Scientific Papers. Series A. Agronomy, Vol. LXV, No. 1, 2022
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

THE VEGETATION CHARACTERISTICS OF A POLLUTED SMALL RIVER (GLAVACIOC RIVER) FROM ROMANIAN PLAIN

Marilena ONETE[1], J. Owen MOUNTFORD[2], Florian P. BODESCU[3], Luiza-Silvia CHIRIAC[1], Minodora MANU[1]

[1]Institute of Biology Bucharest, 296 Splaiul Independentei, Bucharest, Romania
[2]Centre for Ecology & Hydrology, MacLean Bldg, Benson Ln, Crowmarsh Gifford,Wallingford OX10 8BB, United Kingdom
[3]SC Multidimension SRL, 7 Ciprian Porumbescu Street, Saveni, Ialomita, Romania

Corresponding author email: marilena.onete@gmail.com

Abstract

Glavacioc River crosses many rural areas in southern Romania. The soil and groundwater in the neighboring area of the Glavacioc River are mainly polluted by nitrates from agriculture (excessive fertilization with mineral nitrogen fertilizers), husbandry (mismanagement of manure) and/or human waste. Based on previous research regarding soil and water chemical content, our aim was to identify the plant species that could survive in the vicinity of Glavacioc River. Knowing the concentration of chemical content in some localities, we inventoried the plant species from the water and from the river banks. We can argue that the vegetation changes from up to down river, most nitrophilous and ruderal species (diversity and abundance) growing down river. The highest impact on plant species distribution and abundance is given by clear cutting the woody vegetation growing natural on the river banks (riparian). Any management practices should include re-vegetation of river banks with the natural woody vegetation that have a very important role in diminishing the entrance of pollutants in the water and maintaining most of the herbaceous natural vegetation.

***Key words**: Glavacioc River, Romanian Plain, vegetation characteristics.*

INTRODUCTION

The most complex and intensively used ecosystems in the world are considered rivers and their catchments. Peoples understanding of the complex connections between river ecosystems and the landscapes through which they flow increased during recent decades (Calow & Petts, 1994; Naiman & Decamps, 1997; Campos et al, 2002; Burt et al., 2002; Anbumozhi et al., 2005; Shearer & Xiang, 2007; Shabaga & Hill, 2010; Kuglerová et al., 2014; Luke et al., 2019; Fonseca et al., 2021).

In time, European floodplains from temperate zone display patches of vegetation/plant communities (ranging from softwood to hardwood communities) corresponding to natural dynamic stages influenced by abiotic factors (flood, wind, temperature fluctuation): in early successional dynamics, the influence of abiotic factors is strong, the riparian areas are barely structured and comprise short-lived species, and they are very dynamic; the long-lived established hardwood forest stage, may have long time persistence (if no accident occurs), the ecosystem reaches a higher level of organization and becomes stable, the relationships among plants and animals communities increase and diversify (Sanchez-Perez et al., 1993; Huggenberger et al., 1998; Tremolieres et al., 1998). The nutrient status of the riparian zones is determined by regular floods supply of water, nutrients and sediments, the floods being the main driver of the strong dynamics, high productivity, the structure complexity and the species richness (Tornqvist, 1997; Bell et al., 2000). The distribution of organic matter is a controlling factor affecting water quality, habitat, and food webs (Giese et al., 2000). Riparian plant communities are biological processors of terrestrial-aquatic interfaces and they develop a proper response to hydrological disturbance, hydric stress and nutrient or sediment inputs from the floodplain (Tabacchi et al., 2000).

The variety and magnitude of human impacts on rivers and their catchments (very important natural systems) have rapidly accelerated

(Naiman & Decamps, 1997; Martin et al., 1999).

Riparian vegetation can effectively intercept agricultural point and/or diffuse source pollution into the rivers water body and reduce the risk of water pollution (Tang et al., 2021) and have a very important role in reduction, regulation and control of the environmental impacts of agriculture (Birnie et al, 2002; Riis et al., 2020).

In recent decades, water pollution became a major problem of the countries around the world causing water quality degradation (Tabacchi et al., 2000).

N_2O emissions are caused by nitrogen (N) loading and riparian zones might act like buffers for the nitrogen input from agricultural landscapes (Sanchez-Perez et al., 1993; Mayer et al., 2007; Rriis et al., 2020). Even recently, a knowledge gap still exists on how different types of riparian vegetation influence N_2O emissions (Baskerville et al., 2021).

In Romania, a few studies had been performed on some rivers from the Romanian Plain, regarding: the biodiversity of alluvial shrubland characteristic for the Câlniştea River (Paucă-Comănescu et al., 2005), ecosystem characterization of some flooding ash forest from the Neajlov Holm (Giurgiu District) (Falcă et al., 2004), the diversity of alluvial shrubland flora and fauna in the Neajlov Floodplain (Paucă-Comănescu et al., 2004), phenology of the main plant populations from the *Tamarix* shrubland located on the lower floodplain of the Prahova and Teleajen rivers (Paucă-Comănescu et al., 2000; 2002),

The objective of our paper is to highlight the diversity and characteristics of vegetation along a small river valley where nitrogen inputs are already known.

MATERIALS AND METHODS

The Glavacioc River is a permanent small river, tributary of the river Câlniștea, which in turn flows into the Neajlov river and thence via the Argeş river into the Danube river. It rises near the settlement of Ștefan cel Mare, Argeș County (44°31′34″N 25°06′19″E) and discharges into the Câlniștea near Ghimpați (44°09′37″N 25°48′07″E) passing through four counties (Argeș, Dâmbovița, Giurgiu and Teleorman) (Figure 1).

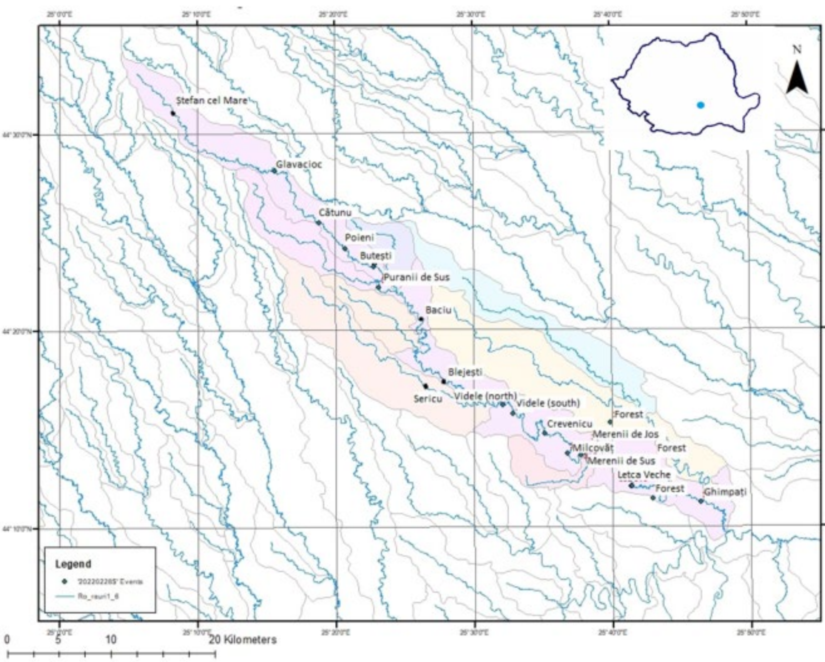

Figure 1. Location of Glavacioc River watershed (EUNIS level 3 map) and localities where plant species were investigated

The total length of the river is *ca* 120 km and it descends from 181 m altitude at its source to 56 m at its confluence with the Câlniștea.

The total area of the Glavacioc basin is 682 km^2, including the following tributary semi-permanent rivulets: Căldăraru, Fătăceni, Glavaciocul Mare, Milcovăț, Sericu, Valea de Margine and Vii (MSM, 2022).

The topography of the basin is gently undulating. Apart from settlements and associated industry, most of the basin is under agriculture (almost entirely arable, with some orchards) but with occasional blocks of woodland, many of which are clearly of planted origin.

The land in Glavacioc watershed is used mainly for agriculture (79% arable land), pastures (4.5%), vineyards and orchards (0.5%), towns and villages (5.3%) and forests (10%) (Figure 2).

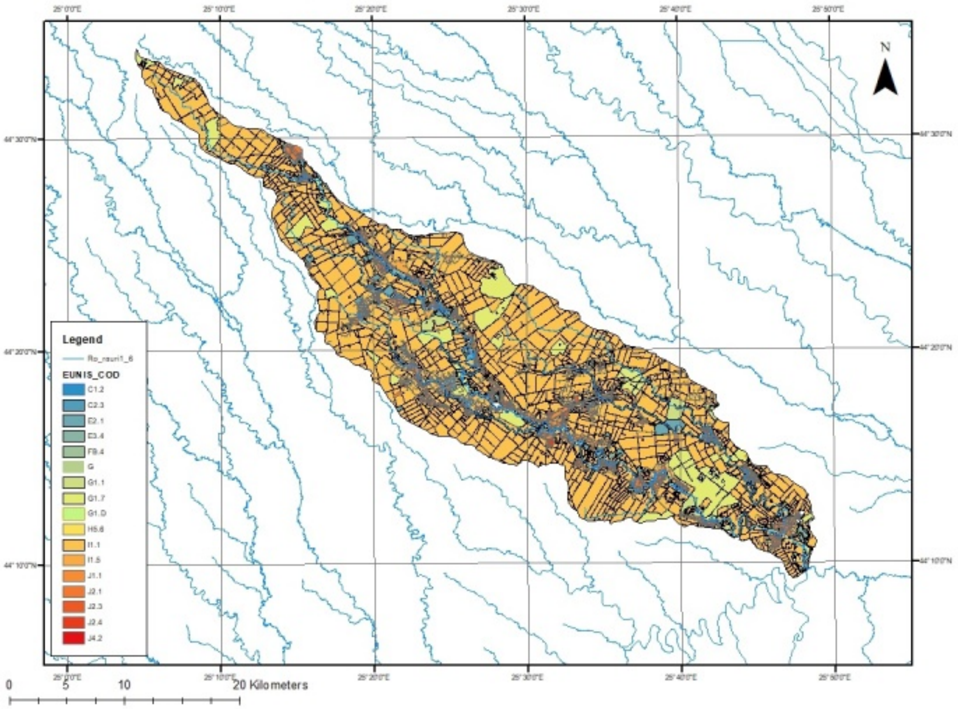

Figure 2. Glavacioc watershed land usage (EUNIS level 3 map)

We conducted our vegetation survey from the place of river discharging (confluence with Câlniștea River) toward its spring (Ștefan cel Mare locality), in towns and villages where the concentration of surface and ground-water nitrate pollution was already investigated by Lăcătușu et al. (2019 a & b) (Table 1).

Our field investigations inventoried plant species (herbaceous, shrubs and trees) from the river margins (dry and wet riparian areas) and inside the water (hygrophytous vegetation) (Table 2) and from a few adjacent forests, characterise the vegetation and habitat type within the riparian zone; note plant species that were important ecologically or in terms of biodiversity; make an appraisal of the impact of human activity on the riparian zone and the river itself.

At each survey-site, the following were recorded: dominant and characteristic species; species of interest including any of higher biodiversity value and any invasive species that constituted a threat to the habitats; management and/or disturbance of the surveyed reach of the river by human beings.

Table 1. The geographic data of the localities where the inventory of plant species had been performed

Location	Coordinates	Altitude (m)
Ghimpați	N44 11.213 E25 46.384	61
Forest between Letca Veche and Ghimpați	N44 11.410 E25 42.954	90
Letca Veche	N44 12.062 E25 41.406	75
Forest near Letca Veche	N44 12.055 E25 41.392	76
Merenii de Jos	N44 14.186 E25 38.328	78
Forest near Merenii de Sus	N44 15.281 E25 39.897	88
Merenii de Sus	N44 13.642 E25 37.730	74
Milcovăț river	N44 13.724 E25 36.769	80
Crevenicu	N44 14.728 E25 35.158	82
Videle (Sowth)	N44 15.777 E25 32.848	90
Videle (Centre)	N44 16.207 E25 32.072	89
Forest near Blejești	N44 13.236 E25 43.056	92
Blejesti	N44 28.563 E25 47.889	100
Baciu	N44 28.429 E25 44.228	100
Puranii de Sus	N44 22.183 E25 23.138	114
Butești	N44 23.385 E25 22.837	119
Poieni	N44 23.223 E25 22.804	117
Poieni	N44 24.176 E25 20.689	125
Catunu	N44 25.501 E25 18.828	123
Glavacioc	N44 28.129 E25 15.601	138
Ștefan cel Mare	N44 48.344 E25 25.136	154

The created database is not a complete inventory of plant species observed during the field assessment but does indicate the main dominant species and those of ecological importance.
The taxonomic order of plant species followed Sârbu et al. (2013). For ecological characterization of each inventoried plant species, ecological indexes from Sârbu et al. (2013) were used.
For statistical multivariate analyses we used the PAST program (Hammer et al., 2001). In table 2 we present the investigated localities and the abbreviations used for statistical analysis.

Table 2. Investigated localities and abbreviation (Abr.)

Locality	Abr.	Locality	Abr.
Toward Letca Veche_forest	TLVF	Crevenicu_water	CW
Letca Veche_water	LVW	Crevenicu_riparian	CVR
Letca Veche_riparian	LVR	Videle_water	VW
Toward Ghimpați_Forest	TGF	Videle_riparian	VR
Ghimpați_water	GW	Baciu_water	BW
Ghimpați_riparian	GR	Baciu_riparian	BR
Toward Merenii de Sus_forest	TMSF	Blejești_water	BLW
Merenii de Sus_water	MSW	Blejești_riparian	BLR
Merenii de Sus_riparian	MSR	Sericu_water	SW
Glavacioc_water	GLW	Puranii de Sus_water	PSW
Glavacioc_riparian	GLR	Puranii de Sus_riparian	PSR
Câlniștea_water	CLW	Butești_water	BTW
Câlniștea_riparian	CR	Butești_riparian	BTR
Cătunu_water	CTW	Ștefan cel Mare_water	SMW
Cătunu_riparian	CTR	Ștefan cel Mare_riparian	SMR
Poieni_riparian	PR		

RESULTS AND DISCUSSIONS

Lăcătușu et al. (2019a) stipulated that in the Glavacioc River basin, shallow groundwater is polluted with nitrates, exceeding the maximum permissible limit (50 mg/L): 7 times the average values and 12 times maximum value. The surface water is slightly alkaline (pH = 8). The input of pollutants in Glavacioc river came from agricultural activities, fertilizers being applied on arable land, pastures, vineyards, orchards; domestic contribution (animal stables, unlined toilets close to the water table and penetrating the soil and clay deposits with low permeability, solutes and polluted waters from human households leaching directly in the water table, etc.
Dunea et al (2021) specified that there is a reduction of nitrates due to the buffering capacity of riparian areas and wetlands, suggesting that the wetland vegetation intercepts and consumes nutrients, diminishing their concentration in the water table. For instance, in Poieni wetland area the lowest pH and nitrates concentration was recorded, especially in the months (March-April) when the development of plants is high and maintaining a steady trend during year.
Statistical analyses of data base highlights the similarities among localities placed downstream and those from upstream, concerning plant species from riparian areas and those

located in the water (Figure 3). The riparian zones within the Glavacioc catchment have different extents, mostly small to very small or even absent (the agricultural fields became riparian). Some riparian areas comprise extensive water bodies (wetland) containing hydro- and hygrophilous herbaceous species: i.e. in riparian areas of Letca veche and Cîlniștea (LVR and CR) with similar abundance and dominance (Figure 3).

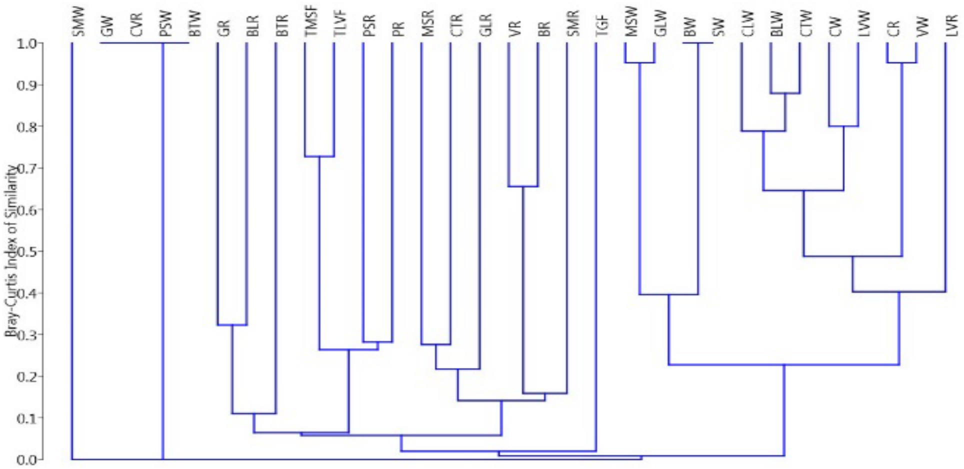

Figure 3. Bray-Curtis similarity of the localities based on inventoried plant species

Principal Components Analysis (Figure 4) shows that the wet areas (river margins and water) comprise similar vegetation, with common plant species in most localities (*Typha latifolia* L., *Sparganium erectum* L. em. Rchb., *Phragmites australis* (Cav.) Steud., *Lemna* sp. cf *minor* L., *Ceratophyllum demersum* L., *Carex riparia* Curtis) but also, some localities had a more distinctive species assemblage. The riparian areas comprise a high variety of species. Most riparian areas are highly anthropized and degraded, with a few remnant trees. The main problem is that the riparian forests shrank or disappeared over large areas Thus, the forests in the Glavacioc basin are patchy and mainly planted (Table 3).

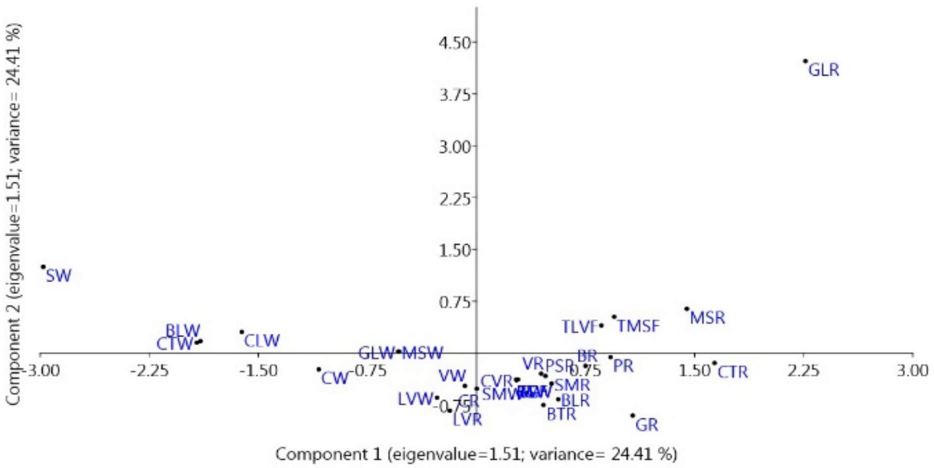

Figure 4. Principal Components Analysis of the localities based on inventoried plant species

Table 3. The trees and shrubs recorded on riparian and neighbouring areas

Plant species	**Distribution in Glavacioc basin**
Salix alba	Common dominant of riverside woodlands and scrub.
Salix purpurea	In most riparian scrub only confirmed rarely.
Salix fragilis	In many places with *S. alba.*
Populus alba	Scattered in most sites within the Glavacioc area but was hardly dominant.
Populus nigra	The morphology of the Glavacioc trees was varied, and we suspect several hybrids and cultivars are present.
Tilia platyphyllos	In small woodland blocks mainly comprised of native trees on drier ground and at the upper edge of the floodplain TLVF and TMSF.
Morus nigra	Planted near habitation but also quite frequent sub-spontaneous in disturbed riparian scrub and woodland along the river in LVR and MSR.
Quercus cerris	Frequent on disturbed banks in woodland near the Glavacioc river; much commoner in small woodlands above the flood-line in TMSF.
Quercus pubescens	Only present in small woodlands above the flood-line in TLVF.
Quercus rubra	A major component of small, planted woodlands, both on higher ground and at the edges of the floodplain in TLVF and TMSF.
Juglans regia	Occasional trees near habitation and rare in BLR.
Gleditsia triacanthos	Quite common on roadsides, at edge of woodland blocks and in disturbed riparian scrub in MSR and GLR.
Amorpha fruticosa	Occasional to frequent on banks of rivers and in woody riparian habitats.
Robinia pseudoacacia	Frequent in planted woodland blocks, by roads and in riparian woodland, and riverbanks in LVR, TMSF and SMR.
Acer negundo	Widespread on verges, woodland edges and scrub including riparian scrub only in MSR.
Acer tataricum	Only in woodland blocks with a native flora on drier, unflooded sites in TLVF, TMSF and GLR
Acer platanoides	On dry and moist soils but is rare where the site is flooded frequently; though native in some woodland sites here, it appeared to be planted in some blocks in TLVF and TMSF.
Euonymus europaeus	In drier woodlands with native flora in TMSF and MSR.
Cornus sanguinea	Mostly in drier woodland blocks with a native flora but also on moist riverbanks TLVF, BTR and CTR.
Tamarix ramosissima	Rarely and confined to the dry verges of roads but not seen on riverbanks.

The preferences of the plants for Light (L), temperature (T), soil humidity (U), soil reaction (pH) (R) and mineral nitrogen soil content (N) (Figure 5) show that in the Glavacioc basin, some plant species prefer shadow (L 4) and semi shadow (L 5), some prefer full light (L 9) and are indifferent (L x) but most species prefer light and weak shading (L 7 and 8).

Regarding temperature preferences, many of the plant species whose distribution is typically in the plain and hilly areas, require warm temperate climate (T 6) but numerous other species are indifferent (eurythermic) (Tx).

The preferences for soil moisture are very varied, showing the diversity of the vegetation areas from the Glavacioc basin and also that dry land is widely distributed into the basin. The number and abundance of species preferring dry soils is higher than of the species preferring wet soil (hydrophytous) or submergent (hygrophytous).

Most of the plant species tolerate neutal soils (with pH low acid to low alkaline) (R 7) and also many species are indifferent (R x).

The preference for nitrogen is highly variable, from N 3 (soils poor in mineral nitrogen) to N 9 (soils with excessive loading of nitrogen, deposits and pollution) dominating plant species growing on soils rich N content (N 7) and soils with higher N content toward excessive (N 8). The plant species preferring (N 9) (*Alliaria petiolata*, *Arctium lappa, Arctium tomentosum*, *Epilobium hirsutum*, *Rubus caesius*, *Rumex patientia*, *Sambucus nigra*) are present in riparian areas.

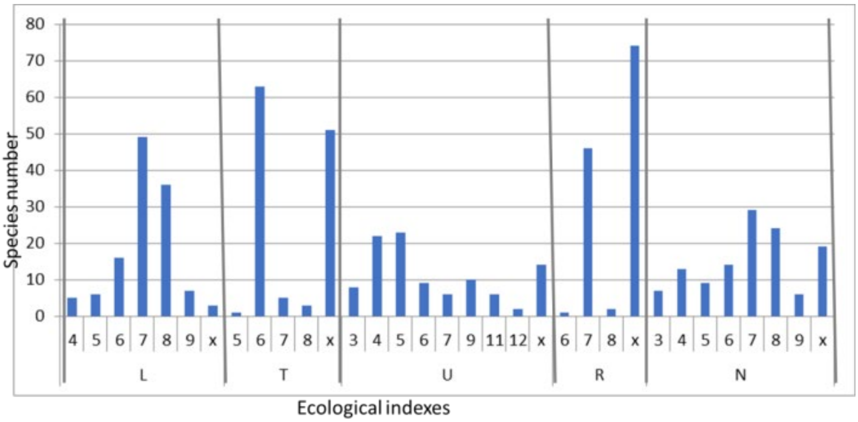

Figure 5. Ecological indexes of inventoried plant species

In Glavacioc basin, plant species dominating riparian areas are as follows: *Bidens vulgatus* (annual invasive species growing in the drawdown zone by the rivers), *Cynodon dactylon* (in many kinds of disturbed, trampled and even steppic grasslands often on paths along the flood-banks of the rivers, and on road verges, but seldom if ever where flooded), *Lythrum salicaria* (most common in marshes, fens and swamps, scattered in taller vegetation on river-banks), *Xanthium italicum* (non-native species from the Americas, it has become typical of nutrient-rich sites, locally dominant near the river especially on broader gently sloping banks, marshes and the edges of paths and tracks).

A common vegetation type in dry land, wetland and water is dominated by *Phragmites australis* which is abundant in many parts of the Glavacioc basin, usually in fringing swamps in shallow water but also in still water of backwaters and adjacent pools and marshes.

The aquatic vegetation is dominated by *Lemna* sp. cf *minor* L. common in still water vegetation of the *Lemnetalia*. In most lengths of the rivers examined in the Glavacioc basin, *Lemna* dominated most of the width (the flow was seldom sufficient to break up the floating carpets). Although only *Lemna minor* was recorded, the related *L. gibba* is likely to have been present and can be difficult to distinguish in forms without the inflated cells under the frond.

Ceratophyllum demersum, typical of the *Potamion* and *Potametalia*, in the Glavacioc basin, is often dominant in still water, especially in backwaters of the rivers.

Carex acutiformis and *C. riparia*: these two *Carex* species occur in similar habitats and often grow together in shallow still water at the edge of rivers and pools, or in marshes (sometimes where shaded). In the Glavacioc basin, they were especially common at the margins of the rivers but also grew in adjacent marshes, especially where these were liable to flooding from the rivers.

Sagittaria sagittifolia is morphologically variable and able to grow in flowing or standing water over a range of depths in communities of *Sagittario-Sparganietum, Phragmition, Oenanthion aquaticae* and *Potamion*. Frequent at the edge of rivers in the Glavacioc basin, usually in still water but occasionally as submerged leaves in the flowing portions.

Upstream (near the source), some plant species were recorded that cannot be found in the rest of the basin: *Alisma plantago-aquatica (*found in shallow and still (or slow-moving) water and on the muddy banks of the drawdown zone in vegetation of the *Phragmititi-Magnocaricetea* and *Bidention*, near the Glavacioc river and its tributaries, it grew in shallows, on gently-sloping wet banks and in seasonally-flooded depressions in riparian scrub or woodland), *Berula erecta* (in swamps and marshes of the *Phragmition, Magnocaricion* and *Glycerio-Sparganion*, in Glavacioc, most common at the upstream end of the river nearing its source, where it formed patches in shallow water at the edge of the flowing river), *Veronica anagallis-*

aquatica (often in shallow water in communities of the *Glycerio-Sparganion*, *Bidention* and *Phragmiti-Magnocaricetea*, in Glavacioc, mainly nearing the source of the river, where there were patches in shallow water at the edge of the flowing river).

Although *Berula erecta* and *Veronica anagallis-aquatica* were rare at the Glavacioc basin level and only grew upstream, near the source, these species prefer high concentration of mineral nitrogen, suggesting that not even the waters near the source are unpolluted.

CONCLUSIONS

Crossing many rural areas in southern Romania, the Glavacioc River itself and the soil and groundwater of its neighbouring area are mainly polluted by nitrates from agriculture (excessive fertilization with mineral nitrogen fertilizers), husbandry (mismanagement of manure) and/or human waste.

The vegetation changes from up to down river, most nitrophilous and ruderal species having diversity and abundance growing down river.

The riparian zone of the Glavacioc and its tributaries represents the only significant area of non-cultivated, semi-natural land in the basin but even here the impact of human activity is clearly discernible. The main problem is that the extent of riparian forests had shrunk or disappeared in large areas, the trees were clear cut, and the remnant herbaceous vegetation is dominated by ruderal species (weeds) or has even been replaced by agricultural fields.

The investigation of the presence, abundance and dominance of plant species in different areas and their ecological characterization, may bring new knowledge about the ecological status of an area. Most of all, inventorying the plant species and characterizing the vegetation may be done by specialists without the need for expensive equipment.

Any management practices should include both re-vegetation of riverbanks with the natural woody vegetation that have a very important role in diminishing the entrance of pollutants in the water (retaining or filtering them) and maintaining most of the herbaceous natural vegetation.

Because of the existence of knowledge gap regarding how different types of riparian vegetation influence N_2O emissions, inter-disciplinary research on Glavacioc River might be valuable.

ACKNOWLEDGEMENTS

The data have been obtained in the framework of Contract 43PCCDI/2018, financed by UEFISCDI in Complex Partnership project PN-III-1.2-PCCDI-2017-0721 (INTER-ASPA). The paper was elaborated in the framework of project RO1567-IBB01 from the Institute of Biology Bucharest of the Romanian Academy, financed by Romanian Academy.

REFERENCES

Anbumozhi, V., Radhakrishnan, J., & Yamaji, E. (2005). Impact of riparian buffer zones on water quality and associated management considerations. *Ecological Engineering*, *24*(5), 517–523.

Baskerville, M., Reddy, N., Ofosu, E., Thevathasan, N. V., & Oelbermann, M. (2021). Vegetation Type Does not Affect Nitrous Oxide Emissions from Riparian Zones in Agricultural Landscapes. *Environmental Management*, *67*(2), 371–383.

Bell, G., Lechowicz, M. J., & Waterway, M. J. (2000). Environmental heterogeneity and species diversity of forest sedges. *Journal of Ecology*, 67–87.

Birnie, R., Dennis, P., Dunn, S., Edwards, A., Horne, P., Hill, G., Paterson E., Langan S., & Wynn, G. (2002). Review of recent UK and European research regarding reduction, regulation and control of the environmental impacts of agriculture. *Report prepared on behalf of the Agriculture and Environment Working Group (AEWG), and funded by the Scottish Executive Environment and Rural Affairs Department under contract MLU/901/01*. 99 pp.

Burt, T. P., Pinay, G., Matheson, F. E., Haycock, N. E., Butturini, A., Clement, J. C., Danielescu, S., Dowrick, D., Hefting, M., Hillbricht-Ilkowsk, A., & Maitre, V. (2002). Water table fluctuations in the riparian zone: comparative results from a pan-European experiment. *Journal of hydrology*, *265*(1-4), 129–148.

Calow P., & Petts G.E. (Eds.) (1994). The rivers handbook: hydrological and ecological principles. Volume 2. Blackwell Scientific Publications, Inc., 523 pp.

Campos, J. B., & Souza, M. C. D. (2002). Arboreous vegetation of an alluvial riparian forest and their soil relations: Porto Rico Island, Paraná River, Brazil. *Brazilian Archives of Biology and Technology*, *45*(2), 137–149.

Ciocârlan, V. (2009). *Flora Ilustrată a României. Pterydophyta et Spermatophyta*, Editura Ceres.

Dunea, D., Bretcan, P., Purcoi, L, Tanislav, D., Serban, G., Neagoe, A., Iordache, V., & Iordache, Ș. (2021).

Effects of riparian vegetation on evapotranspiration processes and water quality of small plain streams. *Ecohydrology & Hydrobiology*, *21*(4), 629–640.

Dunea, D., Iordache, Ș., Iordache, V., Purcoi, L., & Predescu L. (2019). Monitoring of the evapotranspiration processes in riparian grasslands. *Scientific Papers. Series A. Agronomy*, *LXII* (1), 278–285

Falcă, M., Vasiliu-Oromulu, L., Sanda, V., Paucă-Comănescu, M., Honciuc, V., Maican, S., Purice, D., Dobre, A., Stănescu, M., Onete, M., Biță–Nicolae, C., Matei, B., & Codrici, I. (2004). Ecosystem characterization of some flooding ash forest from the Neajlov Holm (Giurgiu District), *Proceedings of the Institute of Biology*, *VI*. 59–72.

Fonseca, A., Ugille, J. P., Michez, A., Rodríguez-González, P. M., Duarte, G., Ferreira, M. T., & Fernandes, M. R. (2021). Assessing the connectivity of Riparian Forests across a gradient of human disturbance: The potential of Copernicus "Riparian Zones" in two hydroregions. *Forests*, *12*(6), 674.

Giese, L. A., Aust, W. M., Trettin, C. C., & Kolka, R. K. (2000). Spatial and temporal patterns of carbon storage and species richness in three South Carolina coastal plain riparian forests. *Ecological Engineering*, *15*, S157–S170.

Guteascu, M., Constantinescu, T., Cracuin, S., Bascoveanu, D., & Podoleanu, D. (2018). Annex VII. Application of the bottom-up multicriteria methodology in eight European River Basin Districts – The Arges-Vedea RBD. Deliverable to Task A3 of the BLUE 2 project "Study on EU integrated policy assessment for the freshwater and marine environment, on the economic benefits of EU water policy and on the costs of its non-implementation". Report to DG ENV.

Hammer, Ř., Harper, D.A.T., Ryan, P.D. (2001). PAST: Paleontological statistics software package for education and data analysis. *Palaeontologia Electronica*, *4*(1), 1–9.

Huggenberger, P., Hoehn, E., Beschta, R., & Woessner, W. (1998). Abiotic aspects of channels and floodplains in riparian ecology. *Freshwater Biology*, *40*(3), 407–425.

Kaushal, S.S., Groffman, P.M., Striz, E., & Gold, A.J. (2008). Effects of stream restoration on denitrification in an urbanizing watershed, *Ecological Applications*, *18*(3), 789–804.

Kuglerová, L., Ågren, A., Jansson, R., & Laudon, H. (2014). Towards optimizing riparian buffer zones: Ecological and biogeochemical implications for forest management. *Forest Ecology and Management*, *334*. 74–84.

Lăcătușu, R., Paltineanu, C., Vrinceanu, A., & Lăcătușu, A.R. (2019a). Influence of domestic activity on the quality of groundwater and surface water in the rural built-up area of the southern Romanian Danube Plain – a case study in the Glavacioc catchment, *Carpathian Journal of Earth and Environmental Sciences*, *14*(2), 323–334.

Lăcătușu, R., Păltineanu, C., Lăcătușu, A. R., Rizea, N., & Dragomir, Ș. (2019b). Nitrate pollution of groundwater from built-up areas of the Glavacioc catchment, Teleorman County, Romania. In 19th International Multidisciplinary Scientific GeoConference SGEM 2019 (pp. 419–426).

Luke, S. H., Slade, E. M., Gray, C. L., Annammala, K. V., Drewer, J., Williamson, J., ... & Struebig, M. J. (2019). Riparian buffers in tropical agriculture: Scientific support, effectiveness and directions for policy. *Journal of Applied Ecology*, *56*(1), 85–92.

Martin, T. L., Kaushik, N. K., Trevors, J. T., & Whiteley, H. R. (1999). Denitrification in temperate climate riparian zones. *Water, Air, and Soil Pollution*, *111*(1), 171–186.

Mayer, P.M., Reynolds, S.K., Mc Cutchen, M.D., & Canfield, T.J. (2007). Metaanalysis of nitrogen removal in riparian buffers. *Journal of Environmental Quality*, *36*. 1172–1180.

Naiman, R.J., & Décamps, H. (1997). The ecology of interfaces: riparian zones. *Annual Review of Ecology, Evolution, and Systematics*, *28*(1), 621–658.

Paucă-Comănescu, M., Onete, M., & Tăcină, A. (2002). Phenology of the main plant populations from the *Tamarix* shrubland located on the lower floodplain of the Prahova and Teleajen rivers, *Proceedings of the Institute of Biology*, *IV,* 133–145.

Paucă-Comănescu, M., Onete, M., Tăcină, A., & Șerbănescu, Gh. (2000). Diversity of the primary producers composition in the *Tamarix* shrubland of the lower Prahova and Teleajen valleys. *Proceedings of the Institute of Biology*, *III*. 99–116.

Paucă-Comănescu, M., G. Dihoru, Onete M., Vasiliu-Oromulu L., Falcă M., Honciuc V., Stănescu M., Purice D., & Matei B. (2004). The diversity of alluvial shrubland flora and fauna in the Neajlov Floodplain. *Proceedings of the Institute of Biology*, *VI*. 105–118

Paucă-Comănescu, M., Onete, M., Ștefănuț, S., Șincu, E.D., Vasiliu-Oromulu, L., Falcă, M., Honciuc, V., Purice, D., Stănescu, M., & Cristina, F. (2005). The biodiversity of alluvial shrubland characteristic for the Câlniștea River. *Proceedings of the Institute of Biology*, *VII*. 87–110.

Riis, T., Kelly-Quinn, M., Aguiar, F. C., Manolaki, P., Bruno, D., Bejarano, M. D., & Dufour, S. (2020). Global overview of ecosystem services provided by riparian vegetation. *BioScience*, *70*(6), 501–514.

Sanchez-Perez, J. M., Trémolières, M., Schnitzler, A., Badre, B., & Carbiener, R. (1993). Nutrient content in alluvial soils submitted to flooding in the Rhine alluvial deciduous forest. *Acta Oecologica*, *14*(3), 371–387.

Sârbu, I., Ștefan N., Oprea, A. (2013). *Plante vasculare din România. Determinator ilustat de teren*, Editura Victor B. Victor.

Shabaga, J. A., & Hill, A. R. (2010). Groundwater-fed surface flow path hydrodynamics and nitrate removal in three riparian zones in southern Ontario, Canada. *Journal of hydrology*, *388*(1-2), 52–64.

Shearer, K. S., & Xiang, W. N. (2007). The Characteristics of Riparian Buffer Studies. *Journal of Environmental Informatics*, *9*(1).

Silverthorn, T.K., & Richardson, J.S. (2021). Forest Management Impacts on Greenhouse Gas Fluxes from Riparian Soils Along Headwater Streams, *Ecosystems*, https://doi.org/10.1007/s10021-021-00621-z

Tabacchi, E., Correll, D. L., Hauer, R., Pinay, G., Planty-Tabacchi, A. M., & Wissmar, R. C. (1998). Development, maintenance and role of riparian vegetation in the river landscape. *Freshwater biology*, *40*(3), 497–516.

Tabacchi, E., Lambs, L., Guilloy, H., Planty-Tabacchi, A. M., Muller, E., & Decamps, H. (2000). Impacts of riparian vegetation on hydrological processes. *Hydrological processes*, *14*(16-17), 2959–2976.

Tang, J., Zhu, Y., Wei, Z., Feng, L., Yang, N., Sun, Z., & Luo, Q. (2021). Effectiveness of Riparian Vegetated Filter Strips in Removing Agricultural Nonpoint Source Pollutants in Agricultural Runoff from the Liao River Area, China. *Polish Journal of Environmental Studies*, *30*(5), 4709–4718.

Tornqvist, T. (1997). Species composition of an alluvial hardwood forest. *Acta Bot. Neerl*, *46*(2), 131–146.

Tremolieres, M., Sanchez-Perez, J.M., Schnitzler, A., & Schmitt. (1998). Impact of river management history on the community structure, species composition and nutrient status in the Rhine alluvial hardwood forest, *Plant Ecology*, *135*. 59–78.

*** MSM, 2022, Mayoralty Ștefan cel Mare, https://www.cjarges.ro/web/stefan-cel-mare/hidrologia (accessed in 2022)