AALBORG UNIVERSITY

URBANWATER

Weather Radar Applications

Estimating runoff coefficients using weather radars

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URBAN DRAINAGE MODELLING
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University of Belgrade, Faculty of Civil Engineering

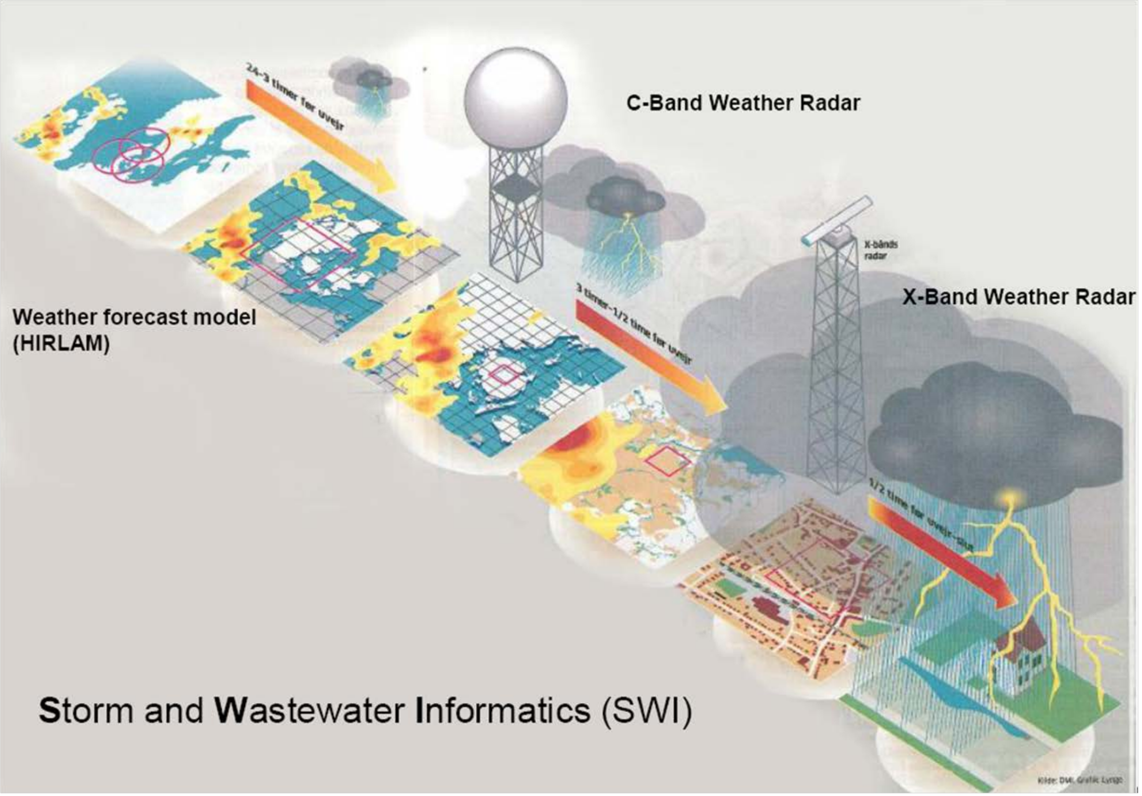
Motivation for the study

Aim of Ph.D. study:

- Develop methods to adjust weather radar QPE by the use of in-situ sewer sensors measurements.

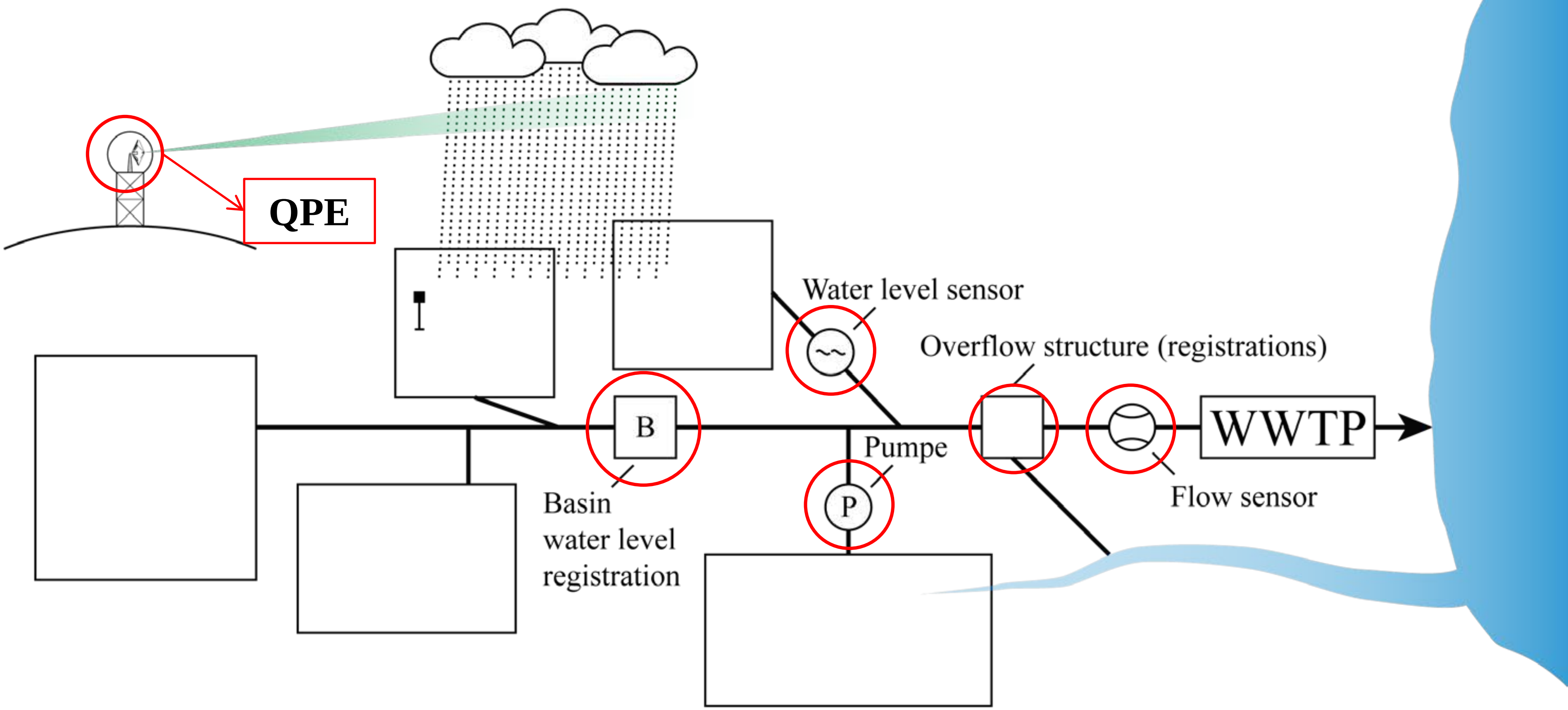
Expected outcome:

- Minimize the uncertainty of flow and water level forecasting for real time control applications of waste water treatment plants and sewer systems.

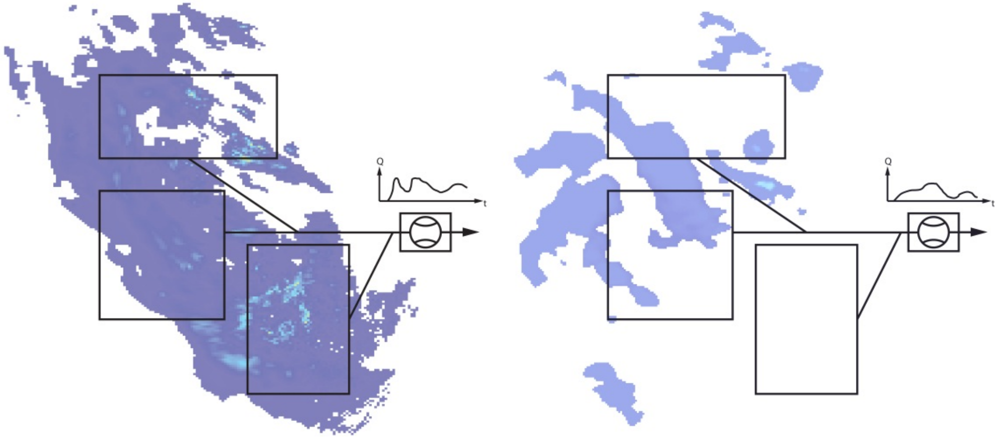


Motivation for the study

In-situ sewer sensor adjustment of weather radar data in urban drainage



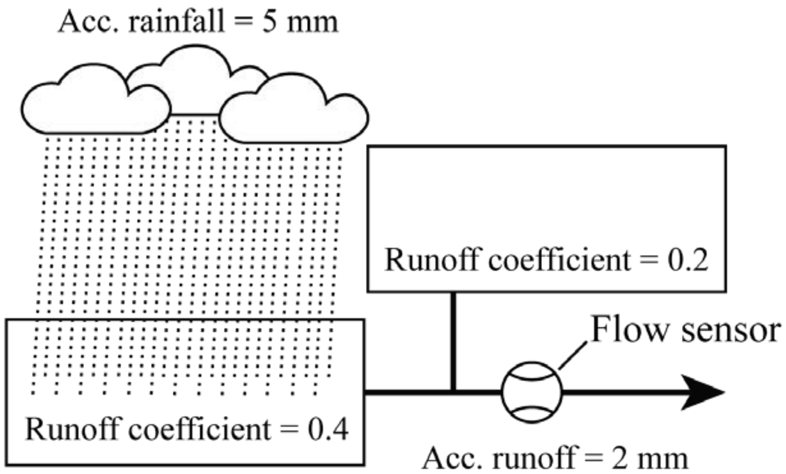
Methodology

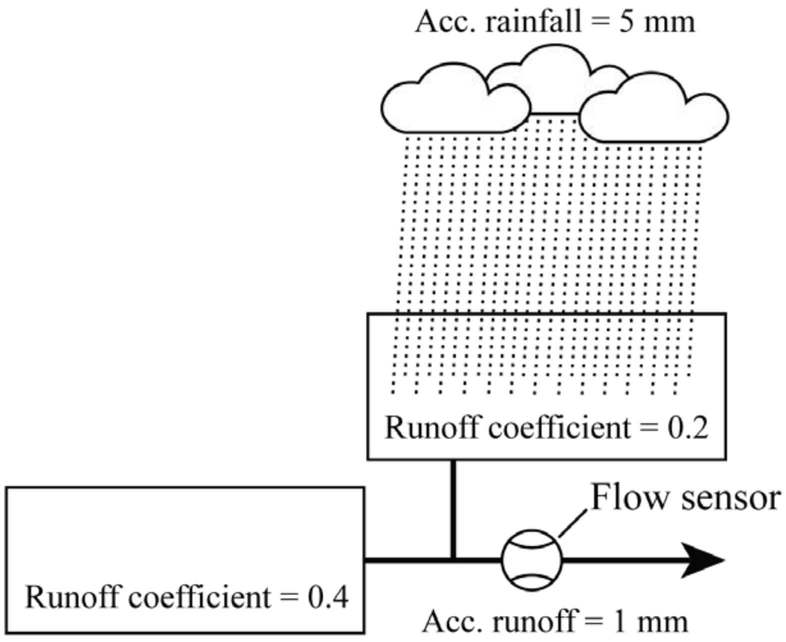


Basic principle:

- Different rainfall structures over an urban drainage area will result in different runoff hydrographs in a down stream point.

SYSTEM IDENTIFICATION!

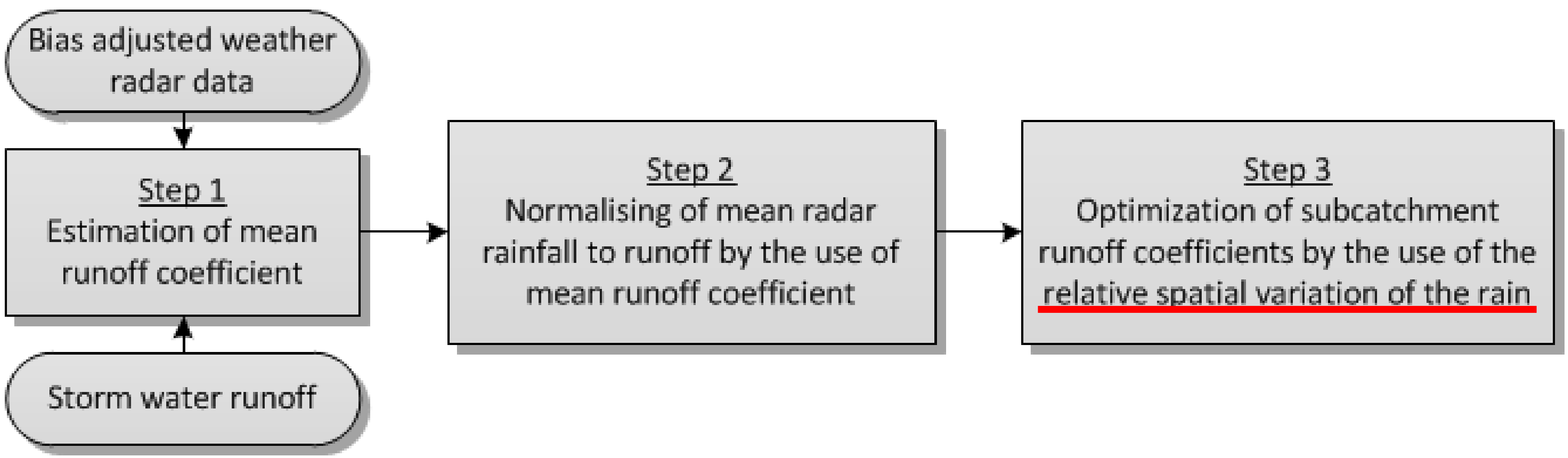




Methodology

Central assumptions:

- Unambiguity between precipitation and runoff in a point downstream
- Consistency between the mean runoff coefficient and runoff coefficients at subcatchment level



Methodology

Under the assumption of unambiguity it is possible to set up a system of linear equations

$$A\mathbf{x} = \mathbf{b} \qquad A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix}, \quad \mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix}, \quad \mathbf{b} = \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_m \end{bmatrix}$$

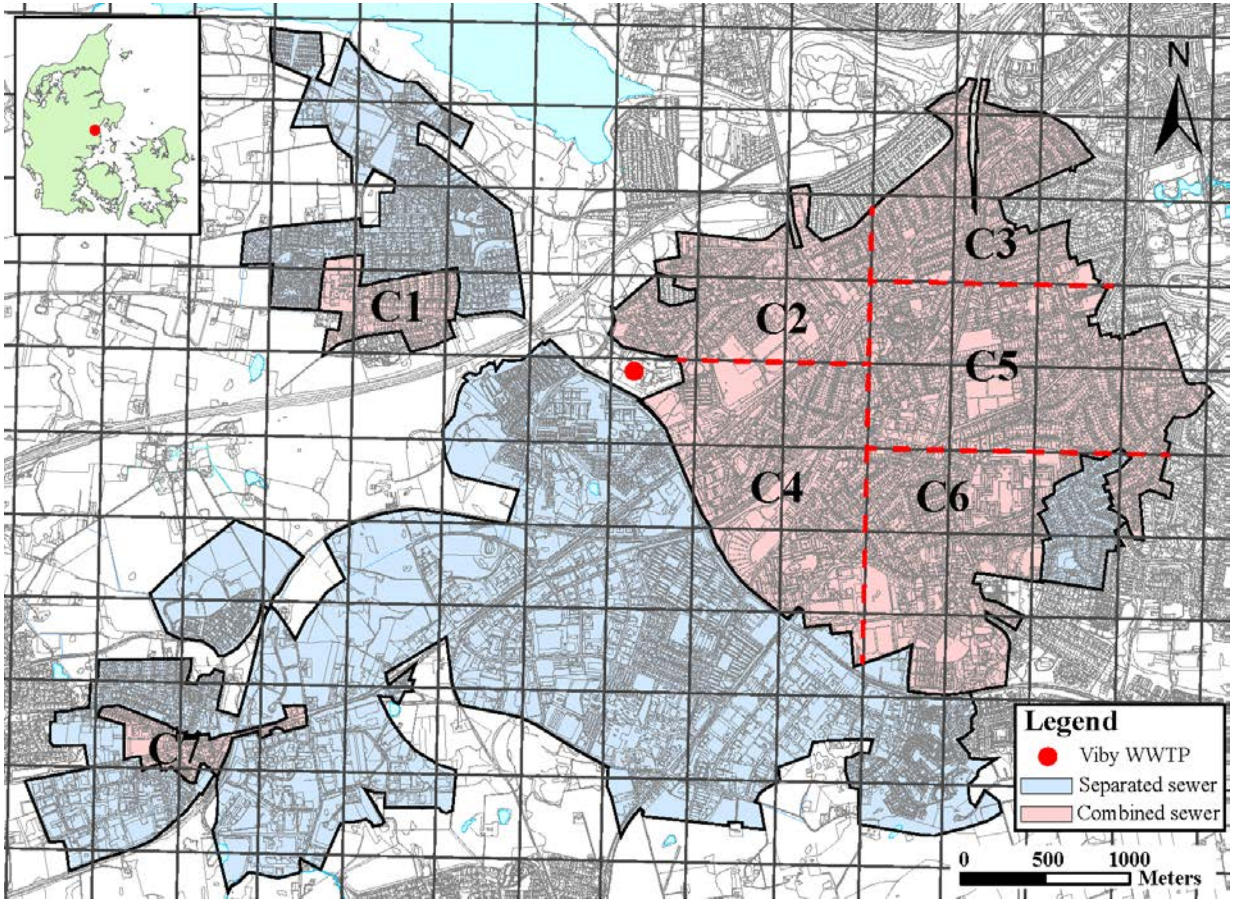
Optimization algorithm (minimization of Least Squared Error)

$$LSE = min\left(\sum \left(RO_{cal,n}(\varphi_m) - RO_{meas,n}\right)^2\right)$$

Case study area and data

Viby Catchment

- 669 ha combined sewer
- Large basin volumes and very limited amount of CSO.
  => Conservation of mass
- 1 min. flow measurements



Weather radar data

- C-band (Distance approx. 15 km)
  - Spatial resolution: 500 m
  - Temporal resolution: 5 min.
  - Standard Marshall Palmer
    A = 220 B = 1.6
- Bias adjusted on event basis

Results – estimated runoff coefficients

Period	C1	C2	C3	C4	C5	C6	C7	AWM	STD
Sep. 2011 – Jan. 2012	0.25	0.31	0.32	0.24	0.23	0.22	0.57	0.26	0.11
Apr. 2012 – Aug. 2012ˣ	0.11	0.33	0.50	0.20	0.22	0.25	0.68	0.28	0.14
Sep. 2011 – Aug. 2012*	0.10	0.31	0.48	0.21	0.22	0.24	0.70	0.27	0.15

ˣ Extended amount of ground clutter.

* Feb. – Mar. 2012 excluded due to snow

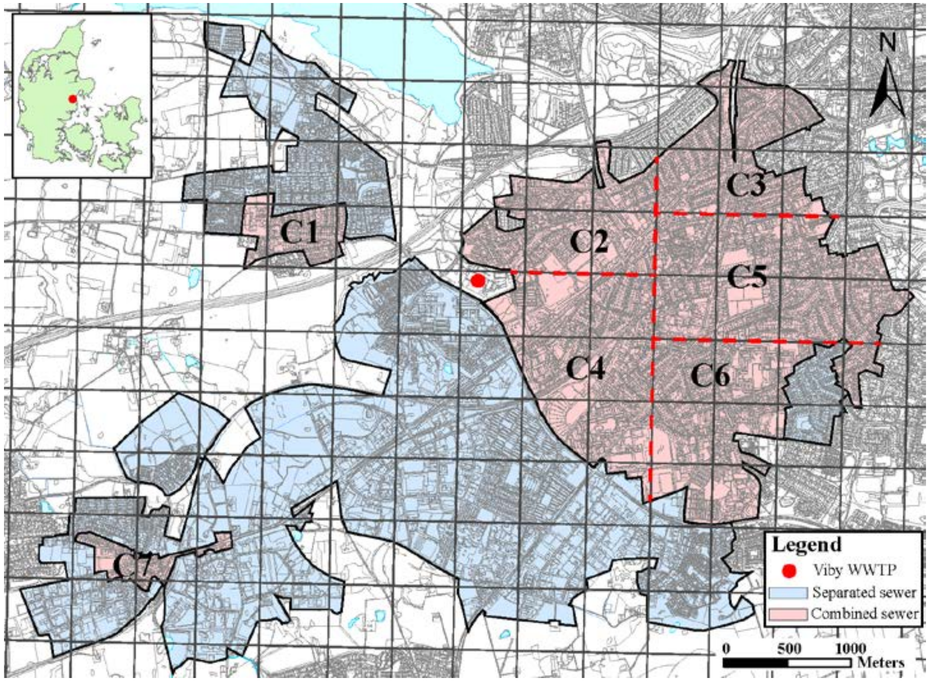
- **Summer period is dominating**
- **Number of events**

  Sep. 2011 – Jan. 2012: 21

  Apr. 2012 – Aug. 2012: 35
- **Accumulated runoff**

  Sep. 2011 – Jan. 2012: 216406 m^3

  Apr. 2012 – Aug. 2012: 453094 m^3



Results – robustness analysis

All events are classified and ranked after the spatial rainfall variability of the event.

- Spatial rainfall variability descripted by the coefficient of variation $\left(CV = \frac{\sigma}{\mu}\right)$.

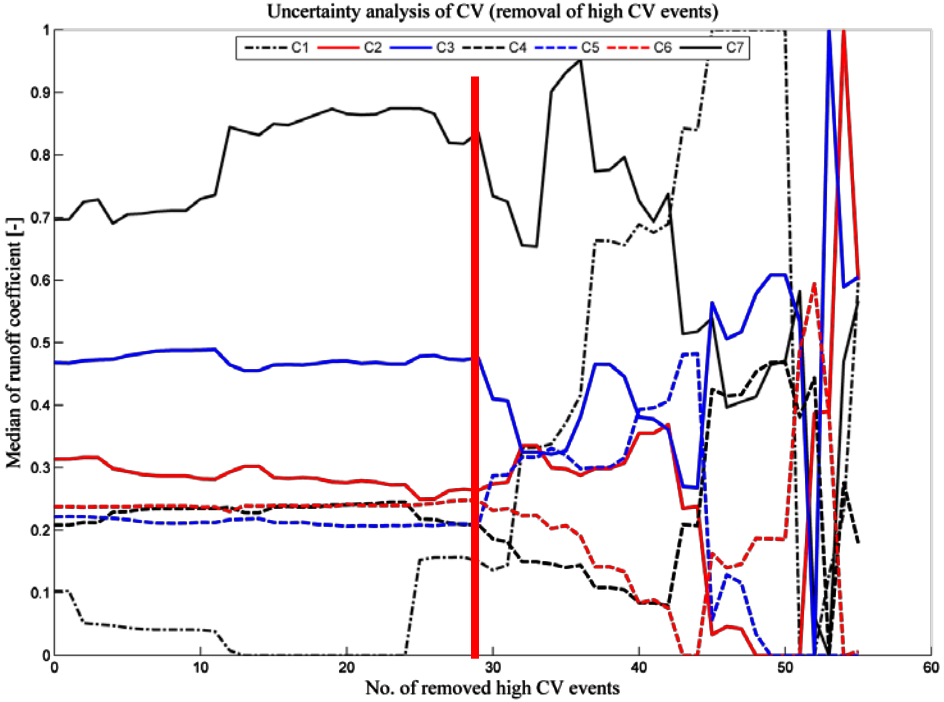
- A high CV value indicates high spatial rainfall variability.

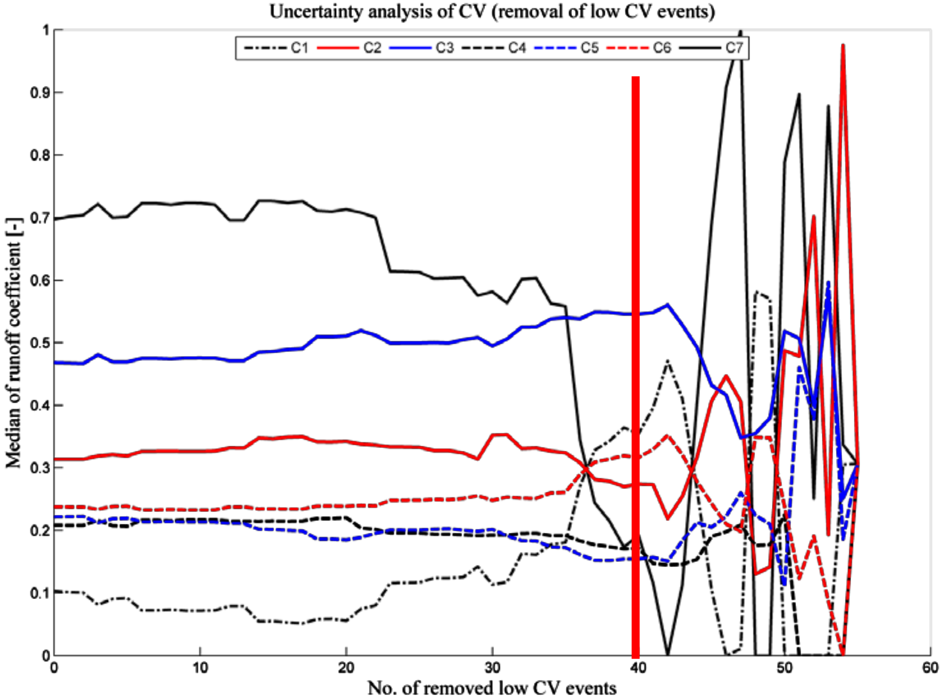
Results – robustness analysis – full periods

One year data	C1	C2	C3	C4	C5	C6	C7	AWM	STD
Sep. 2011 – Aug. 2012*	0.10	0.31	0.48	0.21	0.22	0.24	0.70	0.27	0.15

* Feb. – Mar. 2012 excluded due to snow

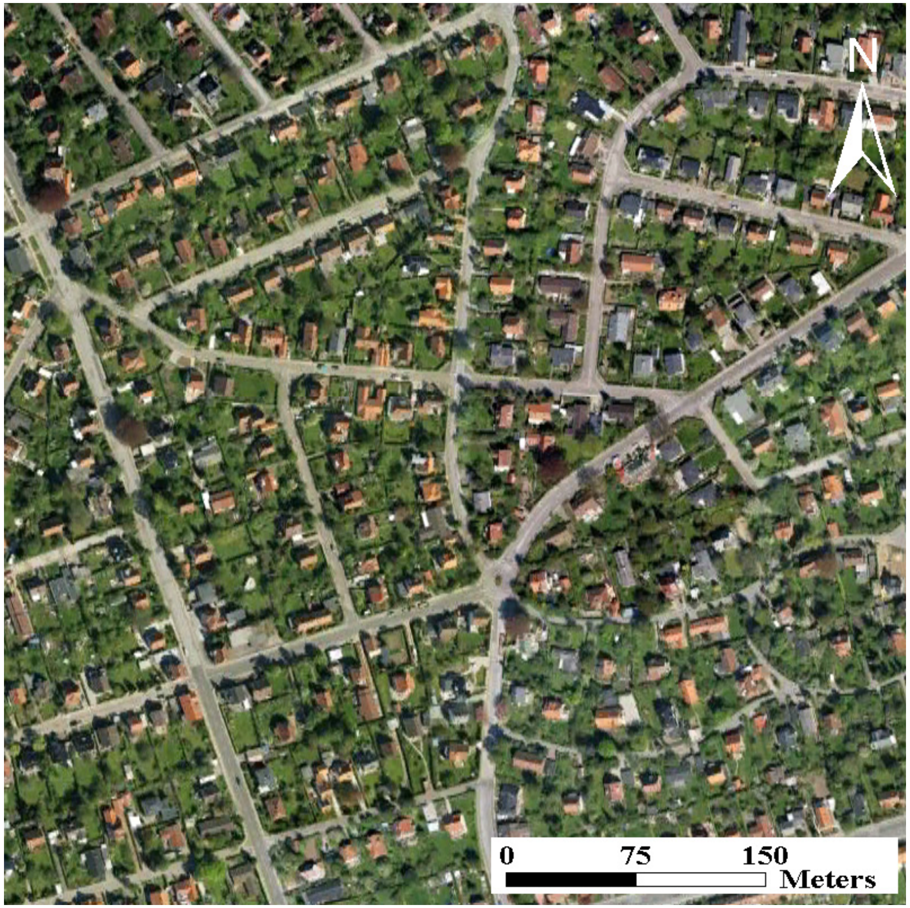
CV threshold: 0.20



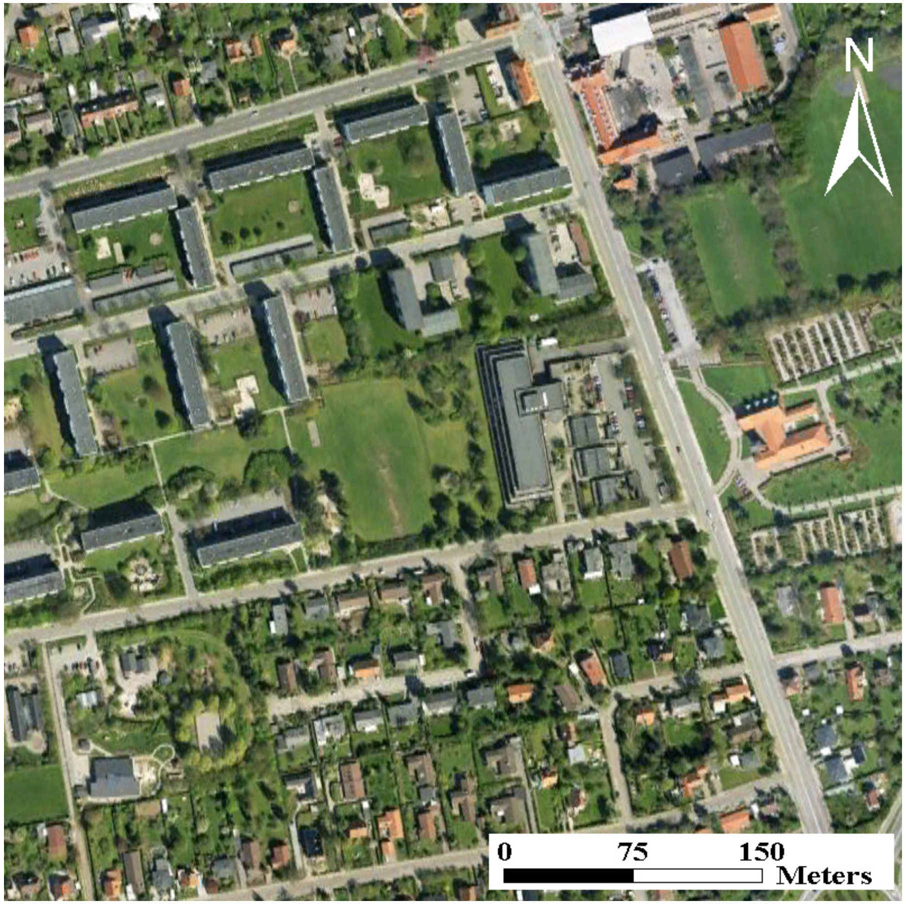


Discussion – aerial photos

Subcatchment C3: Estimated runoff coef.: 0.48



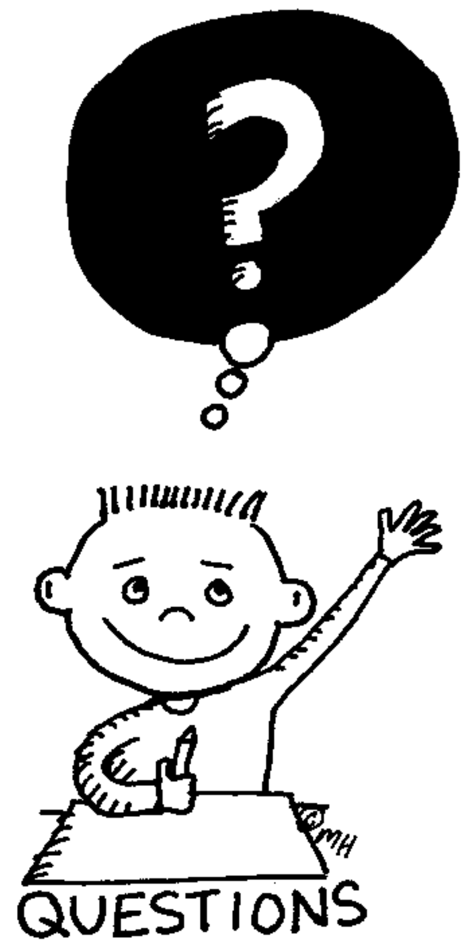
Subcatchment C5: Estimated runoff coef.: 0.22



Conclusion

- **The study has proven that it is possible to identify realistic runoff coefficients by the use of corresponding measurements of the rainfall variability and storm water runoff.**
- **The estimated runoff coefficient are found reasonable when compared to aerial photos.**
- **The method gives stabile results over a data period of one year.**
- **The method is relatively sensitive to the input data, so an extensive data treatment is needed.**
- **The method requires large spatial variation of the accumulated rainfall values.**
- **It is very interesting that it is possible to say something about the distribution of the hydrological parameters on the basis of the system responds to different rainfall events.**

Thank you for your attention…



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