(Urban) flood management in Flanders ,Belgium

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Types and occurences of flooding

Water and flood management

Tidal flooding

© Google Maps

Rough delineation of direct tidal zone of Scheldt River and tributaries

- Not (or not significantly) rainfall induced
- Along coastline (very rare)
- Along Scheldt river + major tributaries
  - Critical situations (near flooding) can occur every couple of years
  - Major floodings in 1953 / 1976 (dyke failures)
- Can cause floodings in upstream rivers or sewer systems

Fluvial flooding

Source : www.overstromingsvoorspeller.be

Source : www.hbvl.be

Source : www.standaard.be (Annelies Desmet)

- Rainfall induced (long to medium response time)
- Along non-tidal rivers and ditches
  - Critical situations occur typically 1-3 times a year
  - Several major floodings in past 10-15 years
- Can cause floodings in upstream sewer systems

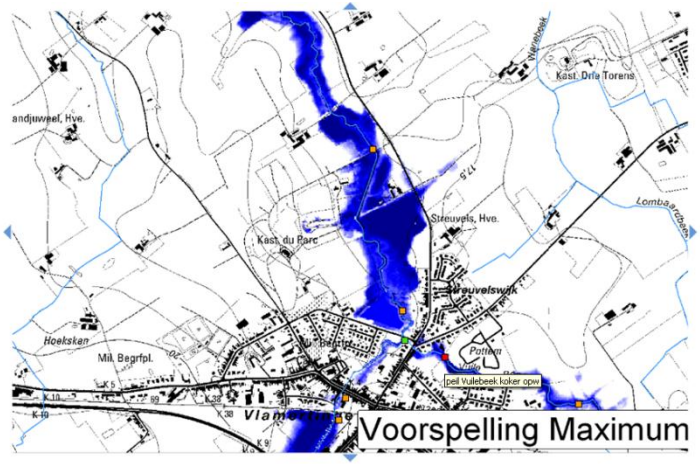
Flood management (tidal-fluvial)

Type of flooding	Who ?	How ?
Tidal (coastal)	MOW	• Coastal Protection Plan
Tidal (rivers)	MOW	• (Revised) Sigma Plan (dykes, controlled flood zones) • Operational Early Warning System • Flood Risk Management Plans (EU)
Fluvial (1st cat. rivers)	VMM	• Extending storage in natural valleys and artificial storage basins • Hydraulic optimisation and maintenance • Operational Early Warning System •Flood Risk Management Plans (EU)
Fluvial (2nd cat. rivers)	Provinces	• Hydraulic optimisation and maintenance • Commonly (2nd) or occasionally (3rd) integrated in VMM's EWS and in FRMPs
Fluvial (3rd cat. rivers)	Municipalities	

MOW : Flemish Ministry of Mobility and Public Works
VMM : Flemish Environmental Agency

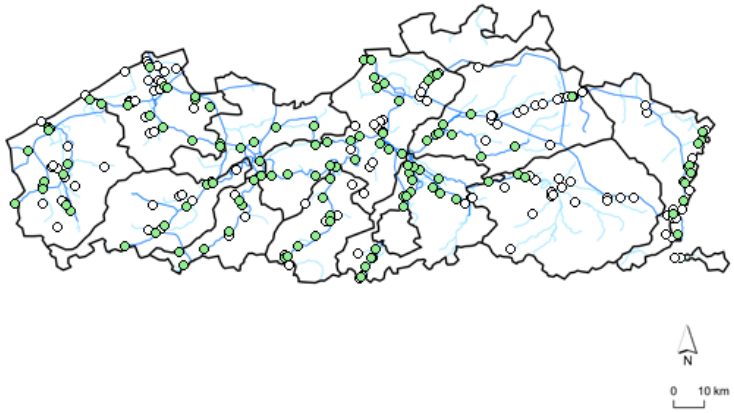
Early Warning systems (VMM)

www.overstromingsvoorspeller.be



Early Warning Systems (MOW)

Waterstanden, debieten en neerslaggegevens voor de laatste 10 dagen.



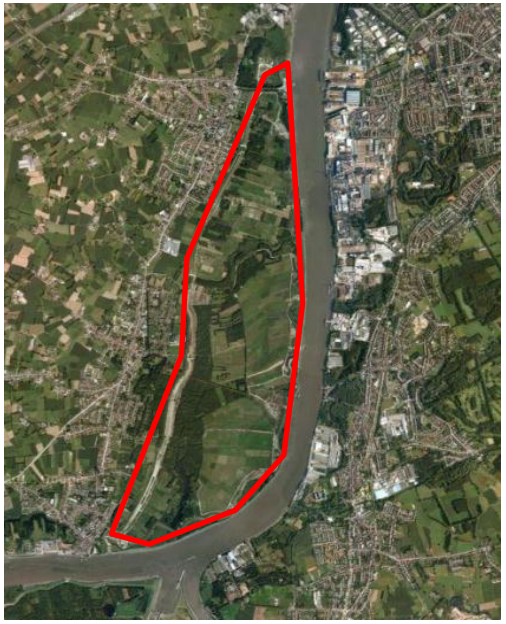
Laatst bijgewerkt **04/04/13 10:15**

Kleur	Betekenis
Groen	Normaal: geen overstromingen
Geel	Pre-waakdrempel overschreden: verhoogde waakzaamheid, geen overstromingen
Oranje	Waakdrempel overschreden: sterk verhoogde waakzaamheid, niet-kritieke overstromingen mogelijk
Rood	Alarmdrempel overschreden: hoogste waakzaamheid, kritieke overstromingen mogelijk

www.waterstanden.be

Flood Prevention

Controlled Flood Zones



© Google Maps

> 600 ha polder u/s Antwerp

Artifical Storage

Source : VMM (www.overstromingsvoorspeller.be)

Storage and sediment catch u/s Leuven

Pluvial flooding

Source : www.demorgen.be © Belga

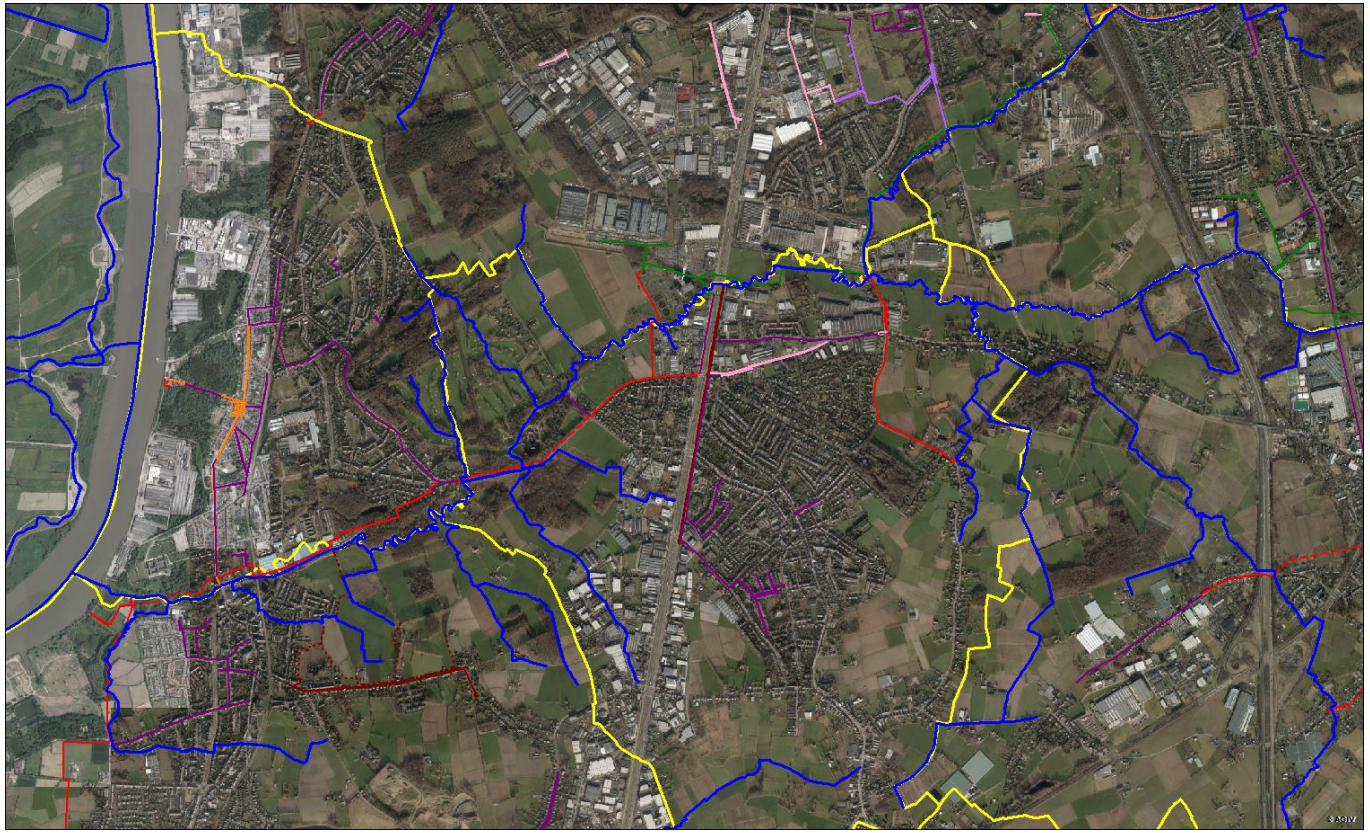
Source : www.demorgen.be © Belga

- Rainfall induced (short response time)
- Along sewer systems, small urban drainage elements (SUDS) and ditches
  - Typically occuring at short heavy intensity rainfall events (‘summer storms’)
  - Floodings of different degrees of severity occur several times a year

Flood management (pluvial)

Where ?	Who ?	How ?
Trunk sewers	Aquafin	• Optimising hydraulic capacity and storage (basins) • Hydrodynamic modelling (standard)
Local sewers, SUDS, ditches	Local sewer operators (incl. Aquafin) or Municipalities	• Optimising hydraulic capacity and storage (local solutions) • Often integrated in trunk sewer hydrodynamic modelling • Storm water management plans (under development)
Motorway (+ alike) drainage	MOW	• Local storage solutions

Everything interacts …



Source : Aquafin & Agiv ©

Watercourses (blue), municipality boundaries (yellow) and trunk sewers (other colours) indicated
Not shown : local sewers, motorway drainage

Urban flood management and modelling

Evolution of sewerage design codes

Period	Applicable	Key points
1996 – 2012	'Old design code'	Mainly traditional urban drainage design • composite design storms (all durations between 10' and 48 hrs in one storm) • hydraulic capacity based on T2 • 50 cm freeboard from flooding at T2 • no flooding at T5 (T10 for 'highly sensitive urban areas')
2002 - 2012	Informal modifications to 'old code'	• Carry out additional sensitivity analysis for T10 and T20 • Evaluate design at different design horizons and different assumptions for conceptual changes (transition combined → separate systems)
2013 -	'New design code'	More focus on sustainable design • Revised composite design storms taking into account more recent rainfall statistics • No flooding allowed at T20 • Focus on infiltration

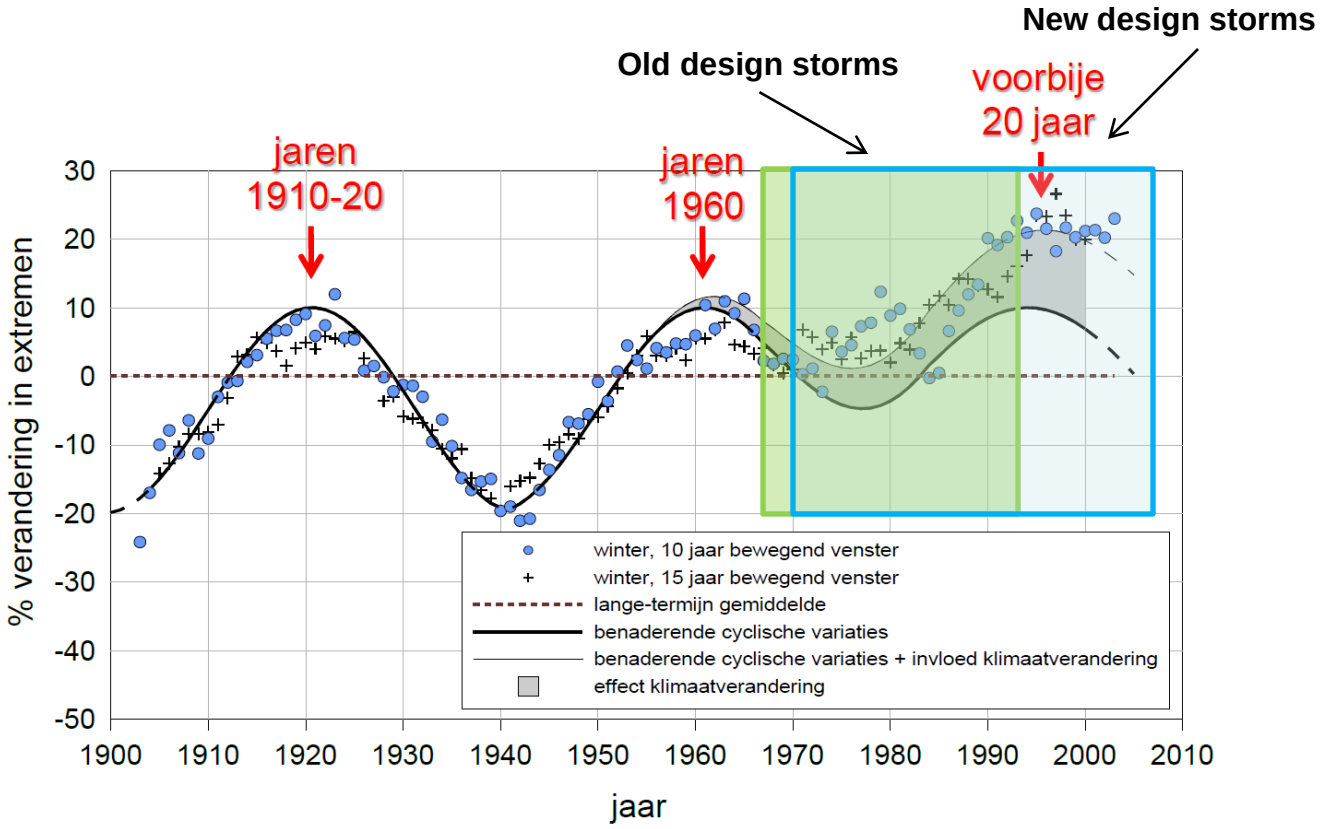
Evolution of building permit regulations

Period	What ?	Key points
1999-2004	Informal advice	Promotion of rainwater tanks (rainwater harvesting and re-use) as source control measure
2004 – 2012	'Old urban planning regulation'	Imposed rules for source control measures : • rainwater tanks • infiltration • detention tanks (limited throughflow)
2013 -	'New urban planning regulation'	Revision of rules for source control measures : • larger rainwater tanks • more focus on infiltration More strict application
2003 –	'Water Proof'	Checklist for general evaluation of building projects/programmes in previously unbuilt areas.

Source control measures

Source : VMM (Flemish Environmental Agency)

Design rainfall revision

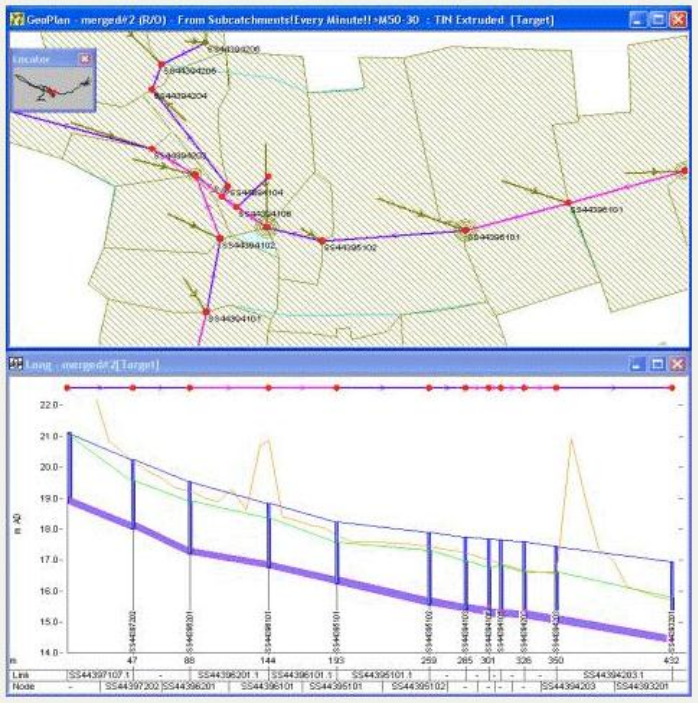


(P. Willems, KU Leuven)

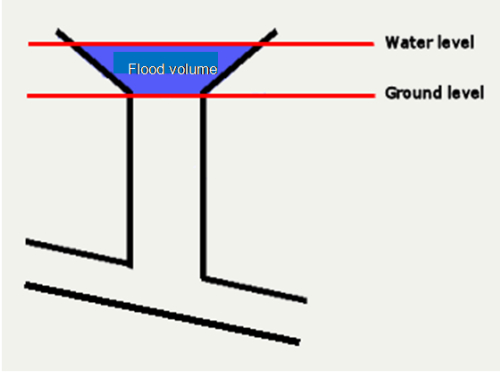
Evolution in urban flood modelling

Traditional methods	New methods
• Use of ‘dummy’ flood cones • No detailed simulation of localised flooding possible • Accuracy of model is unknown as soon as floods occur	• Full 2D or hybrid 1D/2D modelling • More realistic localisation of flooding and preferential flood pathways • Better estimation of flood depths and velocities, flood pathways • Possibility to model flood interactions between sewers and river flood zones

Flood modelling



Localised flooding in nodes



Dummy
flood cones

2D spatial flooding

Source Innovyze Ltd.

Urban flooding EWS

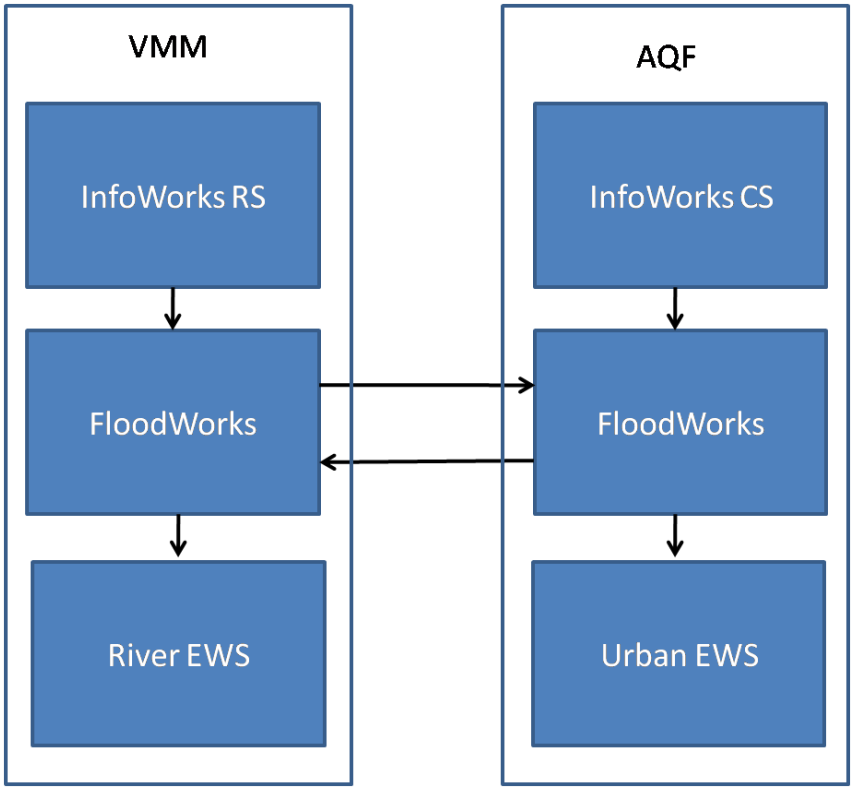
- Based on river flooding EWS concepts …
  - Realtime rainfall feed
  - Realtime hydraulic and flood calculation
  - Simulation update frequency = f (rainfall forecasts)
  - Hindcast simulation to evaluate model performance in realtime
  - Forecast simulation to produce early warnings

Urban flooding EWS (2)

- … but at the same time quite different
  - Response times much shorter
  - Local rainfall patterns more difficult to catch/predict
    - High resolution radar necessary
  - Never enough observations in sewers ...
  - Model flood calculations much harder to validate.

Choice of FloodWorks as EWS

- InfoWorks CS standard sewer modelling package in Flanders
- VMM EWS for rivers based on FloodWorks

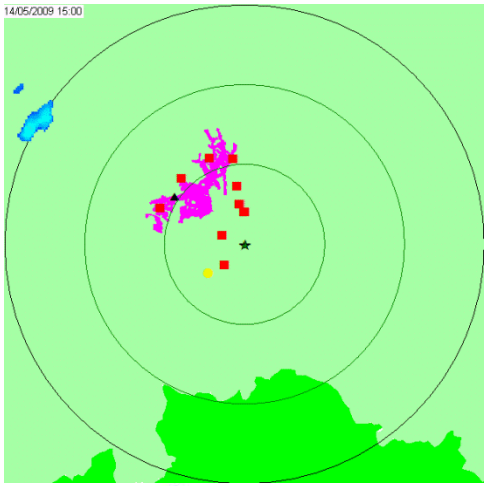


Leuven radar (City LAWR)

- Small scale X-band radar
  - Based on marine technology)
  - 125x125 m² spatial resolution
  - 1 min time resolution
  - 15 km radius

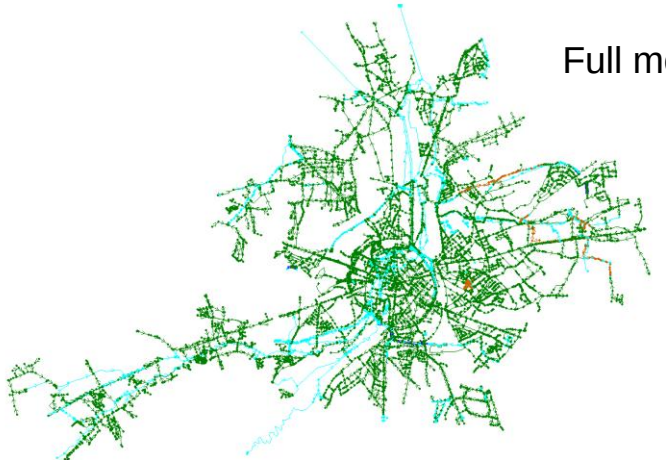
- Operational since 2008
  - Longterm research collaboration KU Leuven-Aquafin
  - Use of data in FloodWorks currently under investigation
    - Data conversion
    - Data quality monitoring

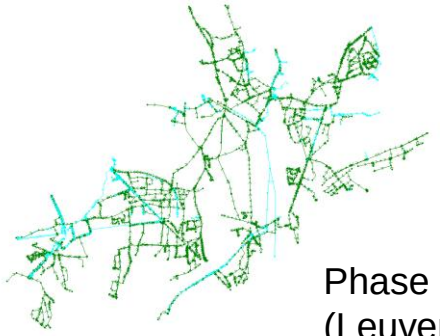
Leuven radar (City LAWR)



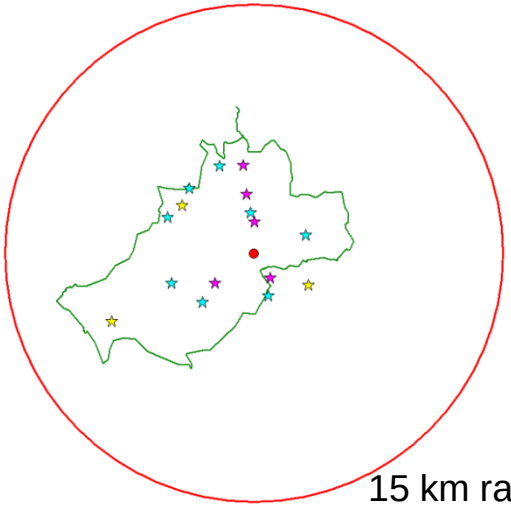
Leuven model

Full model

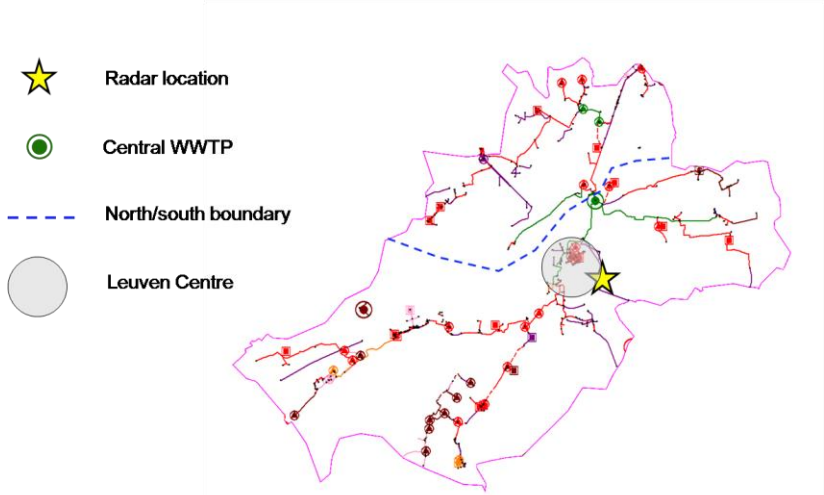




Phase 1 model
(Leuven North)



15 km radar reach



Challenges

- Urban flood management
  - Develop integrated stormwater management plans with all (local) authorities involved
  - Climate change
    - Focus on flexible (adaptive) measures to include for additional flood risk
    - Preferably ‘no regret’ measures, given high degree of uncertainty.
  - Use of realtime control to prevent flooding in most sensitive areas
  - (Early) warning systems for inevitable flooding

Challenges (2)

- Urban flood modelling
  - How do we get our models right ??
    - Need for uncertainty estimation.
      - Very difficult to know the current situation at private properties
      - Do we really know how SUDS behave ?
    - How to verify a 2D flood model ?
      - Community assistance required (social media)
  - Will we be able to run complex models sufficiently fast for early warning ?