Fine-scale rainfall measurement and prediction to enhance urban pluvial flood control

Pilot location: Spaanse polder, Rotterdam, NL

Rainfall

Rain gauges:

- 1 tipping bucket rain gauge with 0.2 mm resolution and 1 min data sampling operated by Rotterdam City and equipped with wireless real-time communication devices.

Radars:

- The area is within the coverage of X-band and C-band radars operated by the TU Delft and KNMI respectively:

Specifications	X-Band*	C-band
Polarisation	Dual-polarisation	Horizontal
Doppler	Yes	No
Beam width	1,8°	1°
Frequency range	9,3 – 9,5 GHz	5,6 GHz
Spatial resolution	30 m	1 Km
Temporal resolution	1 minute scan	5 minute scan
Elevations	0°-90°	0,3°-25°

*The radar will be installed in autumn 2013, currently under tender procedure.

Water depth sensors

6 sensors for water depth measurement in sewers

The sensors are pressure sensors: used at 0,35 bar or 0,7 bar range. All sensors are equipped with wireless real-time communication devices. Sampling frequency: 1 minute.

Figure 1: Monitoring and sewer system

Digital Terrain Model (DTM)

The Municipality provided a set of AHN-2 layers cropped to the administrative limits of the city. This DEM was produced using Light Detection and Ranging (LiDAR) of ground levels from an aerial platform.

The DEM is characterized by
- a spatial resolution of 0.5 m × 0.5 m,
- a vertical precision of 5 cm,
- a systematic error of 5 cm, a random error of 5 cm,
- a minimum precision under two standard deviations of 15 cm.

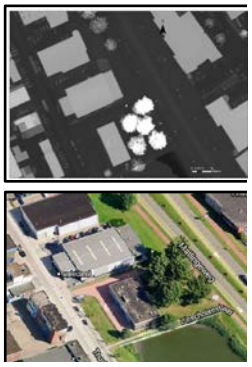

Figure 2: DTM

A drainage urban pluvial flood model has been set up for the Spaanse polder catchment using Sobek-urban 212:

- The sewer system is modelled in 1-dimension (1D) in Sobek Urban: the model consists of 637 manhole nodes, 7 external weir nodes and 2 boundary nodes (which serve as sewer outlets) connected by 691 pipes. Among the latter, 4 are pressurized and 487 are with runoff.
- The rainfall-runoff process is modelled in Sobek RR: runoff to the sewer system is computed by delay factor +losses+infiltration module, where the discharge into the system is computed as a function of rainfall and runoff factors, which in turn depend on slope, area and type of surface. According to Dutch guidelines [1], 12 different area types were set up with 12 associated values of runoff factors.
- The overland flow in the urban surface occurring in case of sewer overflow will be set up using the 2-dimensional Sobek module, where the continuity and momentum equations are solved by finite differences method in each cell of the surface grid.

The Sobek model is semi- distributed and in both 1D and 2D modules, the water flow is computed by solving the complete De Saint Venant equations: 1D continuity and 1D momentum equations for the Sewer Flow module, and 2D continuity equation and 2D momentum equations (for the x and y directions) in the 2D overland flow module.

[1] Module C2100 Rioleringsberekeningen, hydraulisch functioneren. Rioned, 2008.