3rd International Conference - Water resources and wetlands. 8-10 September, 2014 Tulcea (Romania);
Available online at http://www.limnology.ro/wrw2016/proceedings.html
Editors: Petre Gâștescu, Petre Bretcan; ISSN: 2285-7923; Pages:198-205; Open access under CC BY-NC-ND license

WETLANDS LANDSCAPE CHANGES IN COMMON FLOODPLAIN OF JIJIA-PRUT RIVERS ANALYZING THE VARIATION OF WATER BODY SURFACES

[1] Mădălina Pascal, [1] Gheorghe Romanescu, [2] Alin Mihu-Pintilie, [1] Cristian Constantin Stoleriu
[1] University "Alexandru Ioan Cuza" of Iași, Faculty of Geography and Geology, Department of Geography Romania, Email: *mada_mada794@yahoo.com*
[2] University "Alexandru Ioan Cuza" of Iași, Interdisciplinary Research Department – Field Science, ARHEOINVEST Platform, Romania

ABSTRACT
Ramsar Convention on wetlands define the wetlands as areas where the water table is very close to the land surface or areas where water covers the earth's surface to a depth of 6 m. According to the data of the European Environment Agency, extracted from Corine Land Cover (CLC), in Romania the wetlands total area is 5,044.82 km^2 (2.12% of the country area). In Moldova region these areas occupy 1,098.6 km^2 (0.46% of Romania and 21.7% of the country's wetlands total area). Overall, the Moldovian lakes occupy 384.89 km^2, marsh areas occupy 253.89 km^2 and low flow channels occupy 459.8 km^2. The analysis of the Jijia-Prut common floodplain, with a 515.34 km^2 area, was used, as geospatial database, the ortophotoplans from 2005 and 2012. ArcGIS software v.10.1 was used to vectorize aquatic areas such as: rivers, irrigation channels, lakes, wetlands and fish ponds. In 2005 their total area is 25.35 km^2 and in the 2012 total area is 25.85 km^2. This variance of wetland's surface have highlighted a trend concerning the wetlands landscape transformations due to human pressure. The main causes of wetlands fluctuations are: rectification and embankment of riverbeds, industrial and agriculture activities (like fish farming, livestock breeding, intensive agriculture based on irrigation etc.), fluctuations in the groundwater bodies due to drought etc. Preserving the water bodies is a key factor in sustaining the biodiversity of the wetlands landscape located in Jijia-Prut common floodplain.

Keywords: anthropization, biodiversity, Jijia-Prut floodplain, water surface, wetlands landscape

1 INTRODUCTION

In the international literature, wetlands represent transition areas between terrestrial and aquatic systems where, usually, the water mass is close to the topographic surface or the land is covered with low depth waters (Cowardin et al. 1979; Lefor and Kennard, 1977; Reed, 1988). According to the RAMSAR Convention, wetlands are defined as those areas where the water is the main control factor of abiotic and biotic environment. These wetlands include areas where the fresh, brackish and salt water masses are found at/or very close to the surface of earth, and also areas where the water covers the surface of the earth, but with a depth of up to 6 m (RAMSAR Convention, 1998; Tiner, 1999; UNEP-World Conservation Monitoring Centre, accessed on 15.04.2016). In the U.S.A. wetlands are defined as zones that predominantly include the flooded hydric soils or water saturated soils and/or zones with underground water bodies that have a sufficient frequency and duration to support, under normal conditions, the hygrophile vegetation (RAMSAR Convention, 1998; Romanescu, 2008, 2009; Tiner, 1984, 1989, 1991, 1999; USDA Soil Conservation Service, 1988, 1991, 1996). According to UNEP-World Conservation Monitoring Centre, wetlands include almost 570 million ha, which represents approximately 60% of Earth's surface (Ion et al. 2011; http://www.unep-wcmc.org/ - accessed on 15.04.2016).

In Romania, in compliance with the methodology of land use classification CLC – Corine Land Cover, the surface of wetlands, such as lakes, swamps and riverbeds is about 504,482 ha (2.12% of the country's territory). In Moldova region, these zones occupy 109,860 ha (0.46% of Romania's surface), representing almost a quarter (21.7%) of the wetlands surface of our country. The lakes from Moldova totalize a surface of 38,489.7 ha; the swamp areas occupy 25,389.9 ha, and the rivers beds of the main rivers have a total surface of 45,980.2 ha (Romanescu 2008, 2009; Romanescu et al., 2010, 2012; Romanescu and Stoleriu, 2013, 2015; Ion et al., 2011).

The purpose of this paper was to research the changes occurred in the wetlands landscape during the last 10 years, for the area corresponding the common floodplain of Jijia-Prut rivers (surface – 515.34 km^2). In order to determine the spatial dynamics of excessive moisture areas, it was used the mapping of aquatic surfaces corresponding water courses, irrigation channels, lakes, fishing farms and swamp areas. The conservation of water bodies is a key factor in supporting the biodiversity within the wetlands corresponding the common floodplain of Jijia-Prut rivers (Romanescu 2008, 2009).

2 REGIONAL SETTING

The common floodplain of the rivers Jijia and Prut is situated in the north-east part of Romania and overlaps an area with a central-north-eastern position within the Moldavian Plateau. From a mathematical point of view, the limits of the study area are: the northern limit – 47°25’01’’N, the southern limit – 46°54’50’’N, the western limit – 27°17’55’’E and the eastern limit – 28°07’01’’E. Administratively, the study area is entirely on the territory of Iași County, totaling the territories of 20 communes and of 50 settlements. Also, the western limit of the study area corresponds a natural border segment represented by Prut river, between Romania and the Republic of Moldova.

Inside this hydrogeomorphological unit, the analysed zone occupies a surface of 515.34 km^2, with a length of 89.45 km, a maximum width of 19.41 km near Iepureni – Popricani – Sculeni settlements (in the north of the area) and a minimum width of 3.26 km between Zberoaia settlement and the floodplain of Prut river (in the south of the area). In terms of altitude, the floodplain is dominated by interfluvial ridges that compose the right riverbank of Prut, known as the toponym – *the face of the Prut*, and that reach heights up to 280 – 300 m. The minimum altitudes are between 10 – 20 m and characterize the floodplain of Prut and the confluence area with Jijia river. Between the two water courses was developed a longitudinal embankment higher with almost 4 – 5 m than the level drainage, which induced in the landscape the formation of a common floodplain on a relative distance of about 50 – 60 km (Pantazică, 1974) (Figure 1).

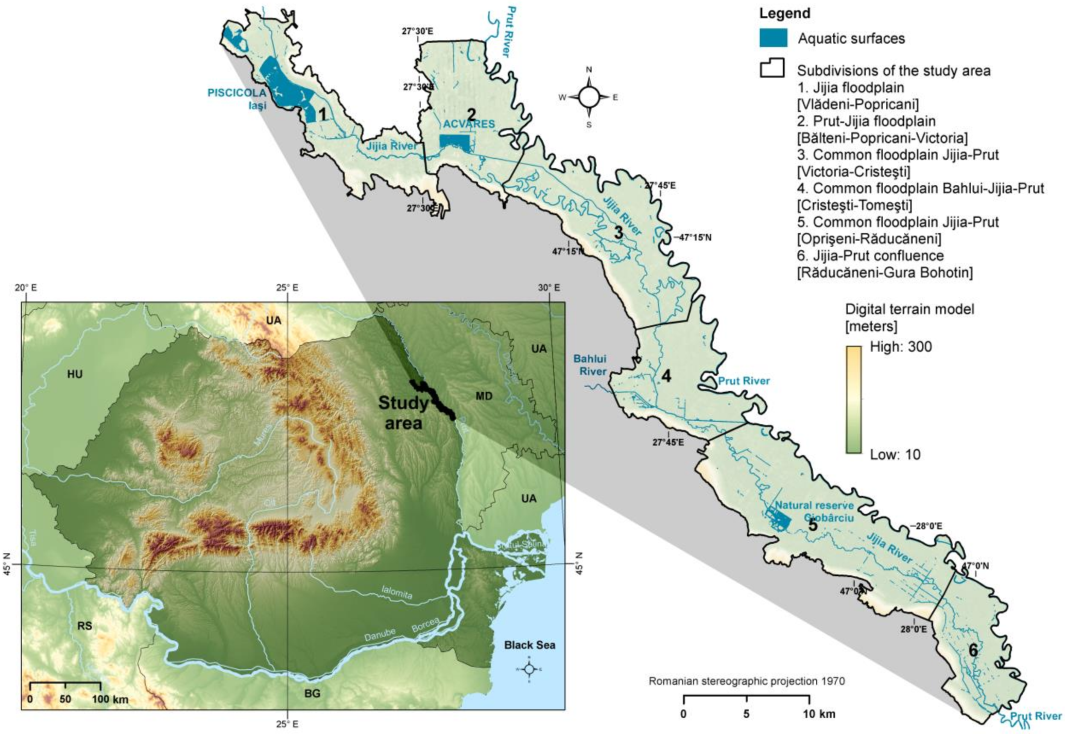

Figure 1. Geographic location of the common floodplain of Jijia-Prut rivers in Romania

3 METHODS AND DATABASE

The evaluation of the changes within wetlands landscape from the common floodplain Jijia-Prut required two distinct stages of research: Stage 1. Identifying excessive moisture areas and/or with hygrophile/hydrophile vegetation; Stage 2. Mapping aquatic surfaces based on GIS techniques and results comparison.

In the first stage was used the direct mapping method of wetlands. Also, the research was directed to the description of the landscape and of the hydrogeomorphological context in which took place the relief formation from the common floodplain Jijia-Prut. This context represented the formation topographic support of numerous meandered water courses, part of which were regularized and/or dammed, irrigation channels, lacustrine accumulations, ponds and excessive moisture areas. Thus, in order to facilitate the inventory and classification of water bodies and wetlands, the study area was divided into 6 distinct

subdivisions. The division was based on hydrographic criteria taking into account: the distribution of catchment basins, river confluences, the degree of human intervention, the water flow etc (Figure 2).

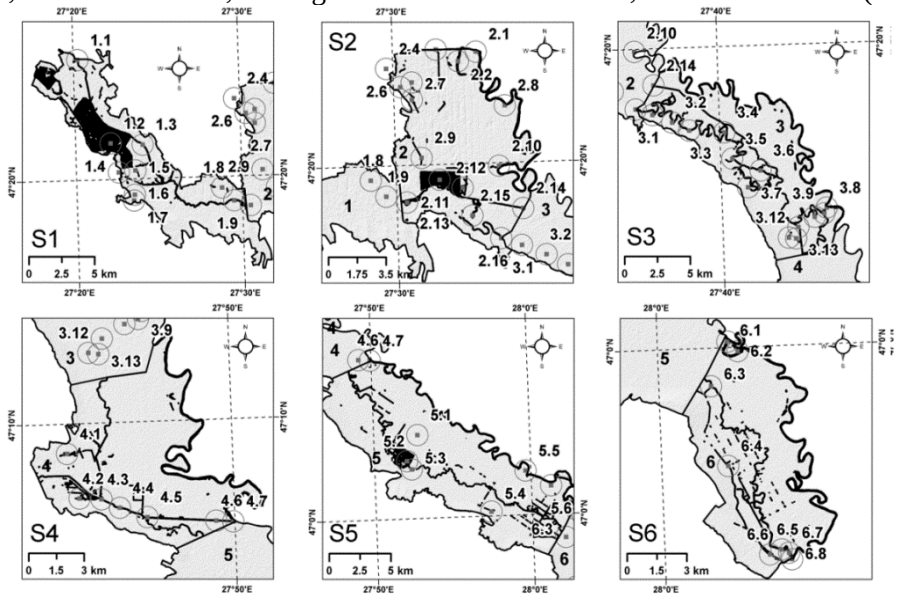

Figure 2. Subdivisions (S) of the study area: 1. Jijia floodplain [Vlădeni-Popricani]; 2. Prut-Jijia floodplain [Bălteni-Popricani-Victoria]; 3. Common floodplain Jijia-Prut [Victoria-Cristești]; 4. Common floodplain Bahlui-Jijia-Prut [Cristești-Tomești]; 5. Common floodplain Jijia-Prut [Oprișeni-Răducăneni]; 6. Jijia-Prut confluence [Răducăneni-Gura Bohotin]

The numbering of subdivisions was assigned according to north-south orientation and from upstream to downstream, respectively. These subdivisions are: 1. Jijia floodplain [Vlădeni-Popricani]; 2. Prut-Jijia floodplain [Bălteni-Popricani-Victoria]; 3. Common floodplain Jijia-Prut [Victoria-Cristești]; 4. Common floodplain Bahlui-Jijia-Prut [Cristești-Tomești]; 5. Common floodplain Jijia-Prut [Oprișeni-Răducăneni]; 6. Jijia-Prut confluence [Răducăneni-Gura Bohotin]. Within these subdivisions have been identified 59 wetlands and deep waters whom were assigned a code, a representative name and GPS coordinates (Table 1.)**.**

Stage 2. consisted in creating a spatial database regarding aquatic surfaces of the study area. As a cartographic support were used the orthophoto plans based on aerial images taken during 2005 and 2012. On these lines was used ArcGIS 10.1 software that helped with the digitization of 1,374 polygons representing aquatic surfaces existing during 2005 and of 1,421 polygons representative for 2012. The level of detail regarding the extracted spatial information corresponds to a DTM of 1 sqm/pixel.

4 RESULTS AND DISCUSSION

The wetlands landscape of the study area is dominated by the presence of middle and lower sector of Jijia river and the middle sector of Prut river. The two hydrographic arteries created inside the common floodplain the support of time dynamics for many excessive moisture areas. Most of them have been transformed through human society interaction with water bodies, but due to physico-geographical context, they still show a great aesthetic, ecological and cultural importance. Also, many of the analysed areas have a remarkably biodiversity, even if anthropization has affected the majority of the water bodies.

Of the 59 identified wetlands, 46 are riverine (77.96%), 10 are lacustrine (16.94%) and 3 are palustrine (5.35%). Within the study area subdivisions, the percentage of wetlands and riverine deep water habitats dominates the subdivisions: 3. Common floodplain Jijia-Prut [Victoria-Cristești], 4. Common floodplain Bahlui-Jijia-Prut [Cristești-Tomești], 5. Common floodplain Jijia-Prut [Oprișeni-Răducăneni] and 6. Jijia-Prut confluence [Răducăneni-Gura Bohotin]. This phenomenon is due to the riverbed regularization of Jijia and its catchment by Prut river, the implementation of irrigation channels, and also to the drainage of wetlands with agricultural purposes.

Table 1. Inventory and classification on spatial subdivisions of wetlands from common floodplain Jijia-Prut based on aquatic surfaces during 2005 and 2012

Subdivisions of the study area	Code	Name of wetland or deep water habitats	Human settlement area	Mathematical position		Water body surface [sqm]	
				Lat. N	Long. E	Year 2005	Year 2012
Jijia floodplain [Vlădeni - Popricani]	**1.1**	Jijia river	Vlădeni	47° 24' 56.00"	27° 20' 09.44"	8,744,000.704	8,856,213.165
	1.2	Lacustrine complex PISCICOLA Iaşi	Movileni	47° 21' 28.51"	27° 22' 01.09"		
	1.3	Jijia river	Mihail Kogălniceanu	47° 21' 23.22"	27° 23' 57.37"		
	1.4	Movileni Lake	Movileni	47° 20' 16.49"	27° 22' 28.18"		
	1.5	Downstream from the PISCICOLA Iaşi	Movileni	47° 20' 19.86"	27° 23' 28.52"		
	1.6	Sbanţu brook	Larga Jijia	47° 19' 20.33"	27° 23' 23.65"		
	1.7	Lakes and ponds	Larga Jijia	47° 19' 06.20"	27° 23' 20.23"		
	1.8	Ponds	Ţigănaşi	47° 19' 31.56"	27° 28' 40.77"		
	1.9	Jijia floodplain	Popricai	47° 18' 58.66"	27° 29' 24.17"		
Prut-Jijia floodplain [Balteni – Popricani - Victoria]	**2.1**	Prut floodplain	Hermeziu	47° 23' 38.73"	27° 33' 56.59"	5,715,707.841	4,164,413.186
	2.2	Natural reserve Bălătău Prut	Bălteni	47° 23' 21.50"	27° 33' 03.92"		
	2.3	Irrigation channel	Bălteni-Hermeziu	47° 23' 45.32"	27° 32' 00.79"		
	2.4	Frasin Lake	Probota	47° 23' 10.48"	27° 29' 34.75"		
	2.5	Ponds	Probota	47° 22' 42.16"	27° 30' 47.87"		
	2.6	Frăsinel brook	Probota	47° 22' 33.79"	27° 30' 14.68"		
	2.7	Lakes and ponds	Probota	47° 22' 08.29"	27° 30' 47.17"		
	2.8	Prut floodplain	Şendreni	47° 21' 51.57"	27° 35' 16.19"		
	2.9	Irrigation channel	Cârniceni	47° 20' 13.31"	27° 31' 09.99"		
	2.10	Prut river	Frăsuleni	47° 19' 52.73"	27° 34' 53.74"		
	2.11	Lacustrine complex ACVARES	Ţigănaşi	47° 19' 29.13"	27° 32' 00.22"		
	2.12	Natural reserve Teiva Vişina	Popricai	47° 19' 11.61"	27° 33' 06.20"		
	2.13	Jijia river	Popricai	47° 18' 46.02"	27° 30' 23.66"		
	2.14	Jijia river - hydrometric station	Victoria-Sculeni	47° 18' 28.21"	27° 36' 00.08"		
	2.15	Jijia river	Cotul Morii	47° 18' 16.63"	27° 33' 31.61"		
	2.16	Jijia river	Victoria	47° 17' 30.41"	27° 34' 52.72"		
Common floodplain Jijia-Prut [Victoria - Cristesti]	**3.1**	Jijia river	Victoria-Stânca	47° 17' 15.58"	27° 35' 52.78"	4050239	4208570
	3.2	Jijia river	Luceni	47° 16' 55.64"	27° 37' 03.09"		
	3.3	Jijia river	Icuşeni	47° 16' 34.42"	27° 38' 03.89"		
	3.4	Jijia river	Cotul Lui Ivan	47° 16' 27.14"	27° 40' 10.89"		
	3.5	Jijia river	Cilibiu	47° 15' 21.54"	27° 40' 36.73"		
	3.6	Jijia river	Podul Jijiei	47° 14' 50.26"	27° 42' 17.30"		
	3.7	Jijia river	Golăieşti	47° 14' 09.69"	27° 41' 30.67"		
	3.8	Prut river	Bosia	47° 13' 12.97"	27° 46' 12.58"		
	3.9	Old meander of Jijia river	Bosia	47° 12' 59.13"	27° 46' 03.08"		
	3.10	Jijia river	Bosia	47° 12' 51.30"	27° 45' 27.65"		
	3.11	Jijia river	Mânzăteşti-Bosia	47° 12' 27.22"	27° 44' 27.78"		
	3.12	Lakes and ponds	Coada Stâncii	47° 12' 02.57"	27° 43' 52.05"		
	3.13	Irrigation channels	Mânzăteşti-Ungheni	47° 11' 59.81"	27° 44' 17.88"		

Table 1. Continued

Common floodplain Bahlui-Jijia-Prut [Cristesti - Tomesti]	**4.1**	Bahlui-Jijia industrial floodplaine	CET Holboca	47° 09' 06.72"	27° 42' 47.79"	2,238,304	2,254,159
	4.2	Bahlui-Jijia floodplaine	Tomeşti	47° 07' 47.65"	27° 43' 16.18"		
	4.3	Jijia-Bahlui confluence	Tomeşti	47° 07' 44.80"	27° 44' 12.75"		
	4.4	Jijia river	Tomeşti	47° 07' 28.77"	27° 44' 59.10"		
	4.5	Jijia channeled	Chipereşti	47° 07' 10.96"	27° 46' 09.59"		
	4.6	Jijia channeled	Oprişeni	47° 07' 00.59"	27° 49' 06.66"		
	4.7	Jijia channeled -Prut confluence	Oprişeni	47° 06' 58.14"	27° 49' 50.27"		
Common floodpain Jijia-Prut [Oprişeni - Răducăneni]	**5.1**	Old meander of Jijia river	Prisecani	47° 03' 38.42"	27° 52' 43.03"	4,081,824	4,185,823
	5.2	Natural reserve Ciobârciu	Costuleni	47° 02' 30.65"	27° 52' 00.02"		
	5.3	Jijia river	Costuleni	47° 02' 08.84"	27° 52' 16.92"		
	5.4	Jijia river – secondary channel	Roşu-Răducăneni	47° 00' 10.77"	27° 57' 17.42"		
	5.5	Prut floodplain	Colţu Cornii	47° 01' 54.88"	27° 59' 33.51"		
	5.6	Old meander of Prut river	Sălăgeni	47° 01' 13.80"	28° 01' 09.76"		
Jijia-Prut confluence [Răducăneni - Gura Bohotin]	**6.1**	Prut floodplain	Grozeşti	47° 00' 08.61"	28° 02' 42.36"	1,967,910	2,134,778
	6.2	Old meander of Prut river	Grozeşti	46° 59' 52.55"	28° 03' 06.26"		
	6.3	Jijia river	Grozeşti	46° 58' 56.73"	28° 01' 59.66"		
	6.4	Cozia-Jijia floodplain	Zberoaia	46° 56' 45.44"	28° 02' 33.18"		
	6.5	Water pumping station on Jijia river	Gura Bohotin	46° 54' 26.06"	28° 04' 32.73"		
	6.6	Bohotin brook	Gorban	46° 54' 18.62"	28° 04' 04.98"		
	6.7	Jijia channeled	Gura Bohotin	46° 54' 20.01"	28° 04' 50.52"		
	6.8	Prut-Jijia confluence	Gura Bohotin	46° 54' 09.45"	28° 04' 57.19"		

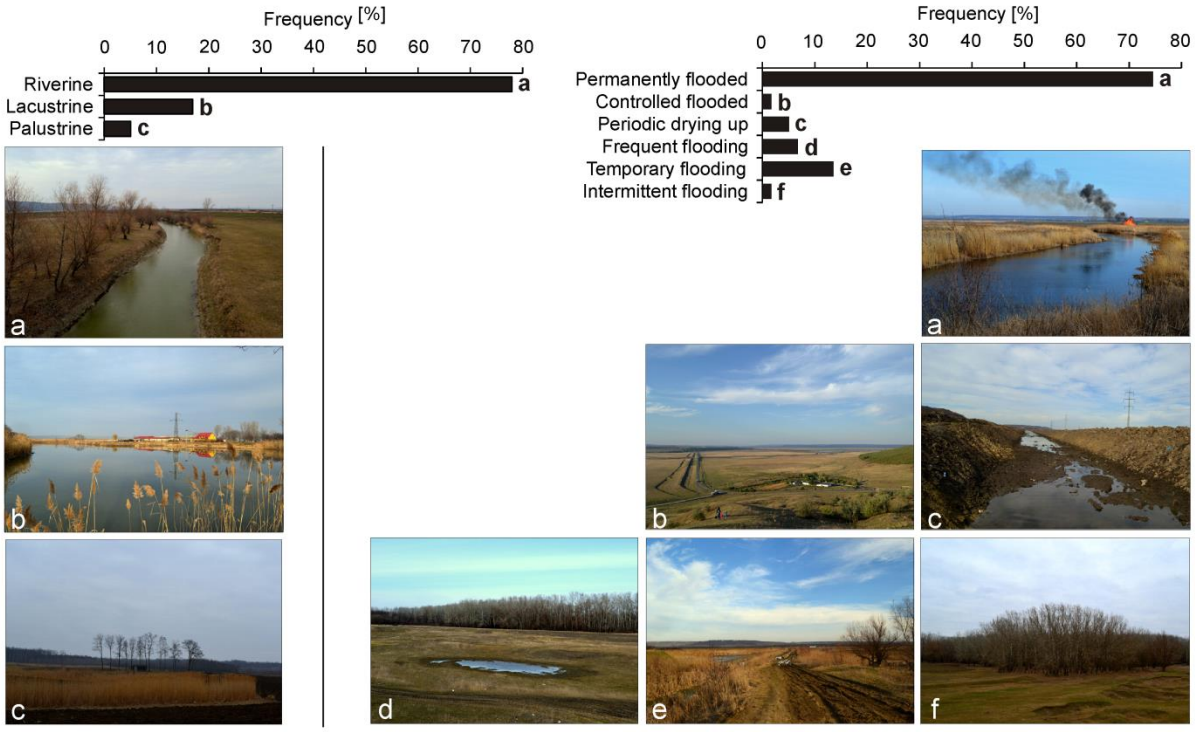

Figure 3. Frequency of type and water regime of wetlands and deep water habitats

Of the 59 identified wetlands, 46 are riverine (77.96%), 10 are lacustrine (16.94%) and 3 are palustrine (5.35%). Within the study area subdivisions, the percentage of wetlands and riverine deep water habitats dominates the subdivisions: 3. Common floodplain Jijia-Prut [Victoria-Cristești], 4. Common floodplain Bahlui-Jijia-Prut [Cristești-Tomești], 5. Common floodplain Jijia-Prut [Oprișeni-Răducăneni] and 6. Jijia-Prut confluence [Răducăneni-Gura Bohotin]. This phenomenon is due to the riverbed regularization of Jijia and its catchment by Prut river, the implementation of irrigation channels, and also to the drainage of wetlands with agricultural purposes.

In the upper sector of the study area, respectively in the subdivisions 1. Jijia floodplain [Vlădeni-Popricani] and 2. Prut-Jijia floodplain [Bălteni-Popricani-Victoria], the lacustrine wetlands are the best represented. The most important areas are administrated by PISCICOLA IAȘI and ACVARES fishing complex which support and maintain lacustrine accumulations. Also, in the middle sector of the area, rather isolated from the zone dominated by lakes, Ciobârciu protected area can be found (in 3. Common floodplain Jijia-Prut [Victoria-Cristești]) which has a relatively large area of water surface. The palustrine wetlands are not well represented due to the human intervention that drains the land through irrigation channels (5.35%) (Figure 3).

The water regime regulates the quality and type of wetland, and provides the development support for hygrophile and hydrophile plant associations. In return, these represent proper habitats that sustain the development of species dependent on aquatic and palustrine ecosystems.

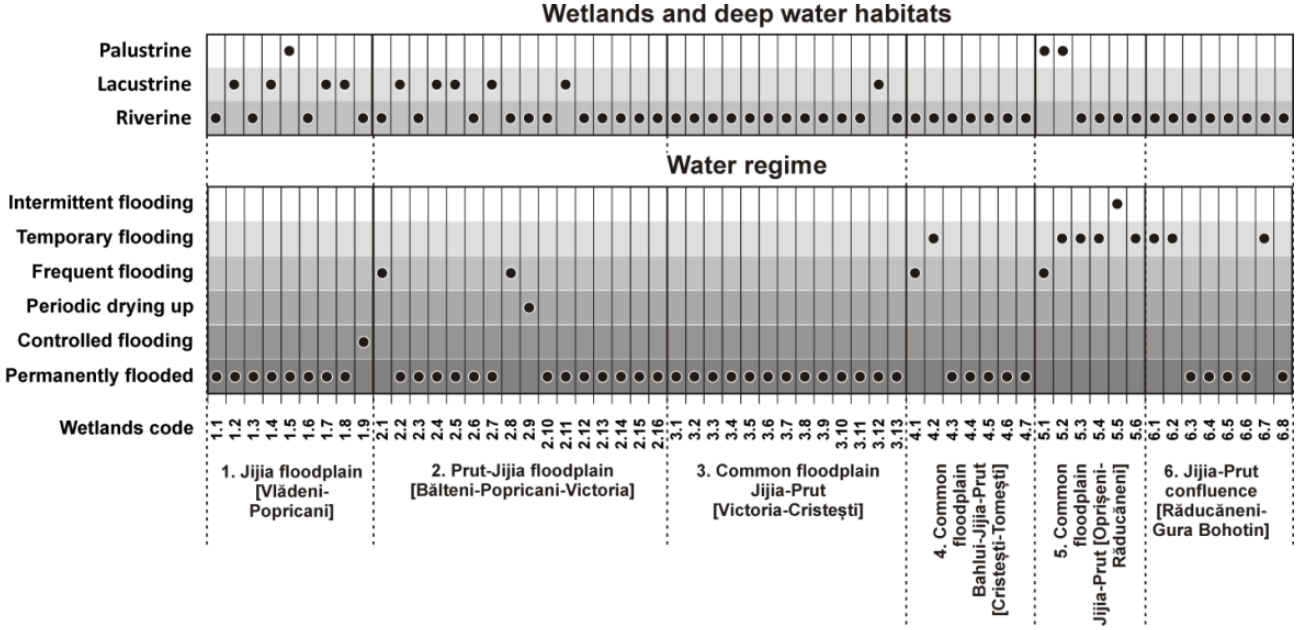

Figure 4. Distribution of wetlands and deep water habitats and water regime

In the study area, the percentage of wetlands based on water regime is: permanently flooded – 74.57%; controlled flooding – 1.69%; periodic drying up – 1.69%; frequent flooding – 6.77%; temporary flooding – 13.55%; intermittent flooding – 1.69%. The subdivision where the aquatic surfaces dynamics is the highest, being controlled by water regime is – 5. Common floodplain Jijia-Prut [Oprișeni-Răducăneni]. In this sector, due to the fact that Jijia was channeled upstream and redirected towards Prut, the old meanders and ponds are intermittently flooded and the aquatic surfaces are temporary. For this reason, wetlands density is higher in the middle and upper sector of the study area, and in the lower sector, known as ”old” Jijia river, land areas with excessive moisture are not well represented (Figure 4).

For a more detailed analysis on water regime and of landscape changes, mapping was used for aquatic surfaces corresponding to the years 2005 and 2012. Thus, during 2005, the aquatic surfaces from the common floodplain Jijia-Prut totaled 25.35 km^2, which represents 4.91% of the total surface of study area. During 2012, the aquatic surface was bigger with +0.5 km^2 (25.85 km^2), respectively 5.01% of the total surface. Although the anthropic pressure on water bodies is increasing, contrary to expectations, the water surface value is higher. The phenomenon is explained by the fact that there is a major impact induced by the control performed on lacustrine units and water courses to compensate fishing, agricultural and zootechnical activity (Figure 5).

Although water requirements for human activities are provided through hydrotechnical control and the water supply is increasing, the wetlands landscape is affected. The dynamics of excessive moisture areas is best represented for common floodplains subdivisions, where the differences are more significant. Thus, if in most areas are not notable differences due to insignificant increases (< 1.7 ha), for the subdivision – 2. Prut-Jijia floodplain [Bălteni-Popricani-Victoria], in the last 10 years there is a decrease of -155.12 ha in aquatic surfaces. The phenomenon is due to regularization work on Jijia and to floodplain management projects against floods, corroborated with hydrotechnical planning developed inside ACVARES fishing farm. At the same time, the drainage of aquatic surfaces from this region is also a consequence of farmland planning.

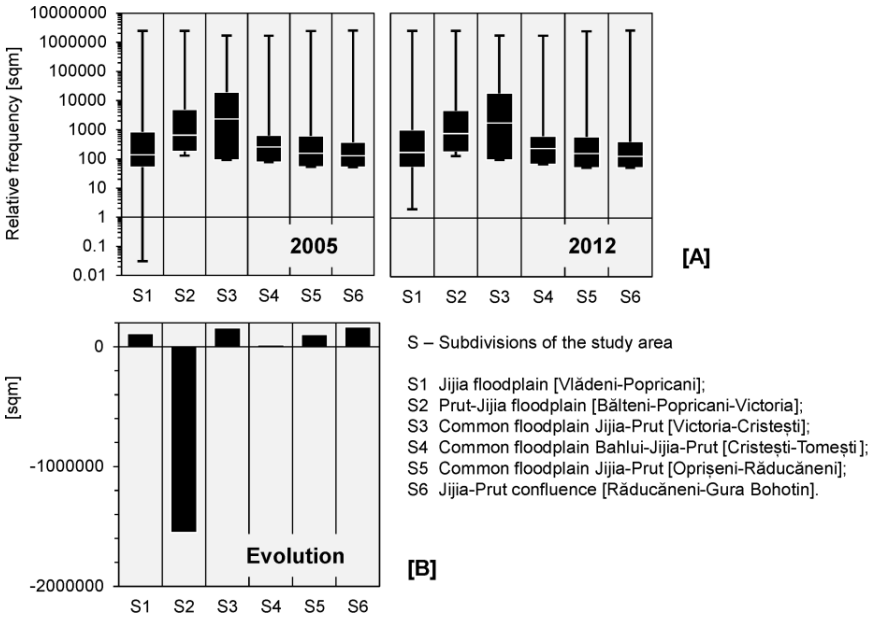

Figure 5. Comparasion of water body surface from common floodplain of Jijia-Prut rivers between 2005 and 2012. [A] Bloxplots represents quartiles and average values of water body surfaces with min and max.; [B] Evolutions of water body surfaces in the last 10 years.

5 CONCLUSIONS

The common floodplain Jijia-Prut (surface – 515.34 km^2) is perhaps the most representative area of wetlands in the region of Moldova (eastern Romania). Thus, during 2005, the aquatic surfaces totalled 25.35 km^2, which represents 4.91% of the total surface of study area. During 2012, the aquatic surface was bigger with +0.5 km^2 (25.85 km^2), respectively 5.01% of the total surface.

Of the 59 identified wetlands, 46 are riverine (77.96%), 10 are lacustrine (16.94%) and 3 are palustrine (5.35%). The percentage of wetlands based on water regime is: permanently flooded – 74.57%; controlled flooding – 1.69%; periodic drying up – 1.69%; frequent flooding – 6.77%; temporary flooding – 13.55%; intermittent flooding – 1.69%. Most of the excessive moisture areas are aquatic surfaces corresponding water courses, irrigation channels, lakes, fishing ponds and swamps. The changes that have occurred in the wetlands landscape are a direct consequence of the water bodies' anthropization. For this reason, their conservation is a key factor for a sustainable biodiversity.

REFERENCES

Cowardin, L.M., Carter, V., Golet, F.C., La Roe, E.T. 1979, *Classification of wetlands and deepwater habitats of the United States*, U.S. Fish and Wildlife Service Report FWS/OBS-79/31, 131p.

Ion, C., Stoleriu, C.C., Baltag, E., Mânzu, C., Ursu, A., Ignat, A.E. 2011, *Păsările şi habitatele din zonele umede ale Moldovei*, Ed. Alexandru Ioan Cuza University of Iaşi, 247p.

Lefor, M.W. and Kennard, W.C. 1977, *Inland wetland definitions: Storrs-Connecticu*t, University of Connecticut, Institute of Resources, Report 28, 63p.

Pantazica, M.1974, *Hidrografia Câmpiei Moldovei [Moldavian Plain hydrography]*, Ed. Junimea, Iaşi, 316p. [in Romanian].

RAMSAR Information Bureau. 1998, *What are Wetlands? Ramsar Information Paper*, Gland-Switzerland, 1:1, 54p.

Reed, P.B. 1988, *National list of plant species that occur in wetlands – National summary*, Washington D.C., U.S. Fish and Wildlife Service Biological Report, 88(24), 244p.

Romanescu, G. 2008, *Inventarierea şi tipologia zonelor umede şi apelor adânci din Podişul Moldovei [The inventory and typology of the wetlands and deep waters from the Moldavian Plateau]*, Ed. Terra Nostra, Iaşi, 242p. [in Romanian]

Romanescu, G. 2009, *Siret river basin planning (Romania) and the role of wetlands in diminishing the floods*, Conferences and Proceedings – WIT Transaction on Ecology and the Environment, Doi: 10.2495/WRM090391., 125:1, 439–453.

Romanescu G., Dinu C., Stoleriu C., Romanescu A.M. 2010. *Present state of trophic parameters of the main wetlands and deep waters from Romania*. Present Environment and Sustainable Development, 4:159-174.

Romanescu, G., Stoleriu, C., Lupascu, A. 2012, *Biochemistry of wetlands in barrage Lacul Rosu catchment (Haghimas - Eastern Carpathian)*, Environmental Engineering and Management Journal, 11(9):1627-1637.

Romanescu, G., Stoleriu, C.C. 2013, *An inter-basin backwater overflow (the Buhai Brook and the Ezer reservoir on the Jijia River, Romania)*, Hydrological Processes, Doi: 10.1002/hyp.9851, 28(7), 3118–3131.

Romanescu, G., Stoleriu, C.C. 2015, *Morpho-bathymetry and GIS-processed mapping in delimiting lacustrine wetlands: the Red Lake (Romania)*. Proceedings GEOBALCANICA. International Scientific Conference, 5-7 June 2015, Skopje, Republic of Macedonia, DOI: http://dx.doi.org/10.18509/GBP.2015.12. UDC: 007:004]:528.94(498). 551.435.38(498), 99–110.

Tiner, R.W. 1984, *Wetlands of the United States-Current status and recent trends: Washington D.C*., U.S. Fish and Wildlife Service Report, 59p.

Tiner, R.W. 1989, *Wetland boundary delineation*, In: Majumdar, S.K., BRooks, R.P., BRenner, F.J., Tiner, R.W. [Eds.] *Wetlands ecology and conservation-Emphasis in Pennsylvania: Easton*, Pa., Pennsylvania Academy of Sciences, 231-248.

Tiner, R.W. 1991, *The concept of a hydrophyte for wetland identification*, BioScience, **41**(4), 236-247.

Tiner, R.W. 1999, *Wetland Indicators – A guide to Wetland Identification, Delineation, Classification, and Mapping, Lewis Publishers*, Boca Raton – London - New York – Washington D.C., 392p.

USDA Soil Conservation Service 1988, *National Food Security Act Manual*. U.S. Department of Agriculture, Washington D.C.

USDA Soil Conservation Service 1991, *Hydric soils of the United States: Washington, D.C*., In: *Cooperation with the National Technical Committee for Hydric Soils*, U.S. Department of Agriculture, Miscellaneous publication.

USDA Soil Conservation Service 1996, *National Food Security Act Manual*, 3rd ed. U.S. Department of agriculture, Washington D.C.

UNEP-*World Conservation Monitoring Centre* [http://www.unep-wcmc.org/ - [(accessed on 15.04.2016)]