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Experimental Methods and Instrumentation SPECIAL

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75 ANNIVERSARY 1935-2010

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Editorial

A special 75th IAHR anniversary issue of Hydrolink

We are pleased to present a special 75th IAHR anniversary issue of Hydrolink devoted to Experimental Methods and Instrumentation (EMI). In recent years there has been an explosion of new techniques for laboratory and field measurements in hydro-environment engineering and research. These techniques include terrestrial and airborne laser scanning of morphology at grain-scale resolution over large spatial domains, acoustic measurement of complete three-dimensional (3D) flow fields and sediment transport at both laboratory and field scale, and highly resolved quantification of 3D turbulent coherent structures using 3D time-resolved Particle Image Velocimetry (PIV) techniques. The data produced by such new techniques offer unprecedented opportunity to understand hydraulic phenomena, both in the observations themselves, and for development, calibration, and validation of sophisticated numerical models.

In recognition of the importance of these developments, the IAHR EMI technical committee has recently been formed by blending the previous Hydraulic Instrumentation Section (past chairs Marian Muste and Vladimir Nikora) and Experimental Methods Section (past chair Clifford Pugh). The EMI is continuing their strong work *to promote new experimental methods, instruments, measurement techniques, and data analysis routines for both laboratory and field hydro-environment studies as well as to coordinate international activities in this dynamic area.*

This special issue of Hydrolink is one example of this work. In this issue we present exciting new research by leading international researchers in terrestrial laser scanning (Brasington), laboratory physical modelling (Schleiss and De Cesare), tomographic PIV (Scarano), and data models that incorporate and utilize all the available data to develop a comprehensive understanding of the physical phenomena (Muste et al.). Furthermore, the inimitable Professor Iehisa Nezu offers his sage opinions based on over thirty years at the forefront of EMI research. Collectively, these articles demonstrate the power and importance of EMI in contemporary hydro-environment engineering and research. Enjoy.

Colin D. Rennie, Ph.D., P.Eng., EMI Chair, Guest editor
Nobuyuki Tamai, IAHR President

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in this issue

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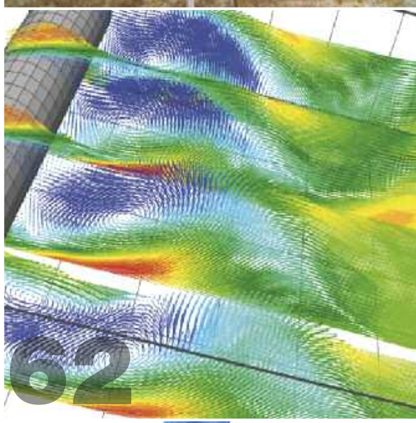

75th IAHR Anniversary SPECIAL
EXPERIMENTAL METHODS AND INSTRUMENTATION

From Grain to Floodplain: Hyperscale Models of Braided Rivers

The last decade has witnessed an unprecedented escalation of geospatial technology with fundamental implications for river science and management. Typical datasets of channel morphology have grown from tens of cross-sections, comprising a few hundred survey observations, to airborne lidar surveys incorporating millions of points. As we report here, the prospect of wide-area terrestrial laser scans with tens of billions of observations now looms large, delivering an increase of seven orders of magnitude in information in a decade. Our observational net has closed rapidly; the challenge now is to reap the scientific rewards from this technological dividend.

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The link between river morphology and fluvial processes has long been recognized to be two-way. Topography both steers and dissipates the energy of flowing water which, at the same time, uses excess energy to erode the bed and banks and transport material before ultimately depositing sediment and building lost topography. The study of river properties, processes and evolution, or **morphodynamics**, integrates these phenomena across space, from grain-scale turbulence to reach-scale channel patterns and through time, as rivers evolve both gradually and catastrophically over seconds to millennia. Unravelling these processes has been a focus of river science for over a century and remains central to managing flood conveyance, erosion/sedimentation and physical habitat.

Accurate models of river channel topography and sedimentology are fundamental to this goal. They provide boundary conditions for numerical models and baselines against which erosion and sedimentation can be measured directly and sediment transport rates estimated inversely. The last decade has witnessed a revolution in survey and sensor technology that has transformed the acquisition of geospatial data both above and below the Earth's surface. These advances have been delivered through a wide range of new technologies including: (i) survey and navigation instruments e.g., the global positioning system (GPS), robotic tacheometry and inertial measurement units; (ii) remote observation methods and sensors e.g., photogrammetry, scanning sonar and lidar, ground-penetrating radar; and (iii) novel survey platforms, such as remote operated vehicles (ROVs), blimps and unmanned aerial vehicles (UAVs).

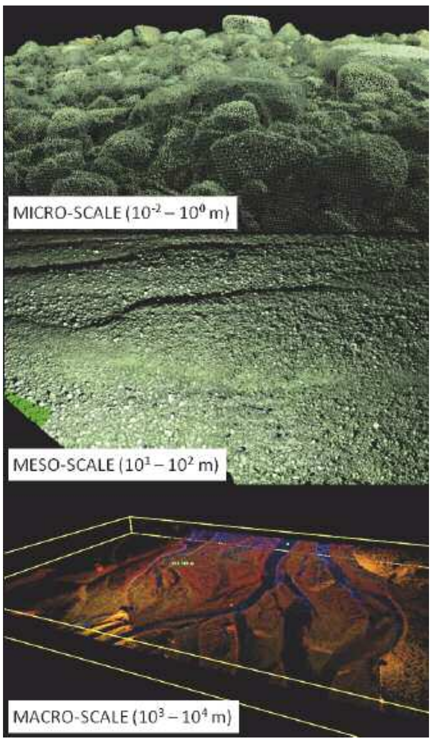

Figure 1: Scale-free topographic models linking micro-macro fluvial forms in a single dataset.

Continuing technical developments are now poised to reset this field with the advent of ruggedized, terrestrial laser scanners. Employing similar physical principles to those used in airborne lidar, these ground-based instruments can acquire unprecedented volumes of survey-grade 3d observations, generating point-cloud datasets with sub-centimetre point spacing and precision. **Terrestrial laser scanning (TLS)** offers, for the first time, the prospect of landscape-scale digital-terrain models constructed seamlessly at the resolution of the fundamental particle-scale building blocks (Figure 1). These data provide unique opportunities to link explicitly channel morphology, surface sedimentology and sediment transport, to the driving controls of river discharge and local hydraulic forces.

The ReesScan project began in 2009 and brings together an international team of river scientists to explore the potential of emerging remote sensing technologies to better connect the patterns of river channel change to the driving physical processes. The project focuses, in particular, on the dynamics of mobile, braided rivers that characterize many of

Figure 2: ArgoScan: a mobile river surveyor.

the world's piedmont regions and are increasingly under pressure due to their rich water and sediment resources. Funded by the UK Natural Environmental Research Council and NIWA NZ, ReesScan involves scientists from the UK, NZ, Spain and Canada and is centred on an eight-month field campaign to study the dynamics of the intensely braided Rees River, Otago, New Zealand.

A key goal of ReesScan is to develop a new TLS-based survey methodology to acquire hyperscale topographic models of a 3 x 0.7 km reach of the Rees after each storm event during the NZ summer flood season. These data will allow the team to quantify the continuous evolution of the river through this flood rich-period and answer key questions including: how do patterns of sediment transport vary with flood flows?; how does the distribution of riverbed facies and structures influence transport rates? and; what are the principal sources of uncertainty in estimated sediment transport rates?

The work-engine of the project is **ArgoScan**, developed in collaboration with the Intelligent Robotics Group at Aberystwyth University. ArgoScan is a mobile river surveyor system which can be fully robotized and is capable of collecting over **one billion survey points per day**; capturing the morphology of the river bed at sub-centimetre precision and resolution. Based on a ruggedized, amphibious, 6x6 wheel vehicle, ArgoScan incorporates a high-speed laser scanner, precision GPS, attitude sensors and a panoramic camera to capture the 3d geometry of the river on the move.
These dense survey data are supported by bathymetric observations collected from boat-based acoustic Doppler current profiling (aDcp) and helicopter-based aerial photography which are used to generate decimetre resolution data on the 10% of the reach which remains under water at low flow. These complementary datasets are then fused to generate digital elevation models of river topography at unprecedented spatial resolution and precision (Figure 3).

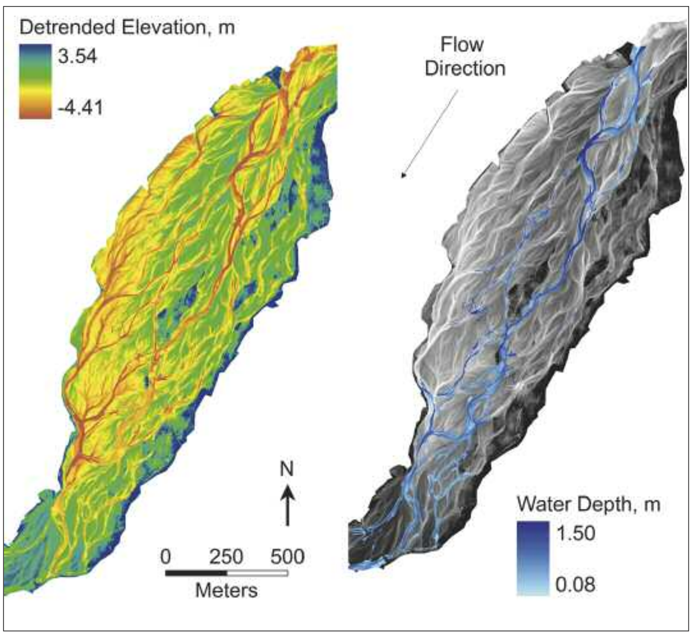

Figure 3: Digital terrain and bathymetric models of the complex, braided Rees River.

The ReesScan field campaign ran successfully from October 2009 – May 2010 and acquired topographic models of the Rees as it was reshaped through 10 competent flood events. These varied in magnitude from 100 – 350 m3s-1, and included a 1:10 year event that caused substantial local flooding. These data create a unique opportunity to integrate the morphodynamic processes that control and maintain braided river morphologies across a full spectrum of space and time scales. It is hoped that this unparalleled dataset will shed new light on the geophysical processes which control the intermittent, unsteady and highly variable pattern of sediment transport in braided rivers.

Once fully compiled these data will be made available to the rivers community and will provide an excellent resource for modellers and empiricists alike. For further information please visit the project's website www.reesscan.org.

Acknowledgements: ReesScan is a team project and would not be possible without the support of Murray Hicks (NIWA), Damia Vericat and Ramon Batalla (University of Lleida), Colin Rennie (University of Ottawa), along with Richard Williams, Becky Goodsell, Mark Neal and Fred Labrosse at Aberystwyth.

Physical Model Experiments

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Dr. Anton J. Schleiss graduated in Civil Engineering from the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland. He is full professor in hydraulic structures and director of Laboratory of Hydraulic Constructions (LCH) at the Ecole polytechnique fédérale de Lausanne (EPFL) in Switzerland. The LCH activities comprise education, research and services in the field of both fundamental and applied hydraulics and design of hydraulic structures and schemes (http://lchwww.epfl.ch). Actually 13 Ph.D. projects are ongoing at LCH under his guidance. Prof. Schleiss is also involved as an international expert in several dam and hydropower plant projects all over the world as well as flood protection projects. He is Director of the Civil Engineering program of EPFL and chairman of the Swiss Committee on Dams.

Dr. Giovanni De Cesare, Senior Research Associate, Laboratory of Hydraulic Constructions (LHC) at the Ecole polytechique fédérale de Lausanne (EPFL), Switzerland. He is lecturer in hydraulic structures and networks at EPFL in the civil engineering programme as well as at the University of Applied Sciences of Western Switzerland. The main research topics concern numerical and physical modelling of hydraulic structures and reservoir sedimentation, sustainable reservoir sediment management as well as ultrasound and other laboratory measurement techniques.

Reservoir sedimentation a key problem of sustainability

Even if the reasons and the involved processes of reservoir sedimentation are well know since a long time, sustainable and preventive measures are rarely taken into consideration in the design of new reservoirs. In order to avoid operation problems of powerhouses, sedimentation is often treated for existing reservoirs with measures, which are efficient during limited time only. Since most of the measures will loose their effect, the sustainable operation of reservoirs and the production of valuable peak energy are endangered. Today's worldwide yearly mean loss of storage capacity due to sedimentation is already higher than the increase of capacity by the construction of new reservoirs for irrigation, drinking water and hydropower. In Asia for example 80% of the useful storage capacity for hydropower production will be lost in 2035.
In Alpine regions the loss rate in reservoir capacity is significantly below world average. The main process in narrow reservoirs is the formation of turbidity currents, which transport the fine sediments regularly near the dam, where they can increase sediment levels up to 1 m per year. The outlet devices such as intakes and bottom outlets are therefore in many reservoirs after 40 to 50 years of operation already affected. The effects of climate change will in future increase the sediment yield entering the reservoirs. Turbidity currents may be stopped and forced to settle down by obstacles situated in the upper part of the reservoir in order to keep the outlet structures free of sediments. They can also be whirled up near the dam and intakes and kept all the time in suspension, which allows a continuous evacuation through the turbines. In certain cases fully venting of turbidity currents is possible.

Research at the Laboratory of Hydraulic Constructions LCH) of the Ecole polytechnique fédérale de Lausanne (EPFL) in Switzerland focuses since a long time on this problem. Several experimental studies tried to answer the following questions:

1) How turbidity currents influence the process of reservoir sedimentation?
2) Is it possible to manage turbidity currents inside a reservoir by technical measures?
3) Which geometry of shallow reservoirs is favorable in view of sedimentation by suspended sediments
4) How turbulence in front of an intake can be created with the purpose to keep the sediments in suspension and to evacuate them continuously through the headrace system of hydropower plants?
5) Which are there optimal pumping and turbining sequences in pumped-storage power plants in view of reservoir sedimentation by suspended sediments?

The challenge of understanding and managing of turbidity currents in reservoirs

In narrow reservoirs with quite steep bottom slopes, turbidity currents (Figure 1) are frequently the main process for the transport and deposit of sediments. These turbidity currents with high sediment concentrations mainly occur during floods and follow the thalweg to the deepest zones of the reservoir near the dam. Depending on the slope of the thalweg, density currents reach velocities in the range of 0.5–0.8 m/s, and exceptionally up to 2 m/s during floods (De Cesare et al., 2001). Sediments, which have already settled down, can therefore be eroded again and transported toward the dam. The resulting introduction of additional suspended sediments into a turbidity current increases its density and consequently its velocity. On the other hand, turbidity currents slow down on low slopes or after a hydraulic jump, which causes the sediments to settle and the current to die out.
If turbidity currents can be entirely stopped in a reservoir, or influenced in such a way that the sediments are not deposited in critical locations like in front of intakes and bottom outlets, the sustainability of the reservoir operation may be increased considerably. Such technical measures to control reservoir sedimentation due to turbidity currents have in principal the purpose to stop, dilute, or divert the flow influencing the location of major sediment deposits. This can be done by a solid or permeable obstacle (Oehy and Schleiss, 2007) or a jet screen placed inside the reservoir (Oehy et al., 2010) (Figure 2).

on Reservoir Sedimentation

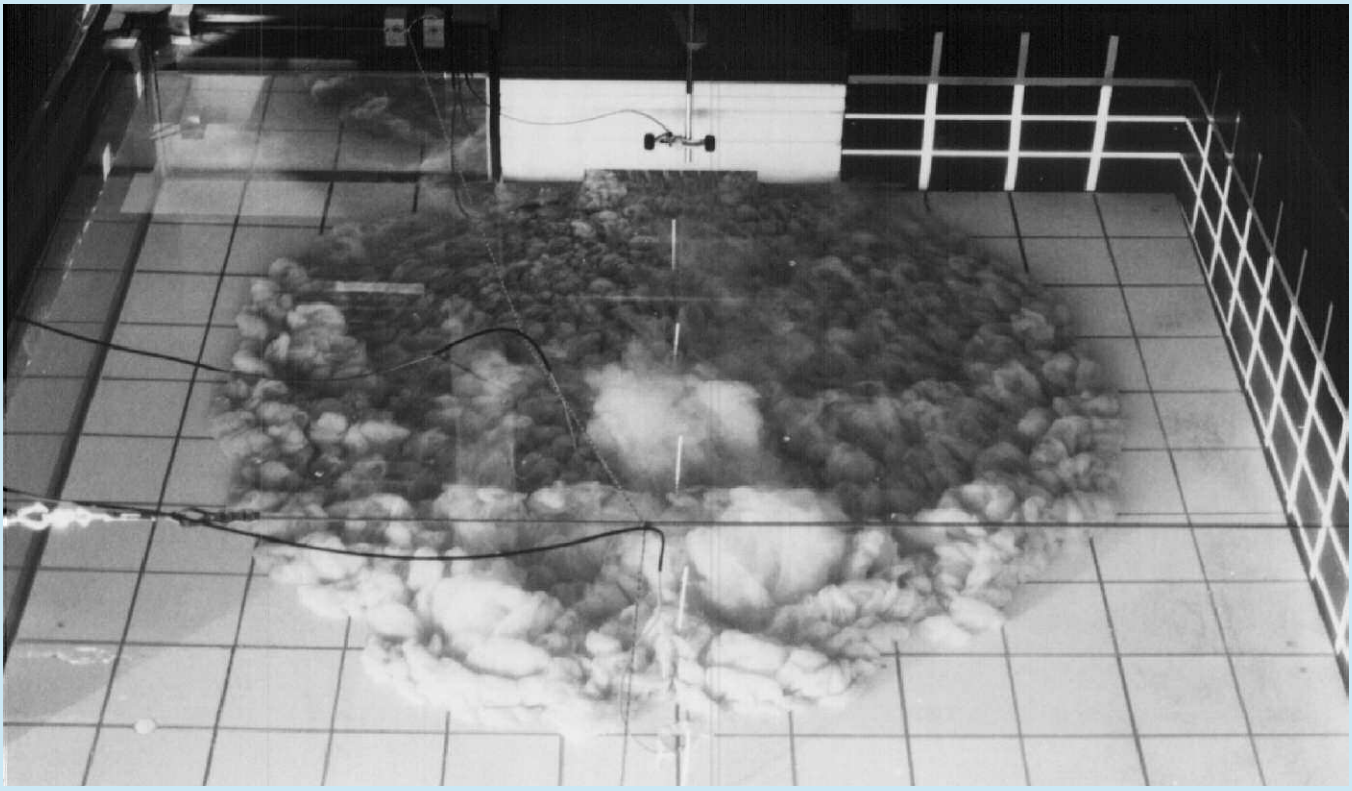

Figure 1: Experimental horizontally spreading turbidity current in a shallow reservoir, streamwise velocity measurement using 5 ultrasound Doppler UVP transducers

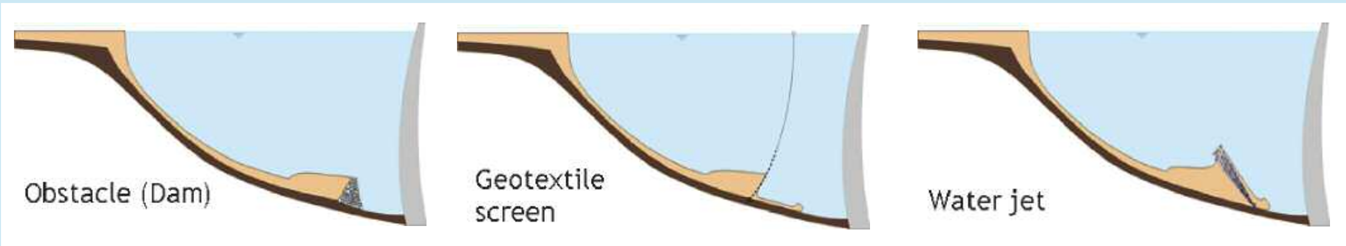

Figure 2: Investigated methods to stop turbidity currents in deep storage reservoirs

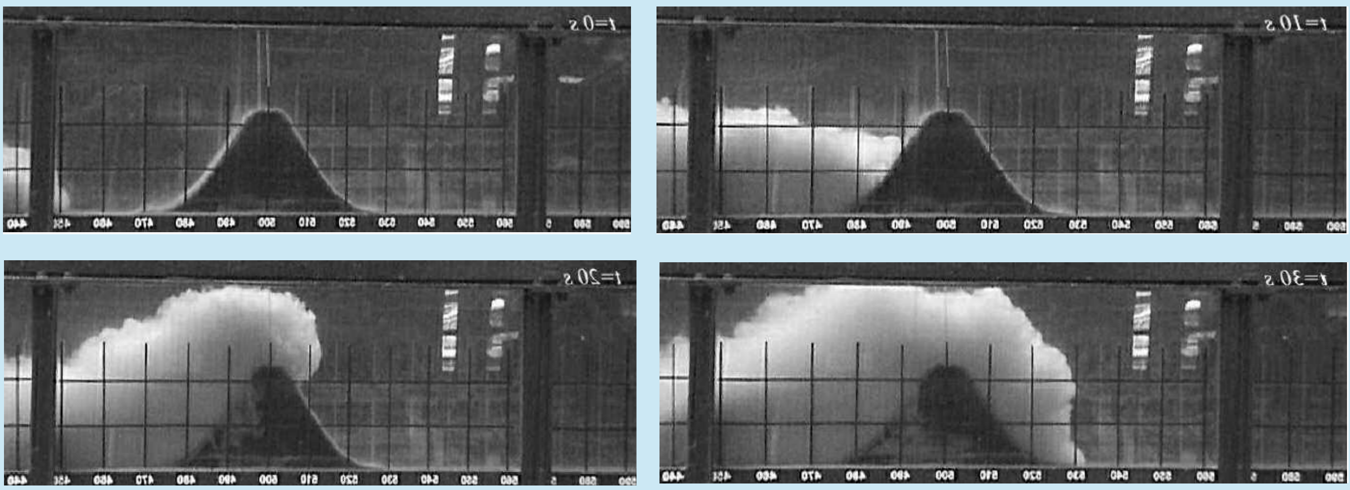

Figure 3: Sequence of a turbidity current flowing over a Gaussian obstacle at time intervals of 10 s. Approach front flow velocity Uf = 0.039 m/s, height of the current h = 0.106 m, grid spacing 0.10 m.

Experiments for testing the efficiency of these measures were carried out in a 8.55 m long, 0.27 m wide and 0.90 m deep multipurpose flume (Figure 3). The flume can be tilted in a slope range between 0% and 5%. In the upper part of the flume a sluice gate allowed the release of the turbidity current in the downstream part simulating a 7.1 m long straight reservoir. An adjacent mixing tank was used to prepare the dense fluid mixture. For the experiments a cohesionless, fine polymer powder with a density of 1'135 kg/m3 and a particle diameter of d50=90 µm was chosen.
In each experiment vertical velocity profiles in the body of the turbidity current were measured with an ultrasonic velocity profiler (UVP). The velocity measurements were made at three locations upstream of the various obstructions and one location downstream. The front velocity of the turbidity current head was determined from video recordings. In order to assess the time and space evolution of deposits due to the turbidity current, a device to measure the local evolution of sediment layer thickness during the experiments was developed based on the fact that the electrical resistance of a layer of particles depends on its thickness.
The investigations showed that turbidity currents can be influenced effectively by properly designed constructive measures. Based on the results of the physical experiments and numerical simulations, some design recommendations for solid (Figure 3) and permeable obstacles as well as for a jet screen are proposed. As an example, the results showed that, in certain configurations, turbidity currents can be partially stopped by a 45° upstream inclined water jet screen (Oehy et al., 2010). Furthermore the deposits downstream of the screen could be reduced up to a factor 2 compared to deposits of a free flowing turbidity current. The height of a solid obstacle should be at least twice as high as the approaching turbidity current (Oehy & Schleiss, 2007).

Figure 5: Picture from the interior of the experimental basin showing the jets fed from above in the foreground and the front wall with the water intake in the back

Influence of geometry of shallow reservoirs on flow pattern and sedimentation by suspended sediments

The effect of different reservoir geometries on flow and sediment deposition was examined in a rectangular shallow reservoir with a smooth horizontal bottom. The maximum depth is 30 cm and maximum horizontal dimensions are 6 m x 4 m. Movable PVC walls allowed changing the length L and the width B of the reservoir, in a way to test different L/B ratios. A horizontal movable square grid (overall dimensions: 1 m x 1 m) formed by 8 UVP transducers (2 MHz) allowed to measure the two horizontal velocity components in 16 points, placed at the intersections between the velocity profiles recorded by each transducer. The distance between each point of measurement is about 24 cm. LSPIV was also used to assess the surface flow pattern in the reservoir (Figure 4).

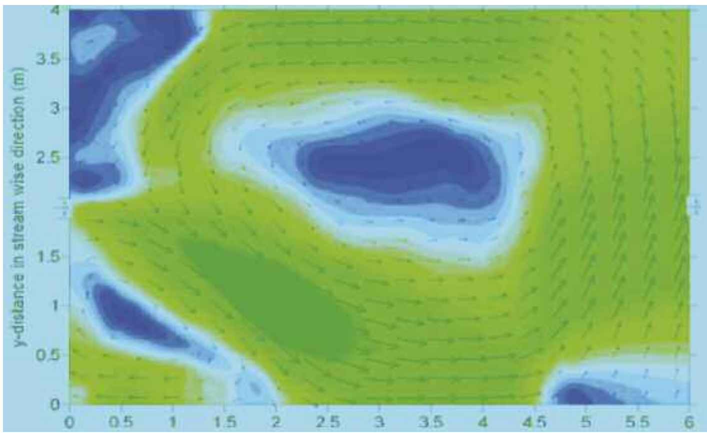

Figure 4: Stationary flow field in a shallow reservoir with sediment transport obtained with LSPIV technique

After carrying out measurements of the velocity flow field developing in clear water conditions for the different reservoir configurations, a sediment supply was added to the inflowing discharge by a mixing tank. Sediments were fed from a sediment tank into the mixing tank, where they were mixed uniformly with water by a rotating propeller. The resulting mean inflowing concentration was about 2 g/l that corresponds to a solid discharge of 50 kg/h. The sediment supply lasted for 4 hours, for a total sediment inflow of 200 kg. The experiment was stopped after the first 2 hours, to measure the intermediate thickness of sediments deposited on reservoir bottom by a laser. Then, other 2 hours of sediment supplying were performed, and the final thickness of sediments deposits was measured. The concentration was monitored at the inlet and at the outlet channels by two turbidimeters. The sediments used for the experiments were crashed walnut shells of mean diameter d50 = 50 µm, with bulk density of the dry sediments ρdry = 550 kg/m3 and bulk density of the wet sediments ρwet = 1150 kg/m3. Their mean settling velocity is vsed = 0.5 mm/s, according to the Stokes' law applied on the mean diameter.
The influence of the geometric parameters was expressed by a geometry shape factor SK and examined for symmetric inflow and outflow conditions (Kantoush et al., 2007 and 2008). As elongated gyres are not stable, the transition from short to a long basin results in a change from one pair to two pairs of gyres. Eventually one large gyre and two upstream satellite gyres are formed (Figure 4). The Coanda effect stabilizes the asymmetric pattern. Adjusting the lateral expansion of the sidewalls, results only in suppression of the satellite gyres. The basin length has a strong influence on the change of the flow field from asymmetric to stable symmetric flow. However, the basin width does not influence the asymmetric separation of the issuing jet. The expansion angle has an influence on the flow pattern and number of circulation cells. The flow instability increases by decreasing the expansion jet angle. It was observed that the basin geometry expressed with a geometry shape factor strongly influences the behaviour of the large turbulence structures. The experiments revealed a critical geometry shape factor SK of 40, above which an initially asymmetric flow will develop towards a symmetric flow due to the Coanda effect. Three types of jet flow regime

were classified according to the basin geometry and flow conditions; symmetric with straight jet, meandering with a wavy jet, and asymmetric with question mark jet. Furthermore the experiments revealed that an asymmetric flow pattern with large stagnant zones and one circulation cell is favorable to minimize retention of sediments.

Continuous release of sediments through intakes by water jet induced cyclonic circulation in the reservoir

The idea is to release continuously the sediments out of the reservoir in order to achieve almost the natural conditions before the dam construction. The method may apply for fine sediments only. This can be done even without loosing precious water for energy production by releasing them through the turbines.

A well arranged set of four water jets creates an artificial turbulence, that means a rotational and upward flow, which lift the fine sediments to the height of the water intake from where they are evacuated during operating hours. In alpine reservoirs, these jets are fed by water convey tunnels from neighboring catchment areas. Different such jet configurations near the intake were tested (Jenzer Althaus et al., 2009). The experimental facility consists of a cubic basin, in which four equal water jets are placed in a circle on a horizontal plane near the bottom where each jet directs in a right angle to the outflow of its neighbouring jet (Figure 5). This jet arrangement creates a cyclonic circulation. Light weight crushed walnut shells with an average diameter of 60 microns are used as sediments. Turbidity measurements give information about the time evolution of the sediment concentration at strategically interesting locations. Flow velocities and patterns were measured by UVP technique.

It could be observed that the flow velocities produced by this jet configuration are strong enough to keep fine sediments in suspension. A sensitivity analysis regarding the momentum flux, the jets Froude Number and the position of the jet cyclone was performed in order to evaluate which configuration gives the optimal combination regarding the suspended sediment release.

Outlook

Because of sedimentation the sustainable use of the reservoirs is not guaranteed in long term. Many possible measures against sedimentation are known from practice, but they are strongly depending on the local conditions. The problematic of sedimentation and sediment management should be considered in the early stage of the design of the reservoir in order to obtain sustainable solutions. Unfortunately this is still not yet the case in many projects today. Innovative research on reservoir sedimentation is therefore still needed in order to define new methods and measures which allow designers to face the serious problem from the very beginning.

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Vision and Progress:
Data Models for Multi-dimensio

The vast amount of available observational data on rivers along with the recent advancement in instrumentation, GIS, and informatics call for the development of a standardized framework for accessing river data, maps, imagery and models, and share the information with the community through search and discovery tools.

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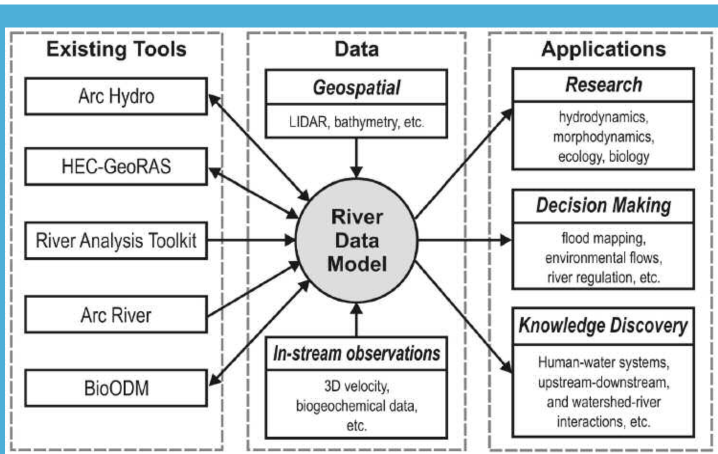
Currently, there are an increasing number of substantial ecological sustainability concerns regarding the world's rivers. Most of these concerns are related to streamflow depletion related to water supply, irrigation, power production, and industrial needs, and extensive use of the in-stream flow conditions for navigation, recreation, waste assimilation, and aquatic habitat. Although many studies have examined human-water dynamics, the complexity of rivers as coupled systems is not well understood largely because of the gaps in our knowledge of river and river network processes, the isolated and disciplinary approach used in the typical analyses, and the lack of efficient tools and data for multidisciplinary studies.

The traditional pillars of the natural systems scientific studies are observation, theory, and analysis. Modern information and communication technology capabilities now allow us to address a new class of problems around the organization of data and information leading to knowledge extraction (Baker and Barton, 2003). The digital revolution is changing radically the way we conduct our science, as well as affecting all facets of society, and it can be argued that informatics has become the fourth pillar of any scientific study. The informatics concept is, however, not new, and it has predecessors in water sciences. The rapid process of electronic encapsulation of information and knowledge in hydroscience since 1990 led to development of the Hydroinformatics field (Abbott, 1991).

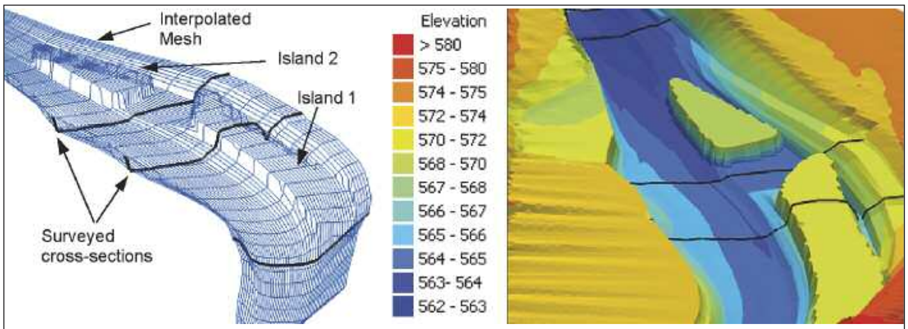
So far, the major focus of hydroinformatics has been in the area of numerical simulation, with little emphasis in the area of data representation, organization, and analysis at watershed scale level to further enhance the use of the data. Data can originate from sensors placed on satellites, airborne, located at close range or deployed in the rivers. Integration of the data from all these sources is a difficult task as the data is heterogeneous with respect to type, format, storage media, accuracy, and spatio-temporal resolution. The integration necessarily requires the use of data models that represent properties and relationships among classes of geospatial and temporal hydrologic and hydraulic data regardless of their provenance. An excellent example of a data model for hydrology is the ArcHydro data model (Maidment, 2002). Data models are necessarily associated with convenient software toolkits for resource discovery, interactive visualization and analysis, and collaboration among distributed teams of investigators.

The vast amount of available observational data about rivers along with the continuously increasing capabilities offered by the Geographic Information Systems (GIS) and the advanced river instrumentation calls for integration and thematic synthesis. For this purpose the geospatial datasets need to be linked with the morpho- and hydrodynamics observational data in GIS web-portals that supply data, maps, imagery and models, and share the information with the community through search and discovery tools (Dangermond and Maidment, 2010). The essential idea of the river data models is that a river is a lot more than just a GIS line feature. Rivers are multi-dimensional objects characterized by geographic (drainage area, river network, soil

Figure 1. Synergy of the River Data Model with existing components for acceleration of the practical implementation



nal Representation of the River Processes



a) Interpolated mesh from surveyed cross-sections b) Integrated terrain with mesh and DEM

Figure 2. Bathymetry generation for Kootenai River (Idaho): (a) interpolation of surveyed cross-sections; and (b) integration with LIDAR digital elevation model (Merwade et al., 2008).

and morphologic data, land use and coverage, socio-economic), hydrodynamic (flows, levels, inundation maps, and three-dimensional in-stream data), and water quality (sediment, pollutants, biologic, and ecohabitat data) characteristics.

Our vision for the River Data Model (RDM) is to support storage, discovery and manipulation of river-related data for scientific and engineering applications including hydrodynamics, morphodynamics, ecology and biology (Fig. 1). Similar to other data models, RDM will be supported by a toolkit for river applications.

There are ongoing developments in the area of river data modeling that can be readily used to accomplish the vision for RDM. These developments include the river channel model within Arc Hydro (Maidment, 2002), the preprocessing toolkit (HECGeoRAS) for hydraulic modeling of the river (USACE, 2009), river bathymetry analysis toolkit (Merwade et al., 2008), Arc River model for ingesting river measurements (Kim et al., 2007), and the recent development of BioODM (Maidment, personal Communication) for biological river data using the Consortium for Advancement of Hydrologic Sciences Inc. (CUAHSI) Hydrologic Information System's (HIS) Observation Data Model (ODM). Essentially all these developments provide unique core functionalities for RDM including handling of geospatial data, observational data, geospatial and temporal analysis, and numerical modeling. For example, ArcHydro and HECGeoRAS have a data model for storing river morphology in the form of cross-sections and profile-lines. River analysis toolkit has functions for spatial interpolation of river bathymetry using orthogonal coordinate system, linear interpolation and integration of river-cross-sections with Light Image Detection and Ranging (LIDAR), and tools for creating approximate river morphology using limited river bathymetry data obtained from acoustic instruments (Fig. 2). The Arc River data model has tools for handling 3D river observations acquired with Acoustic Doppler Current Profilers (Fig. 3). Within RDM, the 3D river characterization will be connected with the

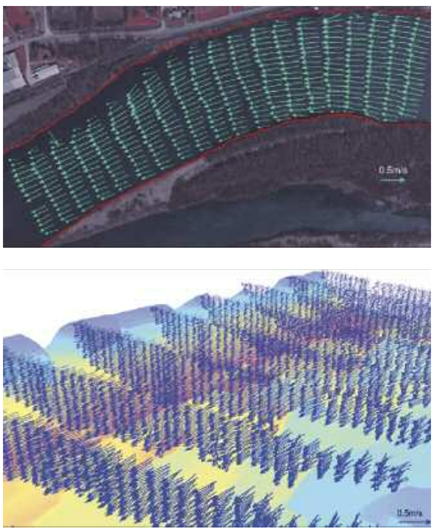


Figure 3. River morphology and mean hydrodynamic characteristics obtained from ADCP measurements on a Mississippi River reach; (a) 2D reach scale representation of spatially double-averaged velocity field; (b) spatially averaged ADCP transect measurements within the reach (Muste et al., 2010).

available mapping for river networks to enable the connection of the rivers with their watersheds. While the developments described above provide a proof of promising progress towards the vision of RDM, several challenges and/or opportunities exist. These include: (i) formulation and development of a data and modeling framework for supporting 2D and 3D modeling of rivers; (ii) integration of real-time point observations (e.g., streamflow and stage) and satellite data (e.g., flood inundation) within RDM; (iii) data mining capabilities for extracting river features from remote sensing data including LIDAR and satellite images; (iv) ability to link river data with other national datasets such as soils and geology for scientific discovery; and (v) meeting the needs of regulatory agencies flood inundation studies and in-stream flow studies. The importance of elevation data in producing accurate flood inundation maps has resulted in availability of more detailed data in the form of LIDAR. Similarly, the need for determining reliable environmental flow conditions requires collection of detailed bathymetry datasets using in-situ acoustic methods for 2D modeling of river channels. All these developments call for a standardized framework for handling and processing river data including supporting tools for river modeling.

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10 QUESTIONS TO... Prof. Iehisa Nezu

Interviewed by Cristiana Di Cristo and Colin Rennie

1

What do you consider to be your greatest achievement in understanding hydraulic phenomena that you have obtained through experimental methods in the laboratory?

During my degrees of Bachelor(1971) and Master(1973) Engineering, I had studied applied Dam Hydraulics theoretically and experimentally, especially hydraulic jump in conduits for new-type spillway development. However, I fully realized that it was very difficult to measure hydraulic jump (air/water two-phase flow) by hot-film anemometers, which had become just available commercially at that time. Just after the entrance to Ph. D course in Kyoto University, I decided to change my research topics completely and highlighted fundamental hydraulics rather than applied. It was very lucky for me to encounter "Organized and Coherent Turbulence" in our Department Library, which was just discovered in boundary layer flows by the Kline group (1967-1971). I concentrated my research on the differences between open-channel flows and boundary layers, and found that turbulence structures of open-channel flows are almost the same near the bed (i.e., in the near-wall region) as those of boundary layers. This motivated me to investigate bursting phenomena near the bed theoretically and experimentally (JFM, vol.80, pp.99-128, 1977 and vol.104, pp.1-43, 1981), which is one of my greatest achievements in journals. After then, my topics were focused on the outer-layer phenomena, i.e., secondary currents, and also the essential interactions between the inner-layer and outer-layer phenomena, which are still being investigated even now.

2

Numerical models are increasingly used by researchers and practitioners to understand complex hydraulic problems. Why do you continue to employ experimental methods in the laboratory?

Numerical models and computational methods are very powerful to compensate the related experiments, but they may not be able to reveal and to predict flow phenomena in nature without any experimental observation. In my opinion, numerical simulations are "virtual", whereas measurements are" real" to understand flow phenomena in nature. Even if the power of supercomputers will be further improved, I expect that experimental methods will still be necessary for research and education in the future. In an ironic sense, even the IT students who never learn hydraulics may be able to compute the N-S equations, but cannot understand the calculated flow structures physically.

3

A fundamental difficulty with measurements is that it is generally impossible to measure all relevant parameters at all relevant scales in space and time, particularly without disturbing the flow field itself. How do you deal with this issue?

Measurements without disturbing the flow field have progressed rapidly with the advent of laser-based devices, especially, laser Doppler anemometer (LDA) and particle-image velocimetry (PIV). At present, it may be possible to measure all three components of velocity and mass concentration using 3-D LDA and stereoscopic PIV with laser-induced fluorescence (LIF), which are all non-intrusive measurement devices in laboratory flumes. Recently, acoustic-based devices such as ADV and ADCP are available commercially in laboratory and field measurements. Nevertheless, it may still be difficult to measure accurately the boundary regions very near the bed (wall) as well as water surfaces.

4

Water resources problems (flooding, contamination, water supply, etc) have important societal and environmental consequences. What role can experimental hydraulic research in particular play in the solution of such problems?

Unlike fluid mechanicians, our hydaulicians, even fundamental academic researchers, should take a great interest in real water resources problems in the world, even though we are but one component to such real problems in which politics, economy, security, human activities, health, food and others are complicatedly linked to each other as well as water sciences and engineering. Experimental hydraulics will contribute to scientific and engineering aspects of such real problems. In these problems, real experiments and careful observations are more useful and contributory to such solutions than virtual numerical simulations.

5

How has experimental research in hydraulics changed in the last twenty years?

In the 1980's, hot-wire/film measurements were in their golden age, and hydrogen-bubble techniques took a turning point for qualitative flow visualization, by which bursting phenomena near the wall and vortex/pairing phenomena in jets were discovered. In the 1990's, laser-based velocimetries such as LDA and PDA (phase Doppler anemometer) became available commercially, although very expensive. In the 2000's, computer-aided flow visualizations such as PIV and PTV have become more popular although their accuracy and resolution are much lower than LDA. This is because the former is excellent in space-information of flow (vortex is easily measured by PIV), whereas the latter is excellent in time-information at a point in the flow (good resolution in spectrum). Experimental flumes have also been innovated in the last twenty years. Previously, water recirculation in a flume was controlled by a head-tank system. However, at present, a computer-aided recirculation system is used in many laboratories, by which it is possible to generate unsteady flows with arbitrary hydrographs and to simulate real flooding flows relatively easily.

6

How do you foresee future development of experimental research in hydraulics? In your opinion, which measurement technique(s) will be most rapidly developed and have a major impact in the next few years?

"Need is mother of development" is a proverb in Japan and other countries. In my opinion, experimental research is and should be a core of hydrodynamics in the same manner as fluid mechanics and aerodynamics. Measurements will never be considered redundant in the near feature, even if supercomputers will be further improved and be able to calculate large-scale turbulence (even the meteorological and geophysical scales) in direct numerical simulation (DNS); the present supercomputer can calculate only low-Reynolds-number flows, say Re=103-104, but geophysical flows such rivers and oceans have Re=107 and more. However, I consider that the development of measurement techniques

Prof. Iehisa Nezu is currently a full professor in Department of Civil Engineering, Kyoto University. His professional background is open-channel turbulence and the associated mass transport which have been investigated most experimentally in the past 40 years. Received the Thesis Prize of JSCE in 1976, the Karl Emil Hilgard Hydraulic Prize of ASCE in 1987, the Most Splendid Paper Award of IAHR-APD in 1998, and the second Yalin Award of IAHR in 2009. He has thus received the major awards of each field in 11-year cycles.

may have plateaued at present. New and breakthrough devices much superior to laser-based ones such as an LDA (previously called "perfect and ideal instrument") will not be invented in the near future. Instead, I foresee that a relevant combination with LDA and PIV/LIF will be most rapidly developed in laboratory experiments. In field tests, a lot of new instruments corresponding to LDA will be feasibly developed. It is even now difficult to use LDA in field tests such as in rivers, lakes, estuaries and oceans even if sufficiently-long fiber-optic LDA probes, say 1000m long, and ultra-high power laser light, say 100W laser power, will be developed. One possibility may be innovative techniques corresponding to PIV and remote sensing/image-based velocimetry. Even velocities below the water surfaces in natural rivers will be able to be measured in the near future by combinations between innovative PIV/remote sensing and illumination systems.

7

Major new experimental hydraulic facilities and instrumentation require significant investment. Why should countries and institutions make such investments? How should the IAHR community best argue for such investment?

It is a real problem. Hot-wire/film anemometers, electromagnetic flow meters and acoustic Doppler velocimetry (ADV and compatible) are often used, as well as PIV/PTV, even in small unit laboratories of universities and institutes. However, LDA is very expensive and furthermore requires careful maintenance at all times. Even when no measurements with LDA are conducted, it is necessary to check the LDA optical arrangements and laser power every time. In many laboratories, experiments and measurements may not be conducted for 365 days, and thus some flumes may be under drying conditions. The running cost of experimental hydraulic facilities and instrumentation is probably much higher than numerical computers; the latter is often shared by many students and researchers. To overcome such investment difficulties in experiments, it may be necessary to use cooperatively hydraulic facilities and instrumentation in one key laboratory that is organized by government and universities. Unfortunately, Japan has not yet such a core and shared hydraulics laboratory although I understand there are some key shared laboratories in EU and other countries. If the IAHR community will foster common-used (shared) hydraulics laboratories, it may be very useful for students and young researchers in particular to study innovative and challenging research topics.

8

How important is collaboration between instrument developers/manufacturers and hydraulic researchers and/or practitioners? How can such collaboration best be realized?

It is a real problem, too. The instrument developers/manufactures are not volunteers, but businesses. I know a good example of such collaboration. When LDA was in its development age, say 1980's -1990's, some LDA manufacturers organized and sponsored international conferences as well as some training courses for invited researchers and users. However, at present, unfortunately, such conferences may not exist. Only some exhibitions of instruments are conducted in conferences and symposia. To realize such collaboration and communication with each other as a first step, I think it will be very useful to organize a session/forum of instrument developers/manufacturers and hydraulic researchers and/or practitioners in conferences. Developers/manufacturers may like to deliver oral presentations of their developed instruments and software even if these may not be suitable to be included in the Proceedings.

9

What advice would you give to a new PhD student, who is beginning his/her experimental research in hydraulics.

I hope very much that a new PhD student should be more ambitious to solve various academic and applied problems, in particular in hydraulic research. Although this may be limited to Japanese students, recently they seem reluctant to go abroad and to visit laboratories in other countries. I think that one of causes is due to the development of the present Internet; enormous information is easily available via the Internet without visiting the other laboratories. Except for the language handicap, such situations may be true in other countries. Instead, I would like to advise a new PhD student to go out of deskwork and exchange with the other laboratories even in his/her home country. Computers are ubiquitously used, but experiments are uniquely conducted. One "seeing" promotes research much more effectively than one hundred "hearings".

10

What do you propose the IAHR in general, and the EMI Committee in particular, should be doing for researchers and practitioners interested in experimental research in hydraulics?

I think that the IAHR is well organized in the international non-government style, and I would like very much to thank the Council members and Journal Editors, in particular the IAHR President, N. Tamai, who now contributes very much to renewal of the IAHR world. I would also expect that the EMI Committee will organize a relevant session of "fantastic World Cup of Measurements", like a soccer game, in some EMI Conferences. The concept is as follows. In advance, the EMI pre-announces the flow conditions of target research which should be measured and revealed, and then researchers/practitioners will try to measure such same flows in the world. As the results, the researchers will be able to present their measured data differently in the conference and compare/discuss with the other researchers; a kind of measurement competition, so called "World Cup". Our World Cup will stimulate students and young researchers/practitioners to challenge fantastic experimental Hydraulics, in which new breakthrough instruments and techniques/analyses are expected to appear in the Hydraulics community. Some examples of particularly challenging topics of flow conditions may be considered as follows: 1) compound channels, 2) vegetated flows, 3) flows over gravel/pebble beds (non-Nikuradse roughness), 4) backward step and dune-type flows, 5) wind-induced air/water interfacial layers and gas transfer, 6) particle-fluid interaction and sediment transport, and others. These topics should be first investigated experimentally rather than numerically, and researchers should reveal such flow structures and applications by using various velocity instruments (including new developed devices). The World Cup of Measurements would be a kind of "scientific amusement" in the same sense as sports, e.g., Olympic Games and World Cup.

3D Optical Diagnostics fro

Tomographic Particle Image Velocimetry was initially conceived to aid the visualization of complex three-dimensional (3D) flows around aircraft. More recently, the range of applications has broadened to include energy systems (wind turbines) and environmental studies. The capability to measure simultaneously the velocity and vorticity field in a three-dimensional domain makes the Tomo-PIV approach effective for the understanding of complex unsteady flows.

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Dr. Fulvio Scarano is full professor at Delft University of Technology, heading the Aerodynamics Section of the Aerospace Engineering Department. He is specialized in experimental aerodynamics with major contributions in Particle Image Velocimetry for turbulent compressible flows. In 2008 he received a European Research Council (ERC) grant for further developments of PIV into aeroacoustics. He now directs the AFDAR project (FP7) for advanced flow diagnostics applications to aeronautics, with European consortium including DLR, CNRS and VKI among other partners.

Flows in the environment have an intrinsic unsteady character and exhibit complex patterns developing in all three dimensions of space. For a long time, significant effort has been devoted to the modeling of the processes occurring in turbulent flows under specific boundary conditions and we are still nowadays far from being able to predict the flow behavior under general conditions. The task is not easier when tackled from experimental simulations. First, the proper simulation of environmental conditions is difficult to scale down to the laboratory. Second, measurement techniques often fail to provide at the same time quantitative as well as insightful information about the flow.

In this article a relatively recently established technique is presented, which allows nowadays to map the three-dimensional instantaneous velocity and vorticity field based on the concept of particle motion tomography. Researchers at the Aerospace Engineering Department of Delft University of Technology, in collaboration with the German company LaVision GmbH, embarked a three-year project for the development and verification of this new measurement technique, which combines the favorable characteristics of stereoscopic PIV and medical tomography.

Although the development was initially aimed at solving complex flow problems for the aeronautical research and development (vortices over delta wings, turbulent boundary layer separation, 3D wakes and jets, interactions of shock waves), its application at larger scale also for environmental flows (e.g. flows over rough surfaces and around obstacles) is envisaged due to the recent progress of laser technology and digital imaging systems.

An example is presented in this article that shows the current capabilities of Tomographic-PIV from a state-of-the-art application to bluff-bodies wake analysis. In the course of the past three years, however, many more applications

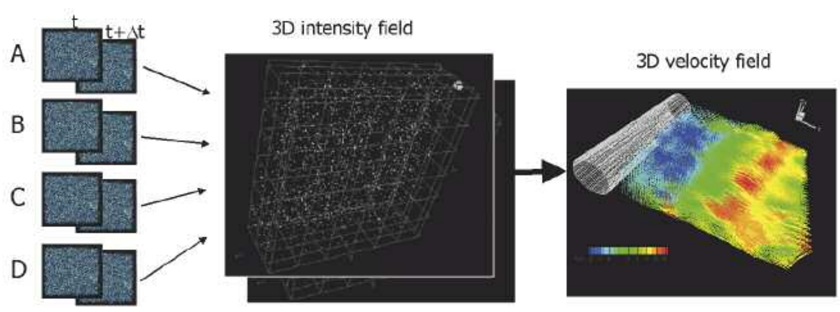


Figure 1: Several CCD cameras subtend a solid angle to record the light scattered by the particle tracers in the wake of a circular cylinder (left). Graphical representation of the data flow from the quadruplet of image pairs to the 3D velocity field (right).

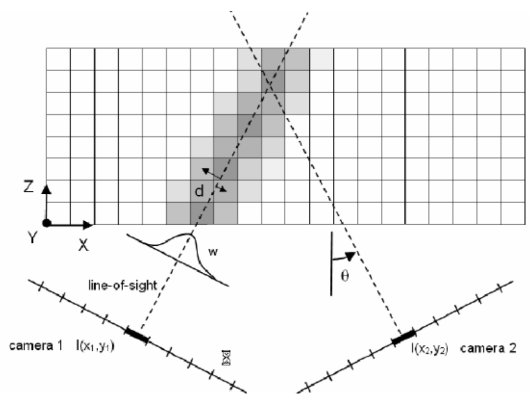


Figure 2: Working principle of tomographic reconstruction. Discretized measurement domain into voxels and respective projection onto the image domain (left, after Elsinga et al., 2006). Iterative reconstruction of a given set of particles (right) by the MART algorithm.

om Aerodynamics to Hydraulics

have appeared in the literature, available to the interested reader (see Elsinga et al. 2009).

Working principle of Tomographic-PIV

The purpose of Particle Image Velocimetry is to determine the velocity in a given flow through the measurement of the velocity of small tracer particles immersed into it. For further reading the reader may refer to Raffel et al. (2008). The particles are typically of micron size and follow the flow and the nuances of its fluctuations with high fidelity. The particles need to be illuminated twice and their image is recorded on digital cameras, either a CCD or a CMOS. A LASER system is used as light source, which delivers high energy within a short pulse. The traditional approach for PIV measurements is to form a thin sheet of light (planar PIV). The position of the particle within the plane is obtained from that recorded on the imager. In the direction normal to the plane, the position is known from the position of the illuminated plane in physical space. The velocity of the particle tracers is evaluated from a computerized analysis of the images with spatial cross-correlation. Because of its versatility, which combines planar field visualization and quantitative analysis (typical measurement accuracy is 98% with confidence level beyond 95%) PIV has become the most widespread tool for flow diagnostics in recent years. Nevertheless, the planar approach is not sufficient to describe the evolution of complex turbulent flows.

The tomographic PIV method is an extension of the planar approach. The flow tracers are illuminated over a domain with a finite volume, not a plane anymore, and the particle images are recorded from several independent directions. Figure 1 shows schematically the steps needed to obtain the 3D velocity field from a quadruplet (four-camera systems are today a standard in this field) of image pairs. The 3D distribution of light scattered by the particle tracers is reconstructed in the form of a discrete 3D array of voxels representing the light intensity in physical space also referred as the object, E(X,Y,Z) from its projections on the CCD arrays. This reconstruction is achieved by the so-called multiplicative algebraic reconstruction technique (MART, Hermann and Lent, 1976), which is implemented iteratively. The accuracy of the reconstruction process strongly depends upon several factors as discussed by Elsinga et al. (2006), the most important being the number of viewing cameras and the density of particle images onto the recordings. A four-camera system is able to deal with a particle image density up to 100,000 particles/Megapixel with a high reconstruction accuracy.

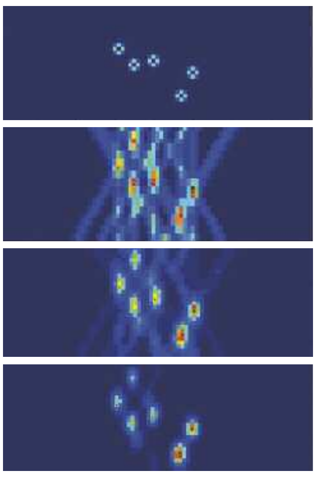
Because the particles belong to a 3D domain and are imaged on a 2D sensor their position along the depth cannot be determined by a single camera view and needs to be determined combining the information of the different cameras. The problem of reconstructing an object in N-dimensional space from its projections in N-1-dimensional images is the subject of tomography and is a well-developed field especially in medical diagnostics. The first publication in this field is that of Elsinga et al. (2006), where the MART algorithm earlier proposed by Hermann and Lent (1976) is applied to PIV images. A schematic with only two cameras is depicted below, showing how the physical domain is discretized into voxels of unknown intensity and known projections along the lines-of-sight. The voxels intensity is determined by means of an iterative procedure starting from an initially uniform and non-zero intensity field.

The vortex pattern behind a circular cylinder

Tomographic PIV is a useful tool to understand the organization and interaction of vortices and other complex features in turbulent flows. As an example, the vortex organization of the cylinder near wake is investigated by time-resolved tomographic Particle Image Velocimetry (TR-Tomo-PIV) and the effect of the Reynolds number is studied, in the range from 180 to 5540, with time resolution capabilities up to Re = 540.

Experimental apparatus and instrumentation

The experiments are performed in the water channel of the Laboratory for Aero &



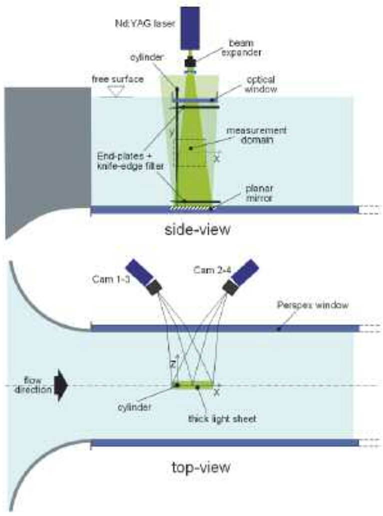


Figure 3: Schematic views of flow facility and PIV apparatus. Drawing not at scale for clarity.

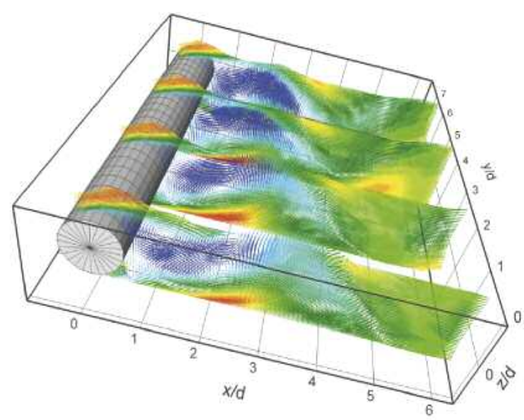


Figure 4: Instantaneous velocity field at Re = 180. Four selected planes along the cylinder span representing velocity vectors (color coding by x-component).

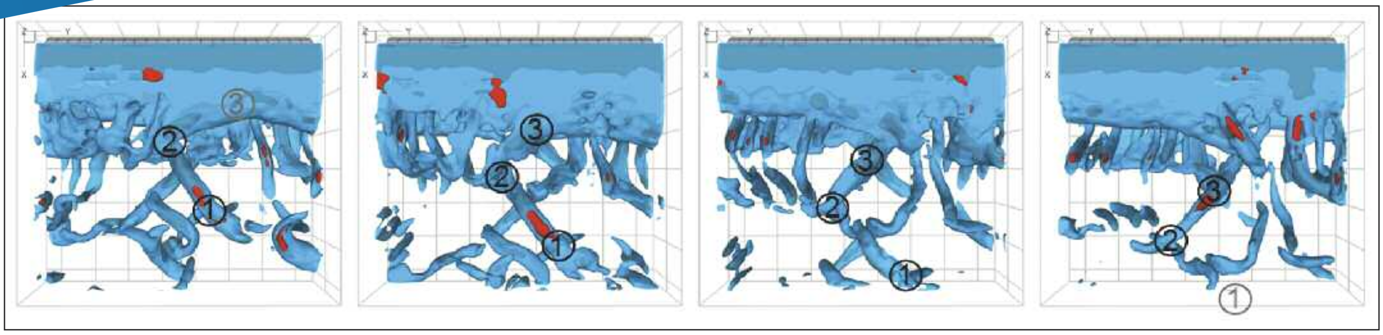


Figure 5: Instantaneous vorticity fields at Re = 360. From left to right: t/Tshed=0, 0.2, 0.4, 0.6. Vorticity magnitude iso-surfaces: | l/V/D=1.6 (external layer in semi-transparent light blue), | l/V/D =3.2 (core region in red); oblique flow features labelled by order of appearance

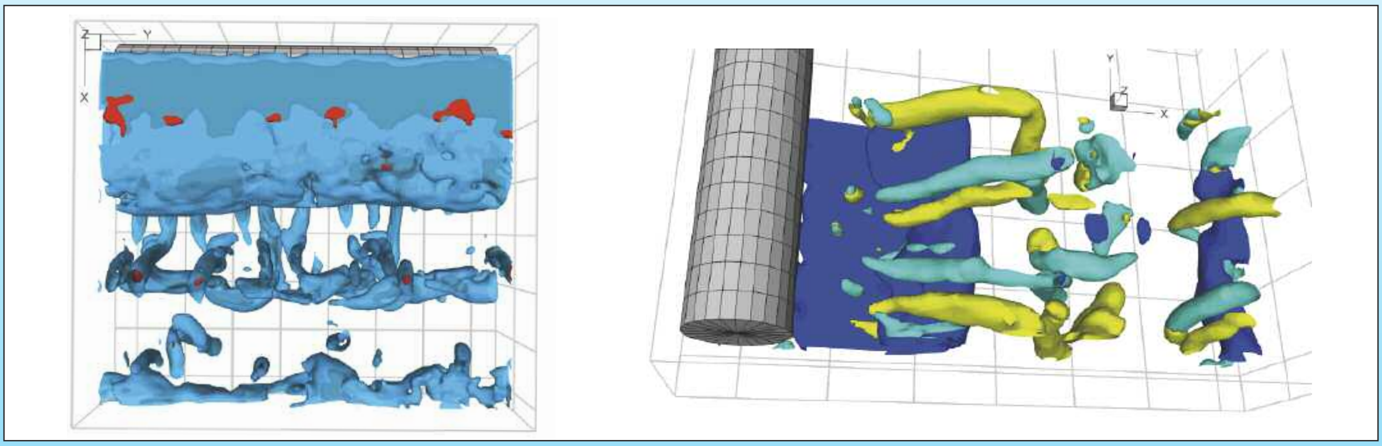
Hydrodynamics of Delft University of Technology. The facility features a 60×60 cm2 cross-section channel with a flow speed varying in the range between 2 cm/s and 1 m/s.

A cylinder with diameter d = 12 mm is installed vertically in the mid section of the channel (Figure 3). Measurements are performed around and in the near wake of the cylinder. The flow is seeded with Vestosynt particles of 56 μm diameter at a concentration of approximately 0.5 particles mm-3. The illumination over a volume of 100×100×20 mm3 is provided by a Quantel CFR 200 Nd:YAG laser with an output of 200 mJ/pulse and a repetition rate up to 7 Hz. The thick laser beam is obtained by a beam expander and by a cylindrical lens, returning an illuminated cross section of 24 mm width. Four LaVision Imager Pro X cameras (2048×2048 pixels, 14 bits) are placed subtending a solid angle of approximately 40×40 degrees2. The chosen magnification yields a typical digital resolution of 20 pixels/mm. The illumination and recording devices are synchronized and controlled by a LaVision programmable timing unit (PTU v9) controlled by DaVis 7.3 software. Each measurement consists of 75 quadruplets of image pairs at a recording frequency of 7 Hz, which is only sufficient to capture the temporal behaviour of the flow up to Re = 540 (approximately 10 samples per shedding cycle). The number of quadruplets is limited by the RAM memory available on the cameras.
Approximately 70,000 to 100,000 particle images are recorded within each frame, corresponding to a particle imaging density up to 0.025 particles per pixel (ppp). Further details of the experiments can be found in Scarano and Poelma (2009).

Laminar wake and 2D shedding regime
The vortex structure and its temporal evolution is easily visualized by the 3D velocity field, revealing a regular shedding (the Bénard-Kármán vortex street, Bénard 1908) at Re = 180, whereas at higher Reynolds (e.g. Re = 1080) the wake exhibits a strong 3D structure requiring the display of vorticity iso-surfaces to aid its interpretation. The 3D structure of the wake is dominated in the latter case by counter-rotating streamwise vortex pairs (characteristic of Mode B, Williamson, 1996).

Observation of Rhombus-vortex cells
The regime at Re = 360 produces a transitional pattern where the counter-rotating vortex pairs (Mode B), coexists with profoundly distorted shedding of oblique elements forming a chain of rhombus vortex cells.
The pattern is illustrated in Figure 5 by four subsequent snapshots separated by one-fifth of the shedding period. The vorticity magnitude iso-surface is used to show the topology of the vortex pattern. The flow structures of interest are labelled (1, 2 and 3 following their appearance in time) to facilitate the tracking of features. The near wake structure appears to exhibit counter-rotating vortex pairs along the left half of the measurement domain.
Approximately in the middle of the measurement domain, the scenario is significantly different from mode B because clear oblique structures are exhibited, which appear to organize along a thread-like sequence.
During this transient event vortices appear to form rhombus-like cells. The phenomenon is only apparently similar to what Williamson (1996) refers to as 3D wake distortion. The full 3D vorticity pattern allows understanding that such shedding mode is not directly comparable with those previously reported in literature (e.g. Cimbala, 1988). During this process the span-

Figure 6 - Instantaneous vorticity field at Re = 540. Vorticity magnitude iso-surfaces (left) and detail of finger-vortices highlighted by streamwise vorticity iso-surfaces (right)



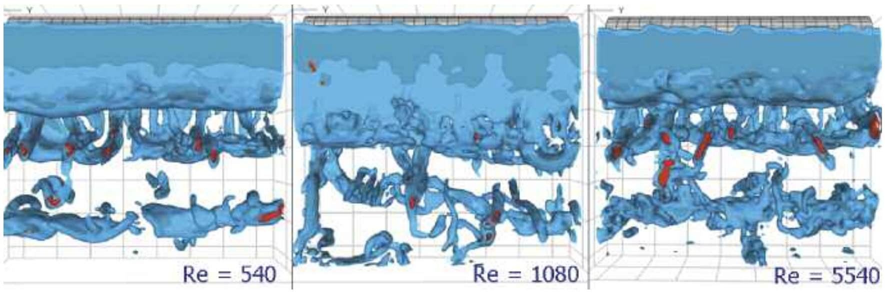


Figure 7 - Instantaneous vorticity fields with varying Reynolds number in the laminar, transitional and fully turbulent regimes.

wise coherence of the vortex formation from the separated shear layer and the shedding phenomenon are dramatically broken by vorticity filaments being torn apart of the vorticity sheet on the cylinder surface and shed obliquely during the roll-up process. Each vortex filament detaches from the deformed vorticity sheet and is stretched along its axis further increasing its core vorticity. The overall pattern may arise from the same dynamics as that of the “vortex dislocation” mechanism first investigated by Gaster (1969) for flows around cones and thoroughly investigated with numerical simulations conducted by Braza et al. (2001).

3D wake organization with Mode B

Increasing the Reynolds number from 540 to 5540 the 3D wake pattern becomes completely dominated by streamwise vortices (Mode B) in the near wake and no occurrence is observed of rhombus vortex cells. At Re = 540 significant span-wise variations of the vorticity in the shear layer prior to the shedding of the main roller are correlated with the location of stream-wise vortices forming on the main roller, where the iso-surface corresponding to the core of the shear layer (in red) has a span-wise quasi-periodicity (Figure 6-left), which degenerates further as the shedding process progresses. The effect of these secondary structures inter-connecting the Kármán rollers appears to stabilize the phase of the roll-up process, returning a more parallel shedding as compared to the lower Reynolds number case. The spanwise waviness of the Kármán rollers is visible at starting or ending locations of finger tip vortices, arranged as vortex pairs as shown in (Figure 6-right).

Reynolds number effects on the wake pattern

At Re = 1080 (Figure 7-centre) the separated shear layer further elongates, with the roll-up process shifted downstream, at approximately two diameters from the cylinder axis. Evolving from the laminar towards the turbulent regime the vorticity pattern reveals the formation of smaller flow scales of more isotropic character. Nevertheless, the counter-rotating vortex pairs clearly visible at Re = 540 are still present in the 3D wake organization even in the fully turbulent regime. However, the correlation between the inception point of such vortices and the core region of the separated shear layer is less clear than for the case at lower Reynolds and they exhibit a smaller cross section at Re = 1080, where they appear rather as thin filaments. The latter also seem to undergo mutual interaction. The precession of counter-rotating vortices or pairing of co-rotating vortices are occasionally observed. These interactions often lead to further three-dimensional distortion of the vortex pattern in the wake. Although the final outcome of this process becomes increasingly complex, the wake vortex system self organizes after the shedding with the Kármán roller embedded in a net of vortex filaments trapped and wrapped around the main structure. This yields a disordered patch of fluctuating vorticity yet far from the condition of isotropic turbulent fluctuations.

Even at Reynolds number above 5000 the most evident 3D coherent phenomenon in the wake is the presence of counter-rotating quasi-streamwise vortex pairs. However, these do not appear to survive the first shedding period due to the strong rate of stretching and the inherent three-dimensional structure of the flow. Remarkably, the global process of vortex formation and shedding recovers a more regular pattern in this regime. The counter-rotating vortices only appear in the roll-up phase and a rapid decay into rather iso0tropic turbulent structures is observed by vortex filaments trapped/wrapped around the Kármán rollers. This leads to a parallel street of vortices forming the wake. Each vortex core structure is formed by small-scale coherent vorticity fluctuations, which although disconnected from each other are not yet isotropic but rather azimuthally elongated. It is not surprising that such organized motion embedded in a turbulent chaotic environment has often been taken as an example for the debated definition of a coherent structure since the pioneering experiments reported by Roshko (1961).

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NEW RESPONSABILITIES FOR IAHR MADRID STAFF

The IAHR Madrid Staff have taken on new responsabilities following the new agreement IAHR-CEDEX and the outsourcing of the IAHR Journals to Taylor & Francis

Introducing Elsa Incio: Programme Officer for the new IAHR Hydraulics Division

Membership Secretary Ms Elsa Incio has been appointed to the additional role of Programme Officer for the new IAHR Hydraulics Division. She will support the Division Chair Prof. Joseph Lee and the Leadership Teams of the Technical Committees.

Elsa first studied for a degree in tourism because of her interest in travelling and languages. After graduating she lived in Dublin for one year in order to improve her English, and then started working for IAHR in WL Delft Hydraulics, assisting with the move to Madrid. She subsequently studied for a postgraduate degree in European Tourism Management (ETM) and lived in Sweden and France for one year before returning to University in Madrid to study a further degree in Humanities. Since graduating she has worked for IAHR again in Madrid responsible for memberships and subscriptions.

Introducing Carmen Sánchez: Programme Officer for Iberoamerica

Carmen Sánchez Medina is responsible for IAHR Accounts. She first trained in Business Administration and then graduated in Labour Relations.

She still feels a strong bond with her nice small hometown in the province of Córdoba in Spain. She has three lovely children. Prior to joining IAHR Carmen worked for twelve years for a consultancy company working as billing manager, looking after the collecting, the accounts and supplier administration. Besides, she cooperated with the Vocational Training Department organizing courses for their clients.

Carmen will dedicate more of her time to supporting IAHR Spanish-language activities in close collaboration with the LAD and the recently established IAHR Capítulo Español.

Introducing Estibaliz Serrano: Programme Officer for IAHR IPD (Innovation and Professional Development Division)

Estibaliz Serrano is a graduate in Journalism from the Complutense University in Madrid (home of the Secretariat) and she also holds a Masters degree in Business Communications. Estibaliz was born in Cadiz in Spain, and is married with three children. Before joining IAHR she worked for eight years in the communication and marketing departments of several companies and associations where she was responsible for external and internal communication activities (customer magazines, events, employee bulletins).

Since joining IAHR in 2004 she is Publications Manager responsible for all our publications and has been especially involved in improvements to Hydrolink, JHR and JRBM. She has also handled the publication of IAHR Monographs (Water Engineering in Ancient Civilizations, Flow and Sediment Transport in Compound Channels, Hydraulicians in Europe Vol. 2) and Proceedings (Coastlab 06, ISEH 04…). In 2010 we handed over the publishing of our two flagship Journals (JHR and JRBM) to Taylor and Francis and Estibaliz is now responsible for managing relations between IAHR and the publisher. In addition to continuing her other publishing responsibilities, Estibaliz has assumed the new task of Programme Officer for IAHR IPD in which role she will provide support to the Division through the Chair Prof. Jean Paul Chabard and Secretary Angelos Findikakis.

Introducing Beatriz Comesaña: Programme Officer, IAHR Hydro-Environment Division

In addition to continuing her other responsibilities, Bea has assumed the new task of Programme Officer for IAHR Hydro-Environment in which role she will provide support to the Division through the Chair Prof. Peter Goodwin and Secretary Prof. Massimo Greco.

Beatriz Comesaña holds a Diploma in Executive Bilingual Secretarial Studies, and Certificate in the Management of International Trade. She is currently finishing part-time studies in Social Anthropology. Bea was born in Vigo, a beautiful area in the Northwest of Spain.

Since joining IAHR part-time in 2007 she has worked as Office Manager responsible for the e-bulletins, conferences and events and marketing issues and Editorial Assistant giving support to Estibaliz Serrano in publications and taking care of JRBM. Before joining IAHR she worked for six years in a consultancy firm as Personal Assistant to the Director Partner in Vigo, and 5 years in a Granite Company in Galicia as Coordinator of the Commercial Department and International Logistics, becoming Regional Sales Manager and establishing business relations with United Kingdom, Ireland, Germany, France and Switzerland during the last two years.

Prof. Seizo Awazu, Nihon Universty, Japan (I-1648) has resigned his membership of IAHR.

New Institute Member

KLIFF – Kaiserslautern Institute for Flood Management and River Engineering

TU Kaiserslautern has recently joined IAHR. We welcome to:

Dr. Cassel-Gintz, Martin (Mr.) ***cassel@rhrk.uni-kl.de***

Dr. Frey, Wolfgang (Mr.) ***wfrey@rhrk.uni-kl.de***

Dr. Gintz, Dorothea (Mrs.) ***vietingh@rhrk.uni-kl.de***

Dr. Gretzschel, Manuela (Mrs.) ***gretzsch@rhrk.uni-kl.de***

Dr. Vietinghoff, Hartwig (Mr.) ***vietingh@rhrk.uni-kl.de***

Dr. Myers has retired from the University of Ulster and resigns from IAHR.

Prof. Phil Totterdell from the Charles Darwin University, Australia passed away in 2009

Dr. Gerard Pichel has been assigned to another DHV project in Saigon, Vietnam after his mission in Bangladesh. He can be currently contacted at ***gerardpjkt@hotmail.com***

Prof. Hung Tao Shen has been appointed Associate Dean of Research at Clarkson University, New York. He is former chair of the IAHR Ice Engineering Committee and current research interests include: River hydraulics; cold regions hydraulic engineering; sediment transport; hydrodynamics dispersion.

Prof. Pao-Shan Yu from the Department of Hydraulic and Ocean Engineering at National Cheng Kung University (NCKU), Tainan, Taiwan, experienced in the fields of hydrological analysis, water resources engineering, flood report and rainfall run-off models, is officially appointed as the new Dean of College of Engineering on August 1st, 2010.

The newly-appointed Prof. Pao-Shan Yu, born in 1954, received his bachelor degree of Hydraulic and Ocean Engineering at National Cheng Kung University, master degree of Civil Engineering at National Taiwan University, and doctoral degree at University of Birmingham, United Kingdom.

Prof. Ian Barr prize to Mara Tonelli

During the First IAHR-Europe Congress the Scottish Hydraulics Study Group has awarded the “Prof. Ian Barr prize for the best presentation by a young researcher” to Mara Tonelli. Mara is a Ph.D. student of the University of Udine – Italy. Mara presented some preliminary results of her thesis on numerical modelling of wave propagation in the nearshore area, with a particular concentration on the hydrodynamics of the surf zone.

The Prize has been awarded to Mara for to clarity of her presentation, the quality of the paper and the ability to answer questions from the audience.

Mara Tonelli receives “ Prof. Ian Barr prize” from Ronnie Falconer, President of the Scottish Hydraulics Study Group.