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Ecohydrology for harmonization of societal needs with the biosphere potential

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Preface

EcoSummit 2012 and Ecohydrology & Hydrobiology

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Editorial

Ecohydrology for harmonization of societal needs with the biosphere potential

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EcoSummit Columbus Declaration

Harmonization of societal needs with the ecosphere in the Anthropocene Era

EcoSummit 2012 Scientific Committee 1

EcoSummit 2012, Columbus, Ohio, USA

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Research Article

Food security in a changing climate

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Abstract

Challenges to global food security are: (i) population increase from 7 billion in 2011 to 9.2 billion in 2050, (ii) climate change, (iii) soil degradation by erosion, salinization, organic matter and nutrient depletion, and elemental imbalance, (iv) decreased availability of water, (v) land competition for urbanization, brick making, biofuel, and non-agricultural uses, and (vi) preferences toward animal-based diet. Global hotspots food insecurity are South Asia and Sub-Saharan Africa. Adopting concepts of ecohydrology, enhancing green water in the root zone, can create climate-resilient agriculture to advance food security and improve the environment. An effective governance is needed to implement policies which promote restorative land uses and recommended management practices. Furthermore, payments for ecosystem services may be a useful strategy to promote sustainable intensification of agriculture by resources-poor farmers.

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Ecohydrol. Hydrobiol. 13(1), 22–30, 2013
Research Article

Soil moisture dynamics under different tillage practices in cassava–sorghum based cropping systems in eastern Uganda

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Abstract

Soil moisture storage in the root zone determines availability of water in crop production, but there is limited attention on water resource management in cassava–sorghum production systems. Soil moisture content was higher under ripping than mouldboard ploughing. Mouldboard ploughed plots had more moisture in the upper (0–10 cm) layer while, the ripped plots accumulated more moisture in the lower (20–40 cm) root zone. Soil surface roughness was stable two months after ploughing. Crop combinations and seasons influenced soil moisture storage over the growing period. The different cropping systems vary in their soil moisture extraction capacities at different growth stages, hence influencing the overall moisture storage and water used in the root zone.

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Research Article

Transport of contaminants in agricultural catchments during snowmelt: buffer strips vs. preferential flow paths

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Abstract

Knowledge of hydrological pathways is essential for an understanding of ability of riparian buffers to mitigate the impact of diffuse pollutants on freshwater ecosystems. We examined flow paths and source areas of contaminants in an agricultural catchment in NE Poland during snowmelts in 2009 and 2010. End-member mixing analysis showed that stream chemistry was controlled by the shallow runoff components. Their contribution to stream runoff varied significantly depending on soil frost, catchment wetness and the water input from snowmelt. In 2009 overland/rill flow was the main mechanism of runoff generation because of the low permeability of the frozen ground. Overland flow had the pronounced impact on stream chemistry during peak discharges, when it amounted up to 70% of discharge (*Q*). Riparian ground/soilwater runoff was important component of runoff throughout stream recession, when it contributed up to 50% of *Q*. High catchment wetness, lack of soil frost and large snowmelt input in 2010 resulted in enhanced infiltration and rapid and large groundwater response. Melt water and tile drain outflow were found to be the major peak runoff components. In 2009 overland flow together with discharge of shallow groundwater were responsible for the export of 88% of nitrate and 98% of orthophosphate. During snowmelt of 2010 70% of NO_3^- and 80% of PO_4^{3-} moved via tile drain network. As migration of chemicals was controlled by preferential flow structures, it is very likely that vast majority of contaminants fluxes bypassed buffers and structures, which could constrain their impact on stream quality.

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Research Article

Longitudinal trends in water chemistry and phytoplankton assemblage downstream of the Riverview WWTP in the Upper Olifants River

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Abstract

Aquatic ecosystem resilience is an integral part of sustainable development for numerous economic, social and culture reasons. The regulation of nutrient inputs into rivers and the capacity of rivers to retain and transform excess nutrients is an important aspect of ecological resilience of aquatic systems and the management of river water quality. The primary production by algae in the selected Olifants River reach, dominated by a cobble or bedrock substrate, had been highly effective in assimilating phosphate concentrations (PO_4) during low river flow regimes in winter months. However, the assimilation of PO_4 by phytoplankton was temporary and caused changes in the phytoplankton community structure, reducing the diversity and degrading habitat downstream. The ecological impact of the Riverview wastewater treatment plant (WWTP) was detectable over a distance of 40 km downstream from the plant. The chloride concentration below the WWTP in July during low flow regimes decreased from 33 mg L^{-1} to 21 mg L^{-1} at 0.1–40 km downstream from the WWTP. During benthic algae mat senescence and flood disturbance during the high flows of the summer months, displaced nutrients accumulated in these filamentous algae mats and was then displaced further downstream to Lake Loskop where they fuelled the development of cyanobacterial blooms in the riverine zone of this man-made lake.

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Research Article

Prediction of the changes in ecological pattern of wetlands due to a new dam establishment in China

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Abstract

Marsh wetlands play an important role in the conservation of biodiversity. However, marshes suffer from constant water scarcity resulting in intensifying habitat degradation, owing to the coupled impacts of global climate change and decline in available regional water resources. Scientific research is required to provide appropriate management strategies for marsh restoration and conservation. The Honghe National Nature Reserve (HNNR), a Wetland of International Importance in China, was selected as a case study to quantitatively demonstrate the relations between hydro-geomorphological gradients and spatial ecological patterns of plant communities. Digital abstraction and analyses of the hydrologic gradient were carried out in the HNNR based on hydrological data with the support of geographic information system and remote sensing techniques. A correlation between wetland water level and corresponding distribution of plant communities in wetland ecosystems was empirically derived based on field surveys and previous scientific research. In accordance with this correlation, management efforts were focused on restoring and optimizing wetland ecosystems resulting from artificially raised water levels. Results show that with a water-level increase of 30 cm at a new dam located in north-eastern HNNR, both areas of marshes and open water markedly increase, while the area of degraded marsh (wet meadow) and non-marsh communities decline. Results from three scenarios (increased water levels of 30, 50 and 70 cm) indicate recovery of wetland vegetation is non-linearly correlated with water-level change. This research provides a case study to show the scientific capacity in analysis, prediction, control and management of wetland ecological restoration.

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Research Article

For improvement in understanding eco-hydrological processes in mire

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Abstract

Various anthropogenic stressors have caused mire degradation in subarctic northern Japan, such as drying and the invasion of an alder-dominant shrub forest. The Japanese government recently started a nature conservation project to restore a formerly meandering river in order to prevent invasive forest species and to rehabilitate the original mire ecosystem. In this study, the process-based National Integrated Catchment-based Eco-hydrology (NICE) model is further developed to improve accuracy in evaluation of nonlinear interactions and feedback of hydro-geomorphology and vegetation dynamics in the ecosystem. The simulated results clarify the impact of groundwater level change, sediment deposition, and nutrient availability on the complex alder invasion after refining the model to include newly-developed down-scaling and feedback processes. The model also shows the interaction between groundwater and inundated flow and its effect on vegetation change, which sheds light on two conflicting conceptualizations of peatland hydrology. This integrated system links the hydrological approach to the ecological one implicitly in the model, and throws some light on the refinement of tipping-point early warning systems for sustainable development and the improvement in boundless biogeochemical cycles along terrestrial-aquatic continuum for global environmental change.

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Research Article

Mississippi River Ecohydrology: Past, present and future

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Abstract

For well over 100 years the twin objectives of navigation/transportation and flood-risk management have led to an intensively managed Mississippi River system which, hydrologically and hydraulically, has been radically altered. Additionally, human disturbances have led to more recent environmental impacts, including increased agricultural chemicals and industrial toxins, altered salinity and sediment loads, and introduction of non-native species, resulting in a riverine and riparian ecosystem far different from its historical condition. These anthropogenic impacts, combined, have led to reduced biodiversity, resilience and ecosystem services provided to society. The goals and objectives of ecosystem rehabilitation must include mechanisms to reverse the physical, chemical and biological alterations to the Mississippi River. Implementing Ecohydrology goals through the reestablishment of the historical floodplain is paramount to successful remediation. Likewise, the ability to measure project success is critical to evaluating the efficacy of the entire rehabilitation program.

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Research Article

Temporal land cover analysis for net ecosystem improvement

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Abstract

Although ecological processes at landscape scales can drive ecosystem structure and function at local sites, the monitoring and assessment of restoration projects and programs rarely incorporates changes in landscapes. Riverscapes naturally have a high level of hydrologic connectivity so when floodplain habitats are reconnected to the main stem river to restore function, it is especially important to consider the potential effects of watershed processes on outcomes. This study demonstrates a method for selecting relevant indicators, identifying appropriate spatial scales, and measuring trends to inform assessment of a large-river restoration program. We identified eight major watersheds contributing to river reaches within the 1468 km^2 historical floodplain of the lower Columbia River and estuary. We assessed land-cover change at the watershed, reach, and restoration site scales by reclassifying remote-sensing data from the NOAA Coastal Change Analysis Program's land cover/change product into forest, wetland, and urban categories. The watershed analysis showed a 361.6 km^2 total and 198.3 km^2 net forest loss during the first six years of the Columbia Estuary Ecosystem Restoration Program, 2001–2006. Total urbanization in the watersheds during 1996–2006 was 48.4 km^2. Trends in forest gain/loss and urbanization differed between watersheds. Wetland gains and losses were within the margin of error of the satellite imagery analysis. These findings are important to restoration planning and assessment, e.g., floodplain restoration sites in reaches downstream of watersheds with decreasing forest cover may be subject to increased sediment loads and those downstream of urbanization may experience altered hydrological processes caused by increased impervious surface.

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