Eberhard Karls Universität Tübingen

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Tyrna, B. G. & Hochschild, V.:

Urban flash flood modelling based on soil sealing information derived from high resolution satellite imagery

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DBU

Deutsche Bundesstiftung Umwelt

www.dbu.de

Heavy rainfall and flash flood events in Germany

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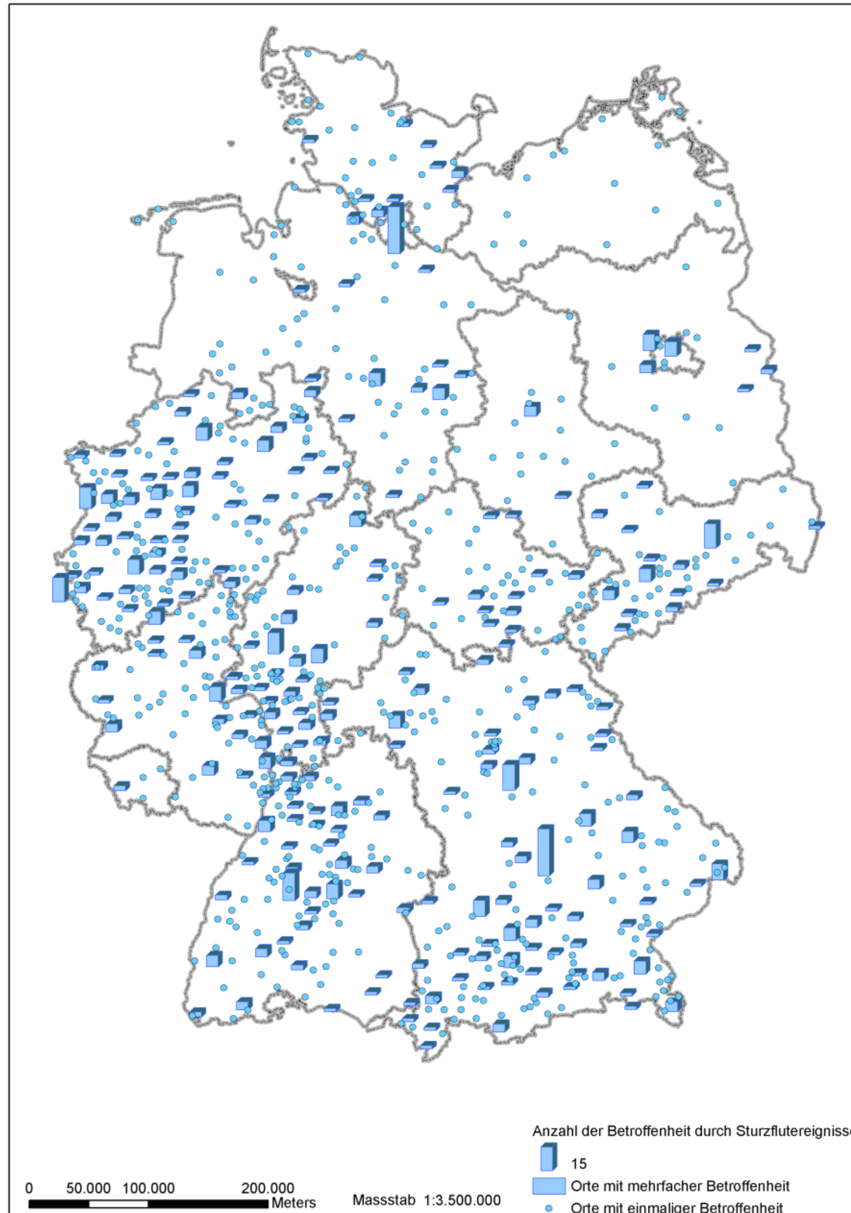
- Distribution of flash flood events URBAS event data base (1990-2007) →
- Sum of financial damages from flash flood events compareable to damage sum of large river floodings
- Objective:
  hazard analysis of flash floods
- Methodology:
  combine remotely sensed soil sealing information with hydrodynamic modelling of overland flow (1m spatial resolution)

Study area: City of Tübingen, Germany

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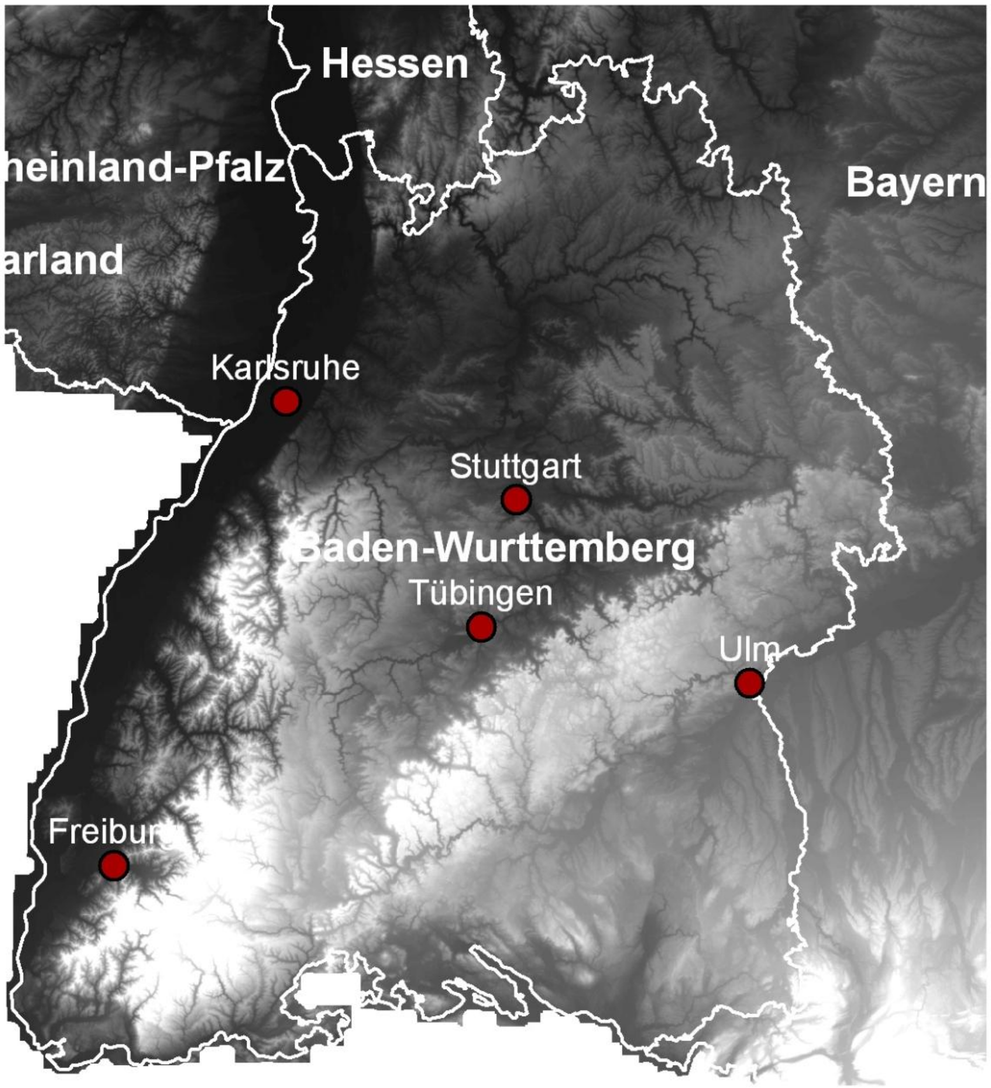

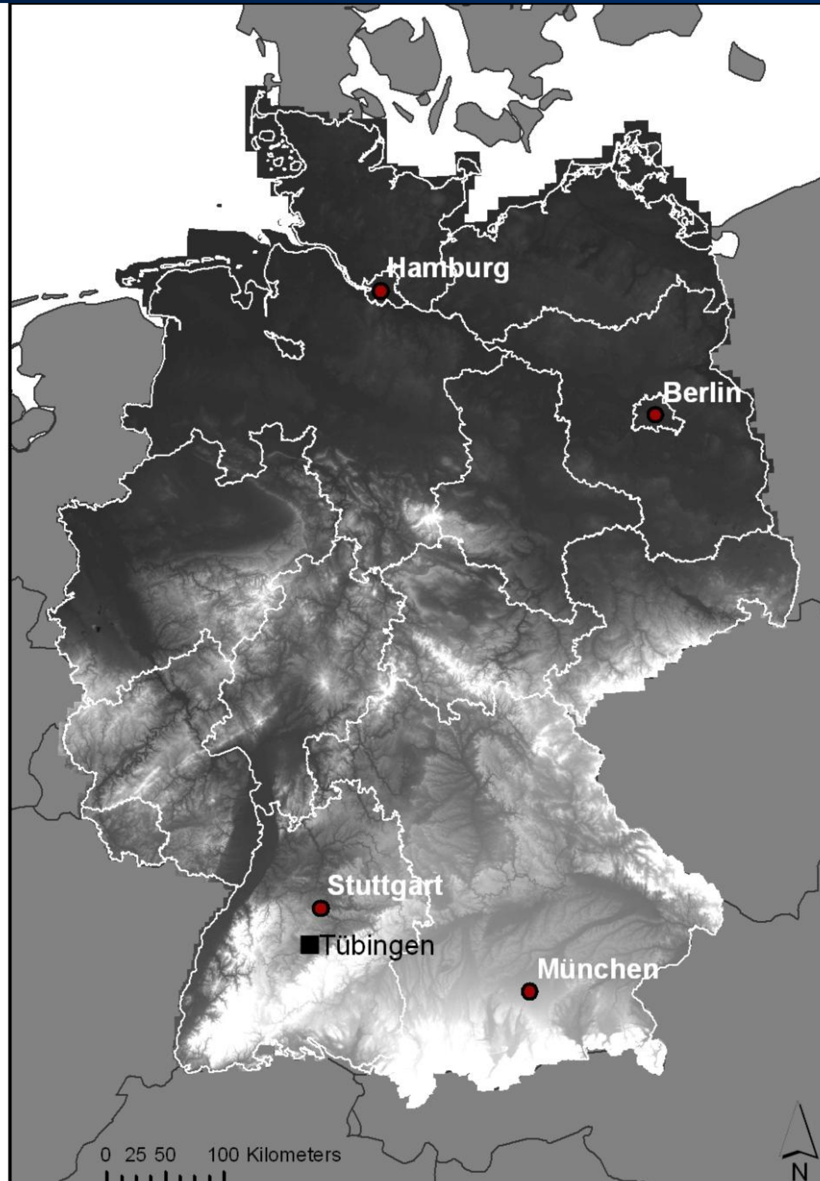

Methodology

1. Object-based image analysis of QuickBird satellite image → land use map
2. Soil sealing modelling using iSurf-A → soil sealing information

   (Impervious Surface Analyst, developed at Uni Würzburg)
3. Calculation of excess rainfall using modified Curve Number method

   CCN = Composite CN

   CN_i = CN (impervious) = 98

   CN_p = CN (pervious) = 71

   a = degree of surface sealing

   P = rainfall [mm]

   Q = excess rainfall [mm]

$$CCN = CN_i \cdot a + CN_p \cdot (1-a)$$

$$Q = \frac{\left(P - \frac{5080}{CCN} + 50{,}8\right)^2}{P + \frac{20320}{CCN} - 203{,}2}$$

4. Modelling of overland flow using GRASS GIS module *r.sim.water*

   LiDAR DEM with 1m resolution and 0.15 m vertical accuracy

Remote sensing: soil sealing analysis for the city of Tuebingen, SW-Germany

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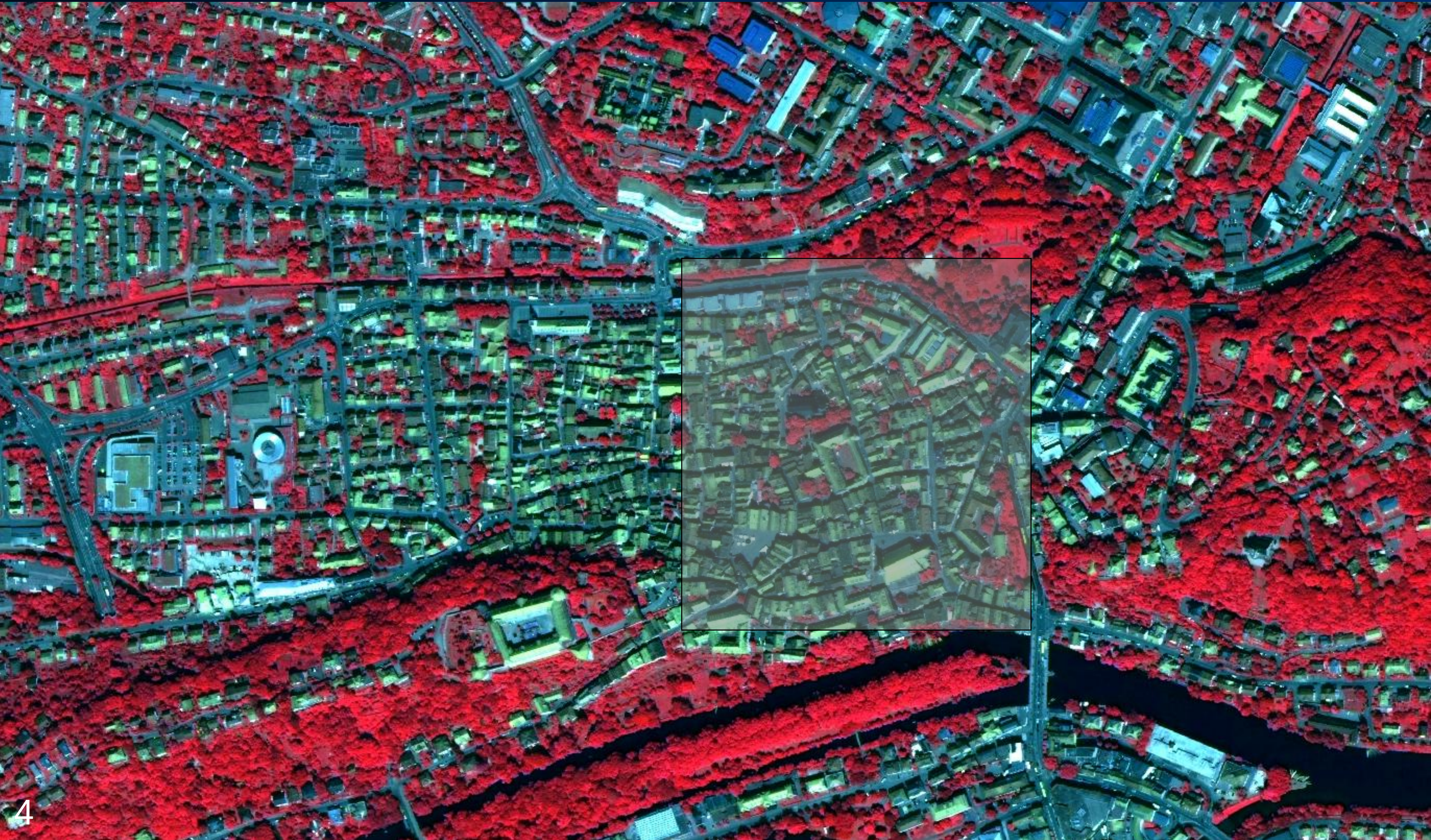
QuickBird satellite image (27 June 2007); resolution: 0,6m (panchromatic), 2,4m (multispectral)



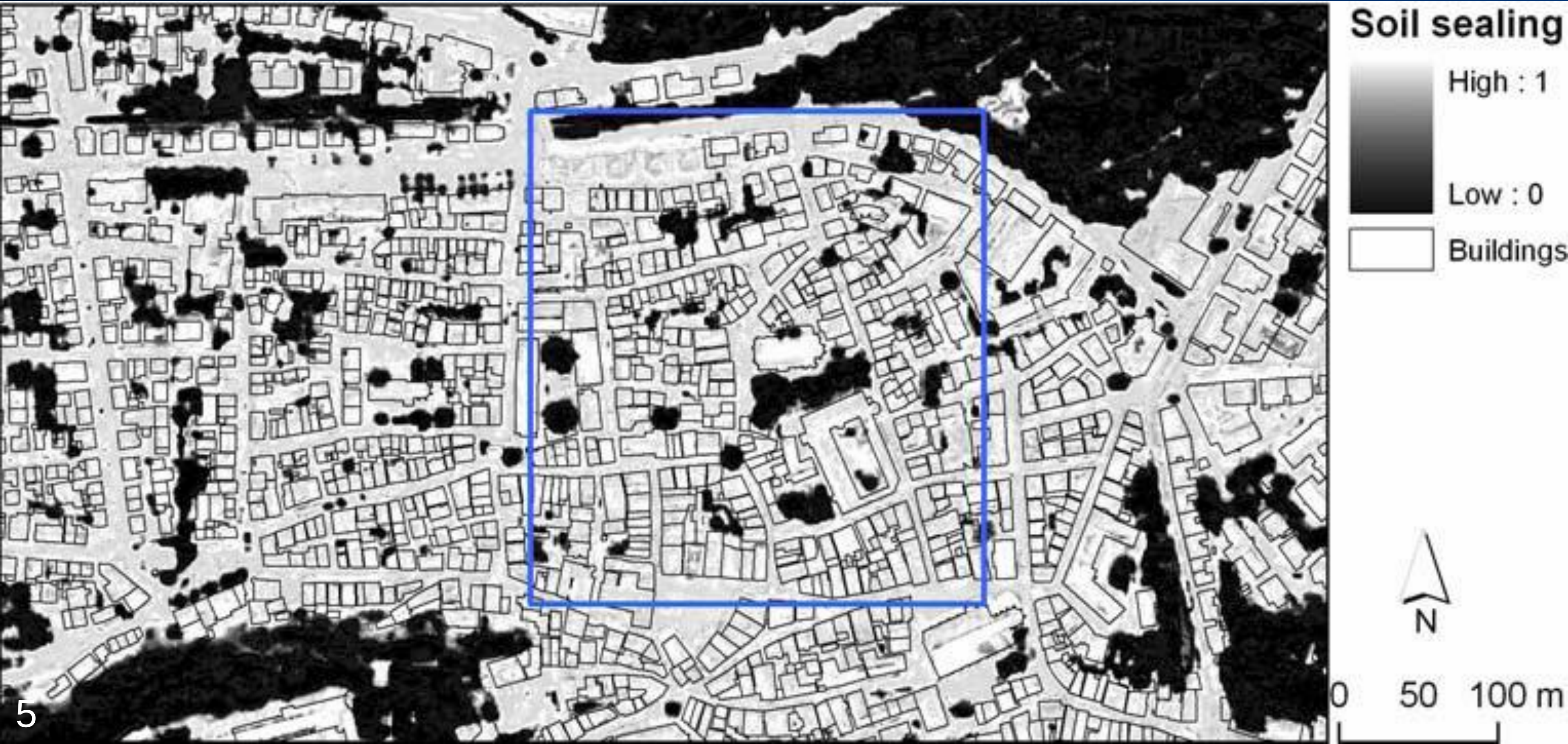
Remote sensing: soil sealing analysis for the city of Tübingen, SW-Germany

Degree of soil sealing:

0 (0% soil sealing = permeable)
to 1 (100% soil sealing = impermeable)

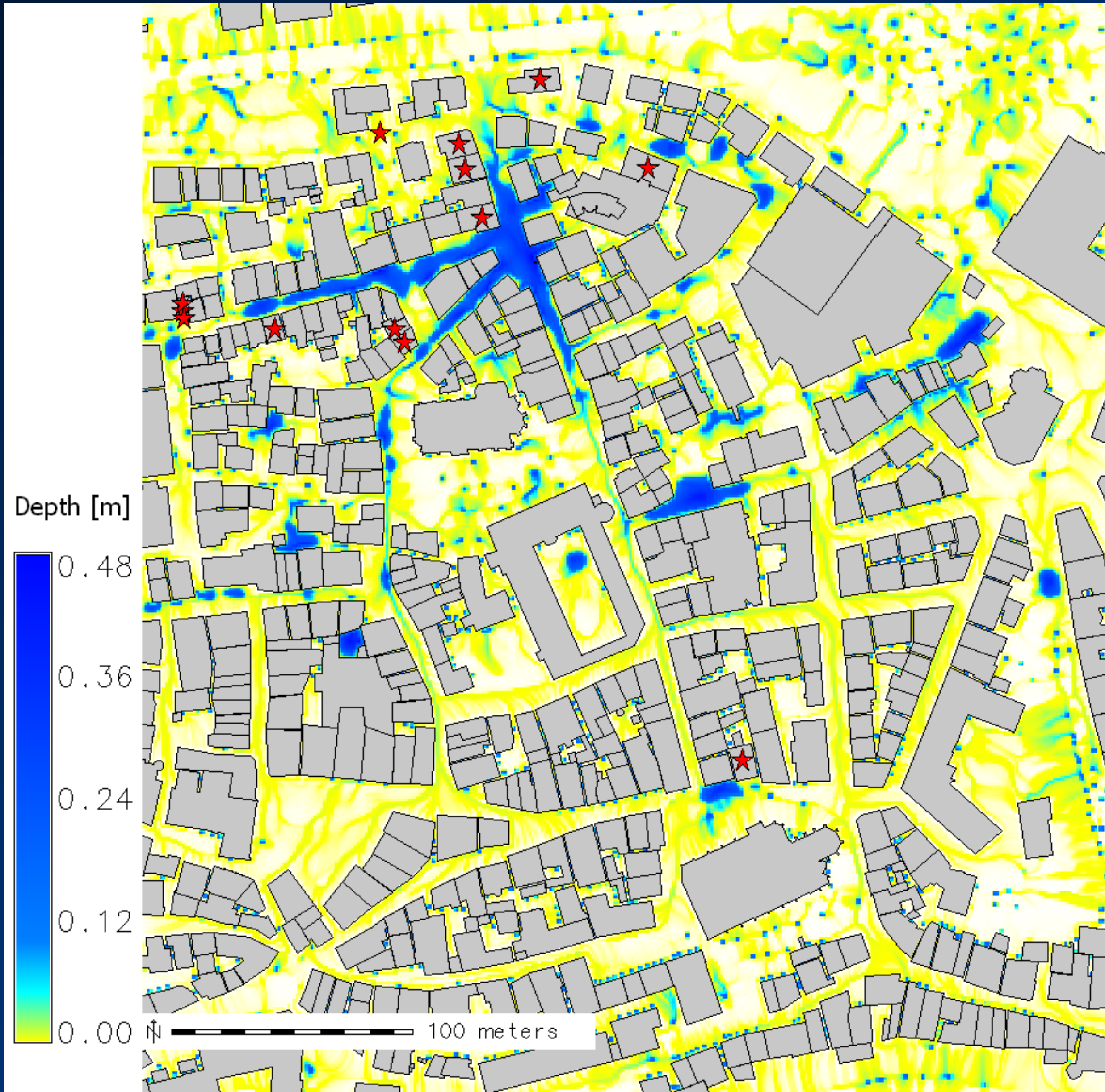
Calculation of runoff (effective rainfall):

$CCN = CN_i \cdot a + CN_p \cdot (1\text{-}a)$



Modelling of overland flow, Tübingen

- Input:
  - LiDAR DEM 1m
  - Excess rainfall
  - Manning's n
- Rainfall intensity: 30 mm/h
- Output:
  - Flow depth after 60min
- Red marks: inundated buildings at 2002 event



Conclusions and outlook

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- Basis for an analysis of urban flash flood hazard
- High spatial resolution → analysis on the level of individual buildings
- Advantages of the remote sensing approach:
  - Application in cities where cadastral data is not available
  - Change detection of soil sealing by time series analysis (how does increased soil sealing affect urban runoff?)
- Future work:
  - Further validation of model results (DEM accuracy?)
  - Simulation of scenarios (rainfall intensity and durarion)
  - Method needed to account for losses in urban sewage system
  - Development of simplified sewage model and coupling with *r.sim.water*

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Thank you very much for your attention!

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Methodology

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