PROGRAM

3rd IAHR Europe Congress

April 14 – 16, 2014

Department of Civil Engineering, Faculty of Engineering, University of Porto, Portugal

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TECHNICAL PROGRAM

Sunday, April 13th, 2014

16:00 – 17:00 **Registration**

17:00 – 18:00 **Welcome Drink | Students' Musical Moment**

Place: **FEUP** **(area E – please consult the congress map)**

Monday, April 14th, 2014

08:00 – 09:00 **Registration**

09:00 – 09:30 **Opening Ceremony**

Room: **Auditorium**

Chair: **Aronne Armanini**, **A. Betâmio de Almeida** and **F. Veloso Gomes**

Sebastião Feyo de Azevedo, Dean of the Faculty of Engineering of the University of Porto
Aronne Armanini, IAHR Europe Division Chair
António Betâmio de Almeida, Local Organizing Committee Chair
Fernando Veloso Gomes, Local Organizing Committee Chair
Roger Falconner, IAHR President
António Abel Henriques, Civil Engineering Department of FEUP

09:45 – 11:00 **Keynote Lectures 1&2 and IAHR 2015 Congress**

Room: **Auditorium**

Chair: **A. Betâmio de Almeida** and **Fernando Veloso Gomes**

09:50 – 10:20 ***Water: the challenge of sustainability***
Francisco Nunes Correia

10:20 – 10:50 ***Mitigation of climate change – the case of Rio de Janeiro. Improving Climate Resilience***
Suzana Kahn Ribeiro

10:50 – 11:00 ***Presentation of the IAHR 2015 Congress***
Arthur E. Mynett, IAHR Vice President /Chair LOC WC 2015

11:00 – 11:30 **Coffee-Break**

11:30 – 13:00 **Journal of Applied Water Engineering and Research (JAWER) Session (1)**

Room: **B032**

Chair: **Teodoro Estrela**

Presentation: 12 min | Q&A: 3 min

11:30 – 12:15 **Introduction to the joint IAHR-WCCE initiative**
Roger Falconner, *IAHR President*

JAWER DEBATE: Putting Science into Practice
Teodoro Estrela, *JAWER Deputy Editor in Chief*

12:15 – 12:30 **Characterizing wave breaking on rubble mound breakwaters on steep bottom slopes** **(Page. 64)**
M.P. Herrera, J. Molines, V. Pardo, M.E. Gómez-Martãn J.A. González-Escrivá and J.R. Medina

12:30 – 12:45	**An experimental study of an oscillating water column with different bottom configuration** V. Sundar, S.A. Sannasiraj, John Ashlin and B. Jegatheeswaran	(Page. 96)
12:45 – 13:00	**Refinements to turbine representation in modelling the Severn barrage** Samuel Bray, Reza Ahmadian and Roger A. Falconer	(Page. 195)

11:30 – 13:00 Wave-Structure Interaction

Room: **B001**

Chair: **Peter Troch**

Presentation: 12 min | Q&A: 3 min

11:30 – 11:45	**Scour around marine foundations in layered sediments: a mathematical modelling approach** Tiago Ferradosa, Francisco Taveira Pinto, Bruno Oliveira, Richard Simons and Kate Porter	(Page. 90)
11:45 – 12:00	**Full-scale wave overtopping resiliency tests of grass established on sandy soils** Christopher Thornton, Steven Hughes and Jeffrey Beasley	(Page. 50)
12:00 – 12:15	**Analysis of the performance of swash in harbour domains** Joan Alabart, Agustin Sánchez-Arcilla and Gerbrant Van Vledder	(Page. 53)
12:15 – 12:30	**Port breakwater development in Spain. The last fifteen years** R. Gutierrez-Serret, J.M.Grassa, and J.I. Grau	(Page. 111)
12:30 – 12:45	**Numerical modelling of free surface flow through porous structures with openFOAM** Pablo Higuera, Javier L. Lara and Iñigo J. Losada	(Page. 97)

11:30 – 13:00 Hydraulic Structures I

Room: **B002**

Chair: **Anton J. Schleiss**

Presentation: 12 min | Q&A: 3 min

11:30 – 11:45	**Hydraulics of circular bottom intake orifices** Mustafa Gogus and Muhammed Bulut	(Page. 130)
11:45 – 12:00	**Experimental investigation of beyhan 1 dam and hydroelectric power plant water intake structures** Mustafa Gogus, A.Burcu Altan-Sakarya, Ismail Aydin, Mete Koken, Cuneyt Yavuz, Ali Ersin Dincer and Kutay Yilmaz	(Page. 138)
12:00 – 12:15	**Experimental and numerical study of water intakes: case study of the Foz tua hydropower plant** Inês Meireles, Soraia Silva, Teresa Viseu and Vitor Sousa	(Page. 188)
12:15 – 12:30	**Constructing a correlation between flow resistance of circular corrugated pipes and geometric parameters using CFD methods** Saeed Vazifehkhah, Kenan Kaya, Alilhsan Koca and Zafer Gemici	(Page. 12)
12:30 – 12:45	**Airflow computational in partially filled conduits using CFD** Sarai Diaz and Javier Gonzalez	(Page. 152)

11:30 – 13:00 Climate Change and Eco-Hydrology

Room: **B003**

Chair: **Peter Goodwin**

Presentation: 12 min | Q&A: 3 min

11:30 – 11:45	**Modeling the influence of the climate change on the vegetation pattern variation using a cellular automata model** Domenico Caracciolo, Erkan Istanbulluoglu and Leonardo V. Noto	(Page. 18)

11:45 – 12:00	**Thermodynamics of hydrologic systems explains vegetation patterns in river basins** <u>Manuel del Jesus</u>, Romano Foti, Andrea Rinaldo and Ignacio Rodriguez-Iturbe	(Page. 34)
12:00 – 12:15	**Climate-proofing of large reservoirs in Belgium by the development of enhanced operation rules** <u>Martin Bruwier</u>, Benjamin Dewals, Sébastien Erpicum, Michel Pirotton and Pierre Archambeau	(Page. 203)
12:15 – 12:30	**Modeling the shrub encroachment in the northern chihuahuan desert grasslands with a cellular automata model** <u>Domenico Caracciolo</u>, Erkan Istanbulluoglu and Leonardo V. Noto	(Page. 149)
12:30 – 12:45	**The importance of mulching on soil and water dynamics: laboratory experiments under simulated rainfall** <u>João R.C.B. Abrantes</u>, A.A.A. Montenegro, V.P. Silva Júnior and J.L.M.P. de Lima	(Page. 41)

13:00 – 14:00 Lunch

14:00 – 14:30 Poster Session (2 minutes presentation for evaluation)

Chair: **Rui Aleixo**

14:30 – 16:00 Journal of Applied Water Engineering and Research (JAWER) Session (2)

Room: **B032**

Chair: **Teodoro Estrela**

Presentation: 12 min | Q&A: 3 min

14:30 – 14:45	**Impact of different sources of uncertainty on the free surface profile in a natural river in flood conditions. An approach based on the Monte Carlo simulation technique** <u>Maria Manuela Portela</u>, António Betâmio de Almeida and Ana Isabel Oliveira	(Page. 216)
14:45 – 15:00	**Influence of hydraulic resistance on flow features in an open channel confluence** <u>S. Creëlle</u>, T. de Mulder, L. Schindfessel and T. Van Oyen	(Page. 189)
15:00 – 15:15	**Hydrodynamics of flow in the vicinity of wall-mounted cylinder with fitted collar** <u>O. Birjukova</u>, P. Sanches, R.M.L. Ferreira and A.H. Cardoso	(Page. 23)
15:15 – 15:30	**Steel-lined pressure tunnels and shafts in anisotropic rock** <u>Alexandre J. Pachoud</u> and Anton J. Schleiss	(Page. 141)
15:30 – 15:45	**Comparison of piano key weir discharge coefficients from experimental and numerical models** <u>Mario Oertel</u> and Blake P. Tullis	(Page. 151)

14:30 – 16:00 Coastal Morphological Numerical Modelling

Room: **B001**

Chair: **Javier L. Lara**

Presentation: 12 min | Q&A: 3 min

14:30 – 14:45	**Numerical analysis of groundwater in a drained beach** <u>Alessandra Saponieri</u> and Leonardo Damiani	(Page. 79)
14:45 – 15:00	**Numerical modelling of the erosion phenomena on nice shoreface using TELEMAC system** Rémi Dumasdelage, Olivier Delestre, Didier Clamond, Arnaud Bonnin, Michaël Moretti, Patrick Ceruti and <u>Philippe Goubesville</u>	(Page. 108)
15:00 – 15:15	**Production of regional shingle sediment budgets from beach monitoring data in southeast England** Alec Dane, Jonathan Clarke and Uwe Dornbusch	(Page. 61)
15:15 – 15:30	**Modelling sediment resuspension caused by navigation, waves and currents (gulf of Trieste, northern Adriatic)** <u>Dušan Žagar</u>, Vanja Ramšak, Maja Jeromel, Marko Perkovič, Matjaž Ličer, and Vlado Malačič	(Page. 86)

15:30 – 15:45	**Longshore transport at shingle beaches** Roberto Tomasicchio and Felice D'Alessandro	(Page. 105)

14:30 – 16:00 River Modelling and Engineering

Room: **B002**

Chair: **Ana M. Ferreira da Silva**

Presentation: 12 min | Q&A: 3 min

14:30 – 14:45	**Numerical modeling of compound channel flows** E. Awad	(Page. 147)
14:45 – 15:00	**Flow structure around two rows of cylindrical rods in floodplain of a compound channel** Alireza Keshavarzi and James Ball	(Page. 24)
15:00 – 15:15	**Velocity measurements in compound open channel with pile permeable groynes** Hassan Safi H. Ahmed, Mona M. Mostafa, Gamal Abozied Abelraheem, Nashaat Abdllah Ali and Akihiro Tominaga	(Page. 21)
15:15 – 15:30	**Numerical 3D simulation for groin flow characteristics upstream the gauge Hattingen at river Ruhr** Jan Balmes and Mario Oertel	(Page. 155)
15:30 – 15:45	**John Fisher Kennedy's contributions to the advancement of river engineering** Robert Ettema	(Page. 196)

14:30 – 16:00 Environmental Hydraulics: Water Quality I

Room: **B003**

Chair: **Paulo Rosa Santos**

Presentation: 12 min | Q&A: 3 min

14:30 – 14:45	**Mathematical modeling of the dispersion-diffusion of momentum and solutes in channel bends** Valerio Caleffi and Alessandro Valiani	(Page. 126)
14:45 – 15:00	**Multiphase CFD modeling of nearfield fate of sediment plumes** Sina Saremi and Jacob Hjelmager Jensen	(Page. 127)
15:00 – 15:15	**Hydraulic aspects of a field experiment on the influence of temperature increase on a manipulated stream ecosystem** J.L.M.P. de Lima and C. Canhoto	(Page. 14)
15:15 – 15:30	**Stream diurnal profiles of dissolved oxygen - case studies** A. Rajwa, P.M. Rowiński, R.J. Bialik and M. Karpiński	(Page. 32)
15:30 – 15:45	**Predicting bacteria movement in rivers - a computational tool based on physical experiments on the fate and transport of bacteria** Kordula Schwarzälder, Minh Duc Bui and Peter Rutschmann	(Page. 38)

16:00 – 16:30 Coffee-Break

16:30 – 18:00 Coastal and Tidal Extremes

Room: **B032**

Chair: **Valeri Penchev**

Presentation: 12 min | Q&A: 3 min

16:30 – 16:45	**Influence of circulation weather types on the tide levels along the Portuguese coast** P. Pinotes, M.A.V.C. Araújo, A. Trigo-Teixeira and I.F. Trigo	(Page. 73)
16:45 – 17:00	**Simulation of a storm surge event in the Tagus estuary** J. Rolim, M.A.V.C. Araújo and A. Trigo-Teixeira	(Page. 91)

17:00 – 17:15	**A tsunami in Lisbon - assessment of critical areas** D. Conde, M.J. Telhado, C. Antunes and R.M.L. Ferreira	(Page. 94)
17:15 – 17:30	**From long wave to short wave evolution** Rodney J. Sobey	(Page. 51)
17:30 – 17:45	**Influence of initial boundary conditions on undular tidal bores** L. David, B. Lebon, L. Chatellier and D. Calluaud	(Page. 60)

16:30 – 18:00 Hydraulic Structures II

Room: **B001**

Chair: **Elsa Carvalho**

Presentation: 12 min | Q&A: 3 min

16:30 – 16:45	**Salamonde II repowering project: natural flood protection of the outlet structure** Vítor Ribeiro, Adriano Oliveira, Sílvia Amaral, José Falcão de Melo and João Nuno Fernandes	(Page. 156)
16:45 – 17:00	**Complementary spillway of Salamonde dam: physical and 3D numerical modelling** Miguel R. Silva, Lúcia T. Couto and António N. Pinheiro	(Page. 172)
17:00 – 17:15	**River bed protection corrective measures downstream of a movable dam founded in a deep alluvia. The case of Crestuma-Lever dam, in Douro river** José Dias da Silva, José Melo, Irene Fernandes, Laura Caldeira and Luís Mendonça	(Page. 142)
17:15 – 17:30	**Scour analysis downstream of Paute-Cardenillo dam** Luis G. Castillo and José M. Carrillo	(Page. 162)
17:30 – 17:45	**Scour analysis downstream a converging stepped spillway equipped with a ski jump bucket** N. Figueiredo, E. Carvalho and F. Taveira Pinto	(Page. 185)

16:30 – 18:00 Risk Management of Floods and Draughts

Room: **B002**

Chair: **J. Ferreira Lemos**

Presentation: 12 min | Q&A: 3 min

16:30 – 16:45	**Flood mapping at river Tagus: A methodology based on mathematical modelling and SAR imaging** R.B. Canelas, S. Heleno, R. Pestana and R.M.L. Ferreira	(Page. 213)
16:45 – 17:00	**Methodology for flood resilience index** Jelena Batica and Philippe Gourbesville	(Page. 215)
17:00 – 17:15	**Decision support system for flood forecasting in the Ebro and Guadalquivir river basins** E. García, A. Moya, A. Andrés, A. Castiella, E. Martínez and E. García	(Page. 209)
17:15 – 17:30	**Drought risk and climate change impacts on Querença-Silves aquifer and Odelouca Watershed (Algarve - PT)** M.E. Novo, M.M. Oliveira and L. Oliveira	(Page. 16)
17:30 – 17:45	**Global sea surface temperature as drought predictor** Manuel del Jesus, Justin Sheffield, Fernando Méndez, Iñigo Losada and Antonio Espejo	(Page. 214)

16:30 – 18:00 Water Pressure Systems

Room: **B003**

Chair: **Massimo Greco**

Presentation: 12 min | Q&A: 3 min

16:30 – 16:45	**Hydraulic transients in pumping systems with horizontal pipes** João Delgado, Dídia I.C. Covas and António Betâmio de Almeida	(Page. 143)

16:45 – 17:00	**Experimental investigation into the rapid reserve generating capability of Francis-type turbines** Dean R. Giosio, Alan D. Henderson, Jessica M. Walker, Paul A. Brandner and Jane E. Sargison	(Page. 153)
17:00 – 17:15	**Determination of the quality of water hammer software using lab and field measurements** Sam van der Zwan, Michiel Tukker and François Clemens	(Page. 167)
17:15 – 17:30	**Characteristics of air-water interface of air pockets in a conduit** Chang Lin, Chia Hsun Lu, Ting Liu and James Yang	(Page. 178)
17:30 – 17:45	**Velocity distribution in a pressurized pipe flow using CFD: mesh independence analysis** Nuno M.C. Martins, Nelson J.G. Carrião, Dídia I.C. Covas and Helena M. Ramos	(Page. 145)

16:30 – 18:00 **Young Professionals Workshop**
Room: **B017**
Chair: **Anton J. Schleiss**
Presentation: 12 min | Q&A: 3 min

16:30 – 16:45	**Welcome IAHR President** Roger Faconner
16:45 – 17:15	**How to Write a Good Paper** Vladimir Nikora
17:15 – 17:30	**Presentation of Cardiff YP Network** Sam Bray, Vice-President, IAHR Cardiff Young Professionals Network, UK
17:30 – 17:45	**Presentation of Universidad Politécnica de Cartagena Student Chapter** José María Carrillo, President, IAHR Universidad Politécnica de Cartagena Student Chapter, Spain
17:45 – 18:00	**Presentation of University of Coimbra Student Chapter** Ricardo Martins, President, IAHR University of Coimbra Student Chapter, Portugal
	Presentation of University of Porto YPN Representative Tiago Ferradosa, FEUP, Portugal

18:30 – 20:00 **Reception (Taylor's Port Wine Cellars)**

Tuesday, April 15th, 2014

08:30 – 10:00 **International Journal of River Basin Management (JRBM) Session (1)**
Room: **B032**
Chair: **Michaela Bray**
Presentation: 12 min | Q&A: 3 min

08:30 – 09:00	**Introduction to JRBM** Roger Falconer (1)/Michaela Bray (2) *(1) IAHR President, (2) JRBM Editor in Chief*	
09:00 – 09:15	**Analytical formulation for the aerated hydraulic jump and physical modelling comparison** Daniel Valero, Omar Fullana, Rafael García-Bartual, Ignacio Andrés-Doménech, Francisco Vallés and Juan Marco	(Page. 129)
09:15 – 09:30	**Influence of flow rate in the mean and fluctuating pressures of a stilling basin** N. Figueiredo, E. Carvalho and F. Taveira Pinto	(Page. 184)
09:30 – 09:45	**Hydropower dams in the lower zambezi river: water quality simulation of Boroma and Lupata reservoirs** P.A. Diogo, A.C. Rodrigues, P. Colaço and A. Alves	(Page. 39)

09:45 – 10:00 **Multivariate statistical analysis of flood variables by copulas: two Italian case studies** (Page. 204)
Matteo Balistrocchi, Roberto Ranzi and Baldassare Bacchi

08:30 – 10:00 Numerical Wave Modelling

Room: **B001**

Chair: **Constantine Memos**

Presentation: 12 min | Q&A: 3 min

08:30 – 08:45 **Hybridisation of a wave propagation model (SWASH) and a meshfree particle method (SPH) for real applications** (Page. 47)
J.M. Domínguez, T. Suzuki, C. Altomare, A.J. Crespo and M. Gómez-Gesteira

08:45 – 09:00 **SPH numerical and physical modeling of wave overtopping a porous breakwater** (Page. 52)
Eric Didier, Diogo Neves, Paulo Teixeira, João Dias and Maria Graça Neves

09:00 – 09:15 **A multi-resolution discontinuous Galerkin method for one dimensional shallow flow modeling** (Page. 70)
Georges Kesserwani, Nils Gerhard, Siegfried Muller and Dilshad A. Haleem

09:15 – 09:30 **2D-3D coupling of shallow water equations with Navier Stokes equations** (Page. 77)
Florian Mintgen and Michael Manhart

09:30 – 09:45 **On SPH modelling of surf zone turbulence under weak plungers** (Page. 85)
Christos V. Makris, Constantine D. Memos, and Yannis N. Krestenitis

08:30 – 10:00 Surface and Groundwater Hydraulics and Hydrology

Room: **B002**

Chair: **Benjamin J. Dewals**

Presentation: 12 min | Q&A: 3 min

08:30 – 08:45 **Applicability of commom surface water simulation programs for urban flash floods** (Page. 120)
Svenja Peterseim, Andreas Schlenkhoff and Sebastian Czickus

08:45 – 09:00 **Impact of different sources of topographic information on hydraulic modelling of floods: application to the Johor river, Malaysia** (Page. 199)
A. Md Ali, G. di Baldassarre and D.P. Solomatine

09:00 – 09:15 **Implementation of a local timestep scheme to a regional scale flood inundation model** (Page. 150)
Sam Jamieson, Grant Wright, Julien Lhomme and Ben Gouldby

09:15 – 09:30 **Modeling periodic seepage face formation and water pressure distribution along a vertical boundary of an aquifer** (Page. 125)
Seyed Mohammad Hossein Jazayeri Shoushtari, Peter Nielsen, Nick Cartwright and Pierre Perrochet

09:30 – 09:45 **Completion/extension of available data based on dendrochronologies and stochastic evaluation of results** (Page. 212)
Bruno Oliveira, Eduardo Vivas, Levi Brekke and Rodrigo Maia

08:30 – 10:00 Open-channel Flow: Experimental Techniques

Room: **B003**

Chair: **Jochen Aberle**

Presentation: 12 min | Q&A: 3 min

08:30 – 08:45 **Stereoscopic piv measurements in turbid waters on natural beds** (Page. 20)
Maxime Rouzès, Frédéric Moulin and Olivier Eiff

08:45 – 09:00 **Velocity field measurements in tailings dam failure experiments using a combined piv-ptv approach** (Page. 177)
R. Aleixo, Y. Ozeren, M. Altinakar and D. Wren

09:00 – 09:15 **Failure by overtopping of earth dams. Quantification of the discharge hydrograph** (Page. 182)
S. Amaral, R. Jónatas, A.M. Bento, J. Palma, T. Viseu, R. Cardoso and R.M.L. Ferreira

09:15 – 09:30 **Development of a method using infrared thermography for shallow flow visualization and quantitative estimation of velocity** (Page. 176)
Rui P. de Lima, Theodore G. Cleveland and Rita F. De Carvalho

09:30 – 09:45 **Use of thermal tracers to characterize overland flow velocities** (Page. 124)
J.L.M.P. de Lima and J.R.C.B. Abrantes

08:30 – 10:00 Drainage Systems and Sustainable Solutions

Room: **B017**
Chair: **Corrado Gisonni**
Presentation: 12 min | Q&A: 3 min

08:30 – 08:45 **Water and energy nexus towards smart water grids: hydropower and irrigation solutions** (Page. 28)
Avin Dadfar and Helena M. Ramos

08:45 – 09:00 **Sediment transport through sustainable urban drainage systems: monitoring methods for long term, multiple event analysis** (Page. 139)
Deonie Allen, Scott Arthur, Heather Haynes, Robert Ellam, Valerie Olive, Kevin Black and Jenny Mant

09:00 – 09:15 **Numerical modelling of air-water flows in a vertical drop and a backdrops** (Page. 193)
P.M.G. Beceiro, M.C. Almeida and J. Matos

09:15 – 09:30 **Multi-criteria optimization towards cost-effectiveness solution for energy recovery in sustainable urban drainage systems (SUDS)** (Page. 163)
Marion Huchet and Helena M. Ramos

09:30 – 09:45 **Energy recovery for sustainable urban drainage systems (SUDS)** (Page. 169)
Irene Samora, H.M. Ramos and Anton J. Schleiss

10:15 – 11:00 Keynote Lecture 3

Room: **Auditorium**
Chair: **Francisco Taveira Pinto**

Coastal engineering challenges in a changing world
Steven A. Hughes

11:00 – 11:30 Coffee-Break

11:30 – 13:00 International Journal of River Basin Management – JRBM Session (2)

Room: **B032**
Chair: **Michaela Bray**
Presentation: 12 min | Q&A: 3 min

11:30 – 11:45 **Transboundary water management and cooperation: priority issues in the Axios/Vardar river basin. Perspectives of common approach** (Page. 119)
Elpida Kolokytha, Anastasia Tsavdaridou and Yannis Mylopoulos

11:45 – 12:00 **Longitudinal development of compound channel flows** (Page. 36)
João Nuno Fernandes, João Bento Leal and António Heleno Cardoso

12:00 – 12:15 **A comparison of statistical and deterministic methods for predicting extreme floods in an alpine catchment** (Page. 134)
Fränz Zeimetz, Ramona G. Receanu, Anton J. Schleiss and Jean-Michel Fallot

12:15 – 12:30 **Analysis of sedimentation and flushing into the reservoir Paute-Cardenillo** (Page. 164)
Luis G. Castillo, Manuel A. Alvarez and José Maria Carrillo

12:30 – 12:45 **Flood risk assessment and mitigation management plan** (Page. 211)
E. Martínez, M.A. Arrabal, S. Gonzalez, C. Luengo, C. C. Lobera, J. Dominguez, P. Roldán, F. Casas and M. Rodriguéz

11:30 – 13:00 Coastal Physical Modelling

Room: **B001**

Chair: **Paulo Rosa Santos**

Presentation: 12 min | Q&A: 3 min

11:30 – 11:45 **Calibration of the large physical model of the port of Zeebrugge** (Page. 99)
Marc Willems, Wael Hassan and Glen Heyvaert

11:45 – 12:00 **Laboratory effects on measuring impact loads on rigid coastal structures** (Page. 59)
Andrea Marzeddu, Xavier Gironella, Agustin Sánchez-Arcilla and James Sutherland

12:00 – 12:15 **3D experimental investigation of wave reflection on a vertical seawall with wave return** (Page. 84)
Theodora Giantsi, Agisilaos Papadopoulos and C.I.Moutzouris

12:15 – 12:30 **Assessing the importance of the initial topography for large scale tests of beach profile response under erosive or accretive conditions** (Page. 62)
M. de la Torre, M.I. Vousdoukas, S. Schimmels, H. Fernandez and T. Kirupakaramoorthy

12:30 – 12:45 **PIV measurements of air bubble breakwater kinematics** (Page. 80)
Maciej Paprota

11:30 – 13:00 Hydraulic Structures III

Room: **B002**

Chair: **Arturo Marcano**

Presentation: 12 min | Q&A: 3 min

11:30 – 11:45 **Angled trashracks with streamwise bars** (Page. 15)
S. Raynal, L. Chatellier, D. Courret, M. Larinier and L. David

11:45 – 12:00 **Contraction under inclined and radial gates** (Page. 186)
Gilles Belaud, Severine Tomas and Bruno Cheviron

12:00 – 12:15 **Hydraulic performance of inlet controlled culverts in steep streams under sediment load** (Page. 165)
Ida E. Gotvassli, Jochen Aberle and Harald Norem

12:15 – 12:30 **Experimentally-based analytical model for air entrainment in central jet dropshafts** (Page. 179)
Angela Esposito, Federico Dell'Orfano, Guelfo Pulci Doria and Paola Gualtieri

12:30 – 12:45 **A detailed measurement campaign of spatial velocity profiles in vertically submersible pumps** (Page. 117)
F.I.H. Verhaart, A. de Fockert and S.A.A. Zwanenburg

11:30 – 13:00 Environmental Hydraulics: Water Quality II

Room: **B003**

Chair: **J. Pedroso de Lima**

Presentation: 12 min | Q&A: 3 min

11:30 – 11:45 **Disinfection kinetics in CFD modelling of solute transport in contact tanks** (Page. 122)
Athanasios Angeloudis, Thorsten Stoesser and Roger Alexander Falconer

11:45 – 12:00 **Sensitivity of an escherichia coli transport model to the decay rate in a coastal basin** (Page. 19)
Maria Bermudez, Reza Ahmadian, Bettina Bockelmann-Evans, Luis Cea and Jeronimo Puertas

12:00 – 12:15	**Modelling quantified source specific microbial pollution from human sources during high flows** Aisling Corkery, John O'Sullivan, Louise Deering, Katalin Demeter, Elisenda Ballesté, Bat Masterson, Wim Meijer, Gregory O'Hare	**(Page. 27)**
12:15 – 12:30	**Management proposal for an intermittently closed coastal lagoon using a wave-driven seawater pump and a volume-salinity box model** <u>S.P.R. Czitrom</u>, I. Penié and G. De la Lanza	**(Page. 31)**
12:30 – 12:45	**Modelling the impact of urban floods in heavily polluted rivers: the case of Kampung Melayu in Jakarta** <u>Diogo Costa</u>, Senthil Gurusamy, Paolo Burlando and Shie-Yui Liong	**(Page. 159)**

11:30 – 13:00 Urban Flooding, Flood Mitigation and Control

Room: **B017**

Chair: **Rui Ferreira**

Presentation: 12 min | Q&A: 3 min

11:30 – 11:45	**Use of 3D classified topographic data with fullswof for high resolution simulation of a river flood event over a dense urban area** Abily Morgan, Delestre Olivier, Amosse Laura, Bertrand Nathalie, Laguerre Christian, Dulut Claire-Marie and <u>Gourbesville Philippe</u>	**(Page. 208)**
11:45 – 12:00	**Flash flood analysis in urban areas** E. Martínez, S. Gonzalez, S. Cordero, M. Rodríguez and J. Dominguez	**(Page. 210)**
12:00 – 12:15	**Water-filled tube constructions for the use in emergency flood control** <u>Baerbel Koppe</u>, Armin Krebs and Karsten Daedler	**(Page. 202)**
12:15 – 12:30	**Flood defence design parameters correlation influence on failure probability – case study of backward erosion piping** <u>J.P. Aguilar López</u>, J.J. Warmink, R.M.J Schielen and S.J.M.H Hulscher	**(Page. 205)**
12:30 – 12:45	**Hydraulic efficiency of street inlets** <u>Andreas</u> Schlenkhoff and Svenja Peterseim	**(Page. 121)**

13:00 – 14:00 Lunch

14:00 – 15:00 IAHR Europe Division Open Meeting – Room: B032 (Members)

15:00 – 16:30 Workshop 1-I - *New Visions on Sediment Transport* Session I

Room: **B032**

Convener: **Aronne Armanini**

Università degli Studi di Trento, Italy

15:00 – 15:25	**Fluctuations of particle transport rates in graved-bed rivers or the quest for equilibrium?** <u>Christophe Ancey</u>, Joris Heyman and Patricio Bohorquez	**(Page. 221)**
15:25 – 15:50	**Hyperconcentrated flows on mobile bed** <u>Aronne Armanini</u>	**(Page. 222)**
15:50 – 16:05	**Interaction forces in submerged gravitational granular flows** <u>Elena Nucci</u>	**(Page. 223)**
16:05 – 16:20	**Bed morphological changes in river contractions** <u>Giuseppe Oliveto</u> and Maria Cristina Marino	**(Page. 225)**
16:20 – 16:30	***General discussion***	

15:00 – 16:30 **Workshop 2 -** ***Climate Change Impacts on Hydraulics and Water Resources***

Room: **B001**

Convener: **Roberto Ranzi**

Università degli Studi di Brescia, Italy

15:00 – 15:15 **Long term statistics of river flow regime: climatic or anthropogenic changes?** (Page. 233)
Roberto Ranzi and Maximo Tomirotti

15:15 – 15:30 **Sea level rise impact assessment of Alexandria shoreline, Egypt** (Page. 234)
Akram Soliman and Youssef Khairy

15:30 – 15:45 **Agricultural development in Lake Koronia. The role of the water footprint of major crops in combating climate change** (Page. 237)
Elpida Kolokytha

15:45 – 16:00 **Methodology for the development of climate change scenarios and climate inputs to run impacts models. Application to the Guadiana river basin** (Page. 238)
Vanessa Ramos, Eduardo Vivas, Levi Brekke and Rodrigo Maia

16:00 – 16:15 **Climate change impacts on groundwater dependent coastal ecosystems: Melides case study** (Page. 239)
M.E. Novo, M.M. Oliveira, L. Oliveira and T. Martins

16:15 – 16:30 ***General discussion***

15:00 – 16:30 **Workshop 3 -** ***Advanced Numerical Methods in Morphodynamics***

Room: **B002**

Convener: **Pilar Garcia-Navarro**

Universidad de Zaragoza, Spain

Presentation: 15 min | Q&A: 3 min

15:00 – 15:15 **One-dimensional finite-volume modeling of the flow and morphological processes during the 1996 lake Ha!Ha! dyke break event** (Page. 243)
F. Franzini and S. Soares-Frazão

15:15 – 15:30 **Development of novel Riemann solvers in hyperbolic systems of equations including source terms** (Page. 244)
J. Murillo and P. Garcia-Navarro

15:30 – 15:45 **2DH shallow-water and morphology solver for strongly transient flows** (Page. 245)
R. B. Canelas and R.M.L. Ferreira

15:45 – 16:00 **Debris flows at the interface between fixed and mobile bed conditions: the development of a "composite" Riemann problem and a possible approximated solver** (Page. 246)
D. Zugliani and G. Rosatti

16:00 – 16:15 **2D numerical simulation of granular flow dynamics and validation with experimental data** (Page. 247)
C. Juez, A. Lacasta, D. Caviedes-Voullième, J. Murillo and P. García-Navarro

16:15 – 16:30 ***General discussion***

15:00 – 16:30 **Workshop 4-I -** ***Hydrodynamics of Vegetated Flows: Turbulence, Flow resistance, Mixing, Sediment Transport***

Session I - ***Experimental studies***

Room: **B003**

Convener: **Vladimir Nikora**

University of Aberdeen, United Kingdom

15:00 – 15:20 **Experimental characterization of drag on arrays of rough cylinders** (Page. 251)
A.M. Ricardo, M. Martinho, P. Sanches, M.J. Franca and R.M.L. Ferreira

15:20 – 15:40	**Drag and reconfiguration of trees: towing tank experiments with TLS based plant characterization** J. Jalonen, J. Järvelä, J.-P. Virtanen, M. Vaaja, H. Hyyppä	(Page. 252)
15:40 – 16:00	**Scouring processes downstream of a rigid bed and effect of vegetation: experimental investigation in a laboratory flume** Donatella Termini	(Page. 254)
16:00 – 16:30	***Discussion:*** *Experimental studies of vegetated flows: Current state and perspectives.*	

15:00 – 16:30 **Workshop 5-I** - *Marine Energy*

Session I - *Overview, Policy, Marine Energy Resource(s)*

Room: **B017**

Convener: **Martin Wosnik**

Center for Ocean Renewable Energy, University of New Hampshire, USA

15:00 – 15:15	**A strategic policy framework for promoting the marine energy sector** A. Vásquez, S. Astariz and G. Iglesias	(Page. 261)
15:15 – 15:30	**Potential wave energy along the coasts of Sicily (Italy)** C. Iuppa, L. Cavallaro and E. Foti	(Page. 262)
15:30 – 15:45	**Impact of wave energy exploitation in the Galician (NW Spain) wave climate** H. Fernandez, R. Carballo, G. Iglesias and S. Schimmels	(Page. 263)
15:45 – 16:00	**Wave energy potential along the coast of Santa Catarina (Brazil)** Vincenzo Ferrante, Marcus Polette and Diego Vicinanza	(Page. 264)
16:00 – 16:15	**The available power obtainable from tidal stream turbines from a flow around an idealised headland** Thomas A.A. Adcock	(Page. 265)
16:15 – 16:30	***General discussion***	

16:30 – 17:00 **Coffee-Break**

17:00 – 18:30 **Workshop 1 -II** - *New Visions on Sediment Transport*

Session II

Room: **B032**

Convener: **Aronne Armanini**

Università degli Studi di Trento, Italy

17:00 – 17:25	**Models of river meanders** Stefano Lanzoni	(Page. 226)
17:25 – 17:50	**On the behaviour of rivers dominated by large-scale horizontal coherent structures** Ana Maria Ferreira da Silva	(Page. 227)
17:50 – 18:05	**Bed topography evolution in a discordant bed channel confluence** Sebastián Guillén, Mário J. Franca, Anton J. Schleiss and António H. Cardoso	(Page. 228)
18:05 – 18:20	**An experimental study of the turbulent events over a loose particle under supercritical flow conditions** Elsa Carvalho, Rodrigo Maia and Rui Aleixo	(Page. 229)
18:20 – 18:30	***General discussion***	

17:00 – 18:30 **Workshop 6 -** ***Medium to Long-term Coastal Evolution***

Room: **B001**

Convener: **Marcel Stive and Joep Storms**

Technical University of Delft, The Netherlands

17:00 – 17:15	**The future of long term morphodynamics research** Marcel Stive	(Page. 273)
17:15 – 17:30	**Long term morphodynamics modelling of tidal systems** Mick van der Wegen	(Page. 273)
17:30 – 17:45	**The role of stratification in long term coastal evolution** Martijn Henriquez	(Page. 273)
17:45 – 18:00	**Scaling issues and uncertainty in long term morphodynamic modelling** Liang Li	(Page. 273)
18:00 – 18:30	***General discussion***	

17:00 – 18:30 **Workshop 7 -** ***Advanced Pressure Transient Analysis***

Room: **B002**

Convener: **Helena Ramos and Dídia Covas**

Universidade de Lisboa, Instituto Superior Técnico, Portugal

17:00 – 17:15	**Intrusion effects in leaks due to transients** Amparo López-Jiménez, J. Jesús Mora-Rodrigues and Helena M. Ramos	(Page. 277)
17:15 – 17:30	**Two-phase gas-liquid experiences in fluid transients: hydraulic system behavior with entrapped air under rapid pressurization** Sandra Martins, Helena Ramos and A. Betâmio de Almeida	(Page. 278)
17:30 – 17:45	**Stress-strain analysis of a coiled copper pipe for inner pressure loads** David Ferras, Dídia Covas and Anton Schleiss	(Page. 279)
17:45 – 18:00	**Fluid structure interaction (FSI) in water supply systems** Mariana Simão, Jesus Mora and H.M. Ramos	(Page. 281)
18:00 – 18:15	**Transients Overview** A. Betâmio de Almeida	
18:15 – 18:30	***General discussion***	

17:00 – 18:30 **Workshop 4 -II -** ***Hydrodynamics of Vegetated Flows: Turbulence, Flow resistance, Mixing, Sediment Transport***

Session II - Analytical and numerical studies

Room: **B003**

Convener: **Vladimir Nikora**

University of Aberdeen, United Kingdom

17:00 – 17:20	**Flow patterns in a partially vegetated large channel** Mouldi Ben Meftah, Francesca de Serio and Michele Mossa	(Page. 256)
17:20 – 17:40	**Numerical modelling of flow - vegetation interaction under oscillatory and unidirectional flow** Maria Maza, Javier L. Lara and Iñigo J. Losada	(Page. 257)
17:40 – 18:00	**Application of SAS turbulence model in flows through rigid submerged vegetation** G. Papadonikolaki and A.I. Stamou	(Page. 258)
18:00 – 18:30	**Discussion:** ***Analytical and numerical modeling of vegetated flows: Current state and perspectives.***	

17:00 – 18:30 **Workshop 5-II - *Marine Energy***
Session II - *Technology*
Room: **B017**
Convener: **Martin Wosnik**
Center for Ocean Renewable Energy, University of New Hampshire, USA

17:00 – 17:15	**Evaluation and comparison of the levelised costs of tidal, wave and offshore wind energy** S. Astariz, A. Vásquez and G. Iglesias	(Page. 266)
17:15 – 17:30	**CECO wave energy converter: concept and physical model tests** Paulo Rosa-Santos, Francisco Taveira-Pinto, Luis Teixeira and José Ribeiro	(Page. 267)
17:30 – 17:45	**Productivity analysis of the full scale ISWEC prototype: the test case of Pantelleria island** Andrea Cagninei, Mattia Raffero, Ermanno Giorcelli, Giuliana Mattiazzo and Davide Poggi	(Page. 268)
17:45 – 18:00	**An overview of the Wecwakes project: physical modeling of an array of 25 wave energy converters** Peter Troch, Vasiliki Stratigaki, Tim Stallard, David Forehand, Matt Folley, Jens Peter Kofoed, Michel Benoit, Aurélien Babarit, Marc Vantorre and Jens Kirkegaard	(Page. 269)
18:00 – 18:15	**Performance prediction of a tidal in-stream current energy converter** Philipp Daus, Frank Biskup, Andreas Ruopp, and Raphael Arlitt	(Page.270)
18:15 – 18:30	***General discussion***	

20:00 – 23:00 **Congress Diner (Casa da Música)**

Wednesday, April 16th, 2014

08:30 – 10:00 **Numerical Modelling and Sediment Transport**
Room: **B032**
Chair: **A. Trigo Teixeira**
Presentation: 12 min | Q&A: 3 min

08:30 – 08:45	**Implicit time step relaxation of bidimensional shallow water finite volume models in unstructured meshes: application to estuarine flow** Jónatan Mulet Martí and Francisco Alcrudo Sánchez	(Page. 72)
08:45 – 09:00	**Numerical modelling of wind waves on a river flood plain** Antoine Joly, Elodie Gagnaire-Renou, Michel Benoit and Damien Violeau	(Page. 109)
09:00 – 09:15	**Experimental verification of a new 3d numerical model involving wave transformation through flushing culverts** Michalis K. Chondros, V. Katsardi, V. Tsoukala and K. Belibassakis	(Page. 81)
09:15 – 09:30	**Particle motions in oscillatory flow over a smooth bed** Karsten Lindegård Jensen, B. Mutlu Sumer, Jørgen Fredsøe and Jacob Hjelmager Jensen	(Page. 68)
09:30 – 09:45	**Morphometric analysis of a sandy dune and breach scenarios: a 3D GIS based approach** Jorge Almeida, Fernando Veloso-Gomes and Claudino Cardoso	(Page. 63)

08:30 – 10:00 **River Morphology**
Room: **B001**
Chair: **Robert Ettema**
Presentation: 12 min | Q&A: 3 min

08:30 – 10:00 **Eco and Environmental Hydraulics**
Room: **B002**
Chair: **A. Pinheiro**
Presentation: 12 min | Q&A: 3 min

08:30 – 10:00 **Computational Hydraulics I**
Room: **B003**
Chair: **Jean-Paul Chabard**
Presentation: 12 min | Q&A: 3 min

09:15 – 09:30	**A free surface vortex modeling with 3D CFD comparison between an experimental case and a numerical one** Grégory Guyot and Amaury Pittion-Rossillon	(Page. 194)
09:30 – 09:45	**Analyses of hydraulic performance of velocity caps** Erik Damgaard Christensen, Mark Chr. Degn Eskesen, Jeppe Buhrkall and Bjarne Jensen	(Page. 191)

10:15 – 11:00 **Keynote Lecture 4**
Room: **Auditorium**
Chair: **Pawel Rowinski**

Ecosystem hydrodynamics: conceptual framework, recent advances, and perspectives
Vladimir Nikora

11:00 – 11:30 **Coffee-Break**

11:30 – 13:00 **Coastal Physical Modelling (2)**
Room: **B032**
Chair: **Marc Willems**
Presentation: 12 min | Q&A: 3 min

11:30 – 11:45	**Review of hydraulic performance studies on detached breakwaters** F. Taveira-Pinto, D. Vicinanza, V. Penchev, V. Ferrante and R. Silva	(Page. 113)
11:45 – 12:00	**Stability of small breakwaters roundheads armoured with single-layer cubipod breakwaters** J. Sande, Enrique Peña, Enrique Maciañeira, L. Priegue and M.E. Gómez-Martín	(Page. 104)
12:00 – 12:15	**Overtopping reduction for harbor quays under very oblique waves attack** Sebastian Dan, Corrado Altomare, Tomohiro Suzuki, Tim Spiesschaert, Marc Willems, and Toon Verwaest	(Page. 66)
12:15 – 12:30	**A new sheet pile berth for controlling wave reflection within ports located in seismic areas** C. Bosco, R.E. Musumeci, G. Indelicato, and E. Foti	(Page. 101)
12:30 – 12:45	**A side-hinged planar wavemaker** Wojciech Sulisz and Aneta Dargacz	(Page. 110)

11:30 – 13:00 **Local and Contraction Scour**
Room: **B001**
Chair: **Mário Franca**
Presentation: 12 min | Q&A: 3 min

11:30 – 11:45	**Application of an artificial neuronal network for estimation of contracting scour** Minh Duc Bui, Petr Penz and Peter Rutschmann	(Page. 123)
11:45 – 12:00	**Contribution of complex pier components on local scour depth** Mario Moreno, Rodrigo Maia, Lúcia Couto and António Heleno Cardoso	(Page. 131)
12:00 – 12:15	**Local scour at single piers revisited** Cristina Fael, Rui Lança, Lúcia Couto and António Heleno Cardoso	(Page. 171)
12:15 – 12:30	**The effect of hydrographs on the geometric characteristics of the scour holes around the bridge piers** Gokcen Bombar	(Page. 192)
12:30 – 12:45	**Airborne hydromapping - a progress in river engineering** Michael Mett, Markus Aufleger and Frank Steinbacher	(Page. 161)

11:30 – 13:00 Water Quality

Room: **B002**

Chair: **Damien Violeau**

Presentation: 12 min | Q&A: 3 min

11:30 – 13:00 Extreme Precipitation and Peak Flow

Room: **B003**

Chair: **P. Gourbesville**

Presentation: 12 min | Q&A: 3 min

12:30 – 14:00 Hydraulic Associations Meeting – Room I-105 (Invited)

13:00 – 14:00 Lunch

14:30 – 16:00 Coastal Hydrodynamic Numerical Modelling

Room: **B032**

Chair: **Enrique Peña González**

Presentation: 12 min | Q&A: 3 min

15:00 – 15:15 **Directionality in stochastic simulation of sea waves** (Page. 45)
Michalis K. Chondros and Constantine D. Memos

15:15 – 15:30 **Validation of a Boussinesq-type wave model applicable to any depth** (Page. 57)
Constantine Papadopoulos, Anastasios Metallinos and Constantine Memos

15:30 – 15:45 **Boussinesq modelling of the impact of pressure retarded osmosis plants in nearshore regions** (Page. 103)
A. Viviano, R.E. Musumeci and E. Foti

14:30 – 16:00 Hydraulic Structures IV

Room: **B001**

Chair: **Jorge Matos**

Presentation: 12 min | Q&A: 3 min

14:30 – 14:45 **Review on pressure distribution on stepped spillways** (Page. 128)
M.J. Ostad Mirza, M. Pfister, J. Matos and A.J. Schleiss

14:45 – 15:00 **Venda Nova III repowering project: outlet and downstream channel scale model studies** (Page. 157)
Vítor Ribeiro, Pedro Pinto, Sébastien Derrien and Luc Bazerque

15:00 – 15:15 **Bi-stable flow fields and two-way couplings between flow and sedimentation in shallow reservoirs** (Page. 13)
Benjamin Dewals, Yann Peltier, Michel Pirotton, Pierre Archambeau and Sébastien Erpicum

15:15 – 15:30 **Estimation of the turbulent features of flow in vertical slot fishway: improvements on fishway design criteria** (Page. 10)
Damien Calluaud, Gerard Pineau, Alain Texier and Laurent David

15:30 – 15:45 **Application of SPH to real-world free-surface flows** (Page. 148)
Damien Violeau, Martin Ferrand, Agnès Leroy, Arno Mayrhofer, Alexander Vorobyev and Alexis Herault

14:30 – 16:00 Environmental Coastal Issues

Room: **B002**

Chair: **Luciana das Neves**

Presentation: 12 min | Q&A: 3 min

14:30 – 14:45 **Assessment of material fluxes in aquatorium of the port of Bourgas (Bulgarian Black Sea coast) by LOICZ biogeochemical model** (Page. 75)
Dimitar Marinov, Svetla Miladinova and Jordan Marinski

14:45 – 15:00 **Common model for environmentally and sustainability development of the south-east European sea ports** (Page. 25)
Jordan Marinski, Dimitar Marinov, Tatiana Branca, Matilda Mali, Tania Floqi and Leonardo Damiani

15:00 – 15:15 **Multivariate analysis of pressures and driving factors affecting the environmental status of the Rio de Janeiro coastal zone** (Page. 76)
Arianna Azzellino, Serap Cevirgen, Marcus Polette and Diego Vicinanza

15:15 – 15:30 **Effects of the wave motion on the propagation of gravity currents** (Page. 100)
R.E. Musumeci and E. Foti

15:30 – 15:45 **Definition of Sines port wave regime using an artmap artificial neural network with fuzzy logic** (Page. 107)
F.L. Santos, Diogo R.C.B. Neves, Maria Teresa Reis, Conceição Juana Fortes, Pedro Poseiro, A.D. Lotufo, and G.F. Maciel

14:30 –16:00 **Computational Hydraulics II**
Room: **B003**
Chair: **Rui Aleixo**
Presentation: 12 min | Q&A: 3 min

14:30 – 14:45	**Steady and unsteady supercritical shallow water modelling using a transformed lattice Boltzmann scheme** Amir H. Hedjripour, David P. Callaghan and Tom E. Baldock	(Page. 09)
14:45 – 15:00	**Experimental study of friction slope in unsteady non-uniform flow in rectangular channel** Magdalena M. Mrokowska, Paweł M. Rowiński and Monika B. Kalinowska	(Page. 118)
15:00 – 15:15	**Sensitivity analysis of different finite-volume numerical schemes to a variation in the celerity estimate for the simulation of dam-break flows** Stefania Evangelista, Massimo Greco and Angelo Leopardi	(Page. 136)
15:15 – 15:30	**2D numerical simulation of granular flow dynamics and validation with experimental data** Carmelo Juez, Asier Lacasta, Daniel Caviedes-Voullième, Javier Murillo and Pilar García-Navarro	(Page. 144)
15:30 – 15:45	**Numerical modeling of supercritical open channel bend flows with OpenFOAM using the volume of fluid (VOF) technique** Javier L. Lara, Pablo Higuera and Iñigo J. Losada	(Page. 180)

16:00 – 16:30 **Coffee-Break**

16:30 – 17:30 **Closing Ceremony**
Room: **Auditorium**
Chair: **António Betâmio de Almeida and Fernando Veloso Gomes**

Message of the Local Organizing Committee
Handover of "Book" from Porto to next Congress
Presentation of the IAHR Europe Congress in 2016

Thursday, April 17th, 2014

Buses leave from FEUP

Technical Visit 1 | 09:00 – 13:00 | Port of Leixões

Technical Visit 2 | 09:00 – 13:00 | Crestuma-Lever Dam

Technical Visit 3 | 08:30 – 17:00 | Venda Nova III Dam

Poster Session | Monday, April 14th, 2014 |14:00 – 14:30 | Congress main corridor

CAN A 3D-NUMERICAL MODEL BE A SUBSTITUTE TO A PHYSICAL MODEL IN ESTIMATING PARAMETERS OF 1D-CONFLUENCE MODELS?

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Abstract

A possibility of using a 3D-numerical model instead of a more expensive physical one for estimation of parameters in 1D-confluence models is considered. A set of existing experimental data from 90° confluence is used for the 3D-model validation. A satisfactory agreement for measured velocities, mean flow angle $\bar{\delta}$ and correction coefficient σ is achieved. It is also shown that the use of a mean flow angle $\bar{\delta}$ in 1D-model provides a better prediction of the component I_{Tx} of the tributary force of inertia.

Keywords: River confluence; 1D-confluence model; 3D-numerical model; Physical model; Model parameters

1. Introduction

Despite rapid development of computer technologies and capacities which enabled immergence of 2D and 3D numerical models and their application in studying confluence hydrodynamics, 1D-models are still widely used in engineering studies of flow in river channel networks and lengthy river reaches. However, in 1D modelling, presence of a channel junction requires a special treatment. Thus far, several 1D-confluence models were developed, mostly by combining theoretical considerations and laboratory experiments (Taylor, 1944; Weber and Greated, 1965; Lin and Soong, 1979; Hager, 1987, 1989; Ramamurthy et al., 1988; Gurram et al., 1997; Hsu et al., 1998a, 1998b; and Gurram and Karki, 2000). The estimation of a tributary influence on the main-channel flow is a crucial point in these models, as it affects proper evaluation of the two upstream flow depths. In estimating this influence, the fact that the tributary flow deflects from the junction angle at the tributary entrance to the confluence must be somehow included in the model. In the early models of Taylor, 1944, Weber and Greated, 1965 and Lin and Soong, 1979 this fact was not taken into account in the model equations. However, in 1D-models proposed after 1980, this was achieved differently: 1) by introducing a correction coefficient σ for the junction angle (Hager, 1987 1989; and Gurram et al., 1997), 2) by observing a pressure difference between the two opposite tributary walls near the confluence (Ramamurthy et al., 1988) and 3) by introducing a mean cross-sectional value of the flow deflection angle at the tributary entrance to the confluence (Hsu et al., 1998a, 1998b). Regardless the accepted approach, experimental measurements were inevitable for defining characteristic values of the coefficients or variables necessary for the estimation of the lateral momentum transfer.

Numerical modelling is applied nowadays as a cost-effective approach in different hydraulic studies as it allows for investigation of a comparably larger number of parameter combinations than it is possible to make in a physical model.

The interchange is acceptable only on condition that a numerical model is properly verified and validated. This paper, thus, aims at assessing how good an existing, non-commercial 3D-numerical model SSIIM2 (Olsen 2000, 2012) is at defining characteristic values of the coefficients and variables in 1D-confluence models. Moreover, it aims at re-evaluating 1D-confluence model assumptions regarding the momentum transfer from the tributary to the main channel.

A set of existing laboratory data (Shumate, 1998), collected with the ADV (Acoustic Doppler Velocimeter) probe in a 90° concordant beds' confluence of equal-width channels, is used in this study. The data was previously used to validate the SSIIM2 model (Đorđević 2013). In this paper, the collected and calculated velocity distributions of the two velocity components on the horizontal plane (u and v) are used to define distributions of the flow angle δ at the tributary entrance to the confluence and to calculate the mean δ-angle value that is applied in some 1D-confluence models. This also allows one to check the validity of the assumption on the constant σ-coefficient value in 1D-models of Hager, 1987 and Gurram et al., 1997. Additionally, measured and calculated u and v velocity distributions are used to assess how good the 3D-model is in estimating the component of the lateral momentum flux that acts in the direction of the main-channel flow (I_{Tx}), i.e. in the direction for which the 1D-momentum equation is written, and to estimate its contribution to the total force of inertia of the tributary ($I_T = (I_{Tx}^2 + I_{Ty}^2 + I_{Tz}^2)^{1/2}$). Finally, they are used to evaluate difference between I_{Tx}-values deduced from measurements, the 3D model and existing 1D-models.

To facilitate the discussion on the appropriateness of the SSIIM2 model in assessing the values of the key parameters and variables in 1D-models, several 1D-confluence models that take into account deflection of a tributary flow at the confluence are briefly presented in the following section. Only those ones that describe subcritical flow at the confluence are selected for this study, as the SSIIM2 model is developed for simulation of 3D flow in alluvial rivers. These are 1D-models of: 1) Hager, 1987, 2) Gurram et al., 1997 and 3) Hsu et al., 1998a. Consequently, the basic information about the mathematical model of 3D flow and 3D finite-volume based numerical model SSIIM2 is given. The Shumate's experimental facility is described in section 3. Numerical modelling details are presented in section 4. Values of the characteristic parameters and variables from 1D-models, deduced from numerical simulation results and measurement data, are compared to each other in section 5. Finally, conclusions about the possible substitution of the expensive physical models with the 3D-numerical model, as an alternative, cost-effective tool, are drawn.

2. Mathematical and numerical models

2.1 1D-confluence models

The manner in which the contribution of the tributary flow to the 1D-momentum equation was taken into account evolved with the development of the measurement instrumentation.

Hager, 1987, used an average inflow angle γ for the downstream tributary cross-section to calculate the contribution of the tributary force of inertia in the direction of the main channel flow. The angle was estimated from the point measurements of the streamline deflection angle at the tributary entrance to the confluence. The data were collected using the miniature angle meter at the mid-depth in five verticals of the downstream tributary cross-section. Hager related the γ-angle to the junction angle α via correction coefficient σ ($\gamma = \sigma\ \alpha$).

This angle enters into the expression for the contraction coefficient μ, which is derived from the momentum equation for the control volume at the confluence (Hager, 1987, Fig. 6, see page 540):

$$\frac{1}{\mu} = \frac{1 + \sqrt{(1-q)(2-q)(1-\frac{2}{3}\cos\gamma - \frac{1}{3}\cos^2\gamma) + \frac{1}{9}\cos^2\gamma}}{1 + \frac{1}{3}\cos\gamma} \qquad [1]$$

where q is the ratio of the discharge in main-channel upstream of the confluence to the total downstream discharge ($q = Q_u/Q_d$). The flow contraction results from the issuance of the boundary streamline from the downstream junction corner. Head loss coefficients between the two cross-sections upstream of the confluence and that on the downstream side of the control volume, depend on the degree of this contraction (Hager, 1987, Eqs. (10) and (11), see page 541). The dependence of the flow depths upstream of the confluence on the μ coefficient and the γ-angle follow from these relationships.

The constant σ-value of 8/9, proposed in Hager, 1987, was estimated based on the experimental data for the confluence with $\alpha = 90^o$. However, in the consequent paper (Hager, 1989), it was shown that the σ-value varied both with the junction angle and the discharge ratio q when $\alpha < 90^o$. Best and Reid, 1987 also observed this dual dependence of σ on α and q for $\alpha \leq 90^o$, but they presented it as a relationship between γ and α using q as a parameter.

Gurram et al., 1997 applied the same measurement technique as Hager for defining parameters of their model. However, they took into account the contribution of the lateral momentum via, so called, lateral momentum coefficient $\tau = [\cos(\sigma\,\alpha)/\cos\alpha]q^{-1}$. It is readily noticeable that the Gurram et al.'s model also uses Hager's correction coefficient σ for the junction angle. Conversely to Best and Reid, 1987 and Hager, 1989, Gurram et al., 1997 recommend a single value of σ (σ = 0.85), although the presented experimental results show variations in α and the downstream Froude number (Gurram et al., 1997, Fig. 9, see page 451). After assuming that the upstream flow depths in the main-channel (h_{MR}) and the tributary (h_T) are equal, their values can be found by solving the equation:

$$Y^3 - Y(2 + F_d)^2 + F_d^2[(1-q)^2 + q\cos\gamma] = 0 \qquad [2]$$

where Y is the ratio of the flow depths in the upstream and downstream cross-sections (h_T / h_d), q is the ratio of the tributary to the total downstream discharge (Q_T/Q_d) and F_d is the downstream Froude number $F_d = Q_d / (gb^2h_d^3)^{1/2}$ (Gurram et al., 1997, Fig. 3, see page 449).

Hsu et al. proposed two models: one for $\alpha = 90^o$ (Hsu et al. 1998a) and the other for the confluence with an arbitrary junction angle (Hsu et al. 1998b). The mean tributary inflow angle $\bar{\delta}$ appears only in the first model. It was determined from detailed measurements of the two velocity components on the horizontal plane.

The velocities were measured with the two-component electromagnetic current meter in eight equally spaced points in each of the eight equally distributed verticals of the downstream tributary cross-section. The model is fourth order polynomial in the depth ratio Y (defined as in the model of Gurram et al.) Due to limited space, the model equations are not given here. Interested readers are referred to expressions (5) to (12) in the original paper (Hsu et al. 1998a). It is worth noting here that the authors observed discrepancies between their $\bar{\delta}$-angle values and the γ-angle values for $\alpha = 90^o$ in Hager, 1989.

2.2 Mathematical and numerical models of 3D flow

Mathematical model of a 3D steady, incompressible fluid flow is used in this paper. It consists of the mass conservation equation and the Reynolds-averaged Navier-Stokes (RANS) equations with a two-equation turbulence model closure in the form of the standard k-ε model. The equations can be found in Olsen (2000). Terms in the RANS equations that describe the flux of momentum $\rho u_j \mathrm{d}V$ through the boundary surface of the elemental fluid volume are of special interest for the present study. They will be discussed in section 5.

The model equations are solved numerically using the SSIIM2 model (Olsen 2012). The model is based on the finite-volume method. The equations are solved on an unstructured multiblock space grid. Multiblock grids are particularly suitable for discretisation of the dendritic flow domains that are characteristic for river confluences. The mass and momentum equations are coupled in the SSIIM2 model using the SIMPLE method (Olsen, 2000). By following the line of previous investigations, the convective terms in the momentum equations are modelled using the second-order upwind scheme (Đorđević, 2010). The rigid-lid approach is the only option to represent the free-surface in SSIIM2.

Boundary conditions at solid boundaries are handeled using the wall-law. Those at open boundaries depend on the type of the boundary. At inflow boundaries a constant discharge is prescribed. A constant depth is prescribed at the outflow boundary and a zero gradient condition is imposed for the remaining dependent variables. The same condition is applied for ε and horizontal velocities at the free-surface, while the vertical velocity component is calculated from the zero discharge condition. The turbulence kinetic energy at the free-surface is set to the half of its bottom value (Olsen, 2000).

3. Experimental setup

A suitability of the SSIIM2 model for the estimation of parameters in 1D-confluence models is assessed using the experimental data of Shumate, 1998. The data were collected in the right-angled concordant beds' confluence of two equal-width laboratory canals with horizontal beds and rectangular cross-sections (Figs. 1a and 1b). Six experiments, with unaltered total discharge of 0.17 m^3/s, covered a range of possible hydrological scenarios at the confluence: the dominance of the tributary flow ($Q_{MR}/Q_{tot} < 0.5$), equal contributions of the two combining flows ($Q_{MR}/Q_{tot} \approx 0.5$) and the dominance of the main-canal flow ($Q_{MR}/Q_{tot} > 0.5$). The flow was steady and subcritical in all experiments. There were overall 2850 measuring points distributed in 19 cross-sections (including the downstream tributary cross-section) in every experimental campaign. Three velocity components were instantaneously measured in each point using ADV (Acoustic Doppler Velocimeter) down-looking probe. The occasion that the downstream tributary cross-section was densely covered with measurements (7 equally spaced verticals with 17 measurement points in each vertical, Fig. 1b), was recognised as an opportunity for conducting this study. Data from the experiments with $D_R = Q_{MR}/Q_{tot} = \{0.250, 0.583, 0.750\}$, which represent three characteristic hydrological scenarios, are chosen for the model assessment.

4. Numerical modelling

The computational domain covers full lengths of the canals in the Shumate's facility (Fig. 1a), thus ensuring no influence of the boundary conditions on the flow pattern in the confluence.

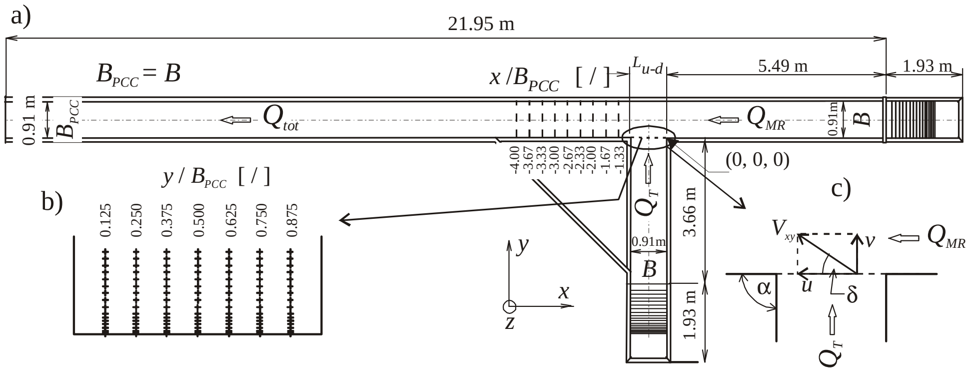

Figure 1. Experimental setup of Shumate, 1998; a) plan-view of the confluence, b) distribution of measurement points in the downstream tributary cross-section, c) definition of the flow deflection angle δ

The multiblock space grid consists of two orthogonal structured grids or blocks. The whole length of the main canal is covered with the block 1. The tributary canal is covered with the block 2. Grid sizes of 838×37×20 cells in the stream-wise, lateral and vertical directions for the block 1, and 182×37×20 cells in the block 2, were found to provide the best overall fit with the measurements (Đorđević, 2010, 2013). They are, therefore, chosen for this study, too. Constant discharges, corresponding to the three considered D_R values, are imposed in the two inflow cross-sections and the constant depth of 0.296 m in the outflow cross-section.

5. Results and discussion

As it was already mentioned, both the estimation of the model parameters in the presented 1D-confluence models of Hager, Gurram et al. and Hsu et al. and the estimation of the component I_{Tx} of the tributary force of inertia are based on the known distributions of the two velocity components on the horizontal plane. Thus, the quality of their prediction with the 3D-numerical model depends on the model's ability to reproduce u and v velocity distributions in the downstream tributary cross-section correctly. The assessment of the SSIIM2 model, therefore, begins with the comparison of the calculated and measured velocity distributions.

Velocity components u and v. Distributions of the stream-wise velocity u and the lateral velocity v (Figs. 2 and 3, respectively) are presented along the junction-lines that connect upstream and downstream junction corners (Fig. 1c). Due to limited space, they are given only for the three characteristic non-dimensional elevations above the tributary bed (i.e. close to the bottom, z/h = 0.008, at the mid-depth z/h = 0.492 and at the second highest measurement point: z/h = 0.772). To facilitate the assessment of the SSIIM2-model performance, limits of the confidence interval that correspond to the significance level of 0.05 are presented in addition to the measured mean-values (subscript "m").

It is readily noticeable that the simulated u- and v-velocity values (subscript "c") are within the confidence interval for the vast majority of measurement points, i.e. there are only a few points with the simulated values which are outside the confidence interval. Moreover, calculated u- and v-velocity distributions follow the shape of the measured ones quite satisfactorily. Larger discrepancies are observed only in the u-velocity distributions close to the upstream junction corner ($l < 0.30L_{u\text{-}d}$) when D_R = 0.750. Nevertheless, the calculated u-values are still within the confidence interval of $u_m \pm 2\sigma_u$.

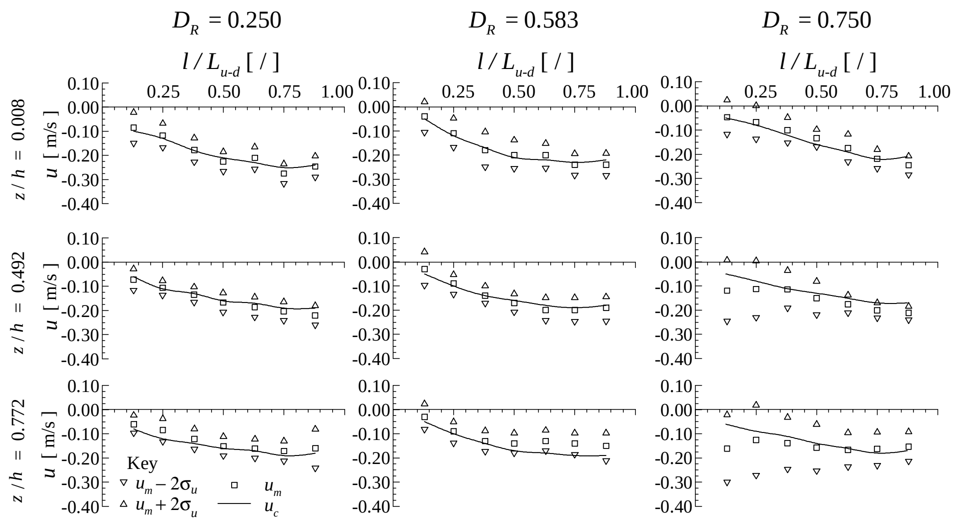

Figure 2. Comparison of the calculated and measured stream-wise (u) velocity distributions along the junction lines at different non-dimensional elevations above the tributary bed; the l distance is measured from the upstream junction corner.

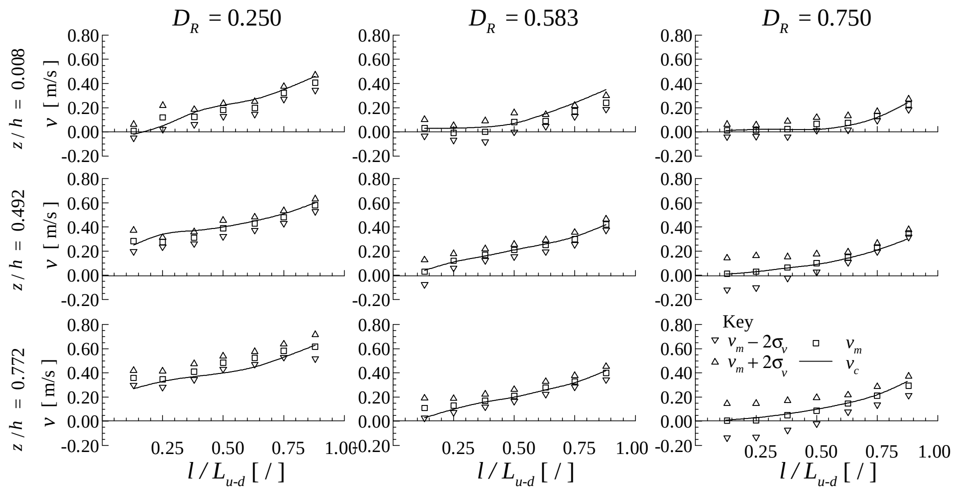

Figure 3. Comparison of the calculated and measured lateral (v) velocity distributions along the junction lines at different non-dimensional elevations above the tributary bed; the l distance is measured from the upstream junction corner.

Mean cross-sectional δ-angle at the tributary entrance to the confluence and correction coefficient σ. A flow-angle δ is the measure of flow deflection on the horizontal plane. This is the angle that the projection of the velocity vector on the horizontal plane ($V_{xy} = (u^2 + v^2)^{1/2}$) makes with the junction-line (Fig. 1c). The local δ-angle value (in an arbitrary point) is calculated based on the intensities of the two velocity components: $\delta = \text{arc tg}\ (v/u)$. The mean cross-sectional δ-angle value ($\bar{\delta}$) is, consequently, determined through the integration of the local values over the cross-section. Mean $\bar{\delta}$- angle values presented in Figure 4a are calculated from the measured and simulated data collected in discrete points that are shown in Figure 1b.

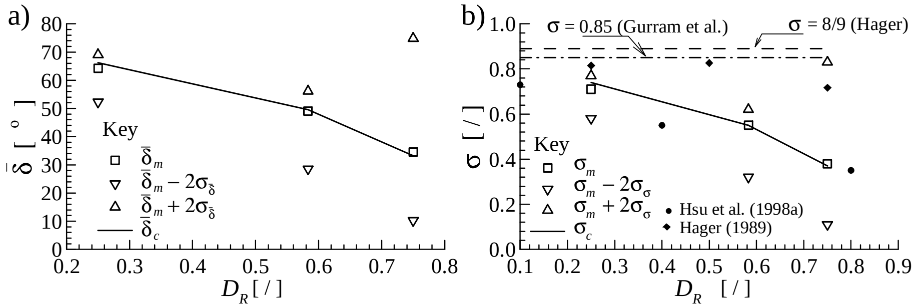

Figure 4. Estimation of the two parameters in 1D-confluence models: a) the mean flow deflection angle ($\bar{\delta}$) and b) the corresponding correction coefficient σ from the measured "*m*" and calculated "*c*" velocities in the downstream tributary cross-section; comparison of the estimated σ –values with those proposed by Hager, 1987, 1989 and Gurram et al. 1997

It is readily noticeable that there is greater dispersion of $\bar{\delta}$ - angle values when $D_R > 0.583$. This increased dispersion results from the occasional penetration of the main-canal flow into the tributary canal in the upstream part of the inflow tributary cross-section that is seen on the velocity distributions at the lower limit of the confidence interval (Fig. 3, column $D_R = 0.750$). Regardless this fluctuating effect, observed with the measured data, the SSIIM2 prediction of the mean δ-angle is very good. The differences between the values derived from the measured and calculated *u* and *v* velocities are less than 4%.

The value of the correction coefficient σ, which is used in the models of Hager and Gurram et al., is calculated from the mean $\bar{\delta}$ - angle: $\sigma = \bar{\delta}/\alpha$. Therefore, the σ-coefficient shows essentially the same behaviour as $\bar{\delta}$ -angle does – it varies with D_R (Fig. 4b). It is interesting to observe that both measured and calculated σ-values are significantly lower than constant values proposed by Hager, 1987 and Gurram et al., 1997.

Additionally, the variability in σ with D_R is more pronounced than that presented in Hager, 1989 for $\alpha = 90^o$ (the data are also plotted in Fig. 4b). The differences are most probably due to the fact that the width-to-depth ratio in Hager's experiments was rather low ($B/h \leq 1.0$), while in Shumate's experiments and those of Hsu et al., 1998a, B/h was > 2.0. Values from the experiments of Hsu et al., 1998a are also plotted in Figure 4b. They are within the presented confidence interval.

Tributary force of inertia and its components. In the Shumate's facility, the inflow of momentum from the tributary to the main canal is through the vertical surface whose normal is in the direction of the *y*-axis. This means that the momentum is carried by the velocity *v*, i.e. that only one term in each of the three RANS equations describes the inflow of the corresponding component of the tributary momentum.

The term $\rho uv\mathrm{d}A_y$ in the equation for the *x*-direction describes the flux of momentum through the elemental surface $\mathrm{d}A_y$ in the direction of the main-canal axis; $\rho vv\mathrm{d}A_y$, in the equation for the *y*-direction, describes the flux of momentum in the lateral direction; and $\rho wv\mathrm{d}A_y$, in the equation for the *z*-direction, describes the flux of momentum in the vertical direction.

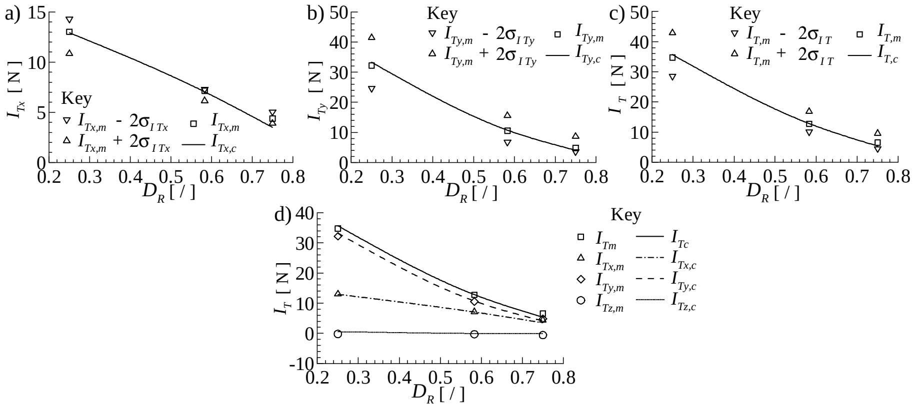

Figure 5. Estimation of the force of inertia in the downstream tributary cross-section – measurements "*m*" vs. simulations "*c*"; a) component I_{Tx} parallel to the main-canal axis, b) component I_{Ty} perpendicular to the main-canal axis, c) total force of inertia $I_T = (I_{Tx}^2 + I_{Ty}^2 + I_{Tz}^2)^{1/2}$; d) contributions of the three components to the total force of inertia.

Integration of the three terms over the downstream tributary cross-section gives components of the tributary force of inertia I_{Tx}, I_{Ty} and I_{Tz}. The component I_{Tx} is of interest for the present study, as it appears in the 1D-momentum equation. Its values are estimated from the measured and calculated *u* and *v*-velocity distributions (Figs. 2 and 3). The I_{Tx} values are presented in Figure 5a. The upper and lower limits of the confidence interval are calculated using corresponding values of the two velocity components. The agreement between the $I_{Tx,m}$ and $I_{Tx,c}$ for $D_R \le 0.583$ is satisfactory – the $I_{Tx,c}$ values are within the confidence interval and the differences between them are less than 1.5%. However, the SSIIM2 model under predicts the I_{Tx} value by 20% when the main-canal flow dominates ($D_R > 0.583$). It can be noticed that the predicted value is below the lower limit of the I_{Tx}-confidence interval (Fig. 5a). This discrepancy results from the superposition of the previously observed deviations of the calculated *u* and *v*-velocity distributions in the upstream part of the tributary cross-section (Figs. 2 and 3 – column $D_R = 0.750$).

Unlike the prediction of the I_{Tx} component, that of the I_{Ty} component (Fig. 5b) and the total force of inertia I_T (Fig. 5c) is acceptable in the whole range of the analysed D_R-values. Moreover, maximal discrepancies between the measured and calculated values for $D_R = 0.750$ are 15% for I_{Ty} and 16% for I_T. For $D_R \le 0.583$ they are less than 3.5% for I_{Ty} and less than 3% for I_T. This good prediction of the I_T-magnitude results from the fact that the contribution of the I_{Tx}-component is much lower than the contribution of the I_{Ty}-component (Fig. 5d). The contribution of the I_{Tx}-component is between 36 and 67%, that of the I_{Ty}-component is between 74 and 93%, whereas the I_{Tz}-component takes part in the total force of inertia with 0.5 to 8%.

Figure 6 shows comparison between different approaches to estimation of the tributary contribution to the 1D-momentum equation. The approach which is based on the application of the mean flow-angle at the inlet cross-section ($I_{Tx} = I_T \cos\bar{\delta}$), i.e. variable σ correction-coefficient-value, overestimates the I_{Tx}-component for $D_R \le 0.583$. However, when the flow in the main-canal takes the dominance over the tributary flow ($D_R > 0.583$), the I_{Tx}-component is under predicted. Both the over prediction and under prediction are less than 25%.

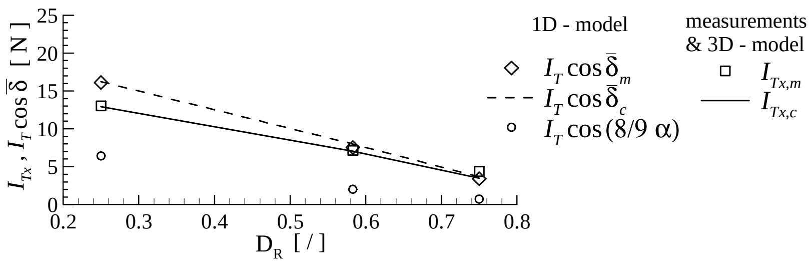

Figure 6. Comparison of the I_{Tx}–component deduced from measurements, 3D model, and 1D-models which use the mean cross-sectional angle in the downstream tributary cross-section and the constant σ-correction coefficient value proposed by Hager, 1987.

The use of constant σ-coefficient values proposed by Hager (σ = 8/9) and Gurram et al. (σ = 0.85) results in significantly larger under prediction of I_{Tx}, due to markedly larger $\overline{\delta}$-angle values ($\overline{\delta} \equiv \gamma = \sigma\ \alpha$). The discrepancies for σ =8/9 range between 50 and 84%, while those for σ = 0.85 range between 34 and 78%. Based on the presented results, it is recommended to use the mean δ-angle value in estimating the influence of the tributary flow in 1D-confluence models.

6. Conclusions

A comparison of the numerical simulation results for the 3D finite-volume based model SSIIM2 with the existing experimental data collected in 90º concordant beds' confluence of two straight, horizontal bed laboratory canals of equal width undoubtedly has shown that this 3D model can be used as a substitute to a physical model in estimating parameters of 1D-confluence models. This conclusion rests on the facts that the simulated distributions of *u* and *v* velocity components, that are used for estimation of the key parameter – the mean cross-sectional flow angle $\overline{\delta}$, are within the confidence interval, which corresponds to the significance level of 0.05. Such a behaviour holds for all three characteristic hydrological scenarios at the confluence D_R = {0.250, 0.583, 0.750}. Moreover, differences between the simulated and measured values are almost negligible for $D_R \leq 0.583$. For $D_R = 0.750$ deviations of simulated *u*-velocity distributions in the upstream part of the tributary inflow cross-section range between 25 and 70%. However, they practically have no effect on the estimation of parameters in 1D-models. Their effect becomes apparent only when calculating the component of the tributary force of inertia in the stream-wise direction of the main-canal (I_{Tx}). The value of this component falls outside the confidence interval for $D_R = 0.750$. Therefore, investigation of the model performance in the case of the dominance of the main-canal flow requires further investigation.

In addition to considerations of the appropriateness of 3D numerical models in estimating parameters of 1D-confluence models, the estimation of the σ correction coefficient from the measured data confirmed the dependence of this "coefficient" on the D_R-value. With reference to this, the evaluation of the I_{Tx}-component from the measured data has shown that the 1D-model, which uses the mean cross-sectional flow angle $\overline{\delta}$ (or variable σ correction coefficient value), predicts this component of the force of inertia much better than the model with the constant σ-value. Hence, use of constant σ -values is not recommended.

Acknowledgments

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