



IAHS Newsletter

NL93 April 2009



ICCE in New Zealand, December 2008, Participants admire the beauty of the Southern Alps during the mid-conference field trip.

Sediment Dynamics in Changing Environments

Report from the International Symposium of the IAHS International Commission on Continental Erosion (ICCE), Christchurch New Zealand, December 2008

ICCE's field of interest can be broadly defined as erosion, transport and deposition of sediment and the interaction of these processes with other components of the environment.

More than 100 scientists from some 40 countries, with a wide range of institutional and disciplinary backgrounds, met in Christchurch, New Zealand, to discuss *Sediment Dynamics in Changing Environments*. Some 60 oral presentations over the five-day symposium covered a wide variety of topics, scales, and techniques for exploring erosional and depositional sedimentary systems. More than 30 posters further explored these topics and enhanced the meeting by providing a stimulus to share research findings and to inspire future research.

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Latest Information on the Hyderabad Convention 6–11 September 2009



Arrangements for the joint IAHS & IAH (International Association of Hydrogeologists) convention in Hyderabad are proceeding apace. There was a huge response to the call for abstracts for the four joint IAHS–IAH symposia and for the two IAHS symposia, and many of the submissions have been accepted for presentation as either full papers (and publication), or poster papers. There has been a great response to the IAH events too. There is still time to submit papers for IAHS workshops; the deadline is 31 May 2009.

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Groundwater Flow and Transport Modelling Training Course in Hyderabad

MODFLOW, MODPATH, MT3DMS, SEAWAT 1–5 September 2009 Details, page 11

IAHS Welcomes Our 5000th Member

Dr Petr Máca recently completed the online form at the IAHS website to join the Association, unaware that he would become our 5000th member. Dr Máca is Assistant Professor in the Department of Water Resources and Environmental Modelling within the Faculty of Environmental Sciences of the Czech University of Life Sciences in Prague, Czech Republic. He teaches Hydrology, Environmental Hydrology and Hydrological Modelling at BSc and MSc level, and supervises PhD students. See page 3

Hydrological Sciences Journal – joint Editors

Hydrological Sciences Journal (HSJ) continues to receive numerous submissions and dealing with them all is a significant task. At the recent meeting of IAHS Ltd, Zbyszek Kundzewicz, *HSJ* Editor, proposed that the current arrangement whereby he is assisted by a Deputy Editor should be changed. This was agreed and in future there will be two Editors of the Journal. Demetris Koutsoyiannis, who has been the Deputy Editor for just over two years, now becomes joint Editor with Zbyszek.

Water science in the 15th century

IAHS Press has just published an extraordinary book. This new volume, by Laurent Pfister, Hubert Savenije and Fabrizio Fenecio, reports the investigations and deliberations of Leonardo Da Vinci on the “origin and fate of water”. Not only was Da Vinci a great painter in his time (1452–1519, remember the Mona Lisa), he was also an engineer and a scientist. Illustrated with many sketches from Da Vinci's notes, this is a fascinating, worthwhile and enjoyable read.

See page 8

A Note to Members *from Arthur Askew, IAHS President*

As this is my first note to members for 2009, I feel I should wish you all a very Happy New Year, except that you would be right to object that I am bit on the late side. So instead, I wish you and your families and friends all the very best for the eight months of 2009 that remain. My best wishes are addressed in particular to those who are suffering from, or have reason to fear, the consequences of the present economic downturn. The importance of our science – our profession – is one that is now being appreciated by the “powers that be” more than it has ever been, and I would like to think that this will protect us from the worst effects of the downturn, but things are neither so simple nor so logical in this world of ours. So, we must take a concerted deep breath and battle on confident in the belief that we have a duty as scientists to help those in power to understand better the world we live in and to use that knowledge to govern us wisely.

Looking ahead to the remainder of this year, there is really only one message that I wish to convey:

SEE YOU IN HYDERABAD!!

Pierre Hubert, our indomitable Secretary General, has recently returned from a visit to India with very good news as regards the logistical arrangements for the Assembly/Convention. One important announcement is that the meeting will not now be held on the premises of the NGRI, but has been moved to the Hyderabad International Conference Centre which has more meeting rooms, a high-tech environment and more convenient and budget accommodation in the close vicinity. One reason for the move is the

great interest in the meeting as expressed in the large number of abstracts that have been received. More information about arrangements for Hyderabad is given elsewhere in this Newsletter. So what we now need are participants to make the Assembly come alive, which is where you can all help: do register for the Assembly and join us in what will surely be a very successful meeting.

From good news to some less-good news: The personal and professional circumstances of our Vice-President, Juan Carlos Bertoni, changed markedly in 2008. This not only made it difficult for him to undertake his responsibilities as a Vice-President during that period, but raised in his mind major doubts as to whether he would be able to complete the tasks assigned to him over the next two to three years. Accordingly, he resigned from the position at the end of last year. We wish Juan Carlos all the very best in the years to come.

And back to good news: with the unanimous approval of the Bureau, I have appointed Denis Hughes of South Africa to fill the vacancy and so now:

Denis Hughes is IAHS Vice-President Responsible for Relations with Developing Countries

We thank him most warmly for agreeing to take on this responsibility and look forward to congratulating him in person in Hyderabad.

The good news does not stop there. A few weeks ago I had the pleasure of participating in a meeting of the Board of Directors of IAHS Ltd, the body that formally oversees the work of IAHS Press. This one-day meeting had, as always, a very full agenda which, under



Denis Hughes, newly appointed IAHS Vice-President with Responsibility for Developing Countries

the wise leadership of Des Walling, we addressed in a very business-like manner. Particular news from the meeting was that the impact factor for *HSJ* has risen once again and the finances of IAHS Ltd are very sound. For this we owe a big “thank you” to Cate Gardner and her colleagues who not only publish *HSJ* and the Red Books, but also maintain contact touch with our individual members, i.e. you – my good friends. It is therefore very encouraging to learn that our list of members now includes over 5000 names – as announced elsewhere in this issue. With reference to *HSJ*, we have benefitted for some years now from the enthusiastic involvement of Demetris Koutsoyiannis as Deputy Editor of the Journal, to the extent that he and Zbigniew Kundzewicz have effectively been working as co-editors. Accordingly, I have been pleased to revise the current appointments so that Demetris and Zbysek are now formally joint Editors of the Journal.

With this I return to my favourite image of IAHS as an Association which brings individual hydrologists together to exchange information and co-ordinate their actions and so the more we are – and the more of us who get to Hyderabad – the more effective we will be at meeting our basic objective:

To promote the study of hydrology as an aspect of the earth sciences and of water resources



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The Newsletter is distributed free of charge to members of IAHS. This Newsletter and previous issues may be downloaded from: www.iahs.info

Articles from IAHS members on all aspects of hydrology and related topics are welcomed for publication in the Newsletter. They should be sent to the IAHS Secretary General, Pierre Hubert, preferably to: piy.hubert@free.fr, or to: IAHS, UMR Sisyphe, Université Pierre & Marie Curie, Case 105, 4 Place Jussieu, 75252 Paris Cedex 05, France

Advertisements may be placed in the Newsletter, or inserts may be mailed with it, at the discretion of the IAHS Secretary General. Contact: cate@iahs.demon.co.uk

The next IAHS Newsletter will be published in late July 2009; copy deadline 17 July 2009.

Learning from the past; looking to the future

From Gordon Young, IAHS President-elect

At the up-coming IAHS General Assembly in Hyderabad I will have the honour of assuming the role of President of the Association, taking over from our current President, Arthur Askew. In similar fashion the Presidencies of our nine International Commissions will also change. Thus there will be substantial changes in the composition of the Bureau of the Association.

This will be a time to reflect on the status and functioning of the Association and to develop strategies for the future. We will be examining our scientific endeavours and asking questions concerning the relevance of the science we undertake to the needs of society and whether we ought to be modifying our approaches in the light of evolving scientific understanding. Are we keeping abreast of new understanding and new developments in our discipline? Are our scientific questions relevant to the managers who make decisions based on our findings and are our findings relevant to the lives and livelihoods of the people in our countries and regions?

We then need to question the effectiveness of the way we conduct our

business. Do we have too many Commissions, Working Groups and Task forces; or do we need to amalgamate some of them; or do we need a different set of such groups to more effectively and efficiently undertake our business? Are our National Representatives for the Association and for individual Commissions effectively promoting our work within individual countries – and if not, then how could we improve their functioning? Are our Assemblies too large or not big enough and are the symposia and meetings organized by individual Commissions performing well?

Our publications and newsletters have recently been under intensive review and changes are currently being effected (starting with the electronic-only publication of this Newsletter), but we must continue to improve these means of communication to our members and to the broader scientific community.

From the perspective of the Association as a whole I believe that the President has an important role to play in soliciting the views on all the topics mentioned above from the officers of the Association, from the officers of the

Commissions and Working Groups, from National Representatives and, just as importantly, from the individual members of the Association. In soliciting the opinions of members of the Association I am following in the footsteps of Arthur Askew and Kuni Takeuchi before me. I am pleased to note that the Presidents of several Commissions have already taken the opportunity to encourage similar dialogue within and between their Commissions for the betterment of the whole Association.

Thus I am requesting that all of you as members of the Association take a few moments to reflect on the past activities and effectiveness of IAHS and to make suggestions from your own particular perspectives on how you would like to see the Association undertake its work in the future. I suggest that you let me know your views by email, and preferably by the end of May 2009, so that I might have time to synthesise your responses in time for our Assembly in Hyderabad where I look forward to meeting and discussing your suggestions.

Gordon Young
gordonyoung_wwap@yahoo.com

5000th member of IAHS

continued from page 1

He is also Vice-Dean for international relations. His teaching reflects his primary research interest which is hydrological modelling in all its facets: rainfall distribution, rainfall-runoff modelling, ANN approaches, uncertainty estimation, etc. Thus it is not so surprising that when, to celebrate his becoming IAHS's 5000th member, we offered him a complimentary copy of any of our books, his choice was Publ. 307: *Large Sample Basin Experiments for Hydrological Model Parameterization: Results of the Model Parameter Experiment, MOPEX* edited by Vazken Andréassian *et al.* This is the volume that, in addition to explaining the MOPEX goals regarding large sample basin experiments, and reporting the results as well as alternative views, presents the databases that were used for MOPEX and publishes much of the data on the accompanying CD (see www.iahs.info/redbooks/307.htm for more information). We envisage that Petr will be using the data for teaching purposes as well as for testing his own modelling in future.

Many IAHS members may be puzzled as to why their membership number is much larger than 5000. The system has been modified at various times and so large blocks of numbers have not been used.

IAHS Past-President Kuni Takeuchi

The International Council for Science (ICSU) and the International Social Science Council are co-sponsoring the new *Integrated Research on Disaster Risk* programme. Kuni Takeuchi, Director of the International Centre for Water Hazard and Risk Management (ICHARM) in Tsukuba, Japan, has recently been appointed to the Scientific Committee of the programme, as have two other IAHS members: Gordon McBean (formerly of Meteorological Service of Environment Canada; University of Western Ontario, Canada) and Michel Lang (CEMAGREF, France).

ICSU's science plan for the programme: *Integrated Research on Disaster Risk: Addressing the Challenge of Natural and Human-induced Environmental Risks*, is available online at the ICSU website: www.icsu.org.

IAHS will be present at EGU2009

As in 2008, IAHS will have a stand at EGU2009, the European Geosciences Union General Assembly in Vienna, 19–24 April 2009. We will be located close to the hydrology sessions. It is an opportunity for IAHS members to view copies of all our recent publications.

We are grateful to Alberto Montanari for setting this up and Katja Gänger for making the necessary arrangements.

Reports from IAHS Commissions and Working Groups

ICCE – Sediment dynamics in changing environments

Continued from page 1

Report from the 2008 International Symposium of the International Commission on Continental Erosion (ICCE) 1–5 December 2008, Christchurch, New Zealand



ICCE 2008 participants exhausted in Canterbury Nor'wester weather at Rakaia Gorge during the mid-conference field trip.

The Symposium was organized around four themes. The papers presented in the theme *Unlocking the archives – dating and source tracing technologies* ranged from evaluations and improvements of dating and source-tracing techniques to applied studies utilizing these techniques to understand catchment sediment budgets and to design appropriate conservation techniques for sustainable management. Prof. Andreas Lang (University of Liverpool) gave a comprehensive keynote address on emerging technologies in dating sediment bodies, highlighting the need for a proper quantification of uncertainties in dating and tracing studies. The research presented in the section *Processes and scales in sedimentary systems – from point to continents* ranged from detailed studies on process behaviour at small scales (such as soil armouring), to investigations into the connectivities of the sediment cascade components over a range of scales, and to analyses of the behaviour of large-scale and long-term sedimentary systems. Dr James Syvitski (CSDMS, University of Colorado) presented in his keynote paper a model of the worlds rivers' suspended sediment which improves our understanding of regional differences in behaviour of sedimentary systems and the varying degrees of

human impact on sedimentary systems around the globe. Subjects discussed in the third section *Global change and erosion* ranged from catchment and regional scale impact studies of past environmental changes to assessments of magnitudes of expected future changes in sedimentary systems on various scales. Prof. Des Walling (University of Exeter) gave a keynote presentation on the changing sediment loads of the worlds' rivers, highlighting the regional variability of human impacts on sedimentary systems. The fourth theme *Linking erosion with environmental and societal impacts: sediment production, river regulations, depositional environments, hazards & risks, management & policy* included topics relating to flood plain restoration, river management, and control of coastal erosion. Prof. Michael Crozier (University of Wellington) gave a keynote address highlighting the magnitude and the complexity of human impacts on sedimentary systems, and how these necessitate identification of geo-indicators to help identify critical sustainability thresholds in geosystems.

The oral papers and some poster papers of the ICCE 2008 Symposium have been published as an IAHS Red Book: *Sediment Dynamics in Changing Environments* (IAHS Publ. 325), available from IAHS Press (*details on page 14*).

Mid-conference field trip

The mid-conference field trip on Wednesday, 3 December was opened with a keynote address from Dr Bryan Jenkins, CEO of Environment Canterbury, on the issues facing the Canterbury region and its rivers from climatic and land-use changes. Dr Murray Hicks (National Institute of Water & Atmospheric Research) then led the ICCE 2008 participants on the field trip from the foothills of the Southern Alps to the braided river systems of the Canterbury Plains. Canterbury sediment dynamics on various temporal and spatial scales were discussed at several very scenic spots, and the controversies around water allocation in the Canterbury Plains were illustrated in the field. The participants – parched by a Canterbury Nor'wester (Foehn Wind) – were refreshed at the end of the day with delicious New Zealand white wine, served in the braided gravel bed of the Waimakariri River!



ICCE participants performing the famously frightening Maori Haka!



ICCE President Jim Bogen presents a glass polar bear to the local organizers during the ICCE Symposium dinner – a symbol of our fragile environment which we need to take care of – all around the globe, from Norway to New Zealand!

ICCE Conference Dinner

The ICCE 2008 dinner was held at the Hotel Grand Chancellor in the heart of the Garden City, Christchurch. ICCE participants “volunteered” to perform several Maori dances including the famous Haka; ICCE President, Dr Jim Bogen presented a glass polar bear to the local organizers. This was a symbol of our fragile environment that we need to take care of – all around the globe, from Norway to New Zealand. At the end of the conference, Jim Bogen announced the hosts for the next ICCE Symposium – which will be Poland.

Looking forward seeing you in Poland in 2010!

*Jochen Schmidt, Organizing Committee ICCE 2008
National Institute of Water & Atmospheric Research,
Christchurch, New Zealand*

ICWRS – Water Resources Systems

www.iahs-icwrs.org

Hyderabad meetings

In Hyderabad, ICWRS will convene one symposium (JS.3) and a workshop (HW.3), and co-convene seven other meetings.

JS.3 Improving integrated surface and groundwater resources management in a vulnerable and changing world

Many parts of the world are extremely vulnerable environments with declining potable water resources and an increasing risk of extreme events due to population growth, intensification of agriculture and urbanisation, and limited development opportunities. With the increasing difficulties of meeting the human demands on water resource quantity and quality, new concepts in water management need to be explored, with a move away from centralised command and control approaches to more participatory multi-stakeholder approaches that have the potential to be more flexible and responsive. New concepts, such as Integrated Water Resources Management (IWRM) and Adaptive Management (AM) are being put into practice but their scientific basis has not been fully explored. This symposium addresses a wide range of problems related to water resources management where water is scarce and/or its quality is threatened by human impact. Issues of water resources availability will be examined as will be the impact of growing cities and the increasing demand for irrigation water, aiming at sustainable use of groundwater aquifers and surface water storages. The symposium will also address the risk associated with extreme events, including floods and droughts with an emphasis on vulnerable environments, their frequencies, forecasting and management both under present day and projected changed conditions. Strategies for assessing and reducing vulnerability from both a resource and risk perspective will be considered. Convenor: Gunter Blöschl

HW.3 Flood risk management

Floods are the greatest cause of human suffering in the world. Since the spectacular flooding of New Orleans much attention has been given to the various ways to protect people against high water levels. In some countries the concept of the safety chain is applied. According to this concept threats should be confronted at all levels: pro-action, prevention, preparation, repression and recovery. Traditionally most

attention is given to the prevention of flooding by dikes and dams. In some cases, preparation and repression are also preferred, and flood warning and evacuation of the people at risk is planned in advance and applied in practice. After the flood, recovery of losses and damage is a logical activity, but not well reported. In this session we would like to invite a discussion on the efficiency of the various shackles in the safety chain. Is it wise to spread the investment and the attention equally or should one shackle get all? Could insurance play a role in the recovery phase or has it only preventative effects? What is the actual damage after a flood? Can we learn from the recovery efforts from previous floods? Convenor: Han Vrijling.

In addition, ICWRS co-convenes:

- JS.4 Hydroinformatics in hydrology, hydrogeology and water resources*
- JW.3 Rural and urban water systems: minimising adverse impacts of global change on water resources*
- HS.2 New approaches to hydrological prediction in data sparse regions*
- HW.1 Regionalisation of models for operational purposes in developing countries*
- HW.5 Prediction in ungauged basins: a benchmark report.*
- HW.7 New statistics in hydrology, and*
- HW.8 Hydrological theory and limits to hydrological predictability in ungauged basins*

Other ICWRS meetings

Every two years there is either an IAHS Scientific Assembly or an IUGG General Assembly. In the years between assemblies, ICWRS organizes a symposium on Integrated Water Resources Management (IWRM). The Fourth ICWRS symposium was held 29–31 October 2008 in Johannesburg, South Africa, and organised in close cooperation with Waternet (www.waternetonline.ihe.nl). The proceedings will be published in *Physics and Chemistry of the Earth*. In 2010, the Fifth International Symposium on Integrated Water Resources Management will be held at Hohai University, Nanjing, China. Prof. Liliang Ren will be the organizer.

This year, European members of ICWRS will meet at the European Geosciences Union annual conference in Vienna (19–24 April 2009). The sessions on *Water Policy and Management* (22 April) are co-organized by ICWRS members.

Nick van de Giesen, Secretary ICWRS

The Role of Hydrology in Water Resources Management

*Report from the international symposium held on the island of Capri, Italy
13–16 October 2008*

Many important political, economic and social decisions, with significant and sustainable impacts on the environment and thus on the hydrological regime and water resources, are still made today without an adequate input of hydrological expertise. Thus the implementation of projects can lead to conflict between managers on the one hand and hydrologists on the other hand. Managers may wish to implement projects quickly and at low cost, while hydrologists and environmentalists would like greater attention to be given to the principles of sustainability and ecological compatibility. These demands from hydrologists and environmentalists often delay the implementation of projects and make them more expensive.

The purpose of the symposium was to discuss ways to achieve a stronger involvement of hydrologists in decision processes impacting on the water balance. At the symposium, hydrologists and decision makers from the fields of politics, economics and social sciences, active in the broader periphery of hydrology, or whose decisions have a sustainable impact on water resources, were invited to discuss these topics. In doing so, the environmental aspects were to be taken into account.

The contributions by hydrologists were expected to focus on the following questions:

- How far can hydrology support decision-making processes at different levels?
- What hydrological inputs are needed to attain the goal of integrated water resources management?
- Are hydrologists sufficiently involved in planning and managing hydraulic and water management projects?
- How can hydrologists promote the compilation and use of integrated sets of data and information in the process of planning and managing hydraulic and water management projects?
- Are the principles of sustainability and environmental compatibility sufficiently considered in the planning and management of projects?
- Which research activities are necessary in hydrology and related sciences to satisfy future needs arising from the move to integrated water resources management?

Contributions from the fields of environmental sciences, politics, economy and social sciences were to deal with the following questions:

- Which demands are made on hydrology?
- What type of information can water managers offer to hydrologists?
- Which contributions can be offered to hydrologists and environmentalists during the planning and managing processes?
- In how far can participation in decision-making processes be offered to hydrologists?
- How can hydrologists foster progress in water resources management by developing new and innovative methodologies?
- What experiences have been gained in cooperating with hydrologists so far?

This Symposium was convened by IAHS as a contribution to the International Hydrological Programme

(IHP-UNESCO) with the support of the Italian National Committees for the IHP and for IAHS, and a number of other Italian bodies, both governmental and non-governmental. The Symposium took place 13–16 October 2008 in the Quisisana Hotel on the island of Capri, Italy.

This Symposium attracted wide interest among hydrologists. Unfortunately, water managers showed less interest in the Symposium.

More than 210 lectures and posters were registered. The initial programme listed six keynote lectures and 63 papers. Unfortunately, many scientists, especially from Africa and Asia, had to decline their participation in the Symposium owing to a lack of travel funds or problems in obtaining visas to enter Italy. Some countries thought the costs were too high.

About 100 participants attended the Symposium, with 67 coming from 27 countries outside Italy. After the Opening Ceremony a Round Table was held on the Archaeology of Water with contributions on Water and Roman urbanisation, Roman Fountains and Thermal Baths, and Roman Water Technologies. Due to the great interest generated by this Round Table session, a follow-up meeting will be organised in the near future on how to incorporate historical and indigenous knowledge sources into modern scientific knowledge bases as a contribution towards forging the much needed Culture of Water.

The Symposium was divided into five sessions and each session was opened by an invited speaker:

1 Integrated Water Resources Management

Challenges for water managers: can sciences help to solve the problems? *Gordon Young*

2 Hydrology and Dams

Hydrological risk and flood management by hydraulic structures *Andreas Schumann*

3 Hydrology for Flood Protection

Risk assessment in an integrated water management perspective *Giorgio Roth et al.*

4 Hydrology and Water Supply Systems

Sustaining water resources in South East England *John C. Rodda*

5 Hydrology for groundwater management and hydrology for the protection of ecosystems

Water resources and management in Libya *Ali Geath Eljadid* (Due to visa problems, Dr Eljadid was unable to present his paper, but it will be published in the proceedings.)

A further 31 papers, which had been screened by the Scientific Committee, were presented by participants. There was also a poster session with 16 posters. The proceedings will be published as a Red Book (Publ. 327) in May this year.

In spite of the small number of contributions the Symposium can be declared successful, especially in view of the fact that more time than usually is the case could be devoted to each presentation and the subsequent discussion. There seemed to be agreement that the Symposium had attracted a number of interesting and well-presented papers and that it had been a very good medium for disseminating knowledge.

*Hans-Jürgen H. Liebscher
Vallendar, Germany*

Review: Charting a course for scientific hydrology

A review of the IAHS Hydrology 2020 Report:

Hydrology 2020: An Integrating Science to Meet World Water Challenges

edited by T. Oki, C. Valeo & K. Heal

Twice during its lifetime, the IAHS has commissioned reports on the future of hydrology (the first back in 1987). The *Hydrology 2020* report by Oki *et al.* (2006) is the final output from the Hydrology 2020 working group—a group composed of 12 young (under 40 years) hydrologists from as many countries. Their charge was to identify future scientific directions in hydrology, and how these relate to addressing the water challenges that are expected to dominate by 2020.

When asked to review the report, I feared a possible drab, bureaucratic statement of the usual set of water related problems and needs. I was very pleasantly surprised to find that rather than a simple laundry list of problems, the *Hydrology 2020* report identifies some of the key gaps in knowledge and infrastructure—from our basic lack of process understanding, especially in the area of coupling and feedbacks between atmospheric–biological–geochemical–hydrological processes—with excellent ideas on the future of the discipline.

The book is divided into eight chapters. Chapter 1 is an introduction to the report and a review of the charge to the Hydrology 2020 committee. Chapter 2 includes an assessment of the current and future global water resource availability and considers how hydrological understanding may contribute to practical water resource management issues. Chapter 3 explores the coupling of societal and water management issues—laying a solid rationale for future hydrological research needs. Chapter 4 deals with measurement needs in hydrology in relation to water quantity and quality, in the context of hydrological understanding and in relation to prediction. Chapter 5 focuses directly on the *status quo* of hydrological modelling and prediction, and where future needs arise. Chapter 6 explores the interdisciplinary aspects of hydrological sciences and areas where new work is needed. Chapter 7 lists a number of gaps and obstacles to moving forward, ranging from scientific to technical to organizational. Chapter 8 summarizes the key messages, recommendations and concluding remarks of the Hydrology 2020 analysis.

I read the *Hydrology 2020* report on a trip to the Upper Blue Nile basin in Ethiopia. There, the sometimes esoteric research needs of scientists in the developed world seemed trivial by comparison to the pressing local problems in

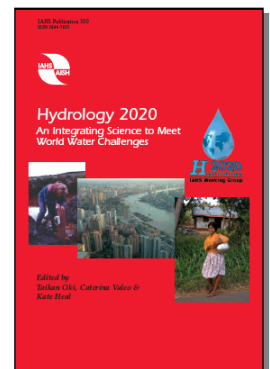
Ethiopia of lack of drinking water, lack of water management infrastructure, burgeoning water borne diseases, lack of irrigation infrastructure, increased flooding and accelerated soil erosion. The *Hydrology 2020* report does an admirable job of linking both of these worlds. Their call for hydrology to be an integrator of knowledge of different water-related disciplines is a key message from the report. In places like Ethiopia, integrated watershed management is hampered by complex socio-political land-use drivers and transboundary issues, slowing water-for-poverty-reduction efforts. The *Hydrology 2020* report speaks to these issues as well as the basic physical hydrology research issues to underpin integrated watershed management in developed and developing countries. The *Hydrology 2020* report highlights several of the “hydrological mega trends”, most notably the need to make predictions of land-use and climate change effects on flow regimes in areas with sparse data, large hydrological diversity and minimal personnel in-country with the training to solve problems. The *Hydrology 2020* report hits not only the research needs but also where capacity must be built in order to address pressing water issues in the developing world. Few groups have produced such a global view on the practical realities of research and implementation. I commend the authors for putting this visionary document together and encourage the IAHS readership to acquire a copy and read their words.

Jeff McDonnell

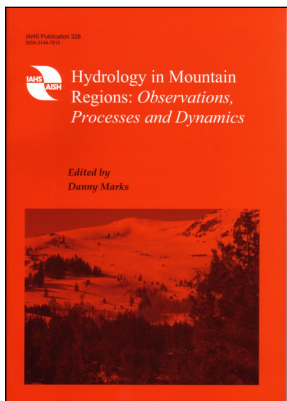
Oregon State University, USA

The *Hydrology 2020* report is still available from IAHS Press. More information about the report, including the Executive Summary in English and translated to Arabic, Chinese, French, German, Japanese, Russian and Spanish, is available at: www.iahs.info/redbooks/300.pdf

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Hydrology in Mountain Regions: Observations, Processes and Dynamics



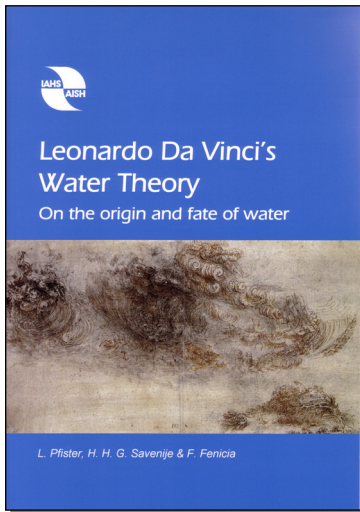
Edited by Danny Marks USDA-Agricultural Research Service, Boise, Idaho

Around the globe, mountainous regions, ranging from arctic to tropical, provide a source of water from orographic-induced rain and snow that can sustain ecosystems, agriculture, and populations in areas that might otherwise be quite arid. Climate warming will alter patterns of mountain precipitation, changing seasonal snow cover and hydrology. It is critical that we understand how climate interacts with snow and mountain hydrology, how streamflow and ecosystems will be affected, and how these changes will translate into impacts on water supply downstream:

- Precipitation distribution and mountain hydrological processes
- Hydrological, geochemical and ecohydrological modelling
- Soil and groundwater hydrology in mountains
- Large-scale analyses in mountain areas
- Tropical mountain hydrology

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Leonardo Da Vinci's Water Theory: On the origin and fate of water



Leonardo Da Vinci (1452–1519) was not only one of the greatest artists of his time, he was also a great engineer and scientist. A large part of his scientific work was dedicated to understanding the movement, circulation and physical characteristics of water in its different forms. This book aims to make Leonardo Da Vinci's contributions to the science of water accessible to a wider public and to compare his ideas with our present knowledge.

Fascinating, revealing and inspiring, Leonardo Da Vinci's Water Theory opens up a new history to the study of water. Two hundred years before Newton, Perrault and Halley, Leonardo Da Vinci was doing hypothesis-driven science and describing and classifying hydrological processes. For example, he came close to the modern definition of the hydrological cycle, recognising that water passes through the major river systems countless times, summing up to volumes much greater than those contained in the world's oceans. Pfister, Savenije and Fenicia carefully report Da Vinci's seminal work and provide a modern hydrological backdrop.

Laurent Pfister

Centre de Recherche Public – Gabriel Lippmann,
Grand-Duchy of Luxembourg

Hubert H. G. Savenije

Delft University of Technology, The Netherlands

Fabrizio Fenicia

Delft University of Technology, The Netherlands

Illustrated with Da Vinci's drawings and sketches

Foreword by Jeff McDonnell

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Postscript by Laurent Pfister & Lucien Hoffmann

UNESCO's Hydrological Processes and Climate Section
Division of Water Sciences, as a contribution to the
International Hydrological Programme.

Laurent Pfister and Hub Savenije approached IAHS in 2007 regarding publishing a book that brought together the concepts and investigations of Leonardo Da Vinci on the topic of water. IAHS agreed in principle to publish, subject to a review of the proposed content. Some months later a manuscript arrived, complete with figures that were, or were derived from, Da Vinci's sketches. It was fascinating, and we were in no doubt that it should be published.

Leonardo Da Vinci, born in Florence, Italy, in 1492, by the age of 15 was demonstrating talent as a painter and sculptor, and soon became very well known for his work. But he was interested in much more than how he could represent landscapes and people: he was involved in various river engineering projects during his lifetime, as well as designing various flying machines, among other projects. And he was also a scientist, though to what extent this was recognised by his peers is uncertain. We know of this work from what remains of what his assistant estimated as 30 000 pages of notes and sketches that he produced during his life. Unfortunately, after his death, many of these were lost; the remainder are now held in museums and libraries. Print versions and

translations in different languages of these notes are available. Pfister and Savenije involved Fabrizio Fenicia in the project, a native Italian speaker, who was able to review the Da Vinci texts with an hydrological perspective. Reading the original notes is not so easy, even for Italians, as Da Vinci frequently used mirror writing, i.e. he wrote everything as the mirror image of the usual text—it seems no-one is entirely sure why he did so, though there are different theories.

Putting the book together at IAHS Press was particularly interesting as we had to establish who owned the copyright to the images (photographic) of the original Da Vinci drawings and sketches that were to be included in the book, and arrange permission to use them (a fee was always required); we would have published earlier than now but for the time that this took. But we also got images of some complete pages of notes and it was remarkable to see, for example, sketches of siphons occur next to drawings of nudes on the same page—we can only speculate whether such proximity was a result of a flash of inspiration whilst sketching nude figures, or *vice versa*, a shortage of paper, or what!

Cate Gardner

International Riverfoundation



International Riverfoundation (IRF) was established in 2003 as an independent not-for-profit organization, with its headquarters in Brisbane, Australia. From Europe to Southeast Asia and Australia, the IRF is working in partnerships around the world to foster the protection and restoration of the world's rivers, lakes and wetlands. As an international dynamic NGO, IRF has a meaningful, measurable and life-changing impact on individuals and communities by helping them to restore and sustainably manage their rivers for improved health, ecological, economic, and social outcomes. Within the IRF's ambit, the management of a river covers its total watershed including surface water, groundwater and the ecosystem. IRF provides companies, NGOs and individuals with the opportunity to be a part of the management solution and to establish an enduring legacy. It works as an advocate and catalyst for the protection and restoration of the world's rivers. The main objectives of IRF are:

- To advocate the protection and restoration of river systems around the world
- To engage national and international organizations on the importance of sustainable river management
- To ensure knowledge regarding effective river systems management is available to those who need it
- To reward and champion those who are making significant achievements in the protection, restoration and management of river systems
- To act as a catalyst for the replication of effective river system management practices, by encouraging partnership between an organization which has successfully restored a degraded river and another organization willing to do so for a river, preferably in a low-income country
- To promote long-term relationships between countries and organizations concerning sustainable management of river systems.

IRF has four main activities that contribute to the sustainable management and restoration of rivers around the world:

- IRF funds the Thies Riverprize, an internationally recognised award for outstanding achievements and excellence in river management in Australia and worldwide. Currently valued at A\$500 000, it is awarded each year during International Riversymposium in Brisbane. Nominations for the 2009 Thies Riverprize will open soon, and nomination forms and judging criteria will be made available at www.riversymposium.com.
- IRF's twinning programme encourages and supports Thies Riverprize winners and finalists to share their skills and knowledge with other watershed groups around the world to improve their rivers and waterways.
- Through the Sponsored Delegates programme IRF financially assists scientists and river practitioners from least and less developed countries to attend International

Riversymposium. This assists in sharing knowledge, building capacity and bringing a greater diversity of opinions, tools and methods to the international river management community.

- IRF also supports the International Riversymposium – the pre-eminent conference on river management and restoration issues worldwide integrating science, business and the community.

Also, IRF has recently appointed Ambassadors worldwide. Their role is to represent and raise the profile of IRF and its programmes among international and national networks, and to assist IRF in achieving its environmental objectives. This global initiative includes ten Ambassadors from Israel, India, Argentina, Kenya, UK, USA and Australia. Dr S. D. Limaye, Director of the Ground Water Institute in India, is one Ambassador working to promote IRF and its cause through his networks around the globe.

The programmes, and the recently appointed IRF Ambassadors, extend IRF's global networks for the benefit of all river managers, ultimately advancing river restoration around the world.

For more information on IRF and the Brisbane International Riversymposium please visit:

<http://www.riverfoundation.org.au/>

River Journeys

A recent publication from International Riverfoundation



104 pp, hard cover. Price: Australian \$39.95 plus postage, available online at www.riverfoundation.org.au (for Australian customers only) or order by email info@riverfoundation.org.au or fax +61 7 3103 4574

International Riverfoundation (IRF) proudly presents its latest book *River Journeys* which provides insights and inspirations from river restoration journeys from Thies riverprize winners over the past decade. The book marks the 10th anniversary of the Riverprize in 2008.

River Journeys features insightful and inspiring interviews with Australian and international people from all walks of life, who out of their love for rivers, worked hard and relentlessly for many years to restore and improve their degraded ecosystems. They all have one thing in common: the love for their land and rivers and a dedication and determination to go an extra mile to repair the damage inflicted upon them. IRF has published the book to spread the optimism and enthusiasm that drives these prize-winning "River Heroes" who have worked and are still working for the re-establishment of natural processes in our ecosystems, for the healthy habitat of wildlife and humankind.

Joint IAHS & IAH International Convention 2009

Water: A Vital Resource Under Stress – How Science Can Help?

Hyderabad, India, 6–12 September 2009

<http://www.appliedhydrology.org/iahs>



The 8th IAHS Scientific Assembly will be held with the 37th IAH (International Association of Hydrogeologists) Congress to form a Joint IAHS–IAH International Convention. IAHS and IAH have each scheduled a full programme of events for their respective associations, but the arrangement has also enabled several joint IAHS–IAH symposia and workshops to be organised. Participants will be welcome to attend any of the sessions.

Summary of the Scientific Programme

Programme Committee Chairs: IAHS – Prof. Dan Rosbjerg (Denmark), IAH – Dr Shivendra Nath Rai (India), IAH VP

IAHS WORKSHOPS HW.1–8 *Deadline for Abstract Submissions 31 May 2009*

- HW.1 Regionalisation of models for operational purposes in developing countries
- HW.2 Sediment problems and sediment management in Asian river basins
- HW.3 Flood risk management
- HW.4 Space–time scaling for ET and soil moisture modelling using remote sensing
- HW.5 PUB – a benchmark report
- HW.6 Precipitation variability and water resources
- HW.7 New statistics in hydrology
- HW.8 Hydrological theory and limits to hydrological predictability in ungauged basins – PUB

The IAHS Workshops are IAHS sessions for which the only submission is an abstract. Submit ALL abstracts electronically through the Convention website: www.appliedhydrology.org/iahs. It is necessary to first make a provisional registration

JOINT IAHS–IAH SYMPOSIA JS.1–4 *Abstract deadline passed*

- JS.1 Ecohydrology of surface and groundwater dependent ecosystems: Concepts, methods and recent developments
- JS.2 Trends and sustainability of groundwater in highly stressed aquifers
- JS.3 Improving integrated surface and groundwater resources management in a vulnerable and changing world
- JS.4 Hydroinformatics in hydrology, hydrogeology and water resources

JOINT IAHS–IAH WORKSHOPS JW.1–4 *Abstract deadline passed*

- JW.1 Measuring and modelling interactions between surface water and groundwater
- JW.2 Transboundary water management: Science and policy ICGW, IAH, ICWQ
- JW.3 Rural and urban water systems: Minimizing adverse impacts of global change on water resources
- JW.4 Isotope tracing for water balance, hydrodynamics and hydrological processes, including groundwater recharge, as indicators of water resources sustainability

IAHS SYMPOSIA HS.1–3 *Abstract deadline passed*

- HS.1 High mountain snow and ice hydrology
- HS.2 New approaches to hydrological prediction in data sparse regions

IAH THEMES G.1–4 ON HYDROGEOLOGY OF HARD ROCKS *Abstract deadline passed*

- G.1 Groundwater resources development in hard rock terrains
- G.2 Groundwater quality and pollution in hard rock aquifers
- G.3 Groundwater resource management in hard rock areas
- G.4 Socio-economic issues relevant to groundwater in hard rock areas

VENUE The venue of the Convention has been changed from the National Geophysical Research Institute (NGRI) to the Hyderabad International Convention Centre (HICC), which has all the facilities to accommodate the opening ceremony, and then the many parallel sessions and meetings.

Responsibility for the management of the infrastructure of the Convention has now been handed over to the event management group *Conference & Incentives Management*.

ACCOMMODATION Hyderabad has many hotels (2–5 star; €75 to €200+ per day) and guest houses (€25 to €50 per day). Registered participants can book accommodation via the convention website.

GETTING THERE Hyderabad has good links by road, rail and internal flights with the other principal Indian cities, and there are direct international flights to Hyderabad from a variety of places worldwide.

REGISTRATION – Early-bird registration deadline 31 MAY 2009

Registration will only be complete when the registration fee has been paid in full. Participants must register as either an IAHS or an IAH member, but are welcome to attend any session.

The registration fee includes many extras:

- One of the Red Books published for the convention
- Attendance at the opening and closing ceremonies, including the Banquet following the opening event
- Free access to the Internet at the venue
- Daily transport from your hotel and back
- Lunch each day, plus morning/afternoon refreshments
- One or two evening entertainments
- Transport from the airport to your hotel, and back

Registration fees

	Before 31 May 2009	After 31 May 2009
Members of IAHS and IAH	€300	€350
Non-members	€350	€400
Students and accompanying persons	€150	€175

Note: payment by credit card is preferred. Amounts equivalent to the euro fee will be deducted in rupees.

Training Course

Groundwater Flow and Transport Modelling

MODFLOW, MODPATH, MT3DMS, SEAWAT

Organized by: Association of Hydrologists of India (AHI) and IAHS

Coordinators: Alyssa Dausman, Mary C. Hill, G. Gurunadha Rao & P. Rajendra Prasad

Course Dates: 1–4 September 2009

Location: National Geophysical Research Institute (NGRI), Uppal Road, Hyderabad, India

Who should attend Students will benefit most from this course if they have a firm understanding of some basics such as Darcy's Law, the advective-dispersion equation, and the three-dimensional groundwater flow and transport equations. The course assumes that participants have had some exposure to numerical or analytical simulation of groundwater flow and transport. Experience in using MODFLOW, MT3DMS is advantageous but not required.

Course Objective

The course will introduce participants to a suite of codes which simulate steady-state and (or) transient groundwater flow and transport in one, two, or three dimensions. MODFLOW simulates constant density flow. MODPATH uses output from MODFLOW to simulate advective transport along with basic exposure to hand rock hydrocarbon. MT3DMS uses output from MODFLOW to simulate constant-density, multi-species advective-dispersive transport. SEAWAT is an integration of MODFLOW and MT3DMS that simulates variable-density groundwater flow and transport.

Example applications are as follows: MODFLOW can be used to evaluate groundwater supply problems MT3DMS can be used to evaluate the transport of some types of contaminants and aquifer storage and recovery when density is not an issue. SEAWAT can be used to evaluate saltwater intrusion and aquifer storage

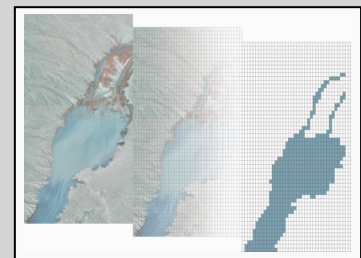
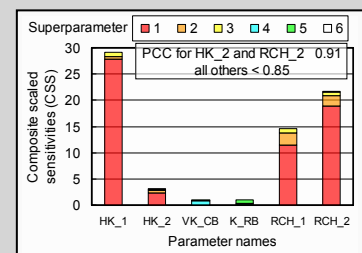
and recovery when density is an issue. In addition, this course addresses the problem of integrating site-specific data into model development. Students will be introduced to the PEST and UCODE programs, which address this issue. The programs are open-source and public domain.

Course Fees

€300 per person, to include participation in the Joint International Convention afterwards, 6–12 September. Participants will have to pay for their accommodation.

Contact

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News from IAHS Press

Electronic Newsletter

We have changed to electronic distribution of the IAHS newsletter to save the cost of posting printed copies to all of the 5000+ IAHS membership three times a year. We have attempted to alert everyone to the fact that this newsletter is only published online, but a few members still have not provided an email address so will not have received the information. If you know of anyone in that situation, please encourage them to forward us their email. We would be glad to have feedback regarding this change and any problems with opening the web version/downloading the printable version.

Recent Publications

Five books have been published since the November newsletter and are detailed at different points herein:

- *Groundwater*, the third in the Benchmark Papers Series, see page 13
- *Leonardo Da Vinci's Water Theory*, Special Publ. 9, see page 8.
- the GQ07 proceedings, IAHS Publ. 324, see below
- the ICCE proceedings, IAHS Publ. 325, see below
- the long-awaited *Hydrology in Mountain Regions*, outstanding from Perugia, IAHS Publ. 326, see page 7

Information about all our publications is available at www.iahs.info

Please contact Jill Gash for more information or to order: jilly@iahs.demon.co.uk
IAHS Press, CEH Wallingford, Oxfordshire OX10 8BB, UK

Forthcoming

The Role of Hydrology in Water Resources Management, edited by H.-J. Liebscher, R. Clarke, J. Rodda, G. Schultz, A. Schumann, L. Ubertini & G. Young, papers selected for publication from the symposium held in Capri in October 2008, as reported on page 6. This book, IAHS Publ. 327, will be published in early May.

Book price reductions and more available online

Since the beginning of 2009, the prices of IAHS Publications 247–253 inclusive have been reduced to the minimum £15. Also, Publications 232–240 have been scanned and will soon be available as pdfs at the website: www.iahs.info.

Hydrological Sciences Journal

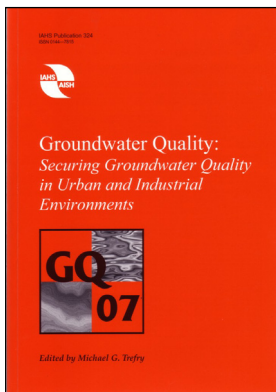
The abstracts of papers published in the Journal can be viewed online at: www.atypon-link.com/IAHS/loi/hysj

A subscription is required for online access to full papers in the 2005–2009 volumes (*HSJ* 49–54); subscribers to vol. 54 receive the six issues of the 2009 journal plus free online access. The normal IAHS member subscription is £80 but for those in financially-disadvantaged countries, it is £40. Institutional subscriptions are available to libraries. Contact frances@iahs.demon.co.uk for *HSJ* details.

Groundwater Quality: Securing Groundwater Quality in Urban and Industrial Environments

Edited by Michael G. Trefry CSIRO Land and Water, Australia

IAHS Publ. 324 (2009) ISBN 978-1-901502-79-4; 566 + x pp. £90



Our relationship with groundwater is bipolar. Increasingly we depend on it for our very survival, both in developed and developing nations. But our urban and industrial activities involve routine and detrimental impacts to the quality of groundwater reserves. Groundwater quality science of is therefore paramount to successful and sustainable management of this precious resource. GQ07 focused on a range of urban and industrial issues:

- major instances of groundwater contamination and consequent human impact,
- emerging chemicals of concern and the ability of the environment to assimilate them,
- new contamination assessment, characterization and remediation techniques,
- data integration and analysis for decision making,
- development of water management policy and controls,
- groundwater quality transformations near receiving environments.

The contributions form a valuable summary of current knowledge. Key topics are arsenic, NAPLs, management of radioactive sites, biogeochemical and isotopic processes, land-use influences, surface water–groundwater interaction, and the regulation and protection of groundwater supplies.

Sediment Dynamics in Changing Environments

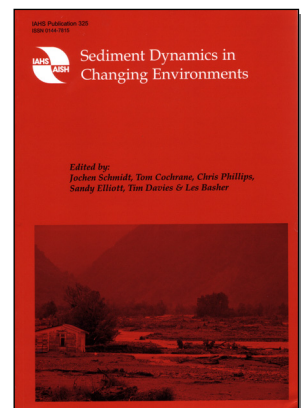
Edited by: Jochen Schmidt, Tom Cochrane, Chris Phillips, Sandy Elliott, Tim Davies & Les Basher

IAHS Publ. 325 (2008) ISBN 978-1-901502-84-8; 626 + xiv pp. £105

To understand *Sediment Dynamics in Changing Environments* we need to advance our knowledge of sedimentary processes and systems, and in particular of associated scaling issues. This knowledge, derived from information and analysis of historical sediment archives and system analysis and modelling, enhances our abilities to assess impacts of global change on sedimentary systems. Most importantly, we need to find ways to link our understanding and models of sedimentary systems with impacts on human environments, including hazard and risk assessment, improvement of management, and feedback into policy frameworks. The papers in this book, first presented at an IAHS Symposium in New Zealand in December 2008, document the international research efforts going into the four themes:

1. *Unlocking the archives – dating and source tracing technologies*
2. *Processes and scales in sedimentary systems – from point to continents*
3. *Global change and erosion*
4. *Linking erosion with environmental and societal impacts*

Abstracts available at
www.iahs.info/redbooks/325.htm



Calendar of Meetings Organized/Sponsored by IAHS

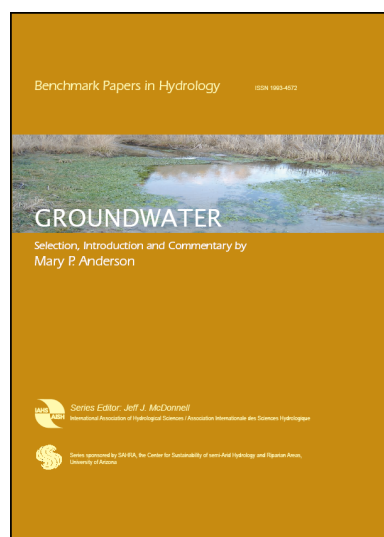
Details of these plus many non-IAHS meetings are provided at <http://iahs.info> – click on *Meetings*

2009	Conference	Contact details
Goslar-Hahnenklee, Germany 30 March–2 April	<i>International Workshop on Status and Perspectives of Hydrology in Small Basins</i>	Ulrich Schröder, schroeder@bafg.de ; Sybille Schumann, s.schumann@tu-bs.de http://www.ws.small-hydro-basins.org
Puebla Cholula, Puebla, Mexico 13–17 April	<i>International Conference on Water, Environment and Health Sciences : The Challenges of the Climate Change (ICWEHS)</i>	ICWEHS Organizing Committee: icwehs@hotmail.com or icwehs@yahoo.com tel:+52 (222) 229 2647 or 229 2031; fax: +52 (222) 229 2096
Vienna, Austria 20–23 April	<i>HydroEco'2009 Hydrology and Ecology: Ecosystems Interfacing with Groundwater and Surface Water</i>	Karel Kovar, Netherlands Environmental Assessment Agency, The Netherlands tel: +31 30 274 3360; karel.kovar@mnp.nl ; www.natur.cuni.cz/hydroeco2009
Montreal, Canada 19–29 July	MOCA-09 Joint Assembly of IAMAS, IAPSO and IACS: <i>Our Warming Planet</i>	montreal2009@nrc.gc.ca ; http://www.iamas-iapso-iacs-montreal.ca
Ohrid, Macedonia 1–5 September	WMHE2009, 11th International Symposium on Water Management and Hydraulic Engineering	Violeta Gesovska, tel: +389 (2) 3116066/ext. 120/210; fax: +389 3118834; violeta@gf.ukim.edu.mk
Hyderabad, India 6–12 September	8th IAHS Scientific Assembly and 37 th IAH Congress	Pierre Hubert, IAHS Secretary General; piy.hubert@free.fr http://www.appliedhydrology.org/iahs
Bratislava, Slovakia 21–24 September	2nd Int. Conf. Biohydrology 2009: <i>A Changing Climate for Biology and Soil Hydrology Interactions</i>	L. Lichner, Institute of Hydrology, Slovak Academy of Sciences, Raciarska 75, 83102 Bratislava, Slovakia; lichner@uh.savba.sk ; http://www.ih.savba.sk/biohydrology2009
Plitvice Lakes, Croatia 23–26 September	<i>Sustainability of the Karst Environment - Dinaric Karst and Other Karst Regions</i>	Jadranka Pejnovic, Centre for Karst, Budacka 12, 53000 Gospic, Croatia tel: +385 53 575 649; fax: 385 53 575 649; jadranka.pejnovic@gs.t-com.hr
Wuhan, China 21–25 October	ModelCARE 2009	Yanxin Wang, China University of Geosciences, Wuhan yx.wang@cug.edu.cn ; http://www.modelcare2009.org
2010		
Vienna, Austria, 2010	13th ERB Conference	Hubert Holzmann, BOKU, Vienna, Austria; hubert.holzmann@boku.ac.at
Krakow, Poland 12–16 September	XXXVIIIth IAH Congress	Stanislaw Witczak, AGH University of Science and Technology Department of Hydrogeology and Engineering Geology, Krakow, Poland tel: +48 (12) 617 2437; fax: +48 (12) 633 2936 witczak@uci.agh.edu.pl
Fez, Morocco 25–29 October 2010	6th World FRIEND Conference. <i>Global Change : Facing Risks and Threats to Water Resources</i>	Eric Servat, friend2010@msem.univ-montp2.fr http://www.unesco.org/friend2010/water/ihp/pdf/call_papers.pdf
2011		
Melbourne, Australia 27 June–8 July	XXVth IUGG General Assembly, including the Ninth IAHS Assembly	

BENCHMARK PAPERS IN HYDROLOGY

This IAHS Series collects together, by theme, the outstanding papers that provide the scientific foundations for hydrological science today. Each thematic volume reprints ~30 papers selected by an expert, who comments on the significance and context of each one. Originally published across a wide spectrum of disciplines, the papers brought together in each volume define the field and provide an overview of the development of ideas that have led to our current concepts and understanding. The Series Editor is Jeff McDonnell.

The books are excellent resources for graduate and post-graduate-level courses, and will be of interest to scientists and engineers generally, particularly as they reproduce many seminal papers which are otherwise difficult to access.



GROUNDWATER

Selection and Commentary by Mary P. Anderson

Mary Anderson's selection and the commentaries that she has prepared to accompany the 35 reprinted papers, detail the development of groundwater hydrology during the 20th century. The fundamentals are introduced with a translation of Darcy's (1856) experimental results that led to Darcy's law, as well as classic papers by Meinzer, Theis and Hubbert, among others. The development of pumping test theory and practice, approaches to estimating aquifer parameters in the field, and flow system analysis are dealt with. Papers reflecting early concerns regarding quantification of uncertainty, how recognition of groundwater interaction with surface water grew, and early research on contaminant occurrence and transport, are included. Slichter's (1905) seminal contribution that identified dispersion in the field, and Skibitzke & Robinson's (1963) laboratory findings, are linked with more recent attempts to represent dispersion and heterogeneity with models.

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ICCE, Continental Erosion

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PUB, Predictions in Ungauged Basins

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ICWQ, Water Quality

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ICT, Tracers

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Eleanor Blyth (UK) emb@ceh.ac.uk

Panel on Hydroinformatics

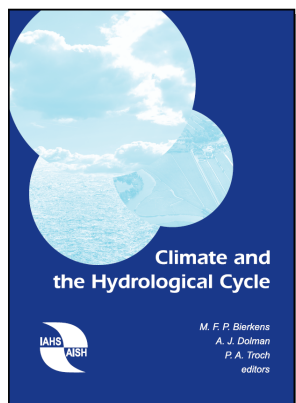
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Climate and the Hydrological Cycle

Edited by: *Marc Bierkens* Utrecht University, The Netherlands
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