Volume 2, Issue 1

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1. Introduction

The fourth issue of the IAHR Cardiff Young Professional Network (YPN) newsletter provides a summary of the different activities accomplished over the last few months and an overview of some of the work carried out by our members. During this period the new YPN committee have maintained the spirit and determination required to continue growing our network and to improve the opportunities it provides both professional and socially.

A highlight and stand out event of the last few months was an afternoon of presentations given by the YPN at the Atkins office in Cardiff. This consisted of an introduction outlining the main features and benefits of our network followed by presentations from HRC PhD researchers. This successful activity is expected to be the first of a series of presentations to be held in prominent water engineering companies throughout South Wales, in order to show the capabilities and opportunities that this organisation offers.

Research updates from some of our members are included within the bulletin in addition to information about a third micro-presentation evening coming up on 4th May. This event will allow current and new members to present their work in a dynamic 'elevator-pitch' format that has been praised by the attendants of past events.

2. Events

Welsh Tidal Energy Options & Challenges

25/11/2015

Cardiff University, Faculty Lecture Theatre, Trevithick Building, The Parade, Cardiff CF24 3AA

CIWEM Welsh Branch, in collaboration with ICE, organised a presentation evening on the topic of Welsh Tidal Energy Options and Challenges, held at Cardiff University School of Engineering. The first two presentations of the evening were given by members of the YPN. Dr Athanasios Angeloudis talked on recent studies into the implementation of tidal range projects along the Welsh coastline and Severn estuary. Sam Bray discussed his recent work to improve the numerical modelling of the Severn Barrage. The third and final presentation of the evening was given by Dr Paul Evans from Intertek Energy & Water Consultancy Services, an alumni of Cardiff University, who tried to answer the question, are energetic tidal straits suitable for power generation?

ENGIN Da Vinci Innovation Awards 2015-2016

25/11/2015

Park Plaza Hotel, Greyfriars Road, Cardiff

The 3rd Da Vinci Innovation Awards event was hosted by the Cardiff School of Engineering last year. Twenty presenters, including staff, postgraduate and undergraduate students, pitched their projects in a time limit of 3 minutes to an audience of more than 100 guests, who voted for those projects they thought most innovative. Each winning pitch has received a grant of £3,000 from the School of Engineering to start their project.

Figure 1. The 20 participants of the Da Vinci Innovation Awards 2015-2016. Among them, Valentine Muhawenimana (first row, 3rd from right) and Saad Mulahasan (first row, 2nd from left).

Two members of our Cardiff YPN from the Cardiff University HRC took part in this competition, namely Valentine Muhawenimana with the project "Going with the Flow: Fish Friendly Engineering" and Saad Mulahasan with the project "Free surface visualization of open channel flows".

We would like to congratulate Valentine for being one of the winners of the evening.

YPN micro-presentation event at Atkins (Cardiff's offices)

09/12/2015

In collaboration with Atkins, the Cardiff Young Professional Network (YPN) organised a micro-presentation event that allowed PhD students and Research Associates from the Cardiff University Hydro-environmental Research Centre (HRC) to present part of their research giving each a 5-minute long presentation following by questions and networking. There were 5 presenters in total, 3 PhD students and 2 research associates.

Figure 2. Participants of micro-presentation event at Atkins.

This idea of introducing the Young Professionals Network to the companies is expected to be continued in other leading water engineering companies, which would expand more the work and network of our group.

Christmas Dinner of the HRC

9/12/2015

The annual Christmas dinner of the Hydro-environmental Research Centre of Cardiff University was successfully organised last year by the YPN committee. The dinner had great attendance as it brings together all the members of the Cardiff University HRC.

Figure 3. HRC Christmas dinner 2015.

3. Research progress

Large-eddy Simulations of Flow and Turbulence in an Asymmetric Compound Channel

By Ken Vui Chua

Asymmetric compound channels consist of a main channel that carries the bank-full, more frequent discharges and inundated floodplains of different width on either side of it. This channel morphology is ubiquitous in the natural environment, however detailed investigations of flow and turbulence properties are rare despite increases in flood extent and frequency and the concomitant flood damages due to global warming. In compound open channel flow, momentum transfer occurs at the interface between main channel and floodplains due to the prevailing cross-streamwise gradient in streamwise velocity. The resulting shear layers produce additional energy losses and reduce the overall discharge capacity of the system.

Under the supervision of Professor Thorsten Stoesser, this research is focused on the numerical simulation of the flow and turbulence in an asymmetric compound channel using the in-house Hydro3D code (visit http://hydro3dproject.github.io). This large eddy simulation (LES) code solves the governing equations of unsteady, incompressible, viscous Newtonian flow. LES resolves the largest, energy-carrying turbulent eddies on a staggered Cartesian grid while the effects of smaller, dissipative scales of turbulent motion are modelled mathematically using the WALE sub-grid scale model. The WENO differencing scheme is

employed to approximate the convective and diffusive fluxes and the solution is advanced in time using the fractional-step method with a three-step Runge-Kutta prediction. The solution of the Poisson pressure-correction equation is provided by a multigrid method. The geometries of the structures in the compound channel are defined by the immersed boundary method, which maps Eulerian velocities onto Lagrangian point-based representations of non-fluid bodies in the flow. This implementation of the Immersed Boundary Method (IB) follows a refined version Uhlman's direct forcing approach. This project is made possible by the Raven supercomputer provided by Advance Research Computing at Cardiff University (ARCCA).

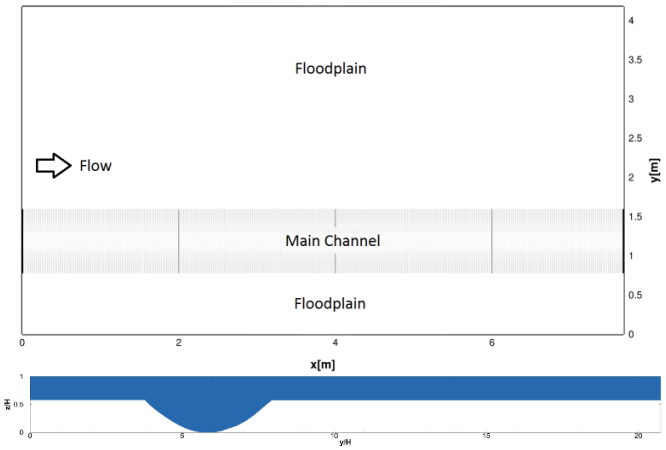

Figure 4. Domain of the asymmetric compound channel in plan (top) and cross-sectional view (flow direction out of paper) (bottom).

This numerical simulation corresponds to the complementary experiments that were carried out at the Georgia Institute of Technology's hydraulic laboratory. At this stage of the project, comparison of the streamwise and time averaged u-velocity profile were made between numerical and experimental results. The agreement between the LES and experimental results is relatively good, see Figure 2.

Further works on the compound channel will include abutments and a bridge, simulating three flood scenarios; free-flow, submerged orifice and overtopping cases. Free-flow is where water level is below the bridge level, a submerged orifice is where water level is at the height of the bridge and an overtopping case is where water level is above the bridge.

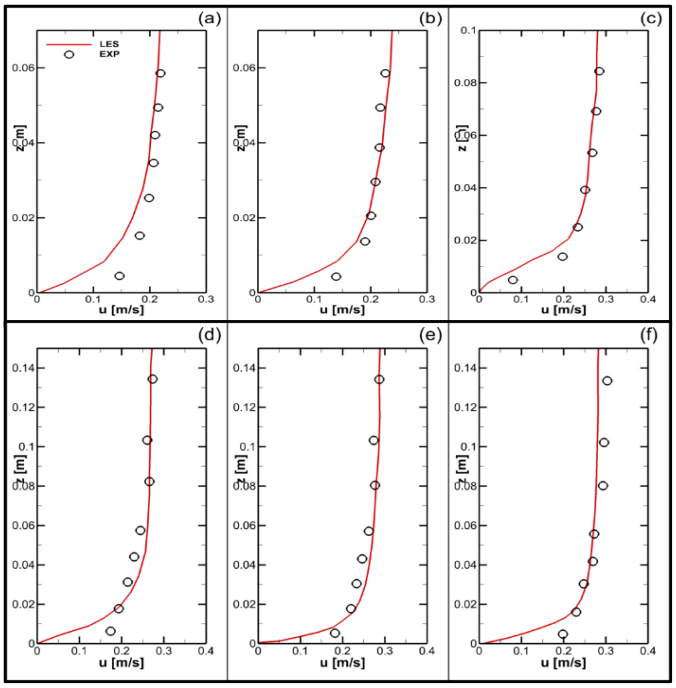

Figure 5. Stream-wise and time averaged u-velocity profile comparing to experimental results. (a)-(c), 3 locations at Y-plane at floodplain, (d)-(f), 3 locations at Y-plane in main channel.

For more information about this project, please contact: Ken Vui Chua, chuakv@cardiff.ac.uk.

Free surface dynamics of open channel flows

By Saad Mulahasan

River flows, flow over weirs, water waves and man-made structures convey water with a free surface, i.e. exposed to the atmosphere. To better understand the complex turbulent flow occurring in these conditions, physical experiments were carried out and analysed, focussing on a number of physical models of free surface dynamics of open channel flows. This research was carried out under the supervision of Professor Thorsten Stoesser.

Visualization of water flow around vegetation is generally carried out using techniques whereby different materials are placed in the flow path and optical imaging is used to track the resulting fluid motion. Significant improvements have been made in this area, benefiting from recent advancements in technology. This has enabled the collection of higher quality and more accurate data and the development of powerful new techniques. Thermal cameras are used to detect, measure and collect the radiated thermal energy and convert this to

signals that can be processed to obtain the image with a colour code. Infrared thermography techniques (IR) may be used in a variety of water science studies such as water resources, hydraulics, hydrology, fluid dynamics, and soil and water preservation. One such technique is the addition of a hot water heat tracer to flows which can be visualized using optical thermal techniques. Using thermography techniques makes it possible to detect more information about the flow structure which may be used for analysis, such as coherent structures (vortices) at the water surface.

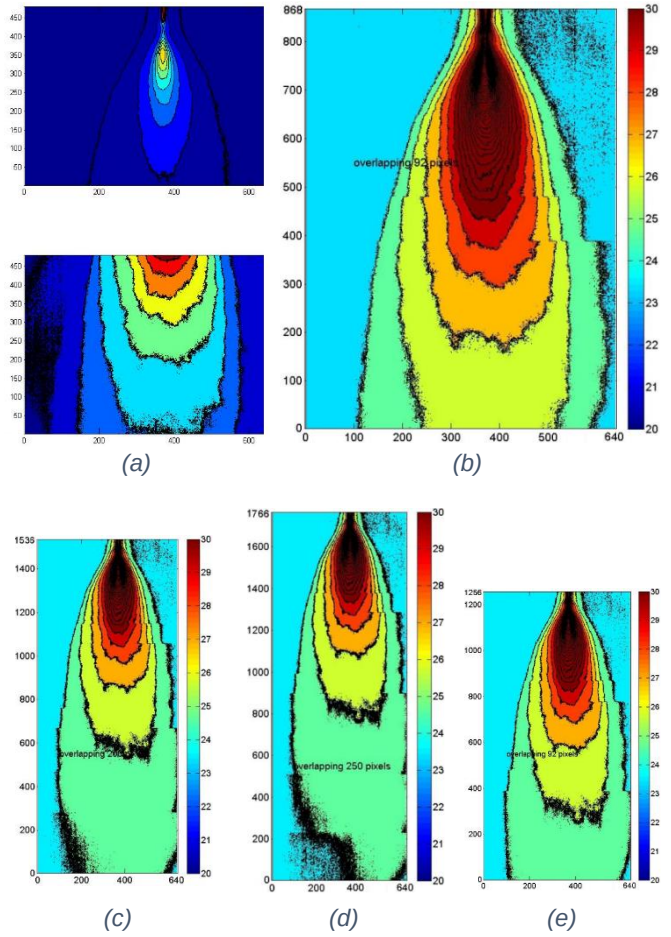

Figure 6. Longitudinal overlaps (a) The first squares (b) overlap1 (c) overlap2 (d) overlap3 (e) overlap 4 for the shear layer at the interface between the main channel and the floodplain for the case of without vegetation on the floodplain for Q = 4.66 l/s. (All the dimensions in pixels).

The process of visualizing shear layer formation using thermal video sequences captured at the interface between the main channel and the floodplain in a shallow flow compound channel was studied. A thermal camera (SC640) operating at 5Hz frequency and 640x480 pixels resolution was mounted vertically at 0.6m above a shallow flow compound channel at the interface between the main channel and the floodplain where a fully developed flow had been achieved. Hot water was then added at the water surface using a small tube at ambient condition at the interface between the main-channel and floodplain. This set-up enabled flow temperature differences to be recorded at 5 locations longitudinally and at 3 locations transversely.

Flir's image processing software and Matlab were used to extract and analyse captured water surface temperature data. Image processing was initially carried out for five locations at the junction edge of the floodplain adjacent to the main channel, with longitudinal overlaps between any two successive images, to creating a section showing the shear layer at the centre (see Fig.6). The five locations surrounding the centre were similarly combined with longitudinal overlaps to create second and third sections of the shear layer, the three sections were then combined to visualize the entire shear layer. Firstly the centre and left sections were horizontally overlapped, following which the process was repeated for the centre and right sections. Visualization of the final shear layer image in Tec-plot (see Fig.7) showed that the shear layer at the interface between the main channel and the floodplain is well captured and quantified by this technique.

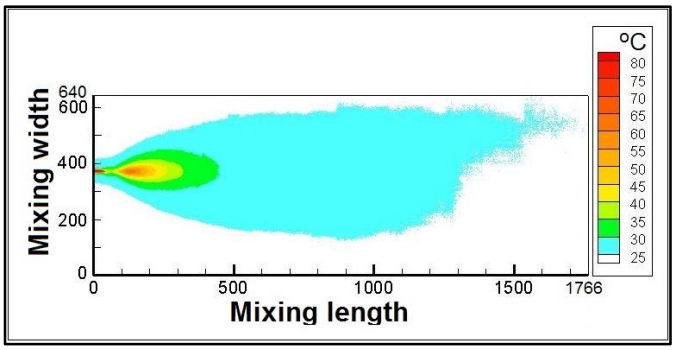

Figure 7. Shear layer form at the interface between the main channel and non-vegetated floodplain in compound channel flow for the case of Q = 4.66 l/s. (Dimensions in pixels).

This research was presented in the 10th Pacific Symposium on Flow Visualization and Image Processing Naples, Italy, 15-18 June, 2015.

For more information about this research, please contact: Saad Mulahasan, mulahasansh@cardiff.ac.uk.

4. Future activities

Tests – White Water Rafting

16/3/2016

A new prototype of a cross-flow turbine will be tested at Cardiff International White Water rafting centre later this month. Similar experiments have been run over the last year in order to complete the intermediate development stage of this technology at Cardiff University. This included small scale testing in the hydraulics facilities at the School of Engineering which provided the knowledge required to manufacture the 1:15 scale turbine to be deployed at the White Water centre.

These tests represent a very significant stage for the project. As laboratory tests indicated the power coefficients of the turbine to be between the expected ranges we will be able to check the reliability of these results. A journal paper detailing the information of the tests is expected to be written in the near future.

The next stages of the turbine development include scaling up to a 1:5 ratio and further research in the laboratory and at the White Water centre to enable further improvement of this technology.

If anybody is interested in knowing more about the project or has any questions, please do not hesitate to contact Luis Priegue (priegueL@cf.ac.uk).

CIWEM Annual Dinner

8/4/2016

On the 8th of April, the Charted Institution of Water and Environmental Management (CIWEM) will hold the Welsh Branch Annual Dinner at the Jurys Inn Hotel, Cardiff. This dinner organised by CIWEM has been kindly open both the CIWEM New Members Group and the Young Professional Network members.

The presence of many recognised professionals within fields related to hydraulics will provide a nice networking opportunity and a great example of the benefits that CIWEM accreditation may offer.

Micro-presentations

4/5/2016

Faculty Lecture Theatre, Trevithick Building, The Parade, Cardiff, CF24 3AA

In collaboration with CIWEM Welsh Branch, the Cardiff Young Professionals Network (YPN) is organising another micro-presentation event. This 5-minute “elevator pitch” will allow PhD students and Research Associates from the Cardiff University Hydro-environmental Research Centre (HRC) and the graduates from companies that belong to the network to get to know their work and projects, enhancing the collaboration possibilities between members.

Provisionally there will be 7 Ph.D. students and 2 research associates giving a glimpse of their work, although the speakers list is not completely defined.

In the past this event has proven to be very successful, with attendance growing year on year. The event is fast paced and dynamic, allowing attendees a brief insight into many different topics in a short period of time, acting as a “teaser” and encouraging conversation between presenters and the audience.

Refreshments and an event booklet prepared by the Cardiff YPN will be handed out to attendees on the day.

5. Publications

Congratulations to Research Assistant Bruño Fraga of HRC for the most downloaded paper from the Journal of Ocean Modelling:

> Fraga B, Stoesser T, Lai C.K and Socolofsky S. (2015). A LES-based Eulerian–Lagrangian approach to predict the dynamics of bubble plumes. Ocean Modelling. *10.1016/j.ocemod.2015.11.005*

Journal Papers

Published in November 2015:

1. Gao, G., Falconer, R. A. and Lin, B. 2015. Modelling the fate and transport of faecal bacteria in estuarine and coastal waters.

Marine Pollution Bulletin. 100(1), 162-168. Open Access doi: 10.1016/j.marpolbul.2015.09.011

Published in February 2016:

2. Harries, T., Kwan, A., Brammer, J. and Falconer, R. 2016. Physical testing of performance characteristics of a novel drag-driven vertical axis tidal stream turbine; with comparisons to a conventional Savonius. International Journal of Marine Energy. In Press Online. Open Access. doi: org/10.1016/j.ijome.2016.01.008

3. Xia, J., Teo, F., Falconer, R. A., Chen, Q. and Deng, S. 2016. Hydrodynamic experiments on the impacts of vehicle blockages at bridges. Journal of Flood Risk Management. In Press Online. doi: 10.1111/jfr3.12228

4. Osei-Twumasi, A., Falconer, R. A. and Ahmadian, R. 2016. Coupling surface water and groundwater flows in a laboratory model using foam as artificial groundwater material. Water Resources Management. 30, 1449-1463. doi: 10.1007/s11269-016-1232-y

Published in March 2016:

5. Angeloudis, A., Ahmadian, R., Falconer, R. A. and Bockelmann-Evans, B. 2016. Numerical model simulations for optimisation of tidal lagoon schemes. Applied Energy. 165, March, 522-536. Open Access doi: org/10.1016/j.apenergy.2015.12.079

6. Angeloudis, A., Stoesser, T., Gualtiere, C. and Falconer, R. A. 2016. Contact tank design im-pact on process performance. Environmental Modeling & Assessment. In Press Online. Open Access. doi: 10.1007/s10666-016-9502-x

Published in April 2016:

7. Bray, S., Ahmadian, R. and Falconer, R. A. 2016. Impact of representation of hydraulic struc-tures in modelling a Severn Barrage. Computers and Geosciences. In Press Online. Open Access. doi: 10.1016/j.cageo.2016.01.010

Conference Papers

1. Angeloudis, A., Ahmadian, R., Bockelmann-Evans, B. and Falconer, R. A. 2015. Numerical modelling of a lagoon along the North Wales coast. Proceedings of 1st Renewable Energies Offshore Conference, Lisbon, Renewable Energies Offshore, Taylor & Francis, London. Ch. 17, 139-145.

2. Bray, S., Ahmadian, R. and Falconer, R. A. 2015. Sensitivity study of modelling of Severn Barrage performance. Proceedings of 1st Renewable Energies Offshore Conference, Lisbon, Renewable Energies Offshore, Taylor & Francis, London. Ch. 18, 147-152.

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