

## ANNUAL REPORT

**A. Division name: DIVISION 1 IAHR HYDRAULICS**

**Committee name: FLUID MECHANICS**

**Reporting period: 2009-2010**

**B. Mission statement / Long range objective**

The focus of our committee is on fundamental and applied environmental fluid mechanics in support of hydraulic research. Particular emphasis is on the fundamentals of transport and mixing phenomena in turbulent flows such as contaminant transport processes in rivers, lakes and coastal regions, anthropogenic influences (e.g., heat, dissolved and suspended organic/inorganic material) and sediment dynamics. Main focus areas for our committee include:

- 1) *stratified flows* (e.g., gravity currents, stratified jets and plumes, internal waves) *and flows in rotating fluids*, where at larger scales the rotation of the earth becomes relevant;
- 2) *shallow flows*, in which the length scale in one direction (depth) is much smaller than the length scales in the other directions, and for which bed friction affects the development of the large-scale quasi two-dimensional structures;
- 3) *flow and turbulence structure over rough boundaries and porous media*, including canopies and vegetation.
- 4) *two-phase laminar and turbulent flows* with particular emphasis on sediment transport, high concentration mixtures showing non-Newtonian fluid behavior (e.g., mud slides, debris flows) and gas-water mixture flows caused by air entrainment at high-velocity in hydraulic structures or by cavitating flows.
- 5) *interface problems*. The air-water interface on the surface of a water body remains enigmatic, especially concerning the generation, growth, and instabilities of wind waves. Similarly, the water-sediment interface at a stream bed separating turbulent water flow from the behavior of granular media has not been successfully described. Solid-water interfaces encountered in biological applications (e.g. boundary layers on individual blades of vegetation or coral branches) present another unique challenge.

Major advances are expected over the next couple of years in gaining insights into the dynamics of these flows using state of the art experimental (e.g., particle image velocimetry) and numerical (e.g., direct numerical simulation DNS, large eddy simulation LES, large-scale predictive models) techniques. In particular, this should allow a better understanding of the role played by the large-scale coherent structures and the interactions between these large scales and the three-dimensional turbulence, and of the effect of the large-scale turbulence on bottom friction and morphodynamic processes.

Three of the most important and imminent challenges in environmental fluid mechanics and environmental hydraulics are to understand:

- 1) to what extent the physics of these flows is dependent on scale effects,
- 2) how the physics changes between the simpler geometries studied in the laboratory in controlled environments or using DNS/LES simulations and the complex geometries present at field scale,
- 3) how detailed understanding of the physics of simpler types of flows (e.g., jets, wakes, mixing layers) can result into better predictive analytical models that can be applied for engineering predictions and design.

These challenges also define our long term objectives. Additionally, several challenges remain related to understanding mass exchange processes relevant to hydraulics. For example, concepts such as large-scale eddy diffusivity or hydrodynamic dispersion cannot be rigorously related to the actual flow or solid matrix properties. Empiricism prevails. Advances are urgently needed to provide the tools for the solution of modern hydraulic engineering problems - which are increasingly devoted to the prediction of the transport and deposition of materials in the natural or engineered environment. Double-diffusion is another phenomenon which has not gained needed attention.

### **C. Committee Membership**

#### 1. Number of committee membership:

**Primary affiliation:** G. Christodolou (co-opted), G. Constantinescu (chair), P. Davies (Past Chair, co-opted), M. Garcia (co-opted), G.N. Ivey, J. Jozsa, G.A. Lawrence, J.H.W. Lee (co-opted), M. Mossa, H. Nepf, Y. Nino (Past Chair, co-opted), J.P. Ortiz (co-opted), W. Uijjtewaal

**Secondary affiliation:** ---

#### 2. Leadership Team:

Chair: George Constantinescu, The University of Iowa, Iowa City, IA,  
USA

Vice-Chair:

#### 3. Name and composition of Working Groups

-no active working groups

### **D. Affiliation with other professional associations**

Affiliation with international programs:

## **E. Report on activities in reporting period**

### **1. Committee meetings**

The last committee meeting was held during the 33<sup>rd</sup> IAHR World Congress held in Vancouver during August 2009. Most of the committee members attended the Congress and the meeting.

-H. Chanson, the Chair of the next IAHR World Congress, gave a presentation of the conference program and an overview on how the conference will be organized. M Garcia and G. Constantinescu made the point that the conference program should highlight a little bit more the sub-tracks where most of the contributions related to environmental fluid mechanics and environmental hydraulics (e.g., stratified flows, eddy resolving numerical simulations) can be submitted. This is important to avoid participant submitting their contributions to the wrong tracks and dispersing these contributions across the various themes.

-Y. Nino and G. Jirka gave a detailed overview of the changes in the structure and organization of IAHR to be implemented following the IAHR World Congress.

-Y. Nino announced that when the new organizational structure of IAHR will be in place, he will take over as secretary of Division 1. He proposed that at that time G. Constantinescu succeeds him as Chair of the Fluid Mechanics Committee. The proposal was approved by the participants. It was decided a vice chair and a secretary as well as two new members will be appointed in about one-year time. It was also proposed and accepted by the participants that the members who were affiliated with the committee for a long time will serve as co-opted members.

-The proposal of George Constantinescu to organize the next International Shallow Flow Symposium in 2012 was accepted by the committee. Two venues were discussed (Iowa City and Chicago). In the end, Iowa City was chosen as the first choice, mostly because of the additional financial burden required to organize the conference in a large city outside a university campus. George Constantinescu will contact Prof. Fernando who expressed in Hong Kong his desire to help with the organization of the next ISSF symposium.

### **2. Specialty conferences**

-M. Ghidoui (Chair) and J. Lee organized the Second International Symposium on Shallow Flows (ISSF) in Hong Kong. The symposium provided a forum for discussion of a wide range of applied and basic research related to shallow flows in water and air environments. A strong point of the conference was the invited talks presented by distinguished international scientists. G. Jirka gave one of the invited talks. The

symposium attracted more than 150 participants. About 200 papers were presented. Most of our committee members attended the conference, were on the Scientific Committee and / or chaired sessions.

-G. Christodoulou is the chair and organizer of the 5<sup>th</sup> International Symposium on Environmental Hydraulics. Athens, Greece to be held this month. Several of our committee members are members of the Scientific Committee and helped with the selection and review of the papers, etc. Joseph Lee is one of the invited speakers.

-Janos Jozsa was one of the keynote speakers at the IAHR European Conference held in Edinburgh, UK this year.

-Our committee co-sponsored the *Ninth International Symposium on Fluid Control, Measurement and Visualization, FLUCOME*, Tallahassee, Florida. G. Constantinescu was on the Scientific Committee.

-Joseph Lee was the organizer of the Nearshore coastal water quality research meeting sponsored by the Crowder Fund Advanced Study Institute. The meeting was attended by several of our committee members

### Activities related to World Congress and Division Congress

-P. Davies and Y. Nino were in charge of the organization of Theme A: Advances in the fundamentals of water science and engineering

-G. Constantinescu co-organized Tracks A-1 1 (The mechanics of water flow), A-4 (Numerical Modeling) and C-4 (Waterway restoration).

-G. Constantinescu organized a special seminar on the on “Use of advanced turbulence modeling techniques for prediction of flow and transport processes in river engineering”

-several of our members chaired sessions at the congress. Also several of our members had comments on the conference program and the titles of the sub-tracks. Some of their suggestions (e.g., related to the way the environmental hydrodynamics sessions will be organized and coordinated, the extension of subtopic C4 Lake and Reservoir hydraulics to Waterways Restoration) were accepted by the organizers.

### 3. (continuing) education activities workshops, training seminars, courses, etc.

Plans are already under way to organize the next summer school at the University of Karlsruhe (W. Brevis is the main contact person) and to couple it with a symposium hosted by the Institute for Hydromechanics honoring Prof. Jirka. Several of our committee members are expected to participate. The summer school unites typically about 40 graduate students from all around the world.

#### 4. Working Group meetings and output

There are no active working groups at the present moment, though two such IAHR activities lead by Mohammed Ghiddaoui (fluid transients) and Gerhard Jirka & Tobias Bleninger (marine outfalls systems) originated in our committee. However, they are now conducted independently of our committee. We are going to discuss this issue during our next full committee meeting that will be held this year.

#### 5. Publications: proceedings; papers for IAHR Journals; state-of-the-art papers; monographs; books

-Y. Nino and G. Constantinescu are associate editors of the IAHR J. Hydraulic Research.

-P. Davies is the Monograph Editor for IAHR.

-G. Constantinescu is working together with W. Rodi and T. Stoesser on a monograph focusing on LES and applications for hydraulics. This project started about a year ago.

-P. Davies and Y. Nino coordinated some of the themes for the IAHR World Congress in Vancouver and helped with conference Proceedings.

-M. Ghiddaoui is the editor of the CD-ROM Proceedings for the 2<sup>nd</sup> International Symposium on Shallow Flows

-G. Christodoulou is the editor of the Proceedings for the 4<sup>th</sup> International Symposium on Environmental Hydraulics to be held this month in Athens.

#### 6. Contacts with other organizations

We have a close contact with ASCE and several of their Technical Committees. We closely collaborated with the chairs of several ASCE committees in organizing the last IAHR Congress in Vancouver.

#### 7.- Other activities.

#### **F. Short range plans (1 to 2 years)**

- specialty conferences

We are presently involved in the organization of three specialty symposia / conferences (International Symposium on Environmental Hydraulics -2010, International Symposium on Stratified Flows – 2011 and International Symposium on Shallow Flows 2012). The chairs of two of these scientific events are members of our committee (G. Christodoulou - ISEH and G. Constantinescu -ISSF). Several of our committee members are members of

the Scientific Committee of the three events and actively participating in their organization.

-The organization of the ISEH symposium to be held in Greece this month is well under way. G. Christodoulou will prepare a short report on the conference activities for the committee.

-Prof. A. Cenovese is organizing the next International Symposium on Stratified Flows in Rome during 2011. Our committee had discussions with Prof. Cenovese regarding the exact dates of the symposium, in relation also with the dates for the IAHR World Congress to be held during the summer of 2011. In the end both parts agreed for the end of August 2011 as the best date for the event.

-The preparation for the 3<sup>rd</sup> ISSF symposium to be held in June 2012 in Iowa City IA are way under way. The symposium is co-organized by IIHR-Hydroscience and Engineering, The University of Iowa and by the Department of Civil Engineering and Geosciences, The University of Notre-Dame. G. Constantinescu is the symposium chair and H.J. Fernando is the chairman of the technical program. The first announcement is out and the conference is advertised on the IIHR webpage. The conference web site is active. We decided on the invited speakers. The Scientific Committee was also set up. Several of our committee members are on the Scientific Committee. We contacted Prof. Christodoulou who will give, during his introductory remarks as chair of the ISEH symposium in Athens, a short presentation of the 3<sup>rd</sup> ISSF symposium. We also contacted ASCE and AGU for co-sponsorship.

-Over the next couple of months, a main decision will be related to the organization of the next International Symposium on Environmental Hydraulics.

#### - activities related to next IAHR World Congress

-G. Constantinescu proposed organizing a mini symposium or special seminar on Coherent Structures and Turbulence Modeling, similar to the mini-symposium he organized in Vancouver.

-our committee sent a list of potential reviewers to the conference organizers

-we expect several of our members will directly help with the organization of some of the conference themes, in particular with themes 3 and 5.

#### - (continuing) education activities

-G. Constantinescu proposed several ideas to the organizers for workshops related to Environmental Fluid Mechanics and Computational Hydraulics during the next IAHR World Congress (Brisbane, 2011).

-We also expect that some of our members will continue their involvement with short courses offered during major conferences and symposium events (e.g., RiverFlow, IAHR World Congress) and summer schools (e.g., Karlsruhe, 2011). We will discuss during our next committee meeting, ways in which these activities can grow in the future.

- working group activities

We are thinking about establishing two working groups, one focusing on flow past vegetation and the other one focusing on gravity currents.

- publications

G. Constantinescu is working with W. Rodi (U. Karlsruhe) and T. Stoesser (Georgia Tech) on a monograph focusing on LES techniques for hydraulics. The first part will focus on theory, present and critically discuss the most popular LES subgrid-scale models and briefly discuss the numerics required by accurate LES simulations. Particular emphasis will be put on hybrid RANS-LES models that allow simulating of flows in complex geometries at field conditions. The second part will be devoted to examples of applications of LES and hybrid RANS-LES methods to predict and investigate the physics of several important categories of flows relevant to hydraulics and environmental fluid mechanics. We completed about 60% of the fundamentals part.

- contacts with other organizations

Our committee will continue working with several IAHR and ASCE committees.

- other activities.

Remarks