ANALYSIS OF BIOTIC PARAMETERS OF FLOODPLAIN FORESTS FRAGMENTS IN THE AGRICULTURAL LANDSCAPE OF THE LOWER VÁH RIVER

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ABSTRACT

We identify only fragments of the original floodplain forests on agricultural land in the alluvium of the lower Váh river. The reason of their elimination is based on the history, particularly because of agricultural land and hydrological modification of rivers. We evaluated biotic parameters of the floodplain forests fragments (life forms, diversity of vegetation, seasonality of leaves and flowering time) in the area of Čalovec and Ďulov Dvor. As for structural changes of vegetation in these areas, we can conclude that there was a difference in the range of species, in the Ďulov Dvor locality hydrophilic population absent and invasive and potentially invasive species are more present (especially at Ďulov Dvor locality). Analysis of biotic parameters of vegetation is part of a complete evaluation of fragments of floodplain forests (including abiotic parameters) aimed to restore their original function in the country.

1. INTRODUCTION

Fragments of floodplain communities represent non-forest woody vegetation in the surrounding agricultural land. The dynamics of alluvial floodplain communities is strongly influenced by water regime (Figure 1). Their species structure is diversified by at least one of the factors of floodplain dynamics – the influence of surface flooding or ground water.

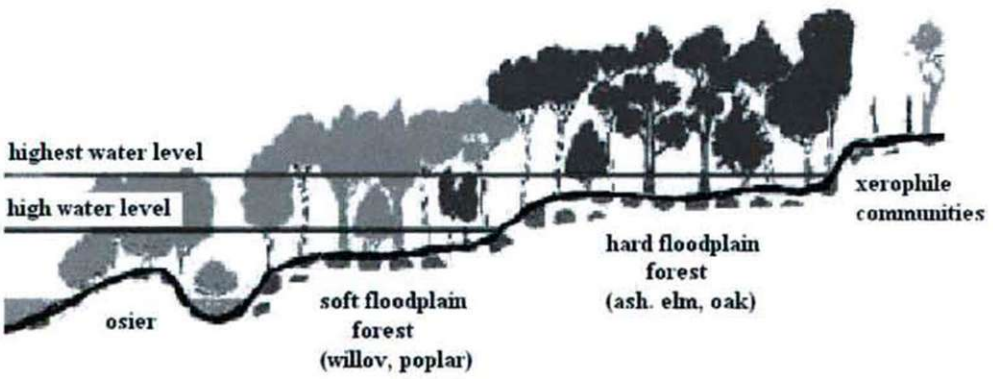


Figure 1. Scheme of alluvial communities' structure

A survey of river habitats and alluvial biotopes of lowland rivers shows a continuous transition by habitats – from the water habitats in the main river, across habitats in varying degrees affected by water to terrestrial habitats (Kotrla, 2005). A smooth change of type's plants from hydrophytes through hygrophytes to terrestrial mezophytes is typical for this

transition. As mentioned in Šimonovič, Šimonovičová (1999), Tepley et al. (2004), floodplain communities of riparian zone provide a unique combination of high species diversity, high density and high productivity.
Vegetation character inform about the degree of anthropogenic impact, it indicates abiotic and soil conditions, water regime and microclimate. Feranec, Oťahel (2003) say, that vegetation is an important indicator of eco-stabilizing solution and socio-economic function in the country.

Woody plants, as edificatory of floodplain forest communities, are the key indicator species of terrestrial and ecotone alluvial habitats (Buček et al., 2004). Status and evolution of woody plants populations and communities is an indicator of not only natural processes but also socio-economic processes in present country. In the distribution of living organisms also climate plays an important role. The climate is decisive for the habitat to which they are bound and on which they depend. Climate changes, which occurred in recent years, bring changes in the distribution of species and consequently change in vegetation type (Davis, 1986).

Floodplain forests are one of the most affected wetlands in Slovakia. According to Vološčuk, Šíbl (2001) thousands of hectares of floodplain forests in the alluvium of our larger rivers were flooded in the dam reservoir, destroyed in the construction of protective levees and other water facilities, additional thousands of hectares have been negatively affected by elimination of flooding and decrease of ground water level. At present time, floodplain forests are most threatened by the construction of water projects and stream regulations. Other threat for floodplain forests is the penetration of non-native, aggressive plant species. This ecologically unfavourable situation leads to the need for restoration of the wetlands ecosystems in the agriculture landscape i.e. to increase area where natural fluvial processes with natural biota can be restored.

The significance of the vegetation has two sides. It highlights the company's interests and its individual members and also reflects natural conditions, where vegetation grows and operates.

2. RESEARCH STANDS

We selected two sides of floodplain forests fragments on agriculture land of lower Váh river, localities Čalovec and Ďulov Dvor.
Čalovec site – Near of the village Čalovec, GPS localization 47° 48' 41" N and 18° 0' 11" E, area 13794 m^2.
Ďulov Dvor site – Near of the town Komárno, part Ďulov Dvor – Zámocká pustatina, GPS localization 47° 47' 23" N and 18° 8' 33" E, area 48020 m^2.
Selected characteristics of the research stands: average year air temperature / temperature in growing season 11.0 °C / 15.7 °C, average annual sum of precipitation / in growing season 520.28 mm / 358.76 mm, soils Calcaric Fluvisols, syntaxonomical structure *Salici–Populetum fac.* Fraxinetosum (Ďulov Dvor) and *Salici–Populetum* typicum (Čalovec), height of underground water level 2.20 m (Ďulov Dvor) and 1.82 m (Čalovec).

3. MATERIAL AND METHODS

In addition to abiotic environmental analysis, detailed analysis of biotic parameters is required in order to realize any human activity aimed at protection or restoration of degraded ecosystems. Were evaluated following biotic parameters:

Life forms – determined by Raunkaier (1934), interpreted by Jurko (1990), Ellenberg et al. (1992), which are biological types with regard to the location of the renewal buds during adverse periods.

In assessment of life forms we consider the relative proportions of annual, biennial, perennial plants and woody plants as the average of all vegetation levels. Margin of life forms is: hydrophytes, one and two terophytes, hemicryptophytes, geophytes, herbaceous and woody plants chamaephytes and shrub and tree phanerophytes. Analysis of living forms is the easiest analysis of plant community, it is a quantitative approach to record of plant community and provides more information than a list of species. The composition of life forms reflects habitat conditions in the growth, use of the space and relations between plant populations. The results were expressed graphically as a spectrum of life forms.

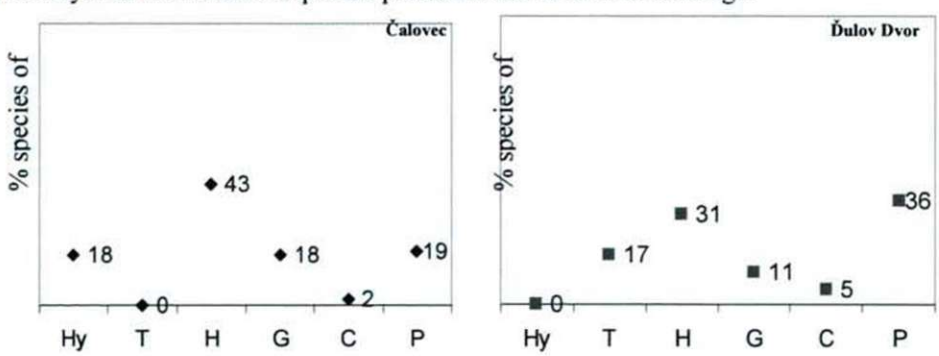
Diversity of vegetation – We evaluated the taxonomic diversity, which is mainly influenced by the particular ecological quality of habitat. The habitat provides conditions and enables to fulfil demands of each species for provided resources. Diversity of vegetation at research sides were processed by Jureková et al. (2008).

Seasonality of leaves has a special importance for the production of metabolism and the competitiveness of species. We monitored time of buds and time of defoliation.

Flowering time – It is a different phonological stages of flowering. We surveyed the beginning of flowering to full bloom. Time categories of flowering were determined by Dierschke (1983).

4. RESULTS AND DISCUSSIONS

In the forest phytocenose we can distinguish functional groups of plants according to each floor – tree, brush and herbaceous ground-floor. The basic of these classifications are growth, respectively life forms of plants. At Čalovec site hemicryptophytes predominated (43 % species of plants) – *Caltha palustris, Carex acuta, Galium palustre, Lysimachia vulgaris, Lythrum salicaria, Mentha aquatica, Scutellaria galericulata, Solidago gigantea, Teucrium scordium*, with an increased proportion of phanerophytes (19 % species of plants) – *Populus × canescens, Salix alba, Salix cinerea, Salix fragilis*, identified by species composition. At the drier site Ďulov Dvor predominated phanerophytes (36 % species of plants): *Crataegus monogyna, Euonymus europaeus, Frangula alnus, Fraxinus angustifolia, Negundo aceroides, Populus × canescens, Prunus cerasifera, Prunus spinosa, Rhamnus catharticus, Robinia pseudoacacia, Salix alba, Salix fragilis, Sambucus nigra, Swida sanguinea, Viburnum opulus.* A high proportion is also hemicryptophytes – 31 % species of plants (Figure 2). Tree and shrub layer of the herbal component predominated in term of coverage.

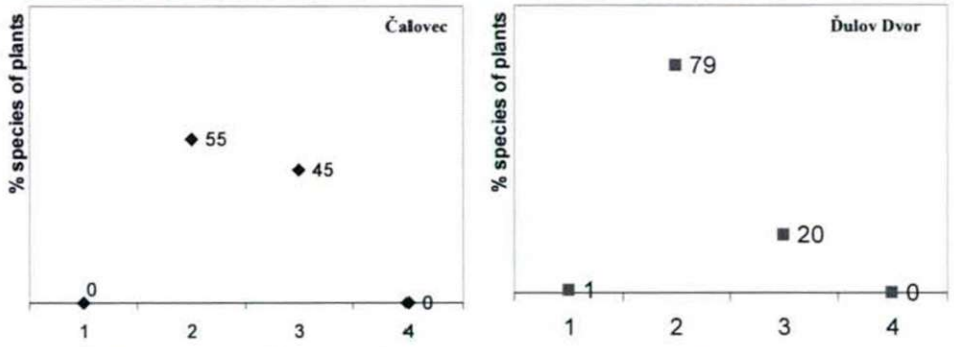


Legend: Hy – hydrophyte, T – terophyte, H – hemicryptophyte, G – geophyte, C – chamaephyte, F – phanerophyte

Figure 2. Spectrum of life forms of plants at research sites

At research sites, we followed the method of reproduction of dominant woody plant species (phanerophytes – *Salix alba* and *Populus* × *canescens*). Vegetative or generative methods are method of reproduction of woody plants. We can say that there exists the dominance of vegetative propagation method for phanerophytes at researched locations - breeding sprouts. The reason can be the fact that seedlings of phanerophytes have hibernated organs at low altitude (in contrast with adults) and they have a short root system. Therefore, they are exposed to adverse temperature conditions during winter and lack of water due to fluctuations in ground water levels during the growing season. High mortality in the regeneration of dominant woody plants may be in addition to fluctuations in groundwater levels and low temperatures caused by the improper light ratios in the dense tree crown cover. Paganová, Jureková, Merganič (2009) confirmed death of seedlings of dominant woody plants in floodplain forest at research sites.

In another experimental research we have seen the seasonality leaves and flowering time. Data on seasonality leaves, the period since the creation of buds until defoliation are shown in the Figure 3. On the sites dominated aestivalen permanence of leaves, leaves are green in summer, (55% of species at Čalovec and 75% of species at Ďulov Dvor), respectively the leaves are green during all summer, or at least until the middle of summer.

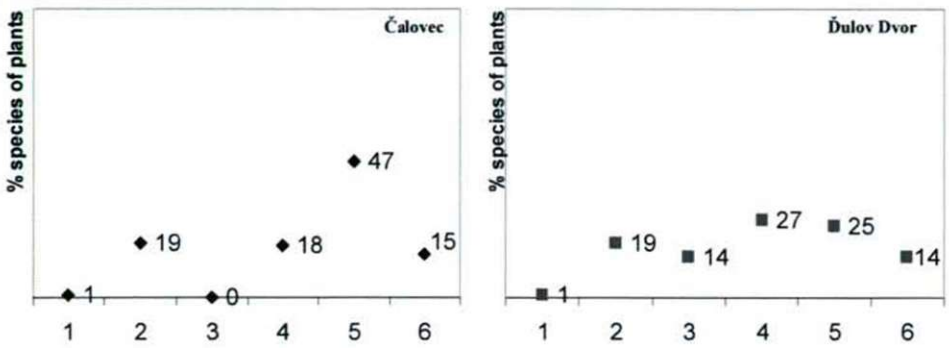


Legend: 1 – green only in spring; 2 – in summer they are green; 3 – hibernate; 4 – evergreen

Figure 3. Seasonality of the leaves at research sites

The most sensitive period for determination of the existence of borders and the spread of species (Thieneman rule) is a period of juvenility and flowering. We determined the phenological stages of flowering also in our experimental work. The results are shown in the Figure 4. At the site Čalovec 47% of species bloom in summer time (the period of full summer - the third decade of June till the second decade of August), respectively on this site 19% of species blooms in early spring period (3rd decade of March till the first decade of May). At site Ďulov Dvor 27% of plant species bloom in late spring (3rd decade of May to the second decade of July) and 25% during the full summer. We conclude that the top life cycle of plants is during the growing season in July and August on both sites.

In terms of taxonomic diversity of sites we observed greater species diversity on drier habitat (Ďulov Dvor) - 42 plants species, and at Čalovec site we identified 23 plants species. Possibility of plant species used habitat conditions determines taxonomic diversity. Particularly the possibilities of plants fulfill their demands on natural resources. We observed difference of plant species on the research sites as a result of difference ground water level and water regime in studied years. It is a natural phenomenon of inundation.



Legend: 1 – end of winter; 2 – early spring; 3 – full of spring; 4 – end of spring; 5 – full summer; 6 – late summer; 7 – autumn

Figure 4. Time of flowering plants at research sites

Ďulov Dvor site (42 species of plant): *Agropyron repens, Agrostis stolonifera, Aster lanceolatus, Atriplex patula, Bryonia alba, Calamagrostis epigejos, Carex acuta, Cirsium arvense, Clematis vitalba, Crataegus monogyna, Cucubalus baccifer, Epipactis helleborine, Epipactis tallosii, Euonymus europaeus, Fallopia dumetorum, Frangula alnus, Fraxinus angustifolia, Galeopsis pubescens, Galinsoga parviflora, Galium aparine, Geranium robertianum, Glechoma hederacea, Humulus lupulus, Iris pseudacorus, Negundo aceroides, Populus × canescens, Prunus cerasifera, Prunus spinosa, Rhamnus catharticus, Robinia pseudoacacia, Rubus caesius, Salix alba, Salix fragilis, Sambucus nigra, Swida sanguinea, Symphytum officinale, Torilis japonica, Urtica dioica, Viburnum opulus, Vicia cracca, Viola hirta, Viola odorata*

Čalovec site (23 species of plant): *Berula erecta, Caltha palustris, Calystegia sepium, Carex acuta, Carex riparia, Galium palustre, Glyceria maxima, Iris pseudacorus, Lycopus europaeus, Lysimachia vulgaris, Lythrum salicaria, Mentha aquatica, Phragmites australis, Populus × canescens, Salix alba, Salix cinerea, Salix fragilis, Scutellaria galericulata, Solanum dulcamara, Solidago gigantea, Stachys palustris, Teucrium scordium, Tithymalus palustris*

From the structural changes of vegetation at the research sites we can conclude a difference in the species range. At the Ďulov Dvor site hydrophilic population absent and invasive or potentially invasive species are more present. The impact of ruderal taxa starts in direct contact phytocoenosis of the intensive cultivated fields (*Cirsium arvense, Solidago canadensis, Galinsonga parviflora* – 12 species). The invasive species are *Negundo aceroides*, potentially invasive are species: *Cirsium arvense, Prunus cerassifera, Bryonia alba, Robinia pseudaccacia*, which may affect negatively the further development of vegetation on the both studied localities.

5. CONCLUSIONS

Today, floodplain forests vegetation creates only a small part of floodplain forest vegetation of the past and they are usually present only in small fragments in shallow depressions.

At present floodplain forests are included to wetland communities. They belong to one of the most endangered ecosystems not only in Slovakia, but throughout Europe.

Abiotic factors (ground water level, physiological drought, heavy metal content) were variable during the period of research, and according to our assumptions they could cause

physiological adaptation of the herb and tree vegetation components in given conditions (Kotrla, Prčík, 2010).

For quantification the structure of plant communities, we have confirmed the different representation of life forms of plants, depending on humidity habitat. At Čalovec site predominated hemicryptophytes (43% of plant species) and at Ďulov Dvor site phanerophytes (36% of plant species) predominated. At Ďulov Dvor site predominated shrub and tree the floor level above herb. The method of plants reproduction is mainly vegetative. Seedlings of woody plants are after germination limited in growth by a lack of water and they are subordinate to competition. At Ďulov Dvor site is limited population of hydrophilic, wetland and aquatic plant species. At Čalovec site, where is a higher ground water level, stored the population hydrophilic species of herbs and grasses.

From experimental research of floodplain forests communities in alluvium of the lower Váh river, we can identify degradation factors decisive in their life processes: anthropogenic impacts related to agriculture around fragments of floodplain forests, changes in hydrological regime caused by changes in the dynamics of groundwater level, microclimatic effects such as a lack of rainfall, especially during the growing season, respectively physiological drought resulting from a precipitation and air temperature, non-native invasive and potentially invasive species.

After a detailed analysis of abiotic and biotic indicators fragments of floodplain forests in lowland agricultural landscapes we can start to restore these habitats in response to disturbance factors. The aim of the process of restoration of wetland habitats in intensively used agricultural land is the increase of their natural functions from the ecological, through environment to the socio-economic functions.

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REFERENCES

1. BUČEK, A. – MADĚRA, P. – PACKOVÁ, P. 2004. Hodnocení a prodikce vývoja geobiocenóz v PR Věstonická nádrž. In Geobiocenologické spisy, svazek č. 8. Brno: MZLU Brno, 2004. 101 s. ISBN 80-7157-781-2.
2. DAVIS, M. B. 1986. Climatic instability, time lags and community disequilibrium. In Diamond, J. – Case, T. J. Community ecology. NY : Harper and Row Publishers, 1986. p. 269-284.
3. DIERSCHKE, H. 1983. Symphänologische Artengruppen sommergüner Laubwälder und verwandter Gesellschaften Mitteleuropas. In Verh. Ges. für Ökologie (Festschr. Ellenberg). 1983. No 11. p. 71 – 87.
4. ELLENBERG, H. et al. 1992. Zeigerwerte on Pflanzen in Mitteleuropas. In Scripta geobotanica, Vol. 18, 1992, No. 1, p.125.
5. FERANEC, J. – OŤAHEĽ, J. 2003. Mapovanie krajinnej pokrývky a zmien krajiny pomocou údajov diaľkového prieskumu Zeme. In Životné prostredie, roč. 37, 2003, č. 1, s. 25-29.
6. JUREKOVÁ, Z. – BARANEC, T. – PAGANOVÁ, V. – KOTRLA, M. – ELIÁŠ, P. jun. 2008. Comparison of the ecological characteristics the willow-poplar floodplain forest fragments on the stands with different height of groundwater level. In Ekológia (Ecology), roč. 27, 2008, č. 1, s. 31-40.

7. JURKO, A. 1990. Ekologické a socioekonomické hodnotenie vegetácie. Bratislava : Príroda,1990. 200 s. ISBN 80-07-00391-6.
8. KOTRLA, M. 2005. Selected indicators of environmental state in the agricultural landscape. In Perspectives of regional development in the Europe regions: international conference, Gödöllö, 18.-20. march 2005. Gödöllö: Szent István Egyetem, 205. p. 109-111.
9. KOTRLA, M. – PRČÍK, M. 2010. Lužné lesy v dolnom toku Váhu a návrh ich obnovy. SPU Nitra, 98 s., ISBN 978-80-552-0444-4
10. PAGANOVÁ, V. – JUREKOVÁ, Z. – MERGANIČ, J. 2009. Growth of the dominant woody plants of floodplain communities in the changing hydrological and climatic condition. In Wood research, Vol. 54, 2009, No. 1, p. 23-36.
11. RAUNKAIER, CH. C. 1934. The Life Forms of Plants and Statistical Plant Geography. Oxford: Oxford University Press, 1934. 632 p.
12. ŠIMONOVIČ, V. – ŠIMONOVIČOVÁ, A. 1999. Lužné lesy v inundačnom území rieky Moravy a ich produkčno-ekologické a mikrobiologické zhodnotenie. In Krajinnoekologické plánovanie na prahu 3. tisícročia, 10.-11. máj 1999 Smolenice, s. 136-141.
13. TEPLEY, A.J. et al. 2004. Natural community abstract for southern floodplain forest. NY: Natural Features Inventory, Lansing, 2004. 14 p
14. VOLOŠČUK, I. – ŠÍBL, J. 2001. Lesné hospodárstvo a ochrana biodiverzity v lesných ekosystémoch. Nitra: SPU, 2001. 214 s. ISBN 80-7137-860-7.