



IAHS Newsletter

NL90 March 2008

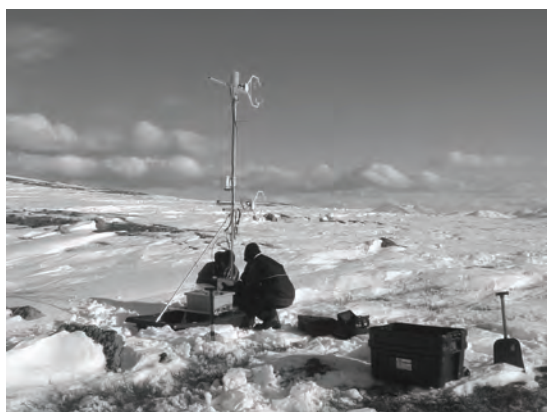
Includes the programme for the 8th IAHS Scientific Assembly, to be held in Hyderabad, India, 6–12 September 2009, with IAH



Arrangements for holding the IAHS Assembly jointly with IAH (International Association of Hydrogeology) in Hyderabad, are agreed. See centre pages for the scientific programme.

Left to right: S. N. Rai (IAH VP), Rajendra Prasad (IAHS VP), Willi Struckmeier (IAH Sec General), V. P. Dimri (Director, NGRI) and Pierre Hubert (IAHS Sec General)

Cold Regions Hydrology in the International Polar Year



There are substantial hydrological activities in the International Polar Year (2007–2008), driven by the need for a better understanding of hydrology in the Polar Regions. This need is made urgent by the ungauged or poorly-gauged nature of much of the Arctic and Antarctic drainage basins and by the importance of melt in governing the balance between terrestrial snow and ice and streamflow. Freshwater inputs can modify ocean currents, particularly

those in the North Atlantic which currently warm Europe. The impacts of a warming Arctic are already raising serious concerns about the stability of the sensitive balance between climate conditions, freshwater input, oceanic circulation and the state of cryospheric components. *Continued p. 15*

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1000s of hydrological science papers available online

Publications 1 to 221 inclusive of the Red Books (IAHS Series of Proceedings and Reports), published between 1924 and 1994, are now available at www.iahs.info for anyone to view or download, as is the complete backfile of *Hydrological Sciences Journal (HSJ)*, vols 1–48. Use the author/title/key word search facility for quick retrieval of the book/papers that you are interested in. UNESCO-IHP provided support to finance the scanning of the more recent Red Books and the *HSJ* backfile.

NE-FRIEND Workshop



A Workshop was held at the University of Birmingham, UK, 19–20 November 2007, as a contribution to the UNESCO-IHP VII crosscutting theme FRIEND (Flow Regimes from International Experimental and Network Data). Organised by David Hannah, coordinator of the Northern European-FRIEND Project 3, the Workshop demonstrated the international dimension of FRIEND with 18 participants, of these 10 young researchers, based in six countries (and representing eight nationalities) from Europe and South America. *See p. 6*



Launch of IAHS Working Group on Statistics in Hydrology

Reflecting the considerable, and increasing, use of statistics in hydrological sciences, a new working group has been set up to facilitate discussion and dissemination of information about the use of statistics in hydrology, and data. *See p. 8*

A Note to Members

First let me wish you and your families and colleagues all the very best for a peaceful, healthy and productive 2008. I apologize for being so late with my greetings, but this issue of the Newsletter has been delayed for the reasons mentioned below.

In the last issue, I took one-and-a-half pages to report on the Assembly in Perugia. In contrast, I will limit myself here to just a few lines because not so much has happened over the past few months on which to comment. That is not to say that the Association is asleep – far from it. Pierre has been very busy reorganizing his secretariat facilities and reformatting digitized Red Books; Gordon is developing plans for what we might do in the long term – see his note below; Dan has been finalizing the scientific

programme for the Hyderabad Assembly; Rajendra has been working on the logistical plans for the Assembly; and Juan Carlos has been working with Cate on our support to developing countries. In addition, the IAHS Commissions and Working Groups are in the first year of their new mandates and are drawing up their programmes for the next three-and-a-half years. In fact a number of them are finalizing plans for some of the 14 conferences and symposia that the Association will be convening or co-sponsoring this year. All this goes to show that the Association never sleeps, but will be in business this year, 24 hours a day for 366 days.

From what I have said above, it will be clear that 2008 will not be a “gap year” for IAHS. In fact, September 2009 might seem a long way off, but if we are to make a

success of the joint meeting in Hyderabad with our colleagues from the International Association of Hydrogeologists (IAH), we will need to work hard over the whole of the next 20 months with that as our aim. It is one thing to announce that we will hold our meetings in parallel, it is quite another to achieve this in practice. So, in September 2007, I attended the 35th Congress of IAH in Lisbon to discuss matters with them. I was given a very warm welcome and we made a lot of progress. In January, Pierre visited Hyderabad together with his IAH counterpart to finalize the plans and this went so well that we are able to publish the final programme in this issue of the Newsletter, which has been delayed a few weeks for this purpose.

Arthur Askew, IAHS President

From the President-Elect

I felt very honoured in Perugia to be elected to serve as the next President of IAHS from 2009 to 2013. For me this is a return to the Association after a number of years of absence when I served in the United Nations system. In the coming two years I look forward to working with Arthur, Pierre, all officers of the Association, and with our several thousand members world-wide.

In planning for the longer term future I foresee important challenges, both administrative and intellectual. There is no doubt that, as a result of recent radical changes in communication and dissemination of information, the Association faces real challenges in how we publish our Journal, our Red Books and our newsletters and how, in general, we communicate with our members and with the scientific community at large. The way that we publish has great implications for our

financial viability. In this regard and to bring me up-to-date with the finances of the Association, Des Walling, Chair of the Board of IAHS Ltd kindly invited me observe at the recent meeting of the Board. I now intend to seek advice from officers of the Association in order to help chart the best course for the future.

The way that we publish and communicate with the hydrological community around the world will have enormous impact on the attractiveness of IAHS to the younger generation of scientists. Our future lies in full involvement of scientists in the early years of their development and that generation is much more in tune with electronic means of communication than, in general, is the case with the older generations. So we must be prepared to move with the times and to seek the opinions and guidance from those just starting their careers.

Throughout its long history IAHS has been a dynamic organization. As emphases have changed in scientific thought, so IAHS has responded by creating new Commissions, Committees and Working Groups. In our most recent history the Working Group on Predictions in Ungauged Basins has proved very effective in energising a large segment of our community and we must encourage such initiatives in the future. The Association must continue to be dynamic and responsive to new challenges as they arise – so long as we act this way we are most likely to attract the brightest and best to our fold.

While we must always encourage science for science’s sake, that is for the development of our understanding of how the hydrological system functions, we must also be very aware that our knowledge and understanding need to be translated into benefits for society. I believe that we should always ask ourselves to what extent our scientific findings can be useful for society, for the betterment of the lives and livelihoods of people. To this end I intend to throw out the challenge to all our Commissions and Working Groups to demonstrate the relevance of their efforts to society at large. This may indeed be quite a challenge, but one to which I am looking forward with enthusiasm.

Gordon Young, President-Elect

IAHS Newsletter © IAHS Press 2008

Published by IAHS Press, Centre for Ecology and Hydrology, Wallingford, OX10 8BB, UK

Edited by Cate Gardner Printed by Alden Group, Oxford, UK

IAHS is a nongovernmental not-for-profit scientific organization dedicated to serving the science of hydrology and the worldwide community of hydrologists.

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: pjh.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 July/August 2008

5th WORLD WATER FORUM
I S T A N B U L 2 0 0 9



**BRIDGING
DIVIDES
FOR WATER**

The 5th World Water Forum, with the theme “Bridging Divides for Water” will be held in Istanbul, Turkey, 16–22 March 2009. Thematic, regional and political processes are being integrated for the development of the Forum. The thematic process is using a “pyramid” approach: all themes, topics and sessions will lead to the achievement of a clear set of experiences, recommendations and commitments for action on bridging water divides among actors, sectors and present and future generations. Building on lessons from previous Forums and to increase commitment from the global water community, the World Water Council (WWC) and the Turkish co-organisers have devised an improved framework for the preparation of the Forum. This relies on three committees in charge of the three components of the Forum (the programme, the political process and communication); each is composed of an equal number of representatives of Turkish and WWC members. They all work with the help of a larger working group of organisations willing to contribute to the preparation of the Forum, and report to an International Steering Committee.

The programme framework, developed by the Programme Committee, specifies the aim, themes and topics. There are six themes:

1. Global changes and risk management
2. Advancing human development and the MDGs
3. Managing and protecting water resources and their supply systems to meet human and environmental needs
4. Governance and management
5. Finance
6. Education, knowledge and capacity building

The development of each theme is the responsibility of the Thematic Coordinator assigned by the Programme Committee. The thematic coordinator’s role is to develop within a thematic consortium the respective theme, topics and sessions, to identify and share experiences and actions, bridging the gaps between actors, sectors, regions and generations of relevance for the theme and to formulate recommendations, commitments and actions to further build these bridges. The coordinators will propose a consortium of institutions to be involved in the development of the theme following guidelines prepared by the Programme Committee. Their proposal will be subject to this committee’s approval to ensure a balanced and representative consortium capable of addressing the main questions.

For each topic, around three sessions will be identified, which should provide the platform to bridge divides between actors, sectors and between the present and the future. Sessions should be inclusive and open, and used in creative ways for building the bridges. Presentation time will be strictly limited to allow for maximum interaction

time between participants. Invitations for contributions to sessions will be sent out early in 2008.

The Forum week will cover seven days: an opening day, five days in which the themes will develop, and a closing day. Plenary sessions will be held in the morning covering the keynotes, feedback from previous day, panels and regional reports. Topic sessions will mainly be concentrated in the afternoon.

In organising the Forum and developing the themes, the following principles were obeyed:

- Bridging the divides: All activities should be multi-stakeholder and focused on narrowing the gaps between actors, sectors, regions and generations.
- Impact oriented: The ensemble of sessions should have a measurable impact on the achievement of the MDGs.
- Inclusiveness: No actors can be excluded from the forum process.
- Freedom of expression: All actors and interest groups have the right to express themselves.
- Participation: Themes, topics and sessions are developed in a participatory manner.

On 5–6 November 2007, a one and a half-day meeting was organized in Istanbul to bring the thematic and regional coordinators of the Forum together, as well as representatives of a huge number of institutions from all around the world. IAHS was among the invitees. On behalf of Dr. Arthur Askew, the IAHS president, Dr. Hafzullah Aksoy of Istanbul Technical University, Turkey, Vice-president IAHS-ICSW, represented IAHS in the meeting.

IAHS expressed interest in the topics of the theme Education, Knowledge and Capacity Building:

- Education and capacity building strategies
- Water science and technology: appropriate and innovative solutions for the 21st century
- Using professional networks and associations to strengthen the water sector.

The thematic and regional coordinators of the Forum met again on 7–8 February 2008, in Istanbul, to develop sessions under each topic. IAHS, represented by Dr Gordon Young (PE IAHS) and Hafzullah Aksoy jointly coordinated, with UNESCO, Topic 6.2: *Education, knowledge and capacity building*. The scoping paper prepared by Drs Arthur Askew (IAHS) and Siegfried Demuth (UNESCO), summarizing the affirmation, aims, partners, activities in the Forum, questions to be addressed, outcomes, preparatory work needed, and sources of funding, was included with the Draft Topic Scoping Papers for Theme 6. Sessions to be developed under Topic 6.2 were discussed and three main sessions were suggested to the Theme Coordinator, with a possible new topic on Data to be discussed by the Forum Program Committee.

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Istanbul Technical University, Department of Civil Engineering

In Memorium

IAHS has been informed of the death of
Professor Zdzisław Kaczmarek (Poland, 1928–2008)
There is an obituary at www.iahs.info

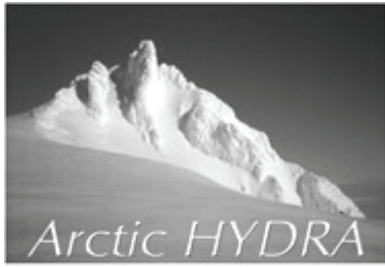
Reports from IAHS Commissions and Working Groups

ICSIH – Snow and Ice Hydrology

Cold Regions Hydrology in the International Polar Year

continued from p.1

In the International Polar Year, cold regions hydrology activities are mainly organised around the Arctic-Hydra Project led by Árni Snorrason of Iceland, <http://arcticportal.org/arctichydra>. This project consists of a network for the observation of the Arctic Hydrological Cycle (AHC) coupled with a suite of intensive, focused process studies that are based on in-depth measurements and modelling of the individual components of the AHC. Furthermore, hydrological models and data assimilation techniques will be developed to generate a comprehensive, integrated description



of the AHC, including the feedbacks between the atmosphere, cryosphere and oceans. The main scientific goals of the Arctic HYDRA project are to:

1. characterize variability in the AHC,
2. examine linkages between atmospheric forcing and continental discharge to the oceans,
3. assess the historical response of the Arctic Ocean to variations in freshwater input from rivers and net precipitation over the ocean,
4. attribute to specific elements of the AHC or to external forcing the sources of observed spatial temporal variability in the land–ocean–ice–atmosphere system,
5. detect emerging changes in the contemporary state of the AHC in near real time and to place such changes into a broader historical context.

Two major activities relating to the IPY and linked to Arctic-Hydra are the Russian national programme for hydrology in IPY and the Canadian IP3 Network (Improved Processes and Parameterizations for Prediction in Cold Regions), both of which have recently had important meetings, as briefly described below.

Russian hydrology activities related to IPY

The scientific programme for Russian participation in IPY was adopted in 2006 by the Russian National Committee for IPY 2007–2008 (http://www.ipyrus.aari.ru/orqcom_comp.html; in Russian language only) under the support of the Government of the Russian Federation. Russian IPY activities assemble researchers from the Federal Service for Hydrometeorology and Environmental Monitoring, Russian Academy of Sciences, Moscow State University, institutes of government ministries and some non-government organizations. A total of 164 projects have been endorsed by the Russian National Committee for IPY 2007–2008. They have an interdisciplinary emphasis and address seven branches of research. The first branch is particularly devoted to hydrological processes in the Arctic region. The main objectives are the estimation of the current and the future changes in the hydrological and ice regimes

of the rivers and lakes, and snow processes in the Russian arctic regions under the climate changes. Within the framework of these objectives, the projects are directed to:

1. collecting a broad-ranging set of hydrometeorological data, which will be made available worldwide,
2. developing a strategy to account for climate change impacts on arctic rivers,
3. assessing probable changes in the large river runoff under changing climate and adapting existing water resources systems to these changes, and
4. estimating the spatial–temporal variability of snow processes and their sensitivity to climate change.

On 3–9 October 2007 in Sochi, the Russian National Committee for IPY 2007–2008 organized a conference where the first results of these studies were discussed. The conference was hosted by the Scientific Centre of the Russian Academy of Science (RAS) and opened with a plenary talk by RAS academician Vladimir M. Kotlyakov, Chair of the Scientific Council of Arctic and Antarctic Research. Over 100 people attended the conference and presented 92 oral and poster reports, of which 13 focused on the hydrological topics. Different approaches to modelling river runoff generation in the permafrost regions, river ice-cover dynamics and ice jam flooding, and seasonal snow-cover processes as well as to estimating the current changes in water and chemical flow of the large Siberian rivers into the Arctic Ocean, and the physical properties of snow cover were reported. The conference closed with a discussion on integration, in the framework of IPY, of the Russian IPY hydrological activity with the international community of cold region hydrology.

The IP3 Research Network: Enhancing Understanding of Water Resources in Canada's Cold Regions as part of IPY

IP3, Improved Processes and Parameterisation for Prediction in Cold Regions, is a research network funded by the Canadian Foundation for Climate and Atmospheric Sciences (CFCAS) for 2006–2010. The Network, comprised of about 80 Investigators, Collaborators, postgraduate students, and postdoctoral fellows from across Canada, the US, and Europe, is devoted to an improved understanding of surface water and weather systems in cold regions, particularly Canada's Rocky Mountains and western Arctic. IP3 makes a contribution to better weather and climate prediction, to estimation of streamflow from ungauged basins, to predicting changes in Rocky Mountain snow and water supplies, to calculating freshwater inputs to the Arctic Ocean, and to sustainable management of mountain and northern water resources.



IP3 has three goals: understanding the key climate system *Processes* relating to the hydrometeorology of cold regions; *Parameterising* land surface *Continues on p.6.*



Scientific Programme of the Joint IAHS & IAH International Convention Water: A Vital Resource Under Stress – How Science Can Help



Hyderabad, India, 6–12 September 2009

IAHS Programme Committee Chairman: Prof. Dan Rosbjerg (Denmark), IAHS VP

IAH Programme Committee Chairman: Dr Shivendra Nath Rai (India), IAH VP

JOINT SYMPOSIA JS.1–4	
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 WORKSHOPS JW.1–4	
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: Minimising 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	IAH THEMES G.1–4 Hydrogeology of Hard Rocks
HS.1	G.1
HS.2	G.2
HS.3	G.3
	G.4
IAHS WORKSHOPS HW.1–7	IAHS SUBTHEMES (details yet to be confirmed)
HW.1	<p align="center">ABSTRACTS</p> <p align="center"><i>Submit ALL abstracts electronically through the Convention website which will be launched shortly.</i></p> <p align="center"><i>There will be links to it from the IAHS and IAH websites</i></p>
HW.2	
HW.3	
HW.4	
HW.5	
HW.6	
HW.7	

Symposia (JSx and HSx) = Sessions for which full papers will be published in a Red Book available at the conference. Abstracts for symposia are due earlier than other abstracts. The abstract deadline is 30 November 2008; acceptance of abstracts will be announced in January 2009; the deadline for full papers is 28 February 2009.

Workshops and Themes = Sessions for which the only submission is the abstract. 31 January 2009 is the deadline for abstracts for these sessions.

JS.1 Ecohydrology of surface and groundwater dependent ecosystems: Concepts, methods and recent developments

ICSW, ICCE, ICWQ, ICCLAS, IAH

With increasing pressures on water resources, there is a strong trend to manage rivers and their catchments as ecosystems. This requires a holistic, interdisciplinary approach that simultaneously considers the physical, chemical, and biological processes between ecosystem components, as well as the many different connections within a network of ecosystems in a watershed. Tremendous progress has been made in understanding water resource ecosystems and Ecohydrology has contributed significantly to this. However, a number of important theoretical and practical consequences have emerged from the interdisciplinary approach of Ecohydrology and these include: (1) Gaps in understanding at the interface between disciplines; (2) Disciplines focusing on specific scales or levels of organization or interest; and, (3) Sub-disciplines often becoming rich in detail, developing their

own view points, assumptions, definitions, lexicons and methods. These issues can impede the integration of various disciplines into a single applied understanding of natural ecosystems, as advocated by Ecohydrology, because attempts to produce an interdisciplinary outcome tend to remain dominated by the paradigms familiar to component disciplines. In particular, the science and applications of environmental flows and the potential influence of climate variability on the delivery of water for environmental concerns is relatively young and rather controversial. This session will focus on the science of Ecohydrology and its contributions to the issues of environmental water allocations and the influence of climate variability on sustainable water management for aquatic ecosystems.

Convener: Martin Thoms (Canberra, Australia), martin.thoms@canberra.edu.au

Co-conveners: Eva Bøgh (Denmark)
António Chambel (Portugal)
Christine Colvin (South Africa)
Kate Heal (UK)
Teresa Melo (Portugal)
Vladimir Smakthin (Sri Lanka)

JS.2 Trends and sustainability of groundwater in highly stressed aquifers

ICGW, IAH, ICWQ

Population growth, urbanization and global climate change have increased urban and agricultural water demands, stressing aquifer systems where groundwater is a source of water supply. The availability and utility of groundwater may further be threatened by factors stressing the quality of groundwater, such as industrial and domestic wastes and agricultural intensification. Consequences include, for example, over-allocation of groundwater, groundwater overdraft, declining well yields and land subsidence; degraded groundwater quality due to mobilization of natural pollutants (arsenic), salt contamination caused by seawater intrusion; increased demand for conjunctively used surface water and resulting conflicts with junior users; and streamflow capture and resulting damage to ecosystems. These consequences may occur incrementally and inequitably across an aquifer. Natural environmental problems can further complicate use of groundwater and increase strain on the aquifer system: e.g. underground structures, geothermal heating (such as heat islands), and geochemical evolution (such as karst formation, excessive salinity, acidity, fluoride, radioactivity, hardness, or turbidity). This session seeks to bring together scientists, including modellers, geochemists, and hydrogeologists, with water supply managers and policy makers to discuss scientific and management ideas and approaches for improving the sustainability of highly stressed aquifers.

Convener: Makoto Taniguchi (RIHN, Japan),
makoto@chikyu.ac.jp

Co-conveners: Alyssa Dausman (USA)
Ken Howard (Canada)
Elango Lakshmanan (India)
Maurizio Polemio (Italy)
Wolfgang Schmid (USA)

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

ICWRS, ICWQ, ICRS, IAH

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 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 will address 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 storage. Papers are invited that explore concepts and components of IWRM and AM, and present examples of their implementation in river basins. Also, new data to assist in IWRM will be explored by using remote sensing methods in synergetic application with ground observations and modelling. Contributions using visible, near and thermal infrared, microwave and other sources like altimetry or gravimetry are solicited. 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.

Convener: Günter Blöschl (Austria), *bloeschl@hydro.tuwien.ac.at*

Co-conveners: Olga Barron (Australia)
Nick van de Giesen (The Netherlands)
D. Muralidharan (India)
Liliang Ren (China)
Frédérique Seyler (France)
Uttam Sharma (India)
Jaroslav Vrba (Czech Republic)

JS.4 Hydroinformatics in hydrology, hydrogeology and water resources

HYINE, ICSW, ICWRS, ICRS, IAH

Hydroinformatics is a branch of Informatics which concentrates on the application of information and communication technologies (ICTs) in addressing the increasingly serious problems of the equitable and efficient use of water. The Joint Committee on Hydroinformatics represents the interests of the International Association of Hydraulics Research (IAHR), the International Water Association (IWA) and IAHS. This symposium will be focused on the problems of model coupling in complex systems, the treatment of uncertainty, the exploitation of artificial intelligence (AI) methodology and advanced GIS and visualisation techniques to the whole field of water resources and hydrology. Hydroinformatics draws on and integrates hydrology, hydraulics and environmental engineering, and many other water disciplines. It sees application at all points in the water cycle from atmosphere to ocean, and truly represents an attempt to support a “whole systems modelling philosophy”. It provides support for decision making at all levels from governance and policy through management to operations. The symposium particularly welcomes contributions in the water resources area from developing countries where efficient and sustainable use of water is an imperative. A Red Book will be produced post-symposium under the editorial guidance of the conveners.

Convener: Ian Cluckie (UK), *i.d.cluckie@bristol.ac.uk*

Co-conveners: Vldan Babovic (Singapore)
Yangbo Chen (China)
Siegfried Demuth (Germany)
Lenny Konikow (USA)
Arthur Mynett (The Netherlands)
Dragan Savic (UK)

JW.1 Measuring and modelling interactions between surface water and groundwater

ICGW, ICSW, ICT, IAEA, IAH

This workshop seeks to advance the integrated analysis of surface water–groundwater systems and their interactions in different geographical, geological, and anthropogenically influenced environments. It will bring together scientists from academia, government, and consultancies, with backgrounds in physics, geology, chemistry, biology and ecology. Contributions are invited on theoretical, numerical, and experimental studies that address all components of the water and energy cycles of surface-water/groundwater systems. Integrated studies that address a wide range of time scales (diurnal to decadal) and spatial scales (column to basin and global scales) are encouraged. Emphasis is placed on coupling different processes of the surface–subsurface–land–surface system, such as rainfall–runoff transformation and stream flow generation; estimation of residence times of water and solutes in catchments; ecological responses in flood plains, coastal zones, groundwater-dependent ecosystems and unsaturated zones; and effects of climate change on surface water–groundwater systems. The symposium also welcomes contributions concerning the development of simple and robust algorithms for modelling surface water–groundwater interactions in data-poor areas (that is, ungauged basins).



Convener: Gunnar Nützmann, (Germany),
nuetzmann@igb-berlin.de

Co-conveners: Corinna Abesser (UK)
Jianyao Chen (China)
Peter Cook (Australia)
Aldo Fiori (Italy)
Sushil Kumar Gupta (India)
David Rassam (Australia)
Jun Shimada (Japan)
V. P. Singh (USA)
Chris Soulsby (UK)

JW.2 Transboundary water management: Science and policy

Joint session with ICGW and ICSWS of IAHS, CTA of IAH, UNESCO and OSS

This session focuses on the science and policy of transboundary aquifers and their interactions with surface water. Almost 40% of the world's population lives in a transboundary river basin and nearly 60% of global fresh surface waters flow across an international boundary. A recent UN study identified 263 transboundary river basins and the International Shared Aquifer Resource Management initiative (ISARM) of UNESCO-IGRAC's global inventory has so far documented 90 transboundary aquifers in Western Europe and 60 each in the Americas and Africa. The scientific and legal issues that affect the management of these shared waters have attracted interest for years, yet intergovernmental agreements remain immature. The one international legal instrument on transboundary water developed between 1970 and 1997 by the United Nations International Law Commission (UN ILC) remains unratified. However, the ILC recently drafted legal articles on the use of transboundary aquifers for adoption by governments. This symposium seeks to improve the science and policy needed to manage transboundary aquifers and associated waters by bringing together scientists, engineers, managers, lawyers and policy makers. Suitable subjects within the context of transboundary waters include, for example, (a) quantifying natural and anthropogenically influenced flux of groundwater across political boundaries; (b) investigation of transport of contaminants; (c) impacts of increasing climate variability, especially where rivers and aquifers are currently supported by snow pack and/or glacial systems; (d) accounting for interactions between groundwater and surface water bodies such as rivers, streams and lakes; (e) socio-economic aspects of using transboundary waters; and (f) legal frameworks for transboundary waters and their consistency with scientific evaluations, (g) examples of transboundary water management. Selected contributions from the symposium will be published in a peer-reviewed IAHS Red Book following the joint IAH Congress and IAHS Scientific Assembly in Hyderabad, India.

Convener: Surin Workakijthamrong (UK),
surin.worakijthamrong@bristol.ac.uk

Co-conveners: Eberhard Braune (South Africa)
Deborah Hathaway (USA)
Youba Sokona (Mali/Tunisia)
Clifford Voss (USA)
Surin Workakijthamrong (UK)
Yongxin Xu (South Africa)

JW.3 Rural and urban water systems: Minimising adverse impacts of global change on water resources

ICWQ, ICWRS, IAH

Hydrological regime and water quality in rivers, lakes and aquifers are dependent on climate conditions and direct and indirect human activities, such as land use, urbanization and water management. Higher temperatures and changes in the timing, intensity and duration of precipitation can affect the hydrological cycle and influence geochemical fluxes in soil and water. Changing climate could lead to alterations in runoff, streamflow and water quality characteristics. Land use patterns

and agricultural practices have a very significant effect on water flows and water quality, as do management actions to control point and diffuse sources of pollution. Consumption of groundwater in large cities leads to lowering of groundwater tables, pollution of surface and groundwater, damaging the ecological systems and land subsidence. Rapid urbanization and its consequences for local and regional water systems (both quantity and quality aspects) are likely to become dramatic in the future. Therefore, water systems in the future will be very dependent on changing climate conditions, as well as on the whole spectrum of human activities. Confidence in estimates of changes in water cycle and water quality is - uncertainty is added by the current lack of understanding of other processes involved and their interface with human activities. The Workshop intends to contribute to this important field of research. Papers are welcomed that address different aspects of observed and projected trends in water regime and water quality under global change, including changing climate, land use change and urbanization.

Conveners: Valentina Krysanova (Germany),
krysanova@pik-potsdam.de

Co-conveners: Nico Goldscheider (Switzerland)
Kate Heal (UK)
Ayorinde Olufayo (Nigeria)
Liliang Ren (China)
Frans van de Ven (The Netherlands)

JW.4 Isotope tracing for water balance, hydro-dynamics and hydrological processes, including groundwater recharge, as indicators of water resources sustainability

ICT, ICSW, ICGW, PUB, IAEA, IAH

Isotopic and geochemical tracers are increasingly being applied at the watershed, basin and continental scale to study water cycling processes that influence sustainability of surface and groundwater resources. Examples include recharge and discharge estimation, quantification of aquifer residence times, surface/groundwater interaction, seawater intrusion, precipitation-runoff mechanisms, evaporation losses, and partitioning of water sources and sinks. Contributions that discuss the role of tracers as tools for integrated water management, transboundary cooperation, climate change impacts, and prediction in ungauged basins are particularly encouraged. Emphasis in the oral session will be placed on quantitative applications, modelling, uncertainty, and sensitivity analysis.

Convener: Piotr Maloszewski (Germany), maloszewski@gf.de

Co-conveners: John Gibson (Canada)
Andrew Herczeg (Australia)
Balbir Singh Sukhijat (India)
Michael Stewart (New Zealand)

HS.1 High mountain snow and ice hydrology

ICSIH, ICRS, PUB, IACS

Changes in storage of water as seasonal snowpack, frozen ground, and perennial snow and glacier ice, and release of meltwater are major components of hydrological systems in the high mountain regions of the world. In such areas, the annual cycle of meltwater production from snow and ice is critical, influencing streamflow regime, soil moisture, and both terrestrial and aquatic ecosystems. Meltwater availability is crucial in cold mountain environments, and in areas downstream, for agriculture and hydropower, particularly where the areas surrounding mountains are otherwise arid and susceptible to drought. Snowpack, permafrost, glaciers and meltwater runoff will continue to be influenced strongly by climate change into the future. Detailed understanding of, and the ability to accurately model inter-relationships between climate, snowpack, ground ice and glacier dynamics coupled with intra-basin hydrological processes, are necessary in order to test hypotheses concerning contemporary and future interactions between high mountain climate, snow, ice, runoff,

biogeochemistry and water quality. This symposium addresses a broad range of topics important for better understanding of snow and ice hydrology in mountain regions and for reducing uncertainty and increasing physical realism in modelling and prediction. Contributions on the following topics are particularly welcome: measurement and monitoring techniques for snow and ice in cold mountainous regions; physical properties of snow, permafrost and ice – linking microscale properties to macroscale processes; using remote sensing for improvement of prediction of runoff from snow and ice in data-sparse mountain areas; forecasting meltwater runoff from ungauged high mountain basins; assessment of risk and prediction of glacier lake outburst floods in mountain areas, and impacts of mountain snow and ice hydrology on water resources in drier downstream areas in a changing climate.

Convener: David Collins (UK), d.n.collins@salford.ac.uk

Co-conveners: Alexander Gelfan (Russia)
Georg Kaser (IACS / Austria)
Danny Marks (USA)
John Pomeroy (Canada)
Pratap Singh (India)

HS.2 New approaches to hydrological prediction in data sparse regions

ICCLAS, ICSIH, ICWRS, ICRS, PUB

In many regions of the world the reliability of hydrological predictions is limited because local data are often sparse or non-existent. New strategies to help reduce the negative consequences of data scarcity are crucial to improving water resources management and to better assessing the evolving impacts of natural and anthropogenic climate change. One important way around this problem is to draw on other sources of information, including, for example: (1) coupled hydro-meteorological predictions, (2) remote sensing technology, and (3) guided monitoring network design. Strategies for improving and exploiting hydro-meteorological predictions might include novel downscaling techniques, improved representation of critical land-surface-atmosphere continuum, assessment of the effects of climate variability/-change on frequency/severity of floods and drought, and approaches to incorporate data assimilation and uncertainty assessment. Strategies for exploiting remote sensing technology might include methods that assimilate such information into water management, that improve water use effectiveness, or that monitor and understand land-use changes in relation to water availability and usage. Strategies focusing on alternatives to expensive ground-based monitoring networks might include guidance on the design of optimum network density and/or sampling strategy to address specific science problems (e.g. dominant process identification) and resource management challenges. Methods for using sparse networks to evaluate the approaches listed above are also important. This symposium seeks contributions that address how such approaches can help reduce the negative consequences of data scarcity and thereby improve hydrological predictions in data sparse regions.

Convener: Koray K. Yilmaz (Turkey and Arizona, USA), koray@hwr.arizona.edu

Co-conveners: Hoshin V. Gupta (USA)
Christopher Neale (USA)
John Pomeroy (Canada)
Hubert Savenije (The Netherlands)
Thorsten Wagener (USA)
Dawen Yang (China)
Ismail Yücel (Turkey)

HS.3 Hydrological theory and limits to hydrological predictability in ungauged basins

PUB, ICSW, ICGW, ICCE, ICWRS, ICCLAS

For PUB to achieve reliable predictions in ungauged basins, we need sound hydrological theory. Currently, no universal

theory of catchment hydrology exists. There are different concepts for different parts of the hydrological cycle and different spatial and temporal scales. In this symposium concepts will be discussed that may help shape a theory of catchment hydrology that can support PUB. Possible contributions include concepts that represent processes simultaneously at various scales and then link them, rather than to upscale small scale processes all the way to obtain aggregate behaviour. An important theoretical and practical issue for PUB is to understand the limits to predictability in hydrology. *Inter alia* predictability may be limited by the life time of hydrological phenomena and by the non-linearity of hydrological systems, as well as lack of knowledge on initial conditions and boundary conditions. One of the issues to be identified is the relative role of these components in different hydrological settings, i.e. what are the theoretical limits to predictability, and how can we improve it in the light of increased data availability, including novel data sources. To address the generalisation issue, comparative hydrology may assist in developing a common method for assessing and quantifying hydrological similarity, through comparisons between catchments in different hydrological regimes. Contributions from all subdisciplines of hydrology are sought, including hydrological forecasting, regional estimation, assessment of hydrological change, and aquifer assessment; all components of the water cycle are addressed, including extremes (floods, low flows), erosion and water quality related parameters.

Convener: Erwin Zehe (Germany), erwin.zehe@uni-potsdam.de

Co-conveners: Stewart Franks (Australia)
Praveen Kumar (USA)
Lakshman Nandagiri (India)
Stan Schymanski (Germany)
Peter Troch (USA)

HW.1 Regionalisation of models for operational purposes in developing countries

ICSW, ICWRS, PUB

Developing countries often represent the most difficult situations in which to apply hydrological models. The general lack, or poor quality and reliability, of the available data suggests that there will be a relatively high degree of uncertainty in modelling results. At the same time, because of the lack of data with which to quantify available water resources, there is a great need for modelling techniques that can provide information useful to decision-makers. It should also be recognised that in many developing countries there is a lack of technical capacity as well as access to internal resources. There is therefore an urgent requirement to roll-out scientific developments and achievements of the PUB programme and to transfer these technologies to demonstrate how to make use of the science to reduce the uncertainty in water resource planning and management in regions of poor data and technical capacity. This could apply *inter alia* to regional estimates of water resource availability (under natural, present day and future scenario situations), as well as the prediction and management of extremes (floods and droughts). The workshop will therefore address issues such as access to, and the combined use of, local and global data sets, appropriate models and modelling platforms, regionalisation of parameters, how to incorporate uncertainty in water resource management, the effective transfer of technology, capacity building and training. There will be an emphasis on the practical implementation of science and technology and the need to provide sound, scientifically based estimation methods for water resource managers in developing countries throughout the world.

Convener: Denis Hughes (South Africa), denis@iwr.ru.ac.za

Co-conveners: András Bárdossy (Germany)
Dan Rosbjerg (Denmark)

HW.2 Sediment problems and sediment management in Asian river basins

ICCE, ISI, WASER

Sediment problems are assuming increasing importance in many areas of the world. These problems relate to the adverse effects of sediment in both water resource development and river management, and to the wider environmental impact of sediment in degrading aquatic ecosystems. Changing sediment fluxes can also have important implications for nutrient inputs to freshwater and coastal ecosystems, and for the stability of channels, and flood plains and river deltas. With their high sediment fluxes and the sensitivity of these fluxes to climate change and to land use change and other human impacts, such as dam construction and river regulation, Asian river basins currently face many sediment-related problems. There is a need for improved understanding of these problems and the sediment budgets of river basins and for the development of effective management strategies. This workshop, organised in collaboration with UNESCO ISI and WASER, will seek to review the nature and extent of sediment problems in Asian river basins and current progress towards developing effective sediment management strategies. Topics to be addressed will include the present and future impacts of climate change, the interaction of different factors causing changing sediment fluxes, sediment management strategies and their effectiveness, and the development of sediment monitoring networks to support effective sediment management.

Convener: Des Walling (UK), d.e.walling@exeter.ac.uk

Co-conveners: Jim Bogen (Norway)
Chunghong Hu (China)
Anil Mishra (UNESCO)
S. C. Rai (India)
Manfred Spreafico (Switzerland)

HW.3 Flood risk management

ICWRS, ICSW, WMO, IFI

Floods are the greatest cause of human suffering in the world. Since the spectacular flooding of New Orleans much attention is given to the various ways to protect people against high waters. 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 prevention of flooding by dikes and dams. In some cases preparation and repression is 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?

Convener: Han Vrijling (The Netherlands),
h.vrijling@ct.tudelft.nl

Co-conveners: Hafzullah Aksoy (Turkey)
Andreas Schumann (Germany)
Joachim Saalmüller (WMO)
Wang Wen (China)

HW.4 Space-time scaling for ET and soil moisture modelling using remote sensing

ICRS, ICCLAS

The rapid population growth in many countries together with a generally increasing standard of living is increasing demands on water for irrigation, industry and urban water supply, and is decreasing the quality of the available surface

water. Recent studies in the USA have suggested possible benefit/cost ratios ranging from 75:1 to 100:1 for using remotely sensed data in hydrology and water resources. These estimates are based on savings from flood prevention and improved planning of irrigation and hydro-electric production. Extensive work has been done over the last few years in both soil moisture monitoring using remote sensing and the application of remote sensing to hydrological runoff modelling. Recent work has noted that there have been few studies that have incorporated remote sensing soil-moisture and evaporation estimates into hydrological models. The reasons for this are many and varied and the fact that spatial and temporal time-scales for which these data are available are often not suitable for hydrological applications is a key issue. Remote sensing offers opportunities to scale these phenomena spatially and temporally. This workshop seeks to examine the state-of-the-art in remote sensing applications with respect to scaling the important state and flux variables of soil moisture and evapotranspiration, respectively. It also seeks to examine the relationship between these variables and hydrological model structure.

Convener: Giuseppe Ciruolo (Italy), giuseppe@idra.unipa.it

Co-conveners: Eva Bøgh (Denmark)
Yangbo Chen (China)
Ian Cluckie (UK)
Alain Pietroniro (Canada)

HW.5 Prediction in Ungauged Basins – a benchmark report

PUB, ICSW, ICGW, ICCE, ICSIH, ICWQ, ICWRS, ICRS, ICCLAS, ICT

The Predictions in Ungauged Basins (PUB) initiative has entered its third Biennium. While the first two Biennia have focused on creating intellectual momentum and building up the movement, the third Biennium will take stock of what has been achieved and at the same time look ahead. The main thrust will be to produce, over the next 2 years, a benchmark report that will assess, on a comprehensive, objective, open and transparent basis, the state of hydrological predictions in the absence of data and identify what the prediction challenges for the future are. The purpose of this workshop will be to contribute to this report, which will serve as a reference to gauge future achievements, specifically, to quantify the degree to which uncertainty in hydrological predictions can be reduced in clearly specified contexts. Disparate views for which there is significant support will be clearly identified, together with relevant arguments. One challenge will be to identify suitable criteria for measuring the performance, which will likely depend on the nature of the variability represented. Unlike conference proceedings and special journal issues, emphasis will be on coherence and the collective message. Unlike a typical monograph, emphasis will be given to quantitative assessment of the state of research, based on an endorsement by the wider hydrological science community. The report will be prepared by a team of Co-ordinating Lead Authors, Lead Authors and Review Editors.

Convener: Günter Blöschl (Austria),
bloeschl@hydro.tuwien.ac.at

Co-conveners: Berit Arheimer (Sweden)
Praveen Kumar (USA)
Jeff McDonnell (USA)
Murugesu Sivapalan (USA)
Ross Woods (New Zealand)

HW.6 Precipitation variability and water resources

PRECIP

In close relationship with the general theme of IAHS on water resources under stress, this workshop focuses on quantifying the variability of precipitation and precipitation surrogates over wide ranges of space-time scales, including

the nature of precipitation extremes, non-stationarities, and uncertainties. This requires the discussion of new observational and data processing techniques for *in situ* networks and/or for remote sensing, new modelling approaches, including climatological/meteorological models, rainfall stochastic and/or scaling models, as well as to better confront models to data. Particular attention will be paid to the various space-time scales that are involved and techniques that allow one to observe, analyse and simulate across scales.

Convener: Daniel Schertzer (ENPC/CEREVE, France),
daniel.schertzer@enpc.fr

Co-conveners: Shaun Lovejoy (Canada)
Nityanand Singh (India)
Eric A. Smith (USA)

HW.7 New statistics in hydrology

STAHY, ICWRS

In the last 20 years many different statistical approaches were developed for the analysis of hydrological extremes, rainfall simulation in time and space, runoff forecasting and management, and other hydrological applications. The introduction of new statistical methods and procedures resulted in improved hydrological analyses. For instance, the relatively recent introduction of copula functions is potentially improving several application fields permitting multivariate analysis in case studies traditionally done by univariate analysis. This session, sponsored by the Statistics in Hydrology Working Group (STAHY-WG), has two aims: the first is to explore innovative statistical methods never applied before, and the second is to collect presentations describing the most recent theory, procedures and applications related to already known topics. The main focus is univariate and multivariate analysis (extreme value, inference procedure, copula function) and stochastic modelling (linear and non-linear models, space-time simulation procedures, time series analysis, long range dependence, non-stationarity detection, point processes). Presentations and poster contributions on theoretical innovative approaches, advanced statistical and mathematical methods, and hydrological applications of mentioned procedures are encouraged.

Convener: Salvatore Grimaldi (Italy), *salvatore.grimaldi@unitus.it*

Co-conveners: Demetris Koutsoyiannis (Greece)
George Kuczera (Australia)
Domenico Piccolo (Italy)

G.1 Groundwater resources development in hard rock terrains

Hard rock terrains make up rather complex aquifer systems that contain important groundwater resources. These aquifers are widely used for the water supply in rural areas, particularly in semi-arid and arid regions, in spite of their heterogeneous groundwater conditions and locally poor storage capacity. This theme session aims at presenting and exchanging ideas and experiences of groundwater exploration in hard rock areas, e.g. using remote sensing, geophysical, geological and geochemical investigation methods for special parameter identification. It also encompasses methods of groundwater resource evaluation, groundwater monitoring and drilling techniques. Examples of artificial recharge in hard rock terrain are invited for presentation. Finally, the importance of hard rock aquifers for environmental sustainability will be discussed.

- Groundwater exploration
- Groundwater assessment and estimation
- Parameter identification
- Techniques for extraction and monitoring of groundwater

Convener: Jiri Krasny (Czech Republik), *krasny.hg@seznam.cz*

Co-conveners: B. Jay Kumar (India)
Didier Pennequin (France)
S.V.N. Rao (India)
V.S. Singh (India)
D.C. Singhal (India)

G.2 Groundwater quality and pollution in hard rock aquifers

Because of their special nature hard rock areas show particular patterns of chemical composition of groundwaters. They are also very vulnerable for pollution, because their self-cleaning potential is considered to be rather low. The session will highlight groundwater quality issues that are specific for hard rock environments and discuss strategies and methods for the assessment of groundwater vulnerability in hard rocks. In addition the pollution of groundwater in hard rocks from various sources as well as methods for cleaning-up contaminated groundwaters, including the cost effective water treatment techniques and remedial measures to control and confine groundwater pollution, will be presented and discussed.

- Natural variation of groundwater quality
- Anthropogenic groundwater pollution
- Remedial measures to control and contain groundwater pollution
- Cost effective water treatment and sanitation techniques

Convener: V. V. S. Gurunadha Rao (India)
gurunadharao@ngri.res.in

Co-conveners: Ian Acworth (Australia),
Al Ramnathan, (India)

G.3 Groundwater resource management in hard rock areas

Owing to the complexities in hard rock areas specific tools for the management of groundwater have to be applied, including the conjunctive use of groundwaters and surface waters. Conceptual hydrogeological and structural modelling is of prime importance in hard rock areas. The session will deal with groundwater flow and solute transport modelling in hard rock media and present and discuss decision support tools for the optimum use of water resources.

- Modelling of groundwater flow and solute transport in fractured media
- Managing aquifer recharge in fractured media
- Decision support tools for optimum use of groundwater

Convener: Shivendra Nath Rai (India), *snrai@ngri.res.in*

Co-conveners: A. Ghosh Bobba (Canada)
Peter Dillon (Australia)
A. K. Rastogi (India)
M. Sekhar (India)
B. Venkateswara Rao (India)

G.4 Socio-economic issues relevant to groundwater in hard rock areas

Hard rock aquifers present useful water resources in large rural areas that are often characterised by a lower status of development and poor conditions for living and farming. Yet groundwater is frequently used without proper understanding of the hard rock aquifer systems. Issues of groundwater governance, including legislation and regulations for groundwater protection, both in terms of quantity and quality, will be discussed. Economic, social and environmental factors governing the integrated water resource management will be highlighted. Health risk assessments specific for hard rock areas are presented. Finally the role of education and the media in awareness raising for groundwater in hard rocks will be stressed.

- Legislation and regulations for groundwater governance
- Awareness: Role of education and media
- Health risk assessment and solution to the problem

Convener: Tushar Shah (India), *t.shah@cgjar.org*

Co-conveners: Shrikant Daji Limaye (India)
Manuel Ramon Llamas (Spain)
Aditi Mukherji (Sri Lanka)

HydroPredict'2008



Predictions for Hydrology, Ecology and Water Resources Management: Using Data and Models to Benefit Society

Prague, Czech Republic, 15–18 September 2008

Organized by IAHS (ICGW), Charles University (Prague), VUV (Prague), US Geological Survey (USGS) and Universität für Bodenkultur (BOKU, Vienna)

Abstracts for poster papers are still being accepted; please submit via the website:

<http://www.natur.cuni.cz/hydropredict2008/>

This interdisciplinary conference will bring together scientists and other experts to discuss how to improve predictions by joint use of data and models in the fields of:

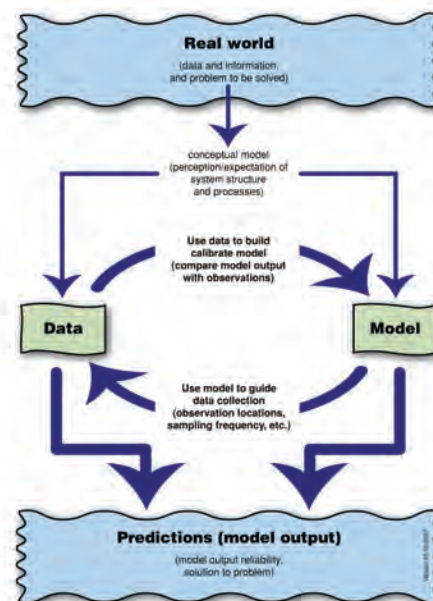
- **hydrology** (groundwater, surface water and catchment, including water quality);
- **ecology** (wetland, riverine, estuarine, terrestrial);
- **water resources management** (groundwater, vadose zone, and surface water).

These three fields are connected through the central, critical role played by **water**.

The conference solicits presentations on innovative technologies and methods of data collection, analysis, integration (combined use) of data and modelling, new techniques and tools for assessment of model performance, and case studies of both successful and problematic applications related to problems in hydrology, ecology, and water resources management. Presentations that address integration (combined use) of data collection, analysis and modelling are particularly welcome.

The conference aims to facilitate the exchange of scientific knowledge and engineering expertise between scientists, engineers (consultants, practitioners), water resources planners and managers, and policy makers. It includes keynote lectures on diverse topics, and contributed oral and poster presentations (both to be published in the proceedings).

Conference Secretariat HydroPredict'2008 c/o ITC Travel & Conference s.r.o., Konevova 41, CZ-130 00 Prague 3, Czech Republic
tel.: +420 222 580 079, 222581215, 222 585 022; fax: +420 222 582 282; hydropredict2008@itctravel.cz



Publications from IAH

The International Association of Hydrogeologists

http://www.iah.org/publications_books.htm

regularly publishes within two separate book series managed by, and available from, Taylor & Francis: <http://www.taylorandfrancis.co.uk/>. Recent books are:

International Contributions to Hydrogeology

ICH 26: Methods in Karst Hydrogeology

by Nico Goldscheider & David Drew

Published June 2007; 978-0-415-42873-6; Price £84.00/US\$149.95

Selected Papers

SP 8: Urban Groundwater – Meeting the Challenge

by Ken W. F. Howard

Published January 2007; 978-0-415-40745-8; Price £54.00/US\$99.95

SP 9: Groundwater in Fractured Rocks

by J. Krásný and John M. Sharp

Published July 2007; 978-0-415-41442-5; Price £99.00/US\$179.95

SP10: Aquifer Systems Management: Darcy's Legacy in a World of Impending Water Shortage

by Laurence Chery & Ghislain de Marsily

Published Sept 2007; 978-0-415-44355-5; Price £109/US\$199.00

SP11: Groundwater Vulnerability Assessment and Mapping

by Andrzej J Witkowski, Andrzej Kowalczyk & Jaroslav Vrba

Published August 2007; 978-0-415-44561-0; Price £59.00/US\$119.95

SP12: Groundwater Flow Understanding

by J Joel Carillo Rivera & M Adrian Ortega Guerrero

Published January 2008; 978-0-415-43678-6; Price £47.00/US\$79.95

60% discount is available to IAH members www.iah.org/join_iah.asp

Methodology in Hydrology

Editors Liliang Ren, Qiongfang Li, Danrong Zhang & Jun Xia

IAHS Publ. 311 (2007) ISBN 978-1-901502-93-0 654 pp. £110.00

This volume provides a unique overview, in English, of current hydrological science in China, detailing issues, approaches, innovations and achievements. The 97 contributions, primarily from China, were selected from a major conference held in Nanjing, and are grouped as follows:

- Hydrological Modelling and Flood Forecasting
- Stochastic Hydrology
- Water Quality Modelling and Analysis
- Water Resources Management and Water Economy
- Interdisciplinary Hydrology

Information about the hydrology of many drainage basins, especially the Yangtze and Yellow rivers, and about engineering projects, including the South-to-North water transfer, is detailed. Thus the book is also a valuable information resource.

Hydrological Sciences for Managing Water Resources in the Asian Developing World

Editors Xiaohong Chen, Yongqin David Chen, Jun Xia & Hailun Zhang

IAHS Publ. 319 (2008) 978-1-901502-44-2 422 + x pp. £72.00

Many regions in Asia are experiencing unprecedented rapid development resulting in great pressures on environmental quality and the sustainable management of natural resources. China has traditionally emphasised water shortages in the Yellow River basin and flooding by the Yangtze River, but water problems in South China, and especially the Pearl River (Zhujiang) basin are now attracting attention. The contributions, many from South China, provide an insight to the on-going innovative work.

- Novel Techniques for Hydrological Analysis
- Hydrological Modelling
- Hydrological Impacts of Global Change and Human Activities
- Optimal Allocation of Water Resources
- Water Resources and Watershed Management
- Water Environment and Aquatic Ecosystems

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hydrology processes that control the coupled atmospheric–hydrological system in cold regions; and validating and improving models for weather, water, and climate systems leading to better *Prediction* and simulation of related atmospheric impacts on water resources and surface climates in cold regions. The first goal is being addressed through intense field campaigns along a transect of eight highly instrumented, small (10–200 km²) research basins that characterize the range of Canada's cold regions. Field investigations are focused on snowpacks (based on land, glaciers, and lake ice), open water (primarily small lakes), and runoff generation over frozen ground, glacierized areas, and permafrost. To address the other two goals, Network members are pursuing a new generation of process hydrology and coupled atmospheric–hydrological models. Recent advances in understanding are being parameterised and integrated into numerical models to improve the predictive capabilities for complex land–atmosphere systems in cold regions.

IP3 held its Second Annual Network Workshop at the Cold Regions Research Centre of Wilfrid Laurier University in Waterloo, Ontario, Canada, 8–10 November 2007. Approximately 90 people attended, including 27 students from across Canada and the UK. The Workshop was also the launch of the Canadian component of the IPY aspect of IP3 and related studies of Arctic-Hydra. The Workshop provided the first link between the IPY and the PUB (IAHS Predictions in Ungauged Basins) Decade.

Dr Gordon Young, President-elect of IAHS, provided a plenary talk on *Cold Regions Hydrology and its Relevance to Canada and the World*. Dr John Pomeroy, IP3 Principal Investigator, gave an overview of the Network and its goals. This was followed by 27 scientific reports from Investigators and Collaborators highlighting cold regions hydrological processes, parameterization of these processes into models, and prediction using a range of modelling strategies which encompassed small-scale process hydrology models through larger scale coupled atmosphere-land surface hydrology models. The third day of the Workshop focused on IP3's international and national collaborations. The Network contributes to PUB as Working Group 16 and has established linkages with the Western Canadian Cryospheric Network, a related CFCAS-funded glaciological research network. Dr Fred Wrona, Acting Director General of the Water Science and Technology Directorate of Environment Canada, spoke on behalf of the Canadian government and highlighted its links to IP3 in Freshwater Systems: Hydrology and Ecology, a Canadian Arctic IPY initiative.

The IP3 Users' Advisory Committee, chaired by Bob Reid, held its first in-person meeting as part of the IP3 workshop with plenary presentations from Ian Church, Science Advisor to the Government of the Yukon, on *The User's Perspective from the North*, and from Bob Sandford, Executive Director of the Western Watersheds Climate Research Collaborative, a prolific Alberta-based author, on *A Tower of North American Babel: Making Climate Science Intelligible To Leaders, Policy Makers, and the Public*. These were followed by a round table discussion on water resource and ecohydrology users' needs from IP3.

In the closing session, Dr Hok Woo, Chair of the IP3 Board of Directors, summarized the good progress IP3 has made in its 16 months of existence. Since the workshop, IP3 has been accepted as a project of CliC (the Climate and Cryosphere Project) of the World Climate Research Programme.

Next ICSIH Meetings

The Nordic Hydrological Conference will be held in Reykjavík on 11–13 August 2008 where Arctic-Hydra and ICSIH will sponsor sessions relating to climate modelling in the Arctic, hydrological measurements and modelling in the Arctic, glaciological measurements and modelling in the Arctic, and climate impacts on Arctic water resources and hydroeco-systems; see <http://www.nhc2008.com>. There will also be further Russian and Canadian events dealing with their IPY studies, including the next IP3 workshop in Whitehorse, Yukon Territory in November 2008.

John Pomeroy, Centre for Hydrology, Univ. Saskatchewan, Saskatoon, Canada

Alexander Gelfan, RAS, Moscow, Russia

Árni Snorrason, Hydrological Service, National Energy Authority, Reykjavík, Iceland

Julie Friddell, IP3 Network, Univ. Saskatchewan, Canada

ICSW – Surface Water

UNESCO-sponsored Workshop on Large-scale Hydrological Variation and Teleconnections

continued from p. 1



Ten young researchers, eight nationalities, six countries, two continents; a truly international and dynamic workshop!

As many participants were new members of NE-FRIEND Project 3, the first day was mostly dedicated to presentation of 14 short papers related to the workshop theme; a series of talks explored modelling techniques and issues: Mathieu Ribatet (CEMAGREF, France) introduced many participants to the Reversible Jump Markov Chain Monte Carlo Model applied to regional flood frequency analysis. Eric Sauquet (CEMAGREF, France) presented Regionalisation of low flows and flow duration curves in the Seine Basin. Richard Essery (Univ. Edinburgh, UK) touched on scaling issues in his talk on subgrid variability in large-scale modelling of snow–atmosphere interactions. David Lavers (Centre for Ecology and Hydrology, CEH, UK) compared the potential skill of raw and downscaled GCM output for seasonal river flow forecasting.

Applied tools for the practitioner (and researchers) were covered with Lubomír Solín (Slovak Academy of Sciences, Slovak Republic) presenting a management system for flood hazard in Slovakia, and Neil MacDonald (Univ. Liverpool, UK) described how he reconstructed long-term records of high-magnitude flood events from historical information.

Hydro-climatic variability and change was, given the general umbrella of the Workshop, the most well represented topic. Harry Dixon (CEH, UK) presented his research on recent river flow trends in western Britain. Federico Gómez (Costa Rican Institute of Electricity, Costa Rica) analysed flow regimes in Central America. Daniel Kingston (University College London, UK) focused on the climate–river flow relationships across the northern North Atlantic region. Sara Alexander (Univ. Leeds, UK) talked about the current trends in the North Atlantic Oscillation, and how this impacts on river discharge. David Hannah (Univ. Birmingham, UK) presented a classification scheme for Western European air-masses and river flow regimes. Anne Fleig (Univ. Oslo, Norway) linked between large-scale climate variables and hydrological drought. Cedric Laize (CEH, UK) investigated hydro-climatic variability at the seasonal scale using a network of UK undisturbed basins. Henny van Lanen (Univ. Wageningen, The Netherlands) introduced the newly launched European project WATER and climate CHange (WATCH), which aims at bringing together hydrology, climatology and water resources.

Day One officially closed with a dinner in a ‘balti house’ at the Mailbox, the organiser having managed to combine the epitome of Birmingham cuisine with one of its most famous architectural landmarks. Informal discussion continued in a traditional English pub located on the city’s canal-side.

Day Two began with Henny van Lanen (coordinator of NE-FRIEND) presenting the UNESCO-IHP FRIEND initiative, followed by David Hannah reviewing the current research and activities of NE-FRIEND Project 3. Breakout group discussions then reviewed the emergent research themes from Day One. Overall all Project 3 themes (for details see: [http://ne-friend.bafg.de/servlet-is/7414/](http://ne-friend.bafg.de/servlet/is/7414/)) were judged to be progressing and relevant to the research interests of Workshop participants. A new theme was proposed aiming at including the implications of hydro-climatic variability for ecology, erosion, sediment transport, fluvial geomorphology, and slope stability.

Issues with data availability and archiving were discussed at length, particularly regarding the updating of the FRIEND – European Water Archive, and the availability of data from central Europe. It was the general consensus that not only must existing data be added to the archive, but monitoring networks have to be maintained against funding pressures. In addition, rather than reducing the need for river gauging, remote sensing actually makes reliable calibration data even more important. The representativeness of benchmark basins in the face of urbanisation and land-use change was also raised.

An aim of one of the breakout sessions on Day Two was to identify how NE-FRIEND Project 3 should engage the wider hydrological community. Suggested topics for collaboration were: (1) environmental impacts due to changes in climate, land use or human activity – it was commented that climate change should receive most attention; (2) analysis of water use; and (3) inter-comparison of different large-scale hydrological modelling approaches and integration of modelling and empirical studies. The last point was also seen as an ideal

area for collaboration within NE FRIEND owing to the wide skill base in the group. Also, links with other FRIEND groups should be encouraged and external associations should be explored with the wider Earth science community (e.g. GEWEX / HEPEX).

Activities suggested to disseminate the work beyond the group were to arrange a session on our research within a large conference, such as the EGU. It was suggested that a special issue of an international journal could raise awareness of the group. Additionally, the launch of the new NE-FRIEND website was seen as key to publicizing our work. It was also noted that the fostering of links within the group was needed – ideas to achieve this included a group newsletter, future meetings and workshops.

The meeting was a great experience all round. For some, it was the first taste of what good work the group does, so it enabled crucial links with fellow researchers to be established. The authors would like to thank, on behalf of all participants, David Hannah for convening this meeting, and UNESCO for their kind support that made the meeting possible.

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ICWQ – Water Quality

ICWQ is actively involved in preparations for the 8th IAHS Scientific Assembly in Hyderabad, India, in 2009. Two of the Commission’s Vice-Presidents, Prof. L. Elango and U. C. Sharma, are based in India and were involved in preparing the case for hosting the Assembly. There should be many opportunities for those working in the field of water quality to present their work at the Assembly as ICWQ is leading and assisting with several symposia and workshops. Topics are expected to include: ecohydrology, groundwater in highly stressed aquifers, improving water resources management in a vulnerable and changing world, trans-boundary water transfers, and rural and urban water systems.

Kate Heal, ICWQ Secretary

ICWRS – Water Resources Systems

Meetings in 2008

Every other year, 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 third ICWRS symposium was held in 2006 in Bochum and was very well attended (see IAHS Publ. 317). In 2008, the ICWRS Symposium will be held from 29 to 31 October in Johannesburg, South Africa, in close cooperation with Waternet (www.waternetonline.ihe.nl). Waternet, together with WARFSA and GWP-SA, organizes a symposium every year in southern Africa on water resources manage-

ment. In 2008, the Ninth Waternet/WARFSA/GWP-SA symposium will be a joint event, co-organized by IAHS-ICWRS. Conveners will be Bekithemba Gumbo, Hubert Savenije, Nick van de Giesen and Ayorinde Olufayo. The symposium will provide a platform for researchers, policy-makers and other stakeholders to meet and exchange ideas. The theme is *Water and Sustainable Development for Improved Livelihoods*.

In 2008, ICWRS will also sponsor:

- *Water Down Under 2008*, 14–18 April in Adelaide, South Australia. See: www.waterdownunder2008.com.
- *HydroChange 2008*, 1–3 October in Kyoto, at the Research Institute for Humanity and Nature. The theme is *Hydrological Changes and Management from headwater to the Ocean*. See: www.chikyu.ac.jp/HC_2008.
- International symposium on the *Role of Hydrology in Water Resources Management*, 14–16 October, Isle of Capri, Naples, Italy (organized by the Italian IHP committee and co-sponsored by UNESCO). Its purpose is to discuss ways in which hydrologists can contribute most effectively to planning and management of freshwater projects. See: www.ihp2008capri.it
- *New Statistical Tools in Hydrology*. In connection with the above symposium, a workshop will be organized on Capri, 13–14 October, to launch the new IAHS “Statistics in Hydrology” Working Group (STAHY-WG).
- *International Symposium on Hydrology, Hydraulics and Water Resources Aspects of Global Water Issues* to celebrate the 30th anniversary of the Water Resources Research Center at Kyoto University, Japan. This event, focusing on the impact of climate change on river basins and water use, will be held on 21 November.

Nick van de Giesen, Secretary ICWRS

STAHY – the Statistics in Hydrology Working Group: Call for Participation

Mission

Use of statistical methods for analysis of hydrological data has a long history and continues to be an intense research topic. Such tools have proved very useful in numerous applications and case studies. The effectiveness of statistical descriptions of hydrological processes may reflect the enormous complexity of hydrological systems, which makes a purely deterministic description ineffective.

Recently, the number of available tools, approaches and procedures in several statistical fields has increased faster than ever before. The correct application of new and updated-old methods is fundamental for hydrological applications. There are over 100 international journals on statistics, more than 40 of which accept contributions on statistical hydrology. Many software routines are available in several languages (S, R, C++, Fortran, etc.), commercially or as freeware. For a single hydrological application there are many potential statistical approaches to use. Consequently it seems appropriate to try to synthesize the enormous amount of information and resources presents in the literature by (but not only) creating a virtual common space for statistical hydrology. This space, used to coordinate, optimize and concentrate resources, will be

fundamental for Statisticians wishing to understand the hydrological applications, for Hydrologists that need to use a statistical tool and want to easily understand what is the right approach, and enable Statistical Hydrologists to easily update on recent developments in their field.

The Statistics in Hydrology working group will create, manage, update, disseminate and make available this virtual common space.

Aims

The Working Group expects to develop its activities through a website. The proposed activities are:

- STAHY Database: every member and/or institution registered to the working group could make available and/or use hydrological data sets. Initially the effort would be to collect data, to accurately describe their characteristics and quality and to make them available on the STAHY Portal in a user-friendly way.
- STAHY “R” Library: members could make available their routines or statistical tools written in S, R or other languages. These will be tested and eventually translated in R freeware language and organized in specific themes so as to create a STAHY R Library for registered researchers.
- STAHY References: members could keep really up to date as to the latest publications on specific “hot” themes.
- STAHY School of Statistical Hydrology. Starting from recent experience in Italy the STAHY working group could give patronage to the newly created School of Statistical Hydrology. Its aim is to periodically (every 6–8 months) organize international short courses (one week, i.e. 30 hours) on different topics proposed by the scientific committee.

Call for Participation

The first step of the WG is to collect people who wish to actively collaborate in STAHY, sharing knowledge, information, papers, data, routines, etc.

The idea is to fix specific topics on which to focus the attention of STAHY activities (Sessions, Workshop, Short Courses, Routines, Benchmark papers and data). For each topic a group of experts with a coordinator should be identified to stimulate the activities, help collect information and organize initiatives.

Initially the following topics are proposed. Each participant is invited to indicate in which topic he/she can contribute or to propose new topics.

TOPIC A: Univariate Frequency Analysis

- Extreme values
- Regional analysis
- Inference

TOPIC B: Multivariate Frequency Analysis

- Extreme values
- Copula function
- Inference

TOPIC C: Time Series Analysis

- Linear modelling (ARMA, etc.) and Markov Chain
- Nonlinear modelling
- Long memory behaviour
- Non stationary detection
- Point processes



Confirm your Participation

To confirm your participation, please send an e-mail to: Francesco Serinaldi, francesco.serinaldi@uniroma1.it and cc. Salvatore Grimaldi, salvatore.grimaldi@unitus.it, briefly describing in which topic you wish to collaborate, what kind of material you could be able to share, and if

you have a topic to propose, a suggestion will be welcome. There will also be the Capri Workshop, 13–14 October.

STAHY WebSite

Once WG participants are known we will commence the collection of materials and setting up the website. The role of the website will be fundamental both to advise on and describe activities, and to organize and make available data, routines and references related to the topics.

Access to the website will be through a free registration process in order to guarantee the identification of users. The Call for free registration to the STAHY Website will be launched in a couple of months.

Calendar of Meetings Organized/Sponsored by IAHS

Details of these plus many non-IAHS meetings are provided at the IAHS web site: [click on meetings](http://www.iahs.org)

2008	Conference	Contact details
Toronto, Canada 14–16 May	<i>4th International Symposium on Flood Defence</i>	Tracy Waddington, twaddington@pacicc.ca http://www.flood2008.org
Golden, Colorado, USA 18–21 May	<i>MODFLOW and More: Ground Water and Public Policy</i>	International Groundwater Modeling Center, Colorado School of Mines, Golden, USA tel: +1 303 273-3103; fax: +1 303 384-2037; igwmc@mines.edu http://www.mines.edu/igwmc/events/modflow2008
Tripoli, Libya 25–27 May	Third International Conference on <i>Managing Shared Aquifer Resources in Africa</i>	Dr Youba Solona, Sahara and Sahel Observatory, BP31, 1080 Tunis, Tunisia, youbasokona@oss.org.tn ; Dr Omar Salem, General Water Authority, PO Box 5332, Tripoli, Libya, gwalibya@hotmail.com ; Dr Alice Aureli, IHP-UNESCO, Paris, France; a.aureli@unesco.org
Ohrid, Macedonia 27–31 May	BALWOIS 2008 Conference: <i>Water Observation and Information Systems for Decision Support</i>	Marc Morell, secretariat@balwois.org http://balwois.viabloga.com
Bled, Slovenia 2–4 June	<i>XXIVth Danube Conference</i>	danube@fgg.uni-lj.si
Karlovy Vary, Czech Republic 2–5 June	10th International Mine Water Association Congress <i>IMWA'2008: Mine Water and the Environment</i>	Dr Nada Rapantová, VŠB Technical University, Ostrava, Czech Republic tel: +420 59 699 3501; nada.rapantova@vsb.cz
Paris, France 6–7 June	IAHS-UNESCO IXth Kovacs Colloquium: <i>River Basins – From hydrological science to water management</i>	Pierre HUBERT, IAHS Secretariat; pjy.hubert@free.fr
Istanbul, Turkey 18–20 June 2008	IAHR Groundwater Symposium: <i>Flow and Transport in Heterogeneous Subsurface Formations: Theory, Modelling & Applications</i>	http://www.iahr-gw2008.net
Kampala, Uganda 25–28 June	<i>Groundwater and Climate in Africa</i>	Richard Taylor, Department of Geography, University College London, UK tel: +44 207 679 0591; fax: +44 207 679 4293; r.taylor@geog.ucl.ac.uk
Prague, Czech Republic 15–18 September	HydroPredict'2008: <i>International Interdisciplinary Conference on Predictions for Hydrology, Ecology and Water Resources Management: Using Data and Models to Benefit Society</i>	Mary C. Hill, US Geological Survey, USA, tel: +1 303 541 3014; mchill@usgs.gov or Karel Kovar, Netherlands Environmental Assessment Agency, The Netherlands tel: +31 30 274 3360; karel.kovar@mnp.nl http://www.natur.cuni.cz/hydropredict2008/
Kraków, Poland 18–20 September	<i>12th Biennial Conference of Euromediterranean Network of Experimental and Representative Basins (ERB 2008) Hydrological Extremes in a Small Basin</i>	Wojciech Chelmicki, Jagiellonian University, Institute of Geography and Spatial Management, Kraków, Poland; w.chelmicki@geo.uj.edu.pl
Kyoto, Japan 1–3 October	<i>HydroChange 2008</i>	Dr Makoto Taniguchi, tel: +81 757072255 makoto@chikyu.ac.jp
Capri, Italy 14–16 October	<i>The Role of Hydrology for Water Resources Management</i>	Crescenzo Violante, IAMC-CNR, Calata Porta di Massa, Porto di Napoli I-80133 Napoli, Italy tel: +39 0815423847; fax: +39 0815423888; crescenzo.violante@iamc.cnr.it
Johannesburg, South Africa 29–31 October	<i>9th WaterNet/WARFSA/GWP-SA Symposium</i>	Prof. Hubert Savenije, ICWRS-IAHS: Delft University of Technology Stevinweg 1, 2628 CN Delft, Netherlands; h.h.g.savenije@tudelft.nl
Christchurch, New Zealand 1–5 December	ICCE International Symposium: <i>Sediment Dynamics in Changing Environments</i>	Jochen Schmidt, NIWA, PO Box 8602 Christchurch, New Zealand tel: +64 (0)3 343 8058; fax: +64 (0)3 348 5548; j.schmidt@niwa.co.nz http://www.civil.canterbury.ac.nz/icce2008/
2009		
Port Elizabeth, South Africa 23–26 February	<i>International Conference on Implementing Environmental Water Allocations</i>	The Secretariat (Cilla Taylor Conferences), PO Box 82, IRENE, 0062 South Africa tel: +27 (0)12 667-3681; fax +27 (0)12 667-3680; confplan@iafrica.com
Germany 30 March–2 April	<i>International Workshop on Status and Perspectives of Hydrology in Small Basins</i>	Mr Ulrich Schröder schroeder@bafg.de Dr Sybille Schumann s.schumann@tu-bs.de
Vienna, Austria 6–9 April	HydroEco'2009 2nd International Multidisciplinary Conference on Hydrology and Ecology: <i>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
Hyderabad, India 6–12 September	8th IAHS Scientific Assembly and 37th IAH Congress	Pierre Hubert, IAHS Secretary General; pjy.hubert@free.fr
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, Racianska 75, 83102 Bratislava, Slovakia; lichner@uh.savba.sk ; http://www.ih.savba.sk/biohydrology2009

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Reducing the Vulnerability of Societies to Water Related Risks at the Basin Scale

Editors Andreas Schumann & Markus Pahlow

IAHS Publ. 317 (2007) ISBN 978-1-901502-29-9, 450 pp. £78.00

The International Commission on Water Resources Systems (ICWRS) of IAHS has, for many years, embraced Integrated Water Resources Management (IWRM) as the main focus of its research agenda. The need for integrated approaches to deal with complex water resources management issues in both the developed and developing world is well recognised, yet, in many places, IWRM is still only a concept and not established practice. This volume, comprised of peer-reviewed papers selected from the Third International Symposium on IWRM (2006, Bochum, Germany), accounts for the heterogeneity of world water problems by addressing the following important questions: What has to be integrated? How can it be accomplished? What are the options to balance the different views? The symposium strived to not only identify problems, but to provide practical solutions; the subject of how to cope with water-related vulnerability of societies formed the overarching theme. Together, the papers provide an excellent overview of current IWRM research worldwide.

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Glacier Mass Balance Changes and Meltwater Discharge

Editors P. Ginot & J. E. Sicart

IAHS Publ. 318 (2007) ISBN 978-1-901502-39-8 210 pp. £46.00

Mountain snow cover and glaciers contribute considerably to streamflow in many parts of the world, and modify runoff in terms of quantity, timing and variability. Their role is emphasized in the light of globally increasing freshwater demand and the potential impacts of future climate change. The effect of snow and ice on runoff varies between climatic regions. While in mid and high-latitude areas seasonal snow cover exerts a strong control on runoff variations, in low-latitudes glaciers provide the main source of water during the dry season.

