Modeling the impact of retention-detention units on sewer surcharge and peak and annual runoff reduction

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Why are we doing this?

Ongoing discussion:

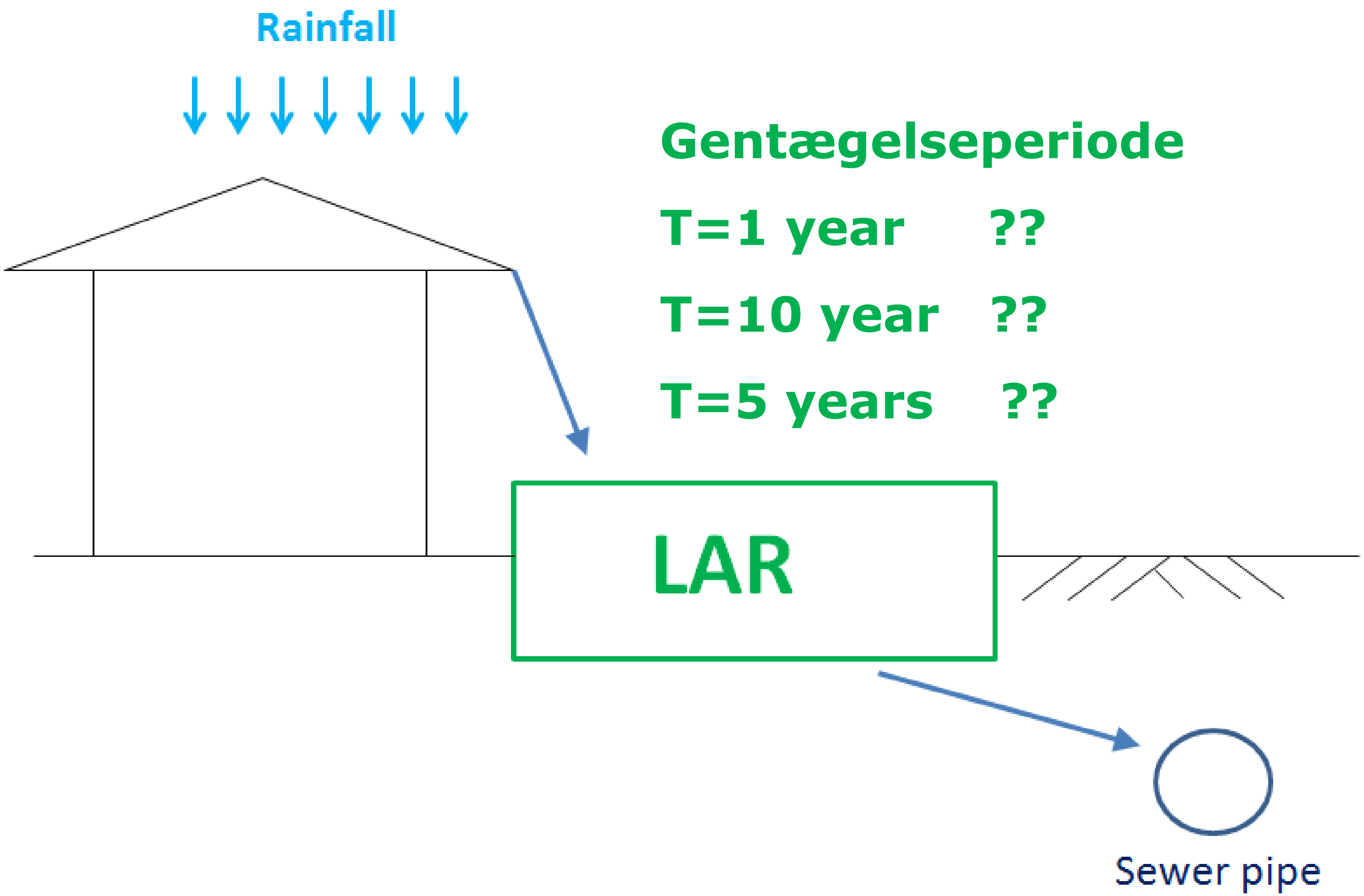
How much water should we handle locally with LAR?

Gentægelseperiode

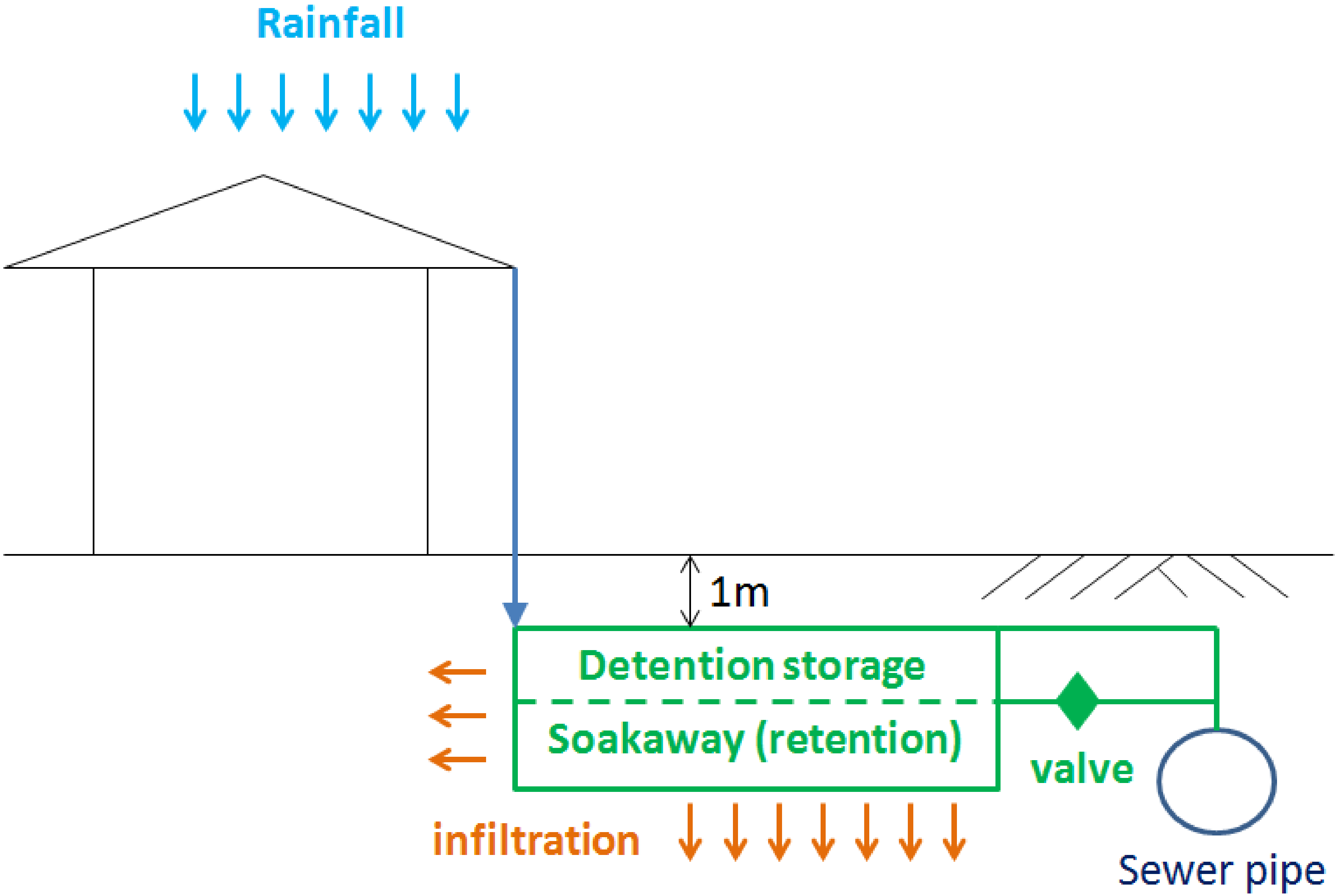
T=1 year ??

T=10 year ??

T=5 years ??



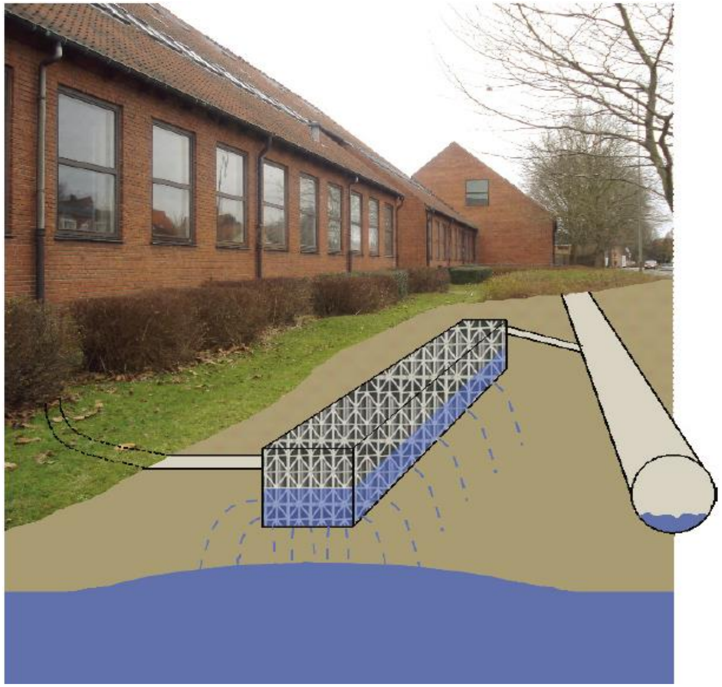
What are retention-detention units?



Aim of the project

To develop a model that can evaluate the performance of retention-detention units

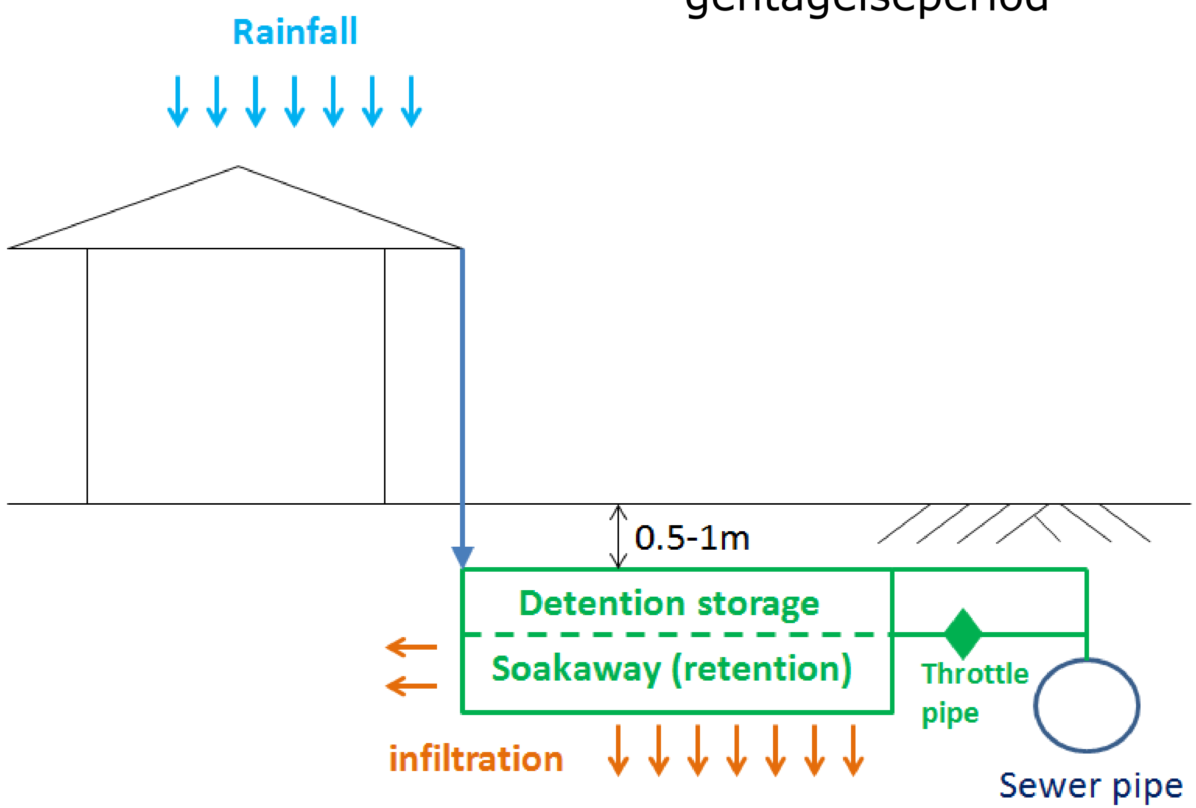
- Annual performance
- Estimate initial conditions for single event simulations
- Peak flow reduction



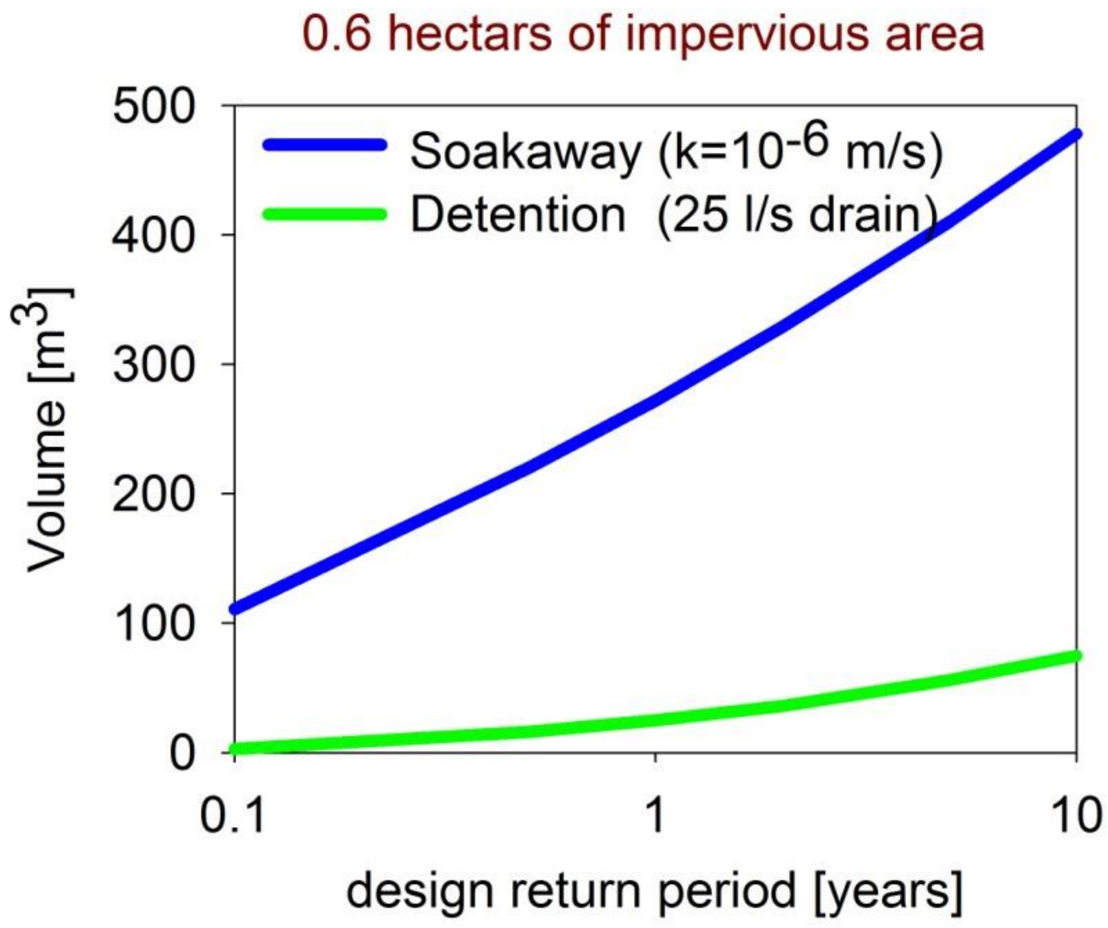
Why retention-detention units?

Detention storage. (forsinkelse) **Single event peak flows.**
To handle design storm events (e.g. T = 10 year).
gentagelseperiod

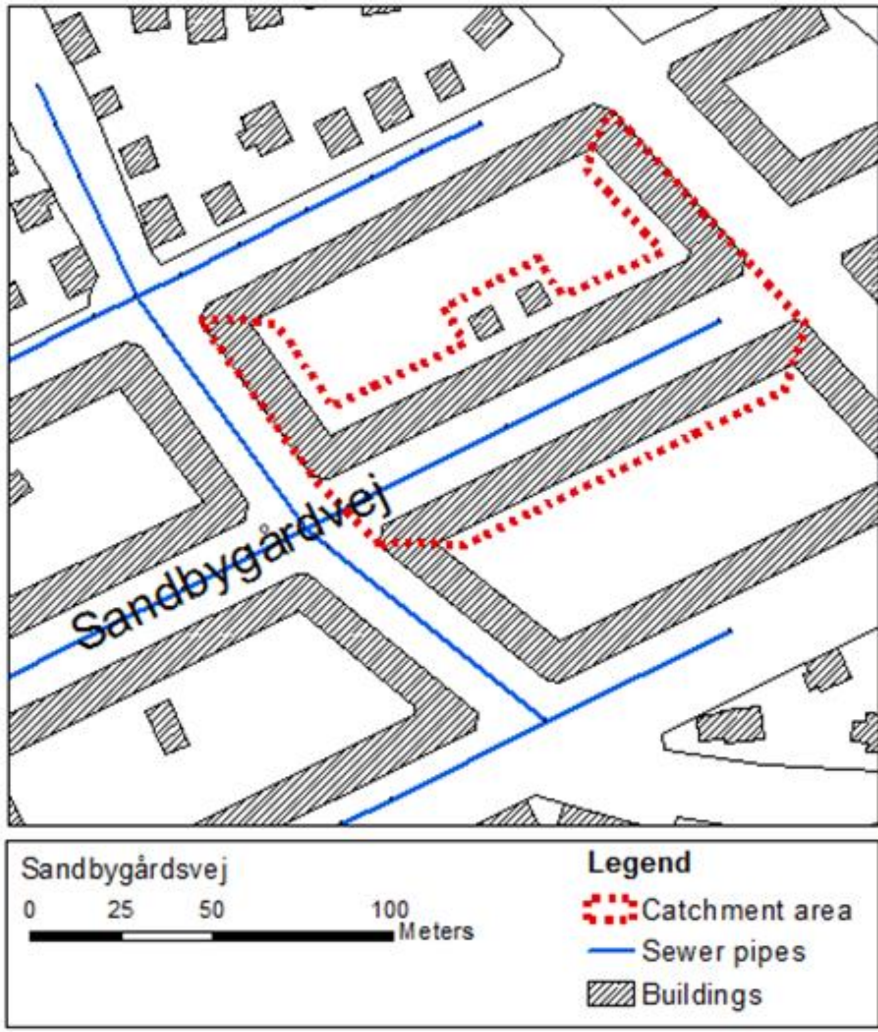
Retention storage. (vandtilbageholdelse) **Annual stormwater runoff reduction.**
To handle everyday events (e.g. T = 0.1 year)
gentagelseperiod

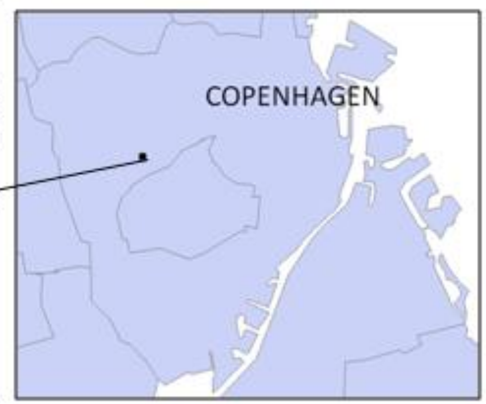


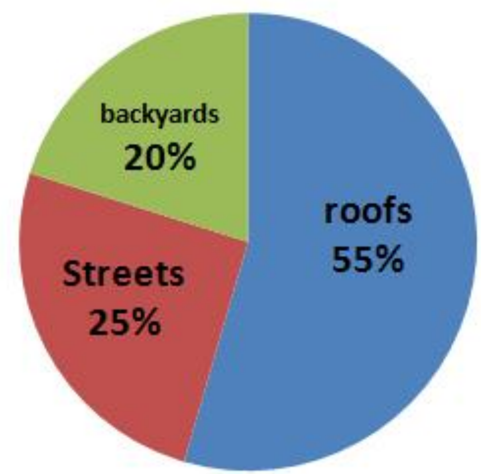
RETENTION VS DETENTION



Case study area





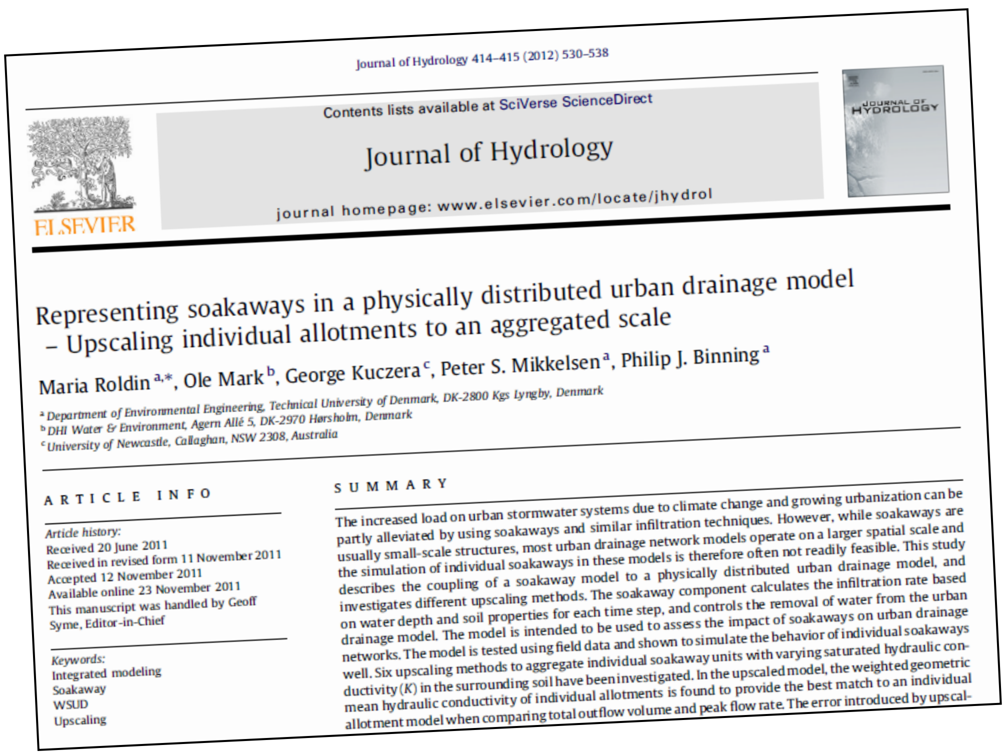


0.6 hectares of impervious area, k= 10^{-6} m/s

Model (1)

TOOL: MIKE URBAN (DHI) + Soakaway model (Roldin et al. 2012)

METHOD: Single soakaways can be modelled as a single aggregated unit (Roldin et al. 2012)



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ELSEVIER

Representing soakaways in a physically distributed urban drainage model – Upscaling individual allotments to an aggregated scale

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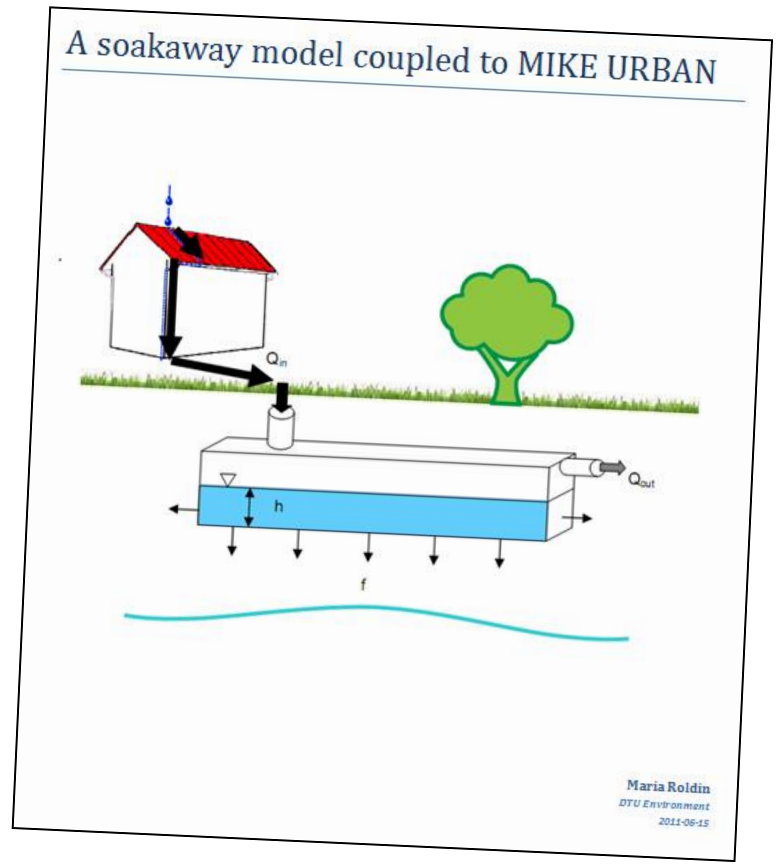
SUMMARY

The increased load on urban stormwater systems due to climate change and growing urbanization can be partly alleviated by using soakaways and similar infiltration techniques. However, while soakaways are usually small-scale structures, most urban drainage network models operate on a larger spatial scale and the simulation of individual soakaways in these models is therefore often not readily feasible. This study describes the coupling of a soakaway model to a physically distributed urban drainage model, and investigates different upscaling methods. The soakaway component calculates the infiltration rate based on water depth and soil properties for each time step, and controls the removal of water from the urban drainage model. The model is intended to be used to assess the impact of soakaways on urban drainage networks. The model is tested using field data and shown to simulate the behavior of individual soakaways well. Six upscaling methods to aggregate individual soakaway units with varying saturated hydraulic conductivity (K) in the surrounding soil have been investigated. In the upscaled model, the weighted geometric mean hydraulic conductivity of individual allotments is found to provide the best match to an individual allotment model when comparing total outflow volume and peak flow rate. The error introduced by upscal-



Method

1. **Model the annual water balance**
   Continuous simulation (22 years)

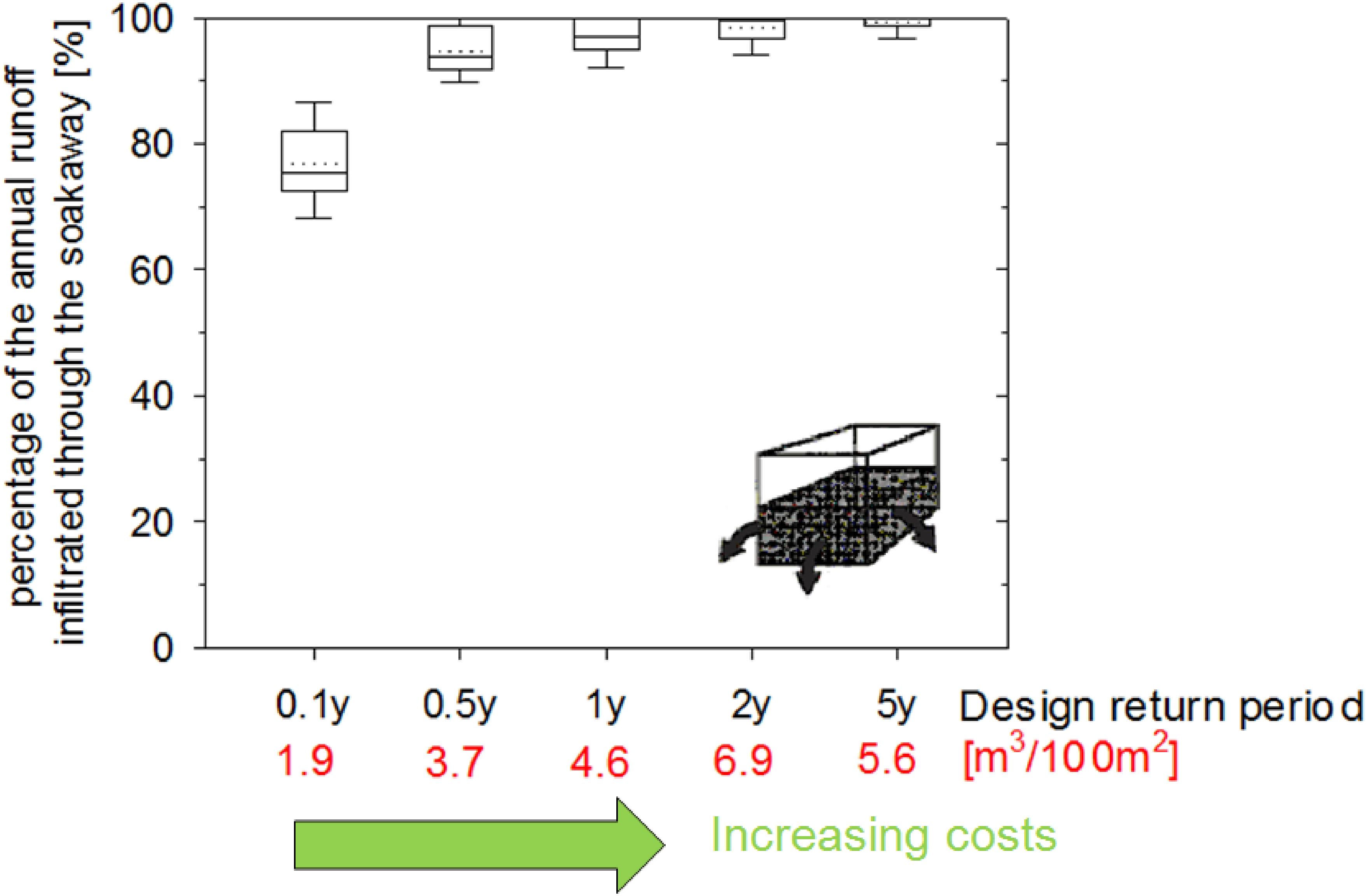
2. **Estimate initial conditions (water content)**
   Continuous simulation (22 years)

3. **Sewer surcharge for a design storm events**
   Single event simulation in Mike Urban (T=10 years)

4. **Modelling of dfferent retention-detention volume combinations**
   Continuous simulation (22 years)

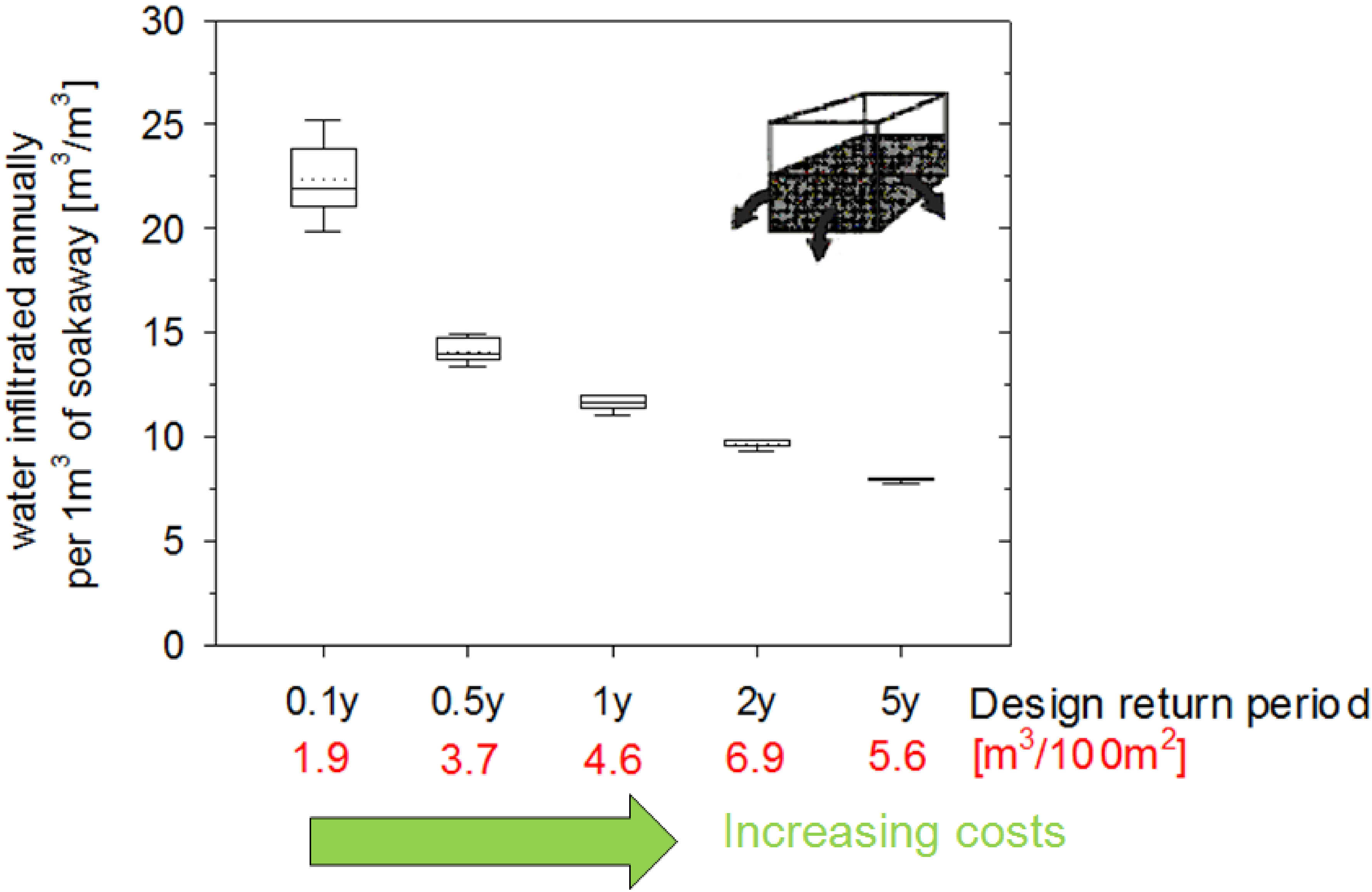
Results (1)

Annual water balance (22y continuous simulation)



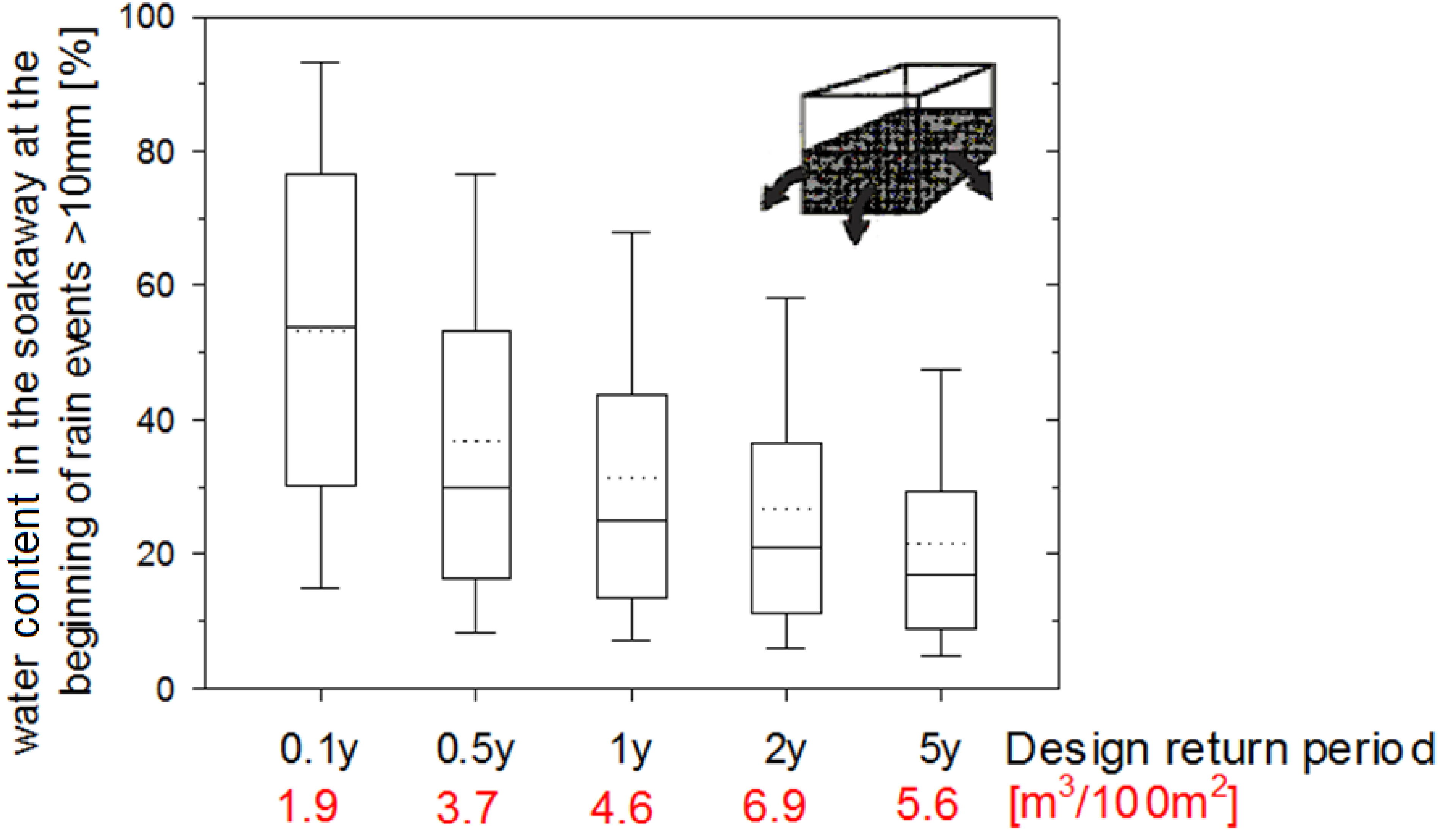
Results (2)

Annual water balance (22y continuous simulation)



Results (3)

Initial conditions (22y continuous simulation)

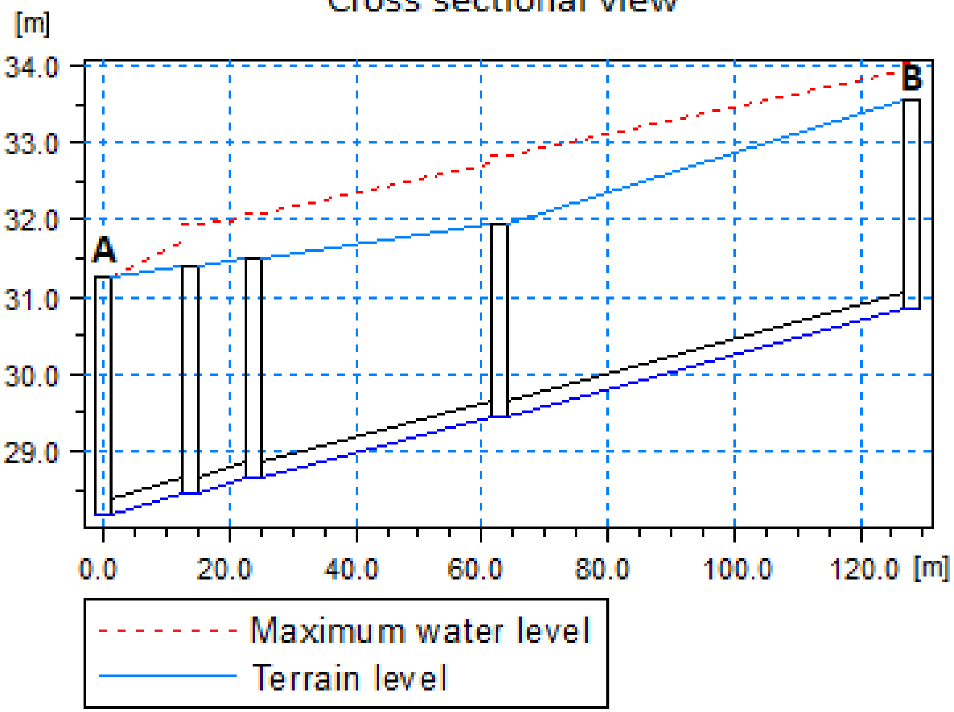


Results (3) Sewer surcharge (single event. MIKE URBAN)

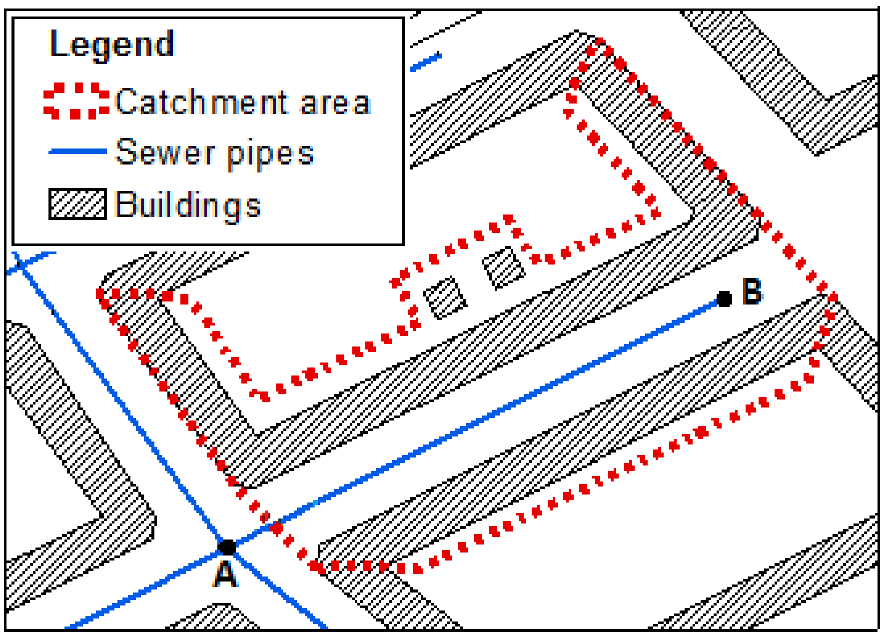
CDS rain with T=10 years

1. Modelling the baseline scenario

Cross sectional view



Plan view

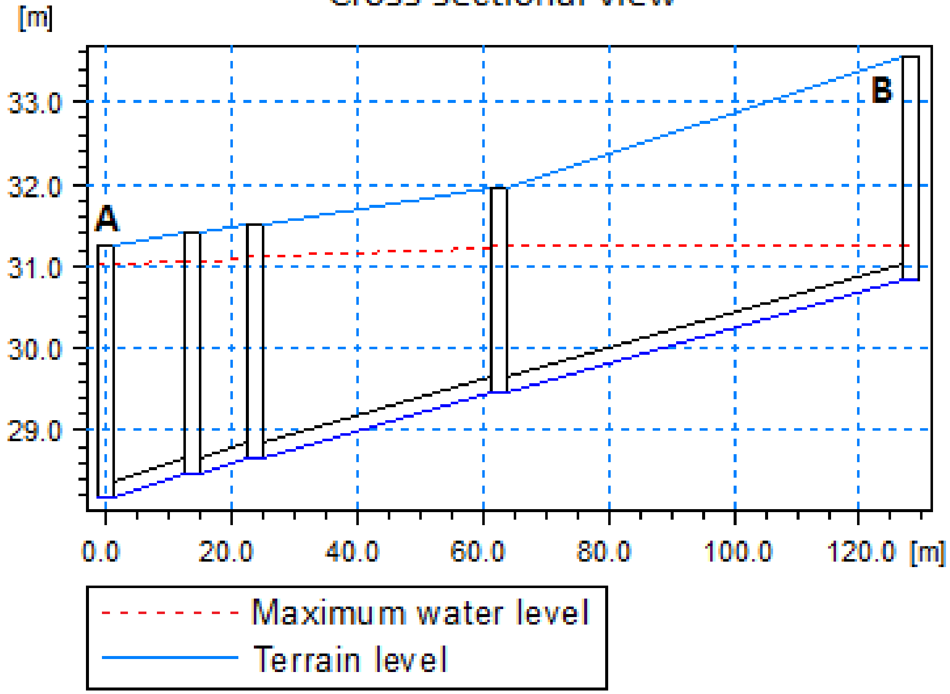


Results (3) Sewer surcharge (single event. MIKE URBAN)

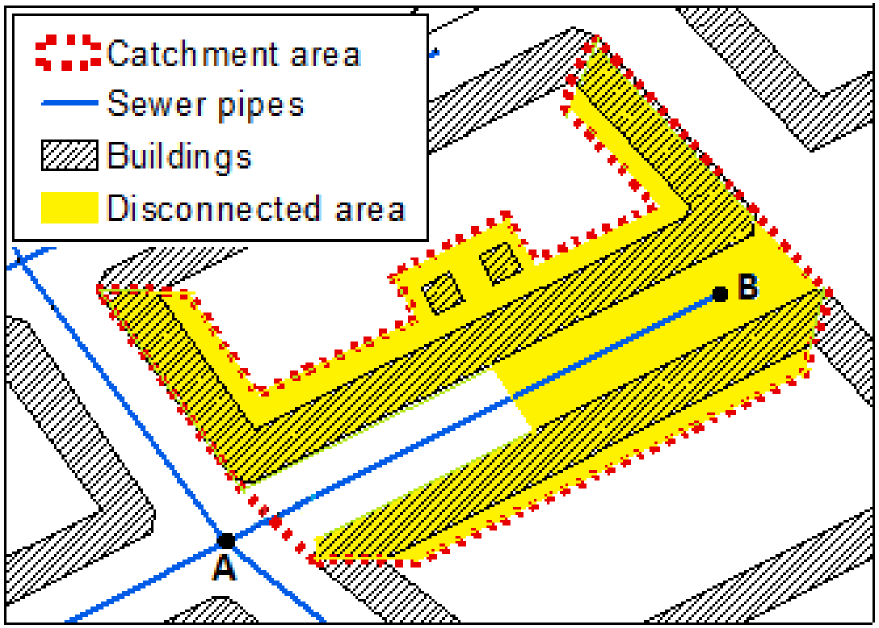
CDS rain with T=10 years

1. Modelling the baseline scenario
2. Modelling of impervious area disconnection

Cross sectional view



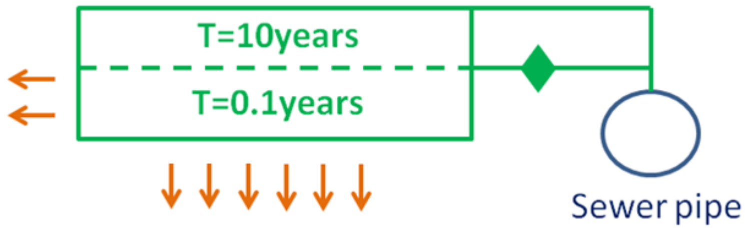
Plan view

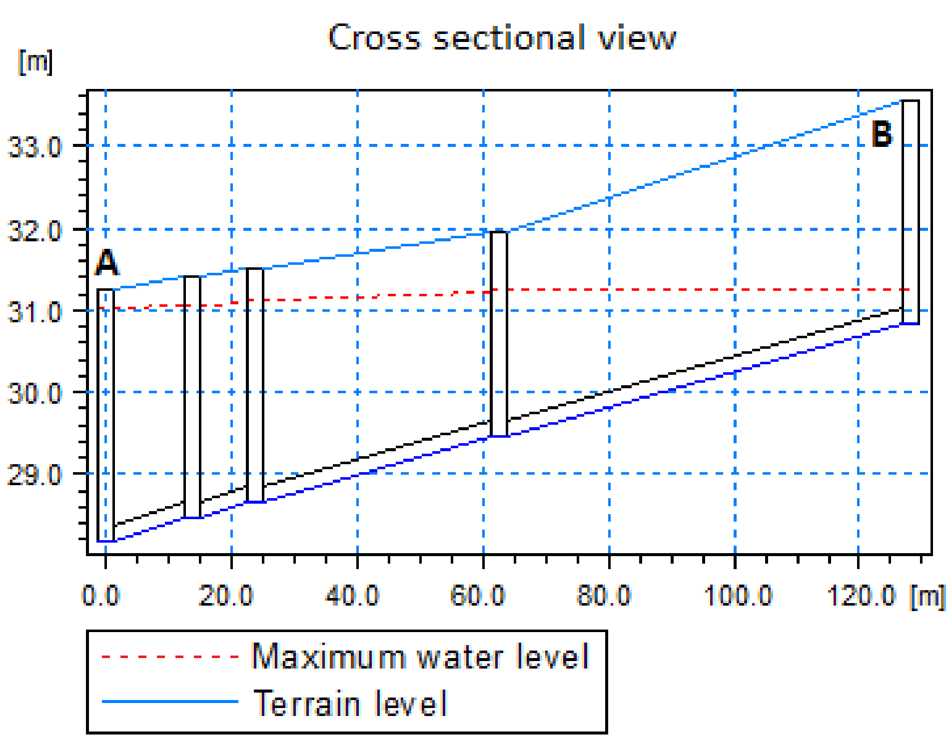


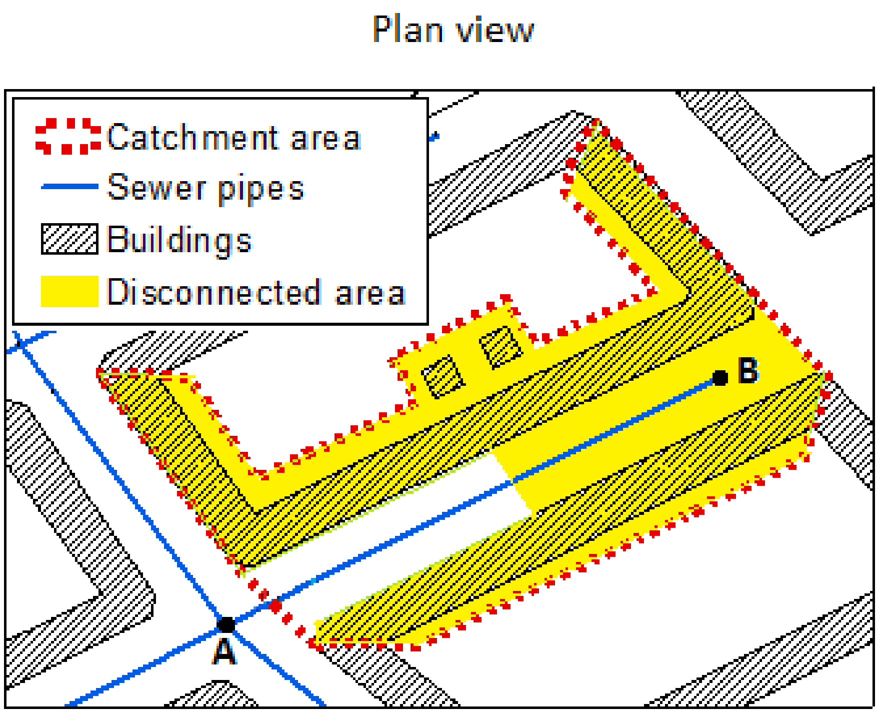
Results (3) Sewer surcharge (single event. MIKE URBAN)

CDS rain with T=10 years

1. Modelling the baseline scenario
2. Modelling of impervious area disconnection



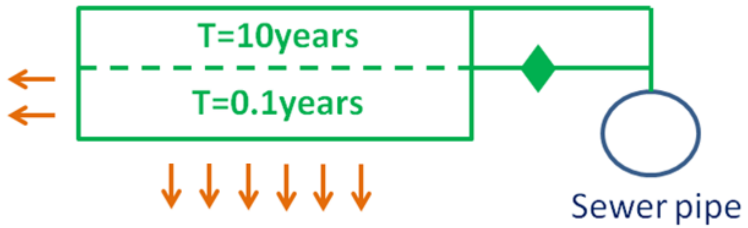


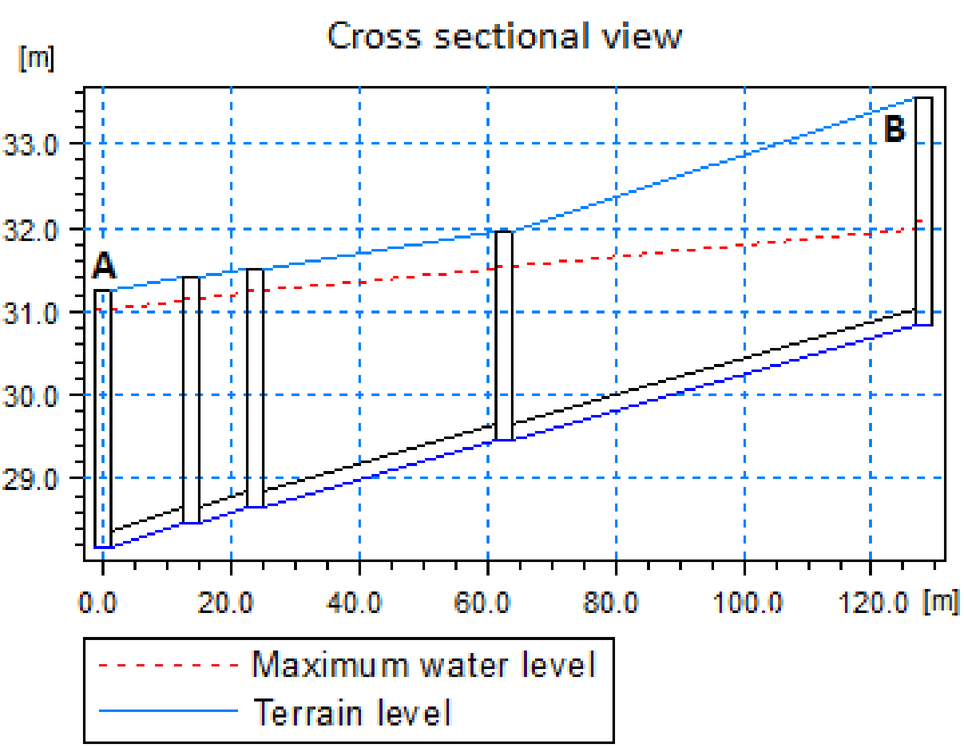


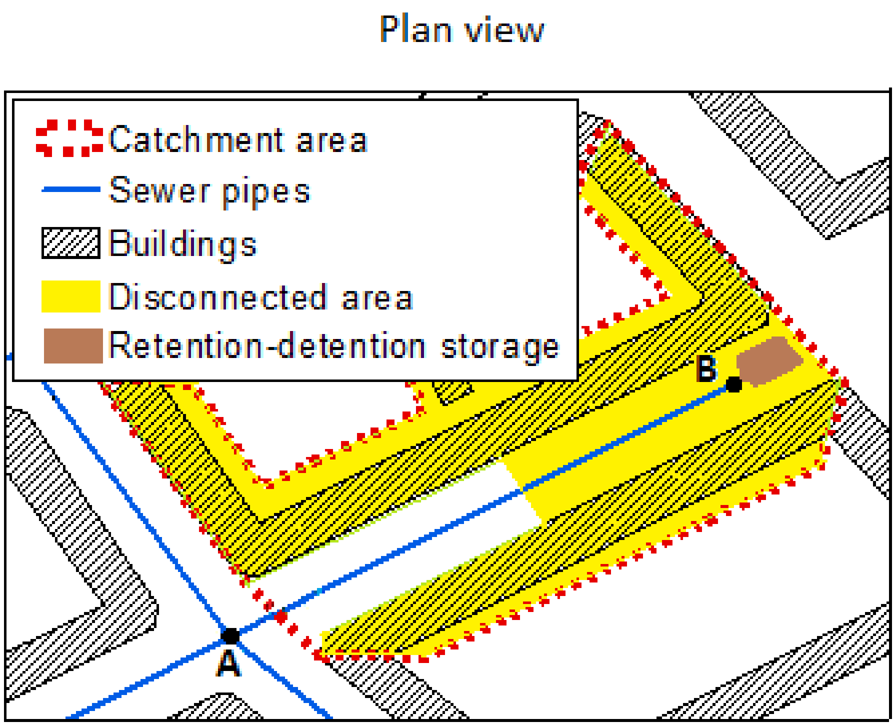
Results (3) Sewer surcharge (single event. MIKE URBAN)

CDS rain with T=10 years

1. Modelling the baseline scenario
2. Modelling of impervious area disconnection
3. Modelling of retention-dention units

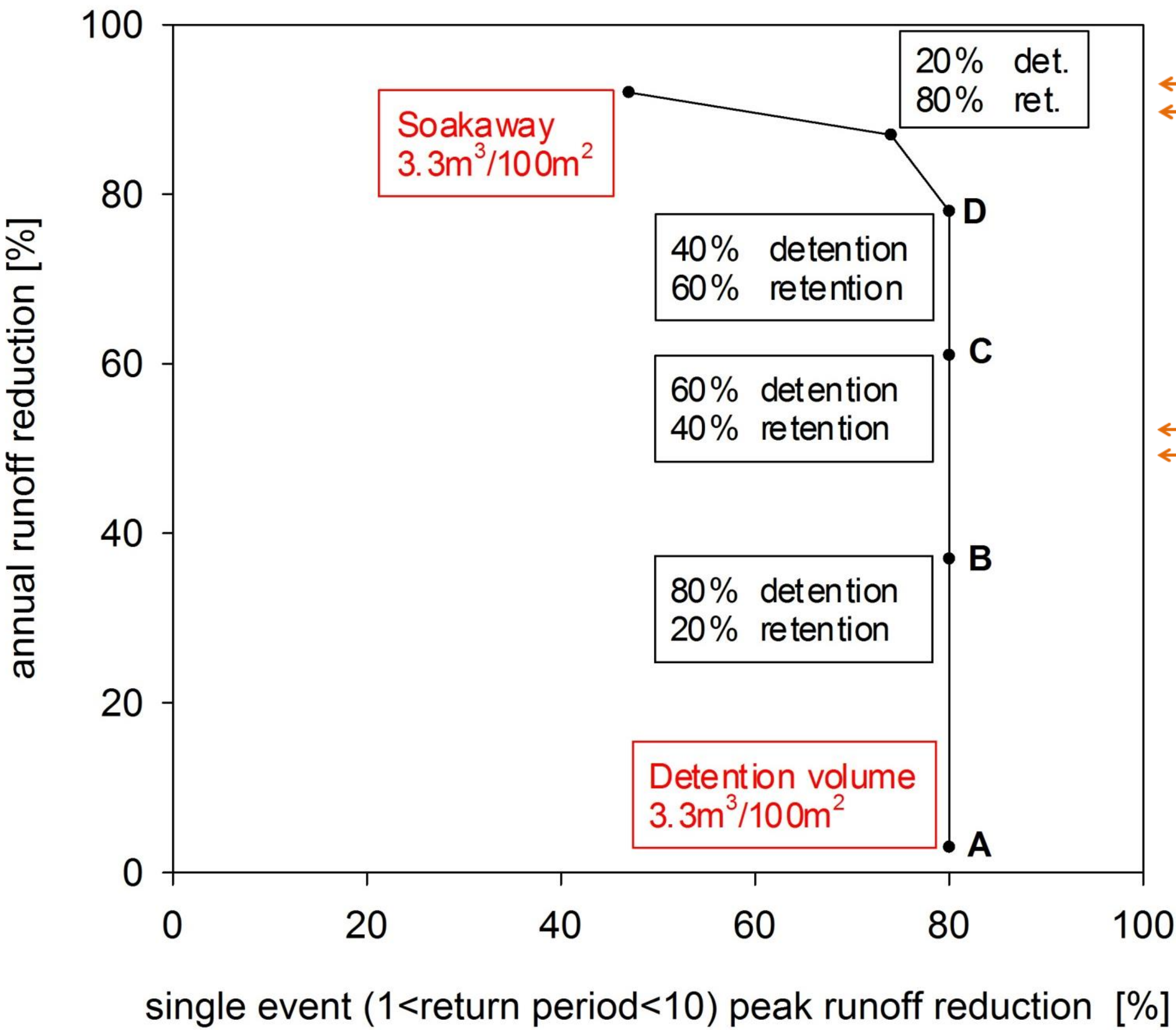


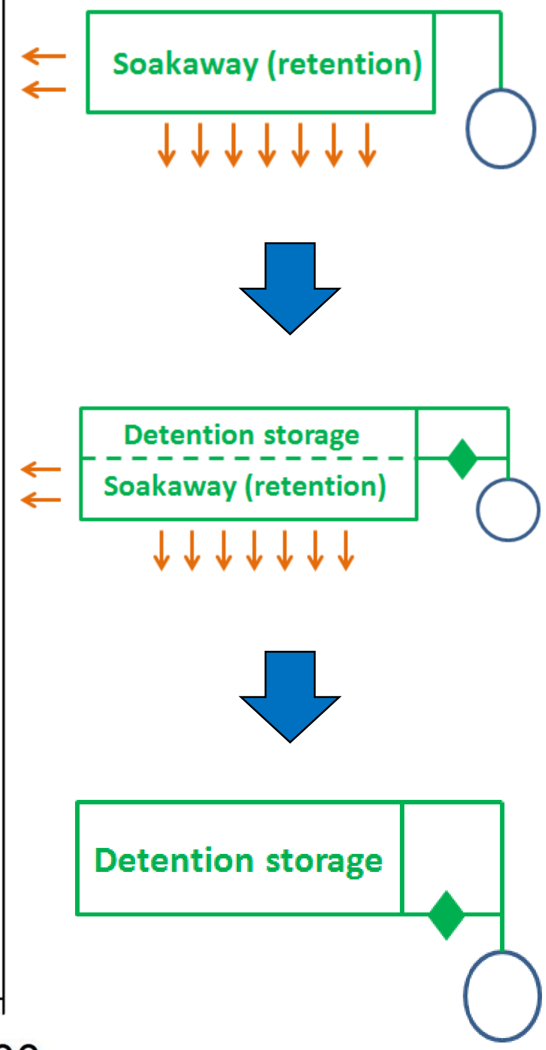




Results (4)

Several retention-detention volume combinations (22y continuous simulation)





Conclusions

- If we design soakaways for design events (i.e. T=5y or 10y) we need significantly bigger volumes compared to detention volumes

- Retention-detention units infiltrate a large percentage of the annual stormwater runoff

- Retention-detention units can reduce sewer surcharge

- Soakaways are on average between 20% and 60% full at the beginning of a single design event.

- By allocating a small part of a soakaway volume to detention can significantly improve peak reduction with little impact on the annual water balance

Thank you for your attention