Flood Inundation Modelling in Large Rivers Under Uncertainty Using Globally and Freely Available Remote Sensing Data

K. Yan[1], G. Di Baldassarre[1], D.P. Solomatine[1,2], F. Dottori[3]

[1] Hydroinformatics Chair Group, UNESCO-IHE Institute for Water Education, Delft, the Netherlands
[2] Water Resources Section, Delft University of Technology, the Netherlands
[3] Università di Bologna, Dipartimento di Scienze Della Terra e Geologico-Ambientali, Bologna, Italy
Contact E-mail: k.yan@unesco-ihe.org

UNESCO-IHE Institute for Water Education

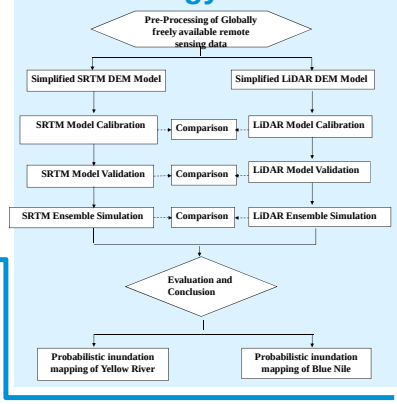
KULTURisk

Abstract

This research aims to contribute to the understanding of whether the globally and freely available remote sensing data may allow for production of probabilistic flood maps for large rivers. In this study, the SRTM DEM is used for hydraulic model building, while ENVISAT-ASAR satellite image is used for model validation. To test the usefulness of these globally and freely available data, a model based on the high resolution LiDAR DTM and ground data is used as a benchmark (Figure 1).

Case study is a data-rich test site: a 98km reach of the River Po in Northern Italy. Potential of the methodology has also been demonstrated on two other case studies: Yellow River and Blue Nile.

Methodology



Results & Discussion

Model Calibration

Two hydraulic models (SRTM- and LiDAR-based) are calibrated against the observed high water marks of 2000 flood.

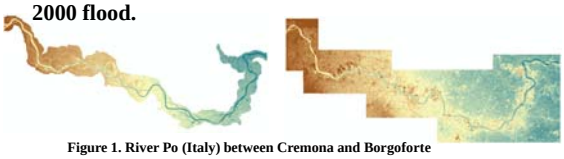


Figure 1. River Po (Italy) between Cremona and Borgoforte (Left: LiDAR DEM, Right: SRTM DEM)

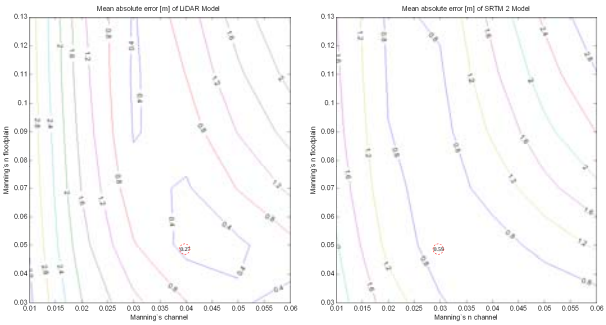


Figure 2. Calibration against high water marks over parameter space (Manning coeffs. of the channel and floodplain) (Left: LiDAR DEM model, Right: SRTM DEM Model)

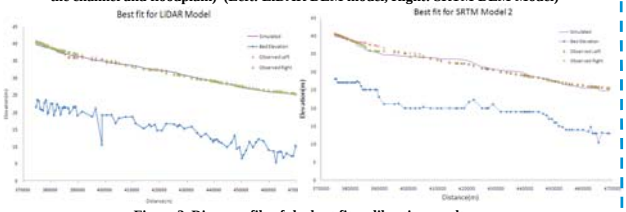


Figure 3. River profile of the best fit calibration results (Left: LiDAR DEM model, Right: SRTM DEM Model)

	Mean Absolute Error (m)	Mean Relative Error (%)
LiDAR DEM Model	0.27	0.84
SRTM DEM Model	0.59	1.83

Table 1. Comparison of the best fit model of SRTM- and LiDAR-based models

The relatively low RMSE for SRTM DEM model and the similar model performances compared with LiDAR DEM model indicate that the SRTM DEM could be used to reproduce large flood event on River Po in 2000.

Model Validation

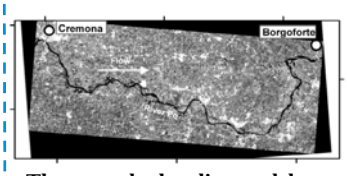


Figure 4. River Po (Italy) between Cremona and Borgoforte (ENVISAT-ASAR imagery in WSM; European Space Agency; Di Baldassarre et al., 2009)

The two hydraulic models are validated against inundation widths obtained from ASAR imagery of 2008 flood event (which is however a small-medium event, so may not allow to draw definitive conclusions).

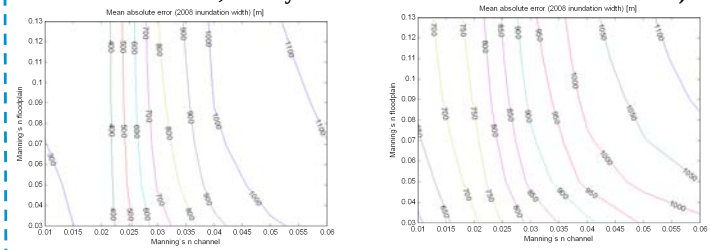


Figure 5. Validation against ASAR inundation width over parameter space (Left: LiDAR DEM model, Right: SRTM DEM Model)

In validation, both two models fail to predict 2008 flood event and there is a large difference in model performances and the corresponding model parameters' values between SRTM- and LiDAR-based models. This might indicate that SRTM DEM may not be the best choice for simulating a small-medium flood event.

Probabilistic flood inundation mapping

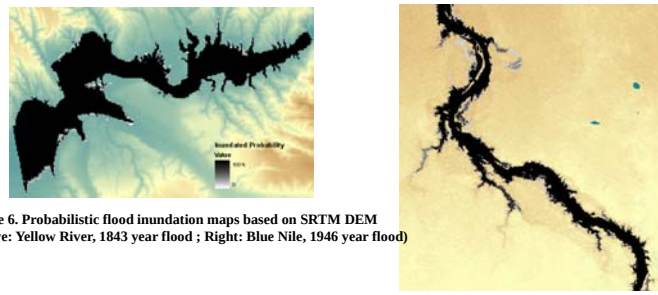


Figure 6. Probabilistic flood inundation maps based on SRTM DEM (Above: Yellow River, 1843 year flood ; Right: Blue Nile, 1946 year flood)

The two floodplain maps indicate that SRTM-based hydraulic model has the potential to reproduce large flood events for large rivers.

Conclusions

The overall description of topography provided by SRTM DEM seems to be adequate for the simulation of large flood event of River Po. The globally freely available SRTM DEM topography data can be used for producing probabilistic flood inundation maps of large flood event for large rivers. The SRTM DEM (calibrated) model however fails to predict a flood event of a different magnitude. This may be attributed to the inflow uncertainty and the model structure (1D not able to simulate 2D floodplain processes), since equally poor results are also obtained with the LiDAR DEM model.

References

Di Baldassarre, G., G. Schumann, et al. (2009). Near real time satellite imagery to support and verify timely flood modelling. *Hydrological processes* **23**: 799-803.