

## Habilitation Thesis

### **“Mathematical modelling in support of Water Management: a Hydroinformatics approach” (contributions of the candidate to Hydroinformatics discipline)**

- Summary -

Present habilitation thesis aims at presenting the outcomes in terms of knowledge, understanding and research activities carried out by the candidate in the 16 years following the awarding of the PhD title. The PhD has been defended at “Politehnica” University of Timisoara, within the Faculty of Hydrotechnics, and confirmed by The Ministry of Education (Ministerul Invatamantului), on the basis of the Order no. 3428 from 17 March 1998. The thesis also aims to incorporate the achievements up to date, of more than 23 years, on delivering lectures, exercises and workshops in a university environment.

The background of the candidate is both in Civil Engineering (graduate of 1987) and Mathematics (graduate of 1994). Consequently the scientific, professional and educational activities performed through the years are in the new innovative field of Hydroinformatics that is combining the two backgrounds. Main achievements after the defence of the PhD in 1998, are presented in this habilitation thesis, however the involvement in the field can be tracked back as far as beginning of September 1990. It started at “Politehnica” University of Timisoara, at former Faculty of Hydrotechnics, where the field of modelling and analysis of numerical solution for equations describing physical phenomena started to be intensively looked at in 1990, as computers were more and more available. Faculty of Hydrotechnics, at that time, was challenged to start offering special programmes related to environment and non-structural engineering solutions to problems of flooding. This new perspectives in engineering created opportunities for young scientists to look into emergent fields of study that offered new insights into solutions to problems of aquatic environment. At the beginning of the year 2001, the candidate joined UNESCO-IHE as lecturer, continuing research and teaching career, with new challenges due to the international nature of the student audience and of the research questions needed to be addressed from the perspective of finding solutions to water related problems that would be applicable worldwide.

The subjects of research, after the PhD, consists on theoretical contributions within the field of Hydroinformatics and applications of the developed theories to problems of aquatic environment.

Theoretical contributions, can be summarized as follows:

- Developing flood modelling approaches for decision making during a flood event;
- Defining flood modelling approaches for reservoir driven river systems, as well as for complex network river systems;
- Defining new parameters forrazil ice in ice models;
- Development of an improved methodology for flood vulnerability index taking into account potential sea level rise due to climate change;
- Developing adapted flood vulnerability indexes for coastal areas;

- Developing algorithms for extracting Xsection data from new types of data (Lidar, DEM, etc) and their use in improving definition of synthetic river Xsections;
- Development of approaches for designing reservoir operation curves, using multi objective optimization;
- Defining general frameworks for decision support systems;

Special applications of the theoretical contributions are:

- Flood inference model between Yellow River reservoir system and flooding of the area downstream of the reservoirs;
- Optimization of reservoir operation strategies; (Yellow River in China, Blue Nile in Sudan, etc);
- Flood vulnerability application to river and coastal areas in complex rivers and deltas of the world (e.g. Mekong, Niger delta, etc) ;
- Use of cloud and cluster computing for flood models;
- Ice flooding on Yellow River;
- Decision support systems for floods with pasive and active involvement of stakeholders;
- Development of educational programmes.

Research results and achievements are presented in detail in section(b-i) (Scientific, professional and academic achievements) based on 10 selected papers published by the candidate in the last five years. The research findings presented in the selected articles are reiterated herein. Section (b-i) of the habilitation thesis is structured in five parts. Section 1 ("Hydroinformatics) presents three of the main thrusts of the Hydroinformatics; mathematical modelling, information flow and information sharing (as decision support systems). The research work and contributions for each of these main thrusts are detailed in the following three sections (Section 2 to Section 4). Modelling, flow of information (as new technologies) and information sharing (as decision support systems) are shown for the particular topics of floods and reservoir operation.

As an academic I have also contributed to academic programs that inspired my teaching of others. Along with my involvement in education, in lecturing several topics (Computational hydraulics, River modelling, Decision support systems, Collaborative Engineering, etc), I have also been active in guiding MSc students, coordinating the specialization of Hydroinformatics (2005-2007), programme coordination of the Water Science and Engineering programme(2010-2011) and PhD supervision. Equally I have been involved in educational research projects varying from testing and implementation of educational paradigms and platforms ([www.TENCompetence.org](http://www.TENCompetence.org)), to organizing educational networks ([www.etnet21.net](http://www.etnet21.net)), as well as conferences sessions and workshops. Therefore in Section 5 ("Higher Education in Hydroinformatics") of this thesis the addition in developing educational programmes is presented, because such type of activity is an important part of the promotion and development of a research field.

Plans for future research and development are presented in section (B-ii). All future plans are related to the fields of research presented in part (B-i) of the habilitation thesis.