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Ecosystem restoration and sustainable management of rivers and wetlands – Introduction to the special issue

Ökosystemrenaturierung und nachhaltiges Management von Flüssen und Feuchtgebieten – Einführung in den Sonderband

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The restoration of ecosystems has become a major challenge throughout the world in the 21st century (see comprehensive surveys from, e. g. Temperton et al. 2004, van Andel & Aronson 2006, Walker et al. 2007, and Zerbe & Wiegleb 2009). Due to non-sustainable land use and inefficient use of natural resources, many ecosystems have been degraded or completely destroyed. Consequently, the functioning of ecosystems has been severely affected and many ecosystem services have been lost.

The Society for Ecological Restoration (SER 2004) defines ecosystem restoration as the "*process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed*". Aronson et al. (2006) add the necessity of the restoration of ecosystem functions and Zerbe et al. (2009) give priority to the restoration of ecosystem services. Restoration, on the one hand, might be achieved through natural processes. In many cases, however, the restoration process must be initiated and supported by technical measures and continuous management. Restoration ecology has become an important scientific discipline in recent decades, which elaborates the basic and the theoretical background for practical ecosystem restoration. Today, restoration ecology as well as ecosystem restoration have to be considered as prerequisites to tackling environmental problems on a global scale, such as climate change, the loss of biodiversity, desertification and soil salinization, and biological invasions.

Since wetlands and rivers, in combination with their floodplains, provide many ecosystem services, e. g. the purification of water, combating desertification, the accumulation of carbon, and providing habitats for plants and animals, a particular focus is laid on their restoration (e. g. Lüderitz & Jüpner 2009). Although much experience and knowledge has been gathered on restoration ecology and practical ecosystem restoration in recent years, there are still many open questions and problems to be solved in order to successfully achieve restoration objectives for rivers and wetlands.

We want to address some of these questions with regard to basic and applied ecology and sustainable management within this special issue. It is comprised of papers which were presented at an international workshop at the University of Applied Sciences in Magdeburg in June 2009. The studies range from Central Europe to South America and East Asia, from streams to wetlands, from natural processes to intensive management, and from ecosystem assessment to practical implication.

For example, Mann & Tischew focus on species-rich, wet grasslands located in floodplains that are within the focus of the European nature conservation policy. In order to develop and implement new cost-efficient strategies for restoration and long-term management of wetlands on former arable land, local NGOs and the Anhalt University of Applied Sciences in Bernburg started a cooperation within a project on a heavily degraded floodplain in the Elbe river valley (Germany). Different grazing regimes by large herbivores, such as Heck cattle and Przewalski horses, were compared by applying various re-vegetation variants.

Wiegleb & Krawczynski investigate the introduction of water buffalos to very wet sites on which cattle or other domestic animals cannot graze. They report on the first results of a ten-year project in East Germany ('Bubalus' project) carried out by the Brandenburg University of Technology of Cottbus. Their study indicates the beneficial impact of moderate grazing on avifauna, amphibians, vegetation, and insects for those wetlands under consideration.

Langheinrich et al. present examples for the implementation of measures and first results of re-wetting assessment in the Drömling Natural Park, the largest fen area in Central Germany. The habitat quality of canals and ditches was enhanced and new shallow ponds were created. They conclude that all applied restoration measures help to maintain and enhance aquatic and amphibian biodiversity and the conservation value. However, the maintenance of a diverse landscape and water body structure demands comprehensive management efforts. Additionally, invasive animal species are a rising problem for the original ecosystems.

In the biosphere reserve Pfälzerwald (Palatinate Forest), Germany the maintenance of approximately 1,000 artificial ponds is endangered due to increasing abandonment. However, a large number of these ponds are of considerable significance for nature conservation and as historical heritage. Frey et al. present assessment methods which are based on easily available data for the evaluation of the ecological and cultural-historical importance of the waters. Recommendations for further development of these ponds are derived from the assessment and summarized in a priority list of ponds where actions are preferential.

Brauckmann et al. carry out an interdisciplinary research project on the integration of nature conservation objectives into organic farming, using a region in the federal state of Hessia, Germany as an example. Since 1998, conventional agricultural land use has been replaced by organic farming in this area. Restoration measures were implemented in running water courses through loess soils and then monitored. The

monitoring program comprised morphological, hydro-chemical, and biological aspects.

The study from Tröstler et al. represents a comprehensive biological and hydro-chemical assessment of small coastal ponds. Special attention is paid to brackish water biotopes. As the main problems regarding these ponds biological invasions and the decline of threatened species are identified.

Using an example from the Canary Islands, Spain, Lüderitz et al. address the problem that a considerable number of streams have decreased dramatically due to non-sustainable consumption of water for agriculture and tourism in the past decades. However, natural reaches of streams with an endemic, macro-invertebrate fauna still exist in protected areas of Tenerife and La Gomera. Those reaches serve as reference status for the development of a specific assessment method for island streams, with particular emphasis on water quality and hydro-morphology.

Ettmer & Alvarado-Ancieta investigate the Ucayali River, whose headwaters are located in high altitudes of the Andean Mountains, and which is one of the water sources of the Amazon River. A broad database on hydrology, sediment transport, and topography of the river bed could be analysed due to a study on the navigability of the Ucayali River, conducted by the Ministry of Transport and Communication in Peru. Since there has been no stream channel modification of the Ucayali River in the past, this database gives insight into the flow pattern of a natural stream in South America. The paper presents the first results, e.g. on sediment transport of the Ucayali River.

Zerbe et al. investigate the Tarim River in Xinjiang, NW China, a river system with its floodplains in continental-arid Central Asia, focusing on vegetation, ecosystem dynamics, and ecosystem restoration. The floodplains of Central Asian rivers harbour riparian, so-called 'Tugai' forests, reeds with *Phragmites australis*, and shrub communities which form a mosaic depending on the variety of available ground water. In recent decades, these natural ecosystems have been strongly altered anthropogenically or completely destroyed. In order to restore these ecosystems, knowledge of vegetation, ecosystem dynamics, and natural regeneration processes is essential. Zerbe et al. present results on soil, vegetation, forest stand age, tree vitality, river course dynamics, and land use on the landscape level. From these investigations, recommendations are derived for the maintenance of these highly valuable floodplain ecosystems, in particular with regard to their biological diversity.

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