Propagation of uncertainties in rainfall and surface model structure to urban flood simulation and forecasting results

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Investing in Opportunities

INTERREG IVB

✓ Introduction

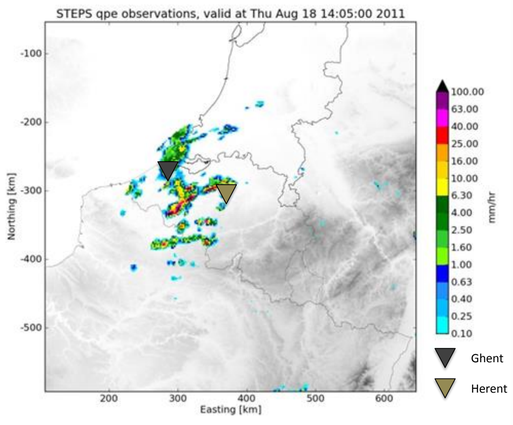
Hydrodynamic 1D (sewer) - 2D (surface) dual-drainage models have shown to be effective tools for the simulation of urban floods. The reliability of such tools depends on different types of uncertainties. The uncertainty in the rainfall inputs is most often the most dominant one, but also the uncertainty in the hydraulic model structure may be of importance. In this study, a rainfall nowcasting model coupled with an urban hydraulic model was used to quantify the **uncertainty** associated with both the *hydraulic model structure* and the *rainfall nowcasting model*.

✓ Rainfall nowcasting model

Short Term Ensemble Prediction System (STEPS), originally co-developed by the UK Met Office and Australian Bureau of Meteorology, further customized by the Royal Meteorological Institute of Belgium (denoted **STEPS-BE**):

- High resolution nowcasts (1km/5min)
- 20 ensemble members
- 2-h forecasting lead time

(Foresti et al, 2014)



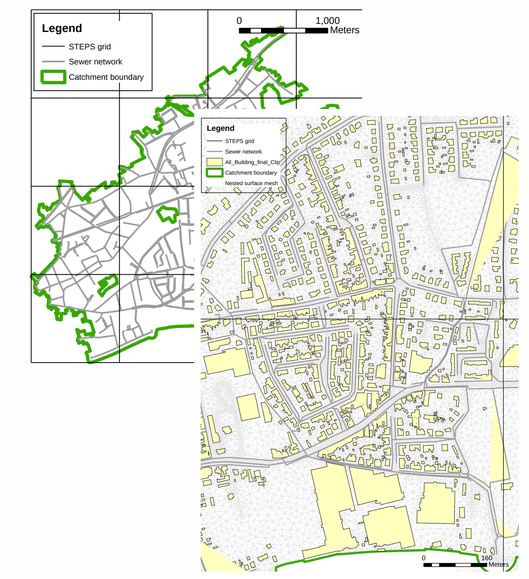
✓ Hydraulic model (i)

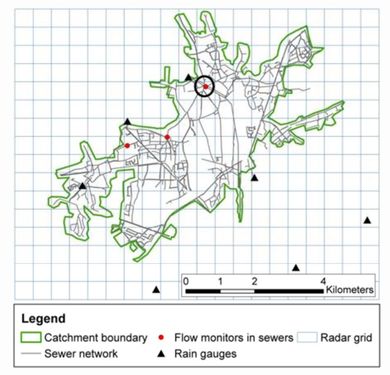
1D sewer network and an innovative **nested** 2D surface model for Ghent (BE), 649 ha. Surface components categorized in 3 groups, modelled using different triangular mesh resolutions (Murla et al, 2015).

✓ Hydraulic model (ii)

Mesh resolutions include: Street zones (3.75-15m^2); High flood hazard (12.5-50m^2); Low flood hazard (75-300m^2) areas.

Semi distributed 1D/1D sewer model of Herent (BE), 2500ha. Local monitoring data availability for this catchment include: 8 tipping bucket rain gauges (1-2min. resolution) and 3 sewer flow gauges (depth & level) (2min. resolution).





✓ Results

Urban structure network uncertainty quantification through the simulation of the 1D/2D nested model approach and a traditional 1D/1D model for a number of historical storm events passing over the flood-prone areas of Ghent.

Rainfall nowcasting model uncertainty quantification through the simulation at Ghent area of:

- Five historical storm events (2013-2014) of 5min with a 2-h lead time and 20 ensemble members, which generate around 2500 simulations per storm event.

✓ Conclusions & Future work

Structuring of the urban surface network has important impacts on the urban flood simulation and forecasting results.

There is a need to consider not only input uncertainties but also correctly *identify*, *quantify* and *propagate* additional sources of uncertainty such as the model structure uncertainty in order to provide complete uncertainty information to flood risk managers

- Rainfall input uncertainty quantification by the use of bayesian merging of Radar and Rain Gauge rainfall estimates - in terms of co-variance of estimation errors - (Wang et al, 2015) at Herent area.

Foresti, L., Seed, A., 2014. "*The effect of flow and orography on the spatial distribution of the very short-term predictability of rainfall from composite radar images".* Hydrol. Earth Syst. Sci., 18(11): 4671-4686.

Murla, D., Willems, P. 2015. "*Development and testing of a nested 1D/2D urban surface model*". JoH. Submitted.

Wang. L-P., Ochoa-Rodriguez. S., Pina. R., Pessemier. M., Kroll. S., Van Assel. J., Willems. P., Onof. C. 2015. "*Enhancement of radar rainfall estimates for urban hydrology through optical flow temporal interpolation and Bayesian gauge-based adjustment".* JoH. In press.