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Towards engineering harmony between water, ecosystem and society

Towards engineering harmony between water, ecosystem and society: editorial

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The Factor Four concept in Eco-Hydrology – is it applicable?

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Abstract

The problems of shortages of water and its quality call for urgent attention. In the last 20 years the focus of environmental policy shifted from economical to biological dimensions. The Factor Four concept of von Weizäcker was originally conceived for solving economic issues of overexploited natural resources. Implementation of an array of technological innovations should lead to sustainability. With increased knowledge about the function of ecosystems this concept needs expansion whereby services rendered by ecosystems are linked to economic activities of humans. Doubling efforts to “protect” water resources will lead to at least twofold increase in its “productivity”. In an “ecohydrological approach”, proper land management improves water resources, which enhances biodiversity and finally protects the environment. The conflict between protection versus use of ecosystems can then be largely resolved.

Key words: environmental policy, protection, water management, ecosystem services, economic dimension.

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Water cycle

Global change scenarios from the perspective of the past

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Abstract

Global change projections are discussed. Anthropogenic pressures have been on the rise and their manifestations, such as changes in population, water footprint, land use and land cover and production output (of energy, food, and any other goods and services) are expected to grow further in future, with serious unwelcome side effects. Climate change has been unabated and unequivocal and is projected to go on until the end of this century and beyond. In order to restrict global warming to below the goal of 2°C, major concerted mitigation efforts, particularly control of atmospheric concentrations of greenhouse gases (GHGs), are necessary, but the probability of adequate efforts being undertaken sufficiently early is not high, and keeps decreasing.

Key words: Global change, climate change, anthropogenic pressure, projections, water footprint.

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Groundwater bodies in ecology and ecosystems

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Abstract

The symbiosis of two worlds, abiotic and biotic, requires a diffusible and active bridge between them, which is water. Furthermore, water takes part in photosynthesis in plants allowing biological organisms to transform inorganic materials into organic ones. The hydraulic connections between surface and ground waters ensure water availability and quality. These interactions have an important ecological significance. The transition zone between the two systems, known as an ecotone, ensures the smooth mutual contribution of the surface, hyporheic and ground water ecosystems. Finally the groundwater systems have their own “groundwater ecology”. As every alteration to the natural environment, climatic change affects the ecosystems, modifying the water supply (precipitation) and ecosystems parameters; e.g., directly in the case of temperature and humidity, or indirectly in the case of pH, electric conductivity, redox potential, and carbon dioxide (CO₂) entrainment.

Key words: symbiosis, hydraulic connections, hyporheic zone, ecotone, climatic change.

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Domesticated ecosystems and novel communities: challenges for the management of large rivers

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Abstract

Throughout the last centuries most large rivers have increasingly become human-dominated ecosystems as a result of land reclamation, floodplain drainage, hydropower production, and channelization for navigation. Their domestication, i.e. their optimization for few ecosystem services, has fundamentally altered habitat conditions and led to the formation of novel biotic communities as well as to the truncation of vital ecosystem processes. Current conservation and management strategies do not yet cope with the dramatic alterations of large rivers. Concurrently, river management competes with the more human-focused targets and directives in the energy, flood control and agricultural sectors. Therefore, there is an urgent need for innovative, adaptive strategies to sustainably manage domesticated large rivers through increasing levels of active intervention.

Key words: ecosystem services, biodiversity, hydropower, invasive species, conservation, Water Framework Directive, restoration.

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The role of vegetation in the water cycle

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Abstract

The contribution summarises different aspects of the involvement of plants in the water cycle at organism, ecosystem and landscape levels. It stresses the importance of soil – plant – air water continuum for local water cycling and plant adaptations for optimized water management. It discusses the fate of precipitation that depends on vegetation type, stand structure, land use, soil properties and precipitation rate. The possibilities for strengthening local water cycling are also presented.

Key words: plants, transpiration, precipitation, run-off, soil water capacity.

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Coastal wetlands at risk: learning from Venice and New Orleans

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Abstract

Coastal regions have progressively become more vulnerable to intense hydrodynamic and atmospheric events, thus raising important questions about their fate in the century of global warming. A variety of natural and anthropogenic factors have contributed to this fragility: eustasy, isostasy, soil compaction, reduced sediment supply and reduced extension of natural defences (barrier islands and coastal wetlands). With the aim to emphasize the crucial role played by the intense human manipulation of the environment, we provide a brief overview of the state of knowledge on this extremely complex problem, moving from two cases of special importance: Venice and New Orleans. We discuss similarities (causes of wetland degradation and related restoration problems) as well as differences (different economical scales involved in the restoration projects, different risk reduction ensured by wetland and natural defence restoration and, finally, cultural relevance of the environment to be preserved) between these two regions.

Key words: delta, lagoons, wetlands, restoration.

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Water challenges in global scale

Shaping of an agricultural landscape to increase water and nutrient retention

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Abstract

One of the most important phenomena, from the point of view of sustainable development of the countryside, is the worsening quality and diminishing quantity of water resources. The agriculture-induced pressure on ecosystems tends to increase while hunger and malnutrition of global population grows, expected to reach 2 billion persons by 2050. Moreover, there is no more land that could be utilized for this purpose. Widespread appearance of erosion, pollution of ground and surface waters and shortages of water resources is therefore expected. This seeks for an urgent need for a new approach to environmental management. For this purpose, not only technical measures, but also natural mechanisms, involving physical and biological processes must be used. This paper presents the results of investigations carried out in Wielkopolska (Poland) and in the Gumera (Gumara) catchment (Ethiopia) on climate and land use changes, and their impacts on water quantity and quality. Possibilities to counteract the worsening of water conditions are presented. Long-term investigations show that proper shaping of landscape structures, mainly by creation of shelterbelts, strips of meadows, land-water ecotones and small water bodies, and improving soil structure by increasing organic matter content, is one of the best tools for achieving this goal.

Key words: Landscape structure, water balance, shelterbelts, mid-fi eld ponds.

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Ecohydrology for a sustainable future in Africa – the cases of Ethiopia, Kenya and Tanzania

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Abstract

The productivity of some African lands has declined by 50% due to soil erosion and desertification over the period 2000-2010. Yield reductions may range from 2% to 40% (8% in average). This leads to increasing starvation of people, where only in Sub-Saharan Africa (SSA) the number of hungry people reached 212 million. In Ethiopia about 90% of arable lands is in mountainous areas, where live 90% of the human population and 60% of all livestock. The highlands exposed to improper agricultural practices has been heavily degraded in the last century. The country faces environmental challenges such as land degradation, limited quantity and quality of water resulting from progressive deforestation, improper agricultural practices and urbanization. Similar problems are touching other African countries, especially in the East Africa. To overcome these problems, efforts have been made to launch afforestation and conservation programs; however, success to date has been limited. Harmonization of ecohydrological principles with the existing efforts has been planned. The Gumera River basin has been chosen to be one of the ecohydrological demonstration sites. The Kenyan-Tanzanian border area is also an area of interest due to the large seasonal migrations of large mammals depending on water availability. Lake Naivasha in Kenya is used to demonstrate possible measures for restoration of land-water ecotone functions of *Cyperus papyrus* by restoration of hydrological regime in the tributaries deltas. This paper uses three cases to discuss the importance of ecohydrology for problem solving in Africa. Establishment of the regional centre for ecohydrology is being proposed.

Key words: integrated models of sustainable management, foresight.

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Water resources, sustainability and societal livelihoods in Indonesia

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Abstract

Rapid national development and increasing population pressures on land resources have caused serious social and environmental problems in Indonesia that require concerted efforts to overcome and proper resource management. A series of national programs dealing with the problem of linking the water environment and community livelihoods were created, and they are being implemented around the country under a framework of broad guidelines for sustainable development and integrated water resources management. This paper presents a brief description of Indonesian water and environmental resources, followed by an overview of progress in and development of an ecohydrological approach that has been introduced during the past decade. It was recognized that the approach provides a strong scientific basis and is in line with the needs and efforts being promoted through national movements in natural resource management to guarantee societal livelihoods and sustainable national development.

Key words: environmental resources, degradation, national programs, ecohydrology approach.

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Harmony between water, ecosystem and society

Securing water as a resource for society: an ecosystem services perspective

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Abstract

Freshwater ecosystems are crucially important providers of ecosystem services as they provide clean water for multiple uses including water for drinking, irrigation or recreation. This study presents a spatially explicit assessment of the benefits of water services at the scale of Europe. We mapped simple indicators for water provision, water regulation by soils, and water purification by river networks. Both the capacity to provide services as well as the actual flow of services were quantified in biophysical terms. Subsequently the monetary value of water purification was assessed for northern Mediterranean river basins using avoided treatment costs. This type of assessment is considered to be a valuable communication tool to integrate scientific disciplines and to facilitate the collaboration between experts, policy makers and citizens in the field of water management. Moreover, it is argued that this type of assessment is a useful and feasible alternative for managing water resources in developing countries.

Key words: natural resources, freshwater, water supply, water purification, mapping, economic valuation, Europe.

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Foresight methodology as a tool for elaboration of plans for sustainable management of water, energy, the environment and society

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Abstract

Integrated models of sustainable management bring together the efforts of three groups of actors: government, society and scientists. The effectiveness of such models depends on their ability to support the management of water, ecosystem and societal resources, and the development of such abilities is one of the goals of the InterAcademy Panel Water Programme. This ability to manage water, ecosystem and social resources is based on full, objective, politically unbiased, and forward-looking information and knowledge. For a long time, environmental modelling has been a source of such information. In recent years foresight has beginning to play a similar role; however, the practical integration of foresight in integrated sustainable management has been very limited. One of the causes of this is the fact that the instrument is not very well known among the people responsible for sustainable management. Therefore, the aim of the article is to close the knowledge gap and to present the basic issues connected to the foresight methodology as a tool for formulating plans for sustainable management of water, energy, environment and society.

Key words: integrated models of sustainable management, foresight.

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