KATHOLIEKE UNIVERSITEIT LEUVEN

Urbanization versus climate change: impact analysis on the river hydrology of the Grote Nete catchment in Belgium

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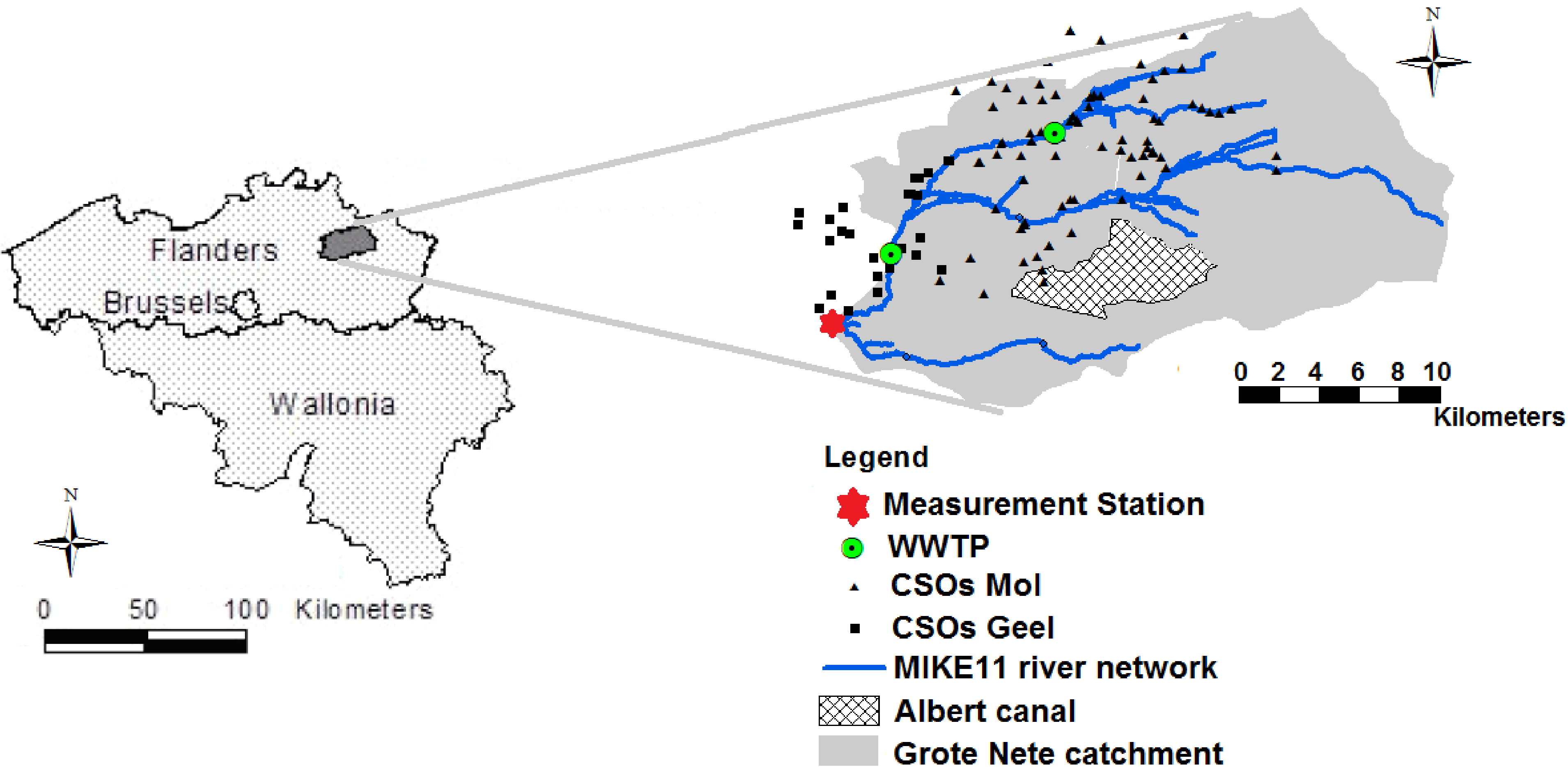
Introduction

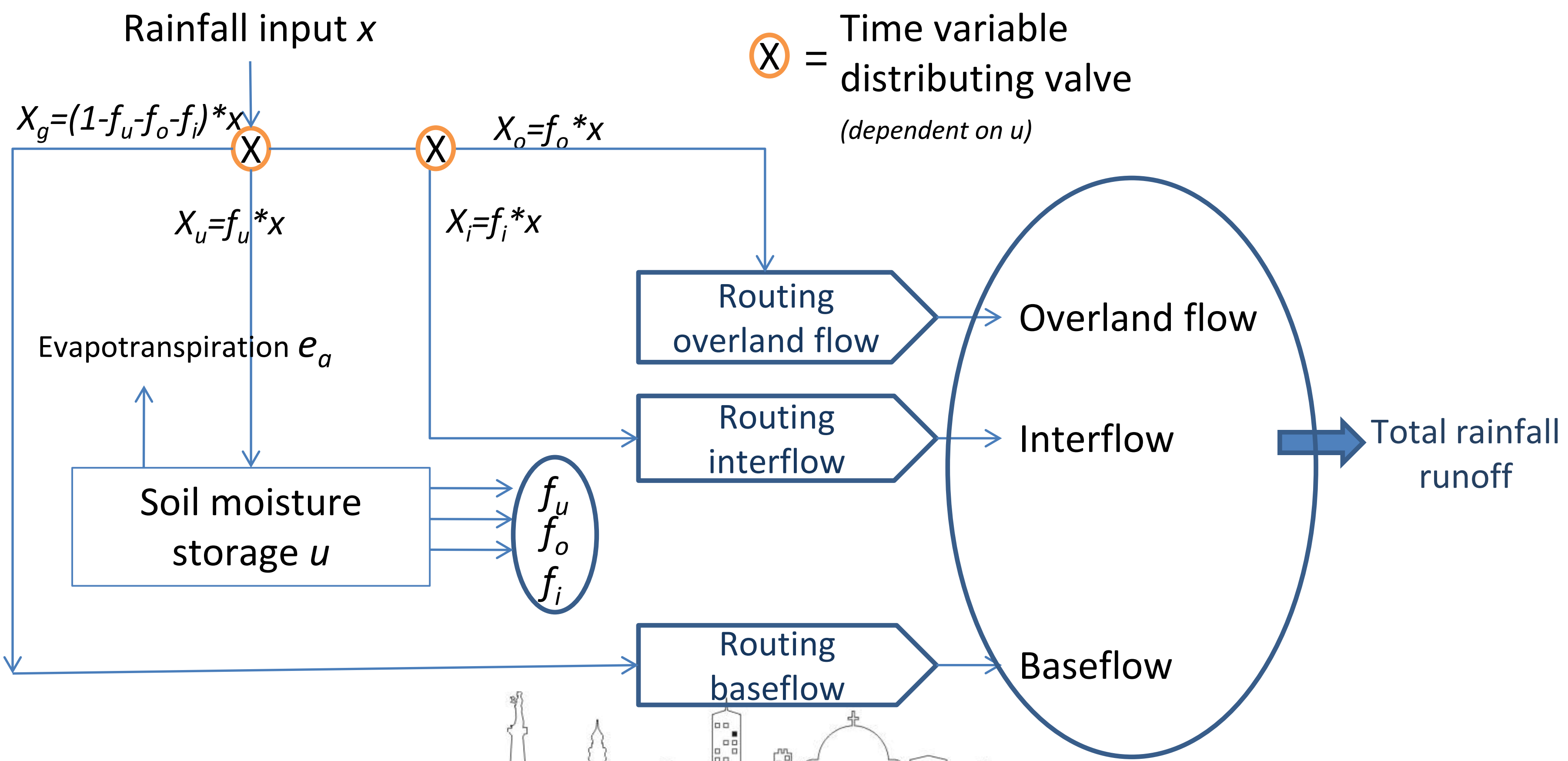
- Climate change causes significant change in rainfall patterns and temperature
  - Impact on urban hydrology?
- Urbanization significantly impacts flow regimes of river systems
  - Pressure of urbanization on the river hydrology can be increased due to climate change as some climate change models predict more intense summer storms
- Quantification requires simulation long time series to account for interaction between both systems (river and sewer systems)

Study Area


Flanders
Brussels
Wallonia
N
0 50 100 Kilometers
N
0 2 4 6 8 10
Kilometers
Legend
Measurement Station
WWTP
CSOs Mol
CSOs Geel
MIKE11 river network
Albert canal
Grote Nete catchment

Methodology

- Hydrological rainfall runoff model
  - VHM



Methodology

- Hydraulic river model
  - MIKE11 (DHI)
  - 138km of rivers divided over 23 branches modelled in detail
  - Cross-section information is included every 50 meters on average, except when there are structures that require a smaller space resolution
  - Δt = 30 second

Methodology

- Urban contributions to river flow
  - WWTP and CSO discharges
  - InfoWorks-CS model developed by the Flemish water company Aquafin NV
  - Modelled time series (Δt 10 min) of urban fluxes that are situated within the catchment are input as point sources in the river model

Methodology

- Climate change
  - CCI-HYDR Perturbation Tool
    - Quantile perturbation method
    - Delta-changes as a continuous function of return period at a daily time scale, for each month different set of perturbation factors are determined
      - for rainfall: both delta-changes to the number of wet days and to the intensity of these wet days
  - Generate perturbed time series for both the rainfall and daily evapotranspiration time series for the projected climate around the 2080s (2071-2100)
    - Rerun rainfall runoff model and sewer model to know modified upstream, lateral and point inflows of the hydraulic river model
  - Four different scenarios
    - high summer
    - high winter
    - mean
    - low

Methodology

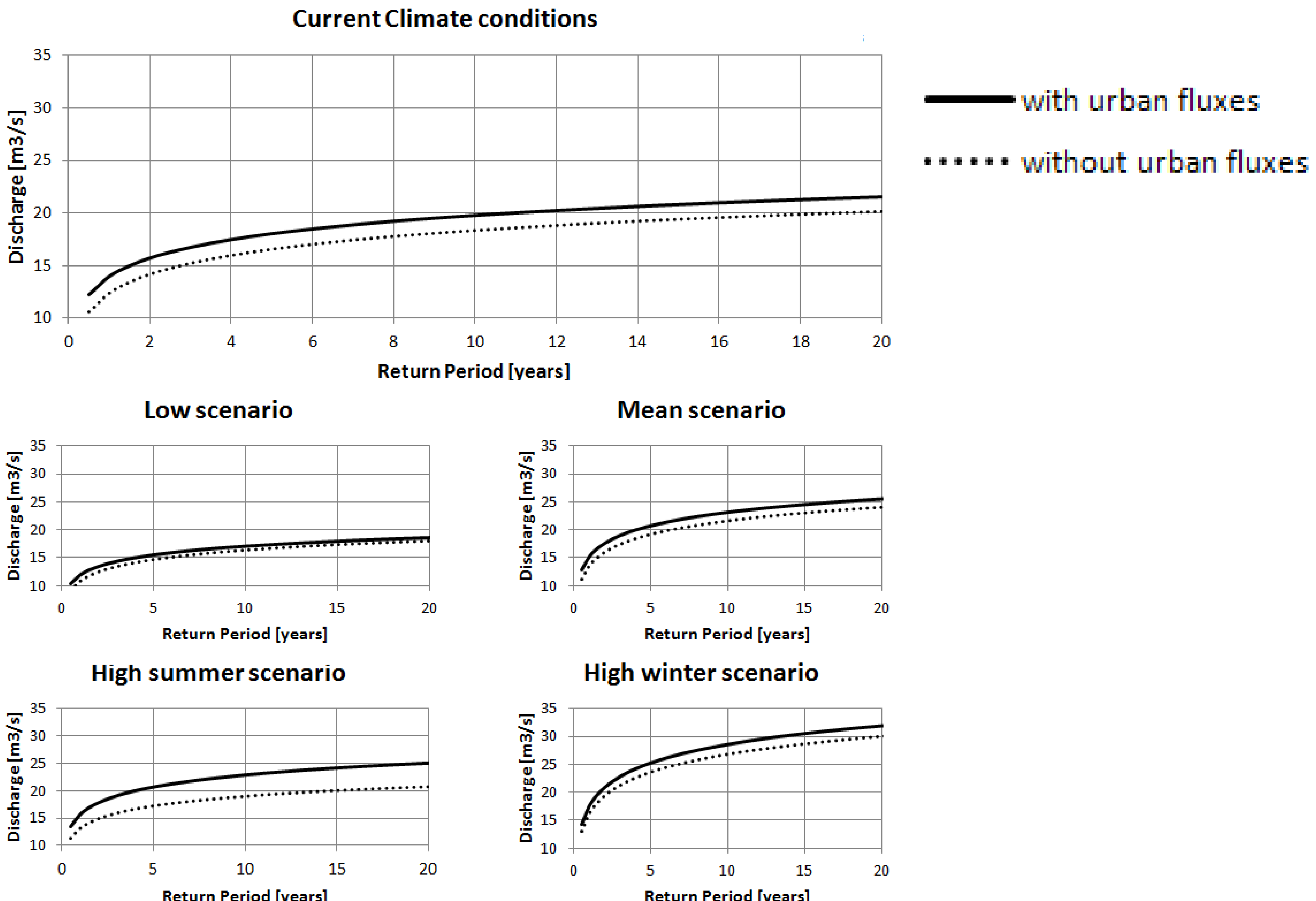
- Extreme value analysis
  - Peak-Over-Threshold (POT) to select nearly independent events
  - Generalized Pareto Distribution

$$G(x) = \begin{cases} 1 - \left(1 + \gamma \dfrac{x - x_t}{\beta}\right)^{-1/\gamma} & \gamma \neq 0 \\ 1 - \exp\left(-\left(\dfrac{x - x_t}{\beta}\right)^{\tau}\right) & \gamma = 0 \end{cases}$$

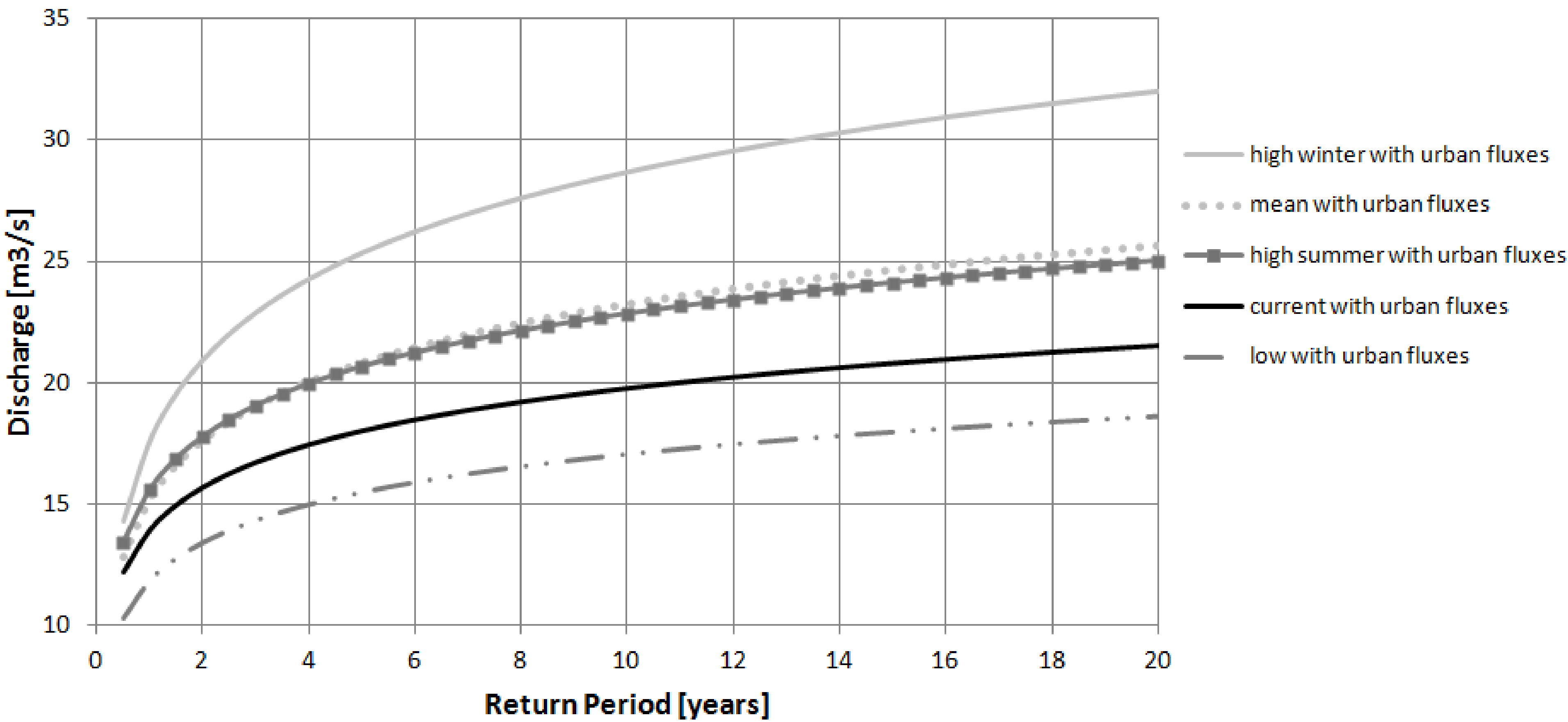
  - From the distribution of the extremes, the return period for different events can be calculated

$$T(x) = \frac{n}{t} \frac{1}{1 - G(x)}$$

Results and discussion

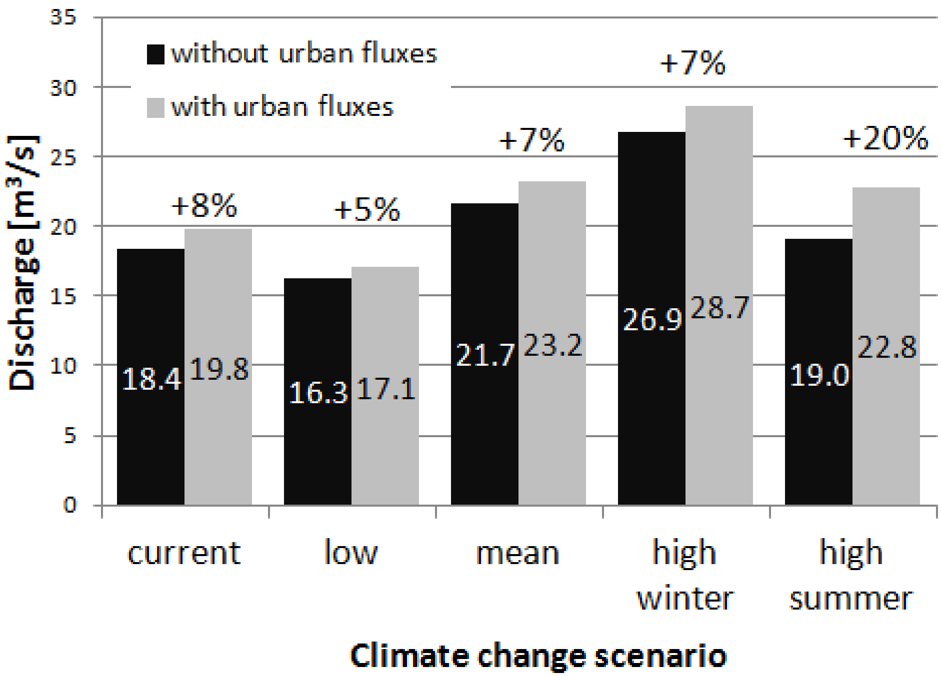


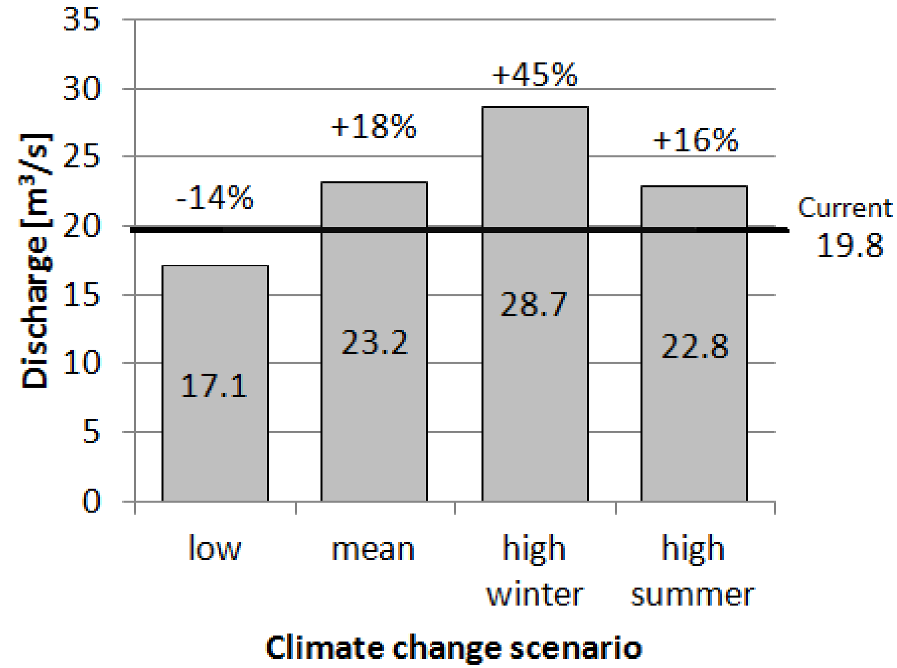
Results and discussion



Results and discussion

- Projected peak flows for a return period of 10 years
  - impact of urbanization
  - impact of climate change when including urban fluxes





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Conclusion

- Impact climate change under the urbanized condition (-14% to +45%) same order of magnitude as impact urbanization (+5% to +20%)
- Different climate change scenarios do not change the impact of urbanization much
  - Exception!
    - High summer scenario: impact of urbanization on the river system increases from 8% to 20%
    - Only found when analysing difference in extreme value distribution, average increase does remain constant for all scenario’s!

Thank you for your attention!

Questions?