A GIS tool to create fluvial flooding maps. Interaction of 1D hydrodynamic model and GIS

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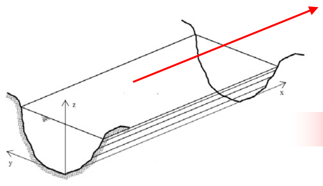
Introduction

Many areas in Europe, and also in Switzerland, are prone to floods phenomenon causing every year damages and destruction.
The purpose of the new *Federal Law on Flood Protection*, (RS 721.100 ,1-1-1993) [1] is the protection of the environment, in particular human life and high value property, from floods and related phenomena.
The non-structural, preventive measures that are the maintenance of the rivers and mainly the land-use planning are of particular importance.

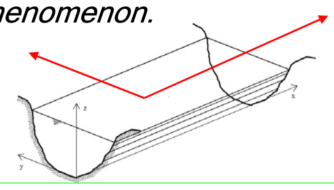
1D vs 2D modeling

- ✓ well computational speed
- ✓ simple calibration
- ✖ bad flooding modeling



In engineering practice the 1D models are more diffuse, even they don't simulate correctly the phenomenon.

The proposed GIS procedure allows to obtain the flooding map,
-known the water depth profile obtained through a 1D model (HEC-RAS, Mike11, etc) along the river axis,
- known an high resolution DTM,
- taking into account the bidimensionality of the flooding phenomenon.



GIS procedure

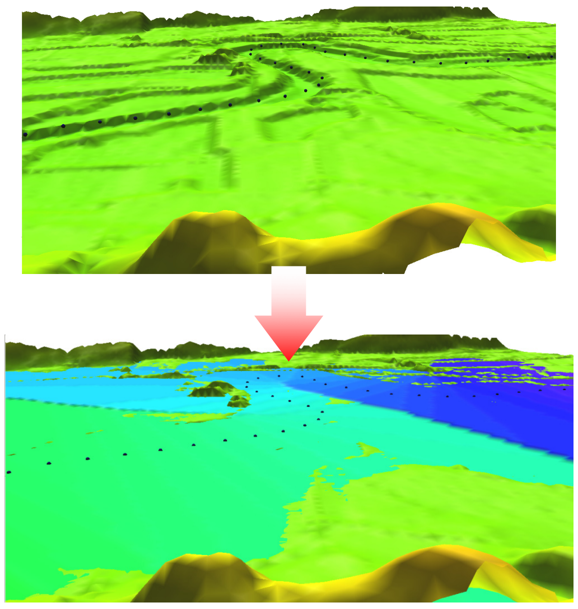


Figure 1 - Water surface profile (1D) along the river axis and corresponding flooding areas

Phase 1 The puntual information of water depth along the river axis is extended on the surrounding surface through the creation of Thiessen polygons

Phase 2 The procedure, neglecting infiltration or underground rivers, removes all the areas previously defined at hazard, but not connected with the river axis, i.e. surrounded by terrain not at hazard

Phase 3 The hypothesis is that water diffuses from river to the surrounding areas only in direction perpendicular to the river axis. All the area defined at hazard at the end of the second phase but protected by levees are eliminated

Phase 4 The hypothesis is that water, outside the main channel, moves along the maximum terrain slope direction. Hence, areas dried in the third phase are defined at hazard if water is able to reach them through 2D maximum slope paths.

The "fourth phases" procedure allows to model 2D flooding only in restricted areas, with lower computational effort.

The GIS procedure was implemented using the open source free software **GRASS** [2] combining the use of the shell script and Fortran languages. Actually it is a available for download as a GRASS add-ons from the webpage: http://grass.osgeo.org/download/addons.php → **r.inund.fluv**

Applications

➢ For a first validation the procedure was applied on a reach of the **Tanaro river** (Italy) 120 km long with a watershed basin of about 6300 km². Model results (fig. 2) are compared with the actually flooding area evaluated by the Po river Basin Authority, wit a good correspondence.

➢ Then the historical and the potentially inundated area caused by the alluvial event in 1994 that interested the **Tanaro river through Alessandria** city were compared with satisfactory results [3] (fig. 3).

➢ Recently, the tool has been applied also to a little stream, **Roggia Scairolo** in the Ticino Canton, for the flooding hazard evaluation [4] obtaining reliable results (fig. 4).

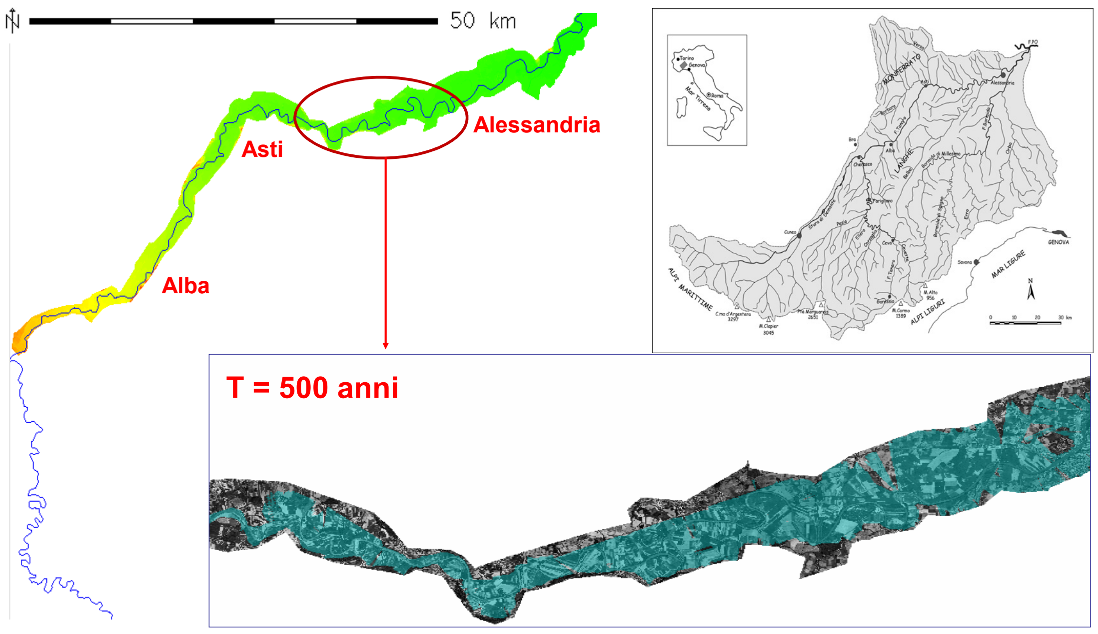


Figure 2 - The Tanaro river (Italy), its watershed basin and the results obtained with the GIS tool

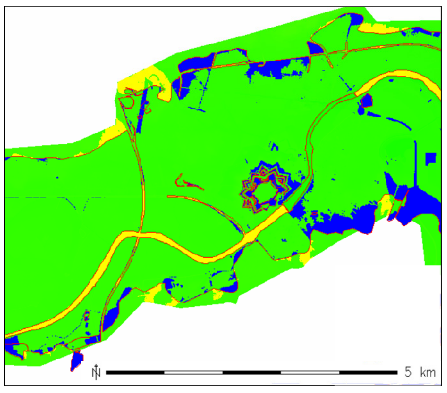


Figure 3 - Differences between the historical (A) and potentially inundated reconstructed (B) area; in blue the area inundated but not simulated, in yellow the area simulated, but not inundated in the 1994 event.

$$\text{Similarity index} = \frac{A \cap B}{A \cup B} = 85\%$$

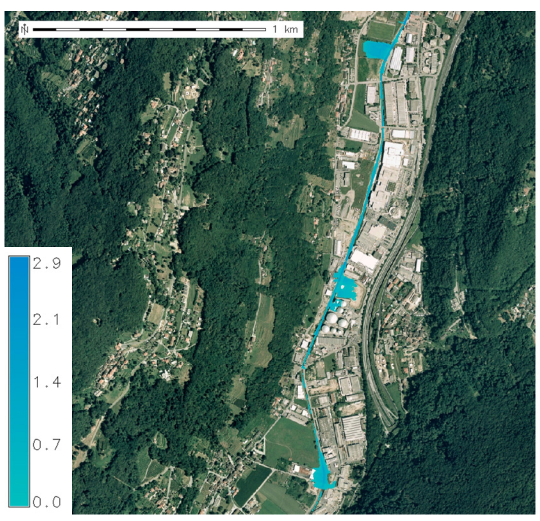


Figure 4 - Particular of the flooding map obtained for the Scairolo stream (Ticino - Switzerland)

Conclusions:

The proposed GIS tool allows to identify flooding area, modeling the 2D phenomenon with low computational effort.
The results obtained are always realistic.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Legge federale sulla sistemazione dei corsi d'acqua del 21 giugno 1991, Swiss Confederation, available online www.admin.ch/ch/i/rs/c721_100.html
[2] GRASS Development Team 2008. Geographic Resources Analysis Support System (GRASS) Software. Open Source Geospatial Foundation Project. http://grass.osgeo.org
[3] Federici, B. Sguerso, D. 2007. Procedura automatica per la creazione di mappe di potenziale inondazione fluviale. Bollettino SIFET, ISSN: 1721-971X, n. 4, pp. 25-42.
[4] Pozzoni, M. Marzocchi, R. Graf, A. 2009. Roggia Scairolo - Zonazione della pericolosità per alluvionamento, Technical report IST