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THE GLOBAL PERSPECTIVE OF EXPERIMENTAL HYDRAULICS

EDITORIAL BY SIMONE VAN SCHIJNDEL AND MICHELE MOSSA

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It is well know that there are three ways to approach the solution of a problem in hydraulics and hydraulic engineering design, i.e. 1) theory and reasoning, 2) experience (for example derived from similar structures), and 3) investigating the problem and testing the design on a model. In any case, past experience may be inadequate due to the uniqueness of the design and circumstances. Furthermore, the complexity of many fluid flows and our still limited analytical abilities permit the strict application of theory and basic flow equations only in certain situations. Therefore, methods using models are needed to achieve a solution or to test the effect of simplifications. In any case, it must be emphasized that a purely experimental approach without any theoretical analysis could be a waste of effort. The term "model" is used in hydraulics to describe a physical or mathematical simulation of a prototype.
A hydraulic simulation may be direct by the use of physical models, semi-direct using analogues, or indirect by making use of theoretical and computer-based analysis. Generally, the basic distinction is between physical and mathematical models.
One of the first to use hydraulic models was Osborne Reynolds, who in 1885 designed and operated a tidal model of the Upper Mersey at Manchester University. In 1898, Hubert Engels established the first River Hydraulics Laboratory at Dresden. Then followed a gradual and, after 1920, an accelerating expansion of laboratories for the study of hydraulic engineering problems using scale models. The widespread use and role of hydraulic models may have changed somewhat in recent years, mainly due to advances in computational modelling, but they remain an important modelling tool, especially in the design of hydraulic structures, river and coastal engineering applications, environmental protection and in providing the physical input to mathematical modelling. An analogue model is a system reproducing a prototype situation in a physically different medium. This technique depends on the equations representing the prototype and model being mathematically identical. Thus, torsional vibrations of a bar may represent the water-level oscillations of a simple surge tank, and both can be simulated by the voltage changes in an electric circuit, i.e. by an electrical analogue. The electronic–hydraulic analogy is a widely used analogy for "electron fluid" in a metal conductor. In fact, electricity and heat were originally understood to be a kind of fluid, and the names of certain electric quantities, such as current, are derived from hydraulic equivalents. As with all analogies, it demands an intuitive and competent understanding of the baseline paradigms.
It is important to highlight that a physical model provides a continuous representation of the prototype but a computational model offers only a finite dimensional approximation; if a model does not reproduce observations accurately, it is necessary to assess the uncertainty in the results. Physical and computational modelling should not be viewed as conflicting methods of investigation. On the contrary, they have complementary strengths and weaknesses. Often a hydraulic engineering problem will require a combination of both methods. In this case, the method is known as hybrid modelling.

In this context in the last decades, many hydraulic large infrastructures have been developed, not always with an international coordination. Of course the lack of coordination causes many problems, since, for example, in the different countries, there are no funds available to support these infrastructures. In this context an important role in the hydraulic physical modelling and experimentation has been performed by HYDRALAB, which is a network of the major environmental hydraulic infrastructures in Europe and combines different disciplines within the EU experimental hydraulics community.

The co-ordinated and integrated approach of HYDRALAB aims at structuring access to unique and costly hydraulic and ice engineering research infrastructures in the European Research Area. The network of HYDRALAB is unique in the hydraulic research community and has large experience in co-operating since its start in 1997. It began by informing and co-ordinating the activities of the partners in HYDRALAB I and II, and via strong collaboration in HYDRALAB III the network now establishes further integration of the research services in Europe in HYDRALAB IV.

Reflecting international developments, progressively more research in experimental research infrastructures goes beyond just hydraulics and focuses on questions regarding the interaction of water with its environment, thus enlarging the complexity. By adopting the theme **More than water** HYDRALAB wants to emphasize the belief that especially for solving the many pressing environmental problems associated with the interaction of water (in ocean, coastal, estuarine, and river systems) with environmental elements, sediment structures and ice an integrated approach is required. Questions that society needs to answer deal with e.g. the development of adaptive strategies to climate change and sustainable measures against natural hazards, like floods.

A fully integrated and balanced ensemble of Networking Activities (5), Joint Research Activities (4) and Transnational Access Activities (10) enhances the operation of the infrastructures and their instrumentation facilities beyond the present state-of-the-art and identifies potential future developments. Further objectives of HYDRALAB are to improve access to experimental data, by providing researchers with a database on results of experiments, and bring young researchers and first time users from across Europe to the cutting edge of experimental research.

Future opportunities for HYDRALAB lie in preparing environmental hydraulic modelling for the upcoming challenges associated with adaptations for climate change and connecting research infrastructures globally. The consequences of climate change urge us to work on getting the infrastructures ready for modelling in interdisciplinary groups with key-members from the structural, morphodynamic, ice and ecohydraulic communities at the same table.

This special Hydrolink issue presents an introduction to HYDRALAB IV and gives an overview of the key projects that were carried out in the framework of HYDRALAB IV. The ensemble of the Joint Research Activities PISCES (**P**rotocols and **I**n**S**trumentation for **C**ombined hydraulic and **E**cological model**S**), WISE (**W**ater-**I**nterface-**S**ediment **E**xperiments) and HyReS (**H**ydraulic **Re**sponse of **S**tructures) is presented in separate articles. The special issue is completed with three examples of Transnational Access projects that were carried out in our research infrastructures.
We hope you enjoy this special issue and that it encourages hydraulic researchers across the globe to work together and share their experiences.

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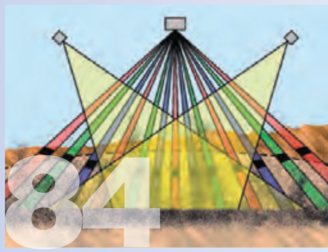
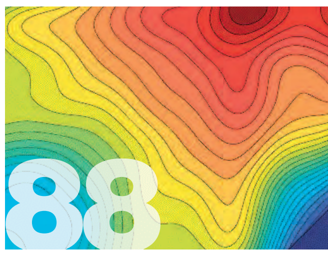




HYDRALAB - A SUCCESSFUL COLLABORATION OF EXPERIMENTAL HYDRAULIC RESEARCHERS

BY SIMONE VAN SCHIJNDEL

The co-ordinated and integrated approach of HYDRALAB aims at structuring the access to unique and costly hydraulic and ice engineering research infrastructures in the European Research Area. Research in our infrastructures deals with complex questions regarding the interaction of water with environmental elements, sediment, structures and ice and goes beyond just hydraulic research: hence we have adopted the theme More than water. Questions that we need to answer deal with e.g. the development of adaptive strategies to climate change and sustainable measures against natural hazards, like floods.


Coastal damage during a flood, courtesy Angela Scott, Environment Agency

Simone van Schijndel **started working at Delft Hydraulics/Deltares in 1997 after finishing her masters in fluid mechanics at the Delft University of Technology. In the first ten years of her career she was closely involved in experimental research for river engineering solutions and did a lot of numerical modelling work related to the 'Room for the River' project. She became involved in HYDRALAB in 2005. Since 2008 she is the coordinator of the network and responsible for the delivery of the projects HYDRALAB III and HYDRALAB IV.**

Adapting to a changing climate

Sea level rise and increasing storminess will likely result in the intensification of coastal zone erosion, which will, in turn, affect the safety against floods and produce changes in coastal ecology. Furthermore, increases in summer rainfall intensities over northern Europe will also increase the likelihood of pluvial flooding and result in changes to river and estuarine ecology, influencing food security and sustainable agriculture. The observed changes in sea ice on the Arctic Ocean and in the mass of the Greenland Ice Sheet, Arctic ice caps and glaciers over the past ten years are dramatic. The impact of renewable energy devices on our environment can also not be ignored and needs investigation, since society needs these innovative devices for clean and effective energy when adapting to climate change.

It is evident that an informed management and use of our water resources and environment is essential to human well-being, and a prerequisite to the development of advanced innovative technologies. To find solutions for these problems research in our hydraulic research infrastructures needs to go beyond just hydraulics and needs to focus more and more on complex questions regarding the interaction of water with other elements. These topics require more than just numerical modelling and really need research in special purpose, and therefore, often unique and costly research infrastructures. The coordinated use of research infrastructures and the development of instrumentation and tools within the field of environmental hydraulics are an essential part of the tools available to study these issues. This is where HYDRALAB plays a vital role in the European research community for experimental hydraulics.

HYDRALAB, structuring the European hydraulic research community

HYDRALAB has been advancing the integration of infrastructure-related services for the European hydraulic research community since 1997. From an initial endeavour launched by 8 organisations, we quickly grew into a large-scale network spanning 15 countries and involving 22 full participants and 8 associated members. In the figure below our partners are presented.

Our activities are carried out in the framework of the Integrating Activities funding scheme of the European Commission. The current project, HYDRALAB IV, runs from 2010 until 2014 and integrates a balanced ensemble of Networking Activities (NA), Joint Research Activities (JRA) and Transnational Access Activities (TA) to enhance the operation of our infrastructures and their instrumentation facilities beyond the present state-of-the-art and identifies potential future developments. Our project focuses on:

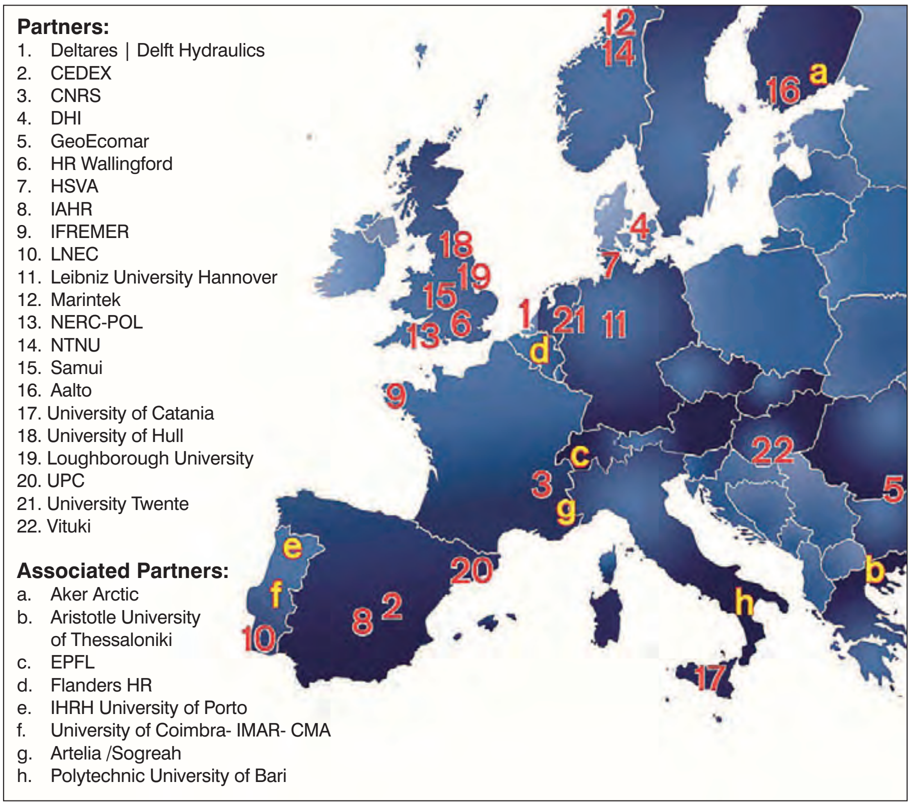
- streamlining the access to key experimental facilities and giving first time users the opportunity to conduct excellent research in major and unique research facilities (TA)
- optimising and upgrading the operation of these installations (JRA)
- bringing well-educated and skilled young researchers from across Europe to the top level of research found at our participants by sharing years of hydraulic experimental experience with the next generation of researchers (NA)
- simplifying access to our unique research infrastructures by developing tools for dissemination of important background information on both infrastructures and instruments and results of experiments (NA and JRA)

This ensures that Europe keeps its position at the forefront of experimental hydraulic research and has a strong focus on combining the knowledge of experienced researchers with new ideas from the next generation of researchers and innovative market players all around the world.

Advancing experimental hydraulic research

In HYDRALAB we conduct a broad range of networking activities comprising events, training of next generation researchers, development of guidelines for experimental research and foresight studies. All networking activities are specifically aimed at enhancing the services provided by the research infrastructures and at disseminating the results to the European user community and beyond. Good examples are the two Design Manuals that are available through IAHR; a Users Guide to Ecohydraulic Modelling and Experimentation (2014) and a Users Guide to Physical Modelling and Experimentation (2011). Additionally, we published three Foresight Papers that identify the gaps and challenges in instrumentation facilities, methods, concepts and technologies beyond HYDRALAB IV in the fields of morphodynamics, ecohydraulics and hydraulic responses to structures and ice.

The research facilities available through HYDRALAB include flumes and basins, large-wave channels, environment hydraulic facilities, a Coriolis platform and sites specifically dedicated to ice and Arctic environments. Applications are channelled through a centralised User Selection Procedure and evaluated by an independent panel of experts. In HYDRALAB IV we have selected more than 30 excellent proposals to conduct research in our facilities. The results of these projects were recently presented during the HYDRALAB Closing Event in July 2014 and collected in the proceedings of this event that are accessible through www.hydralab.eu/flashdrive. In this special issue we will present the results of three of these Transnational Access projects.
The ensemble of the Joint Research Activities PISCES, WISE and HyReS focuses on the development of instrumentation facilities beyond the present state-of-the-art for areas where the interaction of water with environmental elements,



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sediment, structures and ice leads to a complex research problem. In this special issue we present the outcomes of the respective JRA's in more detail.

The aim of PISCES (Protocols and InStrumentation for Combined hydraulic and Ecological modelS) is to develop innovative new technologies, experimental protocols and improved methodologies for incorporating organisms, both plants and animals, into physical hydraulic models. This will enable hydraulic research infrastructures to be used to predict the response of benthic aquatic and marine organisms to changing flows and the influence of organisms on flow and sediment erosion, both of which are poorly understood. PISCES brings together an interdisciplinary team of ecologists, sedimentologists and engineers to bridge the gap between field observations and physical models of plants and animals. Ecohydraulics experts are drawn from the large laboratories offering access in this integrated infrastructure project and other partners with important ecological experience.

The aim of WISE (Water-Interface-Sediment Experiments) is to observe with unprecedented accuracy the simultaneous and collocated profiles, of water and sediment flow and the associated bed-dynamics and particle features. The possibility to have a detailed picture of the flow field both in the horizontal and in the vertical direction is crucial for the correct understanding / quantification of fluid-sediment interactions, (e.g. generation and shedding of vortices). This JRA will, thus, take to a new level the capabilities of sedimentary bed hydraulic facilities by bringing the measurements of water velocity, sediment velocity and concentration, shear stresses (at the boundary), bed-forms and erosion/accretion rates to a new quantitative level. The aim, based on the advances achieved under HYDRALAB III will be to (i); take the significant step of moving from classical one-dimensional vertical profiles, 1DV, to quasi-3D resolution, (ii) extend opto-acoustic measurement capabilities currently limited to suspended sediments (developed under HYDRALAB III), to the highly concentrated nearbed layer usually identified as the bedload or sheet flow layer of primary importance for morphodynamics.

HyReS (**Hy**draulic **Re**sponse of **S**tructures) addresses both structures and ice. The response of coastal and offshore structures to wave loading is a significant issue in their design. At high latitudes, dynamic ice-structure interaction also causes high loads to act on fixed or floating moored offshore structures and harbour facilities. This JRA brings together leading experts in Europe to improve the quality of the service provided by hydraulic infrastructures for the testing of structures by improving techniques on wave generation and measurements on the interaction of water and structures or floating ice.

> **"Our motto for the future will be: adapting to a changing climate"**

Simplifying access to research results

In RADE (**R**emote **A**ccess to **D**ata and **E**xperiments) we have developed a robust set of information systems to improve access to our experiments and data through the innovative use of modern data management, curation and communication technologies. Traditionally, the hydraulic research community is accustomed to exchange the results of their experiments through papers and conferences. The direct exchange of data is limited to the authors and only after the experiment has finished. The objectives of RADE are to allow much larger groups of researchers' access and input to laboratory experiments remotely, thereby saving on costs and the environmental impacts of long distance travel, and to make the results of our experiments more easily accessible for researchers beyond the HYDRALAB community within a shorter time. This further improves the synergy between different partners in Europe and worldwide and the impact of an experiment, thus creating a climate for further innovations.

The systems show data on the screen at your remote desk and give a visual impression of a detail in the experiment that is conducted in the laboratory. The most elaborate information system we have developed also distributes the data in real-time to all that have been invited to witness the experiment remotely.

As part of RADE we also developed the basic data structure and procedures for sharing of information between research installations and research groups through a database of experiments. This has led to the development of a web interface and search engine to explore meta-data obtained from experiments at hydraulic infrastructures. This was a large step forward to facilitate scientific interchange between European researchers and it is a pre-requisite for subsequent access to remote experiments at the installations of research partners. More details on RADE can be found in the previous issue of Hydrolink.

Towards the future

Considering the future is an on-going concern for the HYDRALAB network. Within HYDRALAB IV we have made an inventory of funding possibilities to establish sustainable funding structures to guarantee the continuation of our activities. We believe that the long and intense collaboration within our network provides a strong base for future activities, but advancing experimental hydraulic research in a coordinated way requires considerable resources. We are, therefore, continuously exploring existing and future funding possibilities in Europe and at national levels in our participating countries. Most recently we have submitted a proposal for the European Integrating Activities funding scheme to support the core of our future activities under the name of HYDRALAB+.

The complex and cross-boundary European water-related issues, that will only become more acute with the on-going developments as a result of climate change, have not been solved at present. To address these matters in a sustainable and integrated way requires the influx of new, creative ideas. The HYDRALAB+ project offers an unprecedented combination of environmental hydraulic facilities (among the best in the European Union), observational equipment (novel opto-acoustic techniques never applied before in this field) and the required human skills-base to interpret the results. The outputs from HYDRALAB will benefit and impact upon both direct users (public sector and private companies) and the many agencies responsible for delivering climate change adaptation.

With this in mind, we believe we have a relevant case to continue our network in the field of the large hydraulic experimental research facilities in Europe to deal with the availability of water, safety against flooding and access to new sources of energy and food in a sustainable way at the onset of the consequences of climate change. Our motto for the future will be: adapting to a changing climate.

All the work described in this special issue of Hydrolink is supported by the European Community's 7th Framework Programme through a grant to the budget of the Integrated Infrastructure Initiative HYDRALAB IV, Contract no. 261520.

A CONVERSATION WITH **AD VAN OS** AND **PETER DAVIES**

BY SIMONE VAN SCHIJNDEL

Ad van Os (AvO) is the founding father of Hydralab. In his working life he has served Delft Hydraulics, now Deltares, in various research and management capacities for over 40 years, lastly as coordinator and coach of the EU sponsored research projects of Deltares. He is now retired, but is still involved in Hydralab as advisor to the coordinator.

Peter Davies (PAD) is Professor of Fluid Dynamics in the Department of Civil Engineering at the University of Dundee (UK) where his primary research interests are in waves and mixing in stratified fluids, turbulent buoyancy-driven flows and rotating flows, particularly where such flows are of relevance to geophysical and environmental processes. He has served IAHR in various capacities; Chair, IAHR Fluid Mechanics Committee (2001-2005); Member, IAHR Council Nomination Committee (2010-11); Member: IAHR Prize Nomination Committee, (2009)) and he is currently the Editor of the IAHR Monograph Series. His involvement with Hydralab has arisen through his role as Chair of its International Advisory Board and several of its User Selection Panels.

1. How important is a European coordination of experimental hydraulics from a global perspective?

Ad: There are a lot of Hydraulics laboratories in the world, but apart from the biannual IAHR and Coastal Engineering conferences where the "hydraulics" world meets, there is not very much cooperation and coordination across country borders but for the coordination provided by HYDRALAB in the framework of the EU Research Programmes.
The Infrastructure network HYDRALAB offers the opportunity to effectively coordinate the major experimental hydraulics facilities

- in performing cooperative research aimed at improvement of facilities and measuring methods and equipment,
- by providing access to these facilities to many more researchers than otherwise would be possible and
- by being a platform for exchange of all interested experimental hydraulics infrastructures within Europe and beyond.

In my opinion this is highly important to improve the contribution from the hydraulics community to the adaptation to climate change which is a truly global challenge.

Peter: From the wider perspective, the HYDRALAB programmes have demonstrated, through their open approach to collaboration, that data from the HYDRALAB projects can be disseminated effectively outside Europe via, for example, IAHR initiatives and the involvement of non-European experts in the assessment of projects. The IAHR Congresses in Vancouver (2009) and Chengdu (2013) provided platforms for this global dissemination activity, with notable success being achieved through the HYDRALAB-badged special sessions devoted

(i) to exploring the global perspective of hydraulics infrastructure networks and
(ii) to promoting research collaborations with non-European partners.

2. How state of the art and/or unique is HYDRALAB in that respect?

Ad: I think HYDRALAB is unique in two ways:

1. it coordinates the major environmental hydraulic infrastructures in Europe
2. it combines different disciplines within the EU experimental hydraulics community, such as sediment hydraulics, ice engineering, bio-environmental hydraulics, etc.

Within the last couple of years HYDRALAB produced two IAHR Design Manuals on Physical Modelling and Experimentation and Ecohydraulic Modelling and Experimentation. This proves that HYDRALAB, as far as experimental environmental hydraulics is concerned, certainly is state of the art.

This opinion is seconded by non-EU members of the HYDRALAB International Advisory Board with members from the USA, the Russian Federation and Japan.

Peter: The work being conducted within HYDRALAB is at the forefront of research progress in many aspects of environmental hydraulics and coastal and fluvial engineering. This has been made possible in no small way through investment by the HYDRALAB community in state of the art instrumentation, the successful development, on a collaborative basis, of new experimental techniques and the support and backing by HYDRALAB for promising and novel research directions (for example, in targeted areas of ecohydraulics) particularly suited to hydraulic facilities within Europe. In its trans-national access programmes, HYDRALAB has positively promoted multi-disciplinary team approaches to a wide range of environmentally-important hydraulics problems and has purposely engineered participation by first time users in order to exploit the full talents of the HYDRALAB community. Both of these aspects are certainly unique.

3. What will happen if the European coordination stops?

Ad: The European coordination as sponsored by the EU specifically enhances the possibilities for researchers to do research with facilities to which they have normally no access. This cannot be continued without further EU support since, in the different countries, there are no funds available to support such cross-border research at the levels achieved within HYDRALAB.

Also the cooperative research of the combined facility providers to improve the infrastructures and measuring equipment will be severely hampered.

Peter: A further aspect here is the damage that will be done to the internationally-leading research networks that have been established and nourished through HYDRALAB. Without the support provided by European coordination, the intellectual capital and the technical expertise "memory" within these networks will be dissipated and lost. Furthermore, the enhanced research training provided by HYDRALAB to multi-national cohorts of PhD students, with wide technical and social benefits, will no longer be possible.

4. What does the future of environmental hydraulic infrastructures look like?

Peter: Recent technical advances that have resulted in

(i) the availability of a new generation of new sophisticated instrumentation and

(ii) the development of new techniques for the rapid acquisition and analysis of high quality experimental data mean that it is particularly timely now to utilize fully the advanced hydraulics infrastructures that are available within HYDRALAB and elsewhere. In some cases such utilization will enable measurement of properties of, say,

(i) turbulent flow structures,

(ii) suspended and bed sediments,

(iii) vegetation/ flow interactions at levels of accuracy that permit direct comparison with computational models.

In other cases many environmentally-important problems that have to be addressed urgently are so complex that no numerical or analytical model descriptions are available to describe them adequately; in these cases, the understanding required to provide engineering solutions will only be provided by high quality laboratory experiments conducted at large scale and deploying the new generation of measurement devices.

Ad: Laboratory experiments more and more focus on research of the interactive processes between structures, ice, sediments, ecological elements and turbulent water flows. This is so complicated and needs such specialized skills, that real progress only can be achieved if genuine cooperation and coordination is continued.

If the cooperating institutes in the EU succeed in such a continuation and, at the same time, try to extend the cooperation to countries outside Europe, I am confident that the future of environmental hydraulic infrastructures is bright. Which, by the way, is desperately needed since research in such infrastructures really is of the utmost importance to help solve the adaptation problems to climate change mankind is faced with the coming decades.

ICE LOAD MEASUREMENT BY TACTILE SENSOR IN MODEL SCALE TEST IN RELATION TO RUBBLE ICE TRANSPORT ON ARCTIC OFFSHORE STRUCTURES (RITAS)

BY KARL-ULRICH EVERS & WENJUN LU

Ice is a rather brittle material, strong in compression but weak in tension. The magnitude of ice load largely depends on the corresponding ice feature's dominant failure modes and failure processes. Studying ice-structure interactions or icebreaking processes of icebreaking vessels require a good understanding on ice mechanics and ice failure processes.

Studying ice-structure interactions or icebreaking processes of icebreaking vessels require a good understanding on ice mechanics and ice failure processes.

Physical experiments and numerical simulations are executed in ice tanks with focus on the spatial distribution of ice loads acting on offshore structures located in arctic or sub arctic regions. When designing arctic offshore structures or icebreaking vessels not only the global ice load acting on the structure is of relevance but also the spatial distribution of ice load (local ice pressure) is of interest for a safe and economic design.

When ice encounters sloping sided offshore structures it fails sequentially from breaking, rotating to submerging. Current offshore structure design practice does not differentiate such failure process in a procedural manner. Instead, all the ice load contributions from these failure processes are conservatively added up together to yield the final design load (*API_RP2, 1995; ISO/FDIS/19906, 2010*).

In the framework of the I3 Hydralab-IV contract a transnational access project "Rubble Ice Transport on Arctic Structures (RITAS) was executed in the Large Ice Tank at the Hamburg

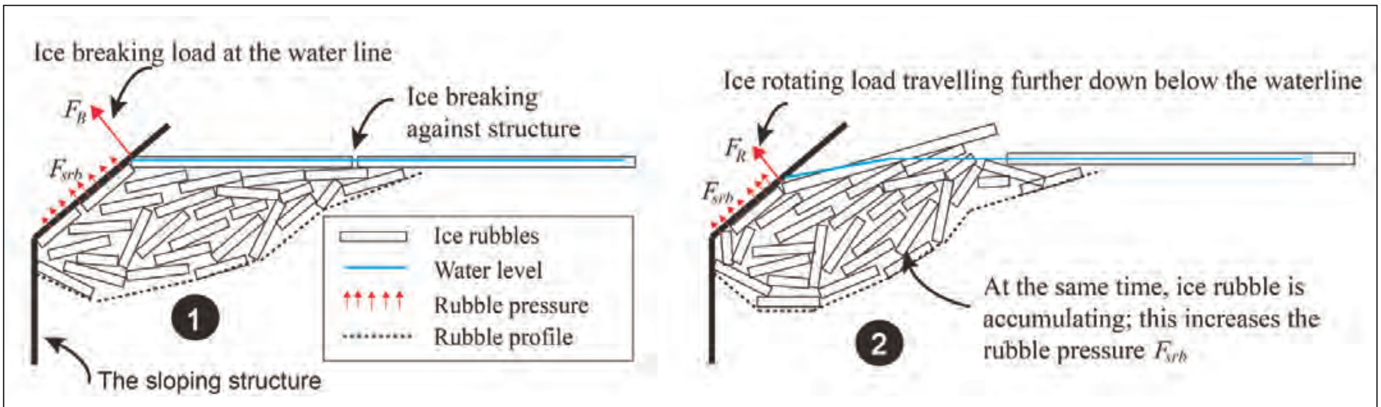


Figure 1 - Schematic diagram of interaction mechanisms between level ice and a wide sloping structure

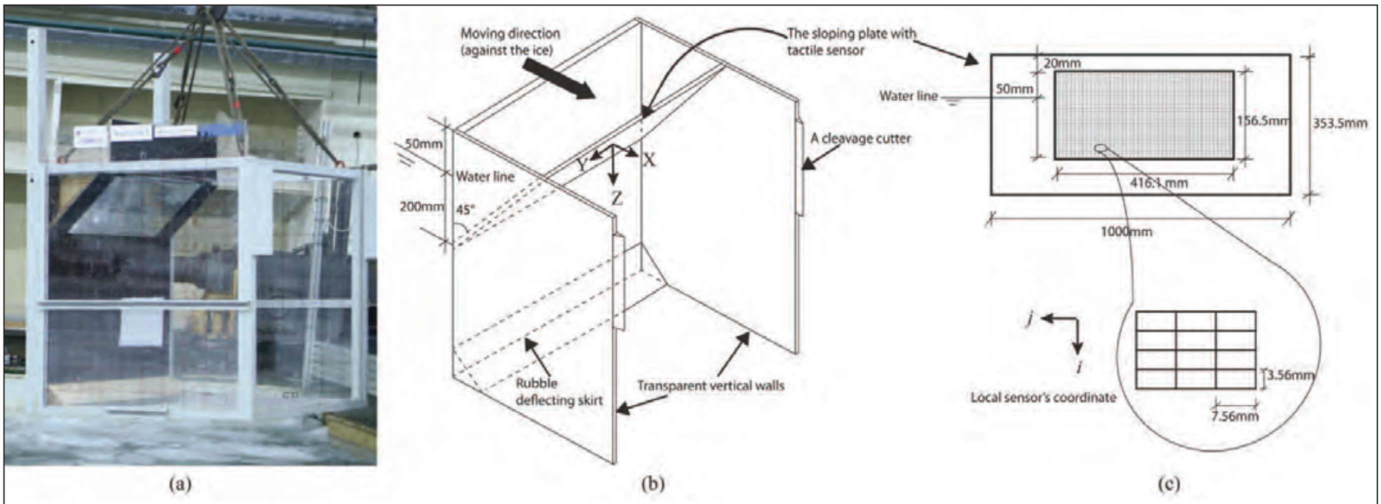
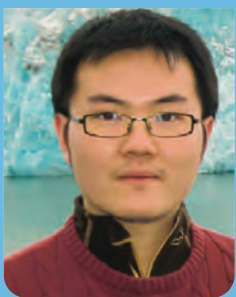


Figure 2 - Buoyancy box (a), schematic diagram of test set-up (b), tactile sensor mat (c)

Karl-Ulrich Evers **is a civil hydraulics engineer graduated at the Leibniz University of Hannover (LUH), Germany. After his studies he joined the Hamburg Ship Model Basin (HSVA) in Hamburg where he works as senior project manager in the Artic Technology department. His main focus is on ice mechanics, ice model testing of arctic offshore structures and consulting in ice engineering. During his professional career he participated actively on 7 Arctic Expeditions and field campaigns. From 2004 to 2008 he was chair of the IAHR International Ice Committee where he is still a co-opted committee member. Since 2011 he represents Germany in the POAC International Committee.**



Wenjun Lu **is currently a PhD candidate of the research centre 'Sustainable Arctic Marine and Coastal Technology (SAMCoT)' of NTNU, Trondheim, Norway. Having a joint MSc degree in Coastal and Marine Engineering (CoMEM) from TU-Delft, University of Southampton, and NTNU, his current research interests involve ice load calculation/measurements, rubbling process and fracturing of ice floes. In addition, he is also a two-term recipient of Best Student Paper Awards from conferences of 'IAHR: Symposium on ice, 2012, Dalian, China' & 'Port and Ocean Engineering Under Arctic Conditions (POAC), 2013, Espoo, Finland'.**

Ship Model Basin (HSVA) in Hamburg, Germany.
The objective of the study was to investigate the temporal and spatial distribution of ice loads on a wide inclined structure with the presence of ice rubble accumulation by application of tactile sensors.

Interaction mechanisms

Wide sloping structures have many applications in ice covered waters. Due to the relatively limited ice clearing capability of a wide sloping structure, the presence of ice rubble greatly influences the whole interaction mechanism *(Serré et al., 2013)*. The interaction mechanism between level ice and wide sloping structure could be categorised into three different stages *(Lu et al., 2014)*. A brief interaction mechanism is shown in *Figure 1*.
The first stage is the ice breaking stage (*Figure 1* ❶). In this stage, the incoming ice fails against the structure and a large ice breaking load is expected to be detected at the waterline.
The second stage is the ice rotating stage see (*Figure 1* ❷). As the broken ice fragment is travelling downwards, the corresponding ice rotating load is supposed to be measured below the waterline. The third stage is the rubble accumulation stage which occurs simultaneously with the previous two stages and is shown in both *Figure 1* ❶ and ❷.
The questions for the current problem are:
(1) Where exactly are these loads spatially located?
(2) What are the comparative values of these loads?
(3) How would these loads evolve with time?

A tactile sensor mat (sensor type #5513) produced by *I-Scan™ Tekscan Inc*. was installed on a sloping surface of a structure confined by two transparent Lexan™ plates. The geometry of the test set-up and the location where the tactile sensor mat is mounted are shown in *Figure 2*.

The operating temperature ranges from -9°C to 60°C; the pressure measuring range is within 0 to 175 MPa. This specific sensor has a rather long tail that ensures that the handle which connects the tail to the computer can be positioned far away from the water.
This sloping structure has been tested in different ice conditions with different ice thickness and different interaction speeds. The application of tactile sensor in all these tests follows generally three important steps which are described below:

Installation of tactile sensor (step 1)

During the installation, great attention has been paid to make sure that the tactile sensor is waterproof and protected against ice abrasion. To achieve this, the sensor was first put in between two plastic films adhered by silicone gel so as to make it waterproof. Afterwards, a metallic adhesive layer was applied above the sensor serving as the abrasion protection. This step is finished in the very beginning of the tests and no further repetition was made as long as the tactile sensor worked properly.

Calibration of tactile sensor (step 2)

Due to the complexity of ice-structure interactions, the ice pressure covers a very wide range of possible values. In the current tests, based on the chosen sensitivity and saturation pressure, tactile sensor tends to capture the ice pressure that repeats most often, saying the pressure that would be around the mean ice pressure. However, for extreme values, the sensor is prone to underestimate the extreme values. Even though, the merits of using tactile sensor in the current test should not be degraded. Tactile sensor will anyhow produce the contact area (i.e. the load's spatial variation) and comparative pressure irrespective of possible errors within its measured maximum values. The pertinent choice on tactile sensor's sensitivity and saturation pressure are made in the literature *(Lu et al., 2013b)*.

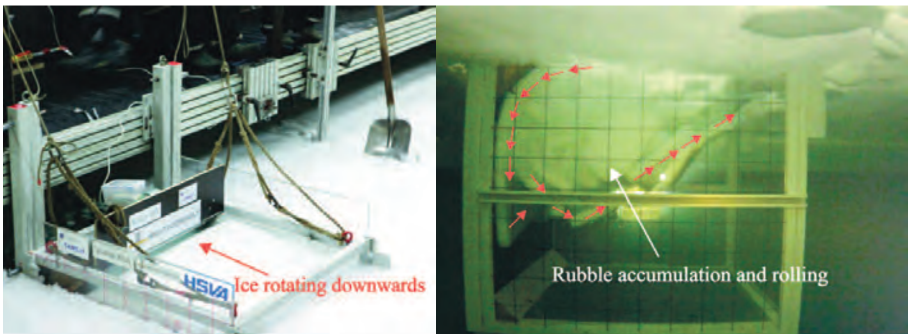


Figure 3 - Sloping structure pushed through level ice (a), the ice failed into fragments along the inclined plate and rotated downwards (left)

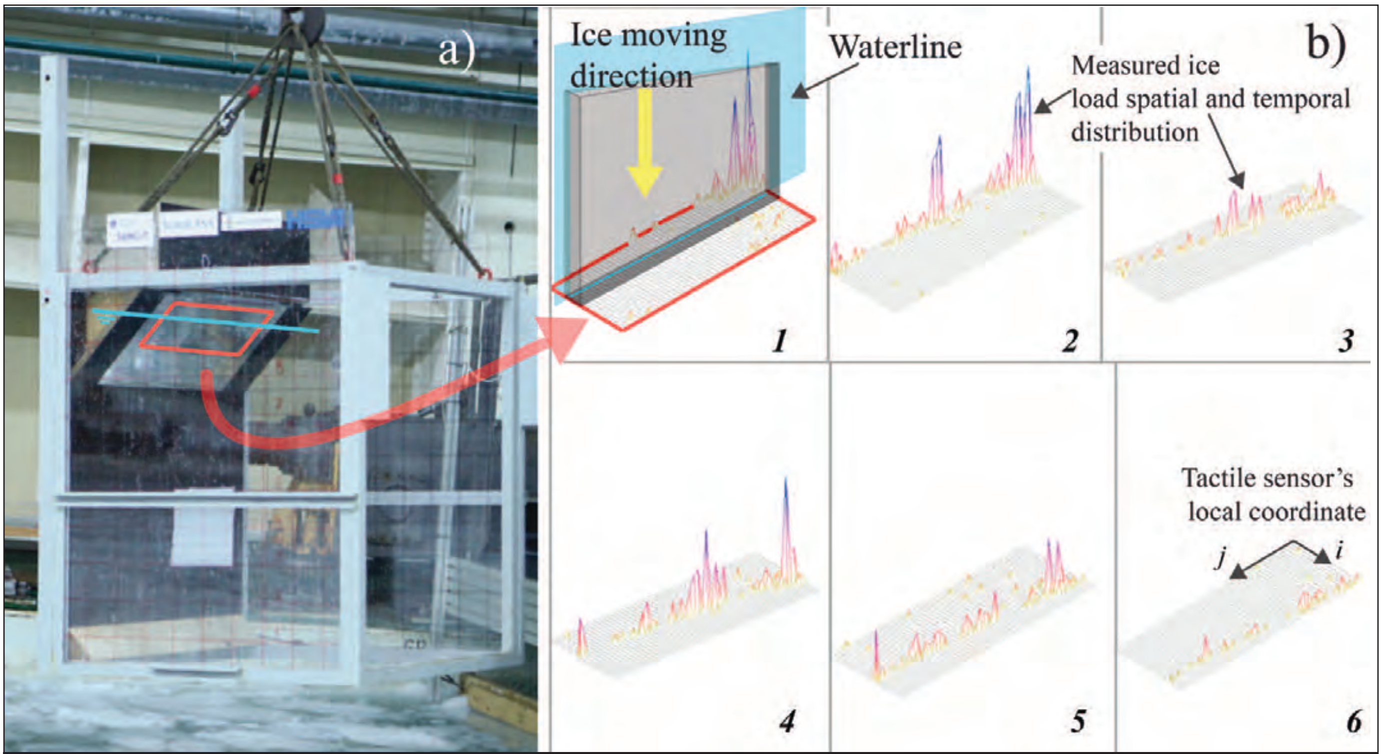


Figure 4 - Plot of ice load development along the sloping surface

Validation of tactile sensor in each test (step 3)
Before each test, the tactile sensor is again validated against several known weights so as to confirm its functionality (calibration check). In all the validations, errors between the measured results and the known weights were all within 15%. With all these three steps implemented, tactile sensor was successfully utilised in measuring the ice load (at least its spatial distribution).

Measurement visualisation

During different tests, the sloping structure in Figure 3 was pushed through level ice sheets in the ice tank. The ice failed into fragments along the inclined plate and rotated downwards *(Figure 3 b)*.
The spatial and temporal variation of the ice load is recorded by the installed tactile sensor. A real time ice load evolution can be exemplified as in *Figure 4* (different colours represent different pressure magnitude). This measurement illustrates one circle of the ice load development, i.e. the ice breaks at the waterline and rotates downwards. It takes approximately 3 seconds for such cycle to develop in *Test 1210*. It can be seen that, after the initial breaking of the incoming ice, the local pressure did not diminish instantly. Instead, the pressure keeps travelling down at a relatively smaller yet comparable magnitude.

Ice load's spatial variation

With the measured data as presented in Figure 5, it is possible to study how the ice load is distributed in the vertical direction (i.e., Z-direction or the short edge's direction of the panel in *Figure 4*).
Summing all the load recordings along the long edge's direction in *Figure 4*, we are able to present the time averaged ice load's spatial distribution as in *Figure 5(a)* and the maximum ice load's spatial distribution as in *Figure 5(b)*.

Since both the elastic foundation beam and plate theory suggest that the tip deflection at flexural failure is minimal comparing to the thickness of the ice, it would be reasonable to assume the ice breaking load (i.e. the load required to bend the incoming intact ice) is within the un-deformed level ice's thickness region (i.e. the shaded area in Figure 5). Note that inside this region, other interaction mechanisms such as the initial ice rotating and rubble effect also exist (Lu et al., 2014). As shown in Figure 5 (b) the maximum loads are mainly found within such shaded area. This agrees with our common sense and previous research assumptions that the ice breaking load is one of the decisive components of the ice load. However, as it is shown in the theoretical model (Lu et al., 2014; Lu et al., 2013a), the ice rotating load would also become decisive when there is sufficient rubble accumulated in front of the structure. For the time being, it can be simply concluded that based on tactile sensor's measurement, the maximum load often takes place around the un-deformed level ice's thickness region. The numerical simulation conducted by *Paavilainen and Tuhkuri (2013)* also detected the maximum ice load slightly below the waterline for gentle slope angles.

Ice load's spatial and temporal variation

Among all important findings based on the measurements from tactile sensor, it is interesting to illustrate the ice load's spatial and temporal variation as shown in *Figure 6*.
It can be seen from *Figure 6* that generally most of the recorded loads in the vertical direction increase with time. This underlines the importance of rubble accumulation. Moreover, below the un-deformed level ice's thickness region, i.e. below bin number 3 and 4, the recorded ice load also increases with time and may become even more significant than the process that occur within the un-deformed level ice's thickness region. This further strengthens the point that the accumulated rubble together with the ice rotating process intensifies the ice load under the un-deformed level ice's thickness region.

Though *Figure 5* and *6* are presented with absolute values of the ice load, caution should be made on the reliability of tactile sensor's measurement since it does not have the same accuracy in all the measuring range. In this test campaign, the tactile sensor was calibrated to capture the mean ice load with a higher accuracy than the maximum ice load. Therefore, the measured absolute value of the mean ice load can be assigned a higher confidence. Furthermore, tactile sensor's capability in measuring the ice load's spatial distribution as in *Figure 5* and *6* supplied valuable information in investigating the pertinent questions regarding spatially load distribution and load evolution with time.

Regarding the sensitivity of measurements with the loading area size, this test campaign was not able to avoid this problem. However, considering the fact that most of the time, the effective ice load behaves a 'line-like' distribution as shown in *Figure 5*. Significant variation in contact area is not expected. Therefore, we can have a higher confidence in the measured value irrespective of this unsolved disadvantage of tactile sensor.

In a further analysis of the measured data in the RITAS project (Lu et al., 2014), we have utilised load cells' measurement to compensate the inaccuracy of tactile sensor's measurement in the maximum ice load range. From experiences made we recommend to use a combination of both measuring techniques in order to obtain most reliable results.

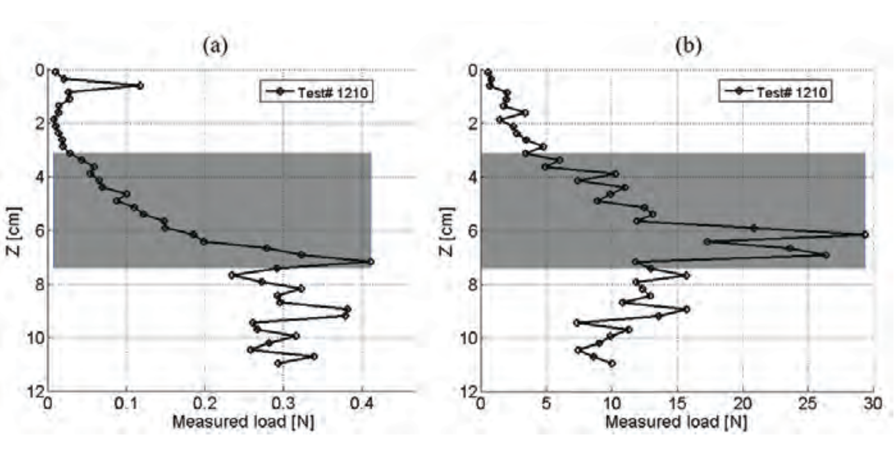


Figure 5 - Time averaged ice load (a) and time history of maximum ice load variation in vertical direction of sensor (b), shaded area is the location of un-deformed level ice

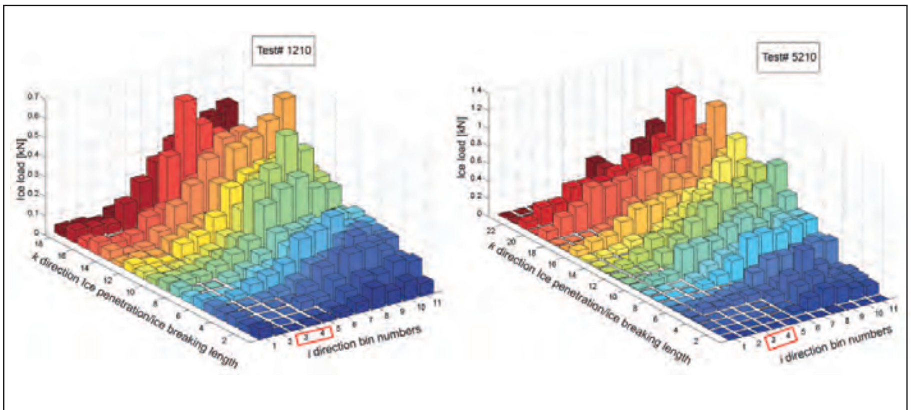


Figure 6 - Vertically spatial and temporal ice load distribution (bins 3 and 4 in the red square indicates approximately the location of un-deformed level ice)

Conclusion

In the study carried out tactile sensors were used to investigate the interaction mechanism between level ice and a wide sloping structure in particular the temporal and spatial distributions for different test scenarios.

Based on these physical experiments we can conclude:

- During the interaction, after the breaking of initially intact ice, the recorded ice load does not diminish instantly. Instead, the ice moves continuously downward with a relatively lower load magnitude (see Figure 4). This is considered due to the effect of ice rotating load in combination of the accumulated rubble effects.
- Based on the mean ice load's (i.e., averaged in time) vertical variation, it is found out that equally large ice load can be detected beneath the un-deformed level ice's thickness region (see Figure 6a). As discussed above, the contribution of this large ice load is mainly due to the combined effects of ice rotating load and the rubble accumulation;
- Generally the recorded maximum load acts at the un-deformed level ice's thickness region (see Figure 6b). The ice breaking occurs mainly at the waterline region. This is in line with previous experiments and assumptions that the ice breaking load is one of the decisive loads regarding design.

With respect to the utilisation of tactile sensor in this test campaign, it can be concluded that tactile sensor is beneficial in displaying ice load's relative spatial distribution while its magnitude should be treated with caution. A measurement system which combines both tactile sensor and the conventional measuring technique (e.g., measuring by load cell) tends to offer a better understanding on the ice load's spatial and temporal variation.

Acknowledgement

The work was supported by the European Community's 7th Framework Programme through the grant to the budget of the Integrated Infrastructure Initiative HYDRALAB-IV, Contract no. 261520. The authors would like to acknowledge the Norwegian Research Council through the project 200618/S60-PetroRisk and the SAMCoT CRI for financial support and all the SAMCoT partners. The financial support from Statoil AS and the test set-up design of Multiconsult is also greatly acknowledged.

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PISCES RESEARCH PROJECT: IMPROVING ECOHYDRAULIC MODELLING AND EXPERIMENTATION

BY STUART McLELLAND

Figure 1 - The Hopavågen tidal inlet, NTNU

Ecohydraulic modelling and experimentation are essential if we are to improve our understanding and management of the environment since organisms can modify their environment and they and their behaviour can be modified by the environment around them. The PISCES project in HYDRLALAB IV aims to improve the physical modelling of plants and animals through the development and improvement of measurement technologies and experimental methodologies and protocols. There is considerable potential for physical models of ecohydraulics to bridge the gaps between field observations and theoretical, stochastic and numerical modelling of aquatic ecology. This integrated approach to understanding ecohydraulics has the potential to improve our ability to predict changes to aquatic ecology resulting from present and future climate change. However, for such research to be meaningful and produce the greatest impact, care has to be taken to ensure that both the ecology and hydraulics are properly represented. The complex interactions between aquatic organisms and physico-chemical processes within ecohydraulics requires an interdisciplinary approach to research; therefore the PISCES research team included ecologists, geomorphologists, sedimentologists and hydraulic engineers to bring together knowledge and expertise from different disciplines.

Although it is challenging to incorporate plants and animals into physical models, it is an essential requirement to improve our representation of natural systems in experiments and to understand how those organisms can modify, or can be modified by, sediment transport dynamics and/or flow patterns and structures. The challenges include maintaining organism health and ensuring realistic behaviour of organisms during experiments as well as working with the complexity of the interactions among organisms, sediments and flow. To help the researchers meet these challenges, the PISCES team has produced an IAHR Design Manual entitled 'Users Guide to Ecohydraulic Modelling and Experimentation' to disseminate good practice. The guide includes practical information on experimental methods and procedures, including animal and plant husbandry, the design and use of surrogates and flow measurements around organisms. It also covers specific experimentation with different types of organisms including biofilms, plants and macrozoobenthos and the design manual concludes with a decision-making framework to assist researchers in their experimental design.

The PISCES project has also undertaken research to evaluate the limitations of using physical models to represent organisms in hydraulic experiments. Two of the key objectives from this research were to understand: (i) the complexity required to adequately reproduce the hydrodynamics of the natural system; and (ii) which aspects of living organisms must be replicated in surrogates to reproduce the hydrodynamics of the natural system.

These questions were investigated in a series of experiments that were conducted in both the field and the laboratory. Field experiments were undertaken at the Hopavågen tidal inlet, NTNU, (Fig. 1). Observations included bathymetry, bed sediment size distribution, macroalgal species distribution, macroalgal geometric properties (e.g. stipe length and diameter, blade length, width and depth, numbers of blades, and blade projected area), and mechanical properties of macroalgae (e.g. Young's bending modulus, flexural rigidity, buoyancy). Laboratory experiments were undertaken at the Total Environment Simulator at the University of Hull (Fig. 2), with replication of the physical conditions found at the field site including mean flow depth, flow rate, bed sediment characteristics, and macroalgal size and position. For both the field and flume cases, measurements of the flow field were taken for four different cases:

- **A.** Full complexity of macroalgae as found in the 'undisturbed' natural environment;
- **B.** Reduced complexity of macroalgae in which the macroalgae community was simplified to a single species *(Laminaria digitata)*;
- **C.** Reduction of the number of macroalgae from 19 individuals to a single macroalga; and
- **D.** "Cleared" condition with no macroalgae.

Additional tests were also undertaken in the flume experiments to investigate the effect of macroalgal arrangements with experiment B


a b

Figure 2 - (a) Experimental set-up in the Total Environment Simulator, University of Hull with flags showing the locations of macroalgae to replicate field distribution. (b) View looking downstream in flume during experiments

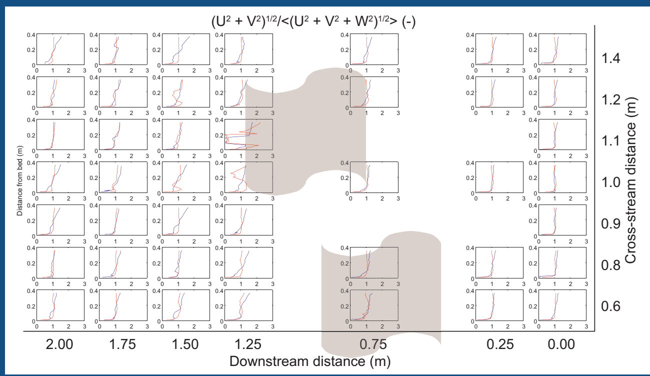

Figure 3 - Comparison of velocity magnitude for flume (red lines) and field (blue lines). At 0.9 and 1.1m cross-stream, locations without profiles are directly above the macroalgae being studied

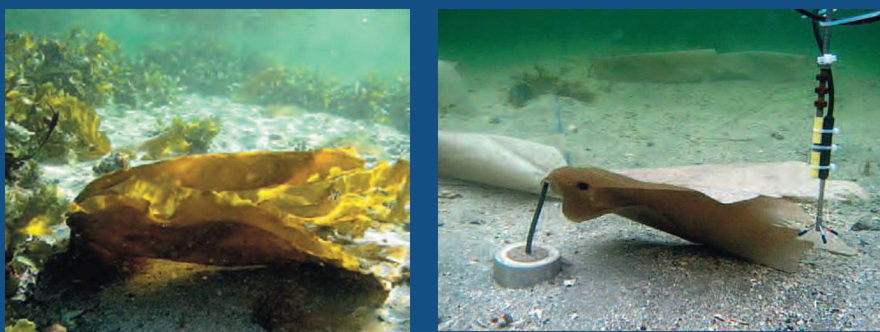
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Figure 4 - (a) Photograph of real macroalgae (Laminaria digitata). (b) Photograph of surrogate macroalgae at the field site (Vectrino profiler measuring flow velocities shown to right of image)

being repeated using the same density of colonization, but with different geometric arrangements of macroalgae.

In all cases, flow measurements in the field and laboratory were repeated with an identical methodology. Detailed, three-dimensional flow measurements were made using the Nortek Vectrino Profiler ADV sampling for 240 s at 100 Hz and with a 0.25 m lateral and longitudinal spacing within a 2 × 2 m grid. New techniques were developed to process ADV data to reduce spikes and noise in these measurements as part of the data analysis programme. In addition, we developed and tested new PIV measurement techniques that could be used in both the field and laboratory so that such measurements can be compared between different environments. Figure 3 shows an example of the flow measurements.

Detailed experiments were also undertaken to improve our understanding of how to use surrogates in experiments and how closely their behaviour replicates natural organisms. Measured macroalgal properties from the field site were used to select potential surrogates of varying stiffness, buoyancy and geometric complexity. The hydrodynamic behaviour (i.e., mean and turbulent flow fields, together with applied drag forces and observations of reconfiguration behaviour) of these test surrogates were compared to real macroalgae during experimental tests at FZK, Hannover (Fig. 4). From these experiments, an “optimum” surrogate was selected for further testing in field and flume experiments where 19 live *Laminaria digitata* thalli (Case B, above) were replaced with 19 of the optimised surrogates.

The key result from our comparison of field and laboratory experiments is that flume experiments can successfully replicate Reynolds- and double-averaged flow conditions at scales larger than individual thalli. But flow structures and behaviour at the same spatial scale as the macroalgae are not as well reproduced since these aspects of the flow field are particularly sensitive to the variability of properties between individual macroalga, which cannot easily be replicated. We have also begun to develop new diagnostic tests to be enable experimentalists to monitor and quantify the integrity of macroalga health and behaviour.

Following two highly successful workshops, attended by research from within Europe and beyond, the PISCES team have also considered the future needs of experimental ecohydraulics research. Together we identified five key themes that should be addressed if we are to improve and progress our understanding of ecohydraulic interactions:

1. Abiotic Factors: the detection of, reaction to, and modification of a number of environmental factors that may be dependent on or independent of the flow field by subaqueous plants and animals;
2. Adaptation: the adjustments made to or by organisms at multiple spatio-temporal scales in response to hydrodynamic forcing, abiotic stimuli or both;
3. Complexity and Feedback: complex interactions between organisms and the hydrodynamic environment and the role of feedback, whether positive or negative, in amplifying or moderating organism or environmental response, respectively;
4. Variation: differences between (parts of) individual organisms, or groups of organisms of any species caused either by genetic differences or by the influence of environmental factors; and
5. Scale and Scaling: is it possible to scale down biological (and biomechanical) processes operating at the large scale, are the variables measured at the large scale pertinent at the small scale and does technology permit us to measure the same variable across scales?

The PISCES project has brought together researchers from a wide range of disciplines to improve experimental research in ecohydraulics through better sharing of existing knowledge and also by developing improved experimental protocols. Results from an extensive series of experiments comparing flow fields around real and surrogate plants in the field and in the laboratory has shown the importance of heterogeneities in plant properties, orientation and position. This will help improve future experimental design so that results can be more widely applicable. The project has also developed robust methodologies for surrogate design and for flow measurements around organisms. Continued interdisciplinary discussion and collaboration are essential if hydraulic experiments are to make a significant contribution to future ecohydraulic research and environmental management under a changing climate.

Stuart McLelland **is a Senior Lecturer in the Department of Geography, Environment and Earth Sciences at the University of Hull. His main research interests are in physical modelling and fluvial processes. This report was written on behalf of a team of over 20 researchers involved in the PISCES project.**

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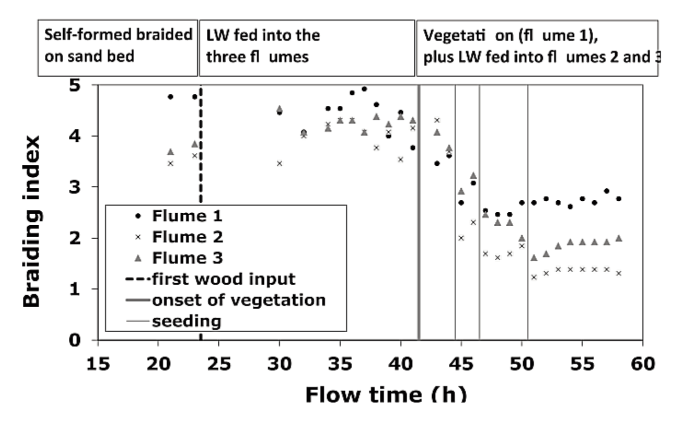
MORPHODYNAMIC EFFECTS OF VEGETATION AND LARGE WOOD IN BRAIDED RIVERS

BY LUCA MAO, WALTER BERTOLDI , FRANCESCO COMITI, NANA A. OSEI, STUART MCLELLAND, BRENDAN MURPHY, DIEGO RAVAZZOLO, MICHAL TAL, ROB THOMAS, MATILDE WELBER & SANDRA ZANELLA

Riparian vegetation plays a crucial role in shaping rivers, acting as an ecological engineer that can increase roughness, stabilize banks, and reduce the number of anabranches in braided rivers (Gurnell, 2014). The geomorphic impact of living plants continues even after their erosion from the banks and transportation through the fluvial network.

Dead or living pieces of large wood can influence river erosion and sedimentation processes, channel morphology, hydraulics, and ecology. Both standing vegetation and large wood elements (LW) contribute to shaping braided river systems with islands, which represent the greatest level of ecosystem integrity in some fluvial systems. Generally, living vegetation acts to reduce channel width and braiding index (i.e. the number of channels per cross-section), whilst LW acts in the opposite way increasing the latter through pioneer islands. However, it is difficult to discriminate the relative importance of these two effects in the field, as they act together. Despite some flume studies on the effects of riparian vegetation on the planform of gravel-bed rivers (i.e. Tal & Paola, 2010), and preliminary attempts to simulate LW dynamics in a flume with mobile bed sediments (Welber et al., 2013), no experimental evidence exists on the integration of these two processes on braided rivers. The series of flume experiments presented here are thus the first reported attempt to elucidate the relative effects of riparian vegetation and LW on the planform configuration and dynamics of braided river systems.

Figure 1 - Reach-averaged braiding index during the different run configurations



Material and methods

Experiments were carried out in the Total Environment Simulator (6 m-wide, 11 m-long flume) at the University of Hull (UK). Three 1.7 m-wide flume channels were constructed inside the facility, and were filled with uniform size sand (d50 0.72 mm). A constant discharge and sand feed rate were imposed upstream, allowing a self-formed braided network to develop to a quasi-steady-state in terms of its morphological pattern and sediment fluxes. Then, cylindrical wooden dowels, representing logs, were fed into the three flume channels at different rates (see Bertoldi et al., 2014 for further details on the scaling approach). Subsequently, the logs were removed and alfalfa (Medicago sativa) was seeded in the

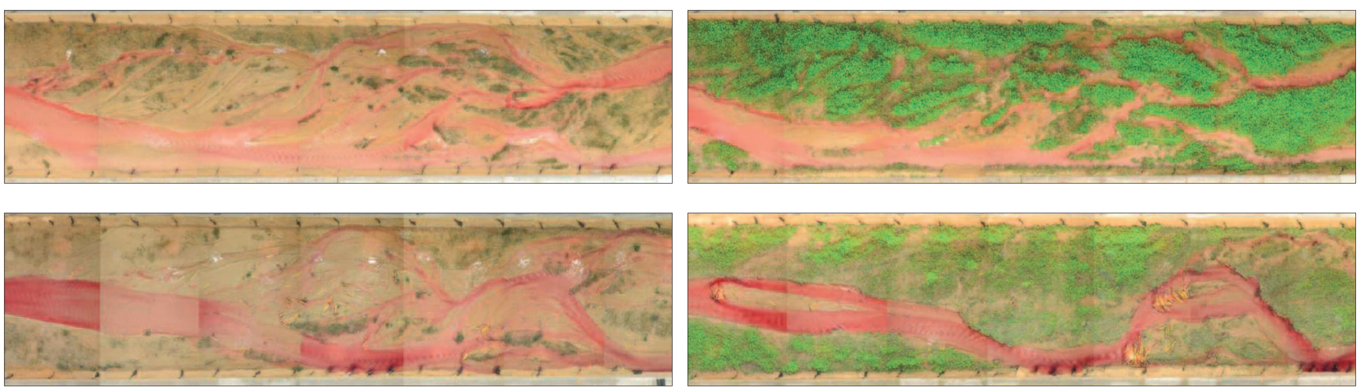


Figure 2 - Vertical photos of two flume channels with self-formed braided pattern taken a few days after the alfalfa seeding (on the left), and towards the end of the experiments (on the right). Photos refer to the flume channel where only alfalfa was seeded but no logs were fed into the system (above), and to the flume channel where logs were also fed at a rate of 120 logs h-1. Flow is from left to right.

three flume channels after the steady-state braided pattern was restored. The growth of the alfalfa seeds was assisted by continuous artificial illumination, and by maintaining a baseflow discharge that was below the threshold for sand transport. A higher flow rate, capable of reworking the braided morphology, was imposed after a week of plant growth. In two flume channels, LW was also fed into the channels, whereas the third channel was left to evolve under the sole influence of vegetation. Following this protocol, experiments were continued for four weeks. High-resolution vertical images covering the entire length of the flume channels were used to measure the reach-averaged braiding index.

Some interesting outcomes

The temporal evolution of braiding index in the flume channels was measured before and during LW dispersal simulations, and then during runs with vegetation growing on proto braidplains. The braiding index of the self-formed morphology without logs and vegetation ranges between 3.5 and 5, which is comparable with previous published experimental results. Interestingly, no statistically significant difference was observed in the index between pre- and post-wood input (Figure 1). This shows that wood alone, when free to move and deposit on a self-formed braided topography, does not significantly affect bed morphology at the reach scale, as assessed in terms of braiding index (see also Bertoldi et al., 2014). After alfalfa established in the flume channel without logs, the braiding index rapidly decreased from ~4.5 to ~2.5. Surprisingly, the braiding index tended to reduce even further in the channels with vegetation and LW, causing a shift towards an almost single-thread morphology (Figure 2). When vegetation and LW exerted their geomorphic role together, the percentage of wood deposited as single elements reduced from 45% to 25%, and jams tended to become larger and much more stable. Under these circumstances, wood remobilization decreased dramatically to < 5%, and newly introduced logs were more likely to jam on already existing accumulations. Large jams formed under high wood input rate (see Figure 2) were particularly stable, and tended to deflect the flow, as commonly observed in single-thread rivers.

Final remarks and future works

These preliminary experiments are the first attempt to simulate the simultaneous effects of vegetation and large wood in braided river systems. Results show that neither wood storage volume nor wood input rate seems to affect braided channel morphology as expressed by the braiding index. This is likely because, for the initial conditions imposed on these experiments, it is the anabranch dynamics that controls wood storage and remobilization rather than the opposite. Also, when acting alone, vegetation rapidly reduces the braiding index, and forces flow into narrower and deeper channels. The addition of logs in vegetated braided rivers forces the formation of fewer but larger jams, which leads to the scour of deeper channels, eventually reducing the braiding index further. Large jams and vegetation also limit the lateral mobility of anabranch channels. Even if the flume is not a precise scaled model of a prototype fluvial system and inert wooden dowels cannot replicate biological activity (i.e. they do not grow, decay or resprout as most riparian plants), the present set of runs is the first successful attempt to simulate vegetation and large wood together in a flume. The results are very promising since they shed light on processes that cannot be fully observed in the field, due to the long time scales they act over. In addition, despite the simplicity of the experiments, the complex morphology that is typical of island-braided rivers appears to have been effectively reproduced (Figure 3).

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Figure 3 - Pieces of large wood stranded on a bar next to a big island in the flume (on the left) and on the Tagliamento River, in Italy (on the right). Flow is from left to right

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HYDRAULIC RESEARCH AT THE FRONTIER BETWEEN WATER AND SEDIMENT

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Sediment transport at land-water boundaries, such as the sea bed or the swash zone, has not yet been adequately solved. This applies to numerical models and to field or lab observations. And yet these boundary fluxes contribute a non negligible percentage of the total sediment transport and cannot be neglected whenever accurate and robust predictions are required.

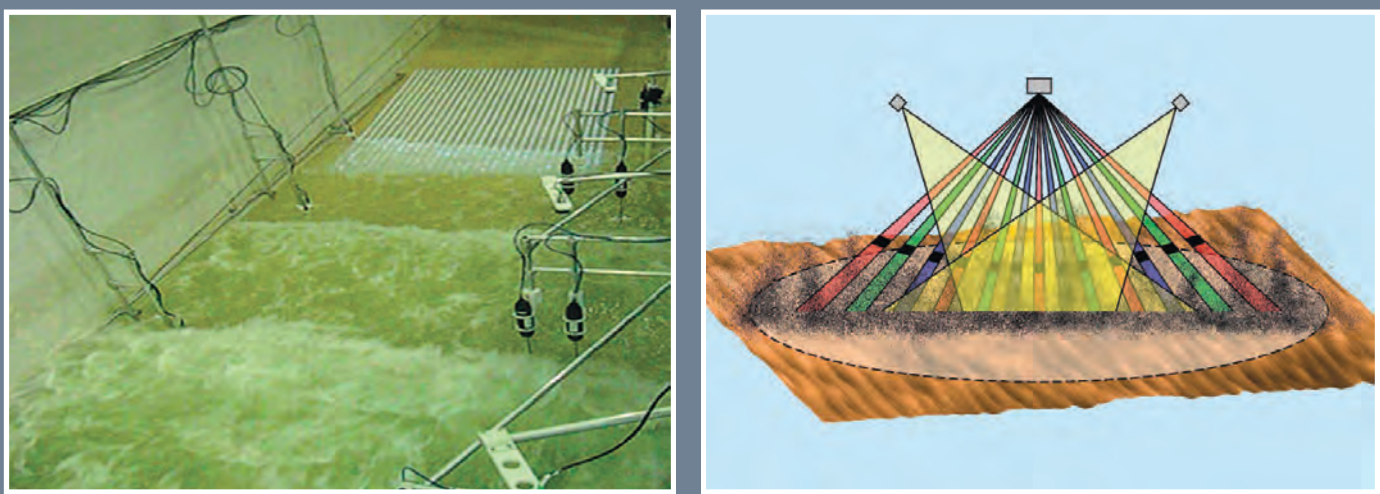
One of the main reasons for this limitation in knowledge is the lack of high resolution observations, particularly under sharp gradients such as those found in boundary areas.
Within the WISE-Hydralab (Water Interface Sediment Experiment) project we have obtained simultaneous and collocated profiles of water and sediment fluxes and the resulting bed dynamics with an unprecedented accuracy. The characterization or the flow field in the horizontal and vertical dimensions has allowed a quantitative understanding and even quantification of sediment transport and entrainment, including vortex shedding and the bed boundary level. This leads to quantitative estimates of bed and suspended load, even in the near bed or sheet flow layer.

To perform such an analysis we have carried out a series of identical large scale tests in the wave flumes of Hanover and Barcelona, using a number of vertical profiles over a horizontal transect. This has provided quasi 3D resolution under controlled laboratory conditions, comparable to the level of information usually provided by numerical models, leading to an upgrade of mobile bed research facilities with information on water-sediment processes above, within and across the flow-bed interface.

Development

Most available instrumentation does not allow recovering the sharp variation of sediment fluxes near the bed boundary nor the pulsing transport in the alternatively wet and dry swash zone. The novel instruments developed and tested in WISE (figure 1a & b) as part of the Hydralab research effort have allowed, for the first time, a resolution comparable to that of advanced numerical formulations, whose development had slowed in the last years due to the limitations of observational equipment.
The novel optic and acoustic instrumentation, plus the experimental protocols to recover reliable and high resolution data, have provided a breakthrough (figure 2) that allows measuring directly sheet flow and suspended loads, sediment properties and even the elusive bed level. This has resulted in a unique data set at two complementary large scales supplemented by numerical modelling results.
Such a combination of hydraulic and numerical modelling has allowed an optimization of the experiments before their execution and guidance support for the equipment deployment. The combination of opto-acoustic techniques includes an enhanced stereoscopic technique for beach topography, including water front tracking in the swash zone. It also features a suspended sediment imager combined with high resolution acoustic concentration and velocity profilers that allow recov-

Figure 1 - Illustration of the newly developed grid of optic points for the swash zone (a, left panel) and the bed form and suspended load acoustic imager for the nearshore zone (b, right panel)



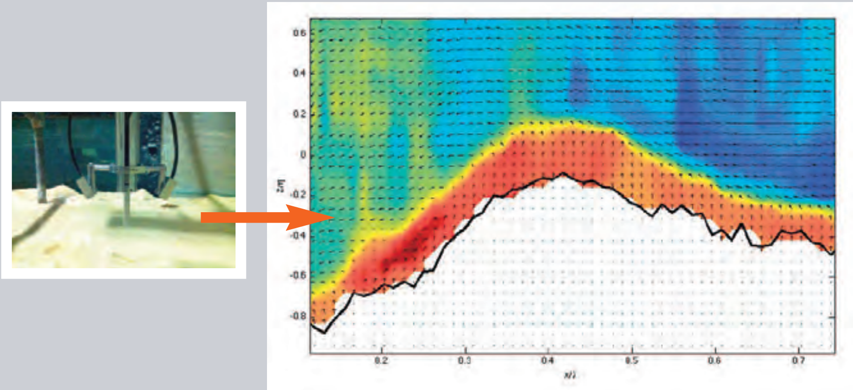


Figure 2 - Sample image of the near bed sheet flow layer and the suspended sediment patterns recovered with 1.5mm vertical resolution and sampling at 50Hz

ering the dynamics of bed levels and forms, as well as some of the sediment characteristics. The resulting data set provides information on bed plus suspended loads, together with bed forms and their evolution. The experimental work has also dealt with novel techniques such as ferrofluid deformation, with an inductive read out strategy to recover near bed velocities.

Results

The WISE results include a benchmark data set with high resolution hydro/morphodynamic observations for erosive and accretive wave conditions. The experiments from the Hanover and Barcelona wave flumes have been designed to reproduce as closely as possible both drivers and responses, allowing an assessment of the limits for facility and instrument performance, as well as providing valuable insight into the controlling processes as a function of scale and energy levels (figure 3).
The numerical modelling has dealt with detailed sediment transport formulations to calculate sediment fluxes as a function of boundary layer streaming and sediment properties. It has also included more integrated hydro-morphodynamic models to predict beach evolution for the simulated hydrodynamics. The results have allowed validating 3D models (including advanced aspects such as sediment entrainment and wave current interaction effects) and improving the efficiency of hydraulic models.

Conclusions

The experimental work performed is expected to contribute to an improved performance of hydraulic facilities, particularly for mobile bed experiments in areas that had not been considered before. This includes the swash zone and the near bed sheet flow. The obtained benchmark set of data will be also useful for process research and numerical modellers, covering aspects such as front tracking techniques, alternatively wet and dry zones and the effects of scaling as a function of dominant processes. More information can be found in a Coastal Engineering collection of papers presenting the advances available at the time of writing (2011, Coastal Engineering Vol. 16, 7).

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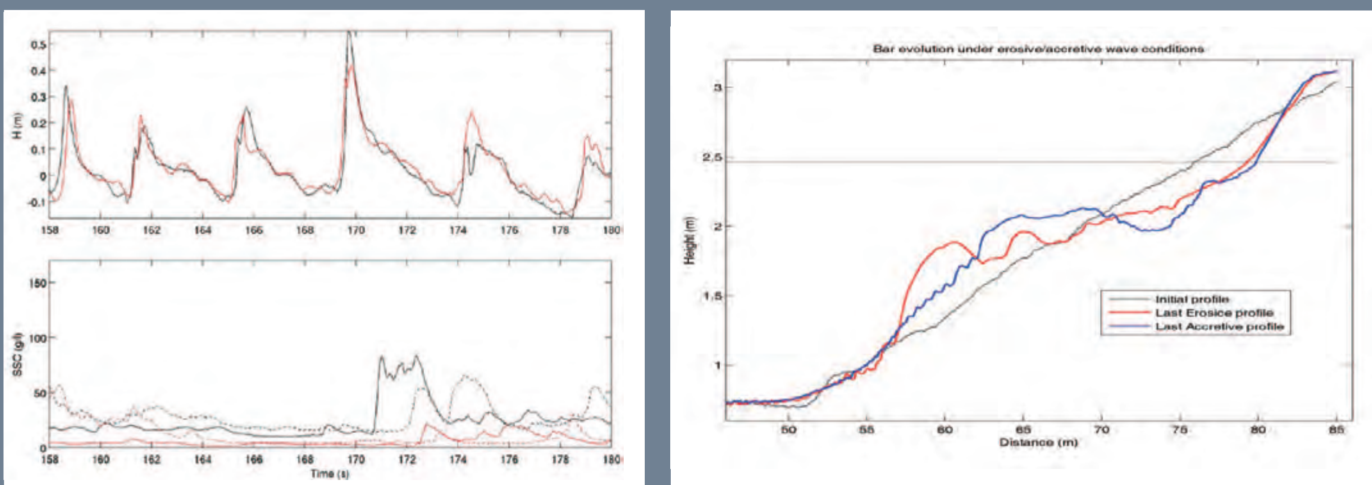
Figure 3 - Sample result of the intra-wave suspended sediment concentration peaks (left panel, below) as a function of the wave height (left panel above). The aggregated result in terms of profile evolution for accretive wave sequences appears in the right hand panel, showing the limited shoreline recovery



MEASUREMENTS OF SAND TRANSPORT PROCESSES UNDER BREAKING AND IRREGULAR WAVES

BY JAN S. RIBBERINK, TOM O'DONOGHUE, DOMINIC A. VAN DER A, JOEP VAN DER ZANDEN, DAVID HURTHER, IVÁN CÁCERES, PETER D. THORNE

Morphodynamic modelling systems used in coastal engineering practice consist of coupled models for waves, currents, sediment transport and bed level change. The sediment transport model usually incorporates a "practical" model for the sediment transport near the bed, comprising empirical formulae relating net sediment transport to the local flow and sediment conditions. Well-founded models are based on insights and measurements from laboratory experiments, and capture the key physical processes determining the transport in a parameterised way. An example is the SANTOSS model, which is formulated to account for the effects of wave skewness and wave asymmetry, wave-induced streaming and sediment phase lag effects, and to apply to a wide range of sand size, wave and wave-plus-current conditions. However, like other models, the SANTOSS model is almost exclusively based on transport rates and processes measured in laboratory experiments involving regular, non-breaking waves. In reality of course, sea waves are always irregular and, in many cases of practical interest, the waves are breaking. Research is therefore needed to identify and quantify the key sediment transport processes associated with wave breaking and wave irregularity in order to improve the predictive capability of coastal morphological models.

Researchers from the University of Twente, the University of Aberdeen, LEGI-CNRS in France and the National Oceanography Centre, Liverpool, combined forces to conduct experiments on irregular and breaking wave sand transport processes using a large wave flume - the Canal d'Investigacio I Experimentacio Maritima (CIEM) at the Universitat Politècnica de Catalunya (UPC) - within the framework of the EU-funded Hydralab IV project. Named SandT-Pro and conducted between October 2013 and January 2014, the experiments used advanced instrumentation to measure the physical processes that drive sand transport under breaking and irregular wave conditions.

Experimental set-up

The primary advantage in using the CIEM facility for these experiments is its large size: the flume is 100m long, 3m wide and 5m deep, and is capable of producing near full-scale-size waves. A facility of this size eliminates the scale effects associated with sediment-based experiments in smaller facilities and enables measurement of detailed processes not easily measured at small scale. For the SandT-Pro experiments the CIEM flume was configured as shown in Figure 1. A bed of medium sand (D_{50} of 0.25mm) was located approximately 50m from the wave paddle. Initially (i.e. before wave action) the sand bed comprised an offshore slope (1:10 or 1:20), followed by a 20-m long, 1.35-m deep horizontal section; a fixed parabolic beach was located beyond the sand bed for wave dissipation.

Two types of experiment were conducted: (i) Regular breaking wave experiments, which focused on the effects of wave breaking on near-bed sediment dynamics, especially the effects of breaking-induced turbulence and sediment stirring; (ii) Irregular non-breaking wave experiments, in which the waves consisted of groups of waves generated by bi-chromatic superposition or amplitude modulation of regular waves; these experiments focused on the effects of wave sequencing on the near-bed hydro- and sediment dynamics.

The breaking wave experiments were conducted with a 2.55m water depth at the wave paddle and waves with period 4s. The waves started to break at the beginning of the horizontal test section and repeated wave action resulted in the development of a large breaker bar (approximately 7.5m long and 0.6m high after 6hrs of wave action for waves with height 0.85m and profile offshore slope 1:10). As the bed profile evolved detailed process measurements were made at a number of cross-shore positions, from the offshore slope to well shoreward of the bar position, with the highest spatial resolution around the breaking point. For the irregular wave experiments, the water depth at the paddle was increased to 2.65m and experiments were conducted for a range of grouped non-breaking wave conditions with wave period 4.4s and maximum wave height up to 0.8m; for these irregular wave experiments, the measurements were made at

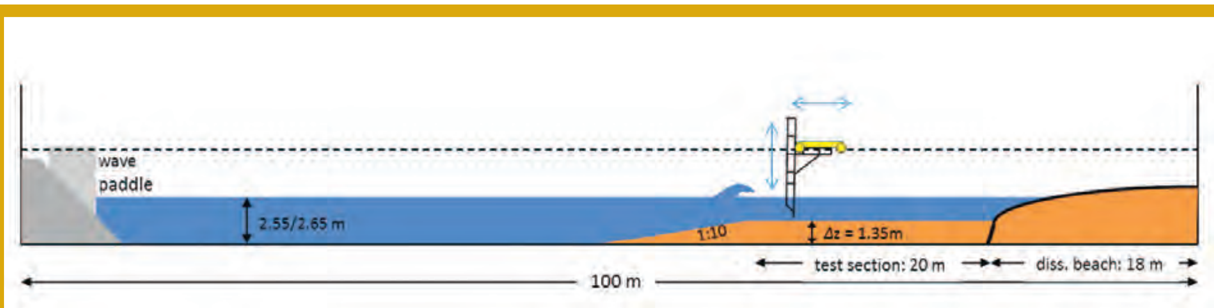


Figure 1 - Set-up in the CIEM for the SandT-Pro experiments

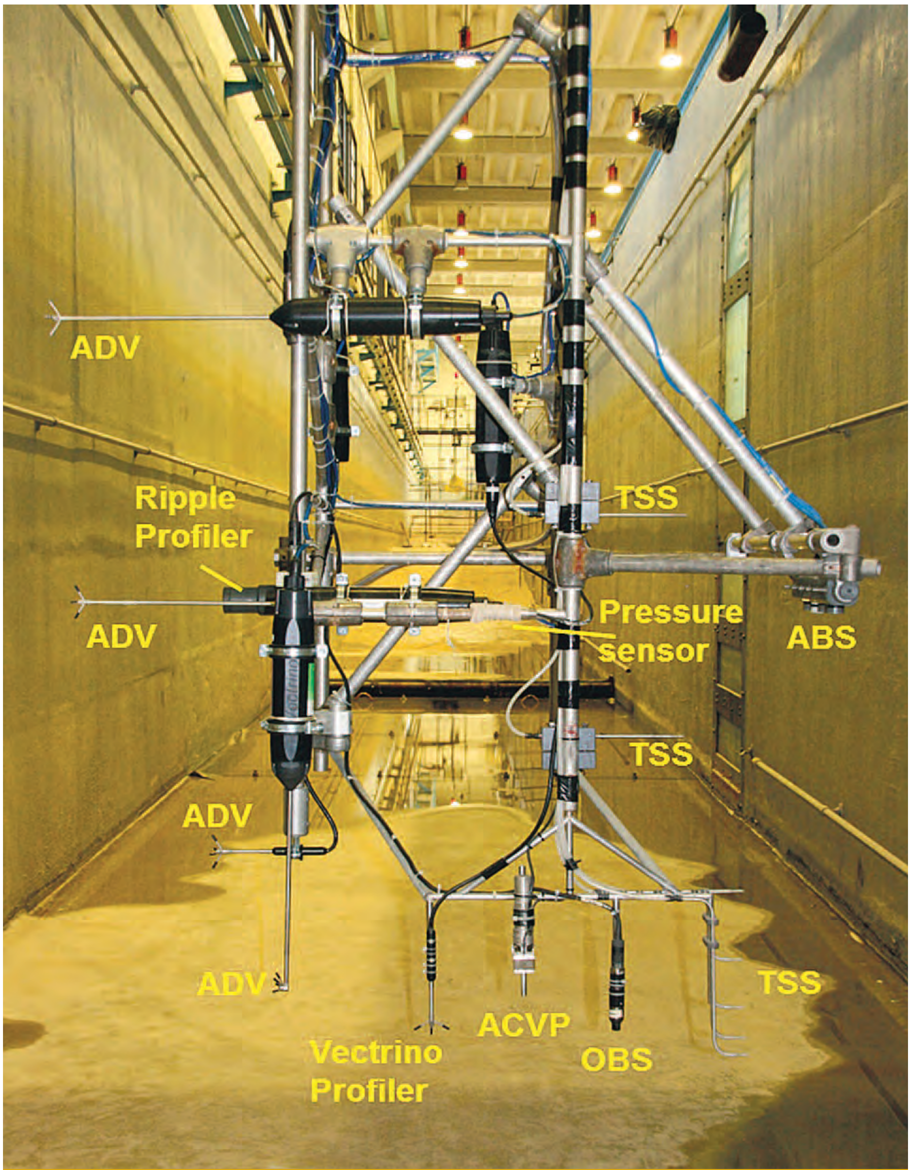


Figure 2 - Instrument set-up on mobile frame.

one cross-shore location in the middle of the 20-m long horizontal section.

Measurements

State-of-the-art instrumentation deployed from a mobile measuring frame custom-built for the experiments (Figure 2) was used to obtain the process measurements. The frame is a stiff construction of small-diameter, steel tubing, and was mounted to the flume's carriage, which runs on rails located at the top of the flume. A spindle adjustment enables the instrument frame to be vertically positioned with 0(mm) accuracy.

The instrument set-up on the frame is shown in Figure 2. Flow velocities were measured using 4 acoustic Doppler velocimeters (ADVs), a Vectrino profiler and a high-resolution acoustic concentration and velocity profiler (HR-ACVP). Sediment concentrations were measured using the HR-ACVP, 3 optical backscatter sensors (OBS), an AQUAscat acoustic backscatter system (ABS) and a 7-nozzle transverse suction sampling system (TSS). Besides the instruments deployed on the instrument frame, two conductivity concentration measurement (CCM) tanks for sheet flow measurements were installed in the sand bed, below two additional HR-ACVPs. Water surface elevation was measured along the flume with 13 resistive wave gauges and, near the breaker location, with 9 pore pressure transducers. Net transport along the profile was calculated using mass conservation principles applied to pre- and post-test bed profiles measured with acoustic bed profilers.

While all instruments are important to the experiment, it is the instruments measuring close to the bed, within the wave bottom boundary layer, which are of primary interest here. Of these, the HR-ACVP is especially important as it simultaneously measures sand concentration and 2 velocity components over a 10-cm vertical profile, with 1mm vertical resolution, thereby revealing the detailed intra-wave sediment fluxes in the near-bed region.

Ongoing work

The experiments have generated a large dataset, the analysis of which is ongoing. Early results show that the bar develops due to the combined effect of onshore-directed sand transport from seaward of the break-point and offshore-directed sand transport from shoreward; the former is mainly driven by wave asymmetry with sheet-flow conditions, while the latter is dominated by the offshore-directed suspended sand transport driven by undertow.

The Hydralab IV SandT-Pro experiments are integrated within a larger research project on sand transport processes under breaking and irregular waves. Named SINBAD, the project is led by the Universities of Twente and Aberdeen and funded by the Dutch STW and the UK's EPSRC. SINBAD involves two additional experimental campaigns in the CIEM, one in which similar detailed process measurements to SandT-Pro are made, but focused on a particular stage of the bar development, and a second in which hydrodynamics only are measured over the barred profile made rigid by laying concrete on the sand bed. The results from the combined set of experiments will be important for the future development of well-founded sand transport models, such as the SANTOSS model.

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ASSESSING THE HYDRAULIC RESPONSE OF STRUCTURES TO WAVES AND ICE

BY JAMES SUTHERLAND

Laboratory measurements of wave and / or ice loads on coastal and maritime structures can play an important role in their final design. The number and range of man-made structures that are subject to these loads is increasing – from offshore oil and gas facilities, through ships and renewable energy devices, to breakwaters, quay walls, bridges and tunnels. However, the capabilities of numerical models are increasing and they have displaced physical models in certain areas, so physical modelling cannot afford to stand still. In order for hydraulic laboratories to remain competitive, we must develop our equipment and techniques to improve the services we offer.

A Foresight study conducted as part of HYDRALAB-IV (Sutherland and Evers, 2013) reviewed techniques for making physical model measurements of wave and ice loads on marine structures, summarised their weaknesses and outlined the advances in modelling techniques that the authors expect to see. Meanwhile, the members of the joint research activity *Hydraulic Response of Structures* (HyReS) have been developing techniques in three main areas:

1. Wave generation – so that a selected time series of waves can be generated;
2. Optimizing the wave sequences at the structure being tested; and
3. Improving techniques for modelling, measuring and interpreting the responses of structures to waves and to ice.

This article summarises some of the main developments made by HyReS partners between 2010 and 2014.

Wave generation

Wave generation using a phase-resolving numerical model

If we can generate nonlinear waves in shallow water, we can conduct tests at larger scales, minimising scale effects and improving accuracy, or we can run the same scale of test in a smaller facility. However, as waves enter shallow water, their shapes evolve from near sinusoidal into skewed (sharp wave crests separated by broad, flat troughs) then into asymmetrical forms (pitched-forward shapes with steep front faces). Hansen et al (2014) have been implementing techniques to drive wave paddles using input from a phase-resolving Boussinesq numerical wave model, so that the waves are generated in shallow water with the required skewness and asymmetry.

The Boussinesq model reproduces wave shoaling and outputs wave flux and surface elevation at a point in shallow water where the wave paddle will be situated in the physical model. Horizontal velocity is determined from flux and the displacement of the water is determined from velocity. The paddle position time series is created by applying a paddle transfer function and is then used to drive the wave paddles in the physical model.

The theory was tested using 2D flume and 3D basin tests, where surface elevations from numerical and physical models were compared a few metres from the wave paddle position (Figure 1). The coupling method was shown to be a robust and reliable wave generation method, capable of reproducing advanced 3D effects over a wide range of wave parameters.

Tsunami wave generation

Tsunami waves have caused significant destruction to coastlines during the last decade. The generation of tsunamis in the laboratory is particularly difficult as they have a very long period and require a very large stroke (peak to peak displacement of the wave paddle). In practice, most 'tsunami' waves generated in laboratories have actually been solitons: a representation of a single wave crest only. HR Wallingford has worked on improving a pneumatic tsunami generator using a OpenFoam CFD model of the test setup. The new design includes a taller and shorter cross-section to reduce sloshing and help in the reproduction of steep leading edge waves. It also features a smoother inlet profile to reduce head losses. A revised tsunami generator was built and tested in a wave flume, where it reproduced N-waves and measured tsunami traces.

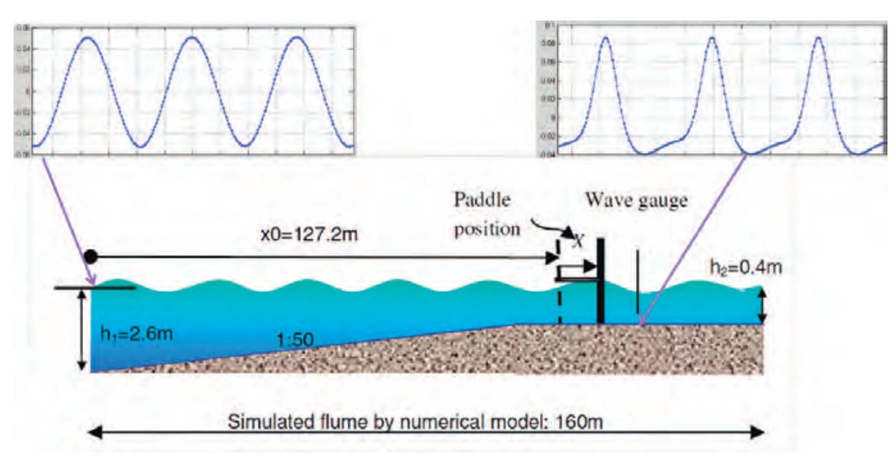

Figure 1 - Numerical wave flume showing waves generated in deep water, passing information to a wave paddle and providing a shallow water time series to compare to the physical model

Propagation and optimisation of wave time series

Sampling schemes

In order to determine extreme loads, long physical model test series are often run to produce many independent extreme events, to which a statistical distribution can be fitted. Hofland et al (2014) has been investigating how to decrease the duration of repeated physical model tests, while still reproducing the same distribution of extreme values. In cases where it is the highest waves that cause the extreme response (for example when only those waves will hit a structure well above water level) it is easy to isolate these events. However, in cases such was wave overtopping of a structure in shallow water, many effects (such as shoaling, breaking and partial reflection) affect the results, so it is not easy to identify which waves will cause the greatest response.

Hofland et al (2014) have adopted a practical approach to these, more complex, test cases. They have developed a procedure for running a single, long duration, test, and using this test to identify the most extreme events. Shortened time series which include the wave groups with the largest events are then run for repeat tests, or those with small changes to the structure. The results are sensitive to the length of time signal around an extreme event that is used to construct the short time series and this varies with the travel time of short waves from the paddle to the structure and the degree of reflection from the structure. Tests with a deterministic New Wave extreme wave group led to overtopping volumes of the same order of magnitude as the long time extreme events.

Focussed wave groups in shallow water

Extreme waves, such as the deterministic New Wave extreme wave group, have been generated in deep water wave flumes and basins for several years using different means of focussing wave groups. Where these techniques generally do not work well is in the presence of a varying bathymetry or a reflective structure.

Fernández et al (2014) have developed the Self Correcting Method (SCM) for the generation of focused waves or other deterministic wave sequences by means of a few iteration steps. The method has been developed, tested in a Numerical Wave Tank (NWT) and eventually validated in the Large Wave Flume or Großer Wellenkanal (GWK). In the SCM phase and amplitude correction steps are used to correct a second order wave profile, so that a focussed wave group can be reproduced at the desired location. The method was developed for flat seabeds then was extended to cases with variable water depths, wave reflection and the combination of both with very good results. The validity of the SCM to produce both non breaking and breaking focused waves over constant depth, variable water depth and with a reflecting structure was demonstrated in experiments in the GWK (Figure 2).

Figure 2 - Focussed wave generated using self-correcting method in shallow water in front of a truss structure (courtesy of LUH)

Assessment of structural response

Active transducers

Physical models of moored floating structures are used extensively when looking at complex wave-structure interactions such as vessel downtime & mooring analysis. In order to correctly represent the motion of a vessel at berth, the nonlinear characteristics of mooring lines and fenders need to be correctly re-created at scale. It is common practice to represent the mooring lines or fenders using either cantilevers or coil springs with integrated strain gauges. However, when faced with modelling a highly nonlinear mooring line or fender response the use of multiple coil springs and cantilevers becomes increasingly impractical. In response to these limitations Sutherland et al (2014) have created a novel active mooring line transducer (AMLT) that uses servomotors to replicate the stiffness characteristics of the mooring line.

The heart of the AMLT system is a servomotor and a programmable logic controller , with a 1ms time base and low latency. A stable torque, which varies with the position of the servomotor, is generated, so the AMLT can be programmed

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to produce a non-linear force – displacement curve. This reproduces the non-linear characteristic of a vessel's mooring lines. The same technology could be applied to reproduce the nonlinear characteristics of render recover winches, constant tension winches, fenders, or dynamic loading.

Quadratic transfer functions

The second order interaction between waves leads to oscillating terms at double, sum and difference frequencies. In the presence of a moored floating body, the second order forces and moments may excite low frequency resonant motions when the difference frequencies become small and they can generate relatively high, low frequency mooring line forces. The magnitude of the low frequency force generated by two component waves is related to those waves by a Quadratic Transfer Function (QTF). A QTF matrix, covering plausible ranges of incident wave frequencies can be built up from measurements of a large number of bi-chromatic sea states, although this is time consuming. Within HyReS MARINTEK, DHI & IFREMER have been developing numerical algorithms to extract the low frequency Quadratic Transfer Functions from random sea tests in wave tanks (Figure 3). Time-domain and cross-bi-spectral analysis methods have been developed.

Tactile Sensors

Pressure distributions on structures during wave impacts are often measured using an array of pressure transducers. However the number of

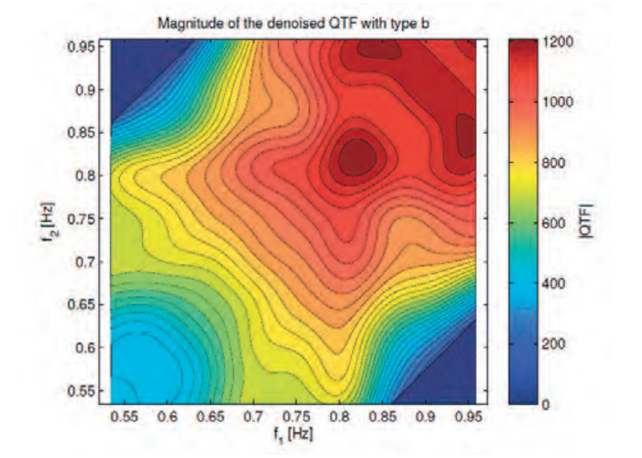

Figure 3 - Quadratic Transfer Function matrix (courtesy of MARINTEK)

sensors is often limited. Within HyReS a number of institutions have been applying tactile (flexible, electronic, grid-based) sensors to a range of scenarios as an alternative to pressure gauges (Ramachandran et al, 2013, Marzeddu et al, 2014, Evers and Lu, 2014).

Tactile sensors are made from two flexible polyester sheets (about 0.1 mm thick) with silver conductive electrodes printed in columns on one sheet and in rows on the other. The intersection between a row and a column creates a sensor or 'sensel'. These matrix based sensors are able to record real-time static and dynamic loads with very high spatial resolution at a reasonable sampling rate. However, each application requires an optimal match between the measurement area, spatial resolution and the pressure range provided by the manufacturer. This optimisation is required as the resolution is low (8-bit) and the total number of samples per second (given by the number of sensels times the sampling frequency) has an upper limit, so high frequencies (in the kilohertz ranges used for wave impacts) can only be obtained by reducing the number of sensels.

Ramachandran et al (2013) explored the application of a tactile sensor to measure wave impact pressures with high spatial and temporal resolution in large scale model tests. They also developed and analysed a dynamic calibration technique. This was tested on the surface of a sloping revetment in the GWK (Figure 4). The sensors were again successfully applied in a HYDRALAB Transnational Access project to measure the wave impact pressures on parapets mounted on a vertical wall.

Marzeddu et al (2014) tested a scaled model of a vertical breakwater in a small flume. The vertical wall of the breakwater was equipped with six pressure sensors, two load cells and a tactile sensor, in order to record the pressure and the total force at the same time. About 290 tests were conducted. Various tests were made under the same wave conditions recording at different sample frequencies (from 50 Hz to 19200 Hz). The total force on the vertical wall was computed for each test using the load cells and the pressure sensors (using interpolation and extrapolation techniques) while the tactile sensor was used to give information on the coherence of impact pressures.

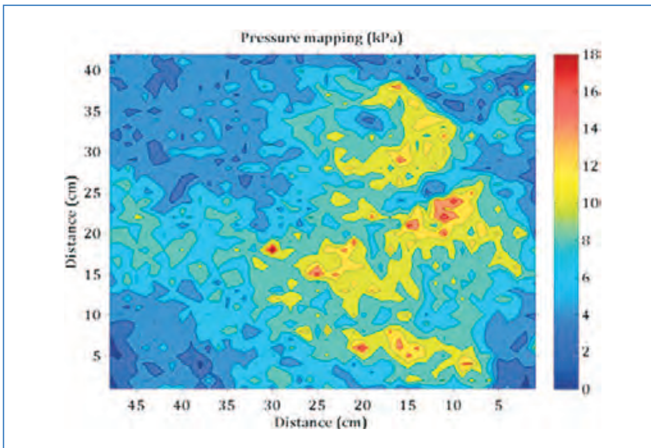

Figure 4 - Spatial distribution of pressure on surface of sloping revetment caused by a breaking wave (courtesy of LUH)

It is common practise in ice model testing to measure the global ice load acting on the entire structure, while in practice most of the load is transmitted through local high pressure zones. The application of tactile sensors to ice loading (Evers and Lu, 2014) is therefore an interesting development as it provides the spatial resolution hitherto unattained in physical models.

Conclusions

The work conducted in the Joint Research Activity 'Hydraulic Response of Structures' as part of HYDRALAB-IV has made noticeable advances in developing techniques for conducting hydraulic model experiments, which have included:

- improved methods for generating water waves,
- improved the efficiency of tests for measuring the structural response to waves,
- developed a technique for focussing wave signals in shallow water or with a structure,
- developed an active mooring line transducer,
- developed code for calculating QTFs from random wave series, and
- investigated how tactile sensors compare to the use of pressure sensors and load cell.

These advances are in the spirit of HYDRALAB as they seek to keep physical modelling as an indispensable tool in hydraulic modelling.

Acknowledgement

The work described in this publication was supported by the European Community's 7th Framework Programme through the grant to the budget of the Integrating Activity HYDRALAB IV, Contract no. 261520. The work was undertaken by the project partners: HR Wallingford, Deltares, CEDEX, DHI, IAHR, IFREMER, Gottfried Wilhelm Leibniz Universitaet Hannover (LUH) and UPC.

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COUNCIL ELECTION 2015 – 2017
NOMINATING COMMITTEE 2015

At its meeting in Porto, Portugal in April 2014, the IAHR Council has identified a Nominating Committee (NC 2015) for the next Council election ahead of the next World Congress in The Hague, The Netherlands, June-July 2015. The Nominating Committee will be chaired by Jean-Paul Chabard (France), former Vice President of IAHR, and comprises Daniel Farias (Argentina), Ana Maria da Silva (Canada), Heidi Nepf (USA), Bruce Melville (New Zealand), Yasuyuki Shimizu (Japan), Yong Sik Cho (Korea), Aronne Armanini (Italy), and Willi Hager (Switzerland). IAHR President Roger Falconer (UK) will serve as the Council contact person.

The NC collects proposals from individual and institute members, searches itself for candidates, and evaluates the performance of present Council members in view of their possible re-election. It must consider the alignment of candidates with Council composition requirements, including the question of progression of Council Members to Vice Presidential positions or to the Presidency.

It is the task of the NC to propose a list of candidates for the 2015 Council election, which includes Executive Committee positions (President, 3 Vice-Presidents and Secretary General) and regularly elected Council members. This list must reflect a balance between the possibly conflicting requirements of:

- world-wide representation of the IAHR membership and yet at the same time a small active group which is capable to lead the Association, and to fulfil Council assignments;
- continuous renewal through new members while assuring necessary continuity;
- adequate representation of hydro-environment engineering practice.

Invitation to the membership for nomination of candidates

The Nominating Committee hereby invites all IAHR members to submit suggestions regarding nomination of possible candidates for Council. Please make your suggestions of potential Council candidates to any member of the NC 2015 **before the end of December 2014**, including a rationale for the suitability of the candidate proposed and an indication of the nominee's willingness to accept if elected. The Nominating Committee will give due consideration to all suggestions.

NC 2015 slate of candidates

The Nominating Committee will evaluate all proposed nominations with respect to their qualification for fulfilling the major tasks of the IAHR Council.

The IAHR Council has the task to promote the interests of the Association and co-ordinate the activities of its members serving the interests and needs of Hydro-environment Engineering and Research, both at global and at regional scale.

This includes long-range planning for the biennial World Congresses as well as co-ordination and interlinkage of activities of Regional and Technical Divisions and Committees, e.g. conferences, IAHR publications and Awards and promotion of continuing education, student chapters and short courses. Membership promotion, finances, IAHR secretariat liaison and links with institute members, industry and the profession are also important tasks, as well as relations with government agencies and other professional/technical societies and international organisations.

The Nominating Committee will develop a slate of candidates, which must be published according to the By-Laws by March 1st. This slate may contain up to two candidates for each position.

Any member wishing to receive a printed list of the slate of candidates should contact the Secretariat after this date.

Nomination by petition

If the Nominating Committee has not included your suggestion in its slate or if you have another suitable candidate not hitherto considered, all members have the option to file a nomination by petition within two months after publication of the NC 2015 slate. The new election procedure gives any group of members in the Association, which feels that its interests are not properly taken into account by the NC 2015 slate, the chance to submit nominations by petition for any of the regular Council member positions. A valid petition requires signatures of 15 members from at least five countries or from a group of countries representing 10% of the IAHR membership. This assures that there is support for a candidate which goes beyond a personal or national interest. All valid nominations by petition will be included in the ballot.

Nominations by Petition must be submitted to the Secretariat within two months after publication of the NC slate of candidates with a statement from the candidate, that she or he is willing to accept the nomination, a resumé including professional career, involvement in IAHR, and a statement on the planned contribution as Council member.

Ballot

The NC will submit its list of candidates to the Secretariat for publication together with any candidates "by Petition", reaching members at least two months prior to the congress. Members will be invited to elect the new Council through written or electronic ballot before and at the The Hague Congress, closing on Wednesday 1st July, 2015.

Contact:

NC 2015 Chair: Prof. Jean-Paul Chabard, EDF France, Former IAHR Vice President
jean-paul.chabard@edf.fr

IAHR AWARDS CALL FOR NOMINATIONS 2015

IAHR AIRH

Supported by CEDEX

IAHR members are invited to submit nominations for the Arthur Thomas Ippen Award, Harold Jan Schoemaker Award, and M. Selim Yalin Award. These awards will be presented at the 36th IAHR World Congress, The Hague, The Netherlands, June 28 – July 3, 2015.

Prof. Marian Muste is co-ordinating nominations received for the 2015 Award. The nominations should consist of a concise statement of the qualifications of the nominee, a listing of his/her outstanding accomplishments, pertinent biographical data, and a proposed statement of the endeavours for which the nominated awardee would be recognised. Each nomination should not be more than two typewritten pages in length.

Nominations for the three awards must be sent by January 15, 2015 using the standard nomination form at www.iahr.org/awards.

19th Arthur Thomas Ippen Award

For outstanding accomplishment in hydraulic engineering and research

The Founding Statement and the Rules for Administration of the Award are as follows:

Founding Statement

The Ippen Award was established by the IAHR Council in 1977 to memorialise Professor Ippen, IAHR President (1959-1963), IAHR Honorary Member (1963-1974), and for many decades an inspirational leader in fluids research, hydraulic engineering, and international co-operation and understanding. The Award is made biennially by IAHR to one of its members who has demonstrated conspicuously outstanding ability, originality, and accomplishment in basic hydraulic research and/or applied hydraulic engineering, and who holds great promise for continuation of a high level of productivity in this profession. The awards are made at the biennial congresses of IAHR, where the most recent recipient delivers the Arthur Thomas Ippen Lecture. The Award fund, which was established by Professor Ippen's family, is authorised to receive contributions from association members and friends of Professor Ippen. The 2013 Award was made to George Constantinescu, Spain.

Rules for the administration of the award

1. The Arthur Thomas Ippen Award (hereinafter referred to as the Award) will be made biennially, in odd-numbered years, to a member of IAHR who has developed a conspicuously outstanding record of accomplishment as demonstrated by his research, publications and/or conception and design of significant engineering hydraulic works; and who holds great promise for a continuing level of productivity in the field of basic hydraulic research and/or applied hydraulic engineering.
2. In selection of awardees preference will be given to members under 45 years of age at the time of presentation of the Award in the Congress.
3. Each awardee will be selected by the IAHR Council from a list of not more than three nominees submitted to the Council by a Committee (hereinafter referred to as the Awards Committee) composed of the Technical Division Secretaries and chaired by IAHR Vice President, Prof. Marian Muste. The Awards Committee will actively seek nominations of awardees from the IAHR membership, and will publish at least annually in the IAHR Newsletter an advertisement, calling for nominations. The advertisement will include a brief description of the support material which is to accompany nominations.
4. The awardee for each year will be selected by the Council by mail ballot in January of the year of the Congress.
5. The award need not be made during any biennium in which the Council considers none of the nominees to be of sufficient high quality.
6. The awardee will present a lecture, to be known as the Ippen Lecture (hereinafter referred to as the Lecture), at the IAHR World Congress following his election. The subject of the Lecture will be agreed upon by the awardee and the IAHR President. The Lecture will be published in the Congress Proceedings. Public presentation of the Award will be made by the President during the opening ceremonies of the Congress.
7. The awardee will be given a suitable certificate which will state the purpose of the Award and indicate the specific contribution(s) of area(s) of endeavour for which the awardee is recognised. The awardee also will receive a monetary honorarium upon presentation of the Lecture. The terms of the honorarium will be published in the announcement of each biennial Award. The monetary honorarium for the Award is US$1,500.
8. Wide distribution of awardees among different countries and different areas of specialisation is to be sought by the Award Committee and by the Council.
9. No individual shall receive the Award more than once.

Previous Winners

G. Constantinescu, USA (2013) for outstanding contributions in the field of fluid mechanics and especially of turbulence modeling with applications to fluvial hydraulics and stratified flows.
X. Sanchez-Vila, Spain (2011) for his outstanding contributions in the field of groundwater flow and contaminant transport with application to flow modeling in heterogeneous porous media.
Y. Niño, Chile (2009) for his outstanding basic contributions in fluid mechanics with applications to sediment transport and environmental flow processes.
M. S. Ghidaoui, HK China (2007) for his outstanding contribution to research in environmental fluid mechanics.
A. M. Da Silva, Canada (2005) for her outstanding contributions in the area of fluvial processes and in particular, sediment transport.

19th Harold Jan Schoemaker Award

for the most outstanding paper in the Journal of Hydraulic Research

IAHR members are invited to submit candidates for nomination for the Harold Jan Schoemaker Award. This Award will be made for the 19th time at the the 36th IAHR World Congress to the author(s) of the paper judged the most outstanding paper published in the IAHR Journal of Hydraulic Research in the issues, starting with Volume 51 (2013) no. 5 up to and including Vol. 52 (2014) no. 4. A proposal for nomination shall be completed with a clear argumentation (maximum one page) regarding its outstanding quality and why the paper is of such a specific quality that it outweighs the other papers of the considered series.

Founding Statement

The Schoemaker Award was established by the IAHR Council in 1980 to recognise the efforts made by Professor Schoemaker, Secretary (1960-1979), in guiding the Journal of Hydraulic Research in its formative years. The Award is made biennially by the IAHR to the author(s) of the paper judged the most outstanding paper published in the IAHR Journal.

Rules for the administration of the Award

1. The Harold Jan Schoemaker Award (hereinafter referred to as the Award) will be made at each biennial IAHR Congress, to the author(s) of the paper judged the most outstanding and published in the IAHR Journal during the preceding two-year period.
2. The awardee will be selected by the IAHR Council from a list of not more than three ranked nominees submitted to the Council by a Committee (hereinafter referred to as the Award Committee) composed of the Technical Division Secretaries and chaired by Prof. Marian Muste. The Award Committee will actively seek nominations of awardees from the IAHR membership (also non-members whose employers are corporate members will be considered)
3. The awardee will be selected by the Council by ballot. The awardee(s) shall be notified immediately by the Executive Director.
4. An award need not be made during any biennium in which the Council considers none of the nominees to be of sufficient high quality.
5. The award will consist of a bronze medal and a certificate.

Previous Winners

V. Heller (2013) for the paper “Scale effects in physical hydraulic engineering models” Vol 49, 2011, Nº 3

H. Nepf (2013) for the paper “Hydrodynamics of vegetated channels” Vol. 50, 2012, Nº 3.

U. Chandra Kothyari, H. Hashimoto and K. Hayashi (2011) for the paper “Effect of tall vegetation on sediment transport by channel flows” (Volume 47, 2009, Nº 6)

H. Morvan, D.W.Knight, N.Wright, X.Tang (2009) for the paper “The Concept of Roughness in fluvial hydraulics and its formulation in 1D, 2D, and 3D numerical simulation models” (Vol. 46, 2008, Nº.2)

K.Blankaert and U.Lemmin (2007) for the paper “Means of noise reduction in acoustic turbulence measurements” (Vol. 44, 2006, Nº 1)

E.J. Wannamaker and E.E. Adams (2007) for the paper “Modelling descending carbon dioxide injections in the ocean” (Vol. 44, 2006, Nº 3)

A. Carrasco and C. A. Vionnet (2005) for the paper “Separation of Scales on a Broad Shallow Turbulent Flow” (Vol. 42, 2004, Nº 6)

5th M. Selim Yalin Award

for significant and enduring contributions to the understanding of the physics of phenomena and/or processes in hydraulic science or engineering, and demonstrated outstanding skills in graduate teaching and supervision

IAHR members are invited to submit candidates for nomination for the M.Selim Yalin Award. This Award will be made for the 5th time at the 36th IAHR World Congress. The Founding Statement and the Rules for Administration of the Award are as follows:

Founding Statement

The M. Selim Yalin Award was established by the IAHR Council in 2006 to honour the memory of Professor M. Selim Yalin, Honorary Member (1925-2007), and Fluvial Hydraulics Section Chairman (1986-1991). Professor Yalin is remembered for his prolific and pioneering research contributions in fluvial hydraulics and sediment transport, and for his inspirational mentoring of students and young researchers.

The Award is made biennially by IAHR to one of its members whose experimental, theoretical or numerical research has resulted in significant and enduring contributions to the understanding of the physics of phenomena and/or processes in hydraulic science or engineering and who demonstrated outstanding skills in graduate teaching and supervision. The awards consisting of a certificate and cash prize are presented during the IAHR World Congresses. The Award fund, which was established by the family and friends of Professor Yalin, is authorised to receive contributions from association members and friends of Professor Yalin.

Rules for the administration of the award

1. The IAHR M. Selim Yalin Award (hereinafter referred to as the Award) will be made biennially, in odd-numbered years, to a member of IAHR whose experimental, theoretical or numerical research has resulted in significant and enduring contributions to the understanding of the physics of phenomena and/or processes in hydraulic science or engineering and who has demonstrated outstanding skills in graduate teaching and supervision.
2. Each awardee will be selected by the IAHR Council from a list of not more than three nominees submitted to the Council by a Committee (hereinafter referred to as the Award Committee) composed of the Technical Division Secretaries and Chaired by a Council Member. The Award Committee will actively seek nomination of awardees from the IAHR membership, and will publish at least annually in the IAHR Newsletter an advertisement, calling for nominations. The advertisement will include a brief description of the support material which is to accompany nominations.
3. The awardee for each biennium will be selected by the Council either at its meeting during the preceding even-numbered year or by mail ballot in January of the year of the Congress.
4. The award need not be made during any biennium in which the Council considers none of the nominees to be of sufficient high quality.
5. Public presentation of the Award will be made by the President during a public ceremony taking place within the Congress.
6. The awardee will be given a suitable certificate which will state the purpose of the Award and indicate the specific contribution(s) of area(s) of endeavour for which the awardee is recognised. The awardee also will receive a monetary honorarium, the terms of which will be published in the announcement of each biennial Award.
7. Wide distribution of awardees among different areas of specialisation is to be sought by the Award Committee and by the Council. Efforts will also be made to ensure a wide geographical distribution.
8. No individual shall receive the Award more than once.

Previous Winner

Y. Shimizu, Japan (2013) for outstanding science and excellence in teaching and mentorship of young professionals as well as contribution to applied projects.

Prof. Ian Wood (2011) for outstanding contributions in the field of hydraulic engineering and especially in the experimental research of hydraulic structures, as well as in the teaching and supervision of graduate students from around the world.

PEOPLE & PLACES

A sad moment

Torkild Carstens (1931-2014)

Torkild was associated with IAHR for almost 40 years. Torkild served as a member of IAHR Council, as a Vice-President and as President of the Association in the years 1991 to 1995. A review of the Association's activities during that period reveals Torkild's significant contributions to IAHR guiding the Association into new engagements with global water affairs. This includes the World Water Convention that IAHR adopted at its 1993 Tokyo congress and the active support of the formation of the World Water Council. During his presidency, the African Regional Division was established. He introduced the topic of "hydro-diplomacy" and promoted the global aspects of water sciences, ecology and water engineering. Torkild was awarded honorary membership of IAHR in 1999. For the full obituary, please go to www.iahr.org under the obituaries section.

Recent PhD Awards

Jose María Carrillo of UPTC, Spain for his thesis entitled “Numerical and experimental methodology for design of plunge pools in the overtopping of concrete dams"
This thesis is available at http://hdl.handle.net/10317/4038 (in Spanish)
Supervisor: Luis Castillo, Professor UPTC

New Leadership Team of the IAHR/IWA Joint Committee on Marine Outfall Systems

Chair
Prof. Adrian Wing-Keung Law
School of Civil and Environmental Engineering
Director, DHI-NTU Centre, Nanyang Environment and Water Research Institute
Nanyang Technological University
Singapore

Vice Chair
Dr. Daniel Botelho
BMT WBM Pty Ltd
Water & Environment
Australia

News from the UCF Student Chapter

Five students from University of Central Florida’s Coastal Hydroscience, Analysis and Predictive Simulations (CHAMPS) Laboratory attended the first annual Young Coastal Scientists and Engineers Conference - North America (YCSEC-NA) 2014 held at the University of Delaware. Davina Passeri, a PhD Candidate in Civil Engineering, won the award for best oral presentation on the impacts of bathymetric, morphological and sea level changes on tidal hydrodynamics in the Grand Bay, MS estuary from 1848 to 2005. Also in attendance were Karim Alizad (PhD Student, Civil Engineering), Milad Hooshyar (PhD Student, Civil Engineering), Paige Hovenga (Master Student, Civil Engineering) and Aaron Thomas (Undergraduate Student, Civil Engineering). The students are all members of the IAHR - UCF Student Chapter and received travel funds through the UCF Student Government Association.

From left to right: Paige Hovenga, Davina Passeri, Aaron Thomas, Karim Alizad, Milad Hooshyar.

IAHR Universidad Nacional de Colombia Young Professionals Network

Universidad Nacional de Colombia - Sede Bogotá
Grupo de Investigación en Ingeniería de Recursos Hídricos - GIREH
President: Alejandra Botero Acosta
Vice President: Karol Yinet Parra Castro
Secretary: Luis Camilo Suescún Casallas

Alistair Borthwick new Position

Alistair G.L. Borthwick has moved from University College Cork to the University of Edinburgh as Professor of Applied Hydrodynamics of the Institute of Energy Systems within the School of Engineering. Prof. Borthwick has recently been elected a Fellow of the Royal Academy of Engineering in the U.K.

PEOPLE & PLACES

NEW NATIONAL CHAPTER: MALAYSIA

We are happy to welcome the Malaysia National Chapter. The most recent events under this National Chapter have been the 13th International Conference on Urban Drainage (ICUD) and a Workshop on Sustainable Urban Water Design. The next activity is the 37th IAHR World Congress, 14-18 August 2017, Kuala Lumpur, Malaysia.
For more information go to the IAHR website/national chapters/malaysia.

IAHR Institute Members News

New Institute Member:
Sultan Qaboos University, Oman
For more information: www.squ.edu.om

CETMEF, France, has became an administrative public institution named CEREMA
For more information: www.cerema.fr

New Chair of the IAHR Ice Research and Engineering Committee

Dr. Matti Leppäranta
Department of Physics
University of Helsinki, Finland

New Secretary of the Asian Pacific Division - APD -

Prof. Jing Peng
Director, Division of International Cooperation
China Institute of Water Resources and Hydropower Research (IWHR), Beijing, China

IAHR and PIANC Sign Collaboration Agreement

IAHR and PIANC, the World Association for Waterborne Transport Infrastructure, recently signed a memorandum of understanding for collaboration in areas of mutual interest - which could include lock design and operation and port design and operation.

IAHR Secretary General, Ramon Gutierrez Serret with Louis Van Schel Secretary General of PIANC

IAHR Scientific Associate of ICSU

The national academies of science of most countries around the world are members of ICSU, and delegates attending IAHR-sponsored congresses may be able to apply for funding support for travel costs through the national bodies. For more information visit www.icsu.org

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