# 1D CROSS SECTIONS FROM A 2D MESH, A FEATURE FOR A HYDRAULIC SIMULATION TOOL.

**Georgina Corestein*, Ernest Bladé[2], Manuel Gómez[2], Josep Dolz[2], Eugenio Oñate*, Javier Piazzese***

* International Center for Numerical Methods in Engineering (CIMNE) - UPC
Campus Nord UPC, 08034 Barcelona, Spain
email: geocores@cimne.upc.edu , web page: http://cimne.upc.es/

† Department of Hydraulic, Maritime and Environmental Engineering (DEHMA) - UPC
Jordi Girona 3-1, Edifici D1, Campus Nord UPC, 08034 Barcelona, Spain
email: ernest.blade@upc.edu - Web page: http://www.flumen.upc.es

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**Abstract.** *A new feature, wrote in tcl and FORTRAN, prepared to obtain 1D meshed cross sections from a 2D mesh of a surface was developed with the idea of improve the existing GiD interface for the hydraulic simulation code CARPA in order to make it able to interact with one of its more useful capabilities, perform 1D-2D coupled simulations.*
*The importance of this option is easily explainable by the huge amount of data involved in a hydraulic simulation of real rivers, which is an aim of this code.*
*These works were developed as part of the RAMFlood-DSS Project an EU granted project finished on February 2005.*

## 1 INTRODUCTION

RAMFLOOD-DSS is a project co-funded by the 5th Framework Program of the European Community - managed by the European Commission - and forms part of the Information Society Technologies (IST) activities. The objective of this project is to develop a web based decision support system to assist public administration and emergency services in the risk assessment and management of floods.

Ramflood uses CARPA [4] hydraulic simulation model to perform flood routing computations in the area of interest. Hydraulic simulation results are then used to train an Artificial Intelligence module based on neural networks which, once trained, can give results of flood risk maps in a few seconds. For neural networks training hundreds of hydraulic simulation results associated to input data are needed, so maximum efficiency of the hydraulic module is sought.

Flood propagation on natural channels is done by numerically solving the Saint Venant equations. This can be done either with a one dimensional or two dimensional approximations, the first one with less computational and information cost, the second one with more precise results when the real flow pattern does not correspond with a 1D domain. CARPA uses a 1D-2D integrated finite volume high resolution numerical scheme.

Ramflood DSS is oriented to different end users profiles, being a crucial one that of a non technical Water Administration or Natural Disasters Manager. For that reason results were represented in terms of risk rather than hydraulic variables to help such administrators in their fast decision taking. The risk criterion of the Catalan Water Agency, which uses a risk classification according to water levels, velocities or a combination of them (partner of the Ramflood Project), was used (Fig. 1 and 2).

## 2 GENERATION CROSS SECTIONS FROM GIS DATA

Using this tool involve a number of steps; first the geometry -terrain surface- has to be created from the GIS data, that can be done using the DTM import tool [2], and meshed; then the user have to select from the surface mesh, which part will be used to create 1D cross section; next the user have to draw the lines that determine the position of the cross section and assign its number, those steps can be done using the specific GiD window; finally by click the option "Create 1D sections" the tool performs the tasks required to create, store and draw the new 1D cross sections.

The interface for this feature, specifics windows and buttons, was written in tcl language as well as the code that collect and prepare the information needed and call the executable that perform the geometric tasks. The code that actually creates the cross section was written in FORTRAN language and works in the following manner: reads from a file the information, of the mesh and about defined reaches and cross sections (information to create planes); Going through each section, creates the plane; looks for the elements that intersects; over these elements list calculates the scalar product between each side of the element and the normal of the plane to determine if they cross or not, if yes them it is verified if the intersection point is between the two nodes that define the side, this procedure is repeated for all the sides, and the point are stored in a list, then sorted according the global axis, a possible point repetition is checked and corrected and finally the point are sorted according local axis. The information from new cross section, including x and y coordinates and roughness coefficient is exported to the input data file that will be used by CARPA to calculate.

## 3 RESULTS ADAPTATION TO DISPLAY IN RISK CRITERIA

As one of the aims of the RAMFlood project was to asses risks of flood, was important to enable the software to show result according to Risk Criteria scales. The hydraulic results produced by the simulation model were pre-processed by using the Gidpost library in order to be shown over the cross sections –lines- both in ranged and graded scales. An example of these results can be seen in Figures 3 and 4.

## 4 APPLICATION CASE: LLOBREGAT RIVER

For the application of the system to the test case area of interest corresponding to the lower reach of Llobregat river, a coupled 1D-2D approximation was used (Fig 5). The topographic information was imported from ArcInfo/Ascii Grid Format (Fig. 6) and discretized using 13480 quadrilaterals in the 2D area and 307 cross sections in the 1D reach (Fig. 7).

Developments made for the 1D cross sections generation from the imported geometry were proved useful in that practical application. After computations results of both the hydraulic simulations and artificial intelligence module the 1D and 2D areas were successfully visualized using GiD (Figures 8 and 9), thus proving the great value of the new interface for coupled 1D-2D free surface flow modelling with great efficiency.

## 5 CONCLUSIONS

- This work has developed a customization of GiD for the one dimensional hydraulic analysis in order to take advantage of all the capacities of the CARPA code.
- A set of particular results, adapted to show simulation values in Risk scale format were created.
- A fully integrated 1D-2D coupled hydraulic simulation environment combining GiD and CARPA was successfully developed and tested.

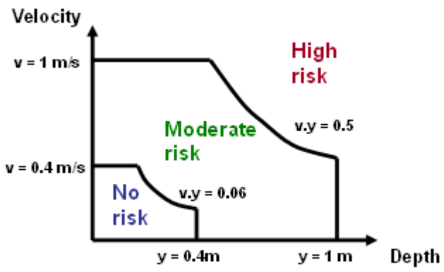


Figure 1: Risk criteria combining water velocities and depths.

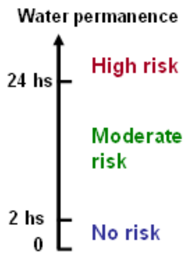


Figure 2: Risk Criteria based on flooding time.

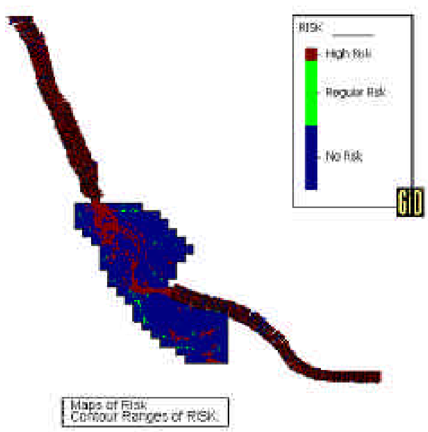


Figure 3: Risk Results, Risk

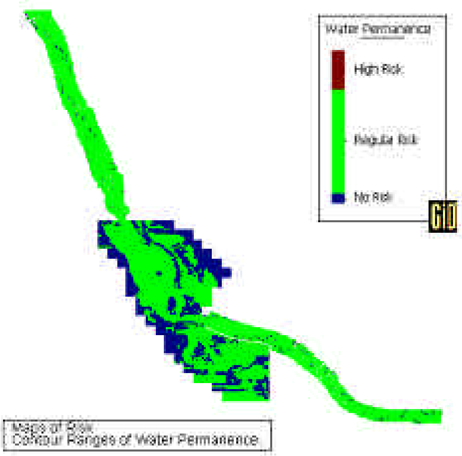


Figure 4: Risk Results, Water Permanence

Figure 5: Coupled 1D-2D Model of last reach of Llobregat River

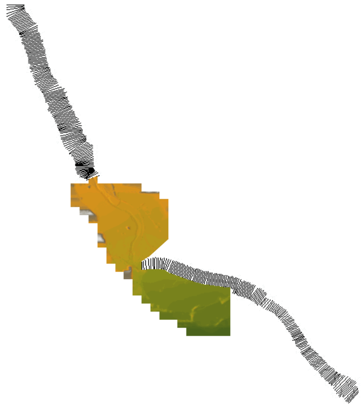

Figure 7: Coupled 1D-2D geometry.

Figure 6: Detail of a rendered image of the topography

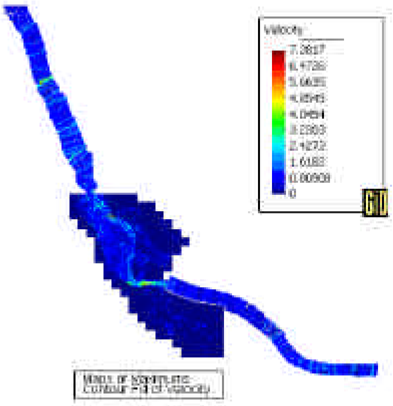

Figure 8: Hydraulic Results, Velocities.

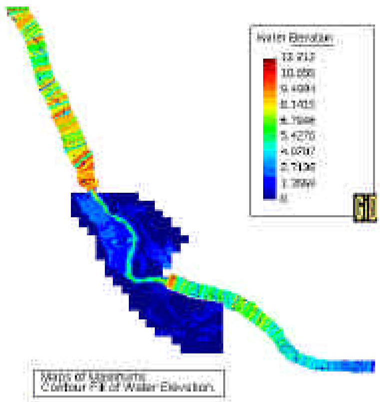

Figure 9: Hydraulic Results, Water Elevation


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