IBER, A RIVER DYNAMICS SIMULATION TOOL

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Abstract. *The works presented in this document are developed under framework of the collaboration agreements signed between the* Centro de Estudios Hidrográficos (CEDEX), FLUMEN *research group* (UPC), GEAMA (UdC) and CIMNE. *The result of this agreement is a numerical simulation code that put together the experience of all the partners in the different aspects of river dynamics.*
The new tool called IBER, *is aimed to the hydrodynamic and morphological simulation of rivers flow. Nowadays* IBER *includes a hydrodynamic module that allows 2D modellization of rivers, a turbulence module and a sediments transport module that considers both bedload and suspended solid discharge.* IBER *offers, as well, a user friendly interface that takes profit of the capabilities of* GiD, *both in pre and post process.*

1 INTRODUCTION

The policies and directives that European and Spanish government are implementing in relation to water and water ennvironment requiere, more and more, studies in two dimensions

of diverse scenarios in order to understand the behavior of rivers, estuaries, channels in general.

Thus, IBER born as a numerical model developed directely from the public administration, adaptable to the different requirements of each situation, is designed to be useful to the technical needs of the Hidrographical Confederations in the implementation of the existing sectoral legislation on water, especially on the requierements derived from the Water Framework Directive, Water Planning Instruction, Flood Directive or the National Plan of Water Quality.

Figure 1: IBER logo and corporative image

2 CORE MODEL

The starting point of this work are the model CARPA[i], developed by the Grup FLUMEN from UPC, and the model Turbillon[ii], developed by the group GEAMA from UdC. Both models shared a number of common characteristics such as resolution of the equations of Saint Venant or shallow water, in two dimensions using numerical shemes based on finite volume technique using high-resolution schemes with extension to second-order based on Roe's scheme.

Turbillon allows consideration of various models of turbulence as the ASM model and several variants of the k-ε model, apart from simpler ones. The model CARPA incorporates, meanwhile, the possibility of joint simulations combining approaches in one and two dimensions, with consequent computational cost saving.

The new model IBER consists of several modules coupled to each calculation. In its first version (v1.0 Iber), includes a hydrodynamic module, a module of turbulence, and a module of tranport sediment bed load and suspended load.

The capabilities and important features of the model in its current version are:

- Integrated resolution of 2D Saint Venant equations using explicit finite volume schemes on unstructured meshes.
- Ability to solve subcritical and supercritical flows, including mobile hydraulic jumps.
- Wetting and drying of the domain with the exact conservation of water volume.
- Modelling of turbulence by models of varying complexity
- Calculation of infiltration, Wind Surface tension, Internal structures: bridges, sluices and weirs.
- Delimitation of the zone of preferential flow as RDPH (Encroachment and areas of serious risk to people and property).
- Evolution of the bed due to sediment transport by bed load and suspended.
- Friendly interface for pre and post-processing.

3 INTERFACE

The interface was created using GiD[iii] software developed by CIMNE and is based on other previous interfaces developed also with GiD[iv]. New pre-processing tools have been developed, for two purposes: provide the program of new skills and make the user interface more friendly. For this second objective the interface has been adapted to show the imposed boundary conditions, and it has set a new tool to export results in raster format to be viewed directly in GIS. For the first objective, highlights the possibility of importing the roughness data from geo-referenced land use, and new methodologies to create meshes that achieve high quality meshes while a more robust program. RTIN and regular mesh creation, and mesh nodes edition from an ASCII grid file are clear examples of these improvements.

Some other developments directly related with the friendlyness of program are the multinlingual interface, the re-definition of label in menues, the posiblity of visualize results while the calculation are still running, the hotstart calculation, the warning and error messages.

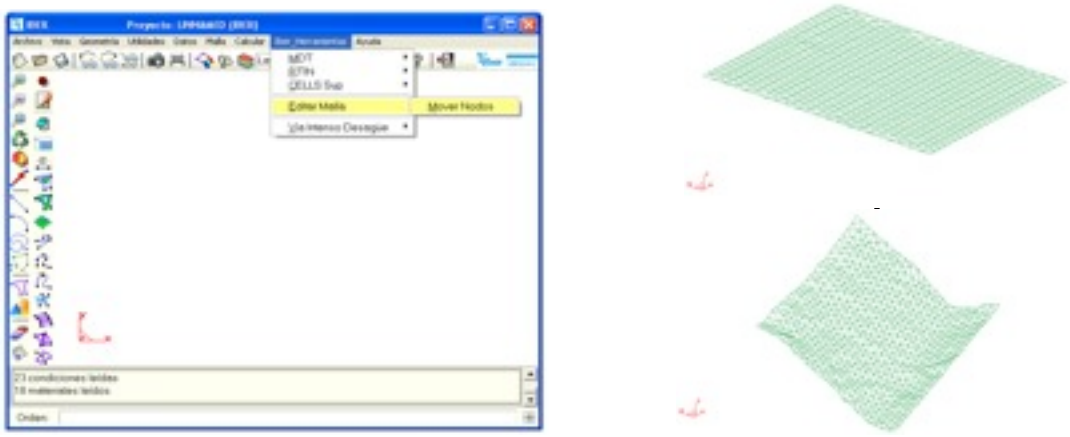

Figure 2: IBER_utils menu and example of mesh nodes edition.

3 APLICATIONS

The potencial aplications of the present version of IBER are diverse, as can be:

- Simulation of free surface flow in rivers.
- Assessment of flood prone areas and their risk. Computation of the preferential flow zones.
- Hydraulic calculation of channels and channel networks.
- Calculation of tidal currents in estuaries.
- Erosion and sedimentation transport of granular material. Stability of the bed sediments

Some previous studies were used as a validation, as well as, contrast with analytical solutions, with other models and laboratory tests and field measurementsand. Many new proyects are carried out using IBER, both by partners and by other collaborating institutions. Results of couple of this studies are presented in next figures.

Figure 3 corresponds to the study of fish ladder using diferent pool configurations, this case shows that despite being a 2D model is able to evaluate a very turbulent flow.

Figure 4 shows the results of a multi-scenario study performed to evaluate the efects of a

new road and bridge in the lower part of the Fluvià River in Catalonia. On the left water depth in GIS format and on the rigth water elevation in standard smooth contour format.

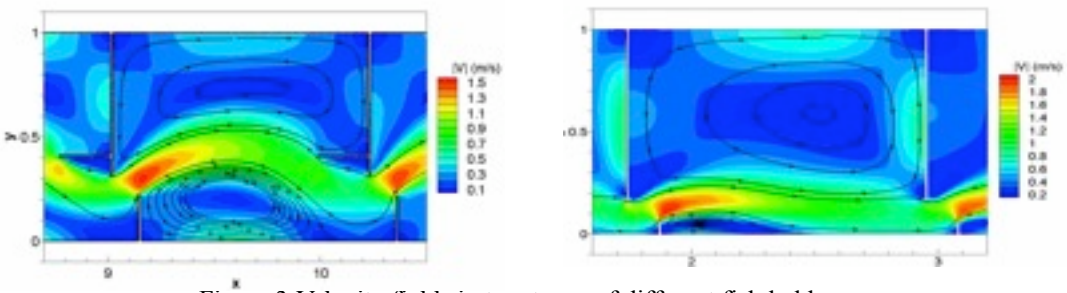

Figure 3:Velocity fields in two types of different fish ladder.

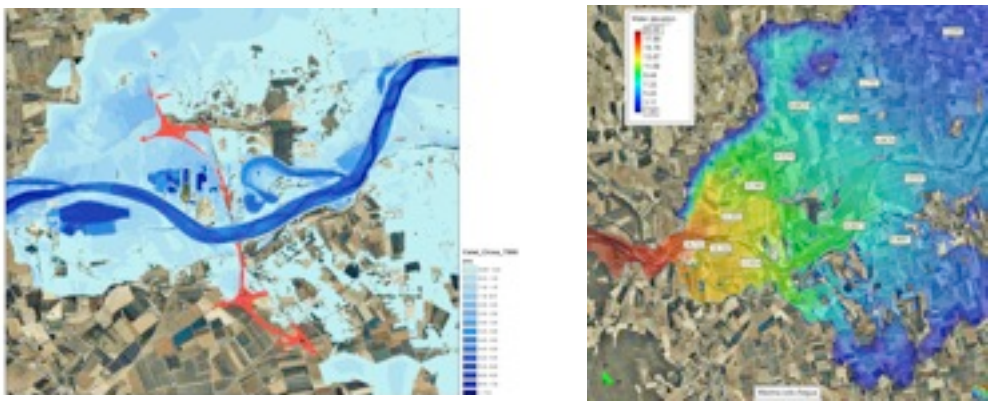

Figure 4: Study of the hydraulic efects of a new road on the Fluvia River.

5 CONCLUSIONS

- A new tool, for numerical simulation of river dynamics was developed by mean the agreements between diverse public institutions.
- The new software called IBER is aimed to provide tools and procedures to study water courses and satisfy the requirements of existing policies and normatives.
- In medium term is espected to continue developing IBER to include new calculation capabilities, as for example ecological discharge or reactive pollutants transport.
- which is open to improvements or adjustments which can be implemented easily thanks to the flexibility of GiD technology

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