plain area and with the surface of the reception basin.

The determination of the ecological status is achieved based on the values of the biological, hydro morphological and physical-chemical parameters recorded on three monitoring sites of the studied water bodies (Tables 2; 3).

Table 2. Sections for monitoring the water quality of the Isalnita Accumulation, according to ABA JIU - 2016 lakes.

No.	Water body	Water body code	River Name	Lake Name	Typology	Section Name
LCA CRAIOVA						
1	Ac. Isalnita	ROLW7.1_B120	Jiu	Isalnita	ROLA01	Ac. Isalnita Middle
2	Ac. Isalnita	ROLW7.1_B120	Jiu	Isalnita	ROLA01	Ac. Isalnita Dam

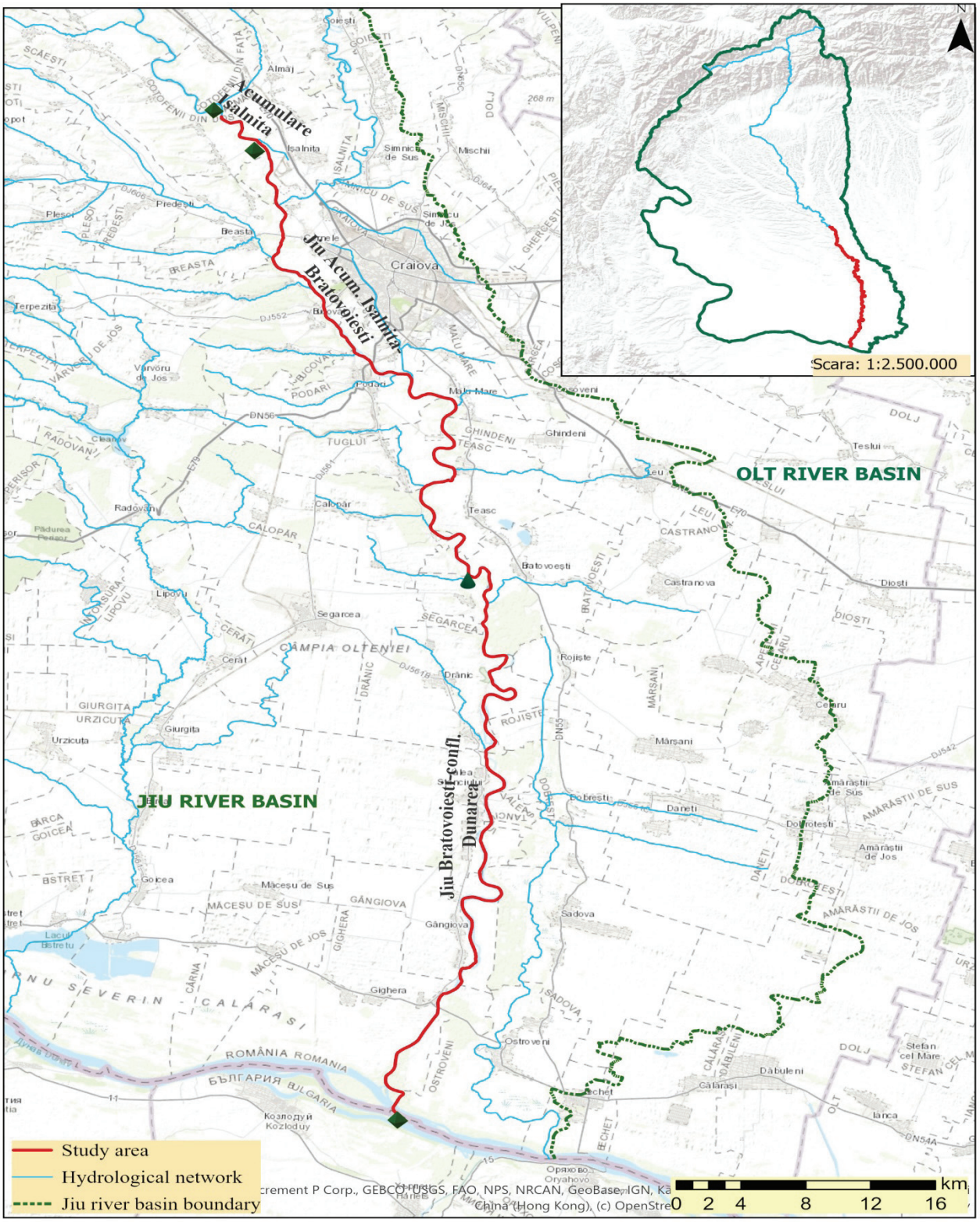

Figure 1. Study area (Process with ArcGIS Pro the next version of ArcGIS Desktop, based on the Jiu River Basin Administration data).

Table 3. Sections for monitoring water quality in the lower Jiu river, according to ABA JIU - 2016 rivers.

No.	River Name	Water body	Water body code	Water body Typology	Section Name
LCA CRAIOVA					
1	Jiu	Jiu - Acum. Ișalnița-Bratovoiești	RORW7.1_B121	RO10	loc. Podari
2	Jiu	Jiu - Acum. Isalnita-Bratovoiesti	RORW7.1_B121	RO10	loc. Malu Mare
3	Jiu	Jiu - Bratovoiesti-confl. Dunarea	RORW7.1_B148	RO11	loc. Zăval

METHODOLOGY

Research methods and legislation framework. The main legislation framework that stand at the basics of this research is Water Framework Directive 2000/60/EC.

In order to analyse hydro morphological conditions, the hydrological regime was considered. The hydrological regime is determined by natural flow regime, river continuity and WFD morphological conditions (BIZJAK A. & MIKOŠ, 2004).

Hydro morphological elements for evaluating the ecological status are represented by the hydrological regimes and the morphological parameters. When evaluating the ecological status of Romanian rivers, the biological elements that are taken into consideration are the phytoplankton, the macro-zoobentos (the composition and abundance of the benthic invertebrate fauna) and fish fauna (composition, abundance and age distribution) (Table 4).

Table 4. Categories of pressure on water bodies, according to the Water Framework Directive 2000/60 / EEC.

Pressure	Main Driver(s)	Clarification on pressures
1.1 Point – Urban waste water	Urban development	Included in the Urban Waste Water Directive or not. Includes discharges from non-manufacturing commercial areas that can be widely assimilated to urban wastewater (agro-industrial units). It includes discharges of partially purified or unclean water that are identified as point sources.
1.4 Point - Non IED plants	Industry	Any industrial point sources not included in E-PRTR.
1.6 Point - Waste disposal sites	Urban development	Point sources due to urban or industrial waste deposits.
1.9 Point – Other		Other point sources not included in the above categories.
2.1 Diffuse - Urban run off	Urban development, Industry	Overflows and discharges in urban areas, not identified as point sources.
2.2 Diffuse – Agricultural	Agriculture	
2.5 Diffuse – Contaminated sites/Abandoned industrial sites	Industry	Pollution from abandoned industrial sites or contaminated sites due to past industrial activities, industrial waste deposits or accidental pollution, which are identified as diffuse sources (for the punctiform ones see above "Punctiform - Contaminated sites / abandoned industrial sites). This category does not cover existing industrial activities.
2.6 Diffuse - Discharges not connected to sewerage network	Urban development	Pollution from urban wastewater without connection to the sewage system and identified as diffuse sources
2.10 Diffuse – Other	Any driver/Other	*Any other sources not included in the above categories.*
3.4 Abstraction/Flow Diversion – Cooling water	Industry; Energy non-hydro	
4.2.2 Dams, barriers and locks for flood protection	Flood Protection	
4.2.3 Dams, barriers and locks for drinking water	Urban development	
8 Unknown Pressures		Relevant pressures only where the condition is less than good and the pressure is unknown.

RESULTS AND DISCUSSIONS

In order to establish the significant pressures on the water bodies that could result in a deterioration or a justification of the quality of the water body with direct impact on the achievement of the environmental objectives (good water condition), the following steps had to be taken:

1. Highlighting the point sources of wastewater disposal from the economic agents from the studied area.
2. Highlight the diffuse sources of pollution with direct impact on the quality of the water bodies.
   - **The agricultural area with direct impact is significant - 64.5%.**
3. Hydro morphological pressures with direct impact especially on the quality of the biological elements of the studied water bodies.

- **The significant hydro morphological pressure is given by the high percentage of flood defences - 89.3%.**

Considering the fact that the dams are positioned as lines of defence outside the lower bank of the Jiu river, their impact on the water bodies from the point of view of biological elements is not felt in the sense of their deterioration, which is demonstrated by the results of the monitoring carried out on these bodies: water (composition and abundance of aquatic / phytobenthous flora; composition and abundance of benthic / macro-non-vertebrate invertebrate fauna; composition, abundance and age structure of the fish fauna / ichtiofauna) (Table 5).

The point pressures (industrial) and diffuse (agricultural) contribute to the pollution of water resources, by evacuating pollutants specific to the type of activity carried out (Fig. 2. Point pressures) presents the significant point sources. From the point of view of the discharges of organic substances (nutrients) in the Jiu river, the wastewater disposal systems can be mentioned, respectively the Craiova municipality which has a wastewater treatment plant. A deficit in this chapter is seen in the rural areas that have not developed the system of wastewater collection and treatment yet. Moreover, significant industrial units are concentrated in northern and southern areas.

Regarding diffuse pressures (Fig. 3. Diffuse pressures), pollution monitoring is more difficult to achieve. Thus, according to Corine land Cover 2018 in the lower basin of the Jiu river (after the Jiu-Amaradia confluence), the predominant surface categories are non-irrigated arable land (211) and complex cultivation patterns (242).

The complex hydrotechnical works (reservoirs, regularizations and dyke works) along the lower Jiu river area represented a need for social-economic development (Fig. 4. Hydro morphological pressures). The improvement works create both significant hydro-morphologic pressures and functional effects which result from the scope for which they had been performed: regularization of natural flows, providing the needs of water (the Işalnița reservoir), protection against the floods (the left bank of the Jiu river between confluence Raznic-Jiu sand confluence Jiu-Danube).

Therefore, diking and regularization works generally cause modifications of the courses, alterations of the hydraulic features and interruptions of lateral continuity (IONUȘ, 2011).

Table 5. Significant pressures in the study area from the economic agents.

No.	A	B	C	D	E	F	G	H	I
1	ROLW7.1_B120	2.2		Nitrates Directive					
2	ROLW7.1_B120	2.5		Not dangerous deposits - SC COMPLEXUL ENERGETIC OLTENIA SA - SE Işalnița (Işalnița I and Işalnița II);	-	YES	-		
3	ROLW7.1_B120	4.2.3		Dam height =18 m	-	YES	-		
4	ROLW7.1_B120	3.4		SC ENERGETIC COMPLEX OLTENIA SA - SE Işalnița (in the situation of open circuit operation);	-	YES	-		
5	RORW7.1_B121	1.4		SC COMPLEXUL ENERGETIC OLTENIA - Electrocentrale Branch Craiova - Işalnița Plant;;	-	YES	-		The measures programmes for this water body will bring the water body in a good ecological state. Switching from diffuse to point pollution controlled by regulatory acts considering specific legislation for the management of water quality will determine the good ecological status of the water body.
6	RORW7.1_B121	2.10		SC GUARDIAN ECO BURN SRL - Işalnița incineration plant (not abandoned);	-	YES	-		
7	RORW7.1_B121	2.5		OMV PETROM SA - Workstation Combinatul Doljchim Craiova;	-	YES	-		
8	RORW7.1_B121	-	-	S.C. PICANORE SRL Craiova- Wastewater treatment plant;	-	-	1.1	NO	
9	RORW7.1_B121	1.6		SC ECO SUD SRL - Ecological deposit Mofleni Craiova;	-	YES	-		
10	RORW7.1_B121	1.4		SC FELVIO PROD SRL;	-	YES	-		
11	RORW7.1_B121	1.4		SC HEINEKEN ROMANIA SA - Brewery;	-	YES	-		
12	RORW7.1_B121	1.4		SC FORD ROMANIA SA – The car factory Craiova;	-	YES	-		
13	RORW7.1_B121	1.4		SC Fortan SRL;					
14	RORW7.1_B121	1.4		S.C.Subansamble Auto S.A. Craiova;					
15	RORW7.1_B121	1.4		S.C.KIRA GROUP S.R.L. Bucovăț;					
16	RORW7.1_B121	1.4		S.C. ILCOST PROD S.R.L. Cârcea;					
17	RORW7.1_B121	1.9		Complexul Turistic R.S.R. Podari Romania;					
18	RORW7.1_B121	1.4		S.C. Zahărul S.A.Podari;					
19	RORW7.1_B121	2.2		Nitrates Directive;					
20	RORW7.1_B121	2.1		Storage of household waste Mofleni;					
21	RORW7.1_B121	2.1		Waste deposit not complying with class "b Mofleni;					
22	RORW7.1_B121	2.5		Warehouse for hazardous waste from the oil extraction industry Ghercești;					
23	RORW7.1_B121	2.10		Potentially contaminated sites - Dezbenzinare Craiova (not abandoned)					
24	RORW7.1_B121	2.10		Potentially contaminated sites - Parc 2					

				Vârteju (not abandoned)					
25	RORW7.1_B121	2.5		Potentially contaminated sites Electroputere S.A., Divizia RMU.					
26	RORW7.1_B121	2.6		Podari clutter					
27	RORW7.1_B121						1.1		Podari clutter
28	RORW7.1_B121	2.6		Malu Mare + Preajba clutter					
29	RORW7.1_B121						1.1		Malu Mare + Preajba clutter
30	RORW7.1_B121	2.6		Țuglui clutter					
31	RORW7.1_B121	2.6		Cotu (agl. < 2000 le)					
32	RORW7.1_B121	2.6		Cârligei (agl. < 2000 le)					
33	RORW7.1_B121	2.6		Bucovăț (agl. < 2000 le)					
34	RORW7.1_B121	2.6		Mihăița (agl. < 2000 le)					
35	RORW7.1_B121	2.6		Mofleni (agl. < 2000 le)					
36	RORW7.1_B121	2.6		Rovine (agl. < 2000 le)					
37	RORW7.1_B121	2.6		Gura Văii (agl. < 2000 le)					
38	RORW7.1_B121	2.6		Livezi (agl. < 2000 le)					
39	RORW7.1_B121	2.6		Popoveni (agl. < 2000 le)					
40	RORW7.1_B121	2.6		Branițe Podari (agl. < 2000 le)					
41	RORW7.1_B121	2.6		Balta Verde (agl. < 2000 le)					
42	RORW7.1_B121	2.6		Secui (agl. < 2000 le)					
43	RORW7.1_B121	2.6		Prunet (agl. < 2000 le)					
44	RORW7.1_B121	2.6		Bădoși (agl. < 2000 le)					
45	RORW7.1_B121	2.6		Bratovoești (agl. < 2000 le)					
46	RORW7.1_B121	2.6		Bâzdâna (agl. < 2000 le)					
47	RORW7.1_B121	2.6		Jiul (agl. < 2000 le)					
48	RORW7.1_B121						1.1		Țuglui clutter
49	RORW7.1_B121	2.6		Population not connected to the sewerage system in Craiova, including from the Cernele de Sus + Cernele agglomerations					
50	RORW7.1_B121	1.1		Population connected to the sewerage system in Craiova, including from the Cernele de Sus + Cernele agglomerations					
51	RORW7.1_B121				1.1				
52	RORW7.1_B121						1.1		Cârcea clutter - Craiova clutter
53	RORW7.1_B121	4.2.2		Dikes: discontinuous on the left side Ac. Ișalnița - Bratovoiești 28.9 km; discontinuous right bank Ac. Ișalnița - Bratovoiești 25.53 km (62.2%)					
54	RORW7.1_B121	3.4		SC COMPLEXUL ENERGETIC OLTENIA SA - SE Ișalnița (in the situation of open circuit operation)					
55	RORW7.1_B148	4.2.2		(Continuous Left dike) 29.5 km (50 %)					
56	RORW7.1_B148	2.6	N	Clutter Valea Stanciului + Horezu Poenari		N			
57	RORW7.1_B148	2.6	N	Comoșteni (agl. < 2000 le)		N			
58	RORW7.1_B148	2.6	N	Gângiova (agl. < 2000 le)		N			
59	RORW7.1_B148	2.6	N	Foișor (agl. < 2000 le)		N			
60	RORW7.1_B148	2.6	N	Padea (agl. < 2000 le)		N			
61	RORW7.1_B148	2.6	N	Zăval (agl. < 2000 le)		N			
62	RORW7.1_B148						1.1		Valea Stanciului + Horezu Poenari clutter
63	RORW7.1_B148	8	N	unknown		N		N	

Legend: A - The water body code**;** B - Type of potentially significant pressures existing in 2013**;** C - CA reaches the environmental target in 2013 (eco / pot.eco st. and chemical state, non-deterioration)**;** D - Potential polluter**;** E - Type of new pressures identified between 2013-2015**;** F - CA reaches the environmental target in 2015 (eco / pot.eco st. and chemical state, non-deterioration)**;** G - Future pressure type 2016-2021**;** H - CA reaches the environmental target in 2021 (eco / pot.eco st. and chemical state, non-deterioration)**;** I – Remarks.

The European Parliament and European Council Directive 2000/60/CE, generally known as the Water Framework Directive (WFD), defines in article 2 the ecological status as an expression of the quality of the structure and functioning of aquatic ecosystems associated with surface waters, by using biological, hydro morphological and physical-chemical quality elements as support functions for the biological ones.

From the legal point of view, the WFD was enforced in the Romanian law by means of Law 310/2004 which modifies and completes the Water Law 107/1996. In Romania, beginning with 2004, the quality assessment of surface waters (according to WFD) is made at the level of river basins. The River Basin Management Plan represents the means to implement the WFD, readjusted through Article 13 and Annex VII, having as main objective the achievement of "a good status" for water bodies corresponding to a balanced management of water resources (Table 6).

Table 6. Ecological assessment of, water bodies, according to the Water Framework Directive 2000/60 / EEC.

Water body	Surface water body code	Value - Ecological Status or Potential	Value - Biological Status or Potential	Value - Hydro morphological Status or Potential	Value - General Physico-Chemical Status or Potential
Ac. Işalniţa	ROLW7.1_B120	2	2	U	2
Jiu Acum. Işalniţa-Bratovoieşti	RORW7.1_B121	2	1	3	2
Jiu Bratovoieşti-confl. Danube	RORW7.1_B148	3	2	3	3

Legend: 1 - very good condition / maximum potential; 2 – good / potentially good condition; 3 – moderate / potentially moderate state; 4 - weak / potentially weak state; 5 - bad / potentially bad condition; N - not relevant; U - not rated

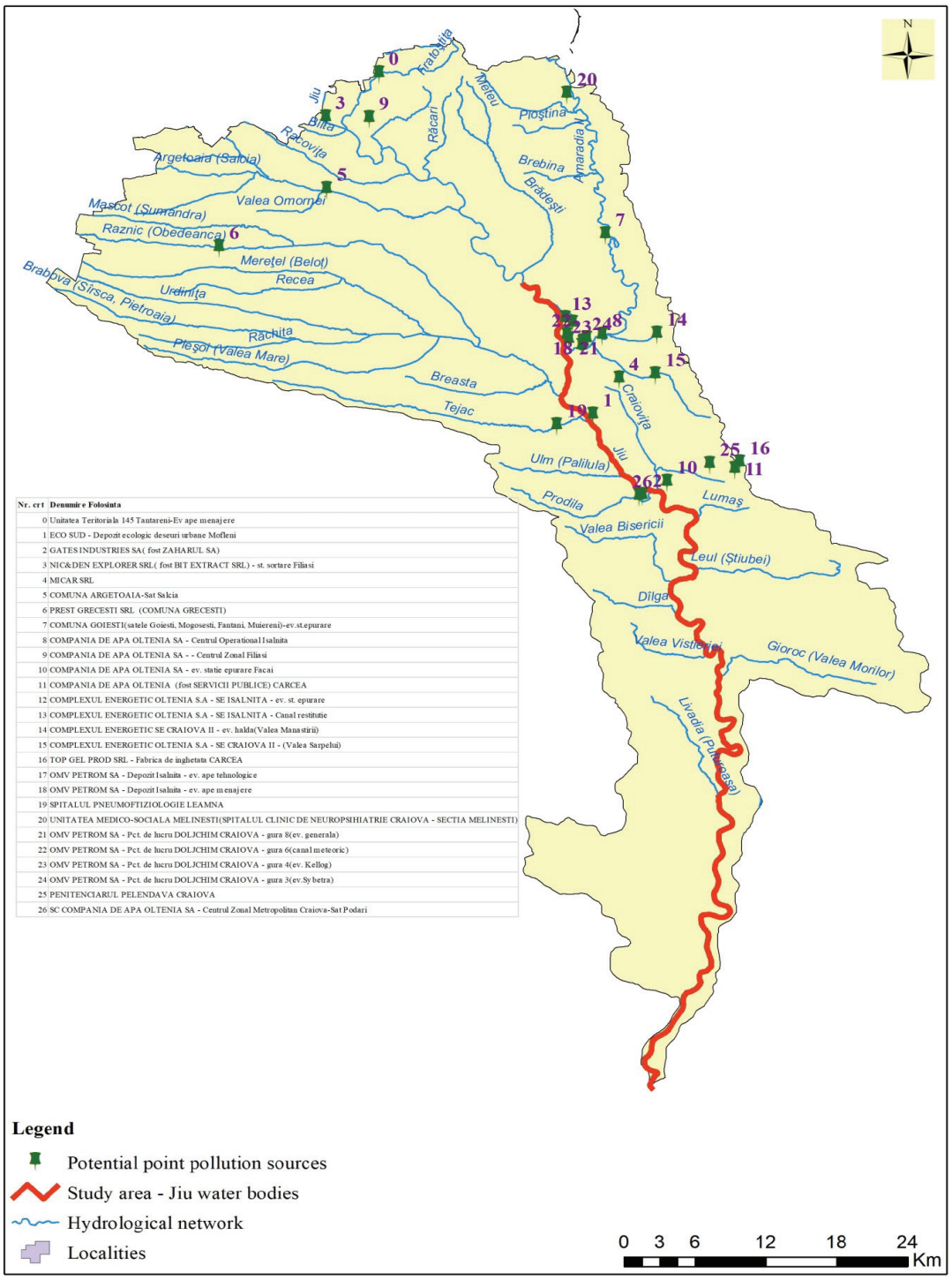

Figure 2. Main point source along the lower Jiu River basin Processed in ArcGIS Desktop 10.4, according to the Jiu River Basin Administration data.

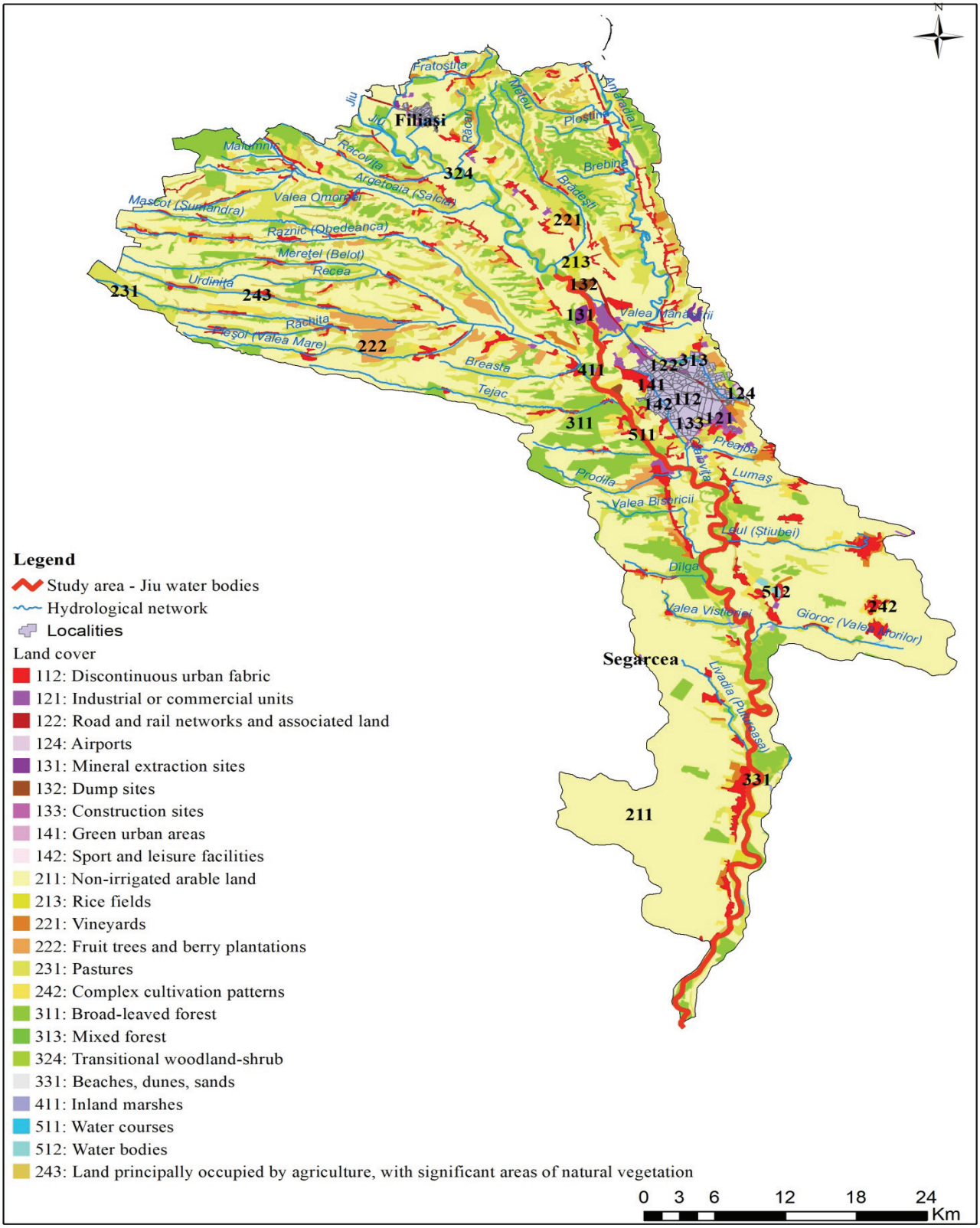

Figure 3. Land cover within the lower Jiu River basin Processed according to Corine land Cover 2018.

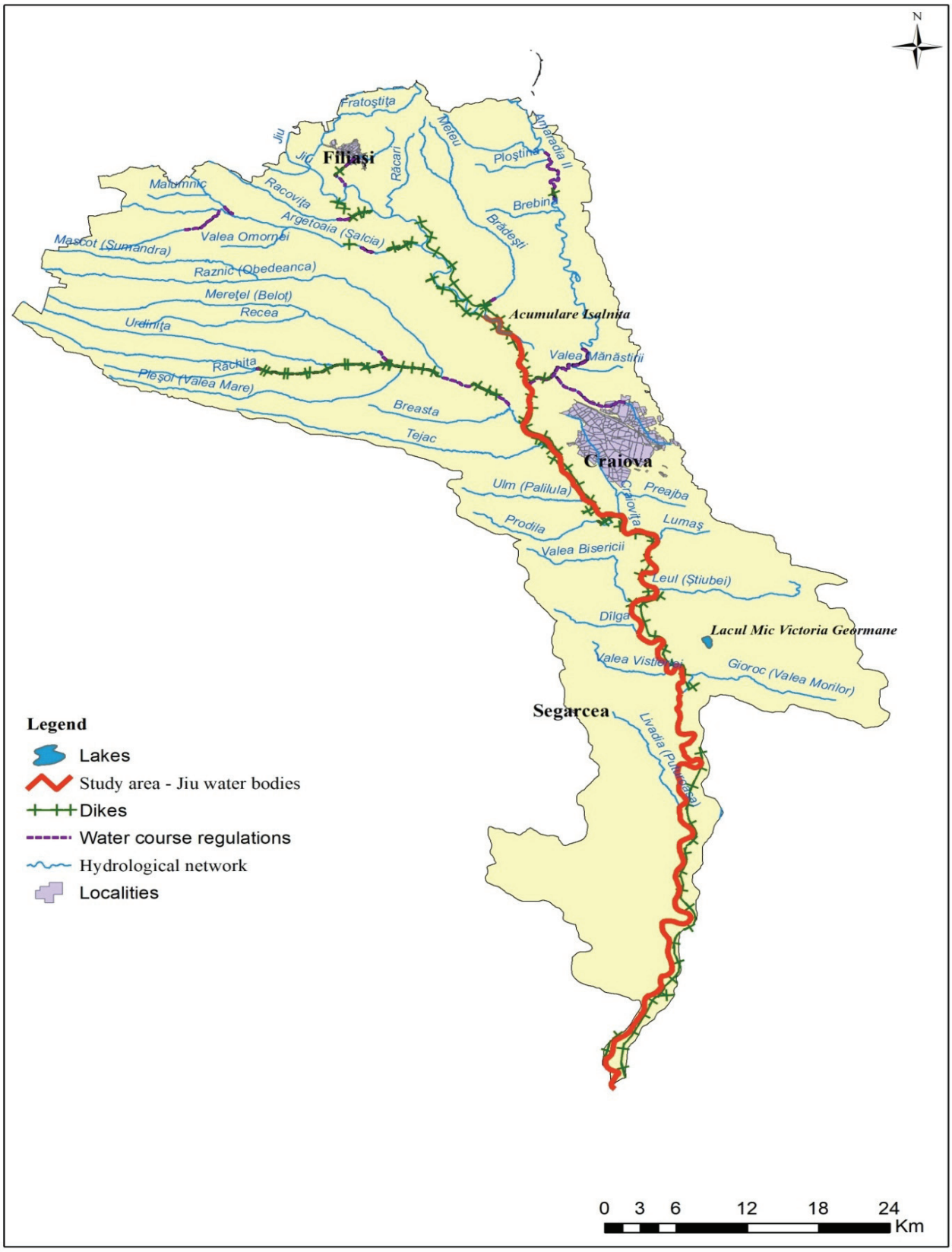

Figure 4. Hydro morphological pressures along the lower Jiu River - Process with ArcGIS Desktop 10.4, according to the Jiu River Basin Administration data).

CONCLUSIONS

Knowing the human pressures, we can establish the ecological status of the lower Jiu River and at the same time measures can be taken in order to provide a good status for the surface water bodies. At the same time, by assigning the qualitative character of the pressures, their impact on the receiver is outlined, including the risks related to the sanogenesis of the population and ecosystems.

Our results constitute a baseline from which future trends can be evaluated, especially in the context of river restoration, where a correlation is necessary between processes and effects that are relevant for the restoration of sites with multiple pressures and various pressure combinations

The importance of this research consists in raising awareness among communities about the reduction of pressures on water bodies along the Lower Jiu River.

REFERENCES

BIZJAK A. & MIKOŠ M. 2004. Synthesis procedure of assessing the hydromorphological status of river corridors: the Dragonja river case study. In *Proceedings of 5th International Symposium on Ecohydraulics. Aquatic Habitats: analysis and restoration*. University Press. Madrid: 325-330.

BREZEANU GH., CIOBOIU OLIVIA, ARDELEAN A. 2011. *Ecologie acvatică*. Vasile Goldiș University Press. Arad. 406 pp.

CIOBOIU OLIVIA & CISMAŞIU CARMEN-MĂDĂLINA. 2016. Structural and functional diversity of some aquatic ecosystems in the lower sector of Jiu (south-western Romania). *Proceedings of the 33nd Congress of International Society of Limnology SIL*. Edit. by University of Torino. **33**: 46-47.

CIOBOIU OLIVIA & CISMAŞIU CARMEN-MĂDĂLINA. 2018. The Influence of Abiotic Factors on the Reconstruction of the Biocoenosis areas Polluted with Organic and Inorganic Compounds from the Lower Sector of the Jiu River. *Journal International Environmental Application & Science*, *ISESER-2018*. Selcuk University Press. Konya. **13**(2): 110-115.

GAVRILESCU ELENA, CIOBOIU OLIVIA, TOMUȘ NICOLAE, DEAK ȘTEFANIA, CISMAŞIU CARMEN-MĂDĂLINA. 2018. Studies on environmental pollution in large installation of combustion in regard with international standards. *Oltenia. Studii şi comunicări. Ştiinţele Naturii*. Muzeul Olteniei Craiova. **34**(2): 204-211.

IONUȘ OANA. 2011. The assessment of human pressure on surface waters within the Motru catchement area, Oltenia region-Romania. *Proceedings of 6-th International Scientific Conference, Global Changes And Regional Development*. University of Sofia "St. Kliment Ohridksi" Press. Sofia. **6**: 43-47.

IONUȘ OANA. 2014. Preliminary data on the Jiu River meanders in the lower course (South-West Romania). *Forum geografic*. Edit. Universității Craiova. **13**(1): 18-24.

KALLIS G. & BUTLER D. 2001. The EU water framework directive: measures and implications. *Water policy*. IWA Publishing. London. **3**(2): 125-142.

SCHINEGGER R., TRAUTWEIN C., MELCHER A., SCHMUTZ S. 2012. Multiple human pressures and their spatial patterns in European running waters. *Water and Environment Journal*. EVISA Published. New York. **26**(2): 261-273.

ȘERBAN A. S. 2011. Physico-chemical quality indicators-supporting elements in the assessment of ecological status for lower Jiu. *Annals of the University of Craiova-Agriculture, Montanology, Cadastre Series*. University Press. Craiova. **39**(2): 360-365.

ŞERBAN S. A. & IONUŞ OANA. 2011. Ecological status assessment of the water bodies located in the lower sectors of the Jiu and the Motru rivers (Oltenia, Romania). *Forum Geografic*. Edit. Universității Craiova. **10**(1): 195-206.

***. Atlas of the Romanian Water Cadastre, 1992 (Accessed February, 2019).

***. Water Framework Directive 2000/60/CEE (Accessed February, 2019).

Zanfir Cristina Georgiana
Jiu Water Basin Administration, 54 N. Romanescu, Craiova, Romania.
E-mail: cristinazanfir1989@yahoo.com

Mititelu-Ionuș Oana
University of Craiova, Geography Department, Al. I. Cuza Str., No. 13, 200585 Craiova, Romania.
E-mail: oana_ionus@yahoo.com

Cioboiu Olivia
The Oltenia Museum, Craiova, Str. Popa Șapcă, No. 8, 200422, Craiova, Romania.
E-mails: oliviacioboiu@gmail.com; cioboiu.olivia@yahoo.com

Received: April 10, 2019
Accepted: September 02, 2019