

SimHydro 2021

Models for complex and global water issues : Practices and expectations

6TH INTERNATIONAL
CONFERENCE
16TH-18TH JUNE 2021
SOPHIA ANTIPOLIS - FRANCE

BENEFIT OF COUPLING 1D-2D MODEL OVER AN URBAN AREA TO ASSESS RUNOFF DURING A STORM EVENT

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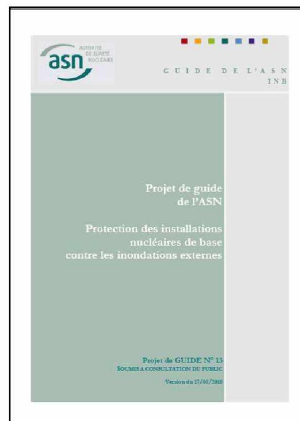
Plan of the presentation

- Context of the study
- Study Case
- Stormwater networks modelling
- Runoff modelling
- Results
- Conclusions and perspectives



The French Institute for Radiological Protection and Nuclear Safety (IRSN) is in charge of assessing the risk of flooding hazards on nuclear sites

ASN Guide n°13 - Protection Against External Flooding



3 parts:

- I - Reference Situations to be considered for Flood hazard
 - Identifying the Reference Flood Situations (RFS)
- II – Characterize the reference flood situations
 - Quantifying the physical phenomena
 - Increase / combination of events (to cover uncertainties)
- III - Flood protection
 - Identifying specific aspects of flood hazards and the principles that guide design choices and protection methods implemented for flooding risk

Nuclear facilities :



Bugey NPP



Marcoule site

Rainfall situation

Probabilistic objective of the Guide : 10^{-4} / year uncertainties covered

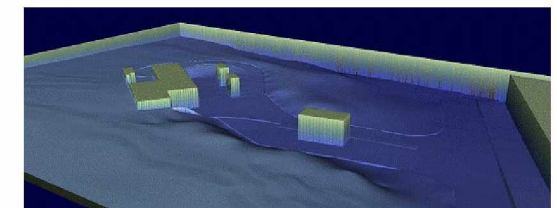
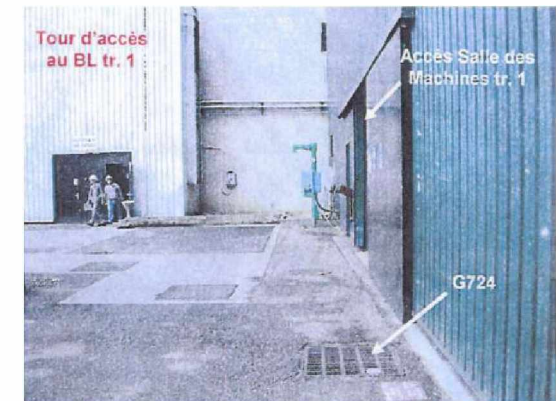
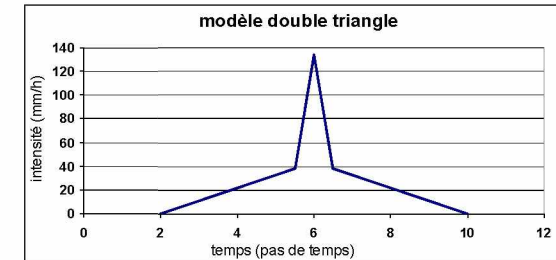
Step 1: Rainfall events to consider

- Upper bound 95 % confidence interval of 100-year return period rainfall
- Various durations of rainfall peaks to get the most challenging conditions
- Historical events if not covered by designed rainfall events

Step 2: Quantifying the physical phenomena

- Drainage system sufficiency evaluation to cope with rainfall event defined (step 1)
- Drainage system not available : facility must cope with a 100-year return period rainfall during one hour considering that inlets of the drainage system are blocked

Step 3: Identify flood hazards and protections needed

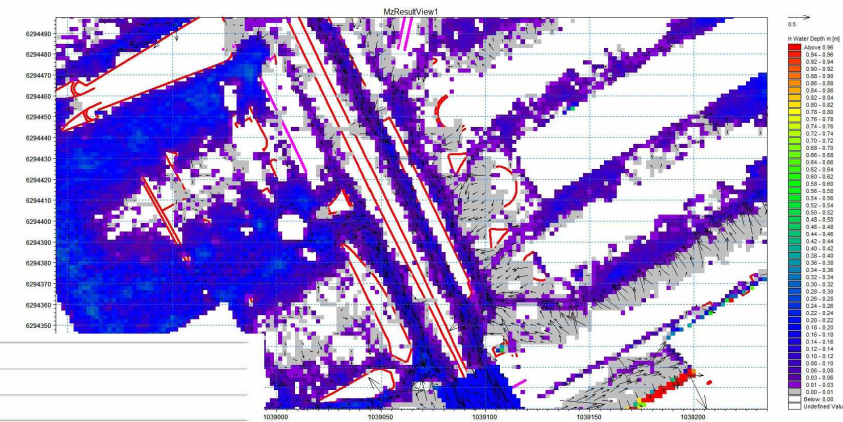
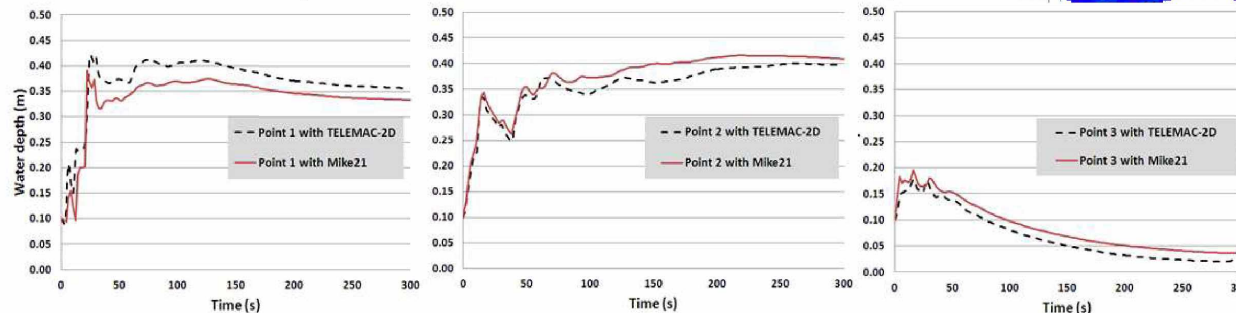


Previous studies done : Drainage system not available

- Using high resolution topographic datasets to represent soil features at different levels of details, to evaluate runoff estimations capabilities and uncertainties assessment with 2D numerical modelling tools



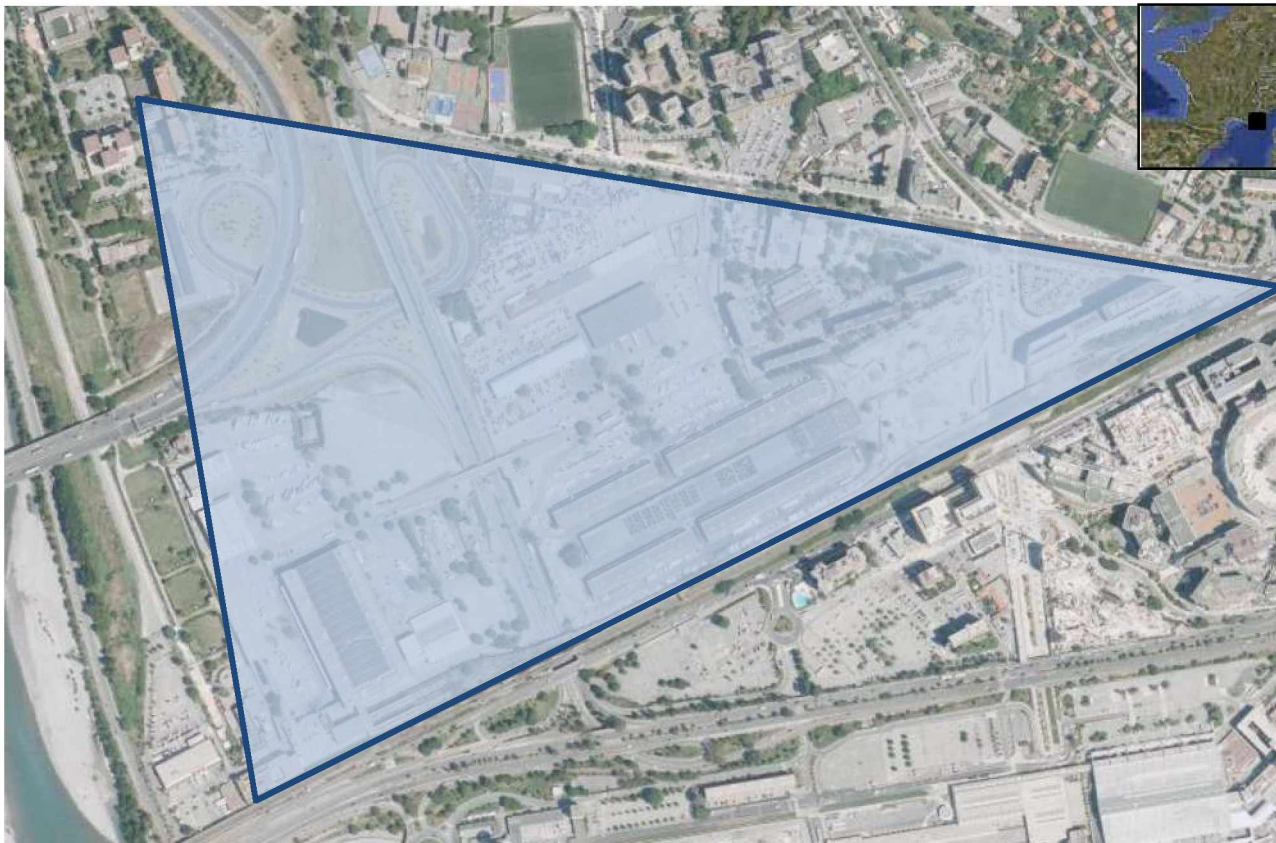
Illustration of water levels evolution simulated at 3 points



From Abily, M. and al. (2016). Spatial Global Sensitivity Analysis of High Resolution classified topographic data use in 2D urban flood modelling. *Environmental Modelling & Software*, **77**, p. 183-195.

Study Case

Marché d'Intérêt National (MIN), in Nice France



From <https://www.geoportail.gouv.fr/carte>

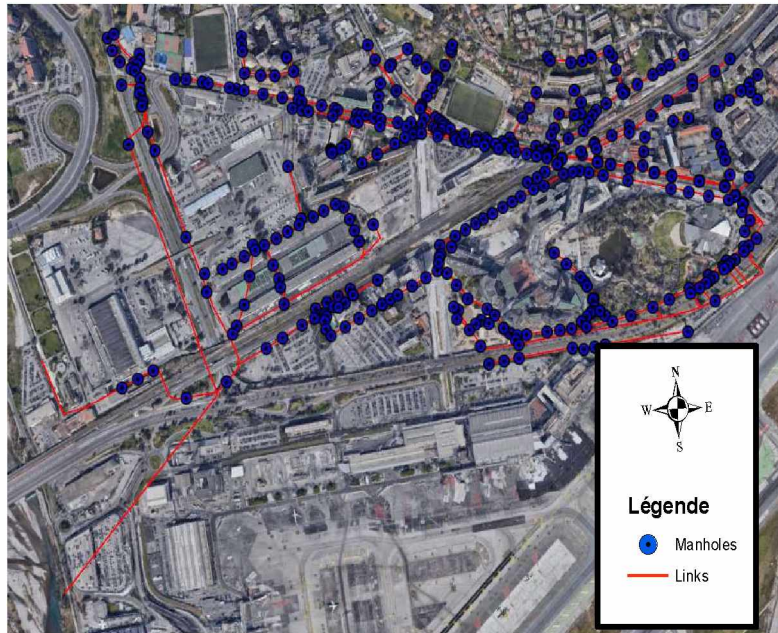
➤ Description :

- Industrial site
- Urban area
- Surface area : 60 ha

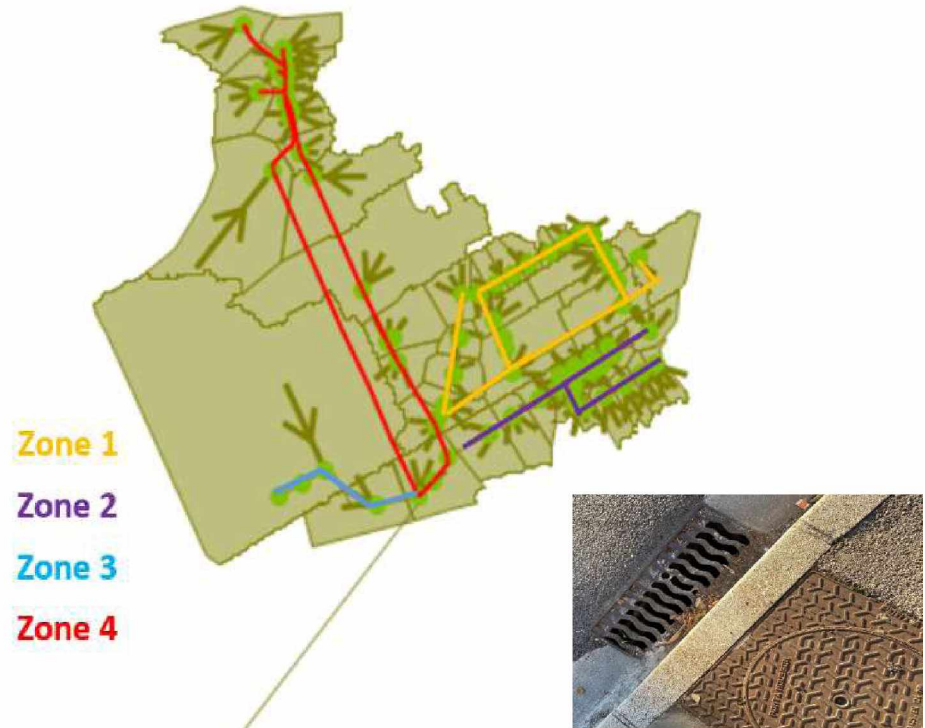
➤ Data available :

- Stormwater network
- Topographic and photogrammetric data

Stormwater networks



➤ Modelling tool : **InfoWorks ICM**

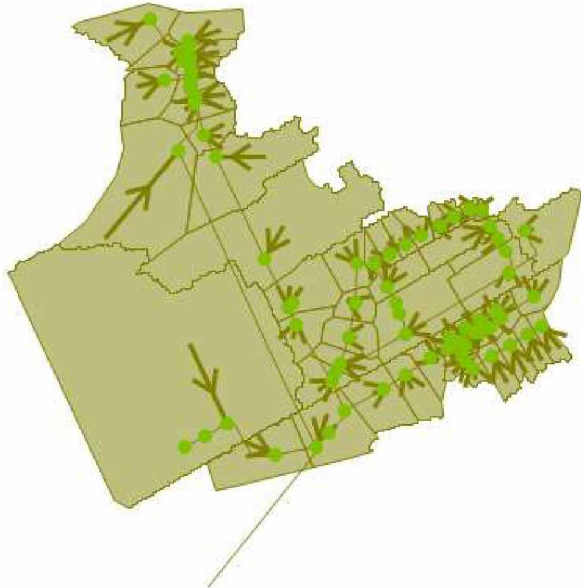


➤ Description :

- 81 manholes
- 60 sub catchments
- Outlet in the Var
- 81 links
- 40 ha modelled
- 100 % impervious

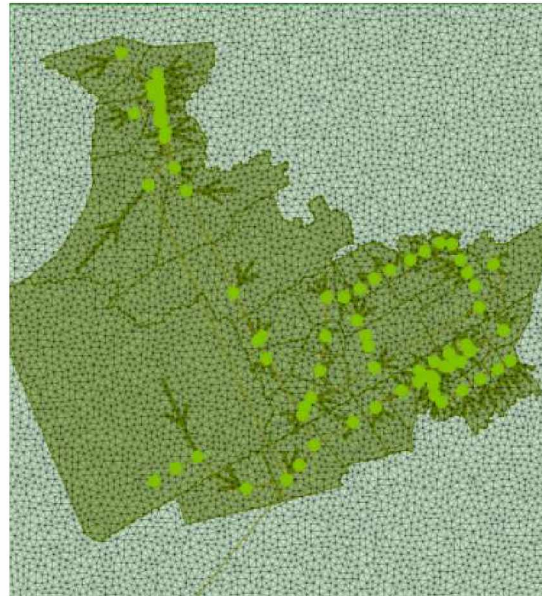
Missing data : Links diameters₇

1D-1D



- 100 % impervious

1D-2D

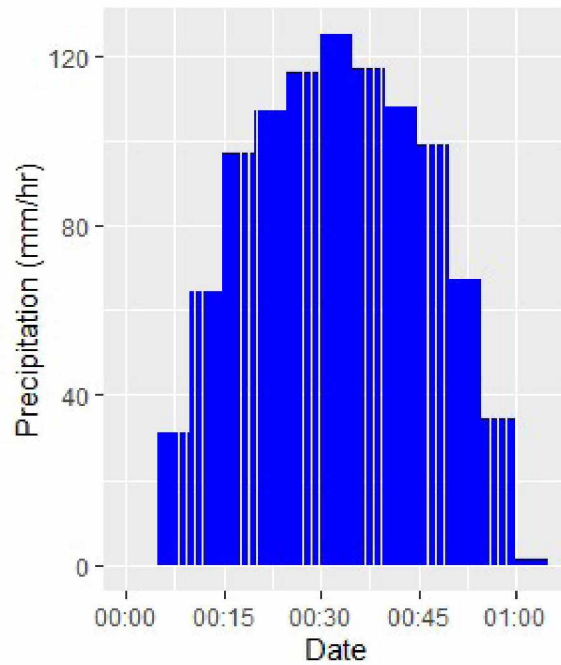


1D-2D building



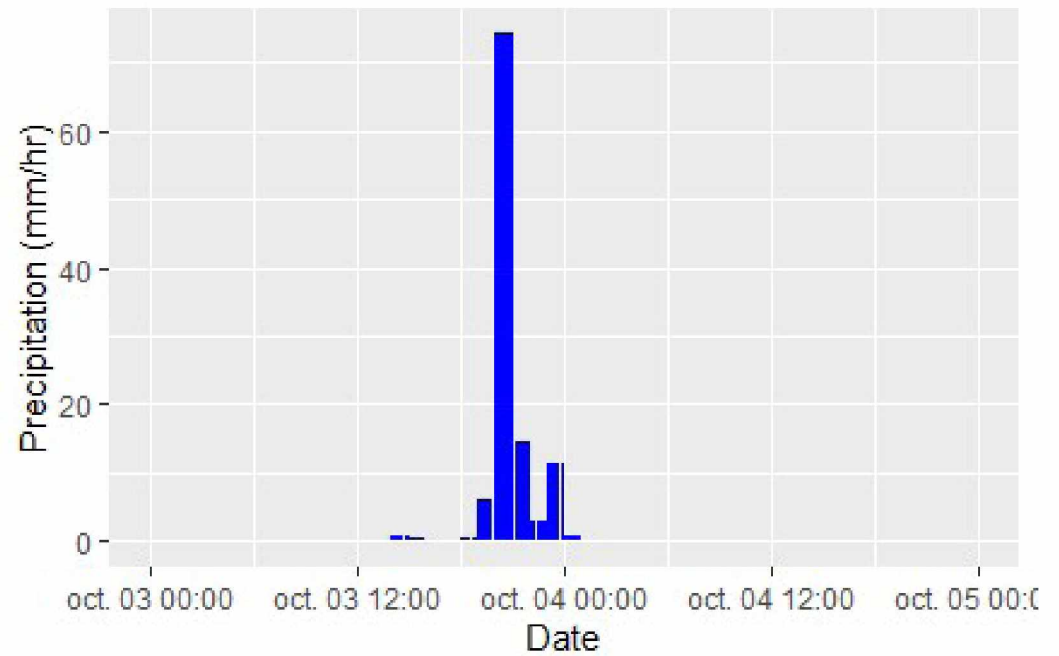
- 5m resolution DTM available for Nice Métropole (2019) used to generate the mesh
- buildings extracted from photogrammetry data available
- uniform Manning's roughness coefficient value of 0.0125

1 hour 100-year* return period rainfall event



80.7 mm in 1 hour

3rd October 2015 event*



112 mm in 5 hours

*From Météo France publithèque and services

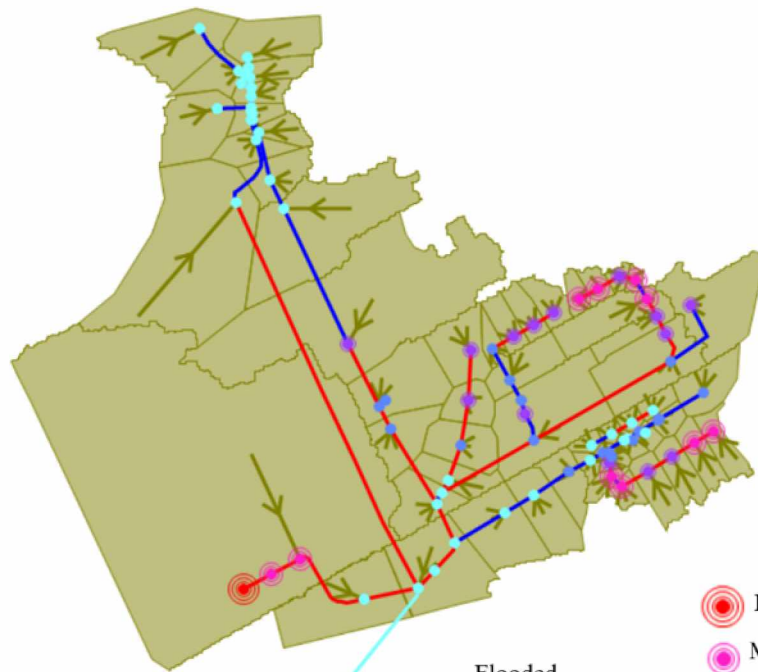
Storm network overflow (1D-1D)

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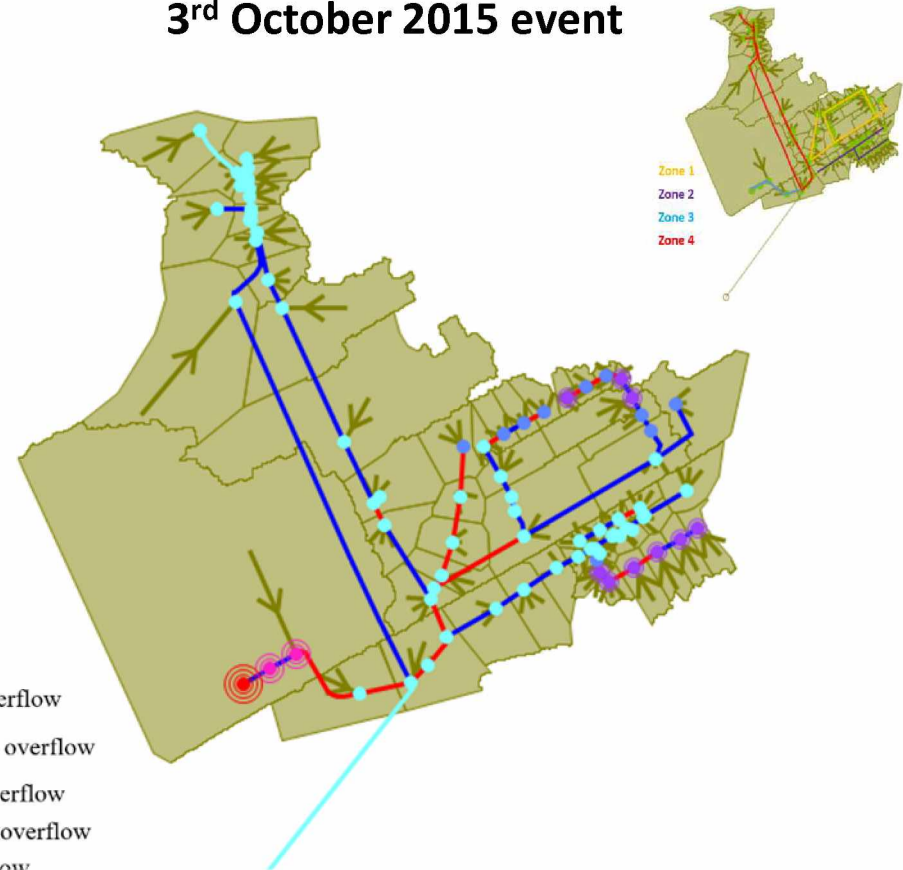
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100-year return event

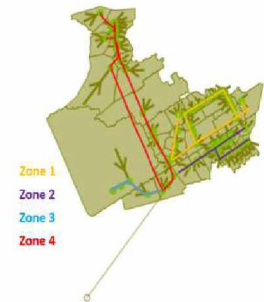


3rd October 2015 event



Stormwater overflowing comparison

	100-year rainfall			3rd October 2015		
	1D-1D	1D-2D	1D-2D buildings	1D-1D	1D-2D	1D-2D buildings
Zone 1	1,056	1,764	1,767	86	359	361
Zone 2	554	1,057	1,058	243	514	515
Zone 3	9,475	9,183	9,749	9,565	9,816	10,652
Zone 4	266	967	969	0	0	0
Total Volume (m ³)	11,351	12,971	13,543	9,894	10,689	11,527



➤ **branches 1 and 2 :**

- larger volumes overflow for the 1D/2D scenarios
- buildings have a marginal influence on overflowing volumes

➤ **branch 3 :**

- larger volumes overflow for the October 2015 event
- flooded volume is much larger when buildings are introduced in the mesh for both events

➤ **branch 4 :**

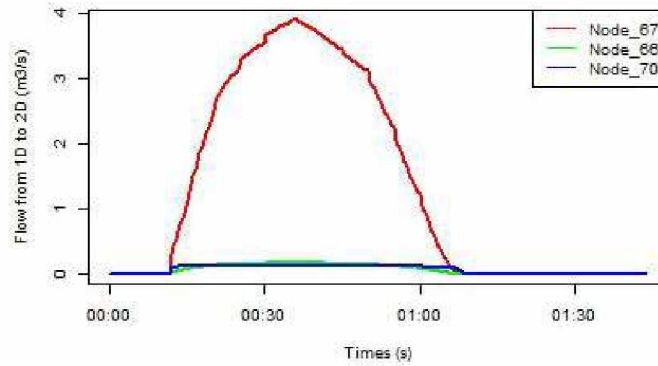
- a limited risk of stormwater flooding

➤ Differences are identified between the models

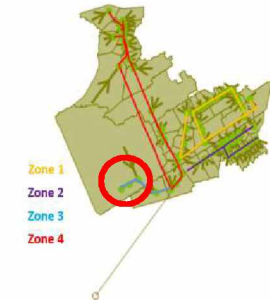
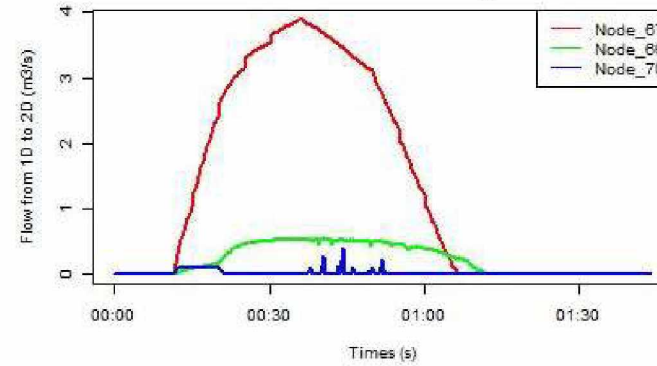
Flow from 1D to 2D for nodes presents in branch 3

100-year

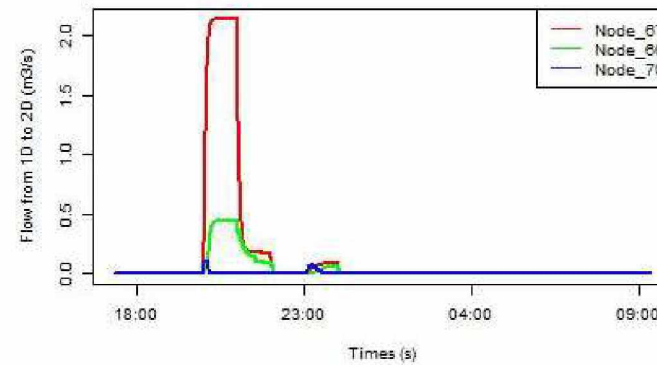
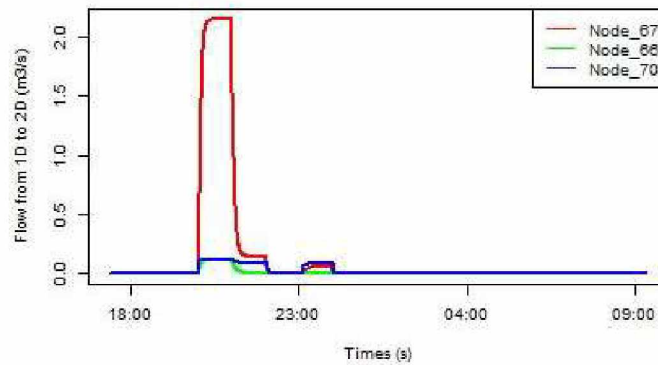
1D-2D



1D-2D building



3rd October 2015



➤ Storm network overflow is influenced by buildings

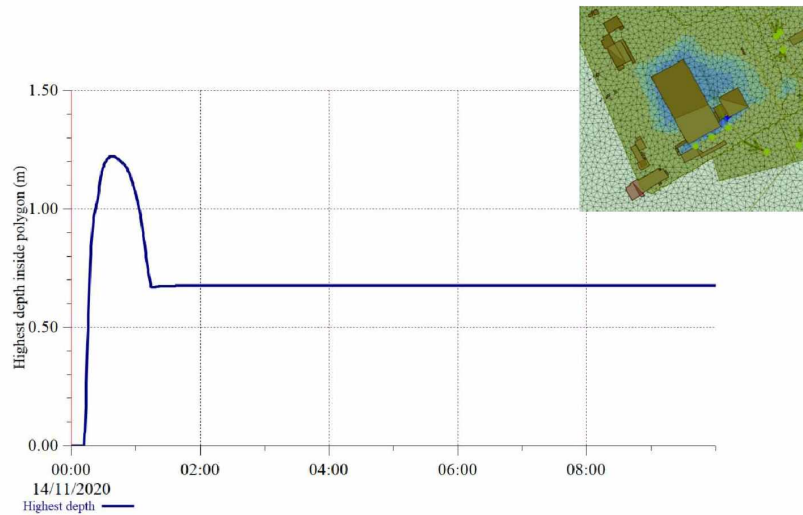
- Maximum water depths modelled with 1D/2D model for the 100-year event



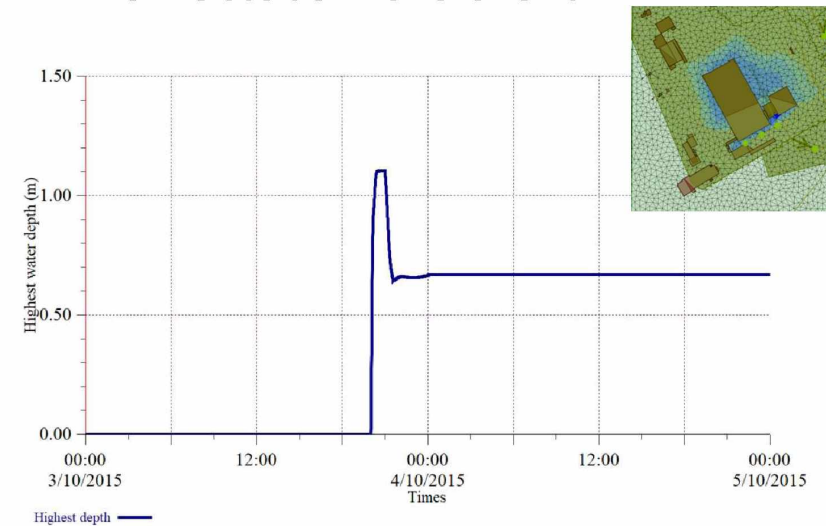
- 4 accumulation zones
- Up to 1.20 m of water

Synopsis of the accumulated water depths over the building area in zone 3

100-year return event



3rd October 2015 event



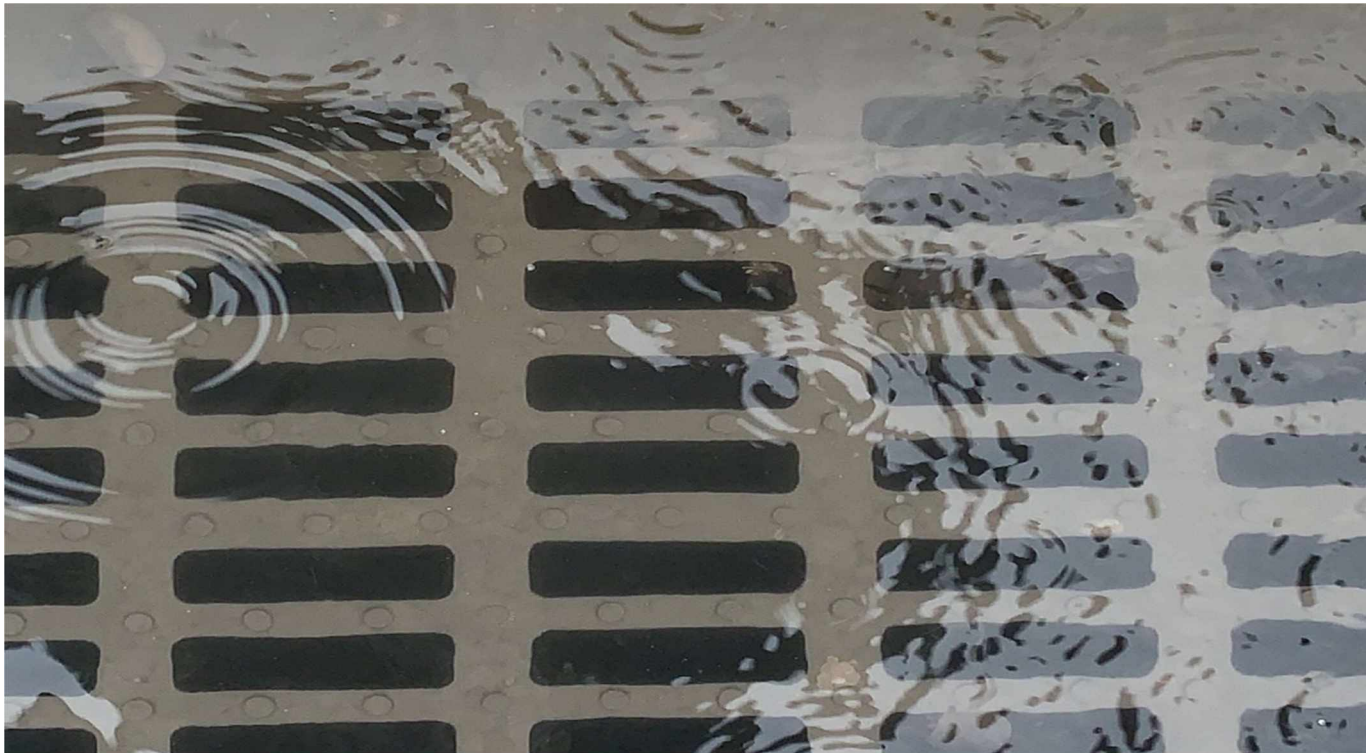
- maximum water height of 1.15 and 1.20 m along the buildings for the two scenarios
- volume overflowing for 3rd October larger however water height is lower

Conclusions

- 1D-1D model does not allow a direct quantification of the water heights accumulated on the surface around the vulnerable areas
- Overflow volumes for 1D-1D model are lower than those calculated by the 1D-2D models
- Presence of buildings influence the overall dynamics between 1D and 2D

Further investigations

- Test vulnerability of a site with different shapes of hyetograms for the same return period
- Quantify the uncertainties related to the parameters of the stormwater network input data
- Advanced 2D modelling to have a better representation of runoff



10th May 2021 rainfall event

Thank you for your attention