Ecohydrology - integrative science for sustainable water, environment and society

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Abstract
In the face of increasing pressure on freshwater resources, there exists an urgent need for new practical tools to achieve their sustainable management. Sustainable water resources and ecosystem services at the global scale can be achieved by two types of actions: first, the reduction of energy and material use *per capita* — expressed by the UNEP Concept of Ecoefficiency and second, by enhancement of the absorbing capacity of ecosystems. The Ecohydrology concept developed during UNESCOs International Hydrological Programme is a new approach in environmental sciences. It is based on the assumption that the control and regulation of nutrients and water cycling by synergistically integrated hydrological and biotic processes at the catchment scale should provide opportunities for restoration and enhancement of the absorbing capacity of ecosystems against human impacts. The new dimensions of ecohydrological research, which are introduced in this special issue, emerged during a conference in Venice and are focused on multidimensional feedbacks between water, biota and society. Based on the Ecohydrology principles formulated during the first phase of the Eecohydrology Project (EH IHP V 2.3/2.4) the development of research on such issues in the framework of IHP VI should provide a new tool for improving water resources, environmental quality, ecosystem services and socio-economic development.
Key words: ecohydrology, methodology of science, hydrological processes, river ecology, socioeconomy

Ecohydrology – a perspective from the Man and the Biosphere Programme

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Abstract
Ecohydrology had its origins in the Ecotone activity of the man and the Biosphere programme, but continues and expands today under the joint activity on water and Ecosystems promoted by UNESCO. The future role for Ecohydrology as an integrative discipline is clear when the emerging issues of Ecosystem management for sustainability are considered. The complementary efforts of the World Network of Biosphere reserves and the Ecosystem approach, promoted by the Convention on Biological Diversity provide an integrating framework around which the research agenda of Ecohydrology can be developed. On the broader environmental canvas the pressures on long-term viability of ecosystems coming from globalization also demand research solutions from the interdisciplinary approach of Ecohydrology.
Key words: Biodiversity; biosphere reserves; Ecosystem Approach; globalization

Monitoring and assessing global water quality – the GEMS/Water experience

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Abstract

Evaluation and assessment of fresh and inland water quality at the regional and global scales is not a simple task. UNEPs GEMS/Water has operated a comprehensive freshwater quality monitoring and assessment programme for over 20 years and is the only such global programme. GEMS/Water operates by inviting national governments to provide water quality data from their water quality monitoring programmes. The data is then compiled into a global database, GLOWDAT, which is a value-added process. GEMS/Water, United Nations agencies and other international organizations use the data to undertake global and regional scale water quality assessments. More than 100 countries participate in the programme that has a database of >1.6 million data entries. Participating countries control, for example, the type of data collected, the location of sampling sites, the frequency of monitoring, the analytical and field methods used and the frequency at which data is transferred to GEMS/Water. In order to make effective water quality assessments, identify emerging water quality issues and environmental 'hotspots', the data available must be of good quality, comparable between countries for a specific parameter, be geographically representative for a given region and be up-to-date. The only way for GEMS/Water to ensure that all these characteristics are satisfied in GLOWDAT would be for GEMS/Water to operate its own global water quality-monitoring programme. This is economically unfeasible. However, GEMS/Water has an operational manual, a modular training course and operates a QA/QC programme to help countries with data quality. Some countries have modernized their water quality programme, a complex and comprehensive activity that includes legal and institutional considerations, technical issues, and a strategic program of capacity building. Implementation of such comprehensive programmes in more countries will lead to better quality data for GEMS/Water.

Keywords: global water quality monitoring, freshwater management, data reliability, water quality assessment, monitoring problems, developing world, global riverine fluxes

Hydrological processes in a catchment scale under global climate change

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Abstract

The following areas of research related to the climate\water resources interface may be identified: detecting changes in atmospheric and hydrological variables by means of measurable indicators, including paleohydrological data; assessing sensitivity of land surface processes to climate characteristics; analyzing implications of climate change on regional water supply and demand; assessing the impact of climate change on physical, chemical and biological processes in water bodies. There is a possibility of applying a range of approaches, from simple empirical relationships to complex conceptual models based on simplified representation of the processes involved in the hydrological cycle. There are still uncertainties propagated through the numerous levels of analysis as one moves from CO_2 scenarios, through the transference of climatic data to hydrologic characteristics, impacts on water sectors and on management decisions and socioeconomic impacts of response measures.

Climate/hydrology impact studies should allow answering questions important for decision making: e.g. is the water system able to fulfil required tasks for the current economic, climatic and hydrologic conditions? If not, what action should be taken to improve the situation? Will the system be able to meet requirements 20 to 50 years from now, assuming stationarity of hydrological processes? If not, what kind of measures must be foreseen to enhance system's ability to cope with water deficits and floods? To what extent a water resource system may be affected as a result of climate change? How to deal with uncertainties? What are the adaptation options? How the analysts should communicate with decision makers in order to demonstrate that there is a problem to be addressed?

Based on the current knowledge, the following conclusions seem to be justified: there are reasons for decision makers to be concerned, because the water supply and demand may be affected by the climate change; water systems may be effectively adapted to changed climatic conditions; cost of adaptation in various regions of the country will vary depending on the depth of expected water deficits; the vulnerability of water systems to changes decrease as the level of water system development increase; improved demand management and institutional adaptation are primary components for increasing the robustness of water resources systems; a continuous adaptation of design criteria, development plans, operating rules and water allocation policies to the newly developed climate scenarios is needed.

Key words: global change, water management

Phytotechnologies and ecohydrology: a comprehensive approach to watershed management

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Abstract
The ecohydrology of an area or region is determined by climate, geomorphology, plant cover/biota dynamics and anthropogenic modifications. By understanding these factors, the potential exists for the application of Phytotechnologies to increase plant biomass and to regulate nutrients and water dynamics, thereby increasing ecosystem carrying capacity, resilience and functionality. This can lead to significant improvements in water quality, enhanced biodiversity, improved agricultural production, potential bioenergy generation, and remediation of degraded ecosystems.
Effective phytotechnology applications require broad-based and expert input for their development. Governments, the private sector and citizens must all be involved, and systems for collecting, synthesizing and feeding back information and knowledge on phytotechnologies must be established and maintained.
Key Words: ecosystems, integration, nature, plants, technology, water

Ecohydrology for sustainable development and management of water resources

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Abstract

There have been no ubiquitous, and unanimously accepted, definitions of the notions of ecohydrology and sustainable development. Aside from the interpretation by the UNESCO IHP-V Projects 2.3/2.4, there exist other ways, in which the terms “ecohydrology” and “hydroecology” are understood. Also several competing definitions of the notion “sustainable development” are available. Yet, a robust finding, holding across a range of definitions and interpretations, is that ecohydrology is a very important tool serving sustainable development and management of water resources. As the water problems of the world are getting increasingly severe, due to the population rise, striving towards higher quality of life and adverse climate change impacts, broadening applications of ecohydrology will be indispensable in the future.

Keywords: Ecohydrology, hydroecology, ecology, hydrology, sustainability, water resources, water availability, watershed management

The eco-hydrological feedbacks as constraints on the development of drylands.

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Abstract:
Under arid (dryland) conditions where the usual rain amounts fall short of the moisture deficit in the surface layers, the occurrence of surface flows is a necessary pre-requisite for the occurrence of groundwater recharge at selected infiltration sites. These surface flows at the same time nourish a variety of plants and biota along the flowpaths, which in turn affect both the quality and quantity of the region's water resources, especially the salinity buildup. Given these circumstances, both the local recharge as well as the flushing of surface salinity and pollutants depend critically on land use and are extremely sensitive to any change which affects the rain/runoff relationship. With increasing population pressures development relies to an ever increasing extent on the import of extraneous water. Management is then faced with the additional problem of water excesses beyond the natural drainage capacity of the arid system on a year round basis and the resulting ecological changes that result.
Key words: arid zone hydrology; surface runoff; groundwater recharge; salinity

Applying ecohydrology to on-ground management of wetlands and floodplains -- 'Learning by doing'

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Abstract:

Ecohydrology in Australia is moving towards solving practical management problems by linking environmental, social and economic factors.

The River Murray Wetland Rehabilitation Project is demonstrating the ecohydrological approach to manage local resources with the involvement of communities. On-ground projects aim to restore key elements of the natural hydrological regime to repair damaged wetland ecosystems. Management objectives include reversing major changes in water regimes, and reducing the impact of introduced exotic fish. 'Learning by doing' is advancing understanding of the ecohydrology of these wetland systems faster than traditional research methods, using active partnerships between managers and researchers. Positive changes in the managed wetlands show that sustainable management is practical.

Key words: wetland rehabilitation, riparian zones, flow regime, wetting and drying cycles

Application of ecohydrology in the Brahmaputra River

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Abstract

Changes in hydro-geological pattern of the river Brahmaputra, due to changes in topography, altitude, precipitation, and soil conditions, has resulted in zonation of the river into five major types of habitats that influence the distribution of fish biota. The erratic nature of water discharge, high rates of erosion and siltation, and habitat destruction have negative impacts on the commercial fishery as shown by a gradual decline of almost all commercial varieties of fishes. The flood pulse is probably the strongest factor that regulates other limnological factors and faunal distribution. Between May and October, there are about two to four high floods and fish landings are closely related to this flood regime, while during the dry season fishing is mostly localized near the confluents of rivers and at river meanders. However, large-scale felling of trees in the catchment areas and construction of embankments along the river and major tributaries have resulted in the river becoming heavily silted and the connecting channels of floodplain lakes dammed. Consequently fishes and other aquatic mega fauna are deprived of adequate water cover. Use of small-meshed gears and certain other highly objectionable fishing methods have threatened the natural stock of fish fauna in the upstream of the river. Hydrology, water management and the management of human interferences play a crucial role in the conservation of biodiversity in the entire Brahmaputra ecosystem. The present paper therefore provides an ecohydrological insight into the Brahmaputra river system and proposes certain remedial measures for sustainable water management.

Keywords: Fish assemblage, habitat restoration, flood regime

Ecohydrology, a low cost - high technology opportunity for Asian countries

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Abstract

Asian countries have broad extremes of development stages, some are technologically very advanced, on the other extreme are people that are dependent to traditional village practices. Rapid population growth in the past three decades have put great stress to the environment mainly due to a greedy natural resources exploitation. In that period traditional wisdom, knowledge, and taboo are being put behind and got a negative signature especially from the group who claimed themselves as modern people.

This paper try to dig into several examples of good traditional practices in Indonesia that has its deep root in a sustainable humanistic environmental management. The 21st century have not only introduce modern mankind practice in the changing face of Asia but have also caused huge environmental degradation along its way of transformation, This paper urge the introduction of ecohydrology principles into Asia countries by bridging a combination approach between traditional knowledge and wisdom that has its deep roots in people daily life with the modern practice learned from modern European experiences.

Key words: Traditional wisdom; population growth; transformation; sustainability

Instilling comprehensive management and technological approaches for the sustainable management of La Plata River Basin water resources

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Abstract

The La Plata River Basin is one of the largest international watersheds in the world (its area is about 3 million km^2), rich in water and other natural resources that are essential for the economic development of the five countries that share its territory: Argentina, Bolivia, Brazil, Paraguay and Uruguay. Together with the development of large reservoirs for energy and other water uses, extensive deforestation, intensive agriculture practices and large urban developments took place in the Paraná, Paraguay and Uruguay basins affecting environmental conditions and raising concerns about water resources use and conservation. There is an urgent need to broadly incorporate new water management paradigms – integrated water resources management, ecohydrology -, and new technological paradigms –environmentally sound technology (with a focus on non structural measures, ecotechnology, phytotechnology) - into regional, national and subnational decision making levels. Also, to disseminate them at the community level seeking, through top down and bottom up approaches, to promote stakeholder's commitment and the coordination of all organizations in the region involved in said management. Strategic Action Programmes, based on a sound transboundary environmental diagnostic analysis, establishing priority widely agreed upon priority strategic actions to address the root causes of environmental degradation and non-governmental networking mechanisms to cooperate with governments in the implementation of these strategies, may become effective tools to achieve said objectives. Both experiences are currently being developed in the La Plata River Basin and their present outcomes are highly promising.

Keywords: Integrated water resources management; Watershed management; Strategic planning; Ecotechnological approach; La Plata River Basin

The use of eco-engineering in a watershed management program in southern Patagonia

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Abstract
A drastic land use change and environmental degradation take place in Southern Andean Patagonia steep watersheds, especially upstream the urbanized areas. The paper presents a synthesis of environmental degradation assessment due erosion at Trabunco-Quitrahue watershed, near the top ski resort of San Martín de los Andes (Argentina). In order to evaluate the degradations processes, a combination of methods is applied by means of GIS techniques with detailed field work. In order to mitigate the soil erosion and land degradation, a Watershed Management Program (WMP) was implemented from interdisciplinary and horizontal cooperation point of view. The WMP includes a set of structural and non structural management measures with the use of eco-engineering techniques. The results demonstrate a growing acceptance of use of "soft measures" combined with traditional ones, in order to mitigate the degradation process. After four years of soft measures implementation the results are very good.
Key words: floods, natural risk, structural and non-structural meausures.

Ecohydrology in South America and the Caribbean: A summary of research and coordination activities (1996 - 2001)

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Abstract
Ecohydrology research projects undertaken, within the framework of the International Hydrological Programme, in Latin America and the Caribbean are presented, together with contact details of the participants. These include investigations by national research organizations in Argentina, Bolivia and Brazil, as well as collaborative projects involving Brazilian researchers and colleagues from Germany, France, Canada and USA. Details of other German, French and USA projects undertaken in the region are also given. The regional co-ordination of ecohydrology projects, undertaken by the author in co-operation with a working group with members from Argentina, Cuba,. Guatemala, Guyana and Paraguay has involved participation in international meetings, contributions to conference proceedings and involvement of research workers from Latin America in a UNESCO IHP V advanced study course in ecohydrology. Budget constraints and other factors limited or precluded research institutes in several countries in the region from participating more fully in the 1996-2001 programme. However, it is hoped that a more comprehensive and better integrated series of ecohydrological research projects will be undertaken during phase 2. It is anticipated that this will lead to a deeper knowledge of the aquatic ecosystems of the Latin America / Caribbean region and to sustainable development of its natural resources through application of ecohydrological principles.
Key words: Latin American and Caribbean, international cooperation, IHP: International Hydrological Program, Titicaca Lake

Establishing Ecohydrology in the Real World: The Lobau Biosphere Reserve and the integrated water scheme in Vienna

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Abstract
Ecohydrology is more than just hydrology and ecology combined. It is functional to its best only, if science, engineering and construction, public administration and political decision assist each other in an integrated scheme and on a common scale. The UNESCO Biosphere Reserve "Lobau", part of the Danube National Park today, is dependant on all four aspects for its sustained existence. The integrated water regime in Vienna, comprising the Danube river, the "New Danube" flood control channel, the Old Danube oxbow, and the water bodies of the Lobau, is presented here. Political decisions backing the efforts of engineers and biologists enabled the municipal administration to provide all necessary resources to keep the biosphere reserve in a healthy status. Finally outlines for initialising some aspects of ecohydrology in the Danube basin are presented.
Key words: hydrology, politics, administration, flood control

Hydro-ecological revitalisation of the Gemenc floodplain in Hungary

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Abstract:

The key to ecological revitalisation of river floodplains is improving the water regime, since this very important abiotic factor has undergone serious deteriorations due to anthropogenic effects. The desired improvement can be achieved by transforming the natural water conveyance infrastructure of the river-floodplain system in an appropriate manner. The proposed revitalisation has been tested on a case study problem dealing with the revitalisation of the Danube riparian Gemenc floodplain.

Key words: river floodplain systems, water regime control, numerical modelling

Use of an ecohydrology model to predict the impact on the Serengeti ecosystem of deforestation, irrigation and the proposed Amala Weir Water Diversion Project in Kenya.

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Abstract

The Mara River catchment is the dry weather refuge for more than one million migrating wildebeest and zebras of the Serengeti ecosystem. The river flow is affected by developments in Kenya, including deforestation and water diversion for irrigation and the proposed Ewaso Ng'iro (South) Hydropower Project. An ecohydrology model was used to predict the likely impact of these developments on the Serengeti ecosystem. The model was forced by observed monthly rainfall in the period 1900-2000 and calibrated against observations of the number of wildebeest and lions also in the period 1960-1999. The projects are predicted to have little effect on the number of migrating wildebeest in the Serengeti until a drought occurs; historically a drought occurs about every seven years. At that time 20 to 80% of the migrating wildebeest may die, according to the severity and duration of the drought. With a 50% die-off, it may take twenty years for the population to recover; with an 80% die-off there may be no population recovery. In practice the economic benefits would go to Kenya while Tanzania would suffer the economic costs, eg the negative impact on the tourism industry. To ensure sustainable development for both Kenya and Tanzania, a transboundary Mara River management plan needs to be implemented and be compatible with ecohydrology principles for the sustainable use of aquatic resources.

Key words: hydrology, wildlife, savannah, drought, sustainable development, Tanzania.

Ireland's changing freshwater habitats: anthropogenic impacts, fishery management problems and ecohydrological perspectives.

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Abstract
The adverse changes to Ireland's rivers and lakes, that result from deterioration in water quality, channelization and alteration of natural hydrological features, have impacted on the habitats of a variety of important fish stocks. These anthropogenic effects, and the recent changes in landscape management, which also threaten the other aspects of aquatic biodiversity of many Irish river catchments are reviewed. The importance of conserving ecotone features and of adopting an integrated ecological approach to monitoring of aquatic environmental change is discussed. Application of ecohydrological principles, for fish conservation and fisheries management is recommended. Further interdisciplinary studies and elaboration of new strategies for sustainable development of Ireland's freshwater resources are outlined.

Key words: water quality; fish conservation; biocomplexity; ecohydrology; species introductions

Phosphorus in a lowland calcareous river basin: a multiscale approach to understanding human impacts

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Abstract
Lowland rivers in industrial countries such as the UK are seriously impacted by phosphorus from a variety of sources. Point sources include numerous sewage-treatment works; diffuse sources include a full range of agricultural activities from fertiliser application to intensive poultry and stock rearing. The scientific consensus is that the concentration of phosphorus is an important measure of eutrophication.
The present study investigated the impact of point source effluents, together with physical impoundment by weirs, on the spatial heterogeneity of river bed sediment characteristics with emphasis on the forms and levels of phosphorus, within the catchment area of the River Wensum, Norfolk, UK.
The within site variability of the sediment characteristics (total phosphorus, bioavailable phosphorus, calcium, iron and organic matter) was tightly linked to the river bed types. Total phosphorus in the sediment was extremely well correlated with total iron (r=0.93) suggesting a possible association between the two parameters. The weirs and impoundments impacted dramatically on the dynamics of instream flow which resulted in extensive problems of siltation in the River Wensum leading to high level of total phosphorus storage above the weir. This, combined with the increased concentration of total phosphorus in the water below the point sources, had the greatest impact on sediment phosphorus availability. Thus the ecology of the river may not follow expected downstream changes.
Key words: nutrient, eutrophication, River Wensum, weir, sewage treatment work, hydrology

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Nutrient input and retention in shallow lakes affected by annual variation in weather conditions: studies from a river–lake cascade in the Masurian Lakeland (Poland).

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Abstract : In a mosaic landscape moderately affected by agriculture and tourism, such as found in the Masurian Lakeland (north-eastern Poland) external input of nutrients (TP, TN, N-NO_3) and their retention were compared in a cascade of shallow in-river lakes, between several years of different weather conditions. The average and maximum air temperature in the summer and winter months and that of the freshet (April) tended to be higher in the late 90s than the late 70s. The annual summer precipitation was lower in some years of the 90s than the 70s. This combination of dry and warm conditions (especially in summer) resulted in the water discharge, renewal rate of lake water and nutrient loads to the lakes becoming drastically reduced and more differentiated between freshet and other periods. This imbalance resulted in the occasional higher concentration of nutrients (due to internal loading) in lake outflows and lower retention of nutrients in the lake systems. Downstream exports of TP or TN took place occasionally from the lakes, although N-NO_3 was usually retained. Speculations are made about how frequently this situation may affect surface-fed, shallow lakes in the light of global warming (already detected in the region) and how important this could become for future eutrophication in shallow, temperate lakes generally.
Key words: lakes, climate changes, nutrient input, nutrient retention, eutrophication

Integrated river basin management: a new ecologically-based modelling approach

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Abstract

This paper introduces a new approach to the modelling of interdisciplinary river catchment management, a project for the management of watersheds being conducted at the UFZ Environmental Research Centre. The new European Union *Water Framework Directive* shifts the management of water resources beyond political boundaries (e.g. state, country) to focus on the total river catchment area. The project currently incorporates the following components: hydrology, sediment and nutrient transport, wetland research, river water quality, ecotoxicology, socio-economics and decision making. A river basin management tool is in the process of being developed, based on basic research in different landscape compartments (e.g. running waters, catchment area). Thus, rehabilitation measures in different landscape compartments can be evaluated, and interactions and dependencies between these components along the river reach can be included in the assessment process.

The integrated management tool consists of several hydrological and biological computer models which are linked in an object orientated way. Each model and its input and output flow is controlled via a GIS interface. Special emphasis is placed on the development of specific regionalization procedures. Modularity is a key feature of the system, allowing each model to be run as a stand-alone model. An additional important feature of the system is it's flexibility in allowing models to be added or removed to fit project requirements.

Key words: object modelling system, river basin management tool, integrated modelling, river ecosystem, landscape functional units, regionalization

Use of a historical situation as a reference for the optimal groundwater situation in Dutch nature conservation areas

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Abstract

A method has been developed for application on a regional scale to determine a historical reference on groundwater level and upward seepage which can be used for the determination of optimal groundwater conditions in nature conservation areas. This ‘historical reference’ is based on fossil soil characteristics, detailed topographical information, historical land use maps, and geohydrological information. The method is especially applicable for the higher sandy, pleistocene areas of the Netherlands. Environmental agencies have a strong need for well defined historical hydrological situation in nature conservation as they were defined in this study.

Key words: water management, GIS, regional policy, land use, wetlands

Towards a simple integrated model for the re-wetting of nature reserves

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Abstract. In the Netherlands hydrological measures are taken to raise the groundwater level in nature reserves that are suffering from groundwater levels that are to low, i.e. from 'desiccation'. These measures often lead to wet damage to agriculture in adjacent areas. There is, however, a lack of insight into these costs in relation to the benefits to nature. In this study a simple model prototype is presented in which economy, ecology and hydrology are integrated. The model provides insight into the cost-effectiveness of restoration projects that reduce desiccation of nature reserves. It shows that the current policy goal to reduce the desiccated surface area will not maximize the increase in the ecological conservation value.
Key words: groundwater level, nature restoration, agriculture, cost-effectiveness, economics

Effects of climate and land use change on hydrological conditions and species composition in Dutch riverine grasslands (*Calthion, Junco-Molinion*)

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Abstract
In this article we describe a method that was developed to predict the effect of climate and land use change on wet to moist mesotrophic grasslands occurring along lowland streams. The indirect climate effects, i.e. through changes in hydrology, and effects of land use changes are calculated with an integrated ecohydrological model. Direct climate effects, through temperature changes, are derived from a comparative biogeographical study. Application in a study area shows that climate effects are probably limited and small compared to land use effects.
Key words: ecohydrology, climate change, wetlands, prediction model

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The strategy of preventing the continual decline of ground water level in UNESCO MAB Biosphere Reserve “Puszcza Kampinoska” by restoration of Vistula flood pulses.

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Abstract
Biosphere Reserve “Puszcza Kampinoska” is situated in the Vistula river valley northwest of Warsaw. It covers an area of inland dunes and wetlands. From 1960s a continual decrease of groundwater level has been observed, threatening valuable ecosystems. Natural and anthropogenic reasons of this process are distinguished. A strategy to restore the groundwater levels in the Reserve has to be elaborated. Following activities are considered to restore natural ways of water circulation: the use the Vistula flood wave through stabilizing and purification system of ponds and channels, renaturalization of Łasica river and a major segment of the drainage system, purification of used water in appropriate biofiltration system in surrounding area. The transfer of Vistula flood pulse into the Biosphere Reserve will not only increase ground water level but also can restore natural pattern of water supply to fragile phytocenosis.
Key words: River valley, renaturalization, wetlands, water conditions, water level

Regional Sediment Management: A review of contemporary practice

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Abstract
This paper reviews contemporary practice in regional sediment management, with respect to rehabilitation design. Historically, these issues were rarely addressed effectively leading to many project failures. Recently, however, there has been an increased consideration of regional sediment issues. This movement has been complemented by the development of an increasing number of design approaches that include sediment continuity as an integral part of their design procedure. Of paramount importance is that we learn from these experiences through the undertaking and dissemination of Post-Project Appraisals. The development of a standardised geomorphic Post-Project Appraisal Procedure (PPA) has thus been furthered to focus specifically on regional sediment issues. The refinement and testing of all these techniques is essential for enhancing future design practice.
Key Words: rehabilitation schemes, sediment continuity, catchment scale approaches, holistic river management, geomorphic post-project appraisals

The Use of Baseflow Turbidity to Assess Catchment Condition.

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Abstract
A method is described for determining the state of health of a river basin in order to monitor any actual or predictive changes that may occur as a result of perturbations in certain key catchment variables. The mean annual baseflow and mean annual baseflow turbidity at chosen sites on the Latrobe River Basin are obtained by using a simple filter on the discharge and turbidity data in a time series. Six variables are used to calculate the factors influencing baseflow turbidity within the sub-catchments and mutiple regression is carried out on a matrix of the data. The resulting calculated turbidity contributions for each sub-catchment is compared to the observed values in order to determine the closeness of correlation. Suggestions for improving the model are provided.
Key words: Latrobe River, turbidity, mathematical model, ecohydrology

Towards New Ecological Drainage System in Malaysia

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Abstract
This article discusses the new Urban Stormwater Manual for Malaysia (MSMA) (DID 2000) to counter the current and major urban problems such as flash flooding, water pollution and ecological damage, urban slope failures, and sedimentation. MSMA uses control-at-source approach instead of rapid disposal as a tool to curb generation of pollutants and to be environmentally friendly. In this article, the authors describe a pilot study designed and constructed in the University Science Malaysia following the MSMA's eco-drainage guidelines. The study found more than 60% reduction in capturing runoff volume. In addition, the peak flow was reduced to more than 50%. The positive results from the study indicate that this manual can be used to solve the problems outlined earlier. Specifically, it shows that MSMA's guidelines are very much suitable to the humid tropical condition of the Malaysian environment.
Key words: Urban Stormwater Manual, MSMA, stormwater, detention/retention, control-at-source, surface runoff

Ecosystem condition and water quality control at impounded sections of rivers by the regulated hydrological regime

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Abstract

Hydrological regime at impounded sections of rivers is regulated by releases from upstream hydroelectric power stations (HEPS). Therefore regulated hydrological regimes can be used to manage ecosystem condition and water quality control. The hydraulic regime determines the functioning of main channel ecosystems; the daily level fluctuations caused by the peak operational regime of HEPS provide the well-being of the connected network (side-arms, flood-plain lakes, ox-bows etc.) and its effect on the water quality in the main channel.

The dissolved oxygen concentration and biochemical oxygen demand are the integrated indices of ecosystem condition and water quality. The reason is that these indices reflect structure and functioning of water ecosystems as a whole, particularly the dependence of organic matter production and decomposition biological processes (self-contamination and self-purification) on hydrological parameters as abiotic components of ecosystems.

The models describing dissolved oxygen dynamics and organic matter (by BOD_{tot}) concentration at impounded sections of rivers in dependence on water regime parameters are developed.

This controlling method is aplied at the impounded sections of Dnieper-River.

Key words: ecosystem condition, water quality, hydrological regime, control.

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Directions and timing of the material fluxes on the floodplain (case study of Vistula river valley near Plock, Poland)

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Abstract

In the hydrological cycle of river valley a vertical water fluxes are controlled by climate (precipitation and evapotranspiration). In the Vistula river valley near Plock periods of water recharge, surplus and deficit in the valley landscape units has been determined using Thornthwaite water balance method. A good tracer of that process is Cl and NO_3 concentration in the ground water. Concentration of these elements in ground water varies depending on the landscape unit, under the dune fields is lowest due to a good recharge ratio. In all units lowest concentration of NO_3 in the ground water are observed in a spring time due to a dilution effect in the period of water surplus in the fluvial system. In the chemistry of small creek Nida representing lateral river runoff reaching main valley a similar to ground water chemistry pattern has been observed. A lowest concentration of Cl (30-40 mg dm^{-3}) and PO_4 (0.25-1 mg dm^{-3}) occur in spring time due to a dilution effect. Highest concentrations of Cl (50-70 mg dm^{-3}) occur in late summer and fall. Spring time with a high runoff produces the highest loads of nutrients. Wetland on the floor of the Vistula river valley located in the lower reach of Nida catchment acts as a natural trap of the nutrients. It lowers concentration of PO_4 during low flows by 55% and NO_3 by 35 % Efficiency of reduction depends on the river discharge.

Key words: water quality, ecotones, ecohydrology

A deeper understanding of river habitat-scale ecohydraulics: interpreting the relationship between habitat type, depth and velocity using knowledge of sediment dynamics and macrophyte growth

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Abstract
Late spring/summer depth and velocity conditions of 16 'functional habitats' were investigated in lowland rivers. The habitats significantly associated with shallower, faster areas were 'submerged, fine-leaved macrophytes' (20-40 cm deep, >0.45 ms^{-1}) and 'macroalgae' (10-30 cm, >0.60 ms^{-1}). 'Cobbles' were associated with slightly slower, shallower conditions (0-20 cm, 0.45 ms^{-1}), 'gravels' with slower conditions again (around 0.15 ms^{-1}, depths from 0-30 cm). The slowest velocity class (0-0.05 ms^{-1}) was associated with 'silt' (depths 20-70 cm), 'marginal plants' (0-20 cm deep), 'emergent macrophytes' (10-80 cm deep), 'submerged, broad-leaved macrophytes' (40-110 cm deep), 'floating leaved macrophytes' (40-150 cm deep) and a second mode of 'macroalgae' (145-180 cm deep). The factors thought to be behind these findings are discussed.
Keywords: patch, physical, control, macroinvertebrates, lowland, entrainment

Influence of vegetation on the hydraulic behaviour of a reconstructed wetland

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Abstract

The ecohydrological approach can be applied to reconstructed wetlands where an appropriate vegetation design is needed in order to optimise hydraulic behaviour, water quality improvement and biodiversity increase. The purpose of this study is to examine the hydraulic effects of different development stages of vegetation in a demonstrative reconstructed wetland in Italy characterised by a central canal and two vegetated lateral shallow zones. Tracer tests were carried out in different vegetation conditions. The residence time distributions were analysed using several parameters. As expected, the results show that with more developed vegetation the hydraulic dead zones increase. On the other hand, a moderate increase of vegetation density doesn't hinder the flow, but rather increases dispersion number. A proper design has to avoid hydraulic short circuiting and provide a good distribution of the flow especially in the vegetated zones.

Keywords: Hydraulic; Meandering channel; Residence time; Tracer; Vegetation; Reconstructed Wetlands.

Phytoremediation of heavy metals: the role of macrophytes in a stormwater basin

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Abstract.
The aim of the study was to test the efficiency of aquatic vegetation to assimilate heavy metals and allow biological epuration in a stormwater basin. Through a periodical collection of water, sediments and macrophytes, a decrease of heavy metals concentrations was investigated from the inlet to the outlet of the basin. No evidence of metal reduction was noticed in the waters due to a general low level of heavy metals. However, accumulation of metals is greater in the sediments and decrease from the inlet to the outlet (47% reduction for Cd, 30% reduction for Pb, 75% reduction for Zn). Some specific organs of macrophytes accumulate heavy metals in various concentrations : *Elodea canadensis* (all organs merged) and crowns of *Glyceria maxima*, *Sagittaria sagittifolia*, *Scirpus lacustris*, *Typha latifolia* contain the highest concentrations in Cd, Pb and Zn.
Key words: Cédrogne's stormwater basin. *Elodea canadensis*. Heavy metal accumulation. Highway runoff. Uptake.

Estimation of denitrification rate in diversified bottom sediments of the Sulejow Reservoir

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Abstract

The aim of this research was estimation and comparison of denitrification rate in the Sulejów Reservoir using two methods: 1). the *in situ* chamber method – the denitrification rate was calculated from the total N_2 flux out of the sediment, measured directly by gas chromatography and ranged from 0 to 677 μmoll N_2 m^{-2} h^{-1}. 2). occurrence of denitrifying bacteria – determined by means of the most probable number (MPN) and plate counting (PC). Environmental conditions determining denitrification process in the Sulejow Reservoir was also identified. The positive correlation between the content of organic carbon in the sediments and the amount of denitrifying bacteria (r=0.86) and denitrification rate (r=0.84) was indicated. The number of denitrifying bacteria in the sediment was estimated at 0.05% to 15.8% of total microflora by MPN, and at 4.6% to 26% using PC. The most frequently isolated bacteria were identified as members of the genera *Pseudomonas*, *Alcaligenes* and *Bacillus*. About 50% of the bacterial strains isolated accumulated nitrite during nitrate reduction.

Key words: eutrophicated reservoirs, denitrification processes, denitrifying bacteria,

Artificial reefs and their effects on fish assemblages in a Brazilian Reservoir and Tailrace

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Abstract

In this paper, we evaluate the effects of artificial reefs on fish assemblages in a hypereutrophic reservoir and in the lotic zone immediately below dam. Fish diversity was highest in the lotic zone relative to the reservoir. We also found an inverse relationship between diversity and distance from the river margin. Catches near the artificial reefs were more diverse than in control areas. A seasonal effect, possibly caused by variation in temperature, was significant in all comparisons. We argue that, in a scale of local effects, the ecological function of these structures would be similar to refuges.

Key words: Artificial reefs; fish, diversity, lotic zone, refuges.

The impact of soil mulching on the intensity and occurrence of droughts in wheat crops of the former Soviet Union

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Abstract
A comparison between the crop water supply at 6 agrometeorological stations in the former Soviet Union, over 20 years, under natural water supply condition and under soil mulching, has shown a rather low natural crop water supply in the forest-steppe and steppe zones, and that soil mulching tends to increase the crop water supply by about 1.7 times.
Key words: agriculture, crop water supply, actual and potential transpiration

How much do we know about planning ecohydrological management actions? (What did we learn in the first phase of the Project?)

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Abstract

In this paper a review of the lessons learned in the past phase of the ecohydrology project are presented from the hydrologist's (environmental engineer's) points of view. The authors believe that so far the ecohydrological programme remained mostly an aquatic-ecological one, without making much use of hydrological and environmental engineering knowledge, which would be required to end up with really working ecohydrological planning tools for the integrated management of water resources. The objective of the paper is to launch, provoke debates and discussions, with the special regard to drawing up the tasks of the next phase of the ecohydrological programme. The basic questions are: what is the role of hydrologists in ecohydrology and how to bridge the still existing gaps of the approaches of ecologists and hydrologists?

The ways and means of solving this problem are discussed down to some of the very details of quantifying processes, such as retention rates of nutrients or the forecasting of the ecological (eutrophication) state of standing waters.

The paper ends with a list of tasks offered for the next period of the ecohydrological programme.

Key words: Catchment modelling, lake modelling, research gaps in ecohydrology