

## ECOLOGICAL RESTORATION WITH ECOREMEDIATION IN PROTECTED AREA (River restoration of degraded water ecosystem)

*Prof. dr. DANIJEL VRHOVŠEK<sup>1</sup> – ALENKA SAJOVIČ<sup>2</sup> – BOJANA KROFLIČ<sup>2</sup> – prof. dr. ANA VOVK KORŽE<sup>3</sup>*

<sup>1</sup> LIMNOS, Company for applied ecology, Požarnice 41, 1351 Brezovica pri Ljubljani, e-mail: [dani@limnos.si](mailto:dani@limnos.si)

<sup>2</sup> Ecoremediation technology center, Kidričeva ulica 25, 3000 Celje, e-mail: [info@ertc.si](mailto:info@ertc.si)

<sup>3</sup> International center for ecoremediation, Faculty of art, Universty of Maribor, e-mail: [ana.vovk@uni-mb.si](mailto:ana.vovk@uni-mb.si)

**Abstract:** Ecoremediation is the application of natural and co-natural systems and processes for nature and environmental protection and restoration and it sets a basis for ecosystem technologies. Those ecosystems have strong buffer, purification and biodiversity capacities, and they are capable to assist by neutralisation, decomposition and compensation of wasted waters, lands and air. Additional value of ecoremediation is that it revitalizes degraded parts of environment thus new value is given back to the environment. With ecoremediation we can protect important ecosystems from pollution and at the same time ecoremediation enables sustainable development as we are using natural processes to achieve this development. Protection of endangered and rare plant and animal species as well as there habitats is possible only with ecosystem technologies. Because only with them we can achieve or create the environment where this species will live and survive. With these technologies we can select the most suitable combination of ecological factors for every species or for the entire habitat. With ecoremediation implementation we would like to establish economic and ecologic advantage of ecoremediation use within Natura 2000 habitat types such as rivers, lakes, wetlands etc. The aim of the article is to show the advantages of using ecoremediation in protected areas such as NATURA 2000 and to present the best practices of ecoremediation as river revitalization Mala Krka in protected area Goricko, vegetation zones, boundary lines, puddles and pools, wetlands and swamps, ecoremediation as substitution ecosystems, constructed wetlands as multipurpose ecosystems. Education as an important part of sustainable development is shown on the some practical examples.

**Keywords:** freshwater habitats, new techniques for management, socio-economics of nature restoration, ecoremediation

### Introduction

Otters typically live in lowland rivers and streams with a shallow riverbed, which isn't more than 5 meters wide, has natural, meandering stream and banks overgrown with undamaged, rich vegetation. Especially important are big, old trees with broad root system, that provide convenient resting places and protected places for holts. Numerous piers, bays, peninsulas, pools and sandbanks increase the variety of otter's habitat and enable the existence of many plant and animal species (Kruuk, 1995).

With greater biodiversity of freshwater ecosystem the variety of otter's prey is much bigger. Such ecosystems are balanced and can more easily withstand different changes and pressures.

Single-purpose interventions, such as the reclamation of land by drainage or the building of sewage systems, have destroyed numerous running waters in Slovenia, as well as some extraordinary ecosystems with rare plant and animal species as is Eurasian otter (*Lutra lutra*). The consequence of canalized river beds is reduction of disburdening and self-protective capabilities of habitats and running waters, restraining of water in region etc. With suitable use of sustainable methods of ecoremediation as are multiple-purpose river restorations we can again established restraining of water, self-cleaning capability and increased biodiversity.

Natural ecosystems have in their ontogenesis developed many remediation systems that enable them to maintain a dynamic diversity. That kind of systems we named natural forms of ecoremediations as are pools, rapids, gravel deposit, swamp vegetation etc. and this natural systems have important role in aquatic ecosystem. Component parts of natural ecoremediations and processes can we tolerate in to sustainable systems for protection and restoration of environment and nature in a benefit to humans.

### **Materials and methods**

The most continuous and viable population of Eurasian otter in Slovenia lives in Prekmurje, more precisely at Goricko. We can locate otter tracks and sprints almost along every stream and river, from rivers Mura, Ledava and Krka to Mačkovski stream, Peskovski stream, Ratkovski stream and Kobiljanski stream. (Honigsfeld Adamič M., 1998).

Within the project LIFE III we cooperated as project partners at execution of project with title: Conservation of Otter Population (*Lutra Lutra*) in Goricko. The aim of the project was to assure favorable conservation status of otter (*Lutra lutra*) population and connectivity of its movement corridors in the area of Goricko (North-eastern Slovenia). Eurasian otter (*Lutra lutra*) has been listed as an endangered species in the Bern Convention (Appendix II), as well as in the FFH Directive (The Council Directive 92/43/EEC), Annex II and Annex IV; hence special protection measures for the species have to be ensured.

The main activates of the project were focused on two direction: to restore the natural habitats of the otter which have been degraded in the past with regulations and meliorations and to assure habitats of good quality with ecosystem technologies – ecoremediation, which imitate principles of natural legalities in aquatic ecosystems.

In frame of the project there were made pilot demonstrated river restorations of three of streams in Prekmurje with intention to conserve the status of otter (*Lutra lutra*) population. As one of the first pilot demonstration objects was made river restoration of stream Mala Krka in Nature Park Goricko with intention to reestablished the ecological balance in a degraded water ecosystem and to conserve otter population and other plant and animal spices. River restoration means that the ecological balance is reestablished through the application of appropriate water management steps. This means that the structure and the function of water biotope is restored and the ecosystem, landscape and multipurpose use of land is defined.

Once naturally meandered stream bed Mala Krka on utmost NE of Slovenia has been regulated in the middle of last century because of intense agriculture. Deepened bottom of stream and hydro morphologic change of river bed caused drain out of wetlands and reducing of level of ground water. Because of removal of vegetation zone by stream, the negative impacts of intense treatment of agricultural surfaces near stream have been larger. Pesticides and fertilizers washed out directly to stream and caused prominent aggravating of quality of water and reduction biodiversity. In village Domanjševci, near Hungary boarder 800 meters of Mala Krka stream has been revitalized. In stream bed of

Mala Krka several different ecoremediation objects have been built, such as: floor thresholds, two dihedrals, vegetation zone and buffers. The aim of these hydro technical measures was to stir up water holster, restraining of water, enhancement of disburdening and self-protective capabilities and creating a new biotope. Built wooden thresholds alongside of stream Mala Krka every few meters contributed to better ecological balance in watercourse. The basic function of wooden thresholds is to restrain tiny sediments, which occur from sewages of nearby housekeeping. Water is purging with this measure and keeping self-cleaning capability (Vrhovšek, Vovk Korže, 2007). Bank of the river was formed to terrace and planted with suitable riverside plants as are emergent macro fits from family Typhaceae, *Juncaceae*, *Cyperaceae*. On the ledge (of terrace) above log grass and different species of bush from family *Fabaceae*, *Myrtaceae* were planted. Planted trees on the highest part of the river bank are most often from the family *Salicaceae*. The main function of riverside zone are: strengthening of riverbanks, restraining of water in the floor, disabling of entry of non-point sources of pollution, enabling of sedimentation, shadowing of the river and remedying of disabling of immoderate warming of water as well as offering of important habitat for waterside animals (Eiseltova, 1995). Alongside Mala Krka Peskovski stream and stream Mokoš have also been revitalized.

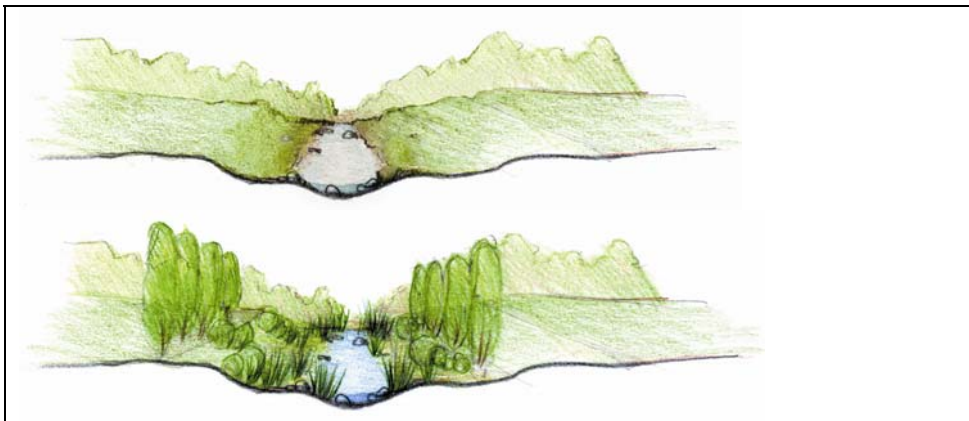


Figure 1. Regulated (above) and revitalized (at the bottom) river basin (Limnos d.o.o)

### Results and discussion

The greatest threat to otter population is degraded habitats due to the agro-operational works, including ameliorations and regulations of watercourses which took place in last decades. Ecological needs of the otter have not been taken into consideration sufficiently by the spatial planners in the course of the operations. At the same time liquid and stagnant waters on Goricko are endangered by non-point sources of pollution (untidy sewerage, elution of fertilizers from agricultural lands). Especially in protected areas and areas protected by NATURA 2000, there are ecologic and economic preferences for decentralized wastewater treatment with co-natural multifunctional systems as are constructed wetlands, vegetation zones, which are disabling the entry of non-point sources of pollution in water ecosystems.

To improve otter habitats we use co-natural and sustainable methods, which are selected and used considering local situations. In the future: the plans for further revitalizations in individual municipalities included in the project have already been made. At that point the river basin in revitalized stream Mala Krka has been already planted with indigenous plants, the pools have been settled by different species of fishes, numerous kinds of dragonflies etc. The main objective and intention of river restoration was to improve ecological condition of habitats of otter population. Secondly the project has also had an important role for raising the awareness level and the education for different target groups. Alongside of the stream of Mala Krka a learning path has been arranged which aware visitors and local inhabitants about correct treatment with water ecosystems and presents negative consequences of regulated watercourses.

### **Conclusions**

In millions of years, the nature and ecosystems evolved exceptional defensive and self-protective capacity to safeguard themselves against sudden and powerful impacts and to remove their harmful consequences. If we wish to keep diversity in our water and waterside ecosystems we have to use ecosystem technologies - ecoremediation in integrated water management. Especially in areas of NATURA 2000, where nature protection impacts and their adjustments to the conditions are more important, ecoremediation are in this case the only way for realizing spatial planning by sustainable principles. Ecoremediation are more and more used as systems not only for protection and renewal of environment but also as the way of living – symbiosis of human being with nature. People recognize all the benefits of ecoremediation as multipurpose, long duration, applicability, social views, economical views, but above all the fact that many problems that we have caused ourselves, such as regulation of watercourses, can be solved only by using natural or co-natural ecosystem technologies.

### **Acknowledgements**

This article is the result of the successful project coordinated by LUTRA, Institute for protection of natural heritage and other partners - Municipality of Gornji Petrovci, LIMNOS d.o.o, Company for applied ecology, Municipality of Dobrovnik, Kobilje, Puconci, Kuzma, Rogašovci, Moravske Toplice, Cankova.

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