

Original scientific paper

UDC 627.152.12(439)
DOI: 10.2298/GSGD1601001L

Received: October 3, 2016

Corrected: November 1, 2016

Accepted: November 9, 2016

Dénes Lóczy¹*, József Dezső*, Levente Ronczyk*

FLOODPLAIN REHABILITATION PROJECTS IN HUNGARY: CASE STUDIES FROM THE DANUBE, TISZA, KÖRÖS AND DRAVA RIVERS

Abstract: Floodplains along regulated rivers often suffer from serious environmental degradation. River and floodplain rehabilitation measures along the major rivers of Hungary are motivated by two objectives: to increase the floodwater retention capacity of floodplains (also beyond the dykes) and to improve the ecological conditions of floodplain habitats (with special regard to oxbow lakes). In this paper reports and documents mostly written in Hungarian are presented for the international public on river and floodplain rehabilitation efforts. Examples for the water management objective are cited from the Tisza and Körös Rivers, while interventions promoting the second, nature conservation (and also forestry and agriculture), aim are mentioned from the Danube and Drava Rivers. A common characteristic of the case studies is that they apply 'hard engineering' solutions to environmental problems. Although water availability in the Szigetköz floodplain has substantially improved after the building of the bottom weir, the efficiency of the recently implemented engineering measures (the emergency reservoirs along the Tisza and water replenishment structures along the Drava) is too early to judge.

Key words: river regulation, flood hazard, floodplain habitats, water replenishment, emergency reservoirs

¹ loczyd@gamma.ttk.pte.hu (corresponding author)

* University of Pécs, Institute of Geography, Hungary

Introduction

In the international literature, several concepts are employed for the remediation of rivers and their floodplains, i.e. repairing degraded conditions. River recovery is defined as a sequence of stages of geomorphic adjustment governed by the nature of the landscape and its sensitivity to floods following disturbance (Sparks, 1990; Fryirs & Brierley, 2000). The narrow active floodplain, however, leaves to little "room for the river" to shape its channel and floodplain and prevents returning to pre-regulation conditions. Therefore, recovery is no option for improving floodplain conditions.

River restoration is usually conceived as "the complete structural and functional return to a predisturbance state" (Cairns, 1991). A complete restoration is often mentioned, but hardly achievable nor even desirable (Downs & Thorne, 2000). Even if restoration can never be perfect, there is wide agreement between researchers that rehabilitation, i.e. "the partial structural and functional return to a pre-disturbance state" (Cairns, 1991) or, in a holistic sense, "the return of an ecosystem to a close approximation of its condition prior to disturbance" (National Research Council, 1992) is a feasible way for preventing the further degradation of the fluvial environment or even for the remediation of past damage to it. The concept of rehabilitation, as used in this paper, covers very similar contents, i.e. measures towards improved ecological (environmental) functioning of the system (Lóczy, 2013). Rehabilitation potential is a concept central to any rehabilitation scheme as it is a tool to measure the realistic opportunities for re-establishing ecosystem services/landscape functions. In spite of rather similar formulations of concepts, in this respect, the target of rehabilitation (e.g. with view of future water availability or species composition) is markedly different from that of restoration defined in a strict sense (Jennings & Harman, 1999; Lóczy et al., 2014). In addition, stabilisation is also cited as another type of river remediation, which aims to exclude both aggrading and degrading conditions over time (Jennings & Harman, 1999).

The paper summarizes the lessons taken from major rehabilitation projects in Hungary utilising case studies from the rivers Danube, Tisza, Körös and Drava (Fig. 1).

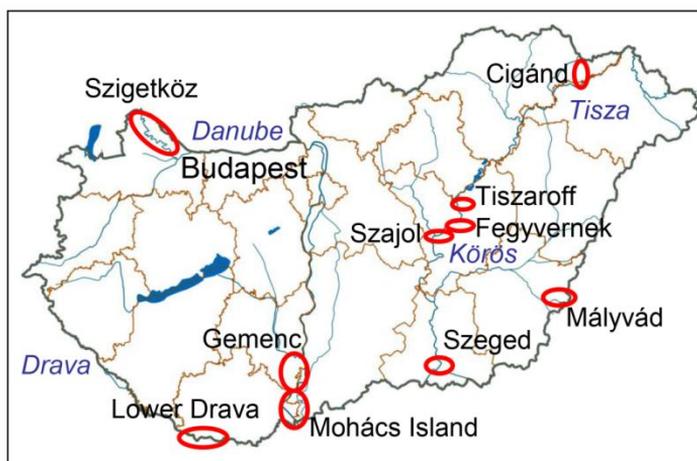


Fig. 1. Location of major river and floodplain rehabilitation projects in Hungary

Rehabilitation sites along the Danube

Szigetköz

The implementation of the Gabčíkovo Barrage project caused fundamental environmental changes along the uppermost Hungarian section of the largest river, the Danube. It involved the diversion of the water discharge of the Danube into a canal on Slovak territory in 1992 and resulted in the desiccation of the Szigetköz floodplain area (between the Old Danube channel and the Moson Danube). The first remediation measure was successful: the bottom weir in the old channel raised water levels along 10 km upstream and provided a better supply of side-channels. However, this was only a partial solution for water availability problems and in 2011 a project was launched entitled "Ecological development of water supply system in the protected site and floodplain areas of Szigetköz", co-founded by the North-Transdanubian Water Directorate (EDUVIZIG) and the European Union (Kun, 2016). The main target was to provide more water for agriculture purposes through irrigation, improving conditions for fishing and providing spawning sites for fish species. Actions taken included dredging and establishing side-arm closures and fish ladders as well as hydraulic structures to supply wetlands with sufficient water. The dimensions of the project are well illustrated by large number of weirs (39) installed in side-arms (Kun, 2016).

Closely associated with the Szigetköz rehabilitation, the interventions also extended to the Moson-Danube (Déri et al., 2015). In order to prevent sedimentation and vegetation overgrowth in the channel, a guide bank is installed in some sections to reduce channel width and to delimit a wetland. The structure is built of locally available materials: gravels and sands extracted from the river channel and willow wattle cover ensuring long-term stability.

The Szigetköz rehabilitation followed the principles of integrated water resource management and of the EU Water Framework Directive: in addition to partially restoring the natural ecosystem, secured the provision of drinking and irrigation water and also enhanced flood control. The participation of stakeholders was emphasised at all stages of the project.

Gemenc Forest

Downstream the Szigetköz only minor instream interventions affecting the Danube (to promote navigation) took place recently (Rákóczi, 2000). The next site of floodplain rehabilitation is located in the Gemenc Forest (Fig. 2), which is part of the Danube-Drava National Park and where flood-control dykes exceptionally run at 6-8 km distance from the channel enclosing a broad floodplain valuable for nature conservation. Rehabilitation planning was made difficult by the lack of precise information on the process of flooding. Monitoring of water and sediment discharges was carried out between 1998 and 2000. Eight project varieties were proposed and the selection among them was made with the help of a one-dimensional hydromorphological model (Sziebert, 2003). A multi-purpose assessment of integrated water management had to consider the requirements of all stakeholders, flood control (ice jam formation), nature conservation, navigation, forestry, fishery, recreation etc. (Sziebert, 2003).

Before regulation works the Rezét branch of the Danube, 14 km long and now only 30-50 m wide, used to be the main channel, with which it is still connected at both ends today (Fig. 2). A total of 200,000 m³ of sandy sediment was dredged from the sediment traps of the side-arm and transported into the main channel and thus connectivity is ensured even at lower water stages. This allows tourism and sports developments. The rehabilitation works (costing HUF 550,000,000) with nature conservation purpose were completed by March 2015.

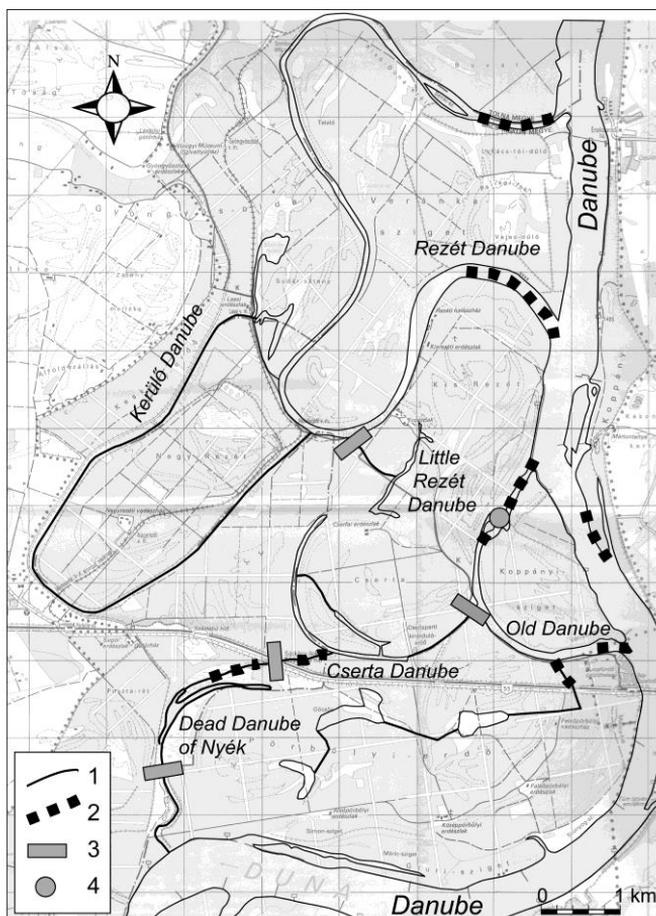


Fig. 2. Rehabilitation of abandoned Danube channels in the Gemenc Forest. 1- watercourses affected ; 2- sections dredged; 3- sluice installed; 4- weir removed

A particular problem of the Gemenc Forest, not yet solved, is that the area is cut into two by the Baja-Bátaszék railway line, which has four bridges of various dimension to ensure communication between sections of the active floodplain. Notwithstanding, the embankment reduces the efficiency of the floodway and impounds flow during flood stages.

The Old Danube of Baja, cut off from the main channel in 1897-1898 and blocked by a rock-fill weir in 1910, is another good example for rehabilitation (Tamás et al., 2014). Although due to the location of its entrance at a concave bend currents prevent the rapid

accumulation of suspended load, sedimentation was considerable. Such a process is irreversible, no recovery can be expected. The width of the side-arm reduced from 450 m to 100 m, current velocity and flushing to zero. Revitalisation began in 1998 and ended in 1999 and through the dredging of the water system of the Dead Danube of Nyék oxbow lake (area: 17 ha at 0.8 m water depth), a valuable wetland habitat and bird area (Nebojszki, 2004; Mátrai et al., 2009), reducing the heights of existing weirs and, at the same time, substantially increasing flow velocities (to 0.3-0.4 m/s) and improved the water supply through the canals of Sárkány-fok and Címer-fok where new sluices were emplaced (Mátrai et al., 2009, Fig. 2). Fifteen years after the intervention a comprehensive survey of water and sediment discharges was executed (Tamás et al., 2014) and confirmed the efficiency of the rehabilitation project – although unfavourable side-arm incision and narrowing could also be observed.

Mohács Island

The entrenchment of the Danube bed (ca 1.5 m over a century) also causes problems for wetlands (oxbow lakes) in the floodplain. A most picturesque oxbow lake, Lake Riha on Mohács Island (area: 67 ha), formed long before the regulation of the Danube River (Pécs, 2009). Two dividing weirs were built splitting the lake into three poorly connected sections. Rehabilitation involved the dredging of 13,000 m³ of deposit and the cleaning of groundwater drainage ditches. Thus, groundwater collected from a large area of Mohács Island can recharge the lake with water. Small floating islets were established on the lake to provide nesting sites for waterfowl.

It is a focal task of nature conservation authorities to preserve Danubian islands with riparian forests. A natural river with anastomosing channel pattern continuously forms new islands and side-arms which then gradually silt up and the islands merge with the mainland. In the regulated Danube, however, new branches are unable to form and the islands are endangered by the sedimentation of blocked side-arms (Siposs, 2013).

A good example for these processes and remediation actions is the Liberty Island (3 km long, 150-200 m wide, area: 47 ha) close to the left bank at the town of Mohács (WWF, 2013). The island and the side-arm belong to the Danube-Drava National Park and part of the Natura 2000 network. Its bank-filtered wells provide drinking water for Pécs and other settlements of southern Baranya county. The island is covered by soft-wood alluvial forest, but hybrid poplar stands were also planted. In 1982 the side-arm was split into two by a 6-m high rock-fill dam and rapid sedimentation ensued. Over 95% of the year no water inflow into the side-arm could be observed.

Within the framework of the WWF LIFE+ Nature project a comprehensive rehabilitation project (EUR 1,800,000) was implemented between 2009 and 2013. The dredging of 160,000 m³ sediment, mainly sand, guarantees permanent inflow and 2-m water depth in the side-arm (WWF, 2013). The island is now owned by the Hungarian State and no commercial forestry is practised. The soft-wood floodplain forest is planned to be restored from seedlings cultivated in tree nurseries. Sedimentation processes and channel dynamics as well as the quality of filtered drinking water are being monitored by authorities. The river has already begun to shape the channel: slumps appear on banks, fluvial features on the channel floor. The recolonization of fish and bird fauna has also

started. The messages learnt from this project are to be utilised in future programmes for the other 100 small Danubian islands.

Rehabilitation sites along the Körös River

The Körös river system (White and Black Körös, Rapid Körös and Berettyó) often generates floods along the Lower Tisza. To alleviate flood hazard two retention basins have been established (Bak, 2010). The Mályvád reservoir (area: 3690 ha; capacity: 75,000,000 m³) at the confluence of the White and Black Körös, close to the Hungarian-Romanian border, was constructed in 1977 and reduced flood levels on three occasions. In 2011 its enlargement and modernisation began and was completed in 2015. Another reservoir called Little Delta (area: 580 ha; capacity: 25,600,000 m³) was built on the left bank of the White Körös. Downstream the Double Körös the Mérges reservoir (area: 1823 ha; capacity: 87,200,000 m³) serves flood protection. However, it has no gate structure and can only be opened by blowing up the dyke.

Rehabilitation sites along the Tisza River

The regulation works narrowed down the active floodplain of the Tisza and floodplain sedimentation during floods was reduced to this narrow zone. Consequently, floodwater conduction capacity became insufficient and flood levels tend to rise constantly. The 2000 cyanide disaster on the Tisza River and other three major flood events in the 1998–2000 period gave impetus to a large-scale water management programme, the New Vásárhelyi Plan (Werners et al., 2013), named after Pál Vásárhelyi, a renowned hydroengineer, leader of river regulation works on the Tisza in the 19th century. The programme offers an alternative to traditional flood control measures, i.e. the constant raising of dykes, which is costly and of doubtful result. If more room is given to rivers, floodwaters are retained in emergency reservoirs in a controlled way, floods will not breach dykes and inundate agricultural and urban land.

Although the first version was ready in 2002, implementation was delayed because of political and budgetary reasons. In the centre of the programme flood protection was placed to be achieved through the establishment of a series of retention (or emergency) reservoirs and the restoration of the traditional 'fok' system, an environmentally friendly floodplain economy, widespread before river regulation along the major rivers (KÖTIVÍZIG, 2013).

The first reservoir was established at Cigánd (Bencze, 2012). Its entrance gate is a huge (9.3 m high and 43 m wide) reinforced concrete structure with sluices capable of letting through 430 m³/s water. Seminatural landscape management was introduced over 3,500 ha of area in the environs. In flood-free periods the agricultural area is cultivated without constraints.

In the second step, the Tiszaroff reservoir was completed in 2009. In its 2,300 ha area 97,000,000 m³ of water can be stored. There are 23.1 km of flood-control dykes of 4.5 m height around the reservoir. The Tiszaroff reservoir successfully contributed to the protection of the town of Szolnok from being flooded in 2010. The experience is also positive as much as no boils developed behind the dykes of the reservoir. With some delay the Hany-Tiszasüly reservoirs (area: 24,700 ha; capacity: 250,000,000 m³) and the

Nagykunság (area: 4,000 ha; storage capacity: 99,000,000 m³) were completed in 2012 and 2013, resp. A problem with these reservoirs that they were established on fertile soils and the damages to be paid to farmers after floods can be high. If inundation will maintain prolonged excess water coverage in the area, landscape degradation may ensue.

The flood protection of the uppermost Hungarian Tisza section was supplemented with the installation of two additional reservoirs. The reservoir, inaugurated in 2014, is one of the largest. Over 5100 ha area it is capable to store 126,000,000 m³ of water. Its gate is 277 m long, 118 m wide and contains 21,000 m³ of concrete and 2560 t of reinforcing steel. The Bereg reservoir (area: 5900 ha; capacity: 58,000,000 m³) is the most recent in row (2015).

Another major project affecting the Tisza floodplain is the rehabilitation of the cutoff meanders of the river (Pinke, 2014). The Dead Tisza of Fegyvernek (area. 88 ha) and of Szajol (area: 70.5 ha) were cut off from the Tisza in 1856-1857 and now they are used as sources of irrigation water (Békési et al., 2015). Water recharge to the lakes is envisioned through the dredging of lake sediments and the reconstruction of the irrigation and excess water drainage network. To reduce flood stages on the Lower Tisza another emergency reservoir is planned to be built upstream the city of Szeged.

Rehabilitation sites along the Drava

The main problem of the Hungarian Drava Plain is not flood hazard but aridification and drought hazard (Lóczy et al., in print). According to a 2004 survey, there are 29 side-arms along the Hungarian Drava River section and 16 of them would need immediate remediation intervention. Habitat rehabilitations were completed in six side-arms of the Danube by the Danube-Drava National Park Directorate. Closures at entrances to side-arms, which reduced stream velocity and resulted in a lentic character of the channels and rapid sedimentation, were removed or lowered. Combined with dredging and constructing culverts at low water levels allowed regular flushing and water recharge to the side-arms. Revitalisation led to the return of valuable fish species.

A large-scale government project, the Old Drava Programme (Pécsi HIDROTERV Bt., 2015), envisions rural development in the floodplain based on water replenishment to cutoff meanders. The first site where water replenishment has been implemented is the Cún-Szaporca oxbow lakes (DDKÖVÍZIG, 2015). A tributary of the Drava is impounded by a dam to levels sufficient to provide a feeder canal with water, which supplies 0.4 m³/s water to the oxbow lake during two or three campaigns per year. Thus a max. 1 m rise in lake levels can be generated. However, evaporation from the lake surface, transpiration from riparian vegetation and seepage to groundwater will strongly limit the long-term efficiency of this intervention. The messages taken from this pilot project are now evaluated (Lóczy et al., in print) and serve as a basis for further oxbow rehabilitation projects within the Old Drava Programme.

Conclusions

River and floodplain rehabilitation projects in Hungary have different objectives. Floodwater retention is more emphasised along the Tisza and Körös, but it is also an important goal along the Danube and Drava. The tools to achieve better protection

against floods, however, are very different. The establishment of emergency reservoirs is a costly solution and only feasible along the lowland rivers. Where the main channel is deeply entrenched, it is more difficult to achieve floodplain connectivity and to use floodplains for flood control. A central task in all projects is the improvement of ecological conditions in the side-arms or abandoned channels of major rivers, the transformation of flow type from lentic to moderately lotic and to provide more diverse environments for the biota and human uses alike. Although ecological considerations are incorporated and stressed, 'hard engineering' solutions in water distribution are still predominant. Background information collected from the long-term monitoring of environmental parameters is mostly insufficient for a sound foundation of project planning.

References

- Bak, S. (2010). *A vízügyi igazgatóságok kezelésében lévő vízgazdálkodási létesítmények állapota, fejlesztési igények és lehetőségek Békés megyében* (State and development of water management structures of water management directorate in Békés County). Report. Körös Region Water Management Directorate (KÖRKÖVÍZIG), Gyula.
- Békési, I., Virágné Kóházi-Kiss, E. & Sólyom P. (2015). Fegyvernek-szajoli öblözetek többcélú fejlesztése (Multi-purpose development of the Fegyverne-Szajol embayments). *33th Conference of the Hungarian Hydrological Society*, Szombathely, 2-4 July 2015.
- Bencze, Á. (2012). A Tisza-völgy árvízi biztonságáért (For security against floods in the Tisza Valley). *Innotéka*. Retrieved from http://www.innoteka.hu/cikk/a_tisza_volgy_arvizi_biztonsagaert.442.html
- Cairns, J. (1991). The status of the theoretical and applied science of restoration ecology. *The Environmental Professional*, 13, 186–194.
- DDKÖVÍZIG (2012). *Revitalization of the Cún-Szaporca oxbow system*. Final Master Plan. South-Transdanubian Environment and Water Directorate, Pécs.
- Déri, L., Horváth, G. & Tóth, J. (2015). Mosoni-Duna és a Lajta folyó térségi vízgazdálkodási rehabilitációja (Rehabilitation of the Moson Danube and the Leitha River). *33th Conference of the Hungarian Hydrological Society*, Szombathely, 2-4 July 2015.
- Downs, P.W. & Thorne, C. R. (2000). Rehabilitation of a lowland river: reconciling flood defence with habitat diversity and geomorphological sustainability. *Journal of Environmental Management*, 58, 249–268.
- Fryirs, K. & Brierley, G. J. (2000). A geomorphic approach for identification of river recovery potential, *Physical Geography*, 21(3), 244–277.
- Jennings, G.D., & Harman, W.A. (1999). Stream restoration lessons learned in North Carolina, USA. In: Rutherford, I., Bartley, R. (eds): *Proceedings, Second Australian Stream Management Conference*, Adelaide, 1, 359–364.
- KÖTIVÍZIG (2013). *A Közép-Tisza-vidék, a Jászság és Nagykunság vízkészlet-hasznosítási stratégiája* (Strategy for the utilisation of water resources in the Middle Tisza area, Jászság and Nagykunság). Middle Tisza Region Water Management Directorate, Szolnok
- Kun, Z. (2016). *Ecological restoration and water system development in the protected site and floodplain areas of Szigetköz in Hungary*. North-Transdanubian Water Directorate (ÉDUVIZIG), Győr.
- Lóczy, D. (2013). *Hydromorphological-geoecological foundations of floodplain management: Case study from Hungary*. Lambert Academic Publishing, Saarbrücken.
- Lóczy, D., Dezső, J., Czigány, Sz., Gyenizse, P., Pirkhoffer, E. & Halász, A. (2014). Rehabilitation potential of the Drava River floodplain in Hungary. In: Gâstescu, P. Marszelewski, W., Bretcan, P. (eds): *Water resources and wetlands*. Conference proceedings. Tulcea, Romania, 11–13 September 2014. Transversal Publishing House, Targoviste, 21–29.

- Lóczy, D., Dezső, J., Czigány, Sz., Prokos, H. & Tóth, G. (in print). Water replenishment to a floodplain lake: an assessment. *Journal of Environmental Management*.
- Mátrai, I., Buzetky, Gy. & Lakatos, Gy. (2009). Ecological status of waterfowl habitat on the Gemenc floodplain area in Hungary. *Journal of Ecology and the Natural Environment*, 1, 5, 120–129.
- National Research Council (1992). *Restoration of aquatic ecosystems: science, technology and public policy*. The National Academies Press, Washington, DC. 576. Retrieved from <http://www.nap.edu/catalog/1807.html>
- Nebojszki, L. (2004). Múltunk öröksége, a Nyéki-Holt-Duna (Heritage of our past, the Dead Danube of Nyék). *Természet Világa*, 135(4), 165–168.
- Pécsi HIDROTERV Bt. (2015). *Ős-Dráva Program Aktualizált Területi Vízgazdálkodási Tanulmányterv (Old Drava Programme: Actualized Plan for Regional Water Management)*. Pécsi HYDROTERV Bt., Pécs. (in Hungarian).
- Pécz, T. (2009). Conservational questions of Lake Riha. In: Halasi-Kun, G.J. (ed.) *Scientific and Social-Institutional Aspects of Central Europe and USA*. Centre for Regional Studies, Transdanubian Research Institute, Pécs – Slovak Academy of Sciences, Institute of Hydrology, Bratislava. 314–321. (Pollution and water resources : Columbia University seminar proceedings, 38–39. 2008–2009).
- Pinke, Zs. (2014). Modernization and decline: an eco-historical perspective on regulation of the Tisza Valley, Hungary. *Journal of Historical Geography*, 45, 92-105.
- Rákóczi, L. (2000). A Duna-meder sorsa Szap és Szob között (The Danube channel between Szap and Szob). *Vízügyi Közlemények*, 82(2), 262–284.
- Siposs, V. (2013). Ártéri élőhelyek rehabilitációja a Szabadság-szigeten és mellékágában (Rehabilitation of floodplain habitats on Liberty Island and its side-arm). In: Kerpely, K. and Siposs, V. (eds): *Mellékágak és ártéri élőhelyek nagy folyóink mentén (Side-arms and floodplain habitats along the major Hungarian rivers)*. Conference Proceedings, Mohács 18-19 November 2013. WWF Hungary, Budapest (in Hungarian).
- Siposs, V. & Ereifej, L. (2014). *How a restoration project can integrate different interests: Liberty Island and side-branch restoration*. Worldwide Fund for Nature (WWF) Hungary, Budapest. PowerPoint presentation, European River Restoration Conference, Vienna, 28 October 2014.
- Siposs, V. & Kerpely, K. (2013). *Restoration of Liberty Island and its side-arm on the Danube*. Worldwide Fund for Nature (WWF) Hungary, Budapest.
- Sparks, R.E., Bayley, P.B., Kohler, S.L. & Osborne, L.L. (1990). Disturbance and recovery of large floodplain rivers. *Environmental Management*, 14(5), 699–709.
- Sziebert, J. (2003). *Vén-Duna élőhely revitalizációs program II. ütem és monitoringja (Stage 2 and monitoring of the Old Danube habitat revitalisation programme)*. Manuscript. Eötvös József College, Baja. Retrieved from <http://www.bite.sugovica.hu/ed2003/cikk/sziebert.htm>
- Szlávik, L., Szibert, L., Zellei, L. & Zsuffa, I. (1995). A nyéki Holt-Duna rehabilitációja (Rehabilitation of the Dead Danube of Nyék). *Vízügyi Közlemények* 77,(3).
- Tamás, E.A., Varga, A., Sziebert, J., Varga, Gy. & Koch, D. (2014). A Vén-Duna mellékág vízzárlásának és hordalékviszonyainak vizsgálata (15 évvel az élőhely-rekonstrukciós célú részleges megnyitás után) (Water and sediment discharge studies in the side-arm of the Old Danube – 15 years after partial opening for habitat reconstruction). *31st Conference of the Hungarian Hydrological Society*. Retrieved from http://www.hidrologia.hu/vandorgyules/31/dolgozatok/word/116_tamas_eniko.pdf
- Werners, S.E., Southern, A. & Flachner, Zs. (2013). Giving Space to the Tisza River in Hungary. In: Warner, J.F., van Buuren, A., Edelenbos, J. (eds) *Making Space for the River: Governance Experiences with Multifunctional River Flood Management in the US and Europe*. IWA Publishing, London, 177–186.

Dénes Lóczy², József Dezső^{*}, Levente Ronczyk^{*}

**ПРОЈЕКТИ РЕХАБИЛИТАЦИЈЕ ПОПЛАВНИХ ПОВРШИНА
У МАЂАРСКОЈ: СТУДИЈЕ СЛУЧАЈА РЕКА ДУНАВ, ТИСА,
КЕРЕШ И ДРАВА**

Резиме: Плавне површине, уз регулисане речне токове, су често угрожене озбиљним еколошким деградацијама. Мере рехабилитације река и плавних површина дуж главних речних токова у Мађарској су дефинисане са два циља: да се повећа капацитет ретензије воде плавних површина (такође изван насипа), и да се побољшају еколошки услови плавних станишта (са посебним освртом на мртваје). У раду се сумирају закључци преузети из главних пројеката рехабилитације у Мађарској, а као студије случаја коришћене су реке Дунав, Тиса, Кереш и Драва. Пројекти рехабилитације река и плавних површина у Мађарској имају различите циљеве. Основни циљ за токове Тисе и Кереша је ретензија поплавног таласа, али је такође важан циљ и дуж Дунава и Драве. Главни задатак у свим пројектима је побољшање еколошких услова у напуштеним каналима великих река, трансформација стајаћих у текуће водне екосистеме да би се створио већи диверзитет еколошких услова. Заједничка карактеристика свих студија случаја јесте и примена „тешког инжењерства“ као решења за проблеме животне средине.

² loczyd@gamma.ttk.pte.hu (аутор за кореспонденцију)

^{*} Универзитет у Печују, Географски институт, Печуј, Мађарска