Ecohydrology & Hydrobiology 16 (2016) 58–65

Contents lists available at ScienceDirect

Ecohydrology & Hydrobiology

journal homepage: www.elsevier.com/locate/ecohyd

Opinion Article

Ecohydrology, floodplain water bodies, European legal provisions and the future

Georg Albert Janauer *

Department of Limnology and Biological Oceanography, University of Vienna, Althanstrasse 14, 1090 Vienna, Austria

ARTICLE INFO

Article history:
Received 17 February 2015
Received in revised form 28 June 2015
Accepted 9 September 2015
Available online 25 September 2015

Keywords:
Ecohydrology
Water Framework Directive
Habitats Directive
Future challenges

ABSTRACT

Using the ecohydrology concept for mitigating or resolving pressures on the natural environment caused by human activities is a successful way to find low-technology solutions which comprise the use of ecosystem services provided by dedicated ecosystems. Today this approach faces constraints by lack of area in highly developed countries, or related to legal tools established by the European Community. Even more important are climate change effects and the inevitable response of ecological systems, which interfere with their present resilience. Science is called on providing new strategies and tools to better predict the future of ecosystem services and how climate change effects can be mitigated or transformation activities can be initiated.

1. Development and application of Ecohydrology

Rachel Carson's *Silent Spring* (Carson, 1962) triggered attention in the public, in politics and in science, on the vulnerability of nature, which – among other activities – lead to the International Biological Program (IBP, 1963). This international activity focused on ecosystem ecology, on biological inventories and their dependence on abiotic habitat parameters, and on describing the flow of energy and nutrients in ecosystems as a whole. In 1971 UNESCO launched the 'Man and the Biosphere Program' (MAB, 1971) aimed on interdisciplinary research related to people and their environment. The '*Convention on Wetlands of International Importance especially as Waterfowl Habitat*' (Ramsar Convention, 1971) entered into force by 1975. UNESCO started the '*Intergovernmental Scientific Cooperative Programme in Hydrology and Water Resources*' (IHP, 1975) devoted to the management and research on water, but also on education and capacity building, regarding aquatic ecosystems. From a new perspective on the impact of land use on aquatic systems UNESCO's MAB Program turned its attention on transitional zones between land and water ecosystems. Collaborative research was proposed in the MAB Digest n° 4, '*The role of land/in-land water ecotones in landscape management and restoration*' (Naiman et al., 1989), which led to intensive research on the type and functioning of ecotones (Parz-Gollner and Herzig, 1989; Naiman and Décamps, 1990; Holland et al., 1991; Janauer and Hary, 1994; Janauer, 1997a,b).

Another important international development was achieved by the United Nations agreement on the '*Convention of Biological Diversity*' in Rio de Janeiro (CBD, 1992). In the same year the European Communities put in force their '*Council Directive on the conservation of natural habitats and of wild fauna and flora*' (Directive, 1992). Both documents underlined the need of not only using, but also conserving natural values, especially through respecting the conditions of habitats for animals and plants.

When integrating the experience of science, water management and the development of the human society into an effective research and application strategy the

* Tel.: +43 1 4277 76400.
E-mail address: georg.janauer@univie.ac.at

http://dx.doi.org/10.1016/j.ecohyd.2015.09.001
1642-3593/

UNESCO programs IHP and MAB joined forces to install '*Ecohydrology*' into the concept of IHP, starting with Program Phase V and VI. This move was supported by the dedicated publications of Zalewski et al. (1997a,b). For the first time a comprehensive view of the conceptual background of ecohydrology and its basic hypotheses was given, including a combined scientific and applied approach to solving problems of water management in a broad sense. Two items of IHP-V, Project 2.3, '*Interactions between river systems, flood plains and wetlands*' and Project 2.4, '*Comprehensive assessment of the surficial ecohydrological processes*' (Janauer, 1997b; Jolankai and Janauer, 1997), as well as the Project Implementation Plan (Pypaert, 1997) were dealt with in detail.

As soon as the theoretical background of ecohydrology was established new aspects were discovered as parts of its wide scope. Early in ecohydrology application it was pointed out that merging the scales of hydrological and biological results often faced a problem when modelling habitat conditions and the reaction of biota (Janauer, 2000). Time was also needed to convince stakeholders of the appropriateness of ecohydrology approaches for solving problems in near-urban areas for establishing sustainable management strategies (Janauer, 2002, 2005, 2006; Zalewski, 2002, 2014a,b). Following the Millennium Ecosystem Assessment '*Ecosystems and Human Well-being: Biodiversity Synthesis*' (MEA, 2005) sustainable solutions for wetlands and water bodies suffering impact from human population present in river basins were highlighted by Zalewski et al. (2008). Since that time ecohydrology solutions were sought for solving problems in wetlands and river floodplains (Janauer, 2005, 2006; Strausz and Janauer, 2007; Barta et al., 2009; Janauer et al., 2013; Obolewski et al., 2015).

Ecohydraulics is a twin-topic of ecohydrology research at a different scale. Research on a hydraulic interpretation studied fish, amphibians, benthic invertebrates, but also aspects of geomorphology and flow fluctuation, as well as the hydraulic effects on riparian strips or the total floodplain vegetation (Maddock et al., 2013). Essential information was also provided by the interpretation of macrophytes and their biodiversity patters responding to hydrodynamic disturbance (Puijalon and Bornette, 2013). Rare wetland types like mires also received attention regarding ecohydrological processes (Nakayama, 2013).

Ecohydrological aspects near or within urban areas were studied for integration of ecology and water management (Janauer, 2005), about storm water handling (Li, 2012), creating more resilient cities (Wagner and Breil, 2013) or finding opportunities for the sustainable use of rainwater (Zawilski et al., 2014). Some research groups focused on topics with a larger geographic scope like the Danube River and the Black Sea (Jelev and Jelev, 2012) or on the Guishui River Basin in China (Guo et al., 2014). Creating sustainable processes for river basins was discussed by Zalewski (2013), and Liu (2011) modelled the groundwater status determined by the type of vegetation in dry areas. Ecohydrology application was proposed for greater geographical areas like parts of Africa by Negussie et al. (2011), whereas McClain et al. (2013) and Zalewski (2014b) advocated for implementation of ecohydrology measures on the scale of the biosphere.

2. Ecosystem services: a cornerstone of Ecohydrology strategies

The UNESCO Office in Venice, the platform for promoting Ecohydrology as part of the International Hydrological Program and as a tool for solving water management-related problems defines this approach as "*...a scientific concept applied to environmental problem-solving ... at a catchment scale ... based upon the assumption that sustainable development of water resources is dependent on the ability to restore and maintain evolutionary established processes of water and nutrient circulation and energy flows at the basin scale*". (http://www.unesco.org/new/en/venice/natural-sciences/water/ecohydrology/).

In many cases the application of ecohydrology principles aims at making use of properties and processes associated with ecosystems and their functions as part of the human environment. These processes and functions are usually seen as ecosystem services. With respect to ecohydrology aims wetlands and inland-water bodies are ecosystem units with outstanding qualities for solving practical needs of human societies. Keddy et al. (2002, Tab. 1.9, p. 58) lists several important ecosystem services. Among others groundwater recharge or discharge, flood flow alteration (i.e. flood impact attenuation), sediment stabilisation, retention of nutrients and pollutants, carbon transformation (through the food web and final sedimentation), but also terrestrial and aquatic diversity, abundance, and reproduction of animals and plants, as well as a refuge and heritage function, and not to forget aspects of recreation are given as examples. Some of these functions relate to the concept of ecotones and other transitional zones in the landscape, which do not only separate different landscape patches from each other, but also serve as buffering elements with filtering properties, and as units of enhanced biodiversity of flora as well as fauna. Biotechnologies on landscape scale often take advantage of using ecosystem services to achieve their goals (Bednarek et al., 2014). However, the possibilities of using ecosystem services may change under impact of climate change (Okruszko et al., 2011).

The importance of ecosystem services as tools for ecohydrology application is clearly explained by many publications. Buffer zones can filter and retain polluting agents (Izydorczyk et al., 2013), still water bodies and wetlands can retain sediments, pollution, nutrients, toxic substances or sewer overflows (Negussie et al., 2011; Wagner and Breil, 2013). The handling of excess of storm water in urban areas by application of ecohydrology principles is discussed in an overview by Wagner and Krauze (2014). Ecosystem services of the Danube River floodplain in Vienna (Upper and Lower Lobau wetland ensemble) formed the basis for finding solutions between competing interests of stakeholders through the application of a multi criteria decision support tool for trade-off analysis of future changes towards a new dynamic surface and groundwater regime (Sanon et al., 2012). Ecosystem services were also involved in regulating the interaction