IAHR
AIRH

Newsletter 6

Volume 19 / 2002 (Supplement to JHR - Vol 40 - No 6)

Saving Venice from the sea

San Marco Piazza completely flooded.

The survival and prosperity of Venice, built on more than a hundred small islands in the middle of a large lagoon at the head of the Adriatic, during its thousand year history has been achieved through solving a range of engineering "problems." These problems are presented and analysed by Dr. Donald R.F. Harleman in his article on page 85.

New Year's Message from IAHR President Forrest Holly

on page 83

International Workshop on Rock Scour

Swan Lake Dam, USA

This successful event held on September 25-29, 2002 in Lausanne, Switzerland *intended to gather experts from different backgrounds and make a collection of past experiences, define the present state-of-the-art knowledge on this subject and the objectives for further research.* Read more about it on page 91.

The recent floods in Central Europe

Library of the Water Research Institute in Prague, Czech Republic completely flooded (August 2002).

The disastrous flood of August 2002 on the Elbe and Danube rivers was one of the largest disasters that ever hit Germany and the Czech Republic. Prof. Erich Plate describes what happened on page 86.

IAHR-ASCE/COPRI Partnering Agreement

The Maritime Hydraulics Section (MHS) of the IAHR and the Coasts, Oceans, Ports, and Rivers Institute (COPRI) of ASCE share a common goal to promote multidisciplinary international activities and collaboration in sustainable development of coasts, oceans, ports, waterways, rivers, and wetlands. MHS / IAHR and COPRI wanted to formalize their past cooperation and officially create an agreement to further the ongoing cooperation of the two organisations. The signing ceremony for the Partnering Agreement took place at the 28th International Conference on Coastal Engineering held in Cardiff, Wales, in July 2002. Forrest Holly, Jr., Etienne Mansard, and Philip L.-F. Liu signed for IAHR and Robert Dalrymple represented COPRI.

Signing ceremony at the ICCE Conference in Wales. From left to right: Etienne Mansard, Vice President of IAHR, Forrest M. Holly, President of IAHR, Robert Dalrymple, incoming COPRI President, and Philip L.F. Liu, Chairman of the Maritime Hydraulics Section of IAHR.

With the partnering agreement now in place, both organisations plan to seek opportunities for collaboration in the development and implementation of seminars, conferences, symposiums, and publications. Specifically, conferences and seminars that are of mutual interest and benefit to COPRI and MHS / IAHR include the Ports conference every three years, the International Conference on Coastal Engineering every two years, the Waves conferences and Coastal Zone Management conferences every couple of years, as well as the IAHR Biennial Congress and other regional IAHR conferences. COPRI is currently helping organise next year's Long Waves Symposium which is being held in conjunction with the XXX IAHR Biennial Congress in Thessaloniki, Greece. This will be the first 'front' of the new partnering agreement. With the formalised alliance now in place, MSH / IAHR look forward to working with COPRI to promote our purposes and shared vision.

Flood Defence '2002

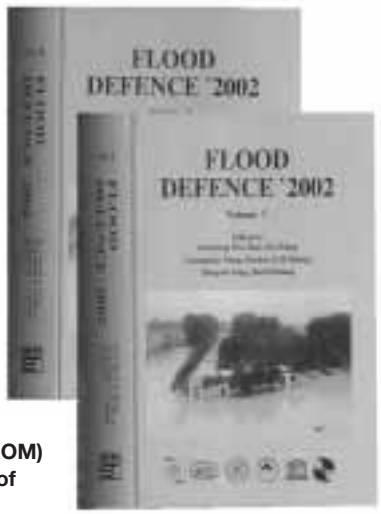
Proceedings of the Second International Symposium on Flood Defence (Beijing, China, September 10-13, 2002)

Edited by Baosheng Wu, Zhao-Yin Wang, Guangqian Wang, Gorden G. H. Huang, Hongwei Fang and Jinchi Huang (Eds)

The two volumes contain the keynote and invited lectures and selected papers presented in the Second International Symposium on Flood Defence held in Beijing, China (Sept. 10-13, 2002). 224 papers were contributed by researchers, practitioners, educators, and public officials working with or interested in flood control, from about 40 countries and regions, and these papers cover nearly everything on flood management. The main topics include: Flood risk and flood disasters; Flood management and flood control strategies; Hydrology and meteorology; Engineering measures mitigating flooding disasters; History and experience of flood control; Flood forecasting; Flood modeling; Information systems for water management; Urban flood; Reservoir management; Erosion and sedimentation; Landslide and debris flow; Environmental impact of floods.

The Proceedings will be of use to anyone with an interest in flood defence. Detailed information about the Symposium can be obtained from: http://www.irtces.org/isshhu/2ISFD.htm. From the website, you can also download the opening speeches of Madam Qian Zhengying, Mr. E Jingping, Prof. E. J. Plate, Prof. K. Takeuchi, Prof. H.T.C. van Stokkom etc free of charge, and you are able to view the Proceedings' table of contents.

Hardcover: 1,733 pages
Publisher: Science Press New York Ltd.
ISBN: 1-880132-54-0



Proceedings (books + CD ROM) can be ordered at the cost of US$110 by writing to:

Dr. Cheng LIU
IRTCES, P.O. Box 366, No. 20 Chegongzhuang West Rd.
Beijing, 100044, P.R. China
Fax: +8610 68411174,
E-mail: chliu@iwhr.com

Dr. Baosheng Wu
Dept. of Hydraulic Engineering, Tsinghua University
Beijing 100084, P.R. China
Fax: +8610 62772643
E-mail: baosheng@tsinghua.edu.cn

In this issue

Contact us:

IAHR Secretariat
Paseo Bajo Virgen del Puerto, 3
28005 Madrid SPAIN
Tel. : +34 91 335 79 08
Fax. : +34 91 335 79 35
website: http://www.iahr.org

Direct lines:
Dr. Christopher George, Executive Director
tel.: +34 91 335 79 64
e-mail: christopher.george@iahr.org

Cristobal Mateos — *Secretary General;*
Yasmin El Harchi — *Editor Newsletter/NewsFlash*
tel.: +34 91 335 79 08
e-mail: yasmin.elharchi@iahr.org
Lara Incio — *Membership and subscriptions*
tel.: +34 91 335 79 19
e-mail: lara.incio@iahr.org
Accounts
tel.: +34 91 335 79 48
e-mail: iahr@iahr.org

General e-mail address: iahr@iahr.org

Our monthly electronic newsletter "NewsFlash" complements the bi-monthly IAHR Newsletter. "NewsFlash" publishes information which would be outdated if published only in our bi-monthly Newsletter "NewsFlash" is available free of charge to anyone interested in hydraulics; if you know of anyone who would like to receive it please ask them to forward their e-mail address to us."NewsFlash" is also available on our homepage: http://www.iahr.org

New Year's Message from the IAHR President Forrest Holly

As I sit down to share some of my thoughts for the new year, on a brisk, clear October day in Iowa, the world seems still to be in the early stages of the new chapter of its history launched with the tragic events of 11 September 2001. The rumblings of armed conflict are very much in the air, there has been tragic loss of life due to a cowardly attack in Bali, and the consequences of potential and actual nuclear arms proliferation remind us of the legacy of the end of World War II and the advent of weapons of mass destruction. Against this pessimistic backdrop, I fervently hope and pray that as you read this in early 2003, the better instincts of humanity are prevailing.

A common motivation for our membership and activity in IAHR is the opportunity to share professional experiences, advances, and challenges in a global forum that is not offered by our national associations. Participation in international conferences and congresses is a significant component of this sharing. I have been pleased to see that during this past year, the discouraging prognoses of greatly reduced international travel to our events have proven to be unfounded. Among the events I was able to attend personally, the Hydroinformatics and ICCE (International Conferences on Coastal Engineering) in Cardiff, UK the joint IAHR-IWA International Conference on Urban Drainage in Portland, USA the joint IAHR-EWRI Conference on Hydraulic Measurements and Experimental Methods in Estes Park, USA and the International Conference on Hydroscience and Engineering in Warsaw, Poland all were vibrant and attended by a truly global representation of the IAHR membership. In addition, the Asian and Pacific Division Congress in Singapore, the Latin American Division Congress in Havana, Cuba and the Conference on Fluvial Flows in Louvain, Belgium were well attended and successful. As of this writing, final planning for the December 2002 African Division Congress in Tanzania is nearing completion. The continuing success of these and other such events demonstrate the vitality and relevance of our global affiliation and activities.

The annual IAHR Council meeting last July in Cardiff, Wales was an especially fruitful one. First, the meeting was held between the end of the Hydroinformatics conference and the beginning of the ICCE conference, all in the same charming venues of Cardiff University and Cardiff City Hall. Our colleague Prof. Marcelo Garcia presented his Ippen Award Lecture at the end of the Hydroinformatics Conference, and the opening of the ICCE conference included the signing of the IAHR-COPRI (ASCE) collaborative agreement. The Hydroinformatics Conference also included an evening bowling competition hosted by the new IAHR Student Chapter at the University of Cardiff, at which yours truly and his spouse acquitted themselves quite

respectfully.

For the first time in several years, the Council meeting did not include Secretariat relocation issues as a major agenda item. Indeed, the Secretariat is now fully established in the facilities of its host CEDEX in Madrid, with the virtual and actual unpacking completed and sights set on the future. The Council meeting included very productive full-group and breakout discussions on the IAHR Strategic Plan and fundraising initiatives. After the presentation of very thorough and attractive proposals for Brisbane from the Brisbane Marketing Convention Bureau and Australian Institution of Engineers, for Cairo from the Egyptian Ministry of Water Resources, and Venice from the Universities of Venice, and Padua, and the Italian CNR, Council voted to hold its 2007 Biennial Congress in Venice, Italy. I would like especially to thank our colleagues from Brisbane and Cairo for their efforts in preparing and presenting their offers to host the 2007 Congress.

IAHR President Forrest Holly

In the second implementation of our new Council nominating and election procedures, Council appointed the Nominating Committee as announced in 2002 Newsletter 4. If you have not already done so, I strongly encourage you to communicate your suggestions and concerns to the Committee members and its Chair, Andreas Mueller, and to return your written ballot when you receive it in April.

The growth in the number of IAHR Student Chapters and their activities has been particularly gratifying to me. I strongly believe that we must continue to welcome new researchers, engineers, and educators into our community, and Student Chapters provide an excellent gateway for this entry. As of this writing, the roster of official Student Chapters is as follows: Stuttgart, Germany, 2000; Iowa, USA, 2002; Napoli, Italy, 2001; Calabria, Italy, 2001; Boise, Idaho, USA 2001; Champaign-Urbana, Illinois, USA, 2001; Cardiff, UK 2002; Iran, 2002. Our first Latin American Chapter in Lima, Peru starts this year. Several other informal student groups have formed and hopefully will be recognized as Student Chapters soon. If you are in a position to host and/or advise an IAHR Student Chapter, I strongly encourage you to do so. It is one of the most important services you can provide to IAHR.

The financial situation of IAHR continues to be secure, but fragile. The assistance of CEDEX in providing a subvention for office staff is greatly appreciated by us all. But IAHR simply must pursue a growth in its revenue stream, coupled with every possible efficiency in publication and Secretariat management, for long-term sustainability. This growth in revenue can arise from several sources, including increase in global membership, growth in publication activities, and expansion of our collective sphere of influence in the water world. Council has approved a modest increase in annual dues (following eight years of constant dues) and is actively exploring avenues of electronic production of the *Journal of Hydraulic Research* that will minimize printing and distribution costs. Council is also working to expand our sphere of influence through the recent new collaborative agreements with ASCE's Environmental and Water Resources Institute (EWRI) and Coastal, Ocean, and Ports Research Institute (COPRI), International Water Resources Association (IWRA), and Canadian Society of Civil Engineers (CSCE). Council is considering the possible launching of a new collaborative publication, *Journal of River Basin Management*, in Spring 2003.

As useful and productive as such collaborations may be, in the end we simply must increase our global membership. The Student Chapters are directly supportive of this thrust. But we also have an enormous untapped resource in all of you, the present membership of IAHR. All of us – and I include myself – have many associates and colleagues in hydroscience and engineering who are not IAHR members. For those of us fortunate enough to live and work in developed countries, the annual cost of IAHR membership scales to an hour or two of consultancy billings – this modest cost should not be an obstacle to affiliation with the global water community and its associated benefits. I urge you all to join me in inviting colleagues and peers to consider joining IAHR.

This said, I am troubled by the problematic situation in the developing countries, where even our reduced annual dues can be a serious obstacle to membership among our professional colleagues. To the extent that IAHR can include a larger portion of water professionals in the developed countries, it should become possible to enable broader representation from the developing world through appropriate subventions.

Planning for the 30th IAHR Congress in Thessaloniki, Greece is proceeding well. A central theme of the Congress being education and learning, several Student Chapters will participate in a Student Chapter Forum and are organizing social events for attending students – this should also attract a strong roster of contestants for the John F. Kennedy Student Paper Competition! The Congress will also provide a natural venue and environment for official launching of the new European Division of IAHR, with sessions and meetings devoted to ETNET (European Thematic Network for Education and Training).

You may have noticed that recent issues of *Journal of Hydraulic Research* have gotten thicker. Council has agreed to a temporary increase in pages, despite the associated costs, in an effort to reduce the backlog of papers. As of this writing, JHR Editor Marcelo Garcia reports an unprecedented interest in the *Journal* among authors, as evidenced by record numbers of paper submittals in 2002. Council has agreed that the in steady state, JHR should maintain its demonstrated reputation as a top-quality publication through a continued rigorous peer-review process, even if this results in a higher rejection rate. The Associate Editors will be playing an increasingly important role in this process.

As I complete my second and last term as IAHR President, I would like to thank all of you who have so faithfully and strongly supported IAHR through your membership and participation in Council, Division, Section, and Congress activities. During my 16 years of activity on the Council, communications and transportation advances, and the growing sense of international community, have continuously increased the importance of IAHR as our collective global "home". I believe that current issues such as virtual laboratories, distance learning, continuing education, hydroinformatics in analysis and design, national and international accreditation and certification, and a perceived divergence of educational outcomes from the needs of practice, will continue to be subjects of our collective attention and collaboration under the big blue umbrella of IAHR.

Saving Venice from the sea

Dr. Harleman is a member of the International Panel for the Environmental Impact Assessment of the Venice flood barrier

Comes from page 81

The first problem was the physical lagoon conservation. Venice was never successfully invaded because the one meter average depth was too deep for armies and too shallow for navies. The lagoon was protected from silting several hundred years ago by diverting the three major rivers outside the lagoon.

The second problem was the protection from Adriatic storm waves of the thin sandy barrier on the lagoon's ocean side. After diversion of the rivers, sediment transported from the lagoon through the three openings was insufficient to prevent barrier erosion. By the 18th century, construction of groins had stabilized the fragile barrier.

The third problem was a result of groundwater pumping in the mainland industrial area in the 1950s. By 1975, Venice had subsided about 12 cm and pumping was stopped; this is equivalent to 300 years of natural subsidence.

The fourth problem is caused by global warming and accelerating sea level rise. Venice is the most sensitive place on earth to the impact of centimeters of tidal elevation change. Due to the combined effect of sinking and sea level rise, tides are 25 cm higher than 100 years ago, and thus floods are more frequent causing economic problems and structural damage. It has been predicted that the sea level will rise some 50 cm in the next 50 to 100 years; this would cause the City to become uninhabitable.

Following the disastrous flood of 1966, in which all of Venice was under a meter of water for 15 hours, the Consorzio Venezia Nuova (CVN) was formed and encharged with protecting the city.

CVN's proposed Venice gates are unique in that they are raised and lowered by buoyancy. Each gate module is a hollow steel box 20 m wide and long. A total of 80 gates are needed to close the three barrier openings. Normally the gates, filled with water, rest horizontally on the bottom and are hinged at the seaward end. They can be raised by expelling the water by compressed air thereby causing the gates to rotate upward to an angle of 45∞.

From early days of planning the protection of Venice against flooding there has been vocal opposition to movable gates by those who insist that more passive defenses are indeed possible. These include permanently narrowing the width and depth of the 3 inlets and raising the level of pavements in the city – however, repeated studies have shown that these interventions cannot protect Venice against the increasing number of storm tide flooding.

In 1996, CVN appointed an International Panel (of which I am a member) to oversee the development of an Environmental Impact Assessment for the movable gates, and the Panel also strongly recommended the gates as the only viable solution. Construction cost is estimated at about 3 billion euros and construction time at 8 years.

Ultimately, the Venice flood gates will have to be built, as they have been in Netherlands and London. The Italian government has recently completed the stabilization of the foundation of the Leaning Tower of Pisa -Venice is incomparably more important and deserves no less attention.

Perspective diagram of the Malamocco opening (1) and a second diagram (2) showing some of the gate segments in a raised position.

By Dr. Donald R. F. Harleman
Ford Professor of Environmental Engineering, Emeritus
Department of Civil and Environmental Engineering, Massachusetts Institute of Technology

The recent floods in Central Europe

The meteorological situation (cold and rainy July and early August) was one of the main factors that led to the terrible floods in Central Europe in August 2002. The cold air slowly moved to the East, being pushed from the South by a low pressure area originating over the western part of the Mediterranean. The winds from this depression were channeled by the Alps and brought in moist and warm air from the Mediterranean, which upon meeting the cold air over East Germany and further East was moved upwards, cooled and dropped its moisture in the form of torrential rains. This meterological situation corresponded exactly to the one which led to the 1997 disaster on the Odra river - the next larger river further to the East - a disaster that caused enormous damage exceeding 4 Billion Euro (or US$) in Poland, but which spared Germany: only a small region on the northern border to Poland was affected, and losses did not reach 300 Million.

This time, the areas that were most affected by the rains were in the catchment of the Elbe river (see map). A first extreme rainfall event started on August 8th on the Moldava catchment followed four days later again in the Czech Republic. The observed rainfall in parts of the country was more than 350 mm in 24 hrs - a rainfall higher than the total in many summers in that area, and as high as the largest daily rainfall ever recorded in Eastern Germany.

The flood: The Elbe catchment was already soaked from the long rainfalls in July - and the runoff was very high. With the strong rainfall of August 8th in Czech Republic, extreme floods occurred - the low lying parts of the city of Prague were partly under water. The flood wave from the first Czech event reached its peak on August 9th, then moved down the Elbe river into Germany towards Dresden. The second flood wave occurred when the floods from the August 12th/13th rainfall arrived. The superposition of the two events caused enormous damage in the Czech Republic: around 200,000 people had to be evacuated, and very high property damage resulted. The subway in Prague was flooded in many parts, and many Czech cities were partially flooded. Losses were estimated to exceed the damage from the 1997 flood. In the South, the floods in the Danube caused extensive damage, making the flood one of the highest in comparison with previous floods. In the city of Passau, on the confluence of the Danube and the Inn river, the floods flooding the lower parts of the city were the highest observed in the last 48 years, and further downstream along the Danube in Austria considerable damage occurred in the cities almost up to Vienna.

The Elbe catchment in Central Europe

The largest damage occurred in the German states of Saxony and Saxe-Anhalt, where the flood waves from the two rainfall events almost coincided. Small cities on the Elbe river (Pirna) and Mulde (Grimma) were not well prepared and suffered enormous damages. Among the worst hit was Grimma, a city that had just been rejuvenated after having been in a very poor state before the 1989 reunification of Germany. It was a lovely city, with all houses freshly remodeled and the streets newly paved, with a lot of engagement by the local citizens. All in ruins! - or at least enormously damaged.

The hardest area hit, however, was the city of Dresden, which suffered from an unusual accumulation of contributing causes. On August 13th, the second wave of extreme rain centered on the Ore mountains, producing flash floods of unheard magnitude. Small reservoirs, which gave a certain sense of safety to the people downstream, filled up rapidly and overflowed into usually harmless little creeks, which became rapid torrents. Among them was the Weisseritz. It had been diverted many years ago from its original bed, and where it once flowed into the city there now was the Main Railroad Station. The creek broke its diverting dike and smashed into the train station, where the trains drowned in the flash flood. The lower part of the city went under water - including the basements of some of the most spectacular buildings: the Zwinger, (i.e.the luxury castle of the kings of Saxony, which houses the invaluable art collection of the former kings - among the treasures are paintings by Leonardo, Rubens and Rafaello - whose wonderful Madonna Sistina alone is worth a trip to Dresden) and the Opera, which is one of the most glorious pieces of 19-th century architecture. Fortunately, the concerted effort of many citizens and art lovers made it possible to save all paintings that had been stored in the basements, and the damage is mostly to pieces of art that could not be moved.

And then came the floods in the Elbe river. Floods from the Czech part of the river and from the Ore mountains reached the city of Dresden on Tuesday, August 13th and peaked about a week later: the water level was more than two meters higher than the largest flood ever measured - and the problem was aggravated by a very poor forecast: somewhere between August 15th and 16th the water administrator of the city had warned that the level of the flood may reach 8.30 m gage level - and on August 17th it actually peaked at more than 9.30 m! The Elbe overflowing its banks continued the

flooding of the city. Of great consequence was the large impediment to transportation. In Dresden, the bridges over the Elbe river were closed for days, (as were the bridges over the Moldava in Prague) and the floods over the land destroyed hundreds of kilometers of roads and railroads.

From Dresden, the flood moved towards the North: cities like Meissen in Saxony, Dessau at the confluence of Mulde and Elbe, the small city of Mühlberg and a large part of the city of Magdeburg went under water. Dikes broke in many places, and diversions had to be opened, for example in the area of confluence of Elbe and Havel. The flood diminished so that the cities further to the North were not as badly affected as the ones further South. In the city of Hamburg, where the flood arrived on August 25th, the water administration was not worried at all: compared to the storm surges that may come in from the North Sea, the flood waves from the river are quite small, and Hamburg is prepared against storm surges with a recurrence interval of about once every 200 years.

The damage everywhere would have been much higher, and many more dikes would have failed if the dikes were not strengthened through enormous numbers of sand bags, which were filled by everybody : from army soldiers to citizens of the affected villages and cities. In the face of this disaster a wonderful solidarity developed , and thousands of people helped - neighbours and helpers of all kinds came to the affected area from all parts of Germany, bringing supplies, equipment, and their own engagement. Together with about 35,000 German soldiers there were groups from other nations - probably more than 1000 soldiers from England, France and the Netherlands volunteered. Nevertheless, in terms of cost the damage of this flood disaster will be the highest ever incurred in Germany; very preliminary estimates range from 20 to 30 Billion Euro (or US $.) Fortunately, the number of fatalities is very small: probably less than 30 persons were killed in Germany, and less than 15 in the Czech Republic as a direct effect of the flood. The German Government reacted very smartly. The Federal Government decided to postpone a planned tax cut for 1 year, so that next year something like 8 Billion Euros will be available. The European Community also is helping, and many millions of Euros are coming in from donations by private citizens, companies, clubs, and other organizations. Politicians and financial experts are at work to make plans on how to best distribute this large amount of money intelligently and most effectively. The issue is not only that large numbers of households are affected, but also that thousands of small businesses are ruined - businesses, which very often just had started, whose stocks are destroyed, and whose debts are not covered. They were already at the upper limit of what could be financed, because they had to start from zero after German reunification in 1989. There also is a psychological issue: how to let people feel, that it is worth starting again, after they may have lost everything for which they had worked and toiled during the last ten years. It is hard to assess the damage to the spirit of the people: the first reaction was tremendous solidarity, but there is a let down after the flood is gone, and the realization sets in on what has to be done to reach the point again that one had reached before the flood. Appropriate encouragement is perhaps the most important support for the people of this part of East Germany. The flood not only gave wonderful examples of solidarity and self help, but provided also some insight into what could be done better. The warning system left much to be desired: the rainfall field was too local to be accurately forecasted by the German Weather Service, the warning did not reach people early enough, and much confusion was caused by not having a clear chain of command for the actions that needed to be taken, and the logistics of where to put which group of helpers did not function in many instances. In the Czech Republic and Bavaria, the authorities had learned from 1997 and later disasters but in the Elbe catchment in Germany, the authorities were not prepared for such a disaster. Although a number of studies were available, which indicated the weakness of the flood defences on the Elbe, and although scientists had warned after the flood of 1997 that the events on the Odra river could be repeated on the Elbe, they had failed to do anything. By learning from the experience, we hope that preparedness will be improved!

By Prof. Erich Plate, Honorary President of IAHR
Universität Karlsruhe, Germany

T.G. Masaryk Water Research Institute in Prague: An example of the devastation caused by the floods

IAHR Corporate Member T.G.Masaryk Water Research Institute in Prague, the Czech Republic was catastrophically affected by the recent floods in August 2002 - as can be seen in the adjoining photograph. The Institute was completely inundated, and irreperable damage included the loss of the Librarycolleaction. The Institute is therefore proud to have just published its first report since the flood - entitled “Model Investigations of Improvement of Navigation Conditions on the Lower Elbe between Strkov and Prostredni Zleb”. by J.Liby, and former JHR Editor, P.Novak.

The Institute is keen to rebuild its library, and if you have material - back issues of JHR being just one example - please contact Dr Christopher George at the IAHR Secretariat (chris.george@iahr.org)

World Summit for Sustainable Development

26 August - 4 September 2002, Johannesburg, South Africa

The emphasis this time has shown a swing away from the natural environment as discussed in Rio de Janeiro in 1992, to Human Problems. Actually the two are intertwined, as some people live off the environment, others want to preserve it. The problems of many people in subsisting, let alone preserving, has been highlighted this year and the developed countries have perceived the problems being experienced by those living in less developed areas. The official theme was People, Planet, Prosperity.

Johannesburg was stretched to its limits to accommodate over 50000 delegates plus attendants and officials. Apart from the official Summit in Sandton, there were 5 other major sites spread over a radius of 30km, with relevant exhibitions and meetings. These included the Water Dome, Ubuntu village and Alexandra, reserved for exhibitions, and Midrand and NASREC where meetings on Governance and Trade took place. The streets and walls were also used for processions and demonstrations. At the main conference center, the Summit was preceeded by over 80 workshops and meetings covering the interests of various groups including Women, Children, Regions, Democracy, Governance, Cities, Energy, Poor, AIDS, Fuels and Employment. The subject of "Biodiversity" was upheld by Amazonians, "Water for Africa" by HABITAT, "Sustainable development within a dynamic Economy" by World Bank as well as "Water, Climate and Agenda 21" and more relevantly "the Capacity for Development" and "Populations in Sustainable Development".

The actual Summit meeting allowed Heads of State and officials to discuss, propos and ratify resolutions, some of which are relevant to us as water engineers and scientists. A lot of money was pledged for development, including US1 billion by the US for Water and Sanitation; Asian Development Bank offered USD505 million for Water Services, and another USD20 million was offered by UN to various bodies for Water and Sanitation. USD770 million was made available for energy initiatives and USD100 million for agricultural programmes. Less was assigned to environmental preservation and clean-up campaigns, showing a remarkable swing to remedying social ills, which may be a stumbling block to ensuring environmental sustainability. The deployment of these funds hinges on Governance and Institutional capacity.

Energy received attention. Despite the problems of energy shortage in developing counties there was an aversion to hydro power, with environmental and social obstacles named, and it is felt that we should be facing these objections and improving the image of hydro power.

The challenges to water engineers and scientists appeared largely in the form of meeting water supply and sanitation shortfalls. 70% of water use is still by agriculture, 90% of water consumption is for human use, and half of the world's population will be without sanitation or access to safe drinking water by 2015. The shortages will be due to distribution in space, and whereas managing water in space and time offers us challenges, without redistribution of wealth little may be done. Even though world population is expected to level at 10 billion people by 2100, 90% of those will be in developing countries, and capacity building in those areas therefore appears a priority.

By Prof. David Stephenson, University of the Witwatersrand
Johannesburg, South Africa
Prof. Stephenson is a Council Member of IAHR

Conference Report

Fifth International Conference on Hydroinformatics July 1-5, 2002, Cardiff, UK

The Conference was held in Cardiff City Hall - a magnificent historic building in the centre of Cardiff, and was organised jointly by the Environmental Water Management Research Centre (Cardiff University) and the Water and Environmental Management Research Centre (University of Bristol). It was co-sponsored by the International Water Association and the International Association of Hydrological Sciences, and was the first of the series to be sponsored by the three learned societies: IAHR, IWA and IAHS. It was also supported by The Royal Academy of Engineering and sponsored by The Environment Agency.

A forum was provided for over 300 engineers, scientists, environmental managers and planners from over 50 countries to review and discuss state-of-the-art developments in hydroinformatics. The main themes included: numerical engines, modelling systems, data acquisition and management, data mining, neural networks, decision support systems, GIS, inverse modelling, integration of technologies, uncertainty and risk, and policy and strategy support systems.

The particular highlight of the conference was the opening by Her Royal Highness The Princess Royal, who spoke on the importance of hydroinformatics generally and its relevance to her own life "as a farmer" and her links with the Third World through her Presidency of The Save The Children Fund. She advised delegates that "an integrated approach involving many disciplines is important" in water management, and "so too is collaboration and communication". She highlighted the significance of the mobile phone in managing water supplies in the Third World and proceeded to discuss "uncertainty". She said that "it is important to recognise the limitations of models when dealing with an unpredictable environment. Humility in the face of natural forces is wise. Your recognition of uncertainty is a strength, but it is one for which you will not be thanked." She heard a most impressive Opening Keynote Address by Mrs. V. Bendre, Director of the Central Water and Power Research Station, Pune, India, on *Hydroinformatics in the Context of Water Resources Development in India: Challenges and Opportunities*. Mrs. Bendre described how India is rising to the challenge of managing water resources based on a host of projects

ranging from flood control and irrigation, to discharge of effluents and structural and foundation engineering. HRH then spent over an hour with Cardiff and Bristol University students, company representatives and conference delegates.

Other keynote presentations were given by: David Fortune (HR Wallingford) on *Urban Drainage and Hydroinformatics*; Konstantine Georgakakos (Hydrologic Research Centre, San Diego, USA) on *Climate Forecasts and Water Resources Management*; Arthur Mynett (WL| Delft Hydraulics) on *Environmental Hydroinformatics*; Richard Harpin (Halcrow) on *Catchment Flood Management*; Vladan Babovic (DHI) on *Introducing Knowledge into Learning Based on Genetic Programming*; and Pilar Garcia-Navarro (University of Zaragova, Spain) on *Recent Advances in Computational Hydraulics*. 238 papers were also presented covering all of the main conference themes. The conference ended with three excellent keynote presentations: Keith Riddell (Babtie Group) on *Disaster Management in Andhra Pradesh, India*; Mike Abbott (WL| Delft Hydraulics) on *The Future of Hydroinformatics*; and Lord Julian Hunt (University College, London) on *Climate Change and the Challenge for Hydroinformaticians*. The final presentation was the prestigious 2001 IAHR Ippen Lecture on *Sediment Transport in Rivers,* delivered by Marcelo Garcia, (University of Illinois), who was unable to deliver this lecture at the IAHR Congress in Beijing, due to the tragic events of 11th September 2001.

Socially, the conference was highly successful. Delegates enjoyed receptions sponsored by Cardiff City Council, HR Wallingford and Halcrow, and visited Cardiff Bay. The Cardiff University Student Chapter showed the rest of the world how to win at ten-pin bowling and Conference dinner delegates enjoyed a performance by a Welsh Male Voice Choir. Many distinguished overseas delegates (including Vladan Babovic and Arthur Mynett) joined the Choir for a singalong in the bar afterwards. Unfortunately, none had the singing talents of Tom Jones!

By Prof. Roger Falconer
Cardiff University, UK
Prof. Falconer is a Council Member of IAHR

HRH The Princess Royal giving the Opening Address at the Hydroinformatics 2002 Conference

HRH Highness meeting Professor Ian Cluckie (Conference Co-Chair), with Professor Falconer (centre)

Conference Report

13th IAHR-Asia and Pacific Division (APD) Congress August 6-8, 2002, Singapore

Opening Ceremony. (from left to right) Prof. Jothi N. Shankar, Vice-Chairman of LOC; Prof. Ng Wun-Jern, Dean of Engineering of National University of Singapore; Mr. Tan Gee Paw, Geust-of-Honor and Chairman of Public Utilities Baord of Singapore; Dr. John Junke Guo, Chairman of LOC; Prof. Sri Harto, Chairman of the APD Committee; Prof. Roger Falconer, Representative of IAHR Council; and Prof. Asih Gupta, Secretary of the APD Committee

The 13th IAHR-APD Congress was hosted by the Department of Civil Engineering, National University of Singapore in Singapore on August 6-8, 2002. More than 300 engineers and scholars from 25 countries participated in the Congress. Amongst them 92 percent were international delegates. The Guest-of-Honour, Mr. Tan Gee Paw, Chairman of Public Utilities Board of Singapore, opened the Congress. The Chairman of the Local Organising Committee, Dr. John Junke Guo, the Dean of Engineering of National University of Singapore, Prof. Ng Wun-Jern, and the Chairman of the APD Committee, Prof. Sri Harto made the welcome speeches.

The technical sessions started with Dr. Christopher George's keynote lecture on "The Global Water Community – What is the Role of Scientists and Engineers?" and concluded with Prof. Mike Abbott's keynote lecture on "Hydroinformatics: Working for People, Working for Nature". Prof. Ihesa Nezu from Tokyo University, Prof. Pierre Julien from Colorado State University, Prof. Ashim Das Gupta from Asian Institute of Technology, Thailand, Prof. Zhaoyin Wang and Prof. Guangqian Wang from Tsinghua University, Beijing also delivered keynote speeches on various aspects of hydraulics and water engineering. In addition, about 140 papers were presented in four parallel sessions covering different areas such as hydraulics and open-channel flow; hydrology, water resources and hydroinformatics; maritime hydraulics; and eco-hydraulics and water quality modeling.

After three days of intensive technical sessions, the Awards Committee consisting of 7 members and chaired by Prof. Hin-Fatt Cheong selected four best papers, two from the host country and two from other countries. The awards for papers from other countries went to Taro Oka and Hironori Higashi for their paper on "Measurement and modelling of evapo-transpiration during plant growth", and to K. Sugawara, T. Abe, A. Aihara and T. Takahashi for their paper on "A study on hydraulic characteristics of vegetative groins". The host country awards were presented to S.Y. Liong and N. Muttil for their paper on "SEA: A robust evolutionary algorithm for rainfall-runoff model calibration", and to Shuqing Yang for his work on open-channel turbulence in the paper entiltled "1st and 2nd order approximate solutions of Reynolds equations in 3-D channels".

During the event, an ice-breaking reception and a congress banquet were held at the Congress site, Marina Mandarin Hotel. Furthermore, in accordance with the APD by laws, the APD Committee selected Prof. Joseph H. W. Lee of Hong Kong University and Prof. Ashim Das Gupta of Asian Institute of Technology, Bangkok to be new Division Chairman and Vice Chairman respectively. The Committee also reviewed two proposals on the future host country of the APD Secretariat and decided to move the Secretariat to Beijing from the 1st of January 2003. After discussing three proposals on the location

of the 14th IAHR-APD Congress, the Committee agreed that this Congress will be hosted by Hong Kong University and co-organised by Hong Kong University of Science and Technology and Hong Kong Chinese University in 2004.

Finally, the two-volumes Proceedings "*Advances in Hydraulics and Hydrology*" have been published by World Scientific. Members who missed the Congress and would like to order the printed proceedings, are requested to visit: http://www.wspc.com.sg/books/engineering/5041.html or contact Dr. John Junke Guo at: cveguoj@nus.edu.sg.

Dr. John Junke Guo,
Chairman of LOC of the 13th IAHR-APD Congress
Prof. Ashim Das Gupta,
Secretary of the APD Committee

Prof. Sri Harto, Retiring Chairman of the APD Committee, presents the best paper award to Dr. Shuqing Yang

The new elected APD Chairman, Prof. Joseph H. W. Lee, makes inaugural speech and concludes the Congress

Delegates enjoy the banquet Karaoke

Workshop Report

International Workshop on Rock Scour due to falling high-velocity jets

September 25-29, 2002, Lausanne, Switzerland

The International Workshop on Rock Scour due to falling high-velocity jets was held in Lausanne at the Swiss Institute of Technology (EPFL). It was organised by the Laboratory of Hydraulic Constructions (LCH) and co-sponsored by IAHR, the American Society of Civil Engineers (ASCE), the U.S. Army Corps of Engineer (USACE), the Geo-Institute of the ASCE, the Swiss Committee on Dams (SWISSCOD)and the Swiss Association for Water Resources (SWV). The event was sponsored by Electrowatt-Ekono Ltd., Switzerland, Engineering and Hydrosystems Inc., United States, Lombardi Engineering Ltd, Switzerland, IM Ingegneria Maggia Ltd., Switzerland and Stucky Consulting Engineers Ltd., Switzerland.

43 delegates from 11 different countries (Belgium, Canada, Iran, Iceland, Italy, France, Portugal, Switzerland, Spain, USA and UK) attended the workshop, including experienced engineers and researchers.

Rock scour has been the object of several studies over the last decades and the workshop intended to gather experts from different backgrounds and make a collection of past experiences, define the present state-of- the-art knowledge on this subject and the objectives for further research. The workshop focused on rock

Rock Scour delegates

erosion by high velocity jets as those issued from overflow gated/un-gated crest or chute spillways or orifices and the resulting erosion due to falling jet impact. Scour can grow to endanger dam foundations and valley slope stability. The aim of scour evaluation is to define the ultimate scour depth, its final geometry and, if possible, its evolution in time. The problem is highly multidisciplinary and demands an integrated approach envolving water-air-rock coupled behaviour. Similar research is underway on erosion of rock cliffs and damage of coastal structures by wave impact.

In the introduction lecture entitled "Scour evaluation in space and time – the challenge of dam designers", Prof. A. J. Schleiss made a review of state-of-the-art, where empirical, semi-empirical and recent physical-based methodologies for rock scour evaluation were presented and their advantages discussed. The former are more adequate for the preliminary and feasibility design stages and are normally followed by physical model studies. Recent advances in research carried out by Dr. E. Bollaert have improved the understanding of the physical process leading to rock scour, from jet issuance and travel in the air, to impingement in the plunge pool, excitation of rock fissures (or concrete slab joints or cracks) by pressure waves, to resonance, fissure propagation by hydraulic jacking and block ejection by dynamic uplift. Open questions concern the evaluation of the prevailing discharge for ultimate scour formation (and associated duration and return period) as well as the effect of a downstream water cushion and the influence of forced aeration of the jet by splitting. Main design features concern the jet issuance conditions (e.g. at the lip of a flip bucket), the construction of a tailpond dam or of a lined stilling basin, or the pre-excavation of the plunge pool.

Technical sessions focused on case studies and prototype observations, physical modelling and scale effects, jet aeration and air entrainment in plunge pools, time scale effects and break-up resistance of rock, and numerical modelling. Twenty-one invited papers were presented.

Modelling of transient two-phase water pressures inside close-end rock joints, by means of a finite volume scheme coupled with a numerical genetic algorithm optimisation, seems promising and certainly opens the way for further development of comprehensive scour models. Another practical application is the simulation of the drainage system of a cracked plunge pool liner under the impact of a free falling jet, using recently obtained near-prototype power spectra density functions to excite the plunge pool lining cracks.

The workshop was concluded by a

highly participated round table led by Prof. H.T. Falvey. The need to continue with research so to obtain, in some decades, a fully coupled air-water-rock numerical model to simulate the entire physical process of rock scour both in time and space, was unanimously recognised. The creation of a database in the framework of existing international associations in the field of hydraulic structures, to compile prototype information of observed events and scour progression, was considered absolutely mandatory for the validation of scour evaluation methods. Furthermore, the evaluation of key parameters as the jet turbulence intensity at issuance, jet diameter or thickness at impact, air concentration in the pool and inside rock fissures, as well as site-specific rock characteristics should be taken into consideration in design practice.

Last but not least, the need to evaluate each project on a case-to-case basis remains unchanged.

The proceedings were published by A.A. Balkema Publishers and are available at www.balkema.nl ISBN 9058095185.
For further information please contact:
P. Manso, E.Bollaert or A.J. Schleiss
Laboratory of Hydraulic Constructions (LCH) EPFL, CH - 1015 Lausanne, Suisse
Tél: +41 21 693 23 85
Fax: +41 21 693 22 64
E-mail: secretariat.lch@epfl.ch

Gebidem Dam, Switzerland

Obituary

Professor Václav Hálek

In the beginning of 2002, Prof. Ing. Václav Hálek, DrSc., for many years an individual member of IAHR, one of the most prominent Czechoslovak hydraulicians of the 20th century, and an excellent specialist in the field of groundwater hydraulic, deceased.

Born on July 19, 1930 in Olomouc, Moravia, he finished his studies in Civil Engineering at the Technical University of Brno in 1954. After successful defence of the thesis „Contribution to the theory of unsteady groundwater flow“, he received the degree Candidate of Sciences in 1957, and on the basis of the thesis „Analogue methods in hydraulic“ the degree Doctor of Sciences in 1966 . Based on his thesis „Theory of hydraulic solution of the artificial infiltration“ Prof. Hálek was appointed associated professor for Hydraulic research in 1969 and following the return of democracy in the Czech Republic he was finally appointed regular professor of hydraulics at the Technical University of Brno in 1990.

Prof. V. Hálek was a successful and popular pedagogue, who acquainted undergraduates and engineers with practice by means of comprehensibly presenting the latest scientific knowledge and the results of his own researches. The Success of his pedagogical activities was fostered by his profound theoretical knowledge and ample practical experiences in the sphere he developed - groundwater hydraulic - as well as in related spheres. Prof.V.Hálek lectured, guided scientific research students and was a member of commissions both for final state examinations and for defence of dissertations not only at the Technical University in Brno, but also in Prague and Bratislava. He often lectured in foreign countries, for example at the Technical Universities in Belgrade, Zagreb, Ljubljana, Tiblisi, etc.

Extraordinarily significant and fruitful were the activities of Prof. V. Hálek in the sphere of scientific research. From 1975 until his retirement he was director of the Institute of Hydraulic Engineering and Water Management at the Technical University in Brno, and under his guidance the Institute attained great advancement and international reputation. Above all, Prof. V. Hálek himself was engaged in the complex problems of theoretical and applied groundwater hydraulics, and he developed many original theories and methods of physical and mathematical modelling. He produced significant results in the research of flow in porous media, determination of yields of well, inclusive its increase by means of artificial infiltration, as well as in the research of active and passive protection of groundwater against pollution. He devoted attention to the problems of the interaction between surface and underground flows and to the phenomena of colmatation. Simultaneously, his research was always directed towards solving concrete problems within engineering practice, and as an acknowledged expert he participated in the preparation and realisation of many significant hydraulic and engineering structures, of which the construction of the metro in Prague and the hydraulic structure Gabčíkovo on the Danube stand out.

Prof. V. Hálek published his research results in various scientific and special journals, on congresses and conferences, and complexly in five textbooks and monographs, among which the greatest level of attention was given to the work „Groundwater Hydraulics“ (Elsevier Publ.Co.,Amsterdam, Oxford, New York, 1979).

The work of Prof.V. Hálek continues to be a standing resource of knowledge and inspiration for the whole contemporary generation of hydraulicians and water management engineers, and it will ensure an enduring remembrance of this scientist and exceptional investigator.

Prof. P. Gabriel,
Czech Technical University in Prague, Czech Republic

Are YOU interested in the history of hydraulics? Is there any study or report in this area that YOU would like to publish in our new newsletter section 'Chronicles on the history of hydraulics'? Please don't hesitate to contact Dr. Pierre-Louis Viollet at: pierre-louis.viollet@edf.fr

Urban drainage and water supply in bronze age cities

(Euphrates and Indus Valley, Syria, Minoan Crete, Mycenaean Greece, 3500 – 1200 BC)

By Pierre-Louis VIOLLET
Electricité de France, France
E-mail : pierre-louis.viollet@edf.fr

The Oriental Bronze Age, between 3500 BC and 1200 BC, is known as the first large urban development period in mankind's history. Referring to the first article of this series (see IAHR Newsletter 4, 2002), the reader may recall reading about the link between controlling the Tigris and Euphrates rivers and the development of the Sumerian civilization in Mesopotamia. Technologies for urban water control were also developed to a high degree : in Mesopotamia and Syria, in the Harapean civilisation of the Indus valley (3000 – 1900 BC), and westward as far as in the Aegean sea, with the Minoan civilisation in Crete (2700-1400 BC), and the Mycenaean civilisation in continental Greece (1600-1200 BC).

By 3500 BC, people from the Sumerian country created a new city, on the upper course of the Euphrates in modern Turkey, in order to control trade with the littoral of Syria. In this small city, known as Habuba Kebira, wastewater was collected and carried outside the city walls by U-shaped terracotta pipes and drains covered with stone slabs, running below the streets. The same techniques for urban drainage were widely used in the 3rd millennium BC, both in the Indus valley and in Crete, with the introduction of bathrooms and latrines in palaces and private houses. Architecture encompassing flat roofs and terraces, and large courts with stone or brick pavements, made the question of rainwater management even more important in those countries where rainfall had damaging potential. Terracotta pipes descending from roofs and terraces were connected with pipes from latrines (sometimes situated on the second floor!) and joined down to the first floor with covered drains made of terracotta pipe elements, baked bricks or stone slabs. This pipes would run below streets and courts, towards larger sewage collectors, sometimes large enough for a man to enter (Fig. 1). In Mohenjo Daro (lower Indus valley), bottomless terracotta jars were used as infiltration drains in streets which were too far from the collector network. In Mari (2800 – 1780 BC), in the middle Euphrates valley in modern Syria, deep vertical drains for excess rainfall evacuation were coated with bitumen. Those same water drainage techniques were used later during the 2nd millennium BC in Mycenaean Greece (Mycens, Tyrins in the Peloponese) and in the littoral of Syria (Ugarit, close to modern Lattaqieh), as well as in the ancient city of Akrotiri in Santorini island. Terracotta tubs in bathrooms were used in Minoan Crete and Mycenaean Greece during the same period.

Of course, water was also a resource. Cities in The Euphrates and Nile valley were directly provided with water through canals connecting to rivers. Wells were found in many Indus valley cities (700 wells existed in Mohenjo Daro, both public and private, about 15 m deep), and to a lesser extent in Syria and Crete. Cisterns were used for rainwater conservation, and advanced hydraulic systems for collecting water from the terraces down to the cisterns were implemented in Ugarit and Mari (Syria) as well as in Cnossos (Crete) – see Fig. 2 and 3. There is no evidence of the use of aqueducts before the Minoans

Fig 1. Exit of the main sewage collector of the palace of Cnossos (Crete). About 80 cm high and 40 cm wide (photo by the author).

Fig 2. A large stone drain for rainfall collection inside the palace of Cnossos (photo by the author)

Fig 3. Canals made of baked bricks for rainwater collection from terraces down to a cistern in Mari, Syria (photo by the author).

in Crete, and there have been debates regarding the water supply of the palace of Cnossos, where clay pipes made with conical elements, -obviously used for water distribution- were found in different places in the palace. It is probable that a terracotta-made aqueduct was used to provide the palace with running water from a source situated on a hill a few kilometers away. This aqueduct may have crossed a small brook upon a bridge which was used for the road between the guest house and the palace. In later Mycenaean palaces, in continental Greece, aqueducts existed for sure : in Pylos, the aqueduct was two kilometers long and made partlyof U-shaped terracotta elements, partly of wood.

Thus, the ancient bronze age civilisations were not only brilliant for their palaces and temple architecture and treasures, but also for the knowledge they developed on urban water management. When those civilisations disappeared, in the chaotic end of the 2nd millennium BC, this knowledge was somehow maintained. Much later, in the classical antiquity, when the Greek philosopher Plato (by 400 BC) wrote about Atlantis, the legendary lost civilisation, he mentioned how the people of Atlantis developed high skills in hydraulic technologies. This may be a memory of the ancient hydraulic engineers from the lost Mari, Ugarit, Cnossos, and Tyrins cities.

Bibliography

Chakrabarti, D. K., *India, an archeological history,* Oxford University Press

Graham, J. W., *The palaces of Crete,* Princeton University Press, 1987

Vallet, R. “Habuba Kebira ou la naissance de l’urbanisme”, *Paleorient,* 22/2, 1997 , p 45-76

Viollet, P.L., *L’hydraulique dans les civilisations anciennes,* Presses des Ponts et Chaussées, 2000

Abstracts of papers in JHR -Vol. 40, Issue 6

Multi-phase plumes in uniform and stratified crossflow

S. A. Socolofsky and E. E. Adams

Laboratory experiments of multi-phase plumes in uniform and stratified crossflows are presented. In uniform crossflow, multi-phase plumes behave as mixed single-phase plumes up to a critical height, h_S, where the entrained fluid separates from the dominant dispersed phase. From the experimental results, an empirical relationship for h_S was calibrated giving $u_\infty/(B/h_S)^{1/3} = 6.3(u_s/(B/h_S)^{1/3})^{-2.4}$, where u_∞ is the crossflow velocity, B is the total kinematic buoyancy flux of the mixed plume, and u_s is the slip velocity. Above h_S the separated continuous-phase plume behaves like a momentum jet and the bubble column follows the trajectory of the vector sum of u_s and u_∞. In stratified crossflow, the trap height in quiescent water, h_T, was compared to h_S. For $h_T \ll h_S$, the plumes are stratification-dominated and separation occurs at $h_T = (2.8 - 0.27u_s/(BN)^{1/4})(B/N^3)^{1/4}$, where N is the Brunt- Vaisälä buoyancy frequency. For $h_T \gg h_S$, the plumes are crossflow-dominated, and separation occurs at h_S. A simple single-phase model was modified to predict the fate of the separated plume above h_S.

Application of gradually-varied flow algorithms to simulate buried streams

Rizwanul Bari and David Hansen

This paper reports the underlying algorithm, implementation, and development details of the Flow Analysis of Buried Streams (FABS) hydraulic model. This model simulates water surface profiles for 1-D non-Darcy flow through buried streams. Buried streams are formed in open-pit coal mines due to the disposal of large volumes of coarse rockfill. In such buried streams the formerly open channel passes through very coarse porous media but the behavior of this flow does not follow Darcy’s law. Rather, it behaves in a manner similar to that of ordinary open channel flow. The longitudinal variation in the depth of water along the stream is not, however, governed by the roughness of the stream-bed, but by the characteristics of the coarse porous media that now fills the channel. Such flow is governed by non-Darcy flow operating under the Dupuit assumptions. The performance of the model in simulating steady non-Darcy flow profiles was evaluated under laboratory experimental conditions and found to be satisfactory. The model uses either Wilkins’ or Stephenson’s equation to compute head losses. It was found that these equations performed equally well in simulating experimental water surface profiles. The performance of the model was also evaluated under three different friction-slope averaging methods, namely, the arithmetic, geometric, and harmonic average. Based on the results obtained in this study, it is suggested that any of these frictions-slope averaging techniques result in satisfactory flow profiles, provided that reach lengths are not excessive. Although there are certain limitations and definite possibilities for further improvement, it is believed that the FABS model represents a significant step forward in providing more explicit assistance in the non-Darcy water surface profile simulation process.

Contribution on transient flow modelling in storm sewers

Musandji Fuamba

Currently, the Preissmann slot model still enjoys popularity in modelling the transition between free-surface and fully pressurised flows in tail-race tunnels. However a fully dynamic and transient modelling technique is needed to predict the surge front location and velocity, the pressure rise in the full flow zone and the

water depth change in the free-surface zone. In this paper, the transient flow is modelled and only one surge front is considered. Three 1-D models, which differ from each other by the computational method used to calculate either the free-surface or the full flow conditions, have been developed and applied successfully to both laboratory and field data. Predictions have been compared to measurements and good agreement found. Comparison between the three fully dynamic models was done and selective criteria were forwarded.

Sources of bias errors in flume experiments on suspended-sediment transport

Marian Muste

Extensive research efforts in the last few decades have only partially elucidated the complexities of suspended-sediment transport. Lacking an adequate formulation and quantification of the interaction between suspended particles and the carrier liquid, it is common practice to combine sediment mechanics theory and empiricism to obtain predictive formulations. Flume data for suspended sediment transport, however, is incomplete and often inconsistent with respect to insights into sediment effects on water flow. Improvement of the data quality/reliability for future similar studies requires identification and evaluation of the sources of bias errors that might affect the experimental results.

The present paper identifies and partially evaluates significant sources of bias errors in flume investigations of suspended-sediment transport. Bias errors are discussed in the order in which they typically arise in the conduct of flume experiments. The paper considers first conceptual errors associated with the governing equations used for the design and interpretation of the experimental results. Considered next are bias errors generated during data acquisition and data reduction. As an outcome of bias error discussion, the paper recommends guidelines to avoid and reduce such errors, hence, to increase the reliability of the experimental results. Special emphasis is placed on illustrating the potential of the non-intrusive measurement instruments for removing bias errors.

Erosion of a polystyrene bed by obliquely impinging circular turbulent air jets

N. Rajaratnam and K.A. Mazurek

This paper presents the results of an experimental study of the erosion of a cohesionless bed by obliquely impinging circular turbulent jets. The jet of air, with velocity of 27.3 to 86.8 m/s and diameter at the nozzle of either 6.35 or 12.6 mm, was set to impinge on a bed of polystyrene particles at varying angles of impingement of 7.5 to 60°. Several characteristic dimensions of the scour hole were measured and analyzed and found to depend on the angle of impingement and the erosion parameter $F_O/(H/d)$, where F_O is the densimetric Froude number, H is the impingement distance, and d is the diameter of the jet at the nozzle. Correlations were developed for the main characteristics of erosion at asymptotic state. Observations of the growth of the scour hole are also presented.

Influence of cohesion on scour around bridge piers

S. A. Ansari, U. C. Kothyari and K. G. Ranga Raju

Experimental results on temporal variation of scour around circular bridge piers founded in cohesionless and cohesive sediments under steady clear water flows are reported. The difference between scour patterns in cohesionless and cohesive sediments is brought out. Considering the horse shoe vortex to be the prime agent causing scour, a procedure is developed for computing the temporal variation of scour depth in cohesive sediments. Empirical relationships have also been obtained for maximum scour depth around bridge piers in cohesive sediments.

Local scouring in low and high gradient streams at bed sills

Mario A. Lenzi, Andrea Marion, Francesco Comiti and Roberto Gaudio

The main characteristics of local scouring downstream of bed sills, forming a staircase-like system in high-gradient streams with non-uniform alluvium, have been investigated through 13 clear-water laboratory runs. Three initial longitudinal slopes and different flow rates were considered, keeping the same distance between the baffles. The grain size distribution of the sediment is that of a real alpine torrent scaled to the model dimensions. The measured scour depth, length and shape are compared to previous results concerning low gradient and uniform sediment gradings. A dimensional analysis approach appears to remain valid; nevertheless some simplifications cannot be made, since the jet regime plays an important role both for the depth and the length of the scour, and consequently affects the scour shape. Two equations are proposed for the estimation of the maximum scour depth and length. The equations are from previous data sets on low-gradient tests and a new one of experimental results on high-gradient cases.

Effect of circulation on critical submergence of an intake pipe

Fiÿkret Kocabaş and Nevzat Yildirim

In this study, the effect of circulation on the critical submergence of an intake pipe is presented. Experiments were conducted on a vertically flowing downward intake pipe in a circulation imposed still-water reservoir. The circulation imposed on the flow causes an outward centrifugal force component in radial direction which increases the critical submergence considerably. For a given flow and geometry, the vane setting angle has a certain value which causes the same critical submergence as in the case of no-vanes (unsteady vortex in no-circulation imposed flow). As the vane setting angle gets larger than its certain value, the critical submergence becomes larger than that in the no-circulation imposed flow (no-vanes). The smaller the vane setting angle, the smaller is the critical submergence. The critical submergence attains its minimum value when the vane setting angle is zero (vanes are set radially). Flow visualization for an intake pipe in a still-water reservoir has indicated that a spherical volume of fluid bounded by a stream surface of a sphere (SSS) develops. This spherical volume, hence SSS, shrinks radially and rotates about its vertical axis. The air-entraining vortex occurs as the SSS collapses. The SSS is a useful concept for the physical explanation of occurrence of the air entraining vortex.