Ecohydrology from Concepts to On-ground Actions: Report of Special Side Event on *Ecohydrology—An Interdisciplinary Challenge*, January 5–7, 2009 in Bangkok, Thailand

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International Hydrological Programme VII (IHP-VII) directs the research objectives of hydrologists all over the world from 2008 to 2013. As a key programme contributed to the IHP VII, UNESCO's Ecohydrology Programme (EHP) has evolved into a trans-disciplinary scientific programme to analyze dynamic relationships between hydrological, social and ecological systems. Twenty international experts from 12 countries were invited by UNESCO to attend the side event on "Ecohydrology—An Interdisciplinary Challenge" in Bangkok, Thailand. It aimed to synthesize knowledge gaps for addressing issues related to critical water systems. This event focused on how better knowledge of the interrelationships between the hydrological cycle, livelihoods and ecosystems could be contributed to more cost-effective and environmental-friendly management. The five themes of the event with 20 keynote lectures were given as fellows.

1 Ecohydrology and UNESCO

Shahbaz Khan, chief of the Sustainable Water Resources Development and Management Section of UNESCO, introduced the IHP-VII and the Ecohydrology Programme. The IHP is the only global intergovernmental scientific programme on water resources of the UN system created in 1975 after the International Hydrological Decade (IHD). The programme is executed by 164 Member States and other partners. UNESCO provides seed money and the member states define needs and plans of phases at different stages. Now it is growing to emphasize management and social aspects. IHP-VII came out with the phase of water dependencies: systems under stress and societal responses. Created the concept of Ecohydrology in 1992, Maciej Zalewski (European Regional Centre for Ecohydrology under the auspices of UNESCO, Poland) pointed out that from the point of view of the methodology of basin/catchment research, two phases of the hydrological cycle should be distinguished: first—atmospheric/terrestrial and second—aquatic. Up to now the both phases of Ecohydrology have been developing independently, however as far as both become new necessary components of the Integrated Water Resorces Management (IWRM). Principles of Ecohydrology as a framework for scientific investigation and problem solving include three aspects: firstly, "Dual Regulation"—biota by hydrology and, vice versa, hydrology by shaping biota or controlling interactions; secondly, integration at the basin scale of various types of regulations toward achieving synergy to improve water quality, biodiversity and freshwater resources; thirdly, harmonization of ecohydrological measures with necessary hydro-technical solutions. Iwona Wagner (Polish Academy of Sciences, Poland) illustrated how Ecohydrology extended from local to global scale by presenting the eight UNESCO demonstration sites and their perspectives in the future. The selection of the demonstration projects addresses variety of water-related issues along a river continuum in a catchment and proposing ecohydrological solutions to these issues. These projects relate to landscape processes, water issues in cities, rivers, floodplains, wetlands, reservoirs and coastal areas.

2 Ecohydrology Current State of Art

For dealing with anthropogenic impacts on coastal ecosystems under the variability imposed by climate change scenarios, Luis Chicharo (International Centre for Coastal Ecohydrology, University of Algarve, Portugal) demonstrated the effects to the Guadiana (south Portugal) estuarine and coastal ecosystems associated with the construction of the large Alqueva dam by proposing several ecohydrologically based approaches to sustain coastal ecosystems functions and uses. Water quality and hydromorphology are the most important stressors for macro-invertebrates. Nicola Fohrer (Kiel University, Germany) compiled an integrated modelling tool to assess the

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impact of environmental stressors on aquatic habitat quality in a catchment of the northern Germany. Brian Davidson (University of Melbourne, Australia) gave a lecture of "Valuing Environment and Livelihoods" for attempting to term with the concepts and trade-offs associated with valuing water for different uses. With the lecture of "Integrating Ecology with Social Science", Shelly Burgin (University of Western Sydney, Australia) suggested that the challenge in Ecohydrology was to bridge the gap between the social and ecological/environmental sciences. Marcelo G Novillo (University of La Plata, Argentina) presented some IWRM cases in Argentina. He concluded that traditional water managers still continue carrying out a biased water resources management, though the principles of Ecohydrology has been popular all over the world. The new instruments and tools based on an ecosystem approach and the principles of Ecohydrology are complex for their implementation. Hence water managers need a friendly toolbox, including standard methodologies, best practices and case studies.

3 Ecohydrology in Basin with Limited Capacity

David Harper (University of Leicester, UK) provided two examples of contrasting basins of the Rift Valley in East Africa, one in Kenya and one trans-boundary between Kenya and Tanzania, with the aim of illustrating problems and providing suggestions for assisting towards their solutions. M S Babel (Asian Institute of Technology, Thailand) modeled the operation of a hydropower system in the La Nga River Basin in Vietnam to understand the impact of maintaining the natural flow regime on hydropower production and to suggest the most suitable scenario of hydropower production with full consideration to environmental flow (EF). Ruth Gamboa (University of the Philippines Mindanao, Philippines) introduced two of the eight river systems and how the network has been creative in overcoming limited resources as scientists try to link environment with livelihood in the Philippines.

4 Tools for Ecohydrology

Gong Huili (Capital Normal University, China) presented an example on how to acquire spatio-temporal ecohydrological information and showed it in three-dimensional scale within a wetland in Beijing, China. A 3D visualization tool named as Visual Ecohdyrological Simulator was developed in his study for the purpose of the integrated watershed management and improving the public's understanding of ecohydrology. Zhou Demin (Chinese Academy of Sciences, China) linked landscape ecological variables generated by remote sensing methods with the hydrological spatial pattern produced by geographical information system method. The established eco-hydrological model indicates that 90% of marsh landscape has been lost in his study area in the past 30 years. Further research of wetland ecohydrology needs to be approached for a better understanding of the ecological degradation process linked with the changing hydrological mechanism. From which, scientists can predict the possible ecological consequence caused by a hydrological alteration. Kwame O Ababio (IUCN-PACO) presented an ecohydrological project on transboundary coordination in the Volta River Basin shared by six countries in West Africa. Peter Hehanussa (Asia Pacific Center for Ecohydrology, Indonesia) introduced some projects at national and regional levels in the Asia Pacific region.

5 Example of Managing Complex Interactions & Ecohydrology for Cultural Biodiversity

Hidayat Pawitan (Bogor Agricultural University, Indonesia) introduced the condition of Indonesia water resources, the anthropogenic influences, and the ecohydrological problems that had been generated, and discussed the impacts on the ecosystem services. Giuseppe Arduino (Hydrological/Geological Unit of UNESCO, Indonesia) introduced the project of "Groundwater Artificial Recharge in Vietnam". Koen Meyers (Environmental Sciences of UNESCO, Indonesia) introduced an UNESCO project in Siberut Island, Indonesia covered by the tropical lowland forest with the high endemism and rich biodiversity, however, with a complex hydrology. He showed a good application of Ecohydrology for balancing natural reserve and the local agroforestry in a vulnerable condition. By giving a lecture on the UNESCO project titled "Water Governance and Culture" in Mali, Brelet Claudine (University of Bamako, Mali) suggested that Ecohydrology putting more emphases on the benefits cultural anthropology can offer more water professionals to integrate the local cultures with traditional believes and values, especially in poor rural communities. Toshi Sonoda (Division of Water Sciences, UNESCO in Paris) introduced the background of the IRBM Project, the targets, principles, policies and institutions of IRBM.