

# FOLYÓPART MEGÚJÍTÁSI LEHETŐSÉGEK

## RIVER LANDSCAPE RENEWAL

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### ABSZTRAKT

Amikor folyókról beszélünk, azokra a vízfolyásokra gondolunk, amelyeket a föld felszínén látunk, holott a folyók csupán a gerincét és dinamikus megjelenését adják a folyami tájnak. A folyami táj olyan tájegység, amelyet a folyó a környező területekről történő, hosszú távon is fennálló koncentrált vízelvezetéssel alakít ki.

A történelem során az emberek jelentősen átalakították a folyók környezetét, saját szükségleteikhez igazítva azt. Ennek következtében csökkent a táj vízmegtartó képessége, vízhiány alakult ki, és a folyók környezete már nem tudta megfelelően elvezetni az árvizeket. Az utóbbi években az árterületeken végzett intenzív beépítések jelentős anyagi károkat okoztak, sőt, emberéleteket is követeltek.

Nyilvánvaló, hogy a jelenlegi folyami tájrendszer nem működik megfelelően. A folyami tájat rekonstruálni kell, alapvető funkcióit helyre kell állítani, mert veszélybe került a teljes táj hidrológiai alaprendszere. Jelenleg a táj nem képes megfelelően reagálni a klímaváltozás kihívásaira. A víz megtartása érdekében átfogó rekonstrukcióra van szükség a folyami tájrendszerben annak érdekében, hogy csökkentsük a víz elfolyását a mezőgazdasági, erdő- és lakóterületekről. A változások biztosításának, valamint a táj működőképességének helyreállításának eszköze a komplex tájtervezés alkalmazása, továbbá a táj egységes szemléletű kezelése és menedzselése.

A folyami táj alapvető és jelentős természeti infrastruktúrát képez – hosszú távú geológiai, talajtani,

hidrológiai és éghajlati folyamatok eredményeként jön létre. Ez a víz, a biológiai sokféleség és az emberek számára nyitott terek közös rendszere, amelynek a jövőben a biodiverzitást fenntartó és elősegítő természetközeli területek gerincévé kell válnia. A tájtervezés lehetőséget nyújt arra, hogy a tájban található infrastruktúrákat közérdekűként ismerjük el. A funkcionális infrastruktúrák alapvető és stabilizáló hatással vannak nemcsak a táj egészére, hanem az életminőségünkre is.

Ha e területeket – legalább részben – újra a folyók rendelkezésére bocsátjuk, jelentősen csökkenhet a nagyobb árvízkárok kockázata, és hosszú távon mérsékelhetők az aszály okozta károk is. A folyami táj egyúttal nyitott térként is szolgálhat az emberek számára (például árvízi parkok formájában), ökológiai folyosóként is működhet, valamint olyan élőhelyeket biztosíthat, amelyek elősegítik a biológiai sokféleség megőrzését. Adjuk meg a folyami tájnak a jogot arra, hogy a lehető legtermészetesebb állapotába visszatérhessen – ezáltal képes lesz stabilizálni a táj vízháztartását, fenntartani a biodiverzitást, és nyitott, élhető tereket biztosítani az emberek számára.

*Kulcsszavak: Folyói táj, biodiverzitás, ökológiai kontinuum, infrastruktúra, táj mint élő szervezet, táji infrastruktúra* ☉

### ABSTRACT

When we talk about rivers, we mean the watercourses that we see on the surface of the earth. But rivers themselves are only the backbone and one dynamic element of the river landscape. The river landscape is the space created by a river by the constant and long-term concentrated draining of water from the surrounding territory. Throughout history, humans severely changed the river landscape and adapted it to their needs. This has affected the entire landscape's ability to retain water, resulting in a lack of water and the inability of the river landscape to cope with floods. In recent years, intensive construction in flood zones has caused more material damage and even loss of human life.

It is clear that the current system of river landscape management is not working adequately. The river landscape should be reconstructed and its important functions restored as the basic hydrological system of the entire landscape is at risk. Presently the landscape is unable to adequately respond to climate change. To retain water in the landscape, it is necessary to initiate the fundamental reconstruction of the river landscape system to reduce water runoff from agricultural, forest, and residential landscapes. The way to ensure change and to improve the landscape is to employ comprehensive landscape planning and ensure management of the landscape as a whole.

The river landscape is an element of fundamental and large-scale natural infrastructure. It is the result of long-term geological, pedological, hydrological and climatic processes. It is a shared common space for water, biodiversity and open space for people. In the near future, it should become a key nature-friendly area creating and fostering biodiversity. Landscape planning allows us to define landscape infrastructure as a public good. Functional infrastructure has a key stabilizing effect on the landscape and on the overall quality of our lives.

If we return the river landscape to a natural form (at least partially), we will reduce the risk of major flood damage. The river landscape can also be an open space for people (flood river parks) and an ecologic continuum. Moreover, it is a biodiversity supporting habitat. Let us grant the river landscape its rights and return it to as close to a natural state as possible. In this way it can support functions to stabilize water in the landscape, as well as promoting biodiversity and becoming an open space for people.

### INTRODUCTION

I first encountered the term river landscape in a publication by Prof. Otakar Štěrba entitled Ecosystems of River Landscapes (Štěrba, 2008). I was surprised by the ecologist's completely logical perception of the water circulation system in landscapes. It is in complete contradiction

with the current, predominantly technical way of treating the space of river landscapes, where we perceive only flowing water in rivers.

We perceive water primarily as a fundamental resource to ensure our lives and activities.

The river landscape as a system has its own rules. Over the course of history, significant changes and adjustments have taken place. The damaged system seriously impacted the functionality of the entire landscape. In adapting the landscape to climate change, we are dealing with the issue of reconstructing the functionality of the river landscape as a fundamental landscape infrastructure element (Corner, 1999; Corner & Hirsch, 2014; Leopold et al., 2020; Mathur et al., 2014; Waldheim, 2006; E. Wohl, 2012; E. E. Wohl, 2008).

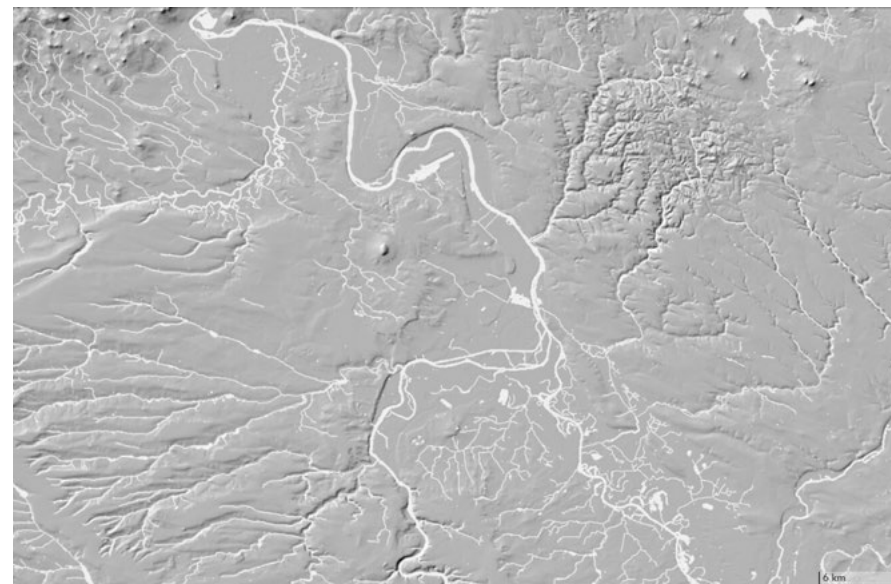
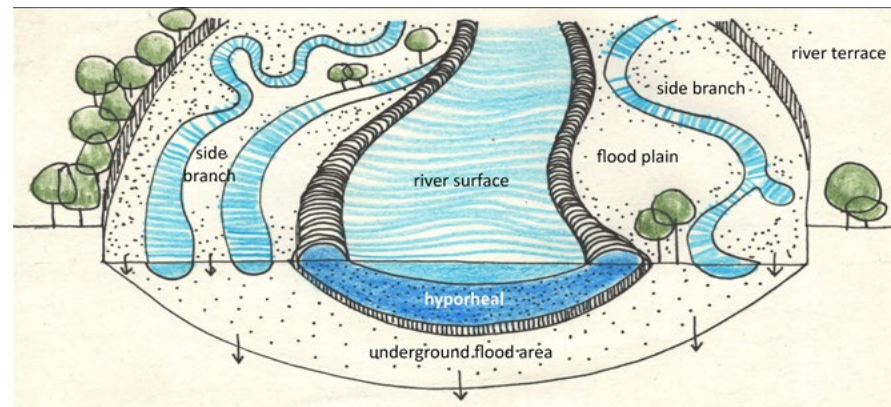
### RIVER LANDSCAPE SYSTEM

To strengthen the methodological foundation of this research, recent advances in international landscape ecological studies should be incorporated. Modern approaches emphasize the need for multi-scalar analyses that move beyond traditional linear perspectives of river systems. As outlined by Erős and Lowe, contemporary riverscape ecology leverages developments in GIS and spatial network models to quantify heterogeneity, connectivity, and ecological processes across entire catchments, rather than focusing solely on individual reaches or segments (Erős & Lowe, 2019). The methodological framework is well complemented by the rehabilitation potential assessment developed by Erdei et al. (2023), which examines urban stretches in Hungary along three dimensions: water quality, ecological-hydromorphological endowments, and recreational and landscape values. The results show that water quality problems, such as point source pollution and agricultural use of the floodplain, and mono-planar riparian vegetation are particular barriers to complex rehabilitation, while some municipalities show high potential in several target areas. This integrated approach fits well with the quantitative analysis of the need for river section rehabilitation in the Czech Republic and could provide a methodological basis for the development of a ranking system (Erdei et al., 2023).

The river landscape is formed (or definitively influenced) by its water flow. We can also say that the river flow is the “controlling ecosystem” of the entire river landscape. It is simply the most important of all sub-ecosystems in the river landscape. This is the situation today, just as in the past. The overall appearance of river landscapes differs greatly depending on altitude, but always forms a closed set of several aquatic and terrestrial sub-ecosystems.

The typical elements here include springs, streams, hyporeal , alluvium, marshes, terrestrial





floodplains, banks ecosystems, aggradational ridges and islands (Fig. 1).

These are always the “building blocks” of river landscapes, no matter whether they are found in the mountains, midstream, or in lowland areas. Each has certain features, retains them at all altitudes.

Riverine landscapes are not just hydrological systems, but complex ecological and social infrastructures that serve multiple functions: as ecological corridors, biodiversity hotspots, and recreational and cultural spaces (Opperman et al., 2010). Modern landscape ecology research emphasizes that riverbeds and floodplains behave as complex spatial networks that enable ecological connectivity and genetic flows at the landscape scale (Erős & Lowe, 2019).

The permanently flowing water continuously shapes its bed. At steep gradients it erodes the parent rock beneath, deepening the entire valley. The eroded mineral material is gradually turned into gravel and sand, becoming loose material in the stream. Long sedimentation creates massive gravel and sand alluvia on both sides of the river with a dry floodplain on its surface. The interaction of the river flow and the underground alluvial water set

the level of the underground phreatic water below the floodplain surface. This water co-determines which kind of plants will grow in the river floodplain. Regular floods are also involved in this process. These floods determine the movement and deposition of sediments carried by the river. Floods also determine the formation of river tributaries, as well as forming and filling the temporary pools and all riparian wetland features in the proximity of the natural river (Štěrba, 2008).

River landscapes have always been of fundamental importance for a wide range of human activities.

This is the result of the shaping and geomorphological nature of the river space, as well as the presence of life-providing water and fishing. In the past, the river also supported life according to principles of connectivity and continuity, by fostering transport and the use of water as an energy source.

According to archaeologists, the interrelation of mankind and the river landscape endured for a long time. We have always needed water and the river landscape. The gradual exploitation of the landscape, the deforestation of the upper river basin, and intensive agriculture have



◀◀Fig. 1: Cross-section of the river landscape (according to prof. Štěrba, 2008)

◀◀Fig. 2: The 5G digital terrain model – the confluence of the Elbe and Vltava rivers, červeně vyznačená plocha na obrázku 3 a 4

SOURCE: WWW.CUZK.CZ

Fig. 3: The 5G digital terrain model – Elbe river landscape and navigation channel

SOURCE: WWW.CUZK.CZ

Fig. 4: The Elbe River original course (1836 – 1852)

SOURCE: © GEOINFORMATICS LABORATORY AT J.E. PURKYNĚ UNIVERSITY – WWW.GEOLAB.CZ © MINISTRY OF THE ENVIRONMENT OF THE CZECH REPUBLIC – WWW.ENV.CZ © AUSTRIAN STATE ARCHIVE/MILITARY ARCHIVE, VIENNA

caused increased erosion and sediment accumulation in floodplains (Rulf, 1994).

Humans have been exploiting river landscapes since prehistory. However, most destruction took place in the last 150 years. The usage of river landscapes is now followed by a certain degree of denaturation. Rivers and their landscapes have become a global environmental problem. Agriculture, forestry, settlement build up, the reshaping of riverbeds and the construction of reservoirs all drastically influence river landscapes.

The cultural landscape of the Czech Republic began to emerge in the Neolithic and is associated with the so-called Neolithic Revolution (Sadlo, 2005).

Hand in hand with agriculture, settlements also appeared in river landscapes. This is logical, since human civilization itself originated near and along rivers. In ancient times, rivers served as the major source of drinking water, providing sustenance and disposal of waste.

Later, the river became a source of hydropower and a transport corridor. The river landscape also proved advantageous for defense, as a natural obstacle complicating crossings and enabling the possibility of building moats. Watercourse modification in the Czech territory

has a long history and was most often carried out for the purpose of flood protection, to facilitate navigation, to enable its exploitation as a source of energy or direct use (by population, irrigation and industry), or to stabilize the riverbed against erosion, etc. During the reign of Charles IV in the 14<sup>th</sup> century, the first modifications to the Vltava (Moldau) and Labe (Elbe) rivers were carried out, enabling some riverine transportation (Fig. 2).

Further major modifications of the Vltava and Labe were carried out in the 16<sup>th</sup> and 17<sup>th</sup> centuries, after the Habsburgs ascended to the Czech throne. However, the systematic use of the Vltava and Labe for navigation only began much later, during the 19<sup>th</sup> century, thanks to the systematic modification of riverbeds, regular maintenance, and the construction of shipyards (Fig. 3). The Vltava Cascade is a system of nine waterworks on the Vltava River, built in stages between 1930 and 1992 (Fig. 4).

The river landscape along the reservoirs has almost completely disappeared. The original drainage system has disappeared along with the original biocenosis. The river floodplain is devoid of vegetation and its surface is covered with a layer of sediment. The original river landscape ensured the roughness of the landscape surface yet



**Fig. 5:** The natural spring of the Mítovský stream headwater in Brdy Mountains (protected area)

PHOTO: AUTHOR

**Fig. 6:** The 5G digital terrain model - the confluence of the Mže and Úslava rivers, St. George Park in Pilsen

SOURCE: WWW.CUZYK.CZ

**Fig. 7:** View of the St. George Church building above the confluence of Úslava and Mže rivers. Saint Adalbert visited this place on his way from Prague to Regensburg

PHOTO: AUTHOR

**Fig. 8:** View of the 2006 flood at St. George in Pilsen

SOURCE: WWW.PLZEN.EU

allowed the flood plain to overflow and for water to percolate underground.

At the same time, water reservoirs are certainly important to our existence and contemporary human civilization.

The construction of reservoirs was motivated by the need to produce electricity, irrigate, and protect against floods. While some control over dam water levels is necessary to prevent floods, other functions of reservoirs include recreation and flow equalization during the dry season.

Throughout the history of civilization, the denaturalization of the entire river landscape has been ubiquitous. The destruction of these ecosystems has become a serious global problem.

Following 1948, large-scale agriculture reforms changed the landscape beyond recognition. Perhaps the most serious consequence was the loss of private landownership. The landscape mosaic disappeared, replaced by field blocks of tens or hundreds of hectares, sown with wide-row crops (especially corn) grown in unsuitable positions, and the reduction of the soil's water absorption capacity. This opened the way to enormous soil erosion.

After the regime change in 1989, it was impossible to return the landscape to its original state. Although the land was returned to the original owners, they were often no longer interested in agriculture and tended to rent out or sell their plots to new, even foreign owners.

There are approximately 788,699 hectares of river landscape in the Czech Republic representing approximately 10% of the whole country area. They are mostly located in the headwaters, springs, and along small streams up to 7 km from their source (Fig. 5). These "headwater river landscapes" are distributed throughout the entire area of the republic, mostly at altitudes of between 380 and 580 m above sea level. Here, massive land reclamation, drainage, and wetland elimination took place. Presently, most of the headwater river landscapes are located in agricultural landscapes (51.5%), subject to complete devastation.

Only one third of Czech rivers are in a satisfactory ecological state, while two thirds are environmentally unsatisfactory, and one third are in a state of ecological disaster (Štěrba, 2008).

The result of intensive usage, field drainage, and damaged river landscapes is a serious disruption of the water retention capacity of river basins. This affects the redistribution of rainwater, i.e. how much water is absorbed by the soil and how much is retained by the vegetation cover. The less water that enters the direct runoff, the smaller the flood wave in the lower river basin.

The major changes in the river landscape are of several types:

- ① The destruction of spring areas.
- ② The shortening, deepening and canalization of smaller streams.
- ③ The drainage of floodplains and spring area wetlands.

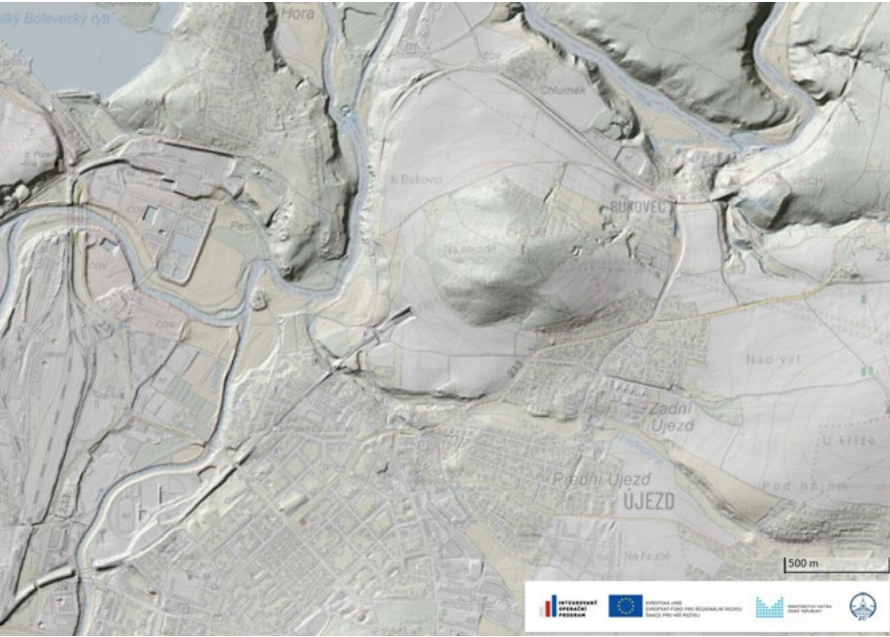
All these changes accelerate water outflow from the territory and speed up the frequency of floods and droughts.

### NEW FUNCTION OF THE RIVER LANDSCAPE

Today we are faced with the task of adapting landscapes to climate change and forming a landscape policy. In 2002, the Czech Republic signed the Council of Europe Landscape Convention to take care for its landscape, set up professional management and organize the landscape planning process. However, this process has barely started. Moreover, boundless faith in technology has assured us that rivers can be harnessed and the danger of floods averted by the reservoir construction.

We learned the true situation in 1997, 2002, 2006, and 2024, when large areas were hit by devastating floods that caused substantial damage to property and even claimed human lives. Apparently, even the perfect network of reservoirs and dams failed to provide full protection. Additionally, we are confronted more and more frequently with local flash floods (Fig. 6, 7, 8).

Unlike in the past, we are confronted by situations in which flooding rivers do not bring a rich harvest,



prosperity and life. On the contrary, they bring damage and even death. The radical flood control measures, such as dams and polders, are not 100% effective. The dams in general, due to their multi-purpose nature, often have a counterproductive effect on the course of flooding. We must humbly return to a natural approach. In seeking new types of farming and forestry that respect the land and soil itself, as well as their absolutely key properties such as organic content, water retention capacity and porosity, we may find a sustainable solution (Lejska, 2009).

We define two basic types of infrastructure – either natural or anthropogenic, i.e. the result of human effort. Natural infrastructure includes the river landscape, the result of long-term natural processes and physical shaping (geological subsoil, soil, water, climate and living organisms). Anthropogenic infrastructure includes rail and road networks, transmission lines, all technology and

of course all settlements. These two types of infrastructure can be interconnected by so-called green infrastructure, precisely defined and supported by ecosystem services.

International stream revitalisation projects are an excellent example of green infrastructure in practice, not only for ecological rehabilitation, but also as urban greenways to restore recreational and landscape connections. Báthoryné (2009) points out that these interventions can become particularly crucial in urbanised or agricultural environments, where the built environment and intensive technical infrastructure often result in a loss of functional connectivity between the stream and the surrounding landscape. Although domestic examples are still rare, they clearly demonstrate the ecological, landscape and urban design importance of streamside landscapes (Báthoryné Nagy, 2009). The green infrastructure improves the



adaptation of our densely populated and modified landscape to the emerging climate change. The concept of green infrastructure is becoming increasingly central in the European environmental policy discourse, especially in the context of Nature-based Solutions (NbS). Renaturalisation of river landscapes not only serves to improve ecological condition, but also contributes to water retention, carbon sequestration, heat island effect reduction and social well-being (Benedict et al., 2012; Benedict, 2006; Nesshöver et al., 2017).

Our current task necessitates merging the multiple functions of these networks and finding ways to enable their interaction.

Of course, such serious changes in the perception of landscapes and their key functions requires the adjustment of a whole range of legislative and subsidy instruments, including adjusting spatial planning standards related to the landscape.

The essential infrastructure for supporting life in the landscape is the territorial system of the so-called river landscape. Water courses form the vascular system of the landscape; they are the basic water drainage system in an area. It is a natural continuous infrastructure, and we consider it the basic infrastructure of the landscape. It is a purely natural element fulfilling a multitude of cultural functions, e.g. the function of a public space, but is also a means of retaining water in the landscape, controlling floods, and promoting biodiversity.

The basic planning tool for the landscape in terms of sustainability is the landscape plan. However, this is still absent from Czech legislation, and therefore it is impossible to ensure a sustainable landscape pattern in the future.

The landscape is a natural, cultural and social space. It is the space of our economic activities, but at the same time it is also the home of all other inhabitants of our planet and environment, humans included.

Landscape sustainability can only be ensured for future generations by taking a comprehensive view of the landscape. First of all, we have to let the interests of nature prevail over the interests of human society. The top priority in landscape planning is the issue of water, as the basis for all forms of life and a basic condition for all economic activities.

The renaturalization of river landscapes is also linked to the Nature Restoration Law. The densely populated and utilized Czech and Moravian landscapes may not provide

enough room to implement any other ecological continuum that would ensure a suitable space for the return and restoration of biodiversity. According to Professor Otakar Štěrba, it is precisely the Czech Republic's river landscape system (representing 10% of the country's territory), which is the most valuable ecosystem overall, that can establish the foundations for fulfilling the Nature Restoration Law, if adapted and managed together with agricultural, forestry, and residential areas. This requires a legislative change – the introduction of landscape planning and the adjustment of subsidies.

The river landscape is a basic natural, multifunctional infrastructure element, to be preserved and supported (renaturalization, reconstruction) as an important public good. This natural system has the potential to improve hydrological functions, including flood control, to provide public recreation space, and at the same time to improve biodiversity potential. (Fig. 9).

The river landscape is a space in which a wide range of species, people, and habitats can evolve and coexist in a natural environment.

DISCUSSION

The outcome of this study is to draw attention to the necessity of perceiving the river landscape as a fundamental, multifunctional infrastructure element. The river landscape is an independently functioning system crucial for supporting hydrological cycles on Earth and thriving biodiversity. These functions can also be attributed to the function of public spaces in cities, municipalities and the open countryside.

The sustainable management of river landscapes goes beyond traditional approaches to water management planning. Successful adaptation requires new landscape-based legal, planning and support frameworks that ensure the preservation of ecosystem services provided by green infrastructure. The objectives of the Nature Restoration Law can only be achieved if river landscapes are treated not as isolated elements but as multifunctional building blocks of the whole landscape (Proposal for a Regulation on Nature Restoration | Legislative Train Schedule, n.d.) ©



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Fig. 9: Revitalization of the Kateřinský brook utilizing natural methods  
SOURCE: WWW.DESOP.CZ



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