Rapid flood inundation modelling in a coastal urban area using a surrogate model of the 2D shallow water equations

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ABSTRACT

Two dimensional shallow water models have demonstrated good capabilities for flood inundation mapping in urban areas. However, even if High Performance Computing techniques have greatly decreased the computational time needed to run a 2D inundation model, this approach remains unsuitable for applications as real time forecasting or uncertainty propagation in a Monte Carlo context, which require fast urban inundation models. One possibility to meet this requirement are data driven models, which directly relate input and output data without analyzing the physical processes involved. Artificial intelligence techniques have been applied in the field of rainfall-runoff modelling at the catchment scale (Dawson et al., 2006), but very few applications to flood inundation modelling have been investigated (Pender & Liu, 2011).

In this paper we propose and compare the application of different linear, non-linear and non-parametric regression techniques as surrogate models of the 2D shallow water equations (SWE) applied to flood inundation mapping in ungauged urban areas. A coastal urban area is used as a test case. Regression models were developed to predict the maximum water depth computed by a SWE model at selected control points (Fig. 1). The predictor variables were derived from the discharge and tide data prescribed at the open boundaries of the SWE model domain, being several variable combinations tested.

Regression based on least-squares support vector machines resulted in better water depth estimates than standard linear regression. The best performance was achieved when considering the discharge of the three input tributaries and the tide level data as predictor variables. In this way, mean absolute errors represented less than 5.5% of the water depth variation computed by the SWE model at all control points. Overall, the results show the potential of the proposed regression

technique for fast and accurate computation of flood inundation maps.

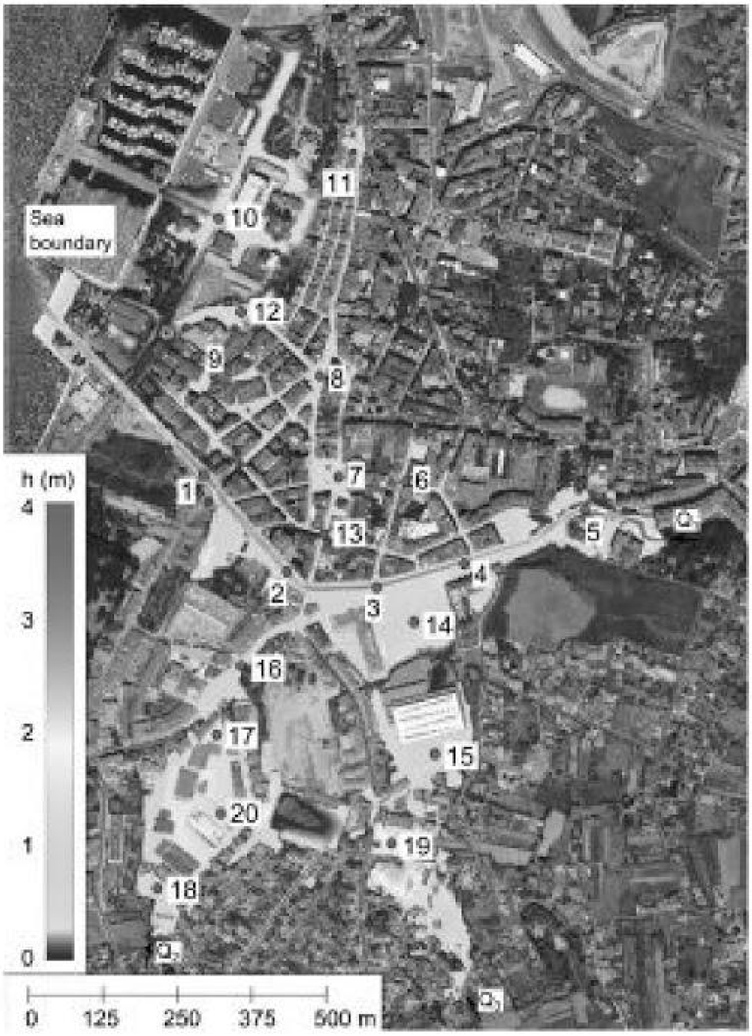

Figure 1. Example of maximum water depth field predicted by the SWE model in the urban area. Location of control points (1–20) and open boundaries (Q_1, Q_2, Q_3 and sea boundary).

REFERENCES

Dawson, C.W., Abrahart, R.J., Shamseldin, A.Y. and Wilby, R.L, 2006. Flood estimation at ungauged sites using artificial neural networks. Journal of Hydrology, 319, pp.391–409.

Pender, G., Liu, Y. 2011. Rapid Flood Inundation Modelling: Meta-Modelling of 2D Hydrodynamic Model Using Artificial Intelligence Techniques (Support Vector Regression, Modified Linear Interpolation and Cellular Automata). FRMRC flood risk management consortium. FRMRC Research Report WP1.3.