ecohydrology

An interdisciplinary approach for the sustainable management of water resources


A joint effort of UNESCO's International Hydrological Programme (IHP) and the Man and the Biosphere (MAB) Programme

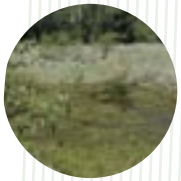
missionstatement

UNESCO's Ecohydrology Programme is a scientific programme to understand and elucidate the dynamic relationships between hydrological, social and ecological systems; to consider how these act upon each other, and to seek new ways to balance human and environmental needs for water resources.

The aims of the programme are:

1. to advance the integration of social, ecological and hydrological research; and
2. to generate outcomes that enable the development of effective policies and practices.

Mission statement



UNESCO and ecohydrology

Task Forces

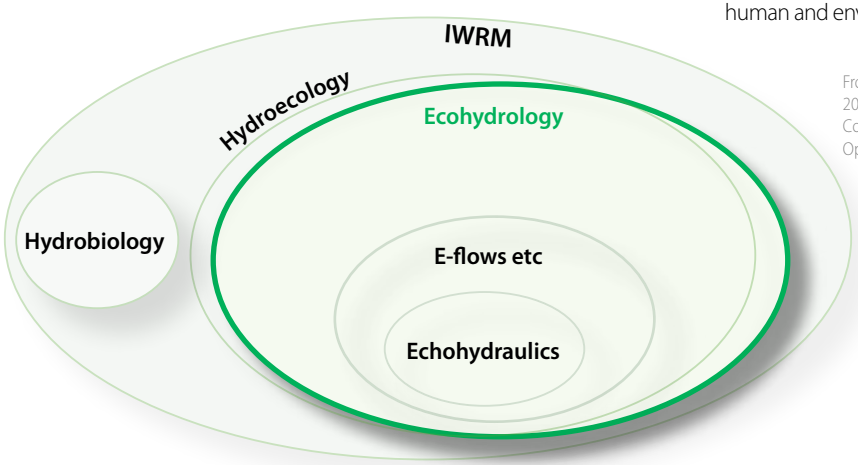
Scientific Advisory Committee

definition

Ecohydrology considers the functional interrelations between hydrology, aquatic ecosystem processes and their biota. It uses ecosystem processes as tools to meet freshwater resource management goals, such as enhancing natural processes of nutrient retention to avoid harmful algal blooms (Zalewski 2000). In effect, it proposes a "dual regulation" of the system by simultaneously using ecological and hydrological processes to enhance the overall integrity of aquatic ecosystems in the face of human-mediated alterations (Zalewski 2006). Ecohydrology does not specify the method of incorporating ecosystem processes into management programmes, as that is necessarily site specific. As part of the strategy, it focuses on understanding useful ecosystem processes and aims to communicate that understanding to water managers in a way that enables incorporation into planned and existing programmes.

By applying new understandings emerging from ecohydrological research as tools in Integrated Water Resources Management (IWRM), water managers can enhance the resilience of freshwater ecosystems to human impacts, thereby capitalizing on ecosystem services and achieving water management goals with minimal engineering inputs and financial investment. The ecohydrology perspective is based on the assumption that sustainable management depends on the restoration and maintenance of established fluvial processes, nutrient cycling, and energy flows (Madsen *et al*. 2006). To date it has been largely applied in the control of pollution in lakes, large reservoirs and rivers through the controlled manipulation of water regimes (e.g., Zalewski et al. 2000; Wagner & Zalewski 2000). However, ecohydrology is becoming broader and more effective by incorporating fundamental social and cultural considerations into the process. It is therefore moving towards a better understanding of the dynamic relationships between hydrological, social and ecological systems, and developing a more holistic "social ecohydrological" model which will, in turn, enable new ways to balance complex human and environmental needs for water.

Relationship between key terms



From: Naiman R.J., Bunn S.E., McClain M.E., Vörösmarty C.J., and Zalewski M. 2006. The Science of Flow-Ecology Relationships: Classifying Key Terms and Concepts. 2006. Paper presented at the Earth System Science Partnership Open Science Conference, Beijing.

IWRM

A process promoting the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (GWP 2000).

References

GWP (Global Water Partnership). 2000. Integrated Water Resources Management. TAC Background Paper 4. Global Water Partnership, Stockholm [available on-line at http://www.gwpforum.org/gwp/library/TACNO4.PDF].

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Wagner I. and Zalewski M. 2000. Effect of hydrobiological patterns of tributaries on processes in lowland reservoir – consequences for restoration. Ecological Engineering 16:79-90.

Zalewski M. 2000. Guest Editorial. Ecohydrology – the scientific background to use ecosystem properties as management tools towards sustainability of water resources. Ecological Engineering 165:1– 8.

Zalewski M. 2006. Flood pulses and river ecosystem robustness. Frontiers in Flood Research/ Le Point de la Recherche sur Les Crues. International Association of Hydrological Sciences (IAHS) Publication No. 305:143-154.

UNESCO and ecohydrology

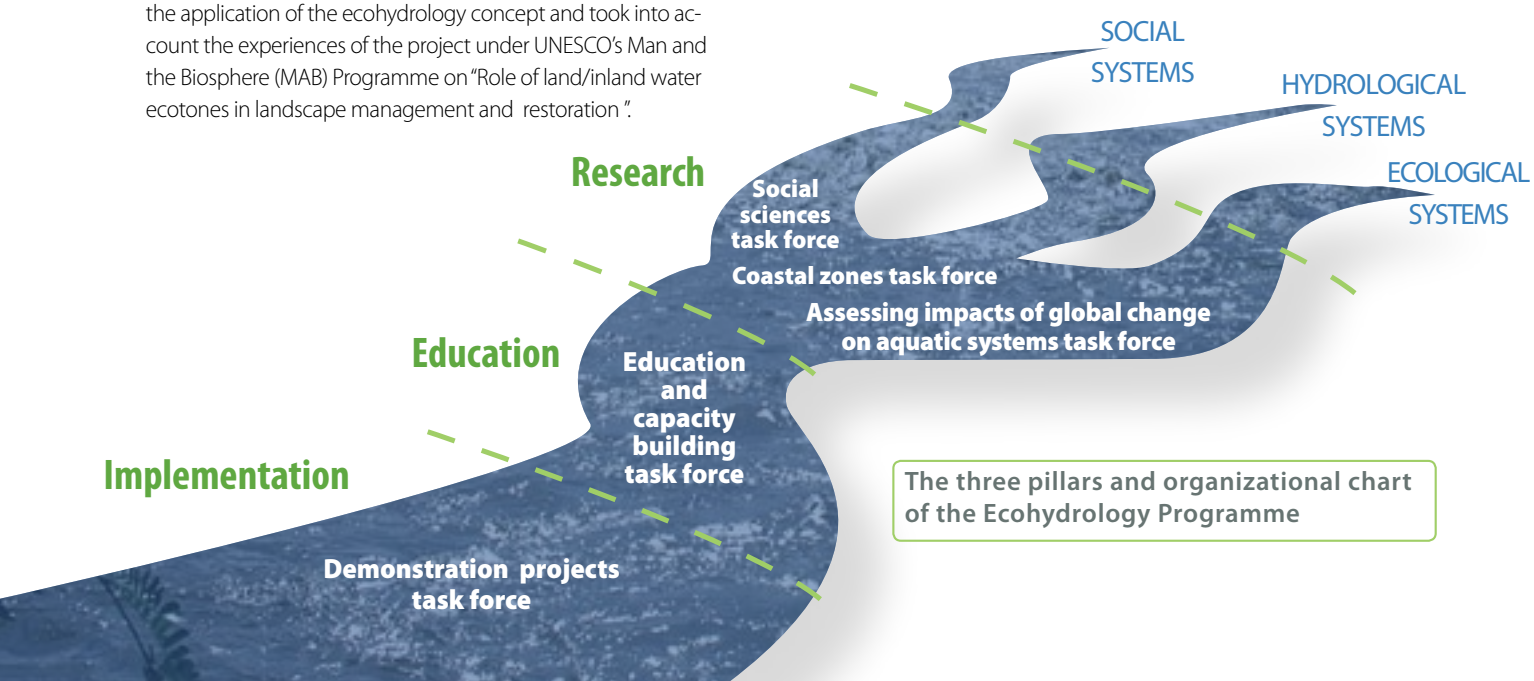
The concept of ecohydrology that developed within the framework of UNESCO's International Hydrological Programme (IHP) was inspired by conclusions from the International Conference on Water and the Environment, held in Dublin in 1992. This conference highlighted the need for new concepts and solutions to achieve sustainability of water resources.

As a follow-up to this conference, in 1996, the IHP launched an activity that focused on the integration of biological and hydrological processes at the catchment scale in order to develop the scientific basis for a new systemic and cost-effective approach to the integrated management of freshwater resources. The ecohydrology approach that developed as the result of this activity is based on the assumption that ecosystem properties and water dynamics can be managed so as to maximize their synergistic interactions and to optimize resilience of ecosystems to human-induced stresses, while also reducing such stresses.

Activities implemented under the fifth phase of the IHP (IHP-V: 1996-2001) focused on the formulation of the principles guiding the application of the ecohydrology concept and took into account the experiences of the project under UNESCO's Man and the Biosphere (MAB) Programme on "Role of land/inland water ecotones in landscape management and restoration ".

New momentum was gained during the sixth phase of the IHP (IHP-VI: 2002-2007), which gave birth to UNESCO's Ecohydrology Programme. In 2005, a network of demonstration projects was launched, which address a wide range of environmental and social issues. In 2006, five Task Forces were launched: (i) Costal Zones; (ii) Assessing Impacts of Global Change on Aquatic Systems; (iii) Social Sciences; (iv) Education and Capacity-building; and (v) Demonstration Projects (which incorporates the network of demonstration projects launched in 2005). These Task Forces together contribute to the three pillars of the Ecohydrology Programme: research, education and implementation.

In 2007, the newly reconstituted Scientific Advisory Committee (SAC) on Ecohydrology developed a new mission statement and strategy for the Ecohydrology Programme. In the seventh phase of the IHP (IHP-VII: 2008-2013), the Programme will build upon knowledge acquired in the previous two phases of the IHP, seeking to move ecohydrology forward as a transdisciplinary approach to the solving of issues surrounding water, environment and people.



The three pillars and organizational chart of the Ecohydrology Programme

coastal zones task force

Why a task force on coastal zones?

Coastal zones are the sites of some of the most important, productive and unique ecosystems on earth. They are also centres of human population and commerce. Both the natural and human elements of coastal zones are vulnerable to changes associated with climate variability in conjunction with anthropogenic pressures. For this reason, sustainable management of coastal zones is essential to both ecosystem and population health. Ecohydrology is proposed as an approach through which sustainable use of estuaries and coastal waters resources can become possible.

Task force vision and methodology

This task force will work towards raising awareness on the importance of the ecohydrology approach in estuaries and coastal areas. The task force will concentrate on creating a worldwide network on the ecohydrology of coastal zones, and publishing scientific and informational material. Based on knowledge and experience accumulated through activities conducted in Europe since 2002, the task force's main aim is to globally disseminate the knowledge consolidated in Europe with regard to how ecohydrology can be applied to coastal areas and estuaries. It also aims to:

- advance scientific knowledge towards the development and application of ecohydrological tools for estuaries and coastal areas around the world;
- promote the application of ecohydrology to find solutions for the sustainable development and use of coastal waters and estuaries;
- promote capacity-building in estuarine and coastal water ecohydrology; and
- facilitate linkages between education, society, and global and local aspects of ecohydrology to ensure that ecosystems continue to provide ecological services to society.

The task force's vision is to globally promote the sustainability of estuaries and coastal waters by applying the low-cost technology ecohydrology approach in different regions around the globe, adapting it to local requirements based on local scientific knowledge and technology. Activities implemented by the task force respect and ensure quality of life for populations, while at the same time promoting ecosystem health. This vision requires solid interactions between scientific development, education, and local societies.

Task Force members

- Task force leader: Luis Chicharo, Associate Professor, Faculty of Marine and Environmental Sciences, University of Algarve, Portugal
- Francisco Arias Isaza, General Director of the Institute of Marine and Coastal Investigation, Colombia
- Suwanna Panutrakul, Assistant Professor, Department of Aquatic Science and Environment, Burapha University, Thailand
- Eric Wolanski, Senior Principal Research Scientist, Australian Institute of Marine Science, Australia

assessing impacts of global change on aquatic systems task force

Why a task force on assessing impacts of global change on aquatic systems?

With major changes – such as population increase and migration, climate change, and industrialization – taking place on the global scale, it is important to monitor these changes and their impacts on ecological and hydrological cycles. The task force was formed to focus on the monitoring and assessment of impacts of global change on aquatic ecosystems.

Task force vision and methodology

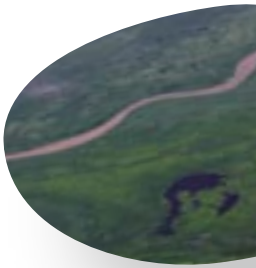
This task force seeks to incorporate the concept of environmental flows into the concept and application of ecohydrology. In the medium-term, the task force will work towards developing databases and indicators that show the global status of the knowledge base on environmental flows and their application in ecohydrological principles. In the short-term, the task force will develop databases and other tools (e.g., indicators) which reflect the global status of key aspects of knowledge and application of ecohydrology principles.

Task Force members

- Task force co-leader: Carmen Revenga, Senior Freshwater Scientist, Global Conservation Approach Team, The Nature Conservancy, United States
- Task force co-leader: Richard Robarts, Director, UNEP GEMS/Water Programme, Canada
- Arun Shrestha, Climate Change Specialist, International Centre for Integrated Mountain Development, Nepal
- Vladimir Smakhtin, Hydrology and Water Resources, International Water Management Institute, Sri Lanka
- Ulric Trotz, Caribbean Community Climate Change Centre, Belize

Environmental flows

Water regime of a river, wetland or coastal zone necessary to maintain the biophysical components, ecological processes and health of aquatic ecosystems, and associated ecological goods and services (Arthington *et al.* 2006).



Reference

Arthington, A.H., S.E. Bunn, N.L. Poff, and R.J. Naiman. 2006. The challenge of providing environmental flow rules to sustain river ecosystems. Ecological Applications 16:1311- 1318

social sciences task force

Why a task force on social sciences?

The existence of this task force is based on the premise that any study of water-related issues that does not take into account human and social contexts can never be complete and would therefore lead to ineffective water resources management policies. Building on the results of a workshop on integrating social and cultural aspects into ecohydrology held in December 2005 at UNESCO, the social sciences task force aims to integrate social and natural sciences in ecohydrology by:

- emphasizing the policy value of the social scientific approach with regard to decision-making, to make the best use of natural and social science knowledge;
- supporting the transfer of knowledge and technologies to decision support tools;
- promoting usable scientific iterativity; and
- offering interdisciplinary and transdisciplinary critiques.

Task force vision and methodology

The social sciences task force aims to integrate social sciences into existing ecohydrology research as well as into demonstration projects, which are beginning to recognize the importance of social and cultural factors but have yet to fully incorporate them in their work. This integration is to be accomplished through the use of small, self-contained research modules, such as communication with stakeholders and student exchanges; eventually, new demonstration projects, which would address social scientific concerns and issues, will be implemented.

Task Force members

- Task force leader: Maria Carmen Lemos, Assistant Professor, School of Natural Resources and Environment, University of Michigan, United States
- Roger Monte Domecq, Research Department Director, National University of Asuncion, Paraguay
- Clive Lipchin, Director of Research, Centre for Environmental Policy, Arava Institute for Environmental Studies, Israel
- Wapalumuka Mulwafu, Senior Lecturer, History, University of Malawi, Malawi
- Jorge Recharte, Director, Andean Programs, The Mountain Institute, Peru
- Ex-officio member: Chiung-Ting Chang, Lecturer in Environmental Economics, UNESCO-IHE

education and capacity-building task force

Why a task force on education and capacity-building?

Education is the building block for all knowledge – local, regional, national and global – and the integrative science of ecohydrology is no exception. Ecohydrology can be considered one of the tools for the implementation of IWRM, as well as for ensuring biodiversity conservation and sustainable development. As such, the task force devoted to education and capacity-building will be based on the following assumptions:

- there have been significant training materials and educational materials already developed in the field of ecohydrology; and
- there is a need for cross-cutting work between the different task forces in order to develop, apply and promote ecohydrology, and to ensure continuity and use of existing expertise and momentum.

Task force vision and methodology

The vision of this task force on education and capacity-building is to ensure that the industry standard for the management and development of water resources will include the principles of ecohydrology. This means that ecohydrology would be developed, applied and promoted as a recognizable banner for sustainable IWRM.

Objectives for this task force for the 2006-2007 biennium are to support the IHP as a central clearinghouse for ecohydrology training and education and to facilitate such training and education to establish a solid building block for future study. In order to accomplish these goals, members of the task force will implement a number of diverse activities over the period 2006-2008.

Task Force members

- Task force leader: Monique Dubé, Associate Professor and Canada Research Chair, Aquatic Ecosystem Health Diagnosis, Toxicology Centre, University of Saskatchewan, Canada.
- Yasin Al-Zu'bi, Dean, Faculty of Agricultural Technology, Al-Balqa' Applied University, Jordan
- Stuart Bunn, Director, Centre for Catchment and In-Stream Research, Faculty of Environmental Sciences, Griffith University, Australia
- Evens Emmanuel, Water Quality and Environment Laboratory Director, University Quisqueya, Haiti
- Mary Seely, Executive Director, Desert Research Foundation of Namibia, Namibia
- Ex-officio member: Jay O'Keefe, WWF Chair of Freshwater Ecosystems, UNESCO-IHE

demonstration projects task force

What is the demonstration projects task force?

The growing demand to provide evidence of successful implementation of ecohydrological solutions called for a worldwide network of demonstration projects. The demonstration projects task force will meet this demand, by highlighting research that validates and quantifies the effectiveness of the ecohydrological approach on the ground in different circumstances around the world.

Demonstration projects aim to:

- demonstrate the application of the ecohydrological approach to the solution of issues surrounding water, environment, and people;
- contribute to the development of research on ecohydrology and to enhance scientific knowledge of implementation of IWRM;
- identify solutions to sustainable development in ecological and social systems where water acts as the main driver; and
- validate the effectiveness of a practical application of ecohydrology, both in qualitative and quantitative terms.

Officially launched in November 2005 at a meeting in Lodz, Poland, leaders of these eight demonstration projects were incorporated, in 2006, as members of the task force on demonstration projects.

Task force vision and methodology

Demonstration projects aim to develop, validate and implement ecohydrology in integrated watershed management. Results of research conducted at each project site will contribute to the development of a cost-effective and comprehensive strategy, not only for improving water quality and quantity, but also for meeting local concerns in a given region.

Demonstration project sites

Eight sites are currently being supported by UNESCO's IHP:

Lacar Lake, Argentina
Sustainable management of Andean-Patagonian watershed: Improving land use policy at Lacar Lake Watershed based on an ecohydrological approach.
Project leader: Ramiro SARANDÓN, University of La Plata, Argentina.

Amazon River Floodplain, Brazil
Sustainable timber production and management of central Amazonian white-water floodplains, Mamirauá Sustainable Development Reserve, Brazil.
Project leader: Florian WITTMANN, Max-Planck Institute for Limnology, Germany.

Paraná Floodplain, Brazil
Creation of a Biosphere Reserve to prevent decline in the unique subtropical river floodplain biodiversity.
Project leader: Angelo Antonio AGOSTINHO, State University of Maringa, Brazil.

Serengeti Plain, Kenya and Tanzania
Study of inter-basin transfer of water resources and water deficit for large mammals migrating to Serengeti.
Project leader: Emmanuel GERETA, Tanzania National Parks, Tanzania.

Lake Naivasha, Kenya
Re-creation of artificial Cyperus papyrus wetlands surrounding the lake and the inflowing rivers delta; basin-wide phyto-technological methods for restoration of the basin hydrology and hydrochemistry.
Project leader: David HARPER and the Lake Naivasha Riparian Association, Kenya.

Biosphere Reserve Lobau, Austria
Sustainable floodplain lake management: conserving macrophyte biodiversity and ecosystem services.
Project leader: Georg JANAUER, University of Vienna, Austria.

Pilica River, Poland
Application of ecohydrology and phytotechnology for water resources management and sustainable development.
Project leader: Iwona WAGNER, University of Lodz, Poland.

Guadiana Estuary, Portugal
Sustainable estuarine zone management for control of eutrophication, toxic blooms, invasive species and conservation of biodiversity.
Project leader: Maria Alexandra CHICHARO, University of Algarve, Portugal.

Scientific Advisory Committee

UNESCO's Scientific Advisory Committee (SAC) on Ecohydrology was reconstituted and formally appointed by the IHP Bureau in May 2006.

The SAC is responsible for:

- setting biannual and annual objectives within the framework of UNESCO's programme and budget, and making sure that the planned objectives are being achieved;
- setting the strategic direction and providing advice concerning UNESCO's Ecohydrology Programme;
- promoting consolidation of ecohydrology activities in their respective regions as well as at the international level;
- facilitating further scientific research on ecohydrology, in particular to promote integration of the concept with related sciences and their application into practice for sustainable IWRM;
- promoting UNESCO's work on ecohydrology through engaging in education, capacity-building, communication and information-dissemination efforts;
- maintaining and strengthening links of UNESCO's Ecohydrology Programme to other activities being undertaken by scientists and organizations around the world in the framework of ecohydrology;
- attracting donors and mobilizing resources, as necessary.

The SAC consists of seven members, representing each of the six regional groups of UNESCO. The SAC also includes one member representing the International Council for Science (ICSU).

- **Region I:** Robert J. Naiman, Professor in the College of Ocean and Fishery Sciences at the University of Washington, United States [SAC Chairperson]
- **Region II:** Maciej Zalewski, Director of the International Centre for Ecology at the Polish Academy of Sciences, Poland
- **Region III:** Marcelo Gavino, Professor at the Department of Hydraulics at the National University of La Plata, Argentina
- **Region IV:** Veronica Strang, Professor of Social Anthropology at the University of Auckland, New Zealand
- **Region V(a):** Laurent Robison, Doctor of Hydrobiology at the National Centre for Environmental Research, Madagascar
- **Region V(b):** Zoubeida Bargaoui, Professor at the Civil engineering Department of the National Engineering School of Tunis at the University of El Manar, Tunisia
- **ICSU:** Charles Vörösmarty, Research Professor of Global-scale Hydrology at the University of New Hampshire, United States

The European Regional Centre for Ecohydrology (ERCE) under the auspices of UNESCO opened in May 2006 in Lodz, Poland. Other regional centres on ecohydrology are expected to be set up in Asia and Latin America, and these regional centres will work in close collaboration with each other and with other water-related centres under the auspices of UNESCO.

for moreinformation

publications

UNESCO IHP Technical Documents in Hydrology

Zalewski M., Janauer G.S., Jolankai G. (ed.). 1997. Ecohydrology - A new Paradigm for the Sustainable Use of Aquatic Resources. No 7.

Viville D., Littlewood I.G. (ed.). 1997. Ecohydrological Processes in Small Basins. Proceedings of the Sixth ERB Conference (Strasbourg, France, 24-26 September 1996). No 14.

Zalewski M., McClain M. 1998. Ecohydrology - A list of Scientific Activities of IHP-V Projects 2.3/2.4. No. 21.

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Harper D., Zalewski M. (ed.). 2001. Ecohydrology - Science and the sustainable management of tropical waters. No 46.

McClain M.E., Zalewski M. (ed.). 2001. Ecohydrology-Hydrological and Geochemical Processes in Large River Basins. No 47.

Bloesch J., Gutknecht D., Iordache V. (ed.). 2005. Hydrology and Limnology: Another Boundary in the Danube River Basin. No 75.

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Ecohydrology and Phytotechnology Handbooks

(joint UNESCO-IHP and UNEP-IETC publication)

UNEP-IETC, UNESCO-IHP. 2002. Guidelines for the Integrated Management of the Watershed - Phytotechnology and Ecohydrology. Zalewski M. (ed.). UNEP-DTIE-IETC, Freshwater Management Series No. 5. **www.unep.or.jp/ietc/Publications/Freshwater/FMS5.**

UNESCO-IHP, UNEP-IETC. 2004. Integrated Watershed Management- Ecohydrology & Phytotechnology Manual. Zalewski M., Wagner-Lotkowska I., Robarts R. (ed.). UNESCO-IHP, UNESCO-ROSTE, UNEPDTIE- IETC, ICE PAS, DAE UL, Venice, Osaka, Warsaw, Lodz. **www.unep.or.jp/ietc/publications/freshwater/watershed_manual.**

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International Hydrological Programme
www.unesco.org/water/ihp

Man and the Biosphere Programme
www.unesco.org/mab

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