NEW GID INTERFACE FOR RAMFLOOD-DSS PROJECT HYDRAULIC SIMULATION CODE.

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Abstract: *As part of the RAMFlood-DSS Project (Decision Support System for Risk Assessment and Management of FLOODS) a new interface between GiD and a two-dimensional hydraulic simulation code (CARPA) was developed.*

A new FORTRAN code and a tcl-proc were created in order to import topographical data from the Arc/Info ASCII grid format and to generate the corresponding NURBS-Surfaces. Another tcl-proc was developed to automatically assign properties from external data base files from satellite image classification. GiDPost library was used to write post process files improving the efficiency of the system.

Performing the simulation requires a large amount of data, corresponding to a Digital Terrain Model. Also huge quantity of information is generated. We found that GiD was capable to deal with these challenges.

INTRODUCTION

RAMFLOOD-DSS is a project co-funded by the 5th Framework Programme of the European Community - managed by the European Commission - and forms part of the Information Society Technologies (IST) activities [1]. 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.

CARPA, developed by the DEHMA of UPC [2], is the code used to perform hydraulic simulations. It uses a finite volume discretisation to solve the one and two dimensional Saint Venant equations on non regular geometries. The code uses a high-resolution total variation diminishing (TVD) explicit scheme [3], with especial care in the correct balancing of source terms.

To prepare and handle data input (topographic information, boundary and initial condition, Manning coefficient) and meshes for this kind of simulation is very hard, and results interpretation is also complicated. A powerful tool is obtained customizing GiD. Besides writing the GiD standard files required to create a new problem type, additional features were implemented to import data from a digital terrain model and automatically assign properties using external data base files from satellite image classification to mesh elements.

Post process code was written in FORTRAN using Gidpost library. Allowing results files to be generated outside the main CARPA code, thus, winning in independence and flexibility. For each result of the hydraulic simulation (depth, x, and y velocity component), the finite volume method produces a single mean value for each element, and we use one Gauss point to visualize it. From these values, two kinds of results are drawn: time dependent and not. To visualize them standard options like display vector and smooth contour fill are used for the first group, and smooth contour fill, contour lines and contour ranges are used for the second group.

DATA IMPORTATION FROM DIGITAL TERRAIN MODEL (DTM)

The two standard formats considered are AutoCAD dxf and Arc/Info ASCII Grid format. For the last one a new code was developed. Data importation requires two independent tasks that must be carried out one after the other; data restoration and data importation.

Data restoration consists, in the first place, in correcting the overlapping of original DTM files by constructing a single big grid, and then splitting it in a number of user specified dimensions files (Figure1). The process is performed by DTM_maker (FORTRAN code) with a Tcl user interface (Figure 2).

The data importation process creates one NURBS-Surface from each DTM file. Arc/Info grid format file is a matrix of elevation values ordered in rows and columns. Rowa represent points with the same y and columns points with the same x (Figure 3). The NUBS-Surface is created by the parallel lines option of GiD, and these NURBS-Lines are obtained from the points of each row of the file (Figure 4). Tode for the importation process was written in tcl.

When the model collapses the result is a group of surfaces that share boundary lines. To improve the performance of the system, and avoid superfluous data, the user can choose to import all the rows and columns, or only one of every 2, 5, 10, 20, 50(Figure5). The resulting model has the advantage of allowing selective mesh refinement by assigning different element sizes to different entities.

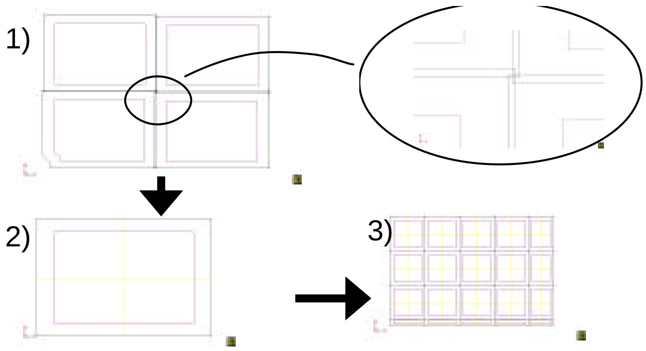

Figure 1: DTM files restoration

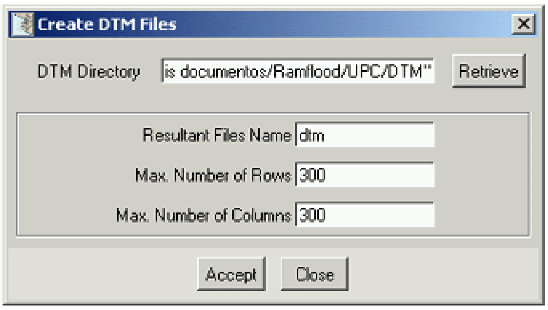

Figure 2: Create DTM menu.

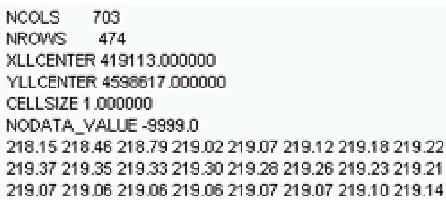
NCOLS 703
NROWS 474
XLLCENTER 419113.000000
YLLCENTER 4598617.000000
CELLSIZE 1.000000
NODATA_VALUE -9999.0
218.15 218.46 218.79 219.02 219.07 219.12 219.18 219.22
219.37 219.35 219.33 219.30 219.28 219.26 219.23 219.21
219.07 219.06 219.06 219.06 219.07 219.07 219.10 219.14

Figure 3: Arc/Info grid ASCII file

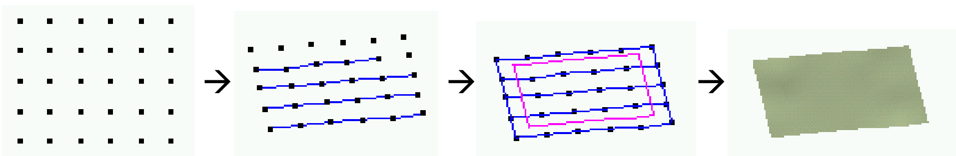

Figure 4: Surface creation from DTM.

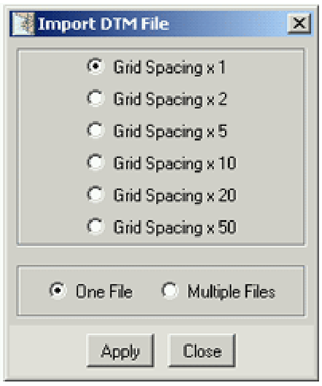

Figure 5: Import DTM menu.

DATA IMPORTATION FROM LAND USE EXTERNAL DATA BASE

Hydraulic simulation results strongly depend on friction between water and terrain. This friction is considered through the Manning coefficient, n, which depends on the land occupation. A land occupation classification can be obtained from remote sensing image interpretation, and translated into a data base. In our case this data base is an x, y, class table.

When there are important variations of land occupation in the study area, the assignation of the Manning coefficient by hand highly inefficient. For that reason a new tool was developed. Using tcl to inquire GiD about mesh (coordinates and elements conectivities), calls for a search algorithm, and assign the Manning coefficient to mesh elements according to the search results (Figure 6).

The written FORTRAN search algorithm looks in the data base for the nearest point to the centre of each element.

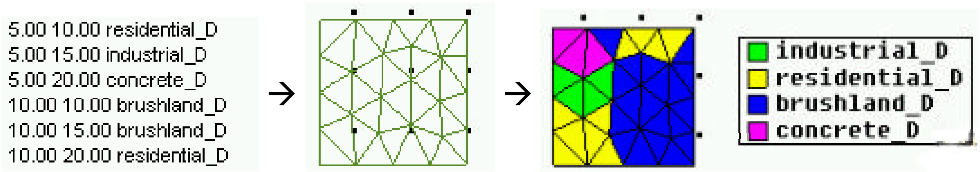

Fig. 6: Step to automatic assignation of properties

Anyway, the option of assigning the Manning coefficient by hand is already available for simple case studies.

SYSTEM PERFORMANCE

Considering the large amount of data required by the system, and the large quantity of information that it generates, we decided to test its performance and the influence of the number of elements of the mesh. Simulations were carried out over the RAMFLOOD Llobregat River area of interest (about 50 km2). Table 1 and Figure. 8 are shown the initialization process time for different number of elements. Although it increases exponentially, if we compare this time with the computation time of CARPA, we find it totally acceptable.

Mesh elements	79682	66433	55159	42374	38804	26818
Mesh nodes	80501	67149	55873	42987	39417	27329
Initialization Time [min]	21.5	15	10.5	6	5	2.5

Table 1: Number of mesh elements vs. Initialization time [(*)]

[(*)] *Simulations ware performed in a Pentium IV, 2.8 GHz, 1 Gb RAM*

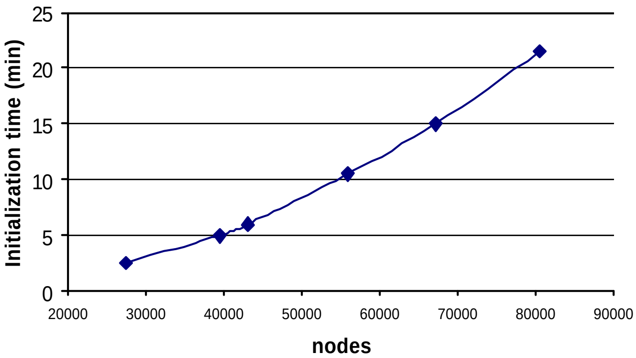

Fig. 8: Curve relationship: Initialization time vs. nodes

CONCLUSION AND FUTURE DEVELOPMENTS

This work has developed a novel application integrating GIS and DTM files into GiD. The environment has shown enough flexibility and adaptability to incorporate this kind of features in future versions.

As part of the RAMFLOOD project, we are already working in the development of a customization of GiD to the one dimensional hydraulic analysis in order to take advantage of all the capacities of CARPA.

REFERENCES

[1] RAMFLOOD-DSS. *Decision Support System for Risk Assessment and Management of FLOODS*. IST-2001-37581.

[2] DEHMA. *Estudio hidráulico del río Segre en el entorno del canal de eslalon de Ponts (Noguera).* Estudio realizado por encago de Gaena Enviroment SL. Junio de 2003.

[3] Toro, E.F. Shock-Capturing methods for Free-Surface flows. Wiley & Sons, Ltd, Chistester, 2000.