

Landscape, ecological and visual impacts of a stream restoration in Hungary

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Abstract

In the course of the preparation for the restoration of the Váli-stream, an environmental impact assessment (EIA) and, as a part of it, foundational wildlife and landscape protection studies were carried out. The goal of the study is to reveal the significant impacts of a planned stream restoration on wildlife protection, and later on, to propose mitigation measures on the adverse effects. The other main goal of the study is to evaluate the intervention's effects on the landscape, regarding the landscape character, land use, landscape structure and scenery as well.

Introduction

The Váli-stream (Fejér County, Hungary, Fig. 1.) was channelled and regulated in several stages during the 20th century. The existing problems, the altered social demands (especially regarding the ecological functions), the natural conditions as well as the requirements of the EU Water Framework Directive (2000/60/EC) all account for technological and ecological interventions – a restoration project – on the full length of the stream. The professional requirements regarding the realization of the restoration project are the following: the improvement of the flood security in the case of the settlements situated in the valley, the improvement of the ecological conditions of the water catchment area and the quantitative and qualitative improvement of the water resource management of the water system. The recent restoration plan of Váli-stream is only one of many elements within a larger development project for watershed management.

The restoration includes:

- development of wetlands,
- planting,
- riverbed relocation,
- dredging,
- reservoir construction,
- reconstruction of maintenance roads, reconstruction or demolition of structures (e.g. floodgates),
- fixing of ravines,
- development of monitoring system (planned).

In the course of the preparation of the restoration of the Váli-stream, an environmental impact assessment (EIA) and, as a part of it, foundational wildlife and landscape protection studies were carried out (Fig. 2.).



Figure 1. Location map of the impact area (Fejér County, Hungary)

The terms used in this study are used in accordance with the SER (2012) interpretation: *Rehabilitation* shares with *restoration* a fundamental focus on historical or pre-existing ecosystems as models or references, but the two activities differ in their goals and strategies. Rehabilitation emphasizes the reparation of ecosystem processes, productivity and services, whereas the goals of restoration also include the re-establishment of the pre-existing biotic integrity in terms of species composition and community structure. Nonetheless, restoration, as broadly conceived herein, probably encompasses a large majority of project work that has previously been identified as rehabilitation.

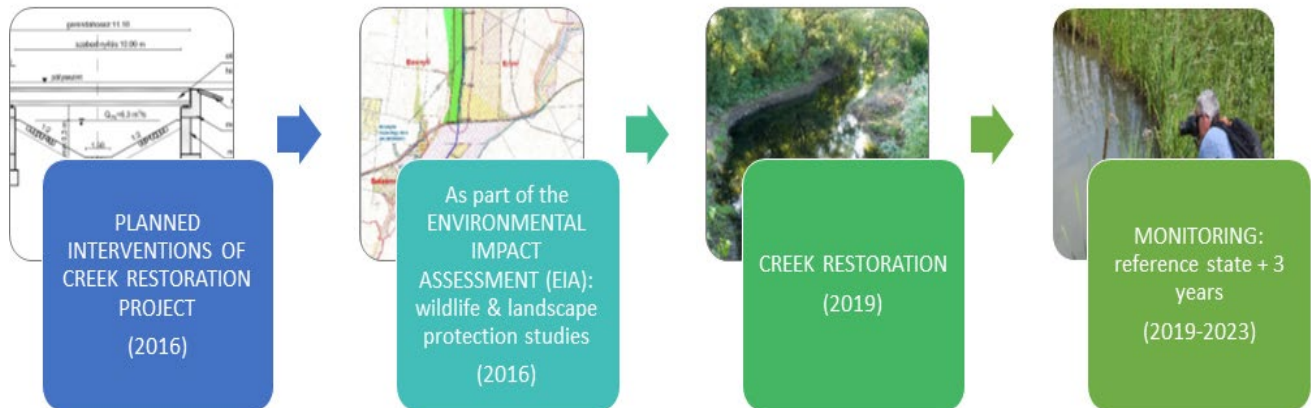


Figure 2. Framework of the restoration project

Mitigation is an action that is intended to compensate environmental damage. Mitigation is commonly required in Hungary as a condition for the issuance of permits for private development and public works

projects that cause damage to wetlands. Some, but perhaps relatively few, mitigation projects satisfy the attributes of restored ecosystems (SER 2012).

The catchment area (657 km²) of the Váli-stream is situated in the foreground of the Trans-Danubian-mountains, between the valleys of the river Danube and Sió-channel. The stream valley is surrounded by 700-900 metres wide alluvial plain from both sides, dominantly sedimented by riverine sand, deposited during the Pleistocene (Dövényi 2010). The Váli-stream originated from several spring-heads at the toes of the Vértes and Gerecse mountains, flowing into the river Danube at Adony. The length of the Váli-stream is 56 km (Boda 2002). The water level of the stream is considerably fluctuating (KöDVGT 2010), seriously affected by seasonality of the karstic water level and mining activity. The restoration interventions affect directly the administrative areas of Óbarok, Felcsút, Alcsútdoboz, Tabajd, Vál, Kajászó, Baracska, Besnyő and Ercsi.

Background and literature review

Over the last 30 years, river and stream restoration has become a widely applied approach to restore freshwater ecosystems (Bernhart 2007; Pander 2012). The assessment of channel morphology (Báthoryné Nagy – Novák, 2005; Teufl et al. 2013), in riparian habitats (Kovács et al. 2011; Smiley – Dipple 2005), and the structural and functional connectivity between the stream and the surrounding landscape have become a subject of investigations (Báthoryné Nagy 2007).

The basic requirements for environmental impact assessments are fixed in the Government Decree of 314/2005. As far as the assessments and evaluation for the landscape are concerned, the landscape aesthetical studies (Aoki 2013, Csima 2011, Csőszí et al. 2007, Junker – Buchecker 2008, Kollányi et al. 2012, Konkoly-Gyúró et al. 2017) are of significance, as well as the visual impact assessment's theoretical background and practical experiences (Maslov et al. 2017, Palmer 2016, Smardon 2016).

Goals and Objectives

The goal of the study is to reveal the significant impacts of the planned restoration regarding wildlife protection, and later on to propose mitigation measures on the adverse effects. The other main goal of the study is to evaluate the intervention's effects on the landscape, regarding the landscape character, land use, landscape structure and scenery as well.

Methods

The natural values present along the Váli-stream were assessed during the fieldwork carried out in the planning area between July and September in 2016, especially in the active intervention (water construction) areas (dredging, bed relocation, reservoirs, check dams), along the stream in a total of approximately 46 km. The expected ecological conflicts were evaluated based on this field survey. In addition, studies on creekside vegetation zones were carried out throughout the previous years (2013-2015) (Boromisza et al. 2016, Mjazovszky – Tamás 2002, Mjazovszky et al. 2003, 2007), and information provided by scientific literature and existing databases were considered as well. Some habitats were defined based on the site features, physiognomy and species composition (Bölöni et al. 2008).

The base maps used were 1:10000 scaled topographic maps (1982-84) and GoogleEarth maps, and preliminary works were carried out by AutoCAD 2016 and ArcGIS 10.0 softwares. Primary

methodologies of the study were fieldwork and literature research. Results were documented by a site map, and photos as well. The intervention area and its 50 metres wide surrounding areas were considered as land use impact area, and its 300 metres wide surrounding areas were considered as scenery impact area.

Results

Potential natural vegetation

The assessment area was covered by marshlands, especially by largely dimensioned reed beds. In the flared Váli valley, forest vegetation was created by gallery forests (willow, poplar and alder).

Actual vegetation

Today the former alluvial plain is replaced by meadows (60-80%), arable lands (15-20%) and forests (approximately 5%). Natural and semi-natural vegetation can be found on mesic grasslands and wetlands alongside the creeks. The most common species at the immediate vicinity of the stream bed are reed (*Phragmites australis*) and cattail (*Typha sp.*). Smaller patches of woodland, forest belts remained between the arable lands as well, usually along watercourses, where maple (*Acer sp.*), poplar (*Populus sp.*) and willow (*Salix sp.*) species can be found, mostly at the area of Alcsútdoboz, around *Felső-rét* and *Alsó-rét*. Black alder stands are present around the source area of Bodzás creek and at the south of Alcsútdoboz. 600-800 metres wide, micromosaic, slightly salty wet meadows, mesic grasslands, gray willow (*Salix cinerea*) scrubs and remnants of old willow-poplar woodlands are found on the southeast of Baracska, beside the Váli-stream. Non-native invasive species are common on the evaluated area: goldenrod species (*Solidago spp.*), black locust (*Robinia pseudoacacia*), tree of heaven (*Ailanthus altissima*), boxelder maple (*Acer negundo*), indigobush (*Amorpha fruticosa*), wild olive (*Elaeagnus angustifolia*) (Bölöni et al. 2008, Dövényi 2010).

Natural and semi-natural habitats at the impact area of the planned intervention area

Eu- and mesotrophic reed and Typha beds

This habitat type primarily stands for the reed beds and Typha stands of the lakes, however, it is reasonable to list here the stands of the shore of the Váli-stream, as well as the larger, partly desiccated stands of the flared valley as well, as their physiognomy and species composition is not significantly different from those standing at the lakeshore. The reason for this derives from the similar environmental qualities: at the studied part of the creek, the water flow is exiguous during the major part of the vegetation period, the bed is often desiccated, thus reminds of the reed zones of the lakeshores (cf. Mjazovszky & Tamás 2002). However, the habitat often narrows down to a few metres on the shore, which was categorized as “Fine scale mosaic or zonation of marsh communities” habitat.

Dominant and characteristic species: *Phragmites australis*, *Calystegia sepium*, *Carex acutiformis*, *Phalaroides arundinacea*, *Poa trivialis* és *Urtica dioica*.

Other characteristic species of the reed and Typha bed of Váli-stream are: *Butomus umbellatus*, *Glyceria maxima*, *Humulus lupulus*, *Typha latifolia*, *Iris pseudacorus*, *Scrophularia umbrosa*.

Species of non-mowed grasslands also appear at the border of the reed beds: *Elymus repens*, *Allium scorodoprasum*, *Galium mollugo*, *Lactuca serriola*.

Large stands are found on the north and east from Felcsút. On the way down from Baracska, until the inflow of the Szent-László-stream, reed cover is practically continuous in the bed.

Glyceria, Sparganium and Schoenoplectus beds

The water demand of the plants of “Glyceria beds” are even higher than those of the reed beds, common species: *Glyceria maxima*, *Iris pseudacorus*, *Phalaroides arundinacea*, as well as aquatic plants: *Berula erecta*, *Sparganium erectum*. Species of drier grasslands (e.g. *Galium mollugo*, *Potentilla reptans*, *Urtica dioica*, *Vicia angustifolia*) can also be found at the fringe of the habitats. These stands are mostly found near structures (bridges), in broadening beds.

Riverine willow-poplar woodlands and its fragmented remnants

Small groups of older trees were listed at the “Scattered native trees or narrow tree lines” habitat type (see below). Dominant and characteristic species: *Populus alba*, *Salix alba*, *Salix fragilis*, *Acer campestre*, *Ulmus minor*, and *Salix cinerea*, *Salix purpurea*, *Euonymus europaeus*, *Cornus sanguinea*, *Sambucus nigra*. The invasive alien species *Amorpha fruticosa* is present in many places as well.

The following species can be found in the herb layer: *Angelica sylvestris*, *Calystegia sepium*, *Chaerophyllum temulum*, *Humulus lupulus*, *Phalaroides arundinacea*, *Poa trivialis*, *Rubus caesius*, *Urtica dioica*, *Phragmites australis*, *Chelidonium maius*, *Lapsana communis*.

Disturbant tolerant, weed species might origin from the semi-dry and mesic grasslands/hay meadows, pastures, or warmer hillsides, situated further away from the creekside (e.g. *Elymus repens*, *Bromus sterilis*, *Calamagrostis epigeios*, *Daucus carota*, *Galium mollugo*, *Rosa canina*, *Rhamnus catharticus*, *Vicia angustifolia*).

Fragments of its stands can be found on different areas along Váli-stream (e.g. between Alcsút and Tabajd: “Alsó-rét”, Felcsút: “Fenék”, Beloianisz-Sinatelep). The gallery forest situated between a main road and the river Danube, consisting of old tree individuals, is an outstanding value in terms of nature conservation.

Scattered native trees or narrow tree lines

Smaller groups of trees consisting of willow and poplar species were listed at this type as well. Characteristic tree species: *Populus alba*, *Populus tremula*, *Salix alba*, *Salix fragilis*. It is a common habitat type along the watercourse.

Uncharacteristic or pioneer softwood forests

Pioneer stands can be found e.g. near the sewage treatment plant in Újbarok and at the floodwater reservoir in Felcsút.

Uncharacteristic wetlands

The species poor marsh communities of the standing water developed in some smaller dimensioned mines were listed here (e.g. on the eastern side of Felcsút).

Uncharacteristic mesic grasslands

The dominant image of the vegetation alongside the Váli-stream is determined by this habitat type. Largely dimensioned mesic meadows can be observed from Felcsút until Beloianisz-Sinatelep. Regarding their aspect they are like “Mesotrophic wet meadows”. In the low-lying abandoned beds “Non-tussock tall-sedge beds” are found as well. Due to the lack of mowing they are infected by *Solidago*, and turn into tall-herb vegetation. Characteristic grasses: *Dactylis glomerata*, *Elymus repens*, *Alopecurus pratensis*, *Arrhenatherum elatius*, *Deschampsia caespitosa*. Other species: *Pastinaca sativa*, *Galium verum*, *Cirsium canum*, *Senecio doria*, *Achillea asplenifolia*. Many mesic grasslands were turned into pastures (horse, cow) in the last years (Felcsút, Baracska), in these areas the spread of the spiky tall herb vegetation, on higher levels salinization occurs.

Dry and semi-dry pioneer scrub

The unused grasslands and wastelands are often becoming scrubs. Characteristic species: *Crataegus monogyna*, *Prunus spinosa*, *Cornus sanguinea*, *Rhamnus catharticus*.



Figure 3. Actual vegetation in the impact area: a) uncharacteristic mesic grasslands and invasive Russian olive stands; b) wet hay meadows and reed beds; c) stands of invasive forbs and pioneer softwood forests; d) fragments of willow-poplar woodlands and ruderal tall-herb vegetation

Actual land use, landscape structure, landscape values

Most of the impact area is defined by agricultural areas: grasslands (mostly meadows, although e.g. in Felcsút cattle farming and pastures are typical as well), large scale arable lands and fallows. Recreation and tourism have less tradition in the impact area. The majority of touristic attractions are mostly eligible for short excursions. The settlements are dominated by rural residential areas and detached houses, larger scale institutions are mostly situated in Felcsút. Among the determinants of the built environment, relevant water construction structures, bridges (there are approximately 100 small structures along the stream), existing reservoirs have to be mentioned. The area near the mouth is a Nature 2000 area, but no interventions are planned here. A protected area of national importance can be found in Alcsútdoboz. The assessment also revealed the protected areas of local importance (4pcs) and historic monuments (17pcs).

Landscape scenery

On the north of the impact area, in the area of Óbarok, mountainous terrain is characteristic, the surface is articulated, and streamflow shows a higher diversity. The visual connections are often limited from the stream towards the closer areas, however e.g. the view of the barren surface of Öreg-szikla (“Old rock”) is an emphatic natural element from further situated, frequented viewpoints as well.

In the south of the impact area, the situation of Felcsút, Alcsútdoboz and Tabajd is significantly different, partly because of the different terrain conditions, partly because of the settlements’ situation in relation to the stream. The surface diversity of the undulate plains and hills are slightly lower, and the stream runs in a strongly regulated, straight bed, only bordering the settlements, thus hardly seen from popular viewpoints.

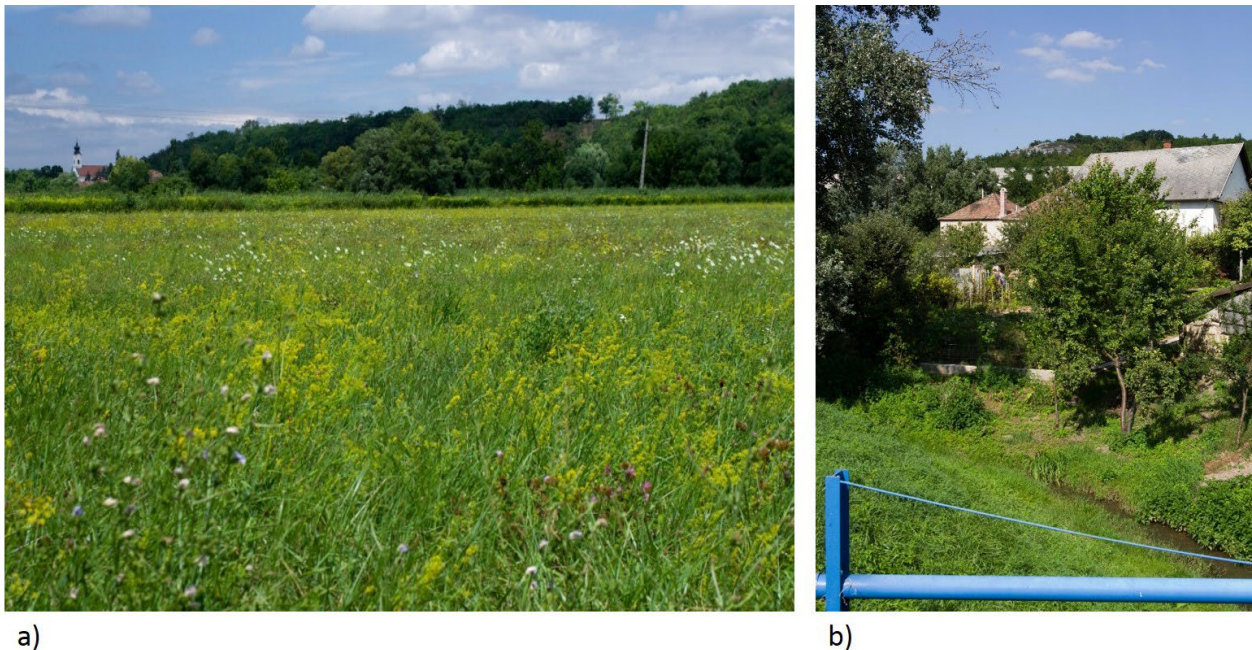


Figure 4. Landscape scenery in the impact area: a) the dominance of the view of the churches preserved for many settlements along the Váli-stream (e.g. for Alcsútdoboz); b) the view of Óbarok village, with the barren surface of Öreg-szikla (“Old rock”) in the background

Land use conflicts, problems

The strong engineering of the stream causes ecological, land use and landscape aesthetic problems as well. In the planning area several ecological barriers are found, which mostly cross the ecological corridor of the Váli-valley in west-east direction. The most important elements are the road 1 and 811, the Budapest-Győr railway, and the M7 highway as linear landscape elements. The constructions too close to the bed can even limit restoration or recreational use in the future. There is a complete lack of buffer zone in many cases, in certain areas arable lands reach the top of bank of the slope. The partly unregulated water inflows and abstractions also considered as land use problems.

Discussion and Conclusion

To conclude the findings, first, an overall picture can be given on the restoration's estimated impacts on wildlife and landscape. Secondly, a strategy and recommendations were prepared to mitigate the negative impacts and enhance the positive ones.

Assessment of the investment's impacts

By the water quality and ecological conditions changing, most of the restoration interventions modify the use and the potential use of the landscape (e.g. better conditions for future ecotouristic developments). The intervention improves the bed's water transfer ability and decreases the risk of floods. As a favourable impact, according to the plans, the structures' ecological barrier character might be moderated. Streambed dredging is not definitely a favourable intervention from an ecological point of view, as it can cause damage in the streambed and benthic habitats and organisms. The bed relocation and other water construction works that require earthwork might cause damage in the forest vegetation along the current bed. This affects softwood vegetation and characteristic, old individual trees as well, and will result in the removal of aquatic/marshland vegetation. This affects negatively the stream shore's buffer, biofilter, and environmental protection functions.

In relation to land use, the construction works of a new reservoir and its complex effects on the landscape are crucial. Due to the investment, new linear elements appear, which modify the landscape pattern (e.g. levees, maintenance roads, new bed sections). Along the stream shore, several new landscape features will appear, influencing the landscape scenery, primarily the change or repair of the deteriorated structures will be favourable. Concerning both the landscape conditions, as well as the traditional land uses, it was found that the investment will not change the landscape, nor the settlement character. In relation to the ecological effects, not all the important elements of the project are clear yet (e.g. the formation method of planned vegetation), however the project's objective is restoration, in certain areas, and can result in a stream with higher ecological quality which better fits the natural conditions and the landscape character.

Mitigation measures, proposals

No action zones

The most valuable habitats concerning landscape conservation were defined among the areas that are directly or potentially affected by the investment. In these areas, intervention is not recommended or only recommended with certain limitations.

No action zones were defined in the bed, where developed marshland vegetation (mostly reed beds) is present. These zones are situated 2-3 km from each other, and are 50 metres long. The wildlife conservation function of these dredging free areas is the following:

- 4.) they help the regeneration of the marshland vegetation after the intervention;
- 5.) they provide shelter for the aquatic macroinvertebrates and vertebrates;
- 6.) their conservation facilitates the transverse connectivity of the stream between the nearby valuable wetlands (reed beds).

Earthwork, construction of roads

The designation of maintenance roads, material deposits and work spaces needs to consider ecological, nature conservation and environmental protection aspects (e.g. limitation in space or time, scheduling, track designation). During the construction works, the mitigation of dust load is expected, especially in dry summer periods (e.g. by spraying), in order to avoid the disturbance of recreation functions. The sludge extracted by dredging must not be disposed in woodlands or in protected areas. The restoration – landscaping and planting – of destroyed surfaces after the construction works is highly recommended due to the recreational use (e.g. dissolving unfavourable scenery, promoting utilization) and ecological aspects (e.g. preventing invasive species from spreading). During the construction works, archaeological monitoring has to be provided in the earthwork areas and in other not excavated areas.

Planting

Between the arable lands and the stream – where it is allowed by property relations – an approximately 5-15 metres wide protection belt with trees and scrubs should be established, in order to retain the infiltration of nutrients from the agricultural areas and to inhibit the spread of weeds.

The planting of alleys or small tree groups can only be allowed by native riverine tree species, aiming for diverse species and age composition. Instead of creating a forest with no levels, the goal is to create a forest belt with minimum 2 canopy levels bordered by a scrub zone from the outside (in fact at least a double alley). To assure the adequate development of the vegetation, continuous care is needed. In case the reason for the planting is only the need for shadowing, it is sufficient to be carried out on the shore with high sun radiation.

Monitoring

The impact of the planned water construction interventions is assured by the yearly biological monitoring assessments and the evaluation of results compared to the original conditions (reference state). The impact monitoring monitors the effects of the investment on the aquatic and riparian macrophytes and the occurrence of the predicted changes. According to the prediction the direct and indirect effects will improve the naturalness of the vegetation (WFD “good state”) in the long run, therefore the assessments have to confirm or refute this predicted improvement (e.g. regeneration of habitats).

Ecotouristic development

One of the most favourable yields of the restoration from the land use aspect, is that it creates new recreational possibilities, attractions for both locals and tourists. Aligned with the current international and national touristic trends, it is certainly recommended to establish ecotouristic developments, relying

on the improving natural conditions, which will allow for a longer stay in the settlements of the impact area. A more significant nature conservation interpretation establishment (e.g. nature observation tower) could be placed in the areas where restoration is carried out. Mainly, the wetland system created around Alcsútdoboz offers a possibility to create a wetland park, interpreting the process of water quality improvement, unfolding the area by an elevated plank path, a partly underwater, covered tunnel, a bird watching point, and a covered outdoor didactic space. Nature conservation interpretation establishments can even be formed as an “adventure chain” with different establishments and organised activities providing continuous income, e.g. as a network of interpretation centres and nature trails in different lengths and designed for different target groups. Particularly the stream areas inside the settlements can be joined in the green space system more intensely, e.g. by creating resting areas, sport fields, playgrounds, paths.

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