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NOVEL METHODS AND RESULTS OF LANDSCAPE RESEARCH IN EUROPE, CENTRAL ASIA AND SIBERIA

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Монография содержит информацию о самых современных методологиях и результатах в ландшафтных исследованиях. Она может быть использована в качестве руководства для исследователей, преподавателей, студентов и всех, кого интересует тема ландшафтной науки и смежных дисциплин. Монография является особо ценной информационной базой для лиц, принимающих решения на различных уровнях, от местных до международных органов по принятию решений. Приведенная в монографии информация представляет собой современный уровень ландшафтной науки в очень краткой форме.

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This monograph shall inform you about up to date methodologies and recent results in landscape research. It is intended as a guide for researchers, teachers, students, decision makers, stakeholders interested in the topic of landscape science and related disciplines. It provides information basis for decision makers at various levels, from local up to international decision bodies, representing the top level of landscape science in a very short form.

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Chapter V/30: MULTI-FUNCTIONALITY AND HOLISTIC APPROACH WHEN ECOLOGICALLY IMPROVING AN AGRICULTURAL STREAM – A CASE STUDY INTRODUCING INTEGRATED BUFFER ZONES AS A LANDSCAPING TOOL IN THE PROJECT LIFE-GOODSTREAM

Глава V/30: Многофункциональность и комплексный подход при экологическом улучшении сельскохозяйственного потока - пример исследования, представляющего интегрированные буферные зоны как ландшафтный инструмент в проекте LIFE-Goodstream

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ABSTRACT. The project LIFE-Goodstream aims at solving or reducing several environmental problems of the stream Trönningeån by using a holistic approach, where all measures are planned with multi-functionality in mind, simultaneously addressing eutrophication, fish migration, biodiversity and floods. In the presented case-study, a 1 km part of the stream, we removed the last remaining migration barrier in the stream. To improve the landscapes hydrological buffer capacity (downstream flood reduction) and to reduce eutrophication, we constructed Integrated Buffer Zones and several new wetlands adjacent to the stream, re-meandered part of the stream, improved the stream bed for salmonid fish and created biotopes (creotopes) for e.g. amphibians. All measures where done in close co-operation with landowners to keep rational agriculture practices possible and to secure future management. The case-study shows that it is possible to do large-scale landscaping for environmental purposes on private land without monetary compensation, if true participatory processes are used, and landowners are engaged from the beginning.

Резюме. Проект LIFE-Goodstream направлен на решение или сокращение нескольких экологических проблем реки Трённинген с использованием комплексного подхода, где все меры планируются с учетом многофункциональности, одновременно решая проблемы эвтрофикации, миграции рыбы, биоразнообразия и наводнений. В представленном тематическом исследовании, в 1 км части потока, мы удалили последний оставшийся миграционный барьер в нём. Для улучшения ландшафтов гидрологического буферного потенциала (сокращение потока вниз по течению) и сокращения эвтрофикации, мы построили интегрированные буферные зоны и несколько новых водно-болотных угодий, прилегающих к потоку; переброшенные части потока, улучшили русло реки для лососевых рыб и создали биотопы (креотопы), например для земноводных. Все меры были приняты в тесном сотрудничестве с землевладельцами в целях сохранения рациональных методов ведения сельского хозяйства и обеспечения будущего управления. В тематическом исследовании показано, что можно использовать масштабное озеленение для экологических целей на частных землях без денежной компенсации, при реальном участии землевладельцев с самого начала работ.

KEYWORDS: eutrophication, Water Framework Directive (WFD), fish migration, floods, landowner involvement, co-operation, landscape restoration, wetland biodiversity
Ключевые слова: эвтрофикация, водная директива, миграция рыб, наводнения, участие землевладельцев, сотрудничество, восстановление ландшафта, биоразнообразие водно-болотных угодий

INTRODUCTION

Agricultural streams often suffer from different forms of environmental stress. In Sweden, as in most industrial countries, the most common environmental problems in these systems are eutrophication [1] and migration barriers [2]. In addition, lowland streams in agricultural areas commonly suffer from low biodiversity, stream bed alterations and a lack of active flood plains. A result of stream alterations together with the environmental pressure from intensive agricultural practice (e.g. pipe drainage) is also a reduced hydrological buffer capacity of the landscape with subsequent floods in downstream areas, both of farmlands and of rural areas and infrastructure. Constructed wetlands have been used for >20 years in Sweden as a cost-efficient method to reduce the transport of nutrients to freshwater bodies and the sea, as well as a method to enhance the biodiversity of rural landscapes [3]. A major driving force was the Swedish Environmental Quality Objectives which were implemented in 1999 and where a numeric goal regarding wetland construction was stated as at least 12,000 hectares by 2010 [4, 5]. Recent evaluations have shown good results for nutrient reduction and increased biodiversity and furthermore showed that local or regional project seems to be most cost-efficient [6], where focus is on e.g. a small administrative unit (municipalities) or a defined stream catchment area. Most wetland projects in agricultural areas in Sweden have nutrient reduction as the main goal [6]. In recent years new environmental measures to combat eutrophication have been presented, such as Integrated Buffer Zones (IBZ) [7] and Level-Adjusted Constructed Wetlands [8]. The multi-functionality of constructed wetlands regarding ecosystem services have been acknowledged but seldom fully addressed in practice. Apart from the commonly sought ecosystem services of nutrient retention and biodiversity enhancement, also hydrological buffering (peak flow reductions and flood prevention) and farmland irrigation possibilities as well as public recreation and education have a potentially very high value for the society, and should be considered and optimized when planning measures and choosing landscaping elements.

AIM OF THE METHOD

The project LIFE-Goodstream aims at reducing several of the environmental problems observed in the stream Trönningeån simultaneously, with a holistic approach where the measures are multi-functional. An important part of the project is also to raise awareness among the landowners and the public communities along the stream, regarding the environmental issues.

PRINCIPLE AND PROCEDURE

Principle: We work from the principle of participatory processes where landowners are early engaged in the project and together with us choose the measures to be done. All measures in the presented case-study are done on private land and a positive response from the landowners is an absolute requisite. Not only for us to get permission to do the measures, but also to ensure future engagement in the management of the measures. Therefore, all measures and their design are planned together with landowners to ensure rational management, using standard farm equipment and we provide detailed management plans to the landowners. Furthermore, we also worked from a holistic approach with the principle that the measures should be multi-functional and address several environmental problems simultaneously. Although the measures are site-specific and designed according to local topography and hydrology, they are planned and constructed to maximize the environmental benefits not only for the immediate surroundings but also for the stream as a whole ecosystem. That includes e.g. downstream effects on flow and flood risks, migration of fish and other aquatic organisms and regional populations of terrestrial and semi-aquatic species.

Procedure: To ensure participatory processes we did not develop any plans of measures prior to landowner contact. Instead we started by informing and engaging the landowners on the project. We discussed the environmental problems and possible solutions from a wide array of different measures. In this way, we got very useful additional information on the stream ecosystem from the landowners and also several new ideas on areas to focus on. The discussions were done by telephone, mail, letters and individual “kitchen table discussions” as well as larger group meetings both in the field and indoors. The individual landowner interest (e.g. fishing, irrigation or a general environmental interest) was the start for further, specific, discussions on what to do on their land individually. From these discussions, we produced a suggested plan of different measures to be approved by the landowner. Thereafter contracts were done with construction companies and the different measures were done.

LANDSCAPING RESULTS – THE STJÄRNARP VALLEY CASE-STUDY

In the middle of the stream catchment area, a small (ca 1,2 km long and 200 m wide) flood plain or river valley had in 1992 been dammed to construct a wetland of ca 3 hectares, which constituted the last remaining migration barrier in the stream. The land was owned by two different landowners, one on each side of the wetland, and they were both positive to the project and had several ideas of environmental improvements. After broad discussions, also with the authorities, detailed plans were developed and the construction work could start in June 2016. The 2-m high embankment, damming the wetland, was removed, ensuring free fish migration. After the water was drained we constructed 5 wetlands and 5 Integrated Buffer Zones (IBZ) adjacent to the stream. We also constructed 8 amphibian ponds and 3 overwintering habitats for amphibians. In addition streambed improvements were done.

Figure 1 – The landscape of the Stjärnarp stream valley prior to the removal of the wetland (migration barrier), September 2016.

IBZ can be efficient tools in areas where large constructed wetlands might not be feasible due to technical or economic reasons. An IBZ typically consist of a minimum 5-m wide aquatic wetland part where drainage pipes are disconnected from the stream, and an infiltration bank surrounded by an embankment. The length is normally 60-100 m and goes parallel to the stream as traditional buffer zones do. The IBZs are constructed so that no water enters the stream directly from the field, neither through drainage pipes nor by surface run-off. All water passes through the infiltration bank. Nutrients are retained by normal wetland processes (denitrification, sedimentation and plant uptake) in the aquatic part of the IBZ and through filtration in the infiltration bank. To further increase infiltration, trees (usually alder) are planted on the infiltration bank to increase soil permeability. The trees can after 15-20 years be harvested and used by the landowner.

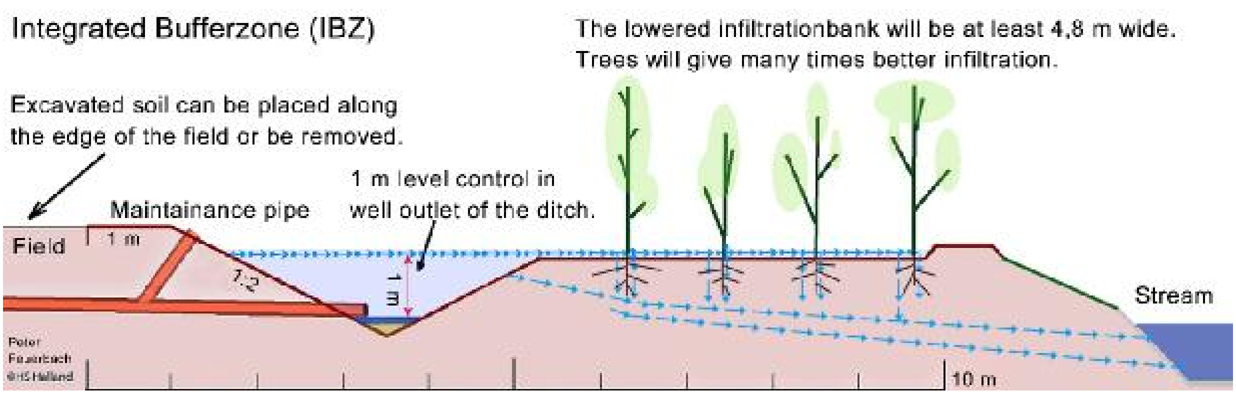

Figure 2 – A cross section of a typical Integrated Buffer Zone.

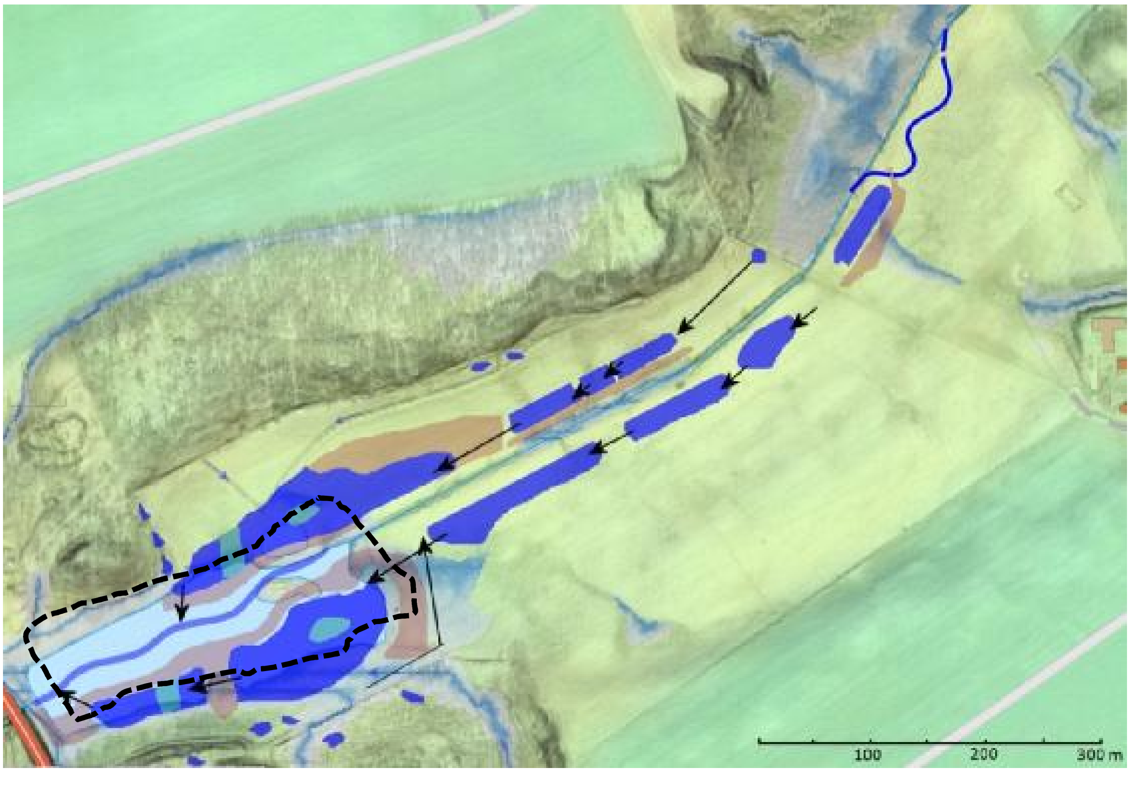

Figure 3 – Upper picture: An aerial view of the landscape of the Stjärnarp valley after the removal of the wetland (migration barrier) and the construction of the new measures (wetlands and IBZs). Note that the wetlands and IBZs are not yet completely filled with water. August 2017. Lower picture: A map showing the extension of the former wetland/migration barrier (dashed line), the new riverbed, wetlands, IBZs and amphibian ponds (dark blue areas) and the way water from adjacent farmland is transported in the constructed measures before it enters the stream (black arrows).

The measures at the case-study were constructed and located so that all water from the surrounding areas is collected into the different wetlands/IBZs and transported parallel to the stream from wetland (or IBZ) to wetland (or IBZ) and enters the stream at the end of the valley further downstream. Thus, we ensure maximum retention of nutrients. Simultaneously we have improved the hydrological buffering capacity of the landscape. The old wetland had a fixed outlet and rarely functioned as a buffer reservoir. The new measures have adjustable outlet levels with varying water levels to be used to increase the hydrological buffer capacity of the area, thus decreasing the risk of downstream floods.

The former stream bed that emerged when the old wetland was drained was modified with gravel to increase the area of spawning habitats for trout, salmon and other species. In May 2017, we observed spawning of several brook lampreys (*Lampetra planeri*) in the new stream bed. In the new wetlands, there were large number of tadpoles (*Rana sp*.) and also great crested newt (*Triturus cristatus*) and common newt (*Lissotriton vulgaris*). Among insects, particularly dragonflies thrived in the new waterbodies where e.g. four-spotted chaser (*Libellula quadrimaculata*) and broad-bodied chaser (*Libellula depressa*) were common the first year after construction. Data from surveys on birds, amphibians and invertebrates are not yet analyzed but already we can state that the biodiversity of the area has increased significantly.

We have a comprehensive monitoring system going, regarding nutrient concentrations and water flow as well as surveys of different organism groups, which will be evaluated in the coming years.

CONCLUSIONS

1. It is possible to implement large-scale landscaping measures for environmental purposes on private land (without payment), if true participatory processes are used, and landowners are engaged from the beginning and are given high level of influence.
2. A holistic approach where several ecosystem services are considered simultaneously seems to be a possible way of solving, or at least decreasing environmental problems. Wetlands are particularly useful as multi-functional tools and deliver numerous ecosystem services.
3. Integrated Buffer Zones is a new useful tool in areas where large wetlands are not possible to construct, and also deliver several ecosystem services.

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REFERENCES

[1]Dupas, R., Delmas, M.,Dorioz, J-M., Garnier, J., Moatar, F., Gascuel-Odoux , C. 2015. Assessing the impact of agricultural pressures on N and P loads and eutrophication risk. Ecological Indicators, 48, 396-407.

[2]Gardner, C., Coghlan Jr, S. M., Zydlewski, J., Saunders, R. 2011. Distribution and abundance of stream fishes in relation to barriers: implications for monitoring stream recovery after barrier removal. River Research and Applications, 29, 65–78.

[3]Government Bill 1990/91:90, 1990. A living environment. En god livsmiljö (in Swedish).

[**4**]Government Bill 1997/98:145, 1997. Swedish Environmental Quality Objectives – An Environmental policy for a sustainable Sweden.

[**5**]Government Bill 2000/01:130, 2000. The Swedish Environmental Objectives – Interim Targets and Action Strategies.

[6]Strand, J. A. & Weisner, S.E.B. 2013. Effects of wetland construction on nitrogen transport and species richness in the agricultural landscape - experiences from Sweden. Ecological Engineering, 56, 14-25.

[7]Strand, J.A., Feuerbach, P., Kronvang, B., Hoffmann, C-C., Jensen, H. 2014. Integrated buffer zones - a new tool for nutrient retention of agricultural drainage and surface water. 2014. In: Gastescu, P., Marzelewski, W., Bretcan, P. (Eds). 2014. Book of abstracts, 2nd International Conference; Water resources and wetlands, September 11–13, 2014, Tulcea, (Romania).

[8]Strand, J.A., Weisner, S.E.B., Feuerbach, P. 2015. Level-adjusted constructed wetlands (LACWs) – a new concept of viewing nutrient leakage. In: The Ministry of the Environment of the Czech Republic (Eds). 2015. Book of abstracts, Wetlands in Agricultural Landscapes: Present state and perspectives in Europe, International conference, České Budějovice, Czech Republic 11 – 16 October 2015.