

Special issue on

**Ecohydrology – needs and opportunities throughout the world:
the UNESCO-IHP Demonstration Projects in Ecohydrology**

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Ecohydrology – why Demonstration Projects throughout the world?

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Abstract

The implementation of Ecohydrology (EH) – a transdisciplinary problem-solving science - has to be based upon the development of system solutions for river basins which have to harmonise hydrological processes with ecosystems dynamics and societies' needs. The network of the UNESCO International Hydrological Programme EH Demonstration Projects was organised for scientific advancement, knowledge transfer, calibration of methods, education and capacity building. From the methodological point of view, the goal has been to accelerate transition from the stage of information collection and knowledge development into wisdom generation, which in practical dimension means a shift from understanding of relationships and patterns to understanding of processes and finally, formulation of principles for action. The selected Demonstration Projects from different continents cover the broad scope of water, ecosystem and society problems in such ecological systems as basin landscapes, wetlands/grasslands and floodplains, cities, lakes & reservoirs and estuaries & costal zones. This unique set of projects of large scale, long term testing and development by adaptive assessment and management, has become not only a fundamental lesson for cost-efficient implementation of the ecohydrology principles for IWRM, but also a starting point for "engineering harmony" between society and environment.

Key words: Ecohydrology, Demonstration Projects, UNESCO IHP, water management, social aspects

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Ecohydrological system solutions to enhance ecosystem services: the Pilica River Demonstration Project

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Abstract

The application of ecohydrology principles as part of Integrated Water Resources Management (IWRM) has the potential to enhance the resilience of a catchment to anthropogenic impacts. Linking this approach with an understanding of water users and social and economic conditions in a given region, provides a foundation for the development of system solutions. Improving the quality of the environment, and the ecosystem services provided, can be a driver of new employment opportunities that contribute to both the overall economy of a region and sustainability. With these goals in mind, the paper presents a four-step approach for implementation of ecohydrology principles in IWRM, including a) monitoring of threats, b) analysis of the cause-effect relationships, c) development of methods, and d) system solutions. This approach was formulated and tested within a UNESCO-IHP and UNEP-IETC Demonstration Project on the Pilica River in Poland. This project aims to support fulfilment of Poland's obligations Resulting from the EU Water Framework Directive and other European directives, and constitutional obligations for sustainable development. Attempts to transfer lessons learned to other catchments and socio-ecological systems (such as urban catchments) are highlighted.

Key words: Ecohydrology; Integrated Water Resources Management; system solution; reservoir; catchment; eutrophication

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The Amazon floodplain Demonstration Site: Sustainable timber production and management of Central Amazonian white-water floodplains

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Abstract

Within the frame of the UNESCO Ecohydrology Program, the present Demonstration Project aims at the enrichment of degraded várzea forest patches with economically important timber species in the Mamirauá Sustainable Development Reserve (MSDR), western Brazilian Amazon. Enrichment plantations will reduce exploitation pressure in the natural environment and will contribute to the conservation of várzea forests and its ecological integrity by introducing alternative sources of income for the inhabitants. We present preliminary results from an interdisciplinary research, including data about the use and the net present values of timber trees in western Brazilian várzea; growth models and management criteria of the most exploited timber species; and germination experiments, which demonstrate that várzea timber species are easy to germinate, without requiring complicate treatments and expensive materials. These data allow for the initialization of timber species reproduction at larger scales, and provide the scientific basis to enrich degraded várzea forests with economically important timber species.

Key words: Amazon, enrichment plantations, germination, sustainable forest management, várzea, wood increment

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Application and demonstration of the Ecohydrology approach for the sustainable functioning of the Guadiana estuary (South Portugal)

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Abstract

The implementation of the UNESCO demosite at the Guadiana estuary represents an excellent opportunity to demonstrate how to adapt, mitigate and restore functioning of estuaries and coastal areas impacted by dams and climatic changes, using the Ecohydrology approach. Worldwide estuaries are suffering similar anthropogenic impacts that affect ecosystem functioning, biodiversity and resources. Therefore, the mesocosms experiments at the Guadiana Ecohydrology demosite constitute a collection of case studies, whose results can be used for testing solutions for the sustainable management of other estuarine systems. We applied the Ecohydrology concepts and methods to test: a) the usefulness of freshwater inflow pulses to regulate biodiversity and to control microalgal blooms, by regulating nutrient ratios and thus enhancing the bottom-up control of water quality; b) the usefulness of using the feeding ability of bivalve assemblages to control microalgal blooms (top-down control of water quality, and; c) the role of salt marsh plants (*Salicornia ramosissima*) to reduce excessive concentrations of nutrients and control estuarine water quality. Results show that the interplay between organisms (bivalves, plants) and hydrological factors is a key for improving water quality and sustaining biodiversity and the good ecological status of this estuarine ecosystem.

Key words: Transitional waters, Water Frame Directive *Salicornia ramosissima*, *Corbicula fluminea*, saltmarshes, plankton

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Adapting floodplain connectivity conditions – a prerequisite for sustaining aquatic macrophyte diversity in the UNESCO Biosphere Reserve Lobau (Austria)

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Abstract

The UNESCO Biosphere Reserve Lobau (Austria), established in 1977 within the city limits of Vienna, is part of the Danube National Park and one of the ecologically richest parts of the Danube River Corridor. Hardly noticed by diverging stakeholder interests the smaller aquatic habitats in the floodplain area are acutely threatened by wetland ageing and terrestrialisation processes. In 2007 an aquatic plant survey was carried out in the water bodies of the active floodplain on the left bank of the Danube main river channel as well as in the semi-separated water bodies of the Lobau. Results clearly show the impact of through-flow on aquatic plant species composition and abundance, as these metrics are significantly higher in the semi-separated location. Suitable water regime for all sensitive aquatic plants is an essential prerequisite for sustaining aquatic macrophyte diversity in the Lobau Biosphere Reserve, and could provide an ecohydrological basis for rehabilitation activities in other regulated river floodplains located in cultivated landscapes.

Key words: floodplain ecology, aquatic vegetation, biodiversity, ecohydrology, connectivity, river restoration

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Ecohydrological principles to underpin the restoration of *Cyperus papyrus* at Lake Naivasha, Kenya

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Abstract

Degradation of *C. papyrus* (papyrus) at Lake Naivasha is the result of a combination of lowered lake levels and destruction by large grazing mammals, buffalo and cattle, followed by several smaller species, in addition to more limited direct human clearance. Restoration of papyrus is considered to be of great importance for the future sustainability of the lake ecosystem. Two different interventions for papyrus (wetland) restoration have been proposed: one located around the delta of the Malewa river, based on ecohydrological principles, the other on land adjacent to the Gilgil river, adopting more of an ecological engineering approach. Both interventions are ecologically feasible. However, the principal limitations of both projects relate to anthropogenic factors and, in this respect, restoration of the Gilgil river is regarded as the more feasible of the two proposals at the present time. Future action should facilitate the involvement of local communities in any restoration projects at Lake Naivasha, with particular emphasis placed on the development of economic goods derivable from papyrus swamps.

Key words: Wetland degradation; Riparian zone; Drawdown; North Swamp; Ecological restoration.

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Effects of water quantity on connectivity: the case of the upper Paraná River floodplain

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Abstract

The hydrological regime is the main force driving processes in river-floodplain systems. The flood pulse concept serves as a base from which to study the processes acting in such a system. However, when the flood pulse is regulated and there is a need to re-establish the hydrography at close to natural conditions, the best way to achieve this is via ecohydrology, a newly emerging paradigm. In this paper, we use principles of ecohydrology to evaluate the effect of water quantity on the limnology, biota and fishery of the upper Paraná River systems, where a UNESCO demonstration site on ecohydrology is located. In addition, we argue that dam operation can be crucial for restoring the hydrography of the Paraná River to near natural conditions. The data used were collected between 1986 and 2006 in several habitats of the floodplain. The limnology, biota (periphyton, phytoplankton, zooplankton, benthic invertebrates, fish, macrophytes and riparian vegetation) and fishery (ecosystems services) were all influenced by the alteration in the hydrography prompted by the functioning of the dams located upstream from the demonstration site area. Moreover, the observed deterioration of the water quality due to the presence of toxic cyanobacteria is another strong argument for adjusting the dam's operation to re-establish the timing of the floods to match critical periods of the biota in order to restore ecosystem biodiversity and services.

Key words: hydrological regime, dam regulation, floodplain, biodiversity, fishery

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Ecohydrology as a tool for the survival of the threatened Serengeti ecosystem

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Abstract

The results of 10 years of monitoring water quality and quantity during the period 1996-2006 in the three rivers (Mbalageti, Grumeti and Mara) draining the Serengeti ecosystem are presented, together with river gauging data starting in 1948, rainfall data starting in 1960, and animal population data starting in 1960. Water quality remained unchanged in the Mbalageti and Grumeti rivers; these rivers are seasonal and they dry out during a drought. The Mara River is perennial and is vital to maintain the ecosystem during a drought. Its quality has changed, with increased contribution from groundwater, with higher pH and visibility and decreasing salinity. The flow rate during a drought has decreased by 68% since 1972. This is attributed to deforestation of its upper catchment in the Mau forest in Kenya and to extraction of water for irrigation in Kenya upstream of the ecosystem. Hydrological modeling suggests that the Mara River would now dry out for two months and one month respectively if the 1949-1952 and the 1972-1973 severe droughts occurred again. Ecohydrologic modeling suggests that this would in turn lead to the collapse of the herbivore population from the lack of drinking water. This model also suggests that providing drinking water to the animals at artificial water holes spread throughout the ecosystem would lead to decadal time-scale booms and busts of the herbivore population. The Serengeti ecosystem stability is maintained by the annual migration that partitions the ecosystem in seasonally used compartments. It is thus necessary to restore the natural hydrology of the Mara River in Kenya, and this requires remediation measures in Kenya. If that does not occur, disaster prevention measures are needed by providing water in weirs, dams, and artificial wetlands along the Mara River in the Serengeti National Park, as well as extending by 5 km the western edge of the park so as to reach Lake Victoria to provide access to permanent water.

Key words: drought, migration, stability, Mara River, Kenya, Tanzania.

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**Lacar Lake Demonstration Project for Ecohydrology:
Improving land use policy at Lacar Lake Watershed
based on an Ecohydrological approach
(San Martín de los Andes – Neuquén – R. Argentina)**

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Abstract

The major point for Lacar Demosite (LDS) is the sustainable management of a representative basin of Andean Patagonian region where the main problem is the impact of land transformation on water quality and environmental services. The aim of the LDS is the reduction of soil erosion, the mitigation of floods in urban areas and the improvement of ecosystem services, based on Ecohydrological ideas and principles, and using phytotechnologies. Advances are presented for LDS showing that regulation of surface hydrology (water runoff; nutrients and sediments loads) at the watershed scale, through land use, vegetation cover and phytotechnologies, improve the aquatic ecological processes and the ecosystems services (water quality, landscape aesthetic values).

Key words: Patagonia, Environmental Management, Landscape Ecology, Phytotechnology, Ecosystem Services

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