



SIL news

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The International Association of Theoretical and Applied Limnology (Societas Internationalis Limnologiae Theoreticae et Applicatae, SIL) promotes and communicates new and emerging knowledge among limnologists to advance the understanding of inland aquatic ecosystems and their management.

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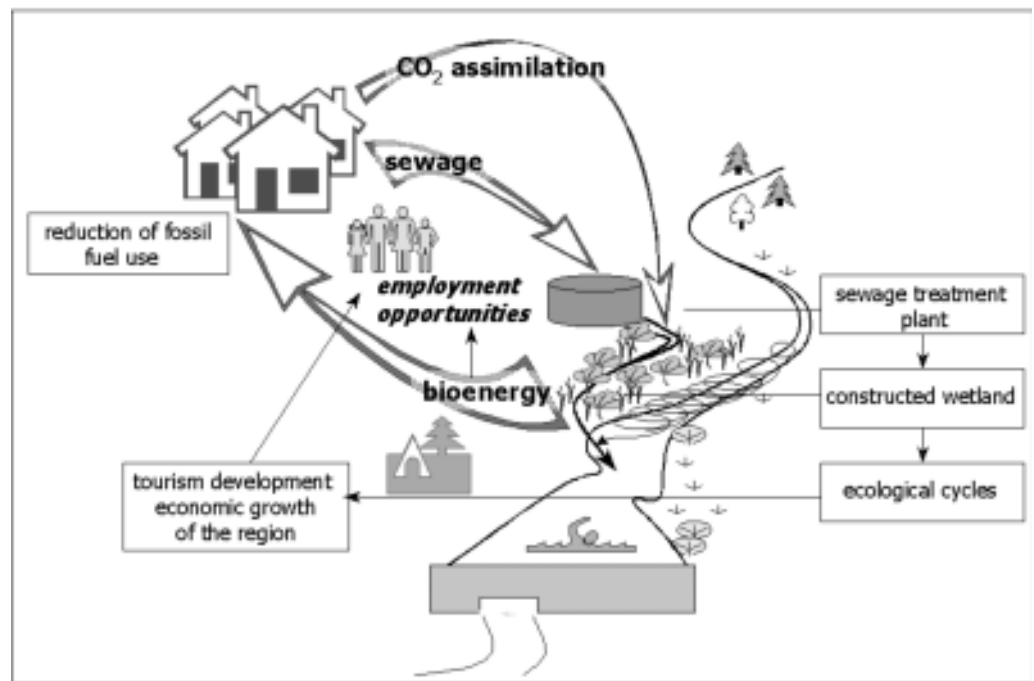


Fig. 1. The development of the ecohydrology concept for improving water quality, ecosystem services and the creation of positive socioeconomic feedbacks.

Material for the January 2004 issue should be sent to the Editor for:

October 1, 2003

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Contributions on a PC formatted disk, in any standard word processor or DOS (ASCII) text, or as email attachments, will assist the Editor.

Ecohydrology - a new paradigm for integrated water resources management*

by
Maciej Zalewski and Richard Robarts

** To learn more about ecohydrology, attend the session at SIL2004 in Finland.*

continued on next page

According to the International Council of Scientific Unions (ICSU) science of the 21st Century has to be integrative and policy oriented in order to achieve sustainable development in the face of rising global scale environmental challenges. Fresh water is becoming a primary limiting resource at the global scale. A holistic problem-solving approach in environmental sciences is the new emerging discipline, ecohydrology that integrates limnology with hydrology.

The decline of water quality and biodiversity observed in both developing and developed countries provides sobering evidence that the purely “mechanistic” and fragmented approach at a global scale to water resources management based largely on hydrotechnical solutions, such as application of sewage treatment plants, has been less than successful. Furthermore, this has often led to an over engineering of the environment. While the elements of this approach remain valid and viable, technical solutions alone are clearly insufficient for the sustainable use of world water resources. In an effort to bridge this gap the scientific basis for the concept of Ecohydrology has been developed by UNESCO-IHP. The general idea of the concept is that by applying an understanding of the interplay between hydrology and biota, considering the range of techniques from the molecular to the catchment scales, an augmentation of the absorbing capacity of ecosystems to human impacts can be achieved. Moreover, during the programme increasing evidence indicated that such a holistic approach could provide not only the means to improve the environment but could also create positive socioeconomic feedbacks (Fig. 1).

An important step for development of the ecohydrology concept occurred during the UNESCO MAB (Man and the Biosphere) Programme, “Role of land/inland water ecotones in management and restoration of landscapes” (Naiman, Decamps & Fournier 1989) in which ecological concepts were integrated with management and conservation goals. Also at that time the UNESCO International Conference on Water in Dublin (1992) noted the world wide decline of water resources, postulated an urgent need for new concepts and solutions. The conclusions and novel results achieved during the “Ecotone” Programme inspired the General Secretary of IHP, Andras Szöllösi-Nagy, to launch in 1996 a subprogramme of the International Hydrological Programme (IHP) that focused on elaborating the scientific basis for integration of biological and hydrological processes in inland waters.

Concept

The primary question to be answered at the initial stage

of the concept formulation was why efforts to integrate the two independent “kingdoms”- limnology and hydrology - did not appear before. The answer is simple: limnology until the last decade of the 20th Century had a low predictive capacity. The biomanipulation concept not only highlighted the functioning (bottom up vs. top down) of freshwater ecosystems, but also demonstrated that the achieved predictive capacity was sufficient for successful management of freshwater ecosystems.

As far as science starts from the definition of principles, during UNESCO IHP V and VI international teams of limnologists and hydrologists worked on the development of the concept. As a result, three principles have been formulated (Zalewski 2000, 2002b, 2002c), providing the framework, target and methodology for ecohydrology:

I Hydrological principle

Framework - Integration of catchment landscape, hydrology and its biota into a single entity.

This covers such aspects as:

- Scale - the mesoscale cycle of water circulation within a basin (terrestrial/aquatic ecosystem coupling) provides a template for the quantification of ecological processes, e.g., nutrient budgets and heat budgets;
- Dynamics - water and temperature have been the driving forces for both terrestrial and freshwater ecosystems, e.g., decomposition rate; and,
- Hierarchy of factors - while abiotic processes are dominant, e.g., hydrological processes, biotic interactions may manifest themselves when they are stable and predictable (Zalewski and Naiman 1985).

II Ecological principle

Target - Enhancement of the evolutionarily established resistance and resilience of ecosystems to stress by using an understanding of the interplay between hydrology and biota. This aspect of ecohydrology expresses the rationale for a proactive approach to the sustainable management of freshwater resources. It assumes that it is not enough to simply protect ecosystems, but, in the face of increasing global changes that are manifested as increases in population, energy consumption, and material and human aspirations, it is necessary to increase the *capacity of ecosystems* (or their resistance and resilience) to absorb human-induced impacts.

III Ecotechnological principle

Methodology - The use of ecosystem properties as a management tool by using biota to control hydrological processes and, vice versa, by using hydrology to regulate biota. The large potential of knowledge which has been generated by the dynamic development of ecological

engineering (Mitsch 1993; Jørgensen 1996) should to a large extent accelerate implementation of the above concept.

All three principles are illustrated in Fig. 2 where the control of eutrophication in a temperate reservoir through application of different ecologically-based measures in the river basin has been focused on a reduction in phosphorus inputs to induce phosphorus limitation of aquatic biological productivity.



Fig. 2. An example of synergistic interactions between different processes to enhance the capacity of a river basin for self-purification (modified from Zalewski, 2000).

Implementation of the Ecohydrology Concept for the improvement of water quality restoration of freshwater ecosystems and the creation of positive socioeconomic feedback.

Traditional sewage treatment plants in a small town usually do not possess a sophisticated tertiary chemical treatment stage due to high costs of construction that local communities cannot afford. They reduce BOD and some nutrients but still negatively influence water quality, reducing the benefits of rivers and reservoirs and their recreational values. Extending the sewage treatment by constructing a wetland results in more efficient reduction of pollutant loads and generates additional societal benefits. Improvement of water quality increases the appeal of water resources for tourism, which contributes to the inflow of capital to a region (Fig. 1). Moreover, the establishment of multispecies willow plantations using local species that can tolerate the resulting high ground water level, maintains river valley landscape biodiversity and provides an alternative source of energy (bioenergy) that can help to reduce CO₂ emissions from burning fossil

fuels. The resultant ash can be used to fertilise forest plantations. Thus, pollutants are converted into bioenergy. Producing bioenergy and timber also generates new employment opportunities and revenue flows while reducing capital outflows for fossil fuel use. The use of ecological knowledge, therefore, results not only in a good quality environment but also can help to elevate the economic status and level of sustainable development in local communities.

Such an implementation case as a UNESCO/UNEP demonstration site has been recently under development at the town of Przedborz on the Pilica River, a western tributary of the Vistula River, above the Sulejow Reservoir in Poland.

Ecohydrology as a consequence of the evolution of scientific paradigms.

The formulation of the ecohydrology concept defined in UNESCO IHP V was to a large extent a logical consequence of the progress of river ecology. It can be thought of in two steps, using fundamental tenets of the scientific method such as Kuhn's paradigm and Popper's null-hypothesis falsification (Fig. 3).

The first step (time axis) was plotting the evolution of river ecology approaches in a series of stages as defined by key publications. The second step (vertical axis) consisted of inspiring oscillations between holistic concepts, e.g., the river continuum (Vannote *et al.* 1980), and reductionist experimental tests and developments, e.g., the interbiome comparison of stream ecosystem dynamics (Minshall *et al.* 1983). This continual interplay has been considered as a major force driving our progress in understanding river ecosystems.

Superimposed on a temporal scale, the scope of thinking about river ecosystems was broadened from river zones to the river continuum, then to rivers and their valleys, and finally to the river basin as an ecohydrological concept. In parallel with this shift in thinking, the approach was developed through the generation of three key hypotheses:

- community structure and its relation to abiotic factors (slope);
- the dynamics of energy flow, nutrient cycling and biodiversity; and,
- the functional relationships between hydrology and biota for control of ecosystem processes - Ecohydrology.

Attempts to place knowledge fragments about the structure of riverine biota into a holistic framework started with Shelford in 1911. But the first effort to

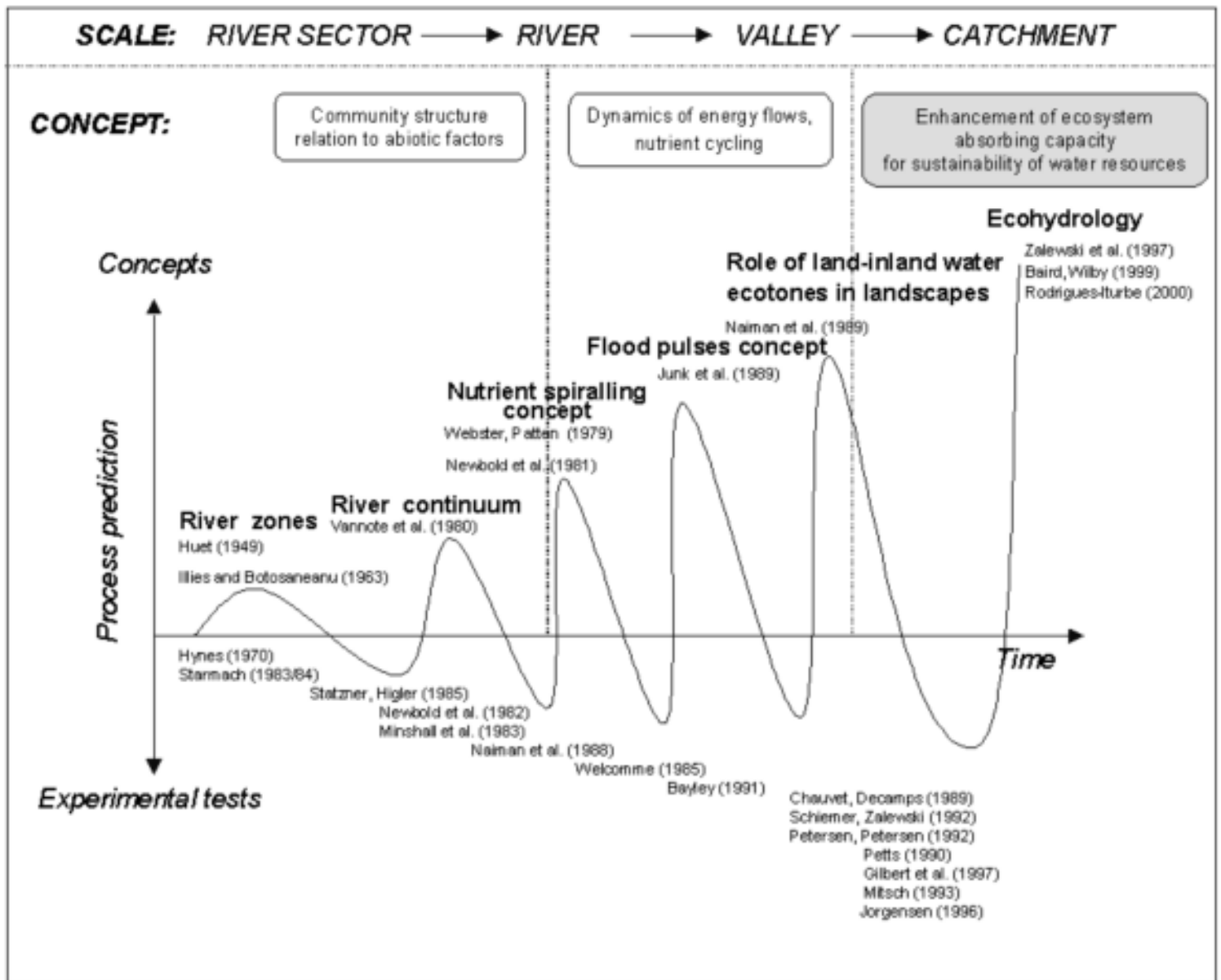


Fig. 3. The genesis of ecohydrology - the interplay between a holistic concept and reductionistic experimental tests and developments as a driving force of progress in knowledge about the ecology of river basins (modified from Zalewski 2002a).

integrate the biological structure of fish communities as a function of abiotic hydrological factors (river slope velocity) was proposed by Huet in 1949. A large step that exceeded the actual level of advancement of river ecology was proposed by Hynes (1970), that rivers should be analyzed from a watershed perspective. The next serious development occurred as a shift from "structural" thinking (species composition in river zones) to "functional" thinking (production to respiration ratio) in the holistic framework of the river continuum. This was extended by the concepts of nutrient-spiralling (Webster and Patten 1979) and the flood pulse (Junk *et al.* 1989). All these ideas were defined through syntheses of experimental and conceptual efforts, and some of the most notable are detailed below the lateral

axis (Fig. 3). One might be especially considered in relation to the genesis of ecohydrology. Zalewski and Naiman (1985) suggested that, considering the regulatory mechanisms for fish communities in rivers, "abiotic factors (hydrology) were of primary importance in most situations but when environmental conditions approach the physiological optimum for fish and become stable and predictable, the role of biotic interactions gradually increases". A substantial change, expressing a new proactive attitude in ecological/environmental thinking, was the consideration of the role of the landscape in mitigating human impacts - namely managing land/water buffering zones (UNESCO MAB Programme). For the first time manipulation of biotic structures (ecotones) with this concept was considered for management, restoration

and, implicitly, for the conservation of aquatic systems. All these efforts created the background against which the ecohydrology concept was formulated and provided a holistic, integrative and interdisciplinary approach for scientific research. It extends from the molecular to the catchment process scale by setting a **framework** for quantifying and integrating hydrological and ecological processes; it **targets** enhancement of ecosystem absorbing capacity; and it is a management **tool**, using ecosystem properties for regulating biota by hydrology and hydrology by biota.

An increasing number of authors are contributing to various aspects of ecohydrology, e.g., Chicharo *et al.* (2001), Gouder de Beauregard *et al.* (2002), Trepel and Kluge (2002).

The most important result of ecohydrology is not only the creation of a scientific paradigm, but also the acceleration of the progress in limnology that provides the capacity to incorporate and use new interdisciplinary knowledge for diagnosis and restoration of freshwater ecosystems. The future trend of the curve in Fig. 3 will be determined by the willingness of ecologists and hydrologists to work collaboratively.

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Recovering from the Australian drought

Australia is currently in the grip of the worst drought on record. Will land and water management practices exacerbate or alleviate the stress of prolonged drought on Australia's rivers and wetlands?

Drought is part of the natural climatic cycle experienced by Australia's rivers, lakes and wetlands. Natural low-flow and dry periods are as important as natural high flows and floods for maintaining biodiversity and healthy rivers. The abilities of organisms to survive prolonged dry conditions and drought (their resistance) and recover from it (their resilience) are 'hard-wired' into healthy aquatic ecosystems through eons of evolution.

Nevertheless, a one-in-a-hundred-year drought is a significant environmental stress. For native populations to survive and recover from a prolonged drought, all their built-in ecological resistance and resilience mechanisms need to be fully functional. That may not be the case in river ecosystems that are stressed by habitat destruction, reduced flows and poor water quality.

For all rivers and wetlands, our ways of managing land and water during and following drought are of critical importance. In particular, in-stream and floodplain drought-refuges, and the organisms they support, need to be protected. The following are some management actions that could help preserve aquatic communities.

- Environmental flows should continue to be released to protect stream refuges and habitats downstream of dams.
- Cart in water for livestock, where possible, rather than pumping it out of waterholes or drying ephemeral streams. Waterholes are critical refuges for freshwater fish, frogs, birds and invertebrates.
- Fence out or move livestock away from wetlands, waterholes and low rivers, so they will not damage the banks and beds and vegetation. Grazing, trampling and dung add severely to the stress these habitats are already bearing.
- Erect signs warning against over-fishing in waterholes and low rivers. Native fish, turtles and invertebrates, such as yabbies congregating in waterholes and low creeks, are the breeding adults that will restock our rivers and wetlands after the drought.

And a final word ... drought can benefit river ecosystems by selectively reducing exotic species poorly adapted to drought conditions. Introduced trout have severe predatory impacts on populations of small native fish such

as Mountain Galaxiids. Droughts are known to selectively reduce trout populations allowing threatened Galaxiid populations to recover.

Supporting literature and further reading

Lake, P.S. 2003. *Freshwater Biology* **48**:1161-1172 and other papers in this special edition on drought research.

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Letter to the Editor

I read in *SILnews* 39 an interesting story on "Is Big Beautiful? Alqueva Reservoir (Portugal): the Largest Artificial Lake in Europe" by Luís M. Zambujal Chicharo. The story was good but it included one major error in the headline and text.

Alqueva Reservoir (area 250 km²) is NOT the largest one in Europe. In the early seventies two large reservoirs, Lokka (417 km²) and Porttipahta (214 km²) were built in the upper part of the Kemijoki River in northern Finland. Both reservoirs were built to produce hydropower with a wide water level regulation range (Lokka max. 5 m, Porttipahta max. 11 m). Flooded areas consisted mainly of peatlands and forests. Since 1986 the reservoirs are connected by a shallow channel, which means that at maximum level an area of 631 km² is covered by water. More detailed information of these northern reservoirs with their environmental consequences can be found in for example, Hellsten *et al.* (1993). (Hellsten, S., Virtanen, M., Nenonen, O., Kinnunen, K. and Riihimäki, J. 1993. Sources of nutrients and organic matters in Northern reservoirs. *Water Science and Technology* **28**:85-94). In addition to these northern reservoirs, there are several much larger reservoirs in the European part of Russia.

It would be very nice if you could publish this correction in a forthcoming *SILnews* issue.

On behalf of many Finnish *SIL* members,

Seppo Hellsten

Finnish Environment Institute

Finland

Working Groups

Plankton Ecology Group (PEG)

We are pleased to announce for the SIL members that a special issue of *Hydrobiologia* (Vol. 491) has just been published, containing peer-reviewed papers dealing with the theme "Recent Developments in Fundamental and Applied Plankton Research" to mark the retirement of Dr. Ramesh D. Gulati from the research staff of the Centre of Limnology at Nieuwersluis (The Netherlands). The symposium was organised jointly by The Netherlands Institute of Ecology (Centre for Limnology, Nieuwersluis) and the Netherlands-Flemish Society of Ecology (NecoV) on 16 March 2001 in Amsterdam at the Royal Netherlands Academy of Arts and Sciences (KNAW). The Plankton Ecology Group (PEG) of the International Association of Theoretical and Applied Limnology (Societas Internationalis Limnologiae, SIL), of which Ramesh Gulati is secretary, also supported the symposium.

This dedication volume of *Hydrobiologia* starts with an introductory paper by Dr. Sikko Parma, former Director of the Centre for Limnology. This volume includes a biographical sketch of Ramesh, his research career at Nieuwersluis, and highlights his lifetime contributions to limnology and aquatic ecology. The subsequent sections contains 32 papers submitted by the symposium participants and invited papers, which are divided into four themes:

1. Biodiversity, distribution and population dynamics of plankton;
2. Grazing by plankton and the importance of food quality;
3. Role of infochemicals in plankton ecology; and,
4. Predation on zooplankton and pelagic food webs.

We hope that this volume will provide a further impetus for future plankton research.

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Message from the President and the General Secretary-Treasurer

Dear Colleagues,

As many of you may know, UNESCO has designated 2003 as the International Year of Fresh Water. We strongly support this initiative and have written to the project leaders, Mr. Alberto Tejada-Guibert, UNESCO Coordinator; Ms. Amy Otchet, UNESCO Bureau of Public Information; and Ms. Isolda Oca, United Nations Information Officer offering SIL's involvement and support.

We have received a most positive and enthusiastic response to our offer and SIL has so far taken the following steps to interact with and support the International Year of Fresh Water 2003.

- Linked web sites from SIL and several from the Freshwater International Year.
- Organized a cooperative meeting with groups interrelated in this effort for the SIL Congress in Lahti, Finland, 2004.
- Asked the appropriate SIL Working Groups and Committees (e.g., conservation, biodiversity, invasive alien species, biomonitoring, and others) to look for opportunities to promote the goals of the International Year of Fresh Water.

For further information and action items (how to get involved) relative to the International Year of Fresh Water 2003, please see web sites: www.wateryear2003.org and www.un.org/events/water. Press kit materials on the International Year may be found at www.wateryear2003.org - click on "Media Corner".

We would appreciate hearing your suggestions about how SIL can play a significant role in the International Year of Fresh Water 2003; and, more importantly how SIL can play a leadership role in the study, protection, and management of inland waters worldwide and long after 2003.

Gene E. Likens
President

Robert G. Wetzel
General Secretary/Treasurer

Announcements

Aquatic Ecology - a news flash

I am greatly pleased to inform the SIL members that *Aquatic Ecology* since early January 2003 (Vol. 37, 1) is covered in the Science Citation Index Expanded, Current Contents/Agriculture, Biology & Environmental Sciences, and ISI Alerting Services. It is also indexed/abstracted in 12 other international indexing agencies (e.g., ASFA, Biosis Previews, Cambridge Scientific Abstracts, etc.).

The international quarterly journal which succeeded the "Netherlands Journal of Aquatic Ecology" in 1997, is now published by Wolter Kluwer Academic Publishers, Dordrecht, The Netherlands (in co-operation with the Netherlands-Flemish Ecological Society (NECOV). The journal publishes peer-reviewed (three reviews evaluating procedure), original papers relating to ecology of aquatic environments: freshwater, brackish, estuarine and marine. Papers on both fundamental and applied research in both the field and laboratory, including descriptive and experiment studies, short communications, topical review papers and book reviews will be included in the journal. In special cases, proceedings of the thematic symposia are also eligible for publication in the journal.

For "Instructions to authors", the submission of manuscripts or for a complimentary copy of the journal, the readers may contact the Kluwer website: <http://www.wkap.nl>, or address their queries to: Kluwer Academic Publishers, P.O. Box 17, 3300 AA Dordrecht, The Netherlands.

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CASPSCI-NET

The Caspian Sea Scientific Net

CASPSCI-NET – the Caspian Sea Scientific Net constructed under a grant funded by the European Community within the Inco-Copernicus-2000 scientific call was recently set at the Internet (<http://www.caspinfo.net>). Several scientific teams from Azerbaijan, Bulgaria, Greece, Kazakhstan, Norway, Romania, Russia, The Netherlands, Turkmenistan and the United Kingdom were jointly involved in the two-year study. The extensive net contains powerful GIS capabilities with vast field data files, figures, articles and maps on physical and social geography, climatology, hydrophysics, hydrochemistry, hydrobiology, ecology, and modern pollution of the Caspian Sea. Since the sea is an international trans-boundary water body affected by intensive human activity and exploitation, the CASPSCI-NET also comprises information on relevant legislation, publications (more than 5,000 items), scientific-research centers, scientists and scientific events. CASPSCI-NET will be useful for limnologists, authorities, NGOs as well as people interested in lakes and nature.

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Book Reviews

Ethiopian Rift Valley Lakes

Edited by C. Tudorancea & W.D. Taylor
289 pp., 2002, hardbound
Backhuys Publishers, Leiden
ISBN 90-5782-114-1
EURO 80.00

This excellent contribution to a) the African literature on Limnology, and b) to the Biology of Inland Water series deals specifically with the Ethiopian Rift Valley Lakes. There are 11 chapters providing a window through which to view an ancient tectonic landscape and its aquatic biology. The book is introduced by the editors through a helpful Chapter 1, giving a short historical background, followed by precise descriptions of physiography and climate.

The geology of the main Ethiopian Rift is given a scholarly treatment by Dr. Woldi-Gabriel. The text is rich in detail, leading to a description, and significance of the main Rift, which because of the post-rift sedimentation and the fossil material caught up in the process, has contributed significantly to understanding human origins. The chapter deserves close study.

For a limnologist like myself, the geology chapter, and Chapter 2 by Dr. Baxter, which describes the morphometry of the lakes and their chemistry, sets the scene for an exploration through the medium of clear writing to an extraordinary rich, limnologically speaking, region of Africa. Granted none of the Ethiopian Rift Lakes were found to be the origins of the mighty rivers of Africa, e.g., the Nile, but with this synthesis the diversity of lake types and their biota is neatly recorded.

Elizabeth Kebede's description of lake phytoplankton, assisted by a number of clear diagrams, is an elegant contribution, in which the author has drawn upon studies beyond Ethiopia. Her studies point to the remarkable success of so many phytoplankton taxa. The problems associated with increasing human population density, and fisheries development on lake eutrophication potential, are stressed.

This chapter is followed by a very useful synthesis of primary and secondary production in the pelagic zones of many of the lakes. The importance of the classical light and dark bottle technique to measure changes in dissolved oxygen concentrations as opposed to the more frequently used ^{14}C -method in water with high dissolved inorganic carbon concentrations is emphasized, particularly in remote locations. It allows a sharper distinction between gross and net primary production than does the ^{14}C -method. The high productivity of the Ethiopian Rift Valley Lakes has allowed studies using dissolved oxygen profiles to show that the ratio P:R is nearly in balance, and this with chlorophyll concentrations of 16 to 1472 mg m^{-3} !

The zooplankton species found are a mixture of taxa found throughout tropical Africa. Palearctic species are found where latitude moderates climate. Salinity is the proximate factor determining richness and diversity such that both decrease

with an increase in salinity. The chapter is enriched, still further, by a section on bacterioplankton. Once again the link between bacterial abundance and chlorophyll is made: 10 – 30% of bacterial production was supported by gross primary production in L. Asawa. This contrasts with the mere 1% of primary production the zooplankton community uses. These preliminary studies in a tropical lake emphasise the importance of the microbial loop once again.

The authors note the dominance of cyanobacteria, particularly *Microcystis* and its toxins. In their view the threat to humans and animals is underestimated. In a sense this dominance represents not only nutrient supply, but the consequences of the “endless summer” in African lakes, and the communities of grazing-resistant algae which develop, and upon which zooplankton exercise little control.

The synthesis given in Chapter 6, Zoobenthic and Weedbed faunas is wide ranging – from a description of composition and abundance in non-saline lakes to the restricted benthic fauna of crater lakes, in which the fauna is limited to Nematoda, Chironomidae, Ephydriidae and Hemiptera. In the hypersaline L. Chittu, the fauna is reduced to the larvae of the chironomid, *Tanytarsus minutipalpis*! By and large the taxa within the aquatic vegetation are well represented and studied based largely upon the earlier investigations of Professor A.D. Harrison. A valuable contribution is the faunal distribution in sediments of different particle size groups – medium sand (0.25 – 0.50 mm) contains the greatest taxa richness. This chapter also includes data on species richness in relation to water chemistry. Richness does not decrease slowly with increasing conductivity, but rather changes abruptly at 5,000 $\mu\text{S cm}^{-1}$ (L. Arenguade) indicating a wide level of tolerance among the taxa generally present. It remains for the readers to appreciate the depth of this synthesis.

There follows a fascinating account in Chapter 7 of the free-living aquatic nematodes. What a challenging subject, very well handled by Dr. Abebe. The most widely distributed family in the Ethiopian Rift Valley Lakes is the lacustrine family Tobrilidae. The earliest collections of nematodes are those Mr. Omer-Cooper made in 1931.

Yet another link, is that of Professor A.D. Harrison who has had a long association with southern African limnology. His short account of the community of chironomid adults in the Ethiopian Rift records 42 species in three subfamilies, of which the Orthoclaudiinae are the richest in species, 37 in all. Once again the non-saline lakes exhibit the highest species richness.

Chapter 9 on Ostracoda by Dr. Martens argues a number of interesting features of the proposed speciation within the commonest genus, *Limnocythere*. Dr. Martens suggests, at first a Holocene origin, but this is discounted, as the present distribution of species and subspecies is not concordant with the palaeo-hydrology of, for example, L. Asawa. This lake was isolated throughout the Holocene, but this is not ‘translated’ into a more distant (phylogenetically speaking) *Limnocythere* population. Obviously this remains a

stimulating field of future investigation.

Chapter 10, by Dr. Golubtsov and his coauthors, reports on the fishes of the Ethiopian Rift Valley, is the largest of the chapters. It is a rich source of ichthyological detail, and to those involved in African freshwater ichthyology, cannot be ignored. The authors have also given an excellent essay commenting upon the place of the Ethiopian Rift Valley within the wider framework of the ichthyological provinces of tropical Africa. Their view that the Ethiopian Highlands and the central and northern parts of the Ethiopian Rift is a region of the Nilo-Sudan Ichthyological Province appears well founded. In this conclusion, they have been very well served by soundness of the taxonomy reported.

A section on fish fauna conservation adds further interest to the chapter, and to one so far away from the valley, it is startling to read just how many exotic taxa have been introduced into an intrinsically rich, ichthyological region. Even the common goldfish finds a place among the list of exotics! In all of this the authors point to the paradigm of fishery managers: If there is seemingly a vacant niche – fill it! It is to be hoped that the new strategy proposed for fishery management will find acceptance.

Chapter 11, the last chapter by Dr. Gebre-Mariam, is essential reading for all those national and international agencies who express concern about the deterioration in aquatic environments. The trouble, as Dr. Gebre-Mariam points out, is that Ethiopia is far away. Visits by various specialists are usually short term. And although a number of limnologists and fisheries biologists have been trained, particularly through the helpful liaison between Ethiopian tertiary institutions and universities in Canada, Eastern Europe and Russia, research funds are limited. Dr. Gebre-Mariam points out that the most recent limnological data are for 1991/1992. To bring these up to date will require the recognition of the severity of the impact the burgeoning population is having upon the water resources which are essential for survival. These issues are of major limno-environmental concern to all developing countries. Their resolution demands the political will to effect the changes necessary.

The book is very well produced by the publishers. I found four typographical errors, and given the fact that English is not the first language for many of the authors, the text is easy to read with few grammatical errors. The chapter references are carefully prepared, and the subject and taxonomic indexes cannot be faulted.

The editors, their contributors and the publishers deserve the approbation of their colleagues in other parts of the limnological world for assembling such a stimulating account of a little known (until now) part of the Great African Rift.

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The Great Lakes of the World (GLOW) Food Web, Health, and Integrity

Edited by M. Munawar and R.E. Hecky
Backhuys Publishers, Leiden, The Netherlands
472 pp., 2001, hardbound
ISBN 90-5782-081-1
Dutch Guilders 268.00/US\$ 134.00

This book is based on the symposium Exploring the Great Lakes of the World (GLOW): food web dynamics, health, and integrity that was held in 1996 in Zimbabwe. Some of the papers presented at this symposium were published in 2000 in a special issue of Aquatic Ecosystem Health and Management (AEHM) while other papers are included in this book. Additional papers were solicited bringing the total number of papers to 21. It considers six African, four Asian, one South American, and ten North American lakes. These papers can be further classified as either reporting research study results, methods for investigating large lakes ecosystems, or as literature reviews.

Several papers deal with relatively recent scientific studies and are written by the researchers conducting these studies. The papers on the African large lakes are particularly well written; those based on lakes Malawi and Victoria consider not only the limnology of these lakes but the multiple threats to their continued well being. The literature cited is extensive and useful for those seeking to know more about these lakes. The paper on the Indonesian lakes Matano and Towuti provides new information on these largely unknown deep, tectonic lake ecosystems. Both lakes are located on Sulawesi Island and have been geologically isolated from mainland Asia for millions of years.

Some of the papers deal with newer methods in limnological research over a range of topics - optical plankton counters, flow cytometry, acoustics, biochemical, and modeling. They provide excellent introductions to these methods and to the scientific insights revealed by their use.

Several literature papers provide good overviews of various lakes - Biwa, Baikal, Titicaca, and Tahoe. There also are two papers on the Laurentian Great Lakes, which given the many decades of well-published studies of these lakes, are less novel.

Overall, this book contains a series of generally well-written and scientifically interesting papers, many of which merit publication in scientific journals. Regrettably, the book is relatively expensive and most likely to be purchased by libraries. It also is somewhat eclectic in nature as often occurs when books are published based on conference proceedings and involve a diverse and numerous authorship. In general, books written by one to a few authors allow for a clearer and more focused presentation of scientific thought. Classic examples are Hutchinson's *A Treatise on Limnology* and Wetzel's *Limnology*. A similar comprehensive textbook on the limnology, fisheries, and watershed management of the large lakes of the world, written by a small number of authors, would be a welcome addition to the scientific literature.

Marlene S. Evans
National Water Research Institute
Canada

Calendar of Events

NALMS 2003: Protecting our Lakes' Legacy,
23rd International Symposium of the North
American Lake Society.

4-8 November 2003

Foxwoods Resort
Mashantucket, Connecticut
USA

Contact: Conference Committee Chair

Elizabeth Herron

emh@uri.edu

Phone: (401) 874-4552

www.nalms.org

Wastewater Hygienisation in Constructed Wetlands,
Ponds and Related Systems.

6 - 7 November 2003

Leipzig, Germany

Contact: Ogarit Uhlmann, M.Sc.

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Halle

Permoserstr. 15

04318 Leipzig, Germany

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Phone: +49 341 / 235-2413

Fax: +49 341 / 235-2782

International Conference on Dissolved Organic
Matter. From Land to Sea- from Science to
Management: Dissolved Organic Matter (DOM).

26 - 28 November 2003

Horsens, Denmark

Contact: Morten Søndergaard

Msondergaard@zi.ku.dk

More information is available at:

www.domaine.ku.dk

Symposium on Urbanization and Stream Ecology.

8 - 10 December 2003

University of Melbourne

Melbourne, Victoria, Australia

Contact: Chris Walsh

CRC for Freshwater Ecology

Water Studies Centre

Monash University

Clayton 3800 Australia

Chris.Walsh@sci.monash.edu.au

Phone: +61 3 9905 4091

Fax: +61 3 9905 4196

[http://www.conferences.unimelb.edu.au/
urbanization_and_stream_ecology/](http://www.conferences.unimelb.edu.au/urbanization_and_stream_ecology/)

International Conference on Water and
Environment (WE-2003).

15 -18 December 2003

Bhopal, India

Contact: R.N. Yadava, Organizing Secretary
Conference Co-Chairman

Regional Research Laboratory

Council of Scientific and Industrial Research

Hoshangabad Road

Bhopal - 462 026

M.P. India

dryadava@yahoo.com

Phone: +91-0755-2589343

Fax: +91-0755-2587042

Limnological Association of Kerala, LAK
International Training Course in Tropical
Freshwater Zooplankton.

20 December 2003 - 5 January 2004

University of Calicut, Irinjalakuda, Kerala, India

Contact: Prof. Dr. C.K. Gopinathan Nayar

Course Director

Thusharam, Azad Road

Irinjalakuda - 680 125, Trichur Dt.

Kerala, India

Phone: +91 (0) 480 - 2826694

lak98@rediffmail.com

[http://www.geocities.com/klri98/
tropical_freshwater_zooplankton](http://www.geocities.com/klri98/tropical_freshwater_zooplankton)

For application forms, please contact:

Mr. Francy K. Kakkassery

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Department of Zoology,

St. Thomas College, Pin .680 001

Thrissur, Kerala, India

kakkassery@yahoo.com

Phone: +91 (0) 487 2339630

+91 (0) 491 2510755

2004

52nd Annual Meeting

North American Benthological Society.

6 - 10 June 2004

Vancouver, British Columbia, Canada

<http://www.benthos.org/>

Sixth International Chrysophyte Symposium.

2 - 7 August 2004

Lammi Biological Station, Central Finland

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Further information will follow

SIL XXIX Congress.

8 - 14 August 2004

Lahti, Finland

Contact: Congress Management Office

University of Helsinki

Palmenia Centre

for Research and Continuing Education

Kirkkokatu 16

15140 Lahti

Finland

sil-2004@helsinki.fi

Phone: + 358 3 892 11

Fax: + 358 3 892 20219

www.palmenia.helsinki.fi/congress/SIL2004

5th International Symposium on Ecohydraulics.

12 - 17 September 2004

Madrid, Spain

Contact: TILESAs, OPC, S.L.

Londres, 17

28028 Madrid, Spain

Phone: +34 91 361 2600

Fax: +34 91 355 9208

ecohydraulics@tileasa.es

<http://www.tileasa.es/ecohydraulics>

9th International Conference on Wetland Systems
for Water Pollution Control.

27 - 30 September 2004

Avignon, France

Contact: Wetlands Systems Conference Secretariat

CEMAGREF - 3, bis quai Chauveau

69336 Lyon Cedex 09

France

wetlands@lyon.cemagref.fr

Fax: +33 4 7847 7875

[http://www.iwahaq.org.uk/
template.cfm?name=wetland_systems](http://www.iwahaq.org.uk/template.cfm?name=wetland_systems)

2005

53rd Annual Meeting

North American Benthological Society.

23 - 27 May 2005

<http://www.benthos.org/>

2006

The Tenth International Symposium on Aquatic
Oligochaete Biology. Tentatively scheduled to
convene at:

The Institute of Hydrobiology

Chinese Academy of Sciences, Wuhan, China

Contact:

Dr. Hongzhu Wang, D.Sc., Associate Professor

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Sciences

Hubei, Wuhan 430072

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Submissions for the SIL web site should be sent by e-mail to webmaster@limnology.org or by fax to the attention of Gordon Goldsborough at: +1 (204) 474-7650.