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Willow brush mattresses – A promising method of direct technical-biological bank protection on waterways

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Introduction

Worldwide waterways are subject to different intensities of navigation within the river and land use along their adjacent river banks. In order to prevent erosion and other negative effects due to navigation-induced hydraulic loads or flooding in the long term, the banks of inland waterways are usually protected with technical revetments such as riprap. In the consequence, river banks with technical bank protection lead to large ecological impacts on river ecosystems. These impacts result in the loss of biodiversity and constraints of ecosystem functionality within river bodies, their banks and floodplains. According to specifications of political framework (e.g. the European Water Framework Directive, introduced in 2000), a major part of river banks is currently classified as heavily modified.

Over the last decades, the public and legal pressure – the introduction of the EU-Water Framework Directive is mentioned in particular – lead to an increasing demand for more environmental friendly bank protection measures. These "technical-biological" measures consist either of living or dead plants or a combination of both, plants and technical components, to avoid erosion and sliding of the bank slope from the natural and vessel-induced flow and wave field. They can replace technical protection methods as riprap or sheet piling, if applicable with regard to the local boundary conditions on inland waterways. One example for technical-biological river bank protection measures are willow brush mattresses, which will be explained in more detail within this paper. This measure aims to protect the bank and in addition to support bank typical habitat structures for indigenous plant and animal species.

In general, numerous experiences and corresponding guidelines for such alternative measures are available for waterways without navigation. To investigate the hydraulic load-bearing capacity and the technical and ecological functionality and effectiveness of technical-biological bank protections along inland waterways the joint research project "Alternative technical-biological bank protections measures on Federal Waterways" was established in 2004. It is conducted in cooperation with the

German Federal Waterways Engineering and Research Institute (BAW) and the German Federal Institute of Hydrology (BfG). Within different scientific approaches, the research project aims to develop application recommendations and dimensioning principles for their use along German Federal Waterways.

Methods

Willow brush mattresses are a shoots and roots forming elastic willow branch layer that covers and stabilizes the bank after removal of riprap. The layer is firmly fixed on the soil by stakes, crossbars and wire bracing (for more construction details see:

[https://izw.baw.de/publikationen/alu/0/KB-Weidenspreitlagen_FEB-2018_\(V2\)_EN_a.pdf](https://izw.baw.de/publikationen/alu/0/KB-Weidenspreitlagen_FEB-2018_(V2)_EN_a.pdf)).

Besides theoretical analyses, laboratory and model tests, on-site experiments with various types of technical-biological measures were implemented along different federal waterways. Willow brush mattresses as one option of direct bank protection were implemented in two test fields (length = 100m each) within a test stretch on the right bank of the river Rhine (km 440,600 - km 441,600) in the Lampertheim district near Worms. The measures were installed from September to December 2011 under extreme natural and high-traffic waterway conditions (high ship induced impacts and flow velocities, very large water level fluctuations, steep slope inclination (1:3) (for more details, see BAW, BfG, 2016, 2019). To evaluate the technical and ecological functionality and the maintenance effort of the measure, a comprehensive monitoring program is carried out by BAW and BfG. The results are available for about five years.

Technical monitoring comprises among others regular bank inspections, photographic documentations, cross section measurements, campaigns to measure hydraulic loads and the pore water pressure in the soil. These studies aim to assess the stability of the measures themselves and the guarantee of bank stability. Within the ecological monitoring different groups of organism were investigated in the aquatic and terrestrial zone, such as vegetation, fish, aquatic invertebrates, birds, spiders, carabids and reptiles (for more details on monitoring and analysis methods, see <http://ufersicherung.baw.de/de>)

Results - Technical functionality

Overall, the tested willow brush mattresses have developed well. Fig. 1 shows the willow brush mattresses immediately after installation, after one vegetation period, and their state in 2018. After installation a critical initial state was observed. Due to repeated high water levels and the initial lack of roots and shoots limited soil erosion took place. In consequence some restructuring measures were required. After that roots and sprouts have increasingly grown out of the willow branches. Excavations revealed that a deeply branched willow root system has evolved during the six years after installation. With this dense root system the safety of the slope against sliding failure due to excess pore water pressure (caused by rapid drawdown of the water level while ship passing) and the safety

against erosion can be guaranteed. Fine roots near the surface can restrain soil and take over filter function. All in all, willow brush mattresses can ensure sufficient bank protection under the given conditions. Long-term maintenance is necessary. Different kinds of maintenance measures have already been tested. The pruning needs to be determined depending on the defined maintenance goal and has to be carried out very carefully.



Fig.1: Willow brush mattresses 2011 after installation (left picture), 2012 after one year of growth (middle picture), 2018 (right picture)

Results – Ecological functionality

Results of the monitoring show, that after a critical initial state, willow shoots and roots grew optimal with a typical mixture of tree and shrub willow species (e.g. *Salix alba*, *Salix purpurea*) Because of shade pressure through dense willow growth, there is a lack of herbaceous species, including neophytes. In general, the planted willow species showed high regeneration capacity after extreme abiotic events, such as long term flooding or periods of drought. However, intensive pruning on an experimental basis, combined with extreme environmental conditions (flooding, drought), led to irreversible damage in small parts of the measure. Moreover, after several years of development the measure can provide valuable softwood habitats for the riparian fauna. Compared to the reference bank with riprap, more site typical species of carabids and spiders, with adaption to softwood habitat structures, could be detected. With regard to nesting bird species moderate improvement of habitat structures occurred, probably because the measure is limited in size and the willow species are still of younger age. The measure is in close vicinity to a sidewalk, which leads to potential disturbance effects for breeding individuals. Because the measure is predominantly limited to the terrestrial zone, habitat improvement for fish and aquatic invertebrates is unverifiable up to now. Depending on maintenance intensities and after several years of growth, overhanging branches could provide shelter for young fish species in the future. Nevertheless, without improving structural diversity in the aquatic zone, the potential for providing suitable habitat structure will always be limited to a minimum.

Conclusion

Summarizing the technical results, willow brush mattresses in principle are well suited as a technical-biological bank protection along inland waterways. The prerequisite is that the willow branches are laid and fixed on the slope in such a way that a solid area-wide contact with the ground is ensured to guarantee a good growth of the roots in to the soil from the beginning. From the ecological point of view, willow brush mattresses show high potential for providing suitable habitat structures for bank typical plant and animal species, if they can be applied in a sustainable manner.

The monitoring is still going on. All results to date are available at <http://ufersicherung.baw.de/en>. They have already been included in a number of recommendations and practical information for planning and conducting technical-biological bank protection on inland waterways. Among others, there is a new design procedure for technical-biological bank protection measures. Furthermore specifications concerning selected bank protection measures, provide information about their mechanisms, construction, installation and resilience.

References

- BAW, BfG (2019): Technical-Biological Bank Protection on Inland Waterways: Publications, Practical Information, Measures and Events, available at <http://ufersicherung.baw.de/en>
- BAW, BfG (2019): Einrichtung einer Versuchsstrecke mit technisch-biologischen Ufersicherungen, Rhein km 440,6 bis km 441,6, rechtes Ufer – Abschlussbericht der Monitoringphase 2012 bis 2017 (in process)
- BAW, BfG (2018): Technical-Biological Bank Protections Applied on Inland Waterways. Living Brush Mattresses. Specification, available at [https://izw.baw.de/publikationen/alu/0/KB-Weidenspreitlagen_FEB-2018_\(V2\)_EN_a.pdf](https://izw.baw.de/publikationen/alu/0/KB-Weidenspreitlagen_FEB-2018_(V2)_EN_a.pdf)
- BAW, BfG (2016): Einrichtung einer Versuchsstrecke mit technisch-biologischen Ufersicherungen, Rhein km 440,6 bis km 441,6, rechtes Ufer – Fünfter Zwischenbericht: Monitoringergebnisse 2015

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