

**Ecohydrology as a system approach for sustainable water biodiversity and ecosystem services.**

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**Abstract**

Ecohydrology is an integrative systemic approach for reversing of the river basin degradation by regulation of hydrological and ecological processes. The use of understanding of interplay between hydrology and biota, especially to minimize floods and various types of pollution has to be harmonized with hydrotechnical infrastructure. The control of nutrients and pollutants in freshwater ecosystem by EH measures provides also an opportunity to maximize water availability and ecosystem services for society such as bioenergy, fisheries, recreation. The case studies presented during Symposium indicate that the development and implementation of Ecohydrology as a new tool in Integrated River Basin. Management has been dependent to great extent on society involvement. On the other hand as the major factor rising environmental consciousness of society, the increasing availability of ecosystem services has been identified. Consequently the key condition of basin scale implementation of EH should be the rule "Ecosystem services first".

Above conclusion imply the urgent need for improvement of predictive potential the processes and its socio-economic effects in the basin scale. This can be achieved by progress and development of ongoing projects at demo sties and the identification of the new aspects of Ecohydrology by special interdisciplinary task forces organized within the framework of cooperation with international organizations: MAB; HELP-FRIEND; SIL; EIFAC FAO; GEMS WATER; UNEP-ITC; Water for Life.

**Key words:** ecohydrology, ecosystem services, river basin

**Modelling the application of ecohydrological pollution control.**

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**Abstract**

A structurally dynamic model has been applied to test if: (1) increased through-flow of a lake without changing nutrient load and (2) increased through-flow in the spring months with a corresponding decrease of the through-flow in the late fall and winter without changing the daily load, would be able to reduce the eutrophication of a lake. It was found that an effect could be achieved, although it was less efficiency at lower nutrient levels.

**Key words:** Ecohydrological Measures, Adaptations and Shifts, Exergy, Eutrophication, Structurally Dynamic Model (SDM)

**Impacts of climate change on reference sites used for ecohydrological restoration and research**

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**Abstract**

The ecohydrology concept provides new perspectives on the control and regulation of water cycling and nutrients by integrating hydrological and biotic processes at the catchment scale. It is now recognised that anthropogenic climate change has the potential to affect many of these processes: directly (through temperature and moisture forcing); indirectly (through new hydrological, water quality, and biological interactions); and in concert with other factors (such as land use change, or diffuse pollution). Potential changes to ecosystem functioning, structure and distribution have implications for ecohydrological research and restoration by modifying the definition and objectives of "good ecological quality" at reference sites. Long-term records of past hydroclimatic variability highlight the dangers of characterising site status on the basis of short-term observations. Change factor and downscaling methods provide means of exploring future climate change impacts at sites where the dominant ecohydrological processes are well understood.

**Key words:** ecohydrology; hydroclimatic variability; downscaling; impact assessment.

**Forest ecosystem structures, forest management, and water retention**

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**Abstract**

This paper deals with linking forest ecosystems theory to practical measures in forestry, which aim at supporting optimisation of the water cycle through forests.

In ecosystem theories of natural forest systems, succession plays a key role. The Mosaic-Cycle theory postulates that in natural forests the stages of temporal cycles (exploration, maturation, senescence and decay) coexist side by side in space, giving rise to a mosaic of different successional stages in a natural forested landscape. Under such forest dynamics, a continuous forest cover with a highly structured canopy layer would be maintained, and evapotranspiration and water retention in forested landscapes would be supported in an optimal way. These principles of ecosystem dynamics and structural development should hence be imitated by management strategies in forestry, in order to make the best possible use of the forest area for a precautionary water flux management. We specify the most important points to consider in practical forest management with respect to water retention and flood control.

**Key words:** forest ecosystem, mosaic-cycle theory, forest management, soil water storage and retention, flood prevention

## **Threats for biodiversity in the floodplain of the Upper Paraná River: effects of hydrological regulation by dams**

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### **Abstract**

The Paraná River is the main tributary of the La Plata River and runs through 4,695 km. Its third upper part, the Upper Paraná River, is almost completely inside the Brazilian territory. In this area, there are more than 130 major reservoirs that inundated most of the river-floodplain system. The stretch left, about 230 km, is the area where a Long Term Ecological Research (LTER; Site 6) is developed. The floodplain presents itself as a mosaic of habitats (river channels, secondary channels and lagoons) with peculiar characteristics, depending on local and/or regional processes. Surveys conducted in the area since 1986 registered about 2,920 species (745 of terrestrial plants; 60 of macrophytes; 543 of phytoplankton; 385 of zooplankton; 188 of benthos; 176 of fish and 417 of other vertebrates). Besides the intense regulation by dams, the flood pulse is still the main function force working on the floodplain. Then, the flood pulse plays important role determining the dynamic of abiotic factors and organisms that live or use the plain for at least one stage of the life cycle. Main disturbances in the area are natural, such as climatic (effects of "El Niño") and anthropogenic, such as damming (the most conspicuous), cattle raising and removal of riparian vegetation. It is concluded that the maintenance of the biodiversity of the area will depend on the integrity of the land-inland water ecotone, represented by the floodplain, especially for large migratory fish species. Then, it is suggested the creation of a permanent floodplain reserve, according to biosphere reserve from MAB/UNESCO.

**Key words:** Neotropical, Reservoir, Connectivity, Flood Regime

**The use of parametrical models for carrying capacity assessment in a natural reserve in Tierra del Fuego (Fireland)**

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**Abstract**

In order to carry out a Strategic Environmental Assessment for a land use proposal in Major Land Valley – Fireland (Valle Tierra Mayor – Tierra del Fuego) a spatially distributed model was developed to assess carrying capacity. With the model we try to assess the ecological fragility of the land. The model was applied with the help of a Geographical Information System (GIS). To build the parametrical model five sets of significant indicators including land erodability, landscape quality, air renovability, biodiversity and potential water pollution were used. Each indicator is a result of a combination of different variables.

Overlapping the indicators, using GIS capabilities, we were able to assess carrying capacity as a result of the ecological fragility. The model offers spatial distribution of critical areas under different scenarios of impacts and different impact mitigation measures considering that all the area is a natural reserve.

**Key words:** Strategic Environmental Assessment, Environmental Indicators, Ecological Fragility, Geographic Information System, Parametrical Model, Carrying Capacity.

**Lake Naivasha, Kenya: Ecohydrology to guide the management of a tropical protected area.**

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**Abstract**

The present ecological and hydrological state of Lake Naivasha, a tropical freshwater Ramsar site, is reviewed from existing research. The ecology of the lake was formerly regulated by ecohydrological control exerted on the inflowing hydrochemistry by the continuous fringing papyrus, with a full swamp on the inflow rivers' delta. The ecology of the lake since that time has been severely disrupted by alien (or exotic) species invasions, particularly the Louisiana crayfish *Procambarus clarkii*. Lake-wide papyrus degradation has also been occurring since about 1980, following a lake level decline of up to 3m through agri-industrial abstraction. The river Malewa, which previously ran through a swamp, now runs directly into the lake, bringing high silt and nutrient loads in wet seasons, making the lake eutrophic.

It is suggested that sustainable management of the lake should focus upon three ecohydrological objectives – control of abstractions to achieve hydrological balance, physical restoration of the former North Swamp and the control of illegal fishing. The latter would enable the commercial fishery returns to maximum sustainable yield so that large *M. salmoides* (large mouthed bass) individuals once again impose a 'top-down' control upon *P. clarkii*, and the crayfish itself be commercially exploited.

**Key Words:** *Procambarus clarkii*, *Cyperus papyrus*, Ramsar site, wise use, water resources, integrated water management

## **Ecohydrological system analysis of the Lower Biebrza Basin**

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### **Abstract**

The Biebrza National Park, situated in north-east Poland, is a unique environment of wetland with very well developed zones of peat ecosystems. At present the wetlands are threatened by numerous factors associated with human activity (drainage, ceasing of mowing) as well as natural succession. Understanding the hydrology gives a proper basis for nature management in the area. The physically-based groundwater and surface water model SIMGRO was used to gain insight in the regional groundwater flow. Using these results, flow lines were calculated, giving information on the sources of water flows to the different ecosystem types in the river basin. Major sources of water are from the glacial plateau, the river water system as water flowing to the Biebrza river and a local system in the flood plains of the Biebrza valley. All this information is important for preserving suitable hydrological conditions for the various wetland types.

**Key words:** groundwater, surface water, modelling, flow lines, Biebrza National Park, wetland management

**Impact of groundwater on surface water quality: role of the riparian area in nitrate transformation in a slowly responding chalk catchment (Noor, The Netherlands)**

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**Abstract**

Nitrate concentration in springs that drain groundwater from a chalk headwater catchment of the River Meuse are high (70-90 mg NO<sub>3</sub><sup>-</sup> dm<sup>-3</sup>) and increasing next decades. The denitrification process in groundwater of the riparian area (23 mg NO<sub>3</sub><sup>-</sup> dm<sup>-3</sup>) is important. Consequently, NO<sub>3</sub><sup>-</sup> concentration of the main stream is lower (mean NO<sub>3</sub><sup>-</sup> concentrations 40-60 mg dm<sup>-3</sup>) due to mixing, which is beneficial for surface water resources. Surface water may take advantage of biomass removal and increased denitrification induced by filling in of man-made spring brooks. It is unclear of NO<sub>3</sub><sup>-</sup> trapping and transformation goes on the account of the partly degraded vegetation in the riparian area.

**Key words:** hydrological cycle, experimental catchment, nitrate fate, monitoring, wetland, vegetation

## **Application of the Ecohydrology Theory in Ukraine**

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### **Abstract**

The scientific discipline of ecological hydrology has been developing in Ukraine for about 30 years. Ecohydrological research is directed to many types of continental water - lakes, reservoirs, limans, ponds, power-station cooling ponds, etc.

Methods of ecohydrology of reservoirs are regarded as of primary importance and thus have become the subject of many publications of authors. Conformities of influence of hydrological processes on formation and functioning of reservoirs' ecosystems are revealed and applied to the estimation and quantitative prediction of water-resource quality. Numerous examples of the application of ecohydrology theory to the solution of ecological problems of reservoirs are available. Attention is drawn to positive experiences of creating and realising methods of ecosystem management through the regulation of the hydrological regime.

**Key words:** ecohydrology, hydrological factor, ecosystem, water quality, management.

**Considering macrophyte species as crucial components of the aquatic ecosystem: a case study of the shallow and freshwater lakes of tropical Eastern Africa.**

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**Abstract**

Aquatic macrophytes have tremendous significance in the understanding of the lake ecosystem dynamics although they are often considered as minor components in the management of these ecosystems. Because they are essential to biodiversity and human relevance, their study must be enhanced and even rehabilitated. The role of macrophytes is illustrated, taking as an example a few lakes of Kenya and Tanzania. Several ecological approaches will be considered, such as their importance in ecohydrology, their function in the ecosystem, their biological significance from a spatio-temporal variability. Their interests, risks and management will be discussed on a scientific and socio-economical basis through examples of recent applied research (1995-2002).

**Key words:** biodiversity, Lake Baringo, Lake Naivasha, paleo-ecology, seed banks, spatio-temporal dynamics.

**Environment and economy - dual benefit of ecohydrology and phytotechnology in water resources management: Pilica River Demonstration Project under the auspices of UNESCO and UNEP.**

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**Abstract**

Ecohydrology provides a new context for sustainable water resources management. After formulation of the theoretical scientific basis of the concept, its further progress can be possible only by its implementation.

The Demonstration Project in the Pilica River catchment (Poland), under the auspices of UNESCO and UNEP, has been the first effort towards implementation of ecohydrology and phytotechnology for solving existing problems. Key issues addressed relate to ecological and health hazards resulting from eutrophication of the river-reservoir system and toxic cyanobacterial blooms, and the socio-economic situation in the region.

The primary goal of the project was mitigation of point and non-point source pollution of the river and reservoir. The phytotechnological solutions enabled the generation of alternative energy sources (bioenergy) and reduced expenditure on fossil fuels. The proposed system approach is concordant with Poland's obligations to comply with European Directives.

**Key words:** ecohydrology, phytotechnology, floodplains, implementation of scientific results.