Scientific Papers. Series A. Agronomy, Vol. LXVII, No. 2, 2024
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

TENDENCIES IN WET ZONES VEGETATION EVOLUTION UNDER ANTHROPIC DISTURBANCES IN THE ROMANIAN BANAT

Alina NEACȘU, Gabriel ARSENE, Florin SALA, Alina LAȚO, Ilinca IMBREA, Diana OBISTIOIU, Iaroslav LAȚO

University of Life Sciences "King Mihai I" from Timisoara, 119 Calea Aradului Street, Timisoara, Romania

Corresponding author email: gabrielarsene@usvt.ro

Abstract

Wet zones have always been of great importance to humanity. The historical province of the Banat was known as a huge expanse of swamps in the past, but the current map of the region (its Romanian part) is fundamentally different, as a result of hydro-relief works. Our study is a synthesis about the evolution of the vegetation of some wet zones. Observations refer to a significant period of time. We processed and compared several hundred species and phytosociological rélevés from many location. Correlations were made between the nucleus of common species, the compared groups, the dendrogram with the grouping of the rélevés, the diversity profile of the parameters. From the processing of the data, it appears that there are significant losses in the current structure and composition of the vegetation. These are caused by a series of factors such as: reduction of the areas occupied by wet habitats, hydro-relief works, climate changes, expansion of invasive species, fragmentation, other agricultural activities.

Key words: *Romanian Banat, wet zones, vegetation, anthropic disturbance.*

INTRODUCTION

Wetlands, defined by the Ramsar Convention as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres" or by the EPA (Environmental Protection Agency) as "areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season", are very vulnerable, Gomoiu et al. (2009) considering them among the most endangered ecosystems on the globe. In the synthesis on the restoration of wetlands in Central Europe, Pfadenhauer & Grootjans (1999) consider essential the in-depth knowledge of ecological processes, Rittenhouse & Peterman (2018) and Stengård et al. (2020) explain the role of connectivity in the conservation of these dynamic ecosystems.
The importance of wetlands, translated by the term ecosystem services, is well known, from supporting the needs of food and water, to mitigating climate change, controlling floods, soil erosion, the circuit of substances, up to multiple cultural services. The causes of wetland degradation and loss are equally well known: agriculture, industries, transportation, excessive urbanization, global warming, pollution, expansion of invasive species etc.
In Europe, there is a wide range of wetlands, estimated at several thousand, as an expression of the climatic peculiarities of our continent. On account of some forecasts, Okruszko et al. (2011) draw attention to the possibility of losing an important number of the services brought by these areas (up to 46% in 2050) and consider that water management is crucial.
In Romania, there are 345 wetland sites covering 10.5% of the country's surface (Tanislav, 2014). In terms of the ecosystem services provided and the biodiversity they conserve, wetlands in Romania are very important, although throughout history they have been underestimated and considered wastelands (Ciobotaru et al., 2014; 2019). Speaking about the value of wetlands, Gomoiu et al. (2009) emphasize the importance of the genetic resources they hold, considering them huge reservoirs of biological diversity. Against the background of the same problems identified globally (Giosan et al., 2014; Davidson, 2018; Walpole & Davidson, 2018; Li et al., 2018; Finlayson, 2019; Cadier et al., 2020; Ballut-Dajud et al., 2022; Beranek et al., 2022 etc.),

the loss of wetland services is a major problem here as well.

The vast majority of wetlands in Romania (96%) are located in the plain area with a dry or semi-arid climate, distributed over a wide variety of soils (Ciobotaru et al., 2014). The Habitat Quality (HQ) index indicates their high susceptibility to pressure exposure state, outside the Danube Delta and Lower Danube Floodplain (Ciobotaru et al., 2019).

Over time, large-scale land reclamation and hydraulic improvement works were carried out in Banat (watercourses regularization and swamps drainage, the latter considered the source of multiple epidemics, from the 18th century), in order to use the land for agriculture and transport development. The current map of the region is fundamentally different from what was described by the Italian scientist Francesco Griselini, on the occasion of his trip to the Banat of Timișoara, in 1774. Few natural wetlands were preserved, so that over time artificial ones were created (for tourism, fish farming, irrigation, flood mitigation, energy generation, as water reservoirs etc.). The only natural wetland that has survived is the Mlaștinile Satchinez area, nicknamed "the Banat delta", an area declared a nature reserve in 1942 with the involvement of the famous Romanian ornithologist, Dionisie Linția, and which is today a Natura 2000 site (ROSCI0115 Mlastina Satchinez, ROSPA0078 Mlastina Satchinez). Unfortunately, its state of preservation is not the best. Several other areas that protect habitats and important species should be mentioned, such as: Lunca Mureșului Natural Park (Ramsar site), Lunca Timișului (ROSCI0109, ROSPA0128), Lunca Mureșului Inferior (ROSCI0108, ROSPA0069), Lunca Bârzavei (ROSPA0127), Mlaştinile Murani (ROSPA 0079), Lacul Surduc (mixed nature reserve).

Gomoiu et al. (2009) show how the changes undergone over time by some wetlands in the Western Plain of Romania influence the flora and vegetation. Among the extinct species, these authors mention: *Hippuris vulgaris, Acorus calamus, Pedicularis palustris, Salix aurita* and among those in expansion, *Phalaris arundinacea, Glyceria maxima, Lythrum salicaria, Lycopus europaeus, Oenanthe aquatica, Rorippa amphibia, Agrostis stolonifera*. Under the aspect of vegetation evolution, attention is paid to the impoverishment of some characteristic phytocenoses and the expansion of ruderalized ones in which the problem of invasive species appears, such as *Reynoutria japonica*. From the list of neophytes from Romanian wet zones, made by Anastasiu et al. (2008), the most invasive are considered: *Amorpha fruticosa, Azolla filiculoides, Elodea nuttallii, Helianthus tuberosus, Impatiens glandulifera, Paspalum paspalodes, Reynoutria japonica, Rudbeckia laciniata, Solidago canadensis, Solidago gigantea* subsp. *serotina, Xanthium strumarium* subsp. *strumarium (X. italicum)*.

Pătruț & Coste (2006) mention that the hydro-ameliorative works carried out throughout history in the Banat Plain have determined the lowering of the water table level, so that the aquatic and palustrine biotopes have decreased their surfaces, the tendency of the evolution of the vegetation being predominantly hydrophilic and paludicolous, towards xerophilic and meso-xerophilic vegetation.

MATERIALS AND METHODS

Within our research we considered phytocenological surveys from some wet zones from Romanian Banat. The samples were made in an interval of over 60 years (1956 - present) by: Soran (1956), Boșcaiu (1966), Grigore (1971), Vicol (1974), Oprea et al. (1974), Arsene et al. (2005), Neacșu et al. (2008 - 2022). The relevés were carried out in the following wet zones: the Timiș floodplain, Liebling (Soran, 1956), the surroundings of Lugoj (Boșcaiu, 1966), the Timiș-Bega interfluve area (Grigore, 1971), Oprea, I.V., Stratul, E., Iacob, M. (1974), the Lugoj piedmont (Vicol, 1974), Satchinez lowland (Arsene et al., 2005), Surduc, Pișchia, Liebling and Sânandrei lakes (Neacșu et al., 2008-2022). The processed variables for own data are: the number of relevés per association, the number of species per relevés, the number of species per association, general vegetation coverage, sample area size, vegetation height.

RESULTS AND DISCUSSIONS

In the synthetic table, we gathered 292 relevés. Of these samples, 124 belong to us and 168 are studied from the scientific literature (other authors). The table contains 386 species. The plant associations analyzed are: *Lemnetum minoris* (Oberd. 1957) Müller et Görs 1960, *Lemno-Spirodeletum* W. Koch 1954, *Eleocharidetum acicularis* W. Koch 1926 em. Oberd. 1957, *Myriophyllo-Potametum* Soó 1934, *Trapetum natantis* Müller et Görs 1960, *Polygono-Potametum natantis* Soó 1964, *Scirpo-Phragmitetum* W. Koch 1926, *Typhaetum angustifoliae* Pignatti 1953, *Typhaetum latifoliae* G. Lang 1973, *Glycerietum maximae* Hueck 1931, *Schoenoplectetum lacustris* Eggler 1933, *Iretum pseudacori* Eggler 1933, *Eleocharidetum palustris* Schennikow 1919, *Leersietum oryzoides* Krause 1955 em. Pass. 1957, *Phalaridetum arundinaceae* (Horvatič 1931) Libbert 1931, *Cariecetum ripariae* Knapp et Stoffer 1962, *Polygono hydropiperi-Bidentetum* Lohm. 1950, *Echinochloo-Polygonetum lapathifolii* (Ujvárosi 1940) Soó et Csűrös (1944) 1947, *Conietum maculati* I. Pop 1968, *Sambucetum ebuli* (Kaiser 1926) Felföldy 1942, *Salicetum albae* Issler 1924 s.l., *Rubi-Salicetum cinereae* Sonasak 1963, *Pruno spinosae-Crataegetum* Heuck 1931.

Data series analysis using bar chart - box plot, led to the diagram in Figure 1. It presents the variation ranges of the data series for the AG (general vegetation coverage), IV (vegetation higth), and SN (species number) parameters, the standard error, and the outlier values (in the case of the IV parameter, R110, come from a *Salicetum albae* phytocoenosis from Surduc).

The multivariate analysis (PCA) led to the diagram presented in Figure 2 (correlation between groups diagram) and Figure 3 (Var-covar disregard diagram). It was found the formation of some groups of study points with common areas, but also with the polarization of some points in relation to the indices considered (AG, IV, SN). In the case of the diagram in Figure 2, axis 1 explains 77.979% of variance and axis 2 explains 16.211% of variance). In the case of the diagram in figure 3, PC1 explained 99.126% of variance and PC2 explained 0.7714% of variance.

On the diagram in Figure 2, it can be seen that on axis 1, which explains 77.979% of the variance, there are mainly marsh associations, slightly flooded up to associations with *Typha angustifolia* and *Typha latifolia*. Most of the other associations, including the aquatic ones, are grouped in the central area and a few are eccentric. Axis 2 has little explanatory value. On the diagram in Figure 3 it can be seen that axis 1, which explains 99.126% of the variance, is influenced by the presence of some abnormal relevés (R110 *Salicetum albae*, R93 *Polygono hydropiperi-Bidentetum*, R117 *Rubi-Salicetum cinereae*, R43 *Typhaetum angustifoliae*, R30 *Scirpo-Phragmitetum*). These relevés are from the Surduc and Pişchia area. Their positioning is mainly due to the large differences in the height of the vegetation (R110), compared to most relevés and the appearance of some species that are missing in the others.

The cluster analysis led to the dendrogram in Figure 4 under conditions of statistical safety (Coph.corr = 0.924). The dendrogram reconfirms the eccentric position of R110 and the separation into 7 clusters. Examining these clusters, it is observed that each brings together relevés with very diverse phytocenoses; we find phytocenoses from the same plant association distributed in different clusters. This can be explained by the fact that the list of species is consistent, that most relevés include few species, so that the accidental presence of a species greatly influences the cluster analysis.

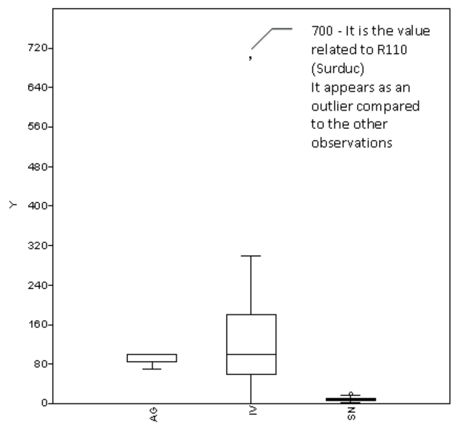

Figure 1. Boxplot diagram for the parameters AG (general vegetation coverage), IV (vegetation height) and SN (species number)

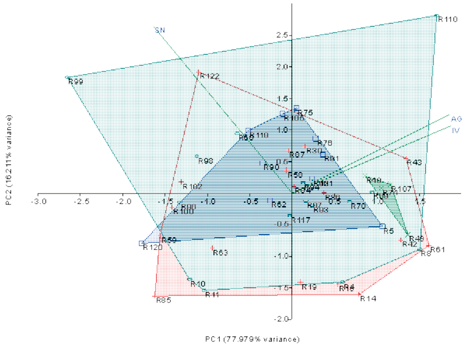

Figure 2. Principal Component Analysis - Correlation between groups

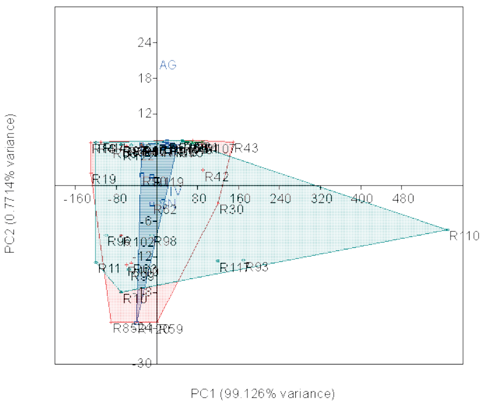

Figure 3. Principal Component Analysis Var-covar Disregard

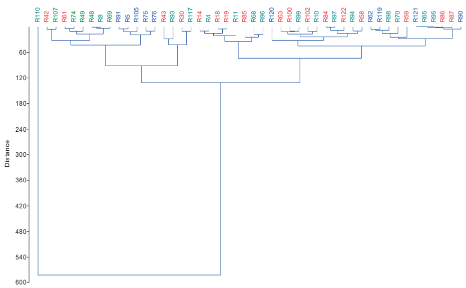

Figure 4. Dendrogram regarding the grouping of relevés (RN) in relation to the general vegetation coverage (AG), vegetation height (IV) and the number of species (SN)

CONCLUSIONS

From the comparative analysis of the data, the following trends can be observed:

- the significant trend of decrease in specific diversity in the wet zones;
- the high presence of adventive species, in recent years studies: *Ambrosia artemisiifolia, Erigeron annuus, Phytolacca americana, Robinia pseudacacia, Xanthium italicum, Xanthium spinosum, Amaranthus retroflexus, Juncus tenuis, Eriochloa villosa*, *Lindernia dubia* (the last two reported in our phytocenoses at Pişchia and Surduc). Also, *Amorpha fruticosa* and *Echinocystis lobata* with sporadic presence in the past (Grigore, 1971, Vicol, 1974), are now among the worst invasive species in the Romanian wet zones;
- the sporadic presence or the disappearance of some important species (*Elatine alsinastrum* - Grigore, 1971: Uliuc, Urseni, Albina, Utvin / Near Threatened IUCN Red List, *Marsilea quadrifolia* - Grigore, 1971: Uliuc, Urseni, Albina, Utvin, Moşniţa Veche, Ghiroda, Sînmihaiul Român / EU Habitats Directive, Bern Convention, *Salvinia natans* - Boşcaiu, 1966: Lugoj surriundings; Grigore, 1971: Albina, Uliuc, Urseni, Ghiroda, Sînmihaiul Român, Moşniţa, Utvin, Peciu Nou, Otelec, Ionel, Livanda, Diniaş, frequent in the interfluve, Timişoara; Vicol, 1974: Lugoj / Bern Convention);
- the decrease of the areas with aquatic and marsh vegetation (e.g. Neacşu et al. 2018);
- the tendency of ruderalization in wet zones.

REFERENCES

Abonyine-Palotas, J., Ahmetovic-Tomka, D., Ancuta, C., Bogdanovic, Z., Bugarcic, P., Bugarski, D., Cretan, R., Curcic, S., Cukic, Z., Dalmacija. B., Davidivic, R., Durdev, B., Duricic, J., Ianos, Gh., Karlovic, E., Kicosev, S., Krajko, G., Lazic, L., Markovic, S., Miljkovic, L., Miljkovic, N., Munteanu, R., Plavsa, J., Romelic, J., Tamas, Z., Tomic, P., Truti, S., Tumbas-Ivancev, I., Vert, C., Voiculescu, M., Voiculescu, S. (1997). *Geographic Monographs of European Regions Banat*, University of Novi Sad, West University of Timisoara, Jozsef Attila University, Lito Studio, Novi Sad.

Anastasiu, P., Negrean, G., Bașnou, C., Sîrbu, C., Oprea, A. (2008). A preliminary study on the neophytes of wetlands in Romania. In Rabitsch, W., F. Essl & F. Klingenstein (Eds.): *Biological Invasions - from Ecology to Conservation*. NEOBIOTA 7: 180-190, http://cachescan.bcub.ro/2008_05_28/577253%20Anastasiu%20et%20al,%20Neophytes%20wetlands%20Romania.pdf.

Ballut-Dajud, G.A., Sandoval Herazo, L.C., Fernández-Lambert, G., Marín-Muñiz, J.L., López Méndez, M.C.; Betanzo-Torres, E.A. (2022). Factors Affecting Wetland Loss: A Review, *Land 2022*, 11, 434, https://doi.org/10.3390/land11030434.

Beranek, C.T., Sanders, S., Clulow, J., Mahony, M. (2022). Factors infuencing persistence of a threatened amphibian in restored wetlands despite severe population decline during climate change driven weather extremes, *Biodiversity and Conservation* 31:1267–1287, https://doi.org/10.1007/s10531-022-02387-9.

Boşcaiu, N. (1966). Vegetaţia acvatică şi palustră din împrejurimile oraşului Lugoj, Universitatea „Babeş-Bolyai" Cluj. Grădina botanică, *Contribuţii botanice II*, Cluj-Napoca, pp. 69-80.

Boşcaiu, N., Coldea, G., Horeanu, C. (1994). Lista roşie a plantelor vasculare, dispărute, periclitate, vulnerabile şi rare din Flora României, *Ocrotirea Naturii şi Mediului Înconjurător*, Bucureşti, pp. 45-56.

Cadier, C., Bayraktarov, E., Piccolo, R., Adame, M.F. (2020). Indicators of Coastal Wetlands Restoration Success: A Systematic Review, *Frontiers in Marine Science*, https://doi.org/10.3389/fmars.2020.600220.

Ciobotaru, N., Laslo, L., Matei, M., Mușat, C., Lupei, Th., Boboc, M., Deák, G. (2014). Mapping Romanian wetlands - a geographical approach, *3rd International Conference - Water resources and wetlands*. 8-10 September, Tulcea (Romania), pp. 220-227, https://www.limnology.ro/wrw2016/proceedings/30_Ciobotaru_Nicu.pdf.

Ciobotaru, N., Laslo, L., Lupei, Th., Deák, G., Matei, M., Bara, N., Noor, N.M. (2019). Preliminary assessment of the status of Romanian wetlands through the framework of habitat quality analysis, *AIP Conference Proceedings*, 020070 (2019), https://aip.scitation.org/doi/abs/10.1063/1.5118078.

Coldea, Gh., Sanda, V., Popescu, A., Ștefan, N. (1997). *Les associations végétales de Roumanie. Tome 1. Les associations herbacées naturelles*, Presses Universitaires de Cluj, Cluj-Napoca.

Corli, A., Rossi, G., Orsenigo, S., Abeli, T. (2021). Biological flora of Central Europe: Marsilea quadrifolia L, Perspectives in *Plant Ecology, Evolution and Systematics, Volume 53*, December, 125641, https://www.sciencedirect.com/science/article/pii/S1433831921000536.

Coste, I., Oncia, S. (2003). The ecological impact of hydrografic accumulations on Romania's rivers, *Réunion IP Agriculture durable et ressources hidriques: comparaison européenne - Evora*, pp. 47-55, Timisoara, RO: Orizonturi Universitare Publishing House.

Cozma, M., Oprea, C. V., Văcaru, P. (1974). *Pământuri renăscute - Sisteme de desecări în judeţul Timiş*, Direcţia Generală a Agriculturii, Industriei alimentare şi apelor din judeţul Timiş, Timișoara.

Davidson, N.C. (2018). Wetland Losses and the Status of Wetland-Dependent Species. In: Finlayson, C., Milton, G., Prentice, R., Davidson, N. (eds) *The Wetland Book*. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-4001-3_197.

Dihoru, G., Dihoru, A. (1994). Plante rare, periclitate şi endemice în Flora României - Lista Roşie, *Acta. Bot. Horti*, Bucureşti.

Dihoru, G., Negrean, G. (2009). *Cartea Roşie a plantelor vasculare din România*, Bucharest, RO: Romanian Academy Publishing House.

Doniță, N., Popescu, A., Paucă-Comănescu, M., Mihăilescu, S., Biriş, I.-A. (2005). *Habitatele din România*, Bucharest, RO: Forestry Technical Publishing House.

Fărcășescu, A.-M., Arsene, G.-G., Neacşu, A.-G. (2008). Eriochloa villosa (Thunb.) Khunt - new invasive weed in Romania, *Journal of Plant Diseases and Protection, Special Issue, XXI*, Eugen Ulmer KG, Stuttgart, pp. 333-334.

Finlayson, C.M. (2019). Addressing the decline in wetland biodiversity, *The Ecological Citizen Vol 2 No 2*, 2019: 139–40, https://www.ecologicalcitizen.net/pdfs/v02n2-05.pdf.

Giosan, L., Syvitski, J., Constantinescu, S., Day, J.W. (2014). Climate change: Protect the world's deltas. *Nature 516*, 31–33. https://doi.org/10.1038/516031a.

Grigore, S. (1971). Flora şi vegetaţia din interfluviul Timiş – Bega, *Teză de doctorat*, Institutul Agronomic „Ion Ionescu de la Brad", Iaşi.

Griselini, F. (1984). *Încercare de istorie politică şi naturală a Banatului Timişoarei*, Timisoara, RO: Facla Publishing House.

Gomoiu, M.-T., Ardelean, A., Ardelean, G., Ardelean, D.I., Onciu T.M., Skolka, M., Karácsonyi, K. (2009). *Zonele umede - abordare ecologică*, Cluj-Napoca, RO: Casa Cărţii de Ştiinţă Publishing House.

Kiss, A. (1999). *Avifauna din zonele umede ale Banatului*, Timisoara, RO: Mirton Publishing House.

Li, X., Bellerby, R., Craft, C., Widney, S.E. (2018). Coastal wetland loss, consequences, and challenges for restoration, *Anthropocene Coasts*: https://cdnsciencepub.com/doi/10.1139/anc-2017-0001.

Munteanu, R., Herşcovici, O. (1970). Consideraţii asupra lacurilor din Banat, *Studii de geografie a Banatului*, (in coord. Cornea, I.) Universitatea din Timişoara, Facultatea de Istorie-Geografie, Timişoara.

Mucina, L., Bültmann, H., Dierssen, K., Theurillat, J.-P., Raus, T., Čarni, A., Šumberová, K., Willner, W., Dengler, J., Gavilán García, R., Chytrý, M., Hájek, M., Di Pietro, R., Iakushenko, D., Pallas, J., Daniëls, F.J.A., Bergmeier, E., Santos Guerra, A., Ermakov, N., Valachovič, M., Schaminée, J.H.J., Lysenko, T., Didukh, Y.P., Pignatti, S., Rodwell, J. S., Capelo, J., Weber, H. E., Solomeshch, A., Dimopoulos, P., Aguiar, C., Hennekens, S. M., Tichý, L. (2016). Vegetation of Europe: hierarchical floristic classification system of vascular plant, bryophyte, lichen, and algal communities. *Applied Vegetation Science. Wiley, vol. 19, supp.1*, 3-264, https://doi.org/10.1111/avsc.12257.

Neacșu, A.-G. (2008). Cercetări asupra biodiversității florei și vegetației unor lacuri de acumulare din județul Timiș, *Teză de doctorat*, U.S.A.M.V.B. Timișoara, Facultatea de Agricultură.

Neacșu, A., Imbrea, I., Lațo, A., Arsene, G. (2021). Lindernia dubia (L.) Pennell: a new invasive in the Romanian Banat area, *Scientific Papers. Series A. Agronomy, Vol. LXIV*, No. 1, pp. 718-723.

Neacșu A., Popescu G., Imbrea I., Nicolin A., Arsene G. (2018). Aspects of evolution of three wet zones in Timis County (W Romania), *Proceedings of the International Conference on Life Sciences*, Filodiritto Editore - Proceedings, pp. 705-712.

Okruszko, T., Duel, H., Acreman, M., Grygoruk, M., Flörke, M., Schneider, C. (2011). Broad-scale ecosystem services of European wetlands - overview of the current situation and future perspectives under different climate and water management scenarios, *Hydrological Sciences Journal, 56:8*, 1501-1517, https://www.tandfonline.com/doi/full/10.1080/02626667.2011.631188.

Oltean, M., Negrean, G., Popescu, A., Roman, N., Dihoru, G., Sanda, V., Mihăilescu, S. (1994). Lista roșie a plantelor superioare din România, *Studii sinteze, documentaţii de ecologie*, Academia Română, Institutul de Biologie, 1, Bucureşti.

Oprea, I.V., Stratul, E., Iacob, M. (1974). Contribuții la cunoașterea florei și vegetației de baltă de la Satchinez (Banat), *Tibiscus - Științe Naturale*, Timișoara, pp. 3-20.

Pătruț, D., Coste, I. (2006). Dinamica populațiilor la unele specii halofile din Câmpia Banatului sub influența lucrărilor hidroameliorative, *Studia Universitatis Vasile Goldiș Arad Seria Științele Vieții (Life Sciences Series)*, vol. 16, pp. 149-152.

Pfadenhauer, J., Grootjans, A. (1999). Wetland restoration in Central Europe: aims and methods. *Applied Vegetation Science, 2(1)*, pp. 95-106.

Rittenhouse, T.A., Peterman, W.E. (2018). Connectivity of Wetlands. In: Finlayson, C.M., et al. *The Wetland Book*, Springer, Dordrecht. https://doi.org/10.1007/978-90-481-9659-3_54.

Sanda, V., Popescu, A., Barabas, N. (1998). Bibliografia fitocenologică a României, Complexul Muzeal de Științele Naturii, *Studii și comunicări, Biologie vegetală, 15*, Bacău, RO: "I. Borcea" Publishing House.

Sanda, V., Popescu, A., Doltu, M. I., Nedelcu, G. A. (1979). Conspectul vegetaţiei acvatice şi palustre din România, *Studii şi Comunicări 23, Muzeul Brukenthal, Ştiinţe Naturale*, Sibiu, pp. 117-162.

Schneider-Binder, E. (2014). The fourleaf water clover (Marsilea quadrifolia L.) an endangered species. Aspects of conservation and management, Transylv. *Rev. Syst. Ecol. Res., 16 (1)*, 161-176, https://www.sciendo.com/article/10.1515/trser-2015-0011.

Soran, V. (1956). Câteva asociaţii de plante acvatice şi palustre din Banat, *Studii şi cercetări de biologie, 1-4*, Cluj, pp.107-124.

Stănescu, D., Coste, I., Pălăgeşiu, I., Arsene, G.-G., Török-Oance, M., Török-Oance, R., Pătruţ, D., Duma, I., Prunar, F., Faur, F.-M., Neacşu, A.-G., Manci, C. O., Iluţ, I., Pârvulescu, L., Putnoky, E. (2005*). Mlaştinile de la Satchinez. Flora şi fauna ariei protejate*, Timisoara, RO: Artpress Publishing House.

Stengård, E., Räsänen, A., Santos Ferreira, C.S., Kalantari, Z. (2020). Inventory and Connectivity Assessment of Wetlands in Northern Landscapes with a Depression-Based DEM Method, *Water 2020, 12*, 3355, https://doi.org/10.3390/w12123355.

Tanislav, D. (2014). Protected wetlands in Romania, *2nd International Conference - Water resources and wetlands.* 11-13 September, Tulcea (Romania), pp. 469-474. https://www.limnology.ro/water2014/proceedings/62_Tanislav.pdf

Tökes, L. (1905). Enumeratio plantarum vascularium a Temesvár (Hungária,comit. Temes) sponte crescentium et frequentius cultarum, *Természettudományi Füzetek*, A Délmagyarországi Természettudományi Társulat Kolonel. XXIX. Évfolyam, 2. Füzet, pp. 7-49.

Török, Z. (2002). The Romanian wetland inventory project, *Scientific annals of the Danube Delta Institute for research and development*, Tulcea – Romania, pp. 161-173, https://www.researchgate.net/publication/235441363_The_Romanian_wetland_inventory_project.

Vicol, E.C. (1974). Flora și vegetația Piemontului Lugojului. *Teză de doctorat*, Cluj-Napoca.

Walpole, M., Davidson, N. (2018). Stop draining the swamp: it's time to tackle wetland loss, Oryx, 52(4), 595–596, *2018 Fauna & Flora International*, https://doi.org/10.1017/S0030605318001059.

https://www.epa.gov/wetlands/what-wetland

https://www.ramsar.org/

https://www.ramsar.org/sites/default/files/documents/library/current_convention_text_e.pdf