Probabilistic Forecasting For Urban Water Management

An Urban Case Study: Aarhus, Denmark

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$$P(S \le x|\hat{S}=0) = P(S \le x|S>0,\hat{S}=0)P(S>0|\hat{S}=0) + P(S=0|\hat{S}=0)$$

$$\hat{P}(S=0|\hat{S}=x^*) = a\exp(bx^*) + c$$

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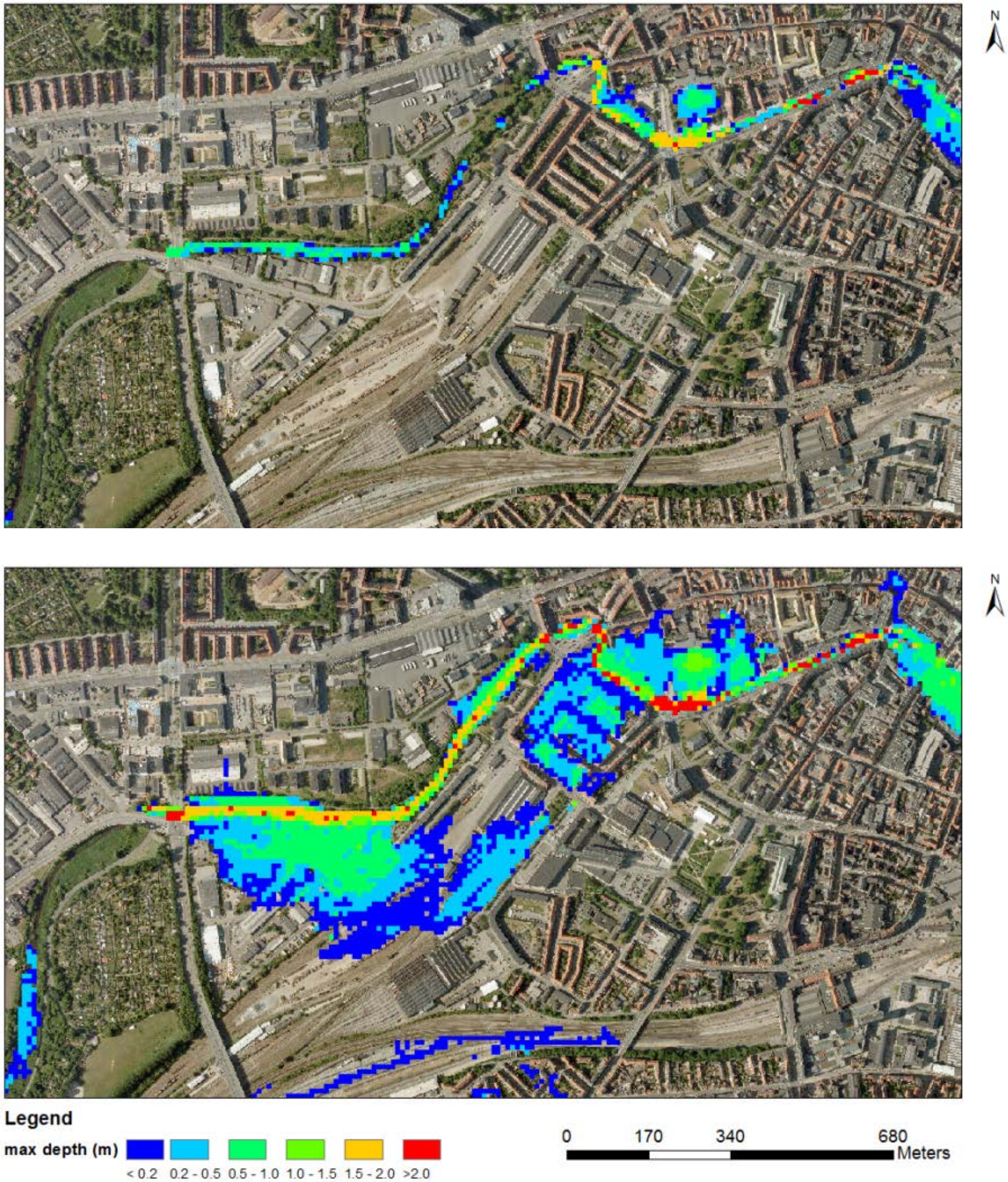
What we'll cover?



- 50th percentile
- 95th percentile

Background

OCTOBER 20, 2010

Is Heavy Flooding In St. Lucia A Glimpse Into The Future Of The Caribbean?

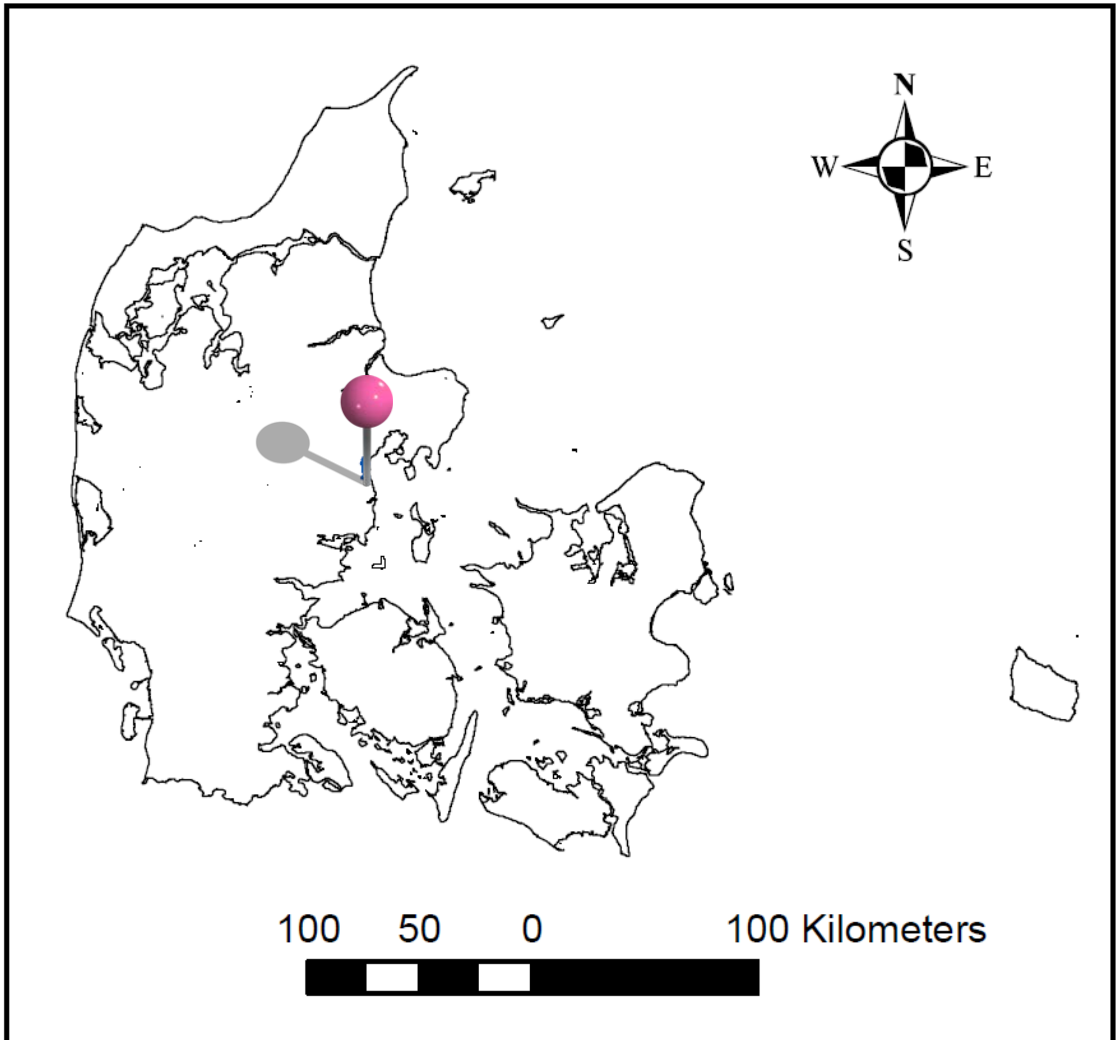
What have we done?

- Developed a method for estimating the uncertainty in the rainfall forecast
  - Compared rainfall forecast from NWP model with observed rainfall from rain gauges
  - Compared two approaches for quantifying the uncertainty in the rainfall forecast
  - Use the probabilistic information as input to a hydrological hydraulic model

What assumptions have we made?

- Observed rainfall is the ‘real’ rainfall
- Sewer model is fit for the purpose
- Complete temporal dependence between lead – times
  - Hence comparison of LHS results to the quantile approach

Case Study-Aarhus Denmark



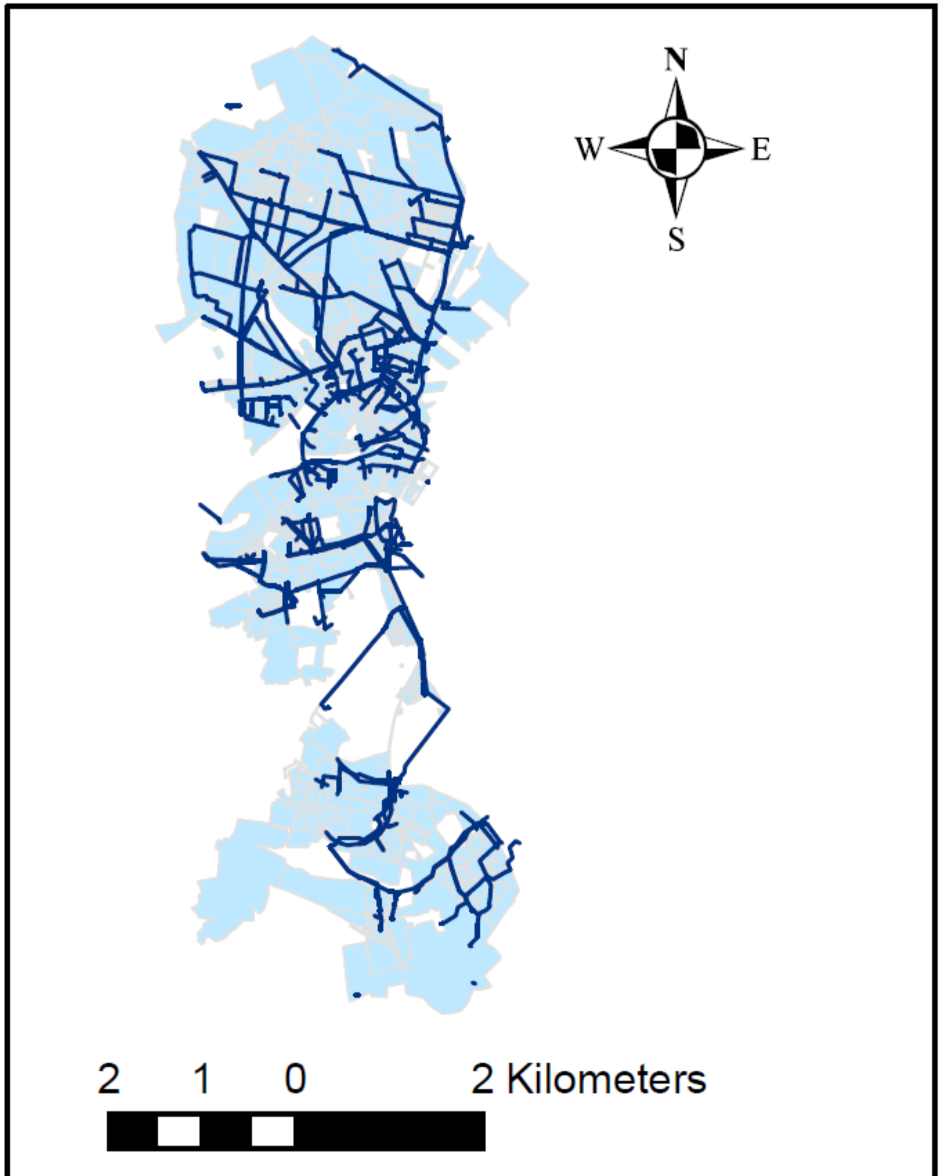
Population – 250,000

High quality data for the sewer system

Archived rainfall forecasts

Long records of observed data

Good rain gauge coverage



Model Case Study

1926 manholes

1657 pipes

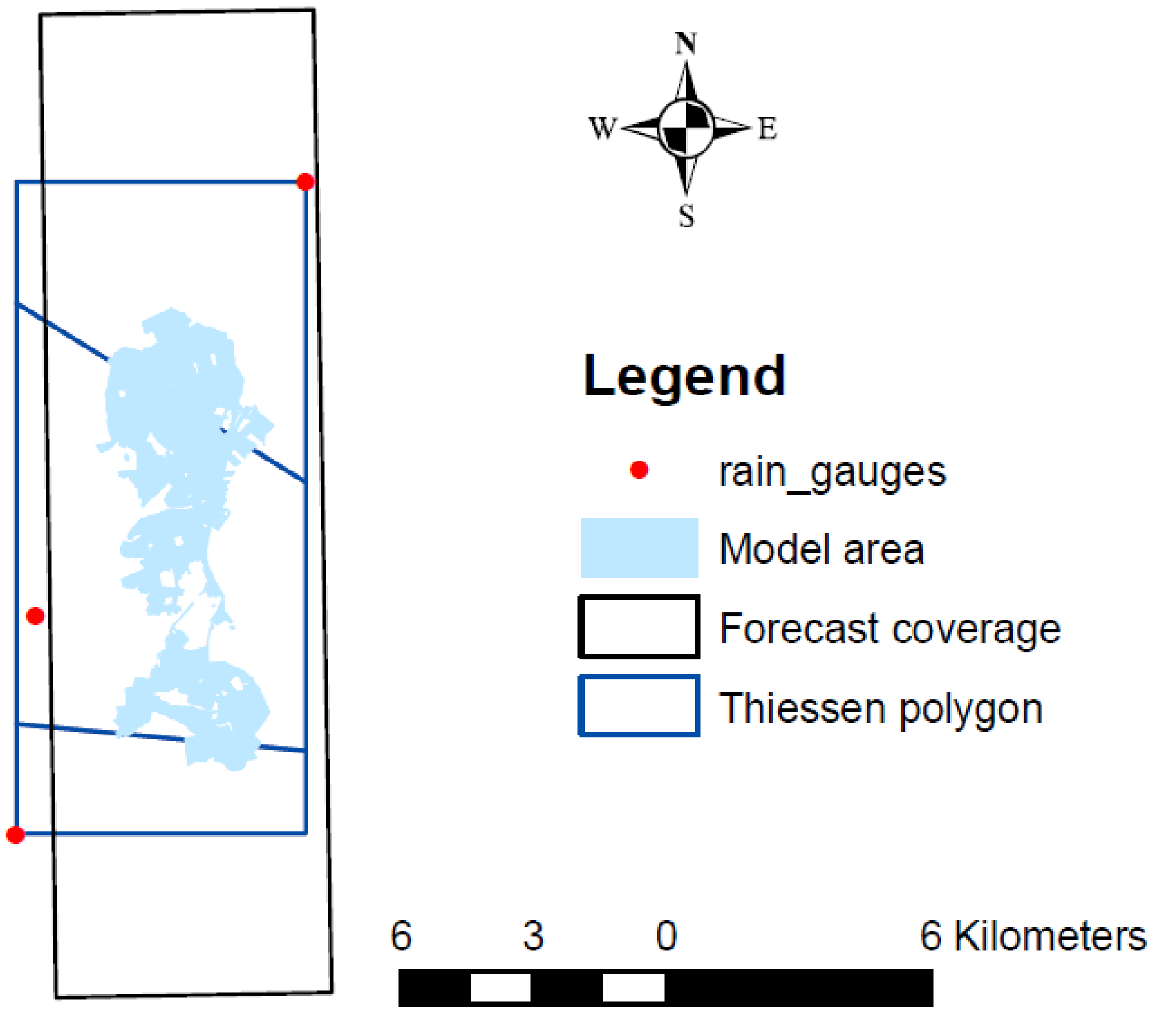
196 weirs

83 basins

26 pumps

…………..

Complex network



Data Set

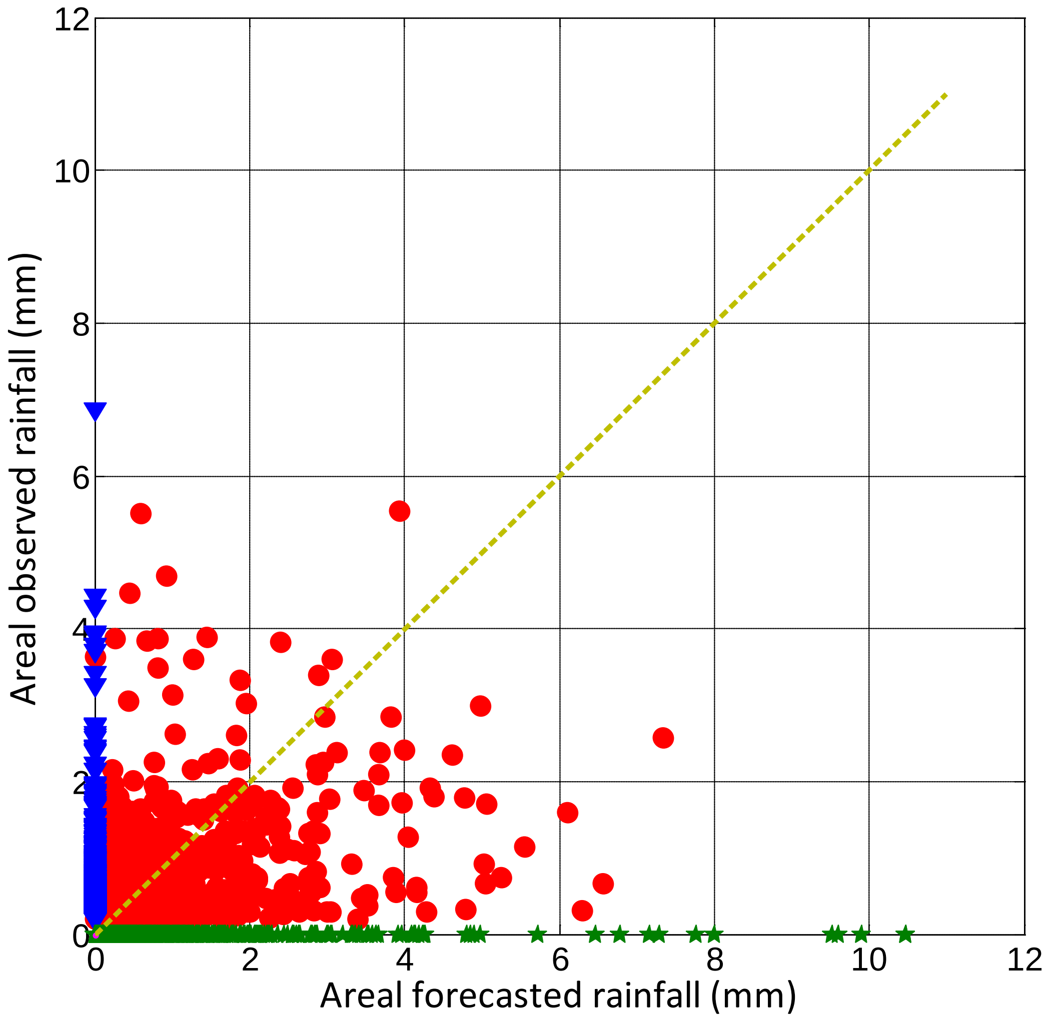
Rain gauge network

- 3 rain gauges
- Volumetric resolution = 0.2mm
- Temporal resolution = 1minute
- Duration =10 years of data

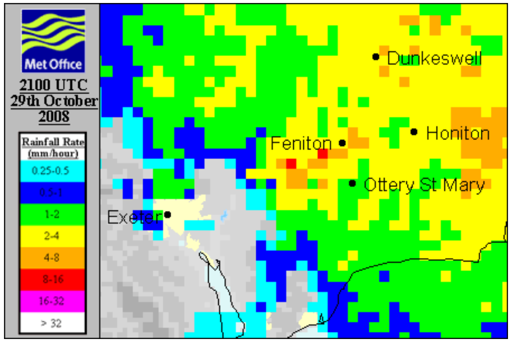
NWP model data

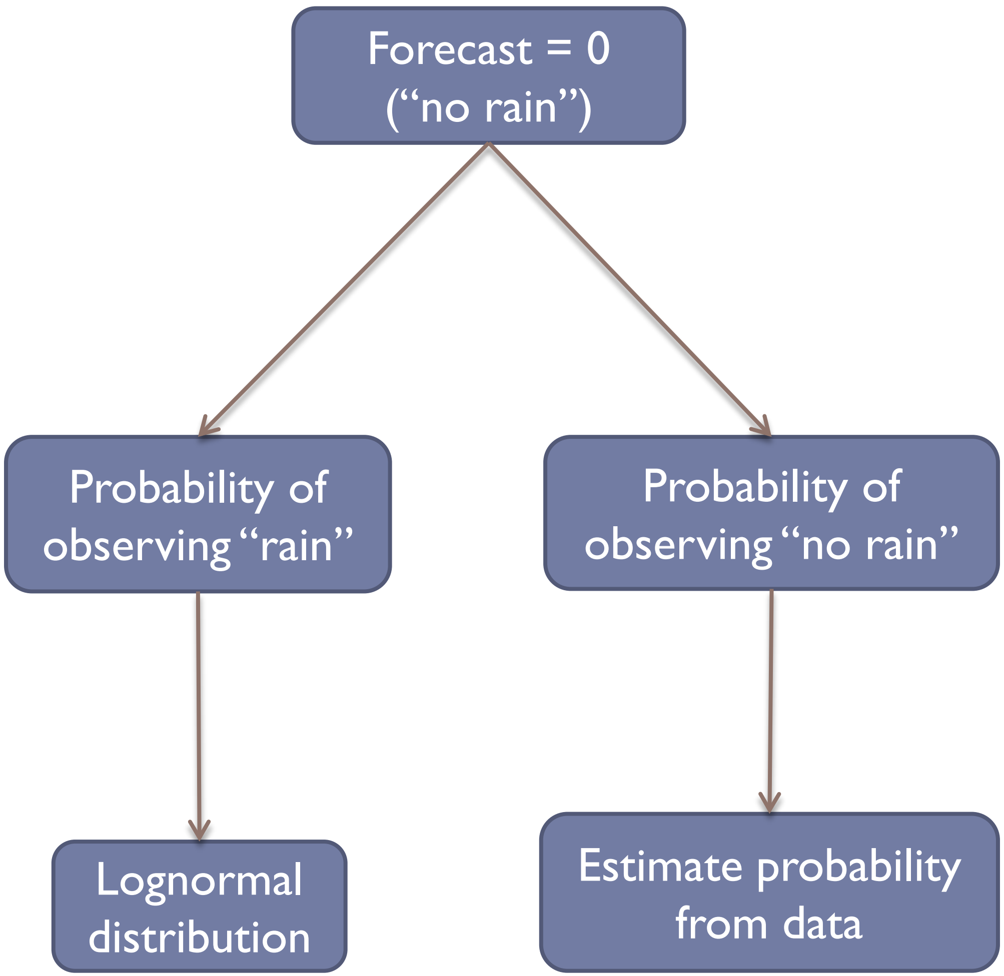
- Grid resolution = (6.2x11.1)km
- Study area = 138km^2
- Temporal resolution = 1hr
- Duration = 2 years of data

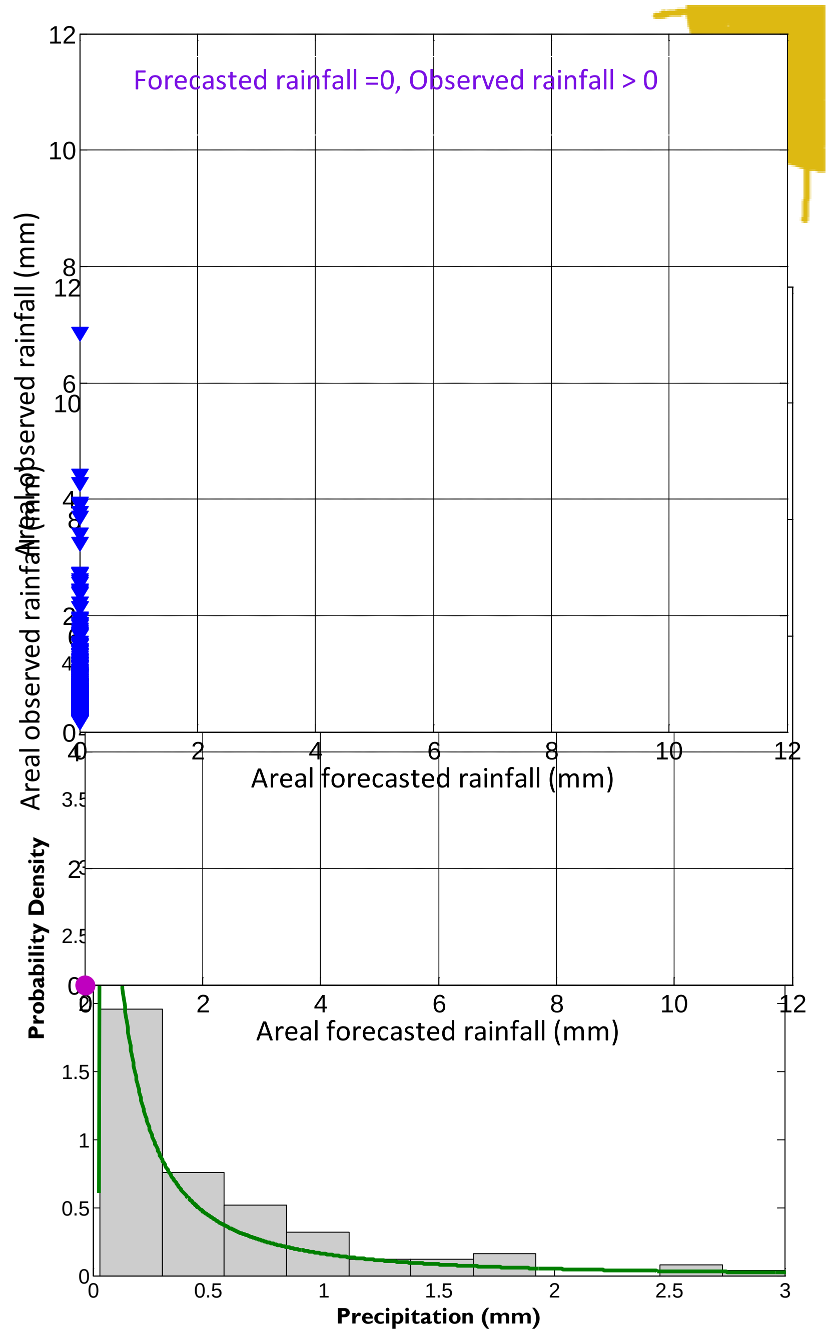
Motivation - Fact

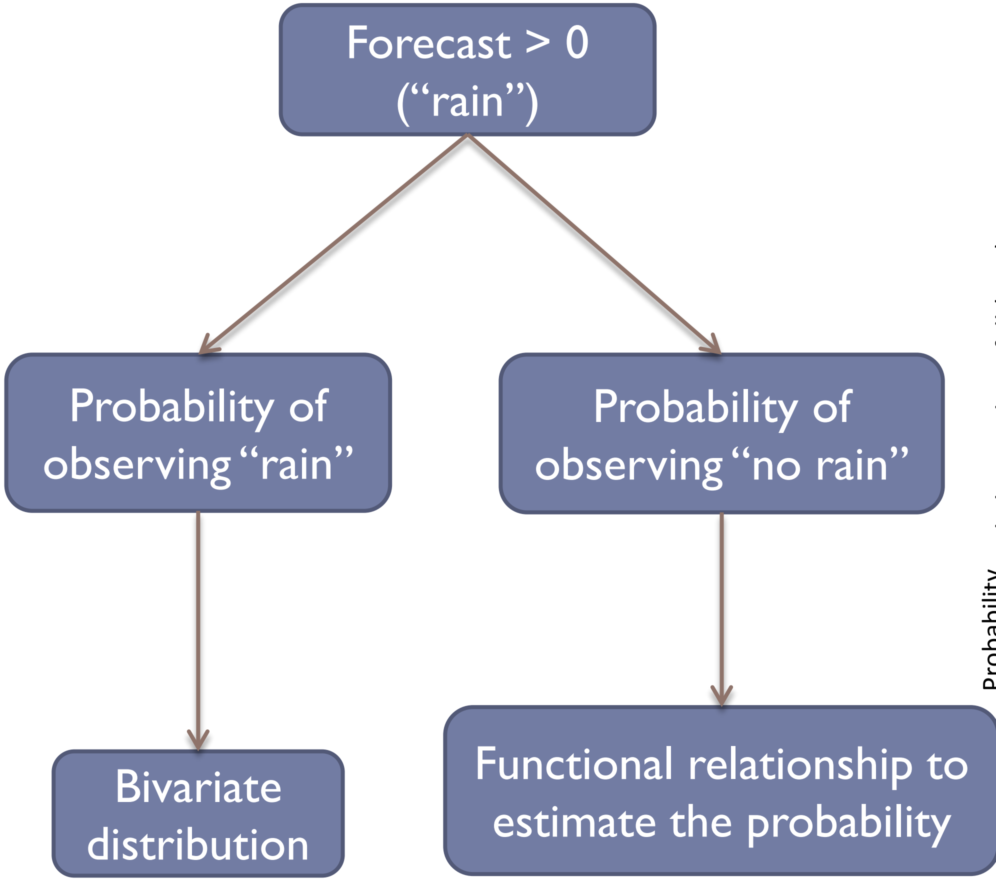


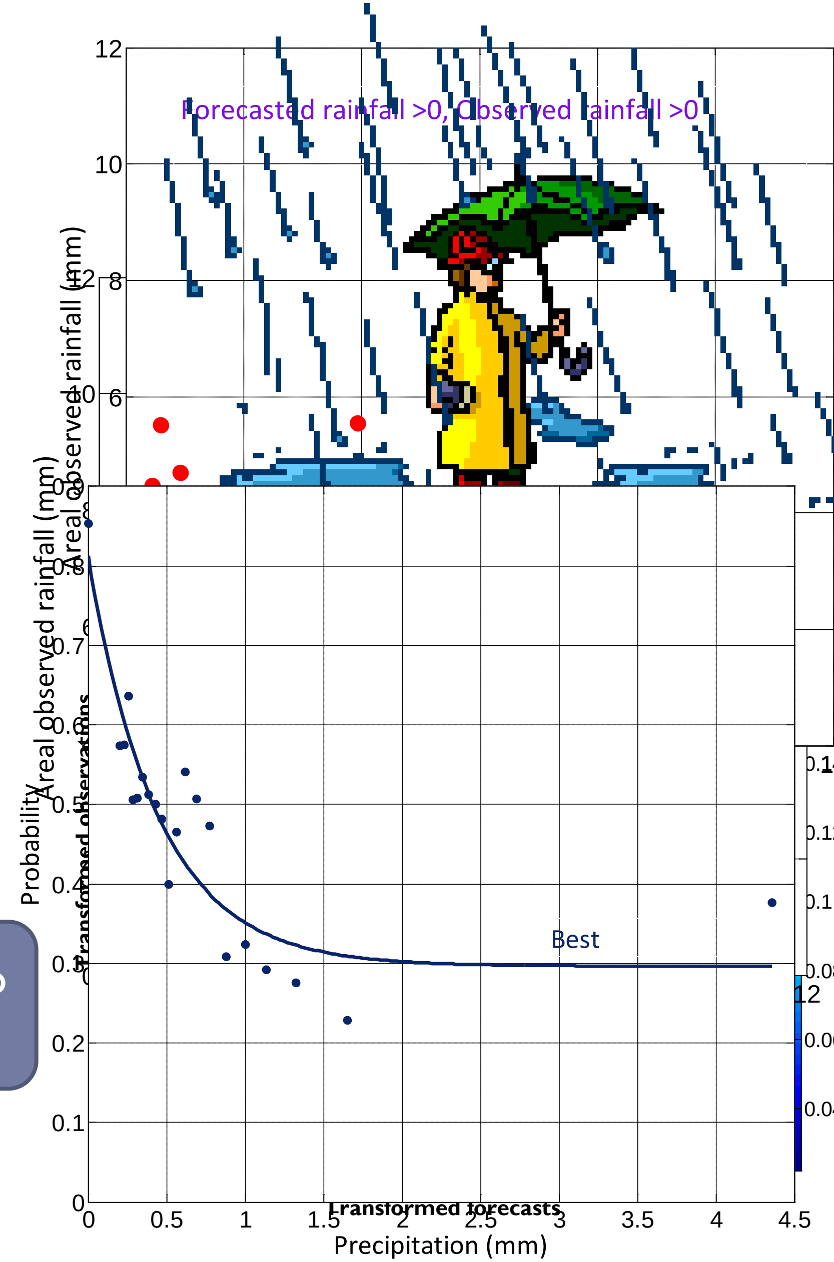
Discrepancy between the forecasted and observed rainfall



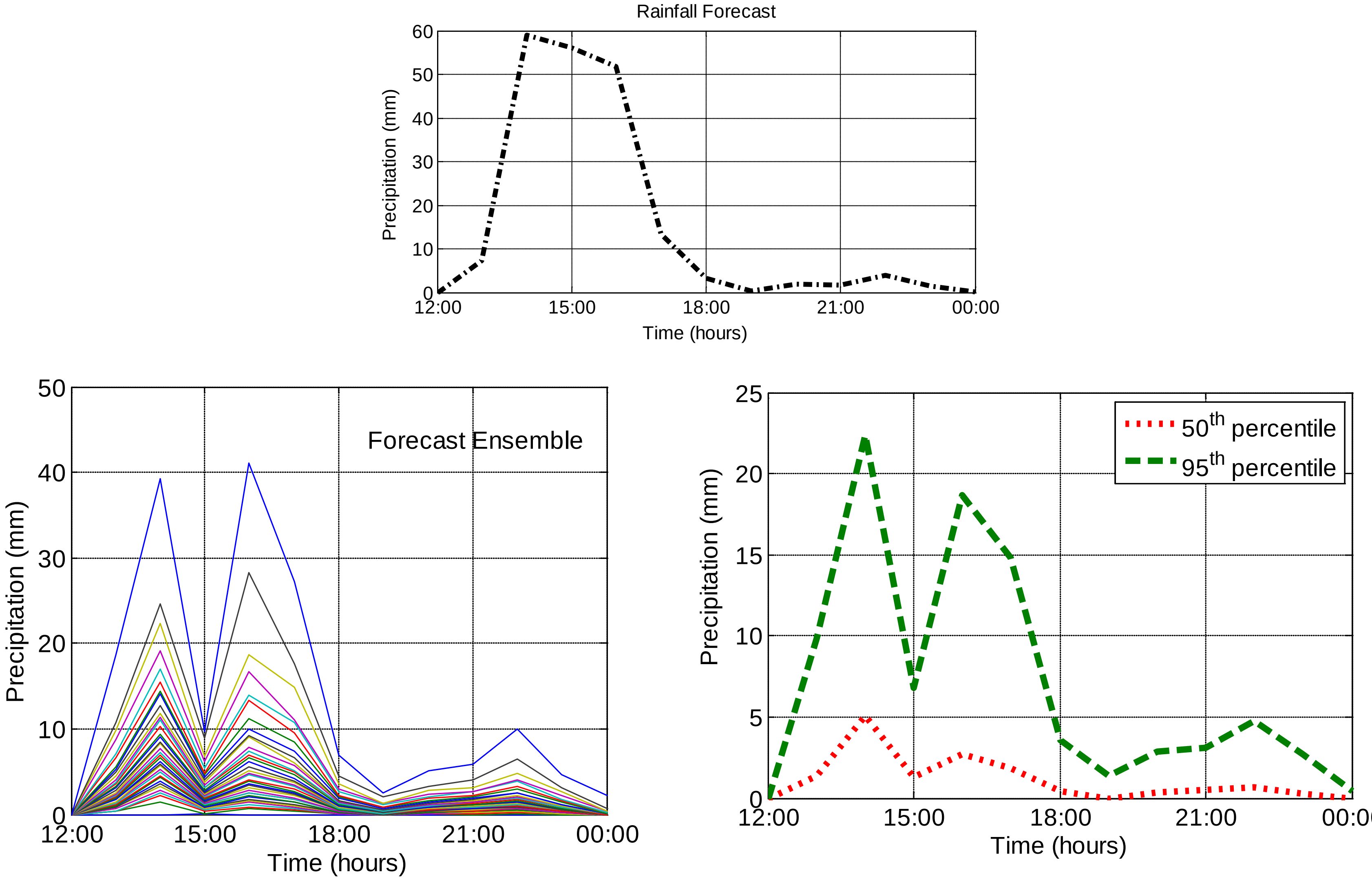

Forecast = 0
("no rain")
Probability of observing "rain"
Probability of observing "no rain"
Lognormal distribution
Estimate probability from data


Forecasted rainfall =0, Observed rainfall > 0
Areal observed rainfall (mm)
Areal forecasted rainfall (mm)
Probability Density
Precipitation (mm)

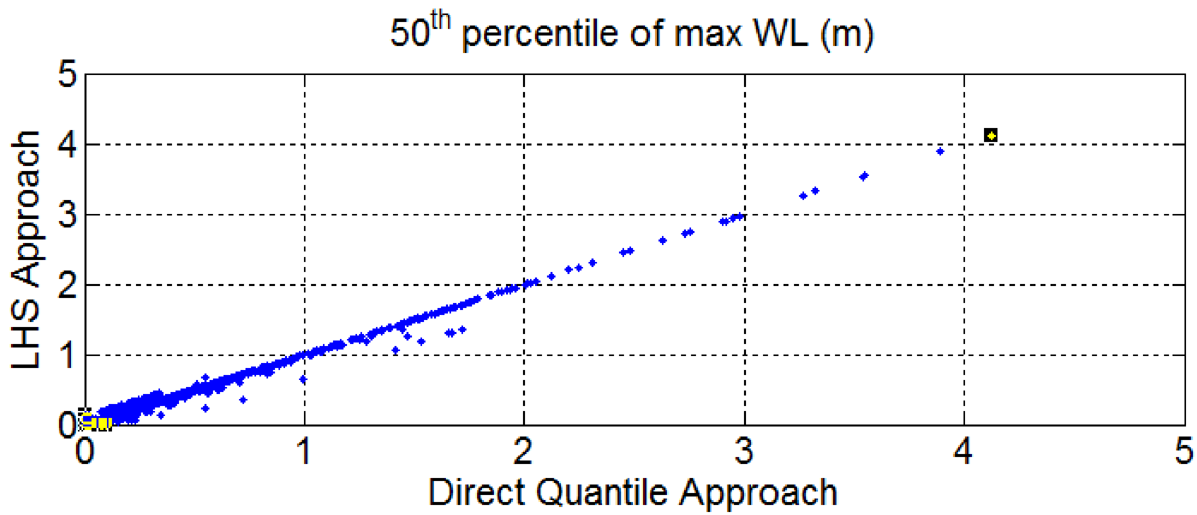

Forecast > 0
("rain")
Probability of observing "rain"
Probability of observing "no rain"
Bivariate distribution
Functional relationship to estimate the probability

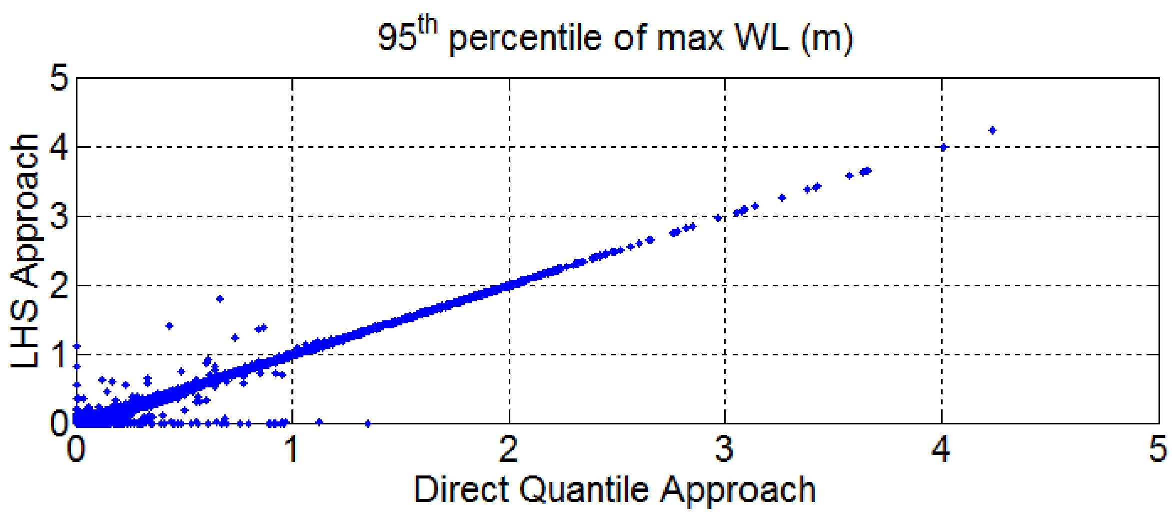

Forecasted rainfall >0, Observed rainfall >0
Areal observed rainfall (mm)
Probability
Best
Transformed forecasts
Precipitation (mm)

LHS and Direct Quantile Approach

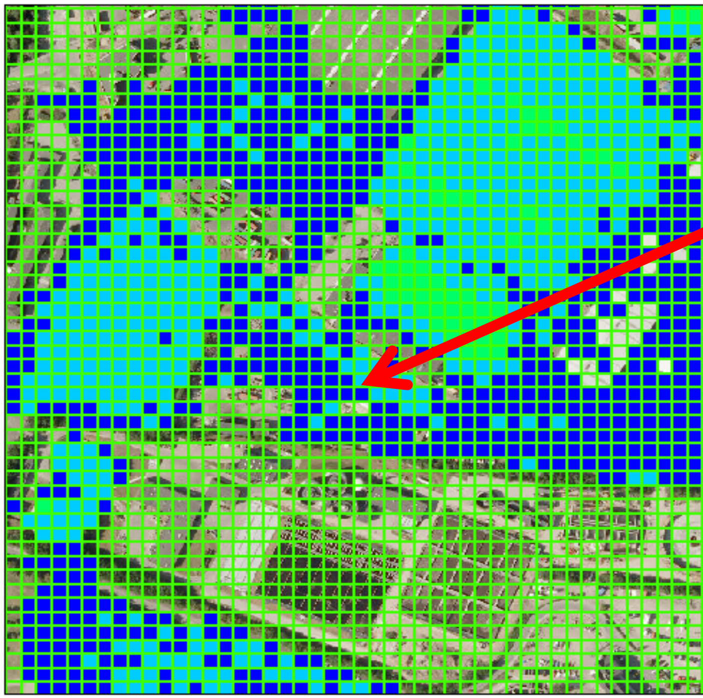


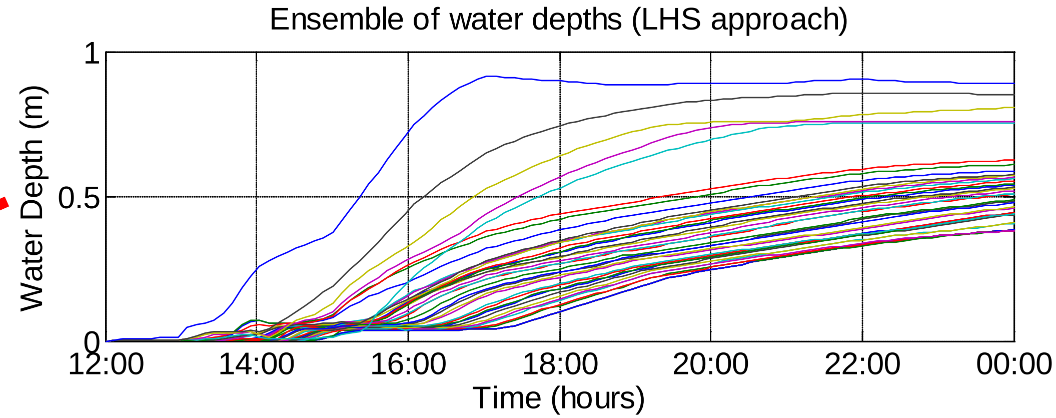
Comparison of max. WL over 2D grid

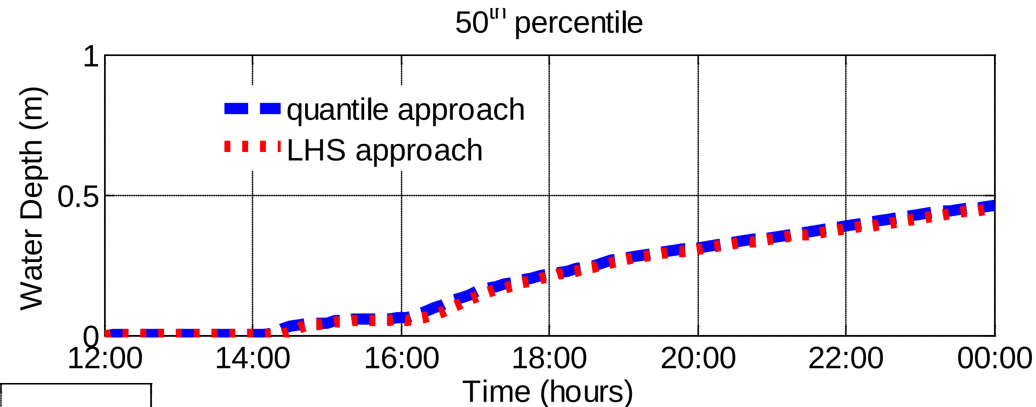


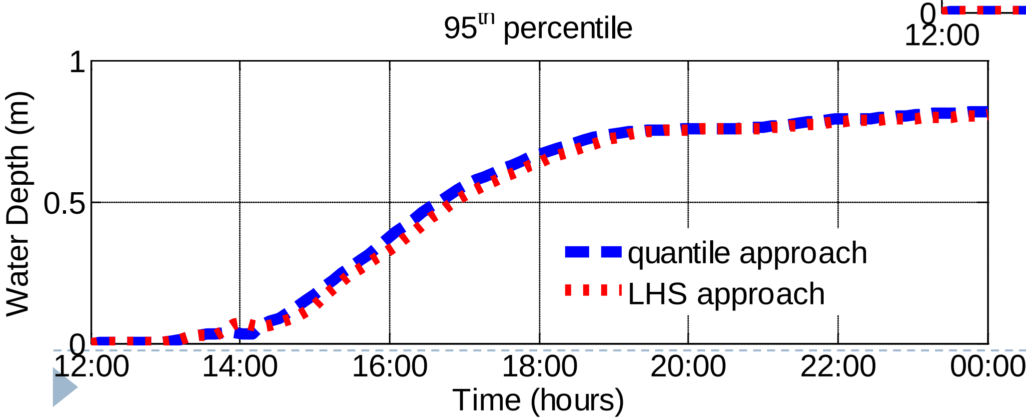


Results from hydrodynamic model



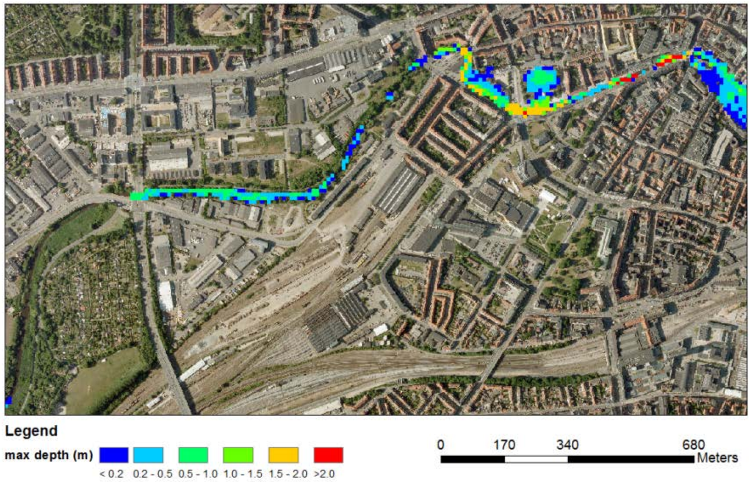


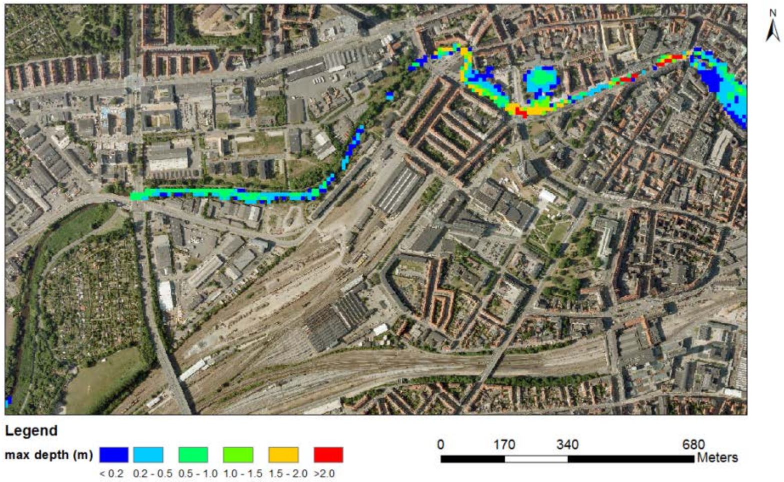




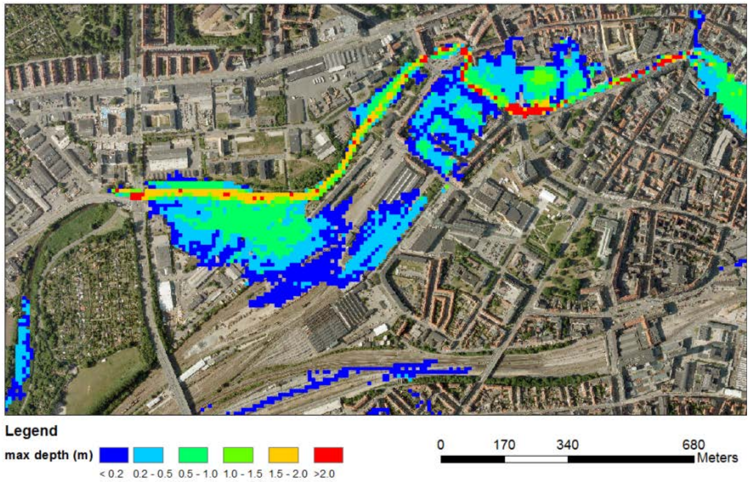
LHS approach

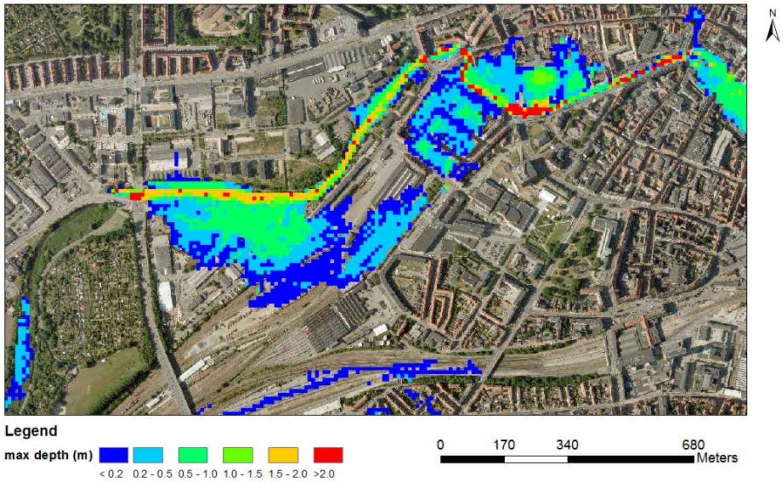
Direct quantile approach





50th percentile





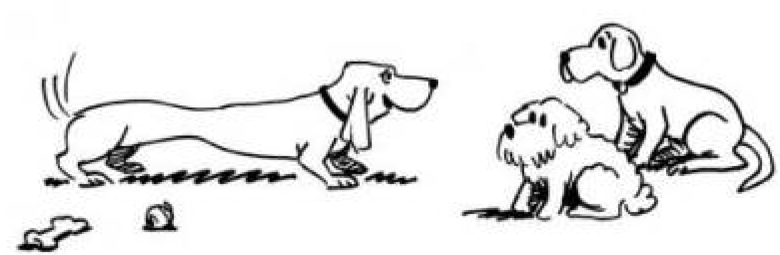
95th percentile

Final thoughts

- Making decisions under uncertainty is one of the most difficult management decisions but is the most important one!!!

- Addressing uncertainty as a reality shifts the question:

  1. Should a flood warning be issued?
  2. With what confidence it might succeed?



Questions?

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