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# Identfication of uncertainty sources in flood forecasting

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# Outline

- Introduction
- Case study
- Method to assess the total forecast uncertainty
- Variance Decomposition
- Results
- Next steps
- Conclusions

# Introduction

- Flood forecasts are subject to different sources of uncertainty.
- Identification of the most important sources of uncertainty is essential in improving the flood forecasting system in an efficient way.
- Decompostion of total forecast uncertainty in its key sources by variance decomposition.




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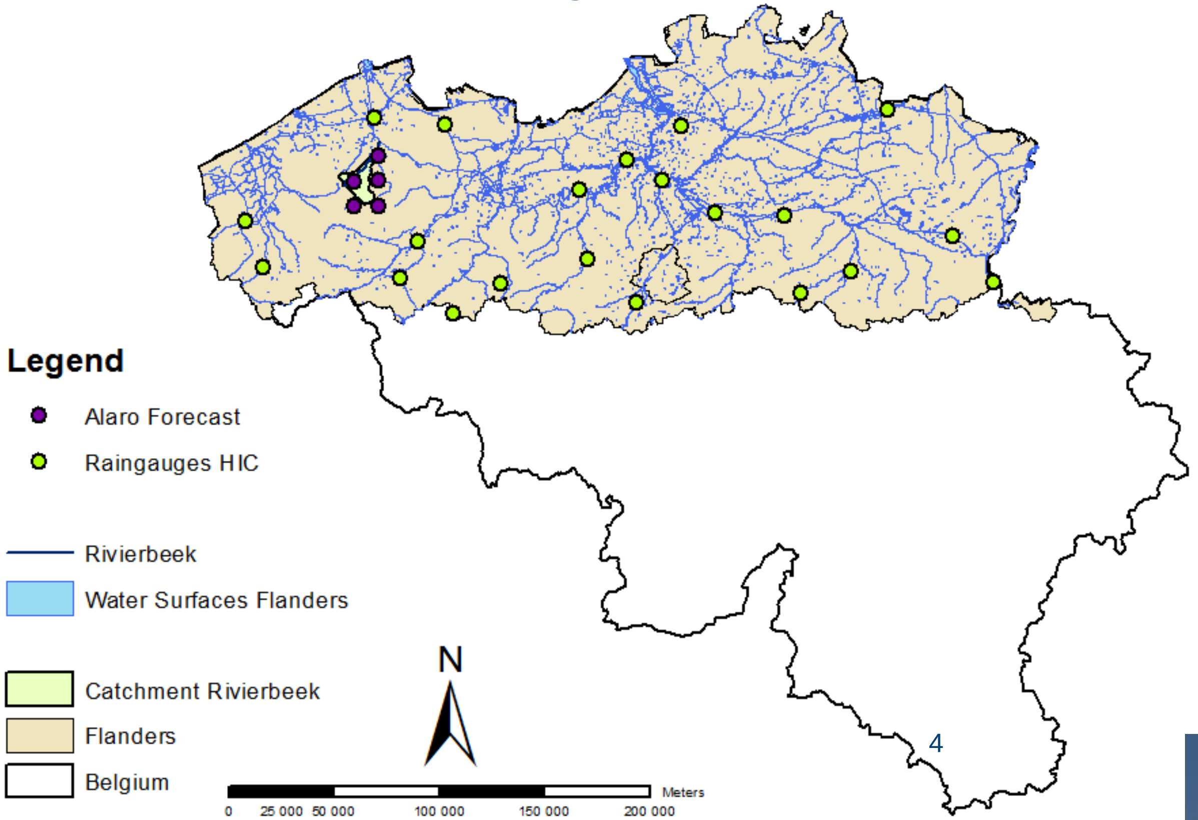
# Case study

- Catchment: Rivierbeek (western part of Belgium)
  - 64 km²
  - Av. discharge: 0.6m³/s;  Max. discharge: >8m³/s



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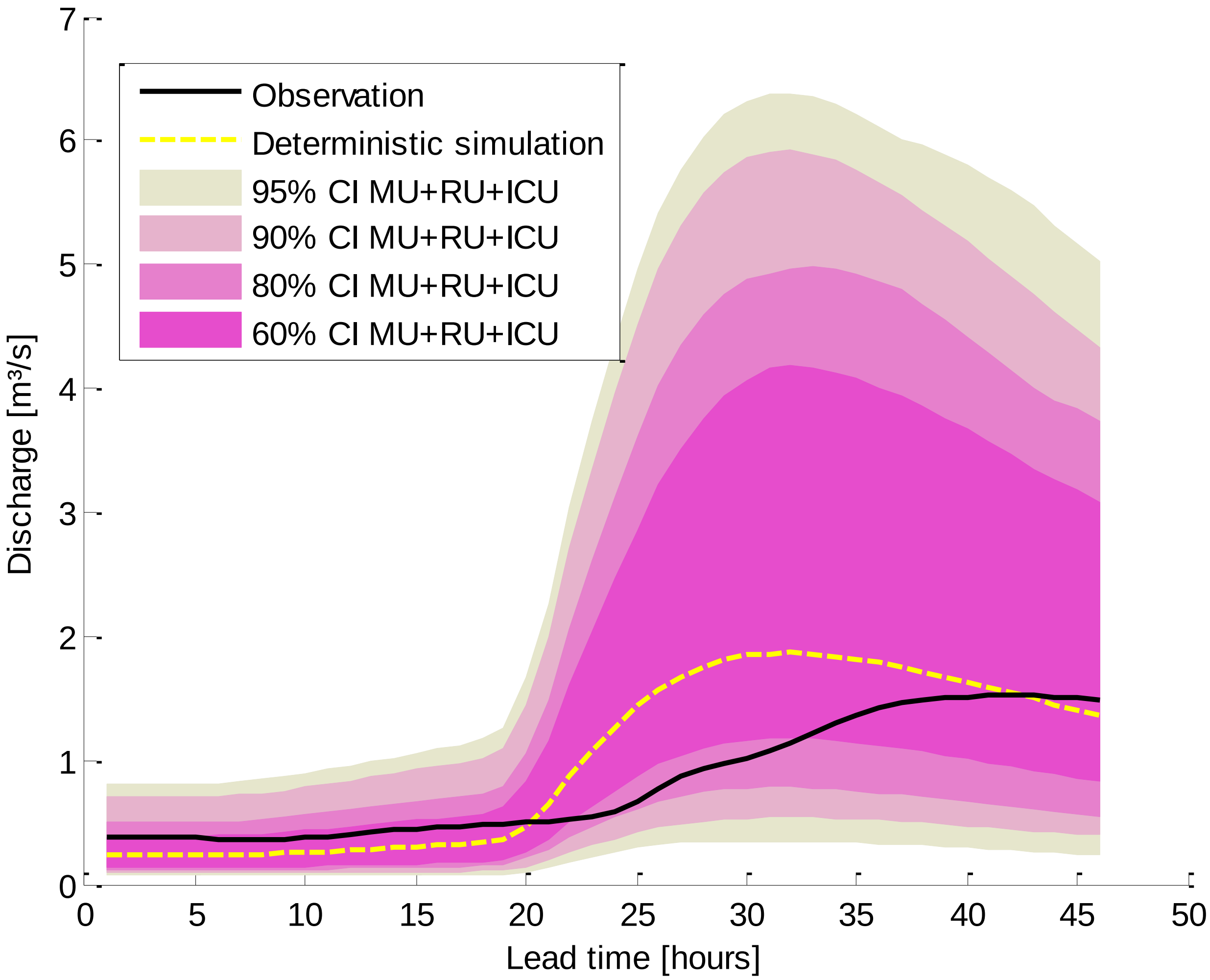
# Case study

- Flood forecasting system:
  - Operational system of Flanders Hydraulics Research
  - Navigable waterways in Flanders
  - Lead time of 48h
  - Floodwatch system of DHI (incl. Mike11 & NAM)
  - Rainfall forecasts: NWP Alaro (7x7km grid, 3h cum.)
  - Data assimilation on Hydrodynamic output not on Hydrological output
  - In this research only the hydrological part of the FF-system is considered.

# Method to assess total forecast uncertainty

- Non-parametric Data-based Approach (NDA)
  - Uncertainty analysis of historical flood forecasts
  - Calculation of residuals between observed and forecasted discharge
  - Classification of residuals according to lead time and forecasted discharge
  - For each combination of lead time class and forcasted discharge class, different percentiles are calculated and stored in 3D-error matrix
  - By interpolation in error matrix confidence intervals can be calculated
  - Residual = $(Q_{obs} – Q_{for})/Q_{for}$

# Method to assess total forecast uncertainty



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# Variance Decomposition

- Identification of three uncertainty sources: Model Uncertainty (MU), Forecasted Rainfall Uncertainty (RU), Initial Conditions Uncertainty (ICU)

- Resimulation of historical forecasts with optimal initial conditions, based on a long term simulation run => MU + RU
- Resimulation with observed rainfall instead of rainfall forecasts => MU
- Original historical forecasts => MU + ICU + RU

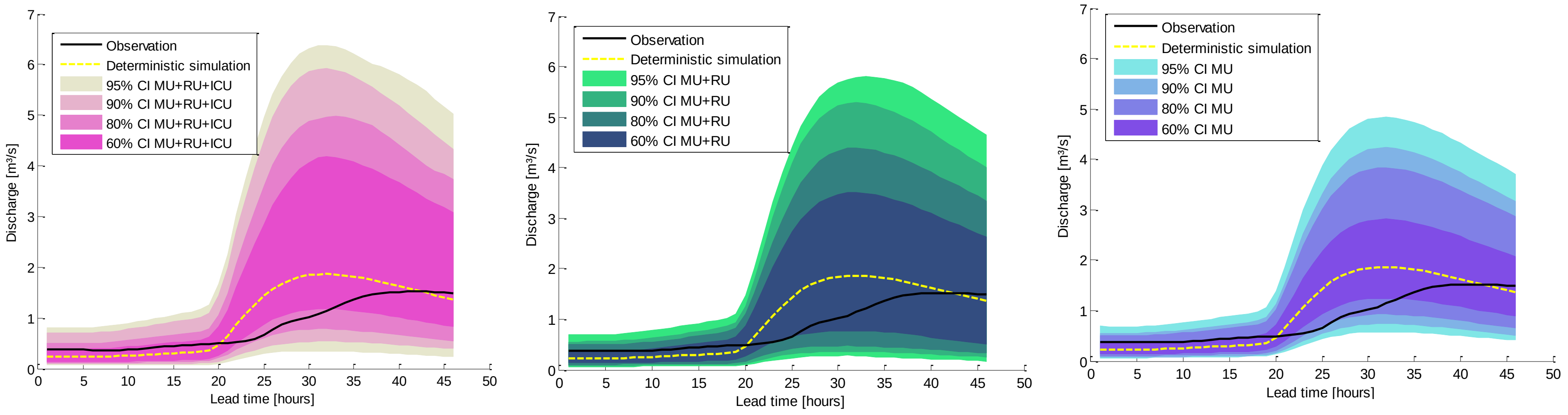
# Variance Decomposition

- $w_{1,i}$ = mean width of confidence interval MU+RU+ICU
- $w_{2,i}$ = mean width of confidence interval MU+RU
- $w_{3,i}$ = mean width of confidence interval MU
- i = lead time class

  - Relative contribution of MU = $\frac{w^2{}_{3,i}}{w^2{}_{1,i}}$
  - Relative contribution of ICU = 1 - $\frac{w^2{}_{2,i}}{w^2{}_{1,i}}$
  - Relative contribution of RU = $\frac{w^2{}_{2,i} - w^2{}_{3,i}}{w^2{}_{1,i}}$

# Results

## Single Event: Time of forecast 05/11/2012 06:00h.



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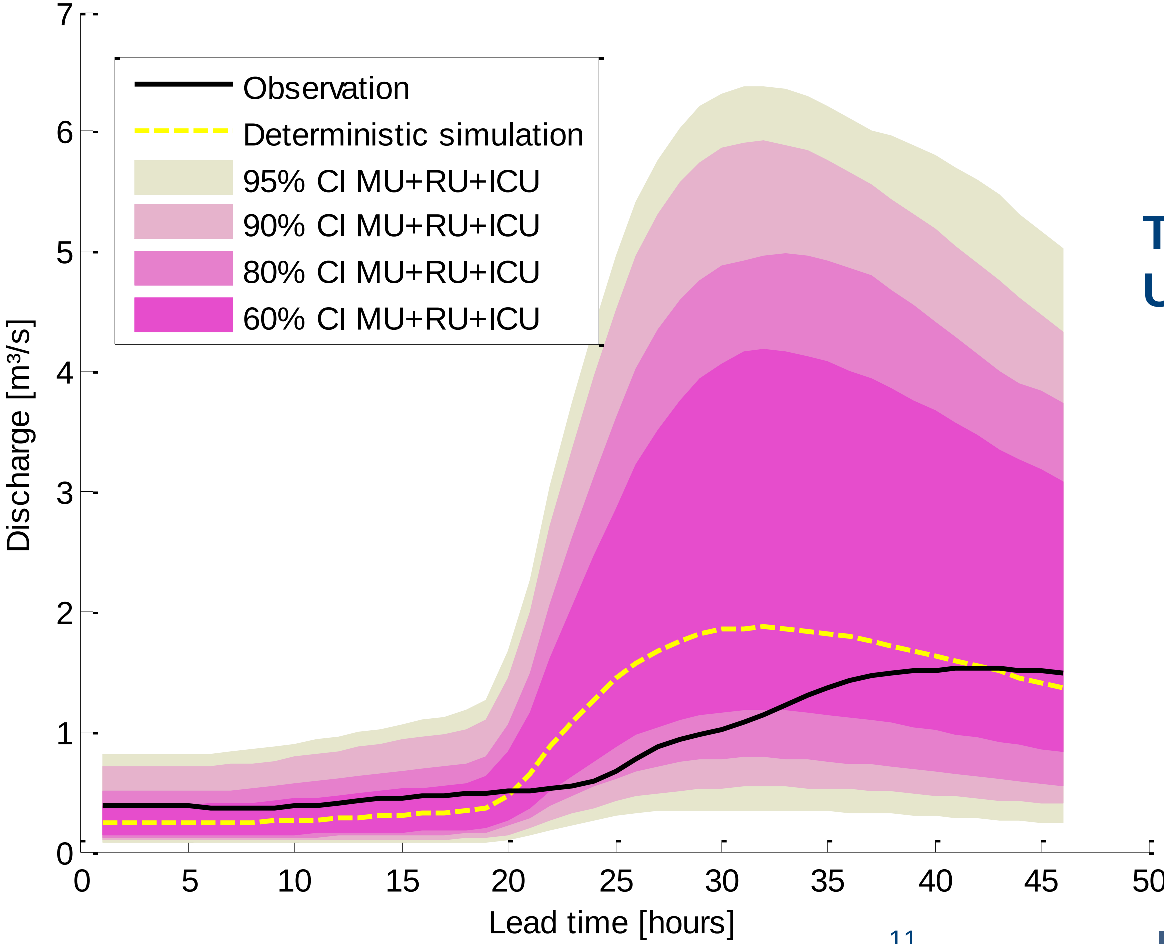
# Results

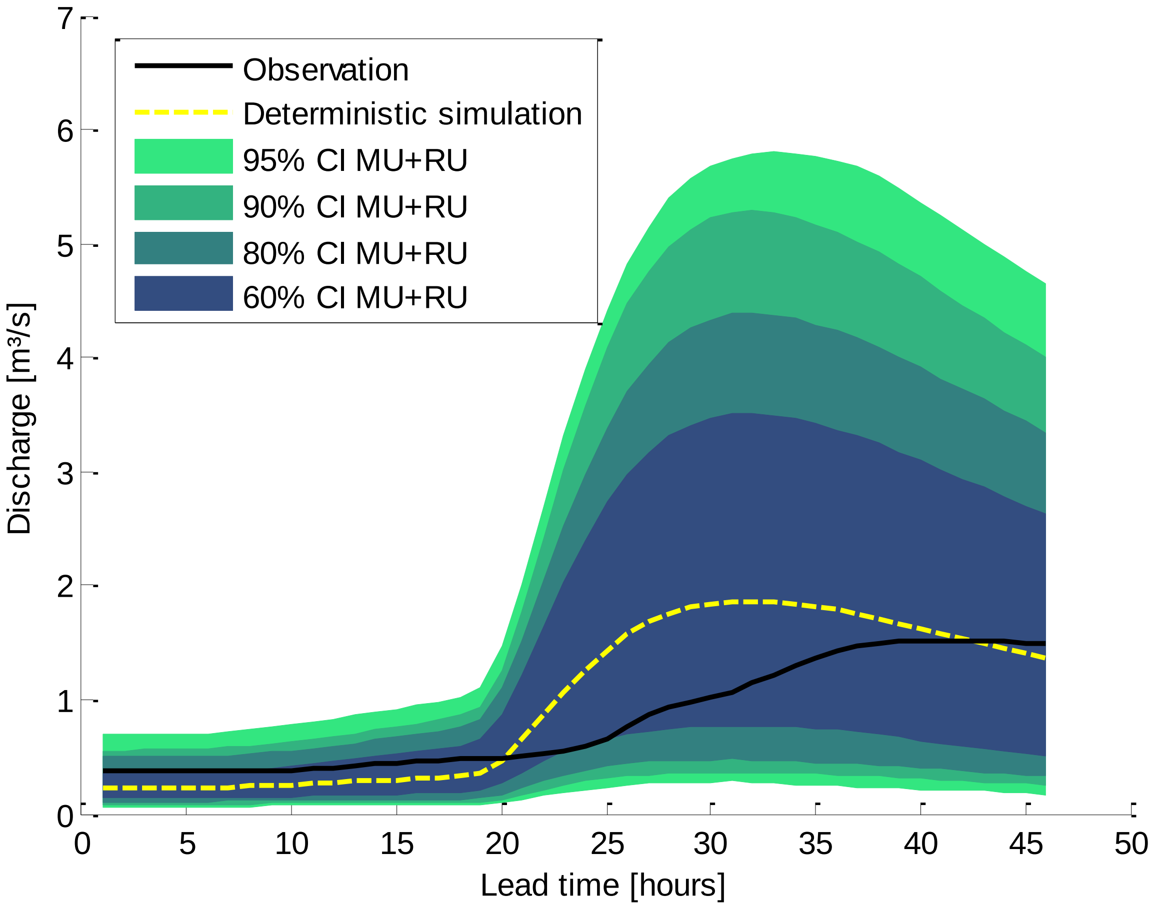
## Single Event: Time of forecast 05/11/2012 06:00h.




**Total Flood Forecast Uncertainty**

# Results

Single Event: Time of forecast 05/11/2012 06:00h.




**Model + Rainfall Forecast Uncertainty**

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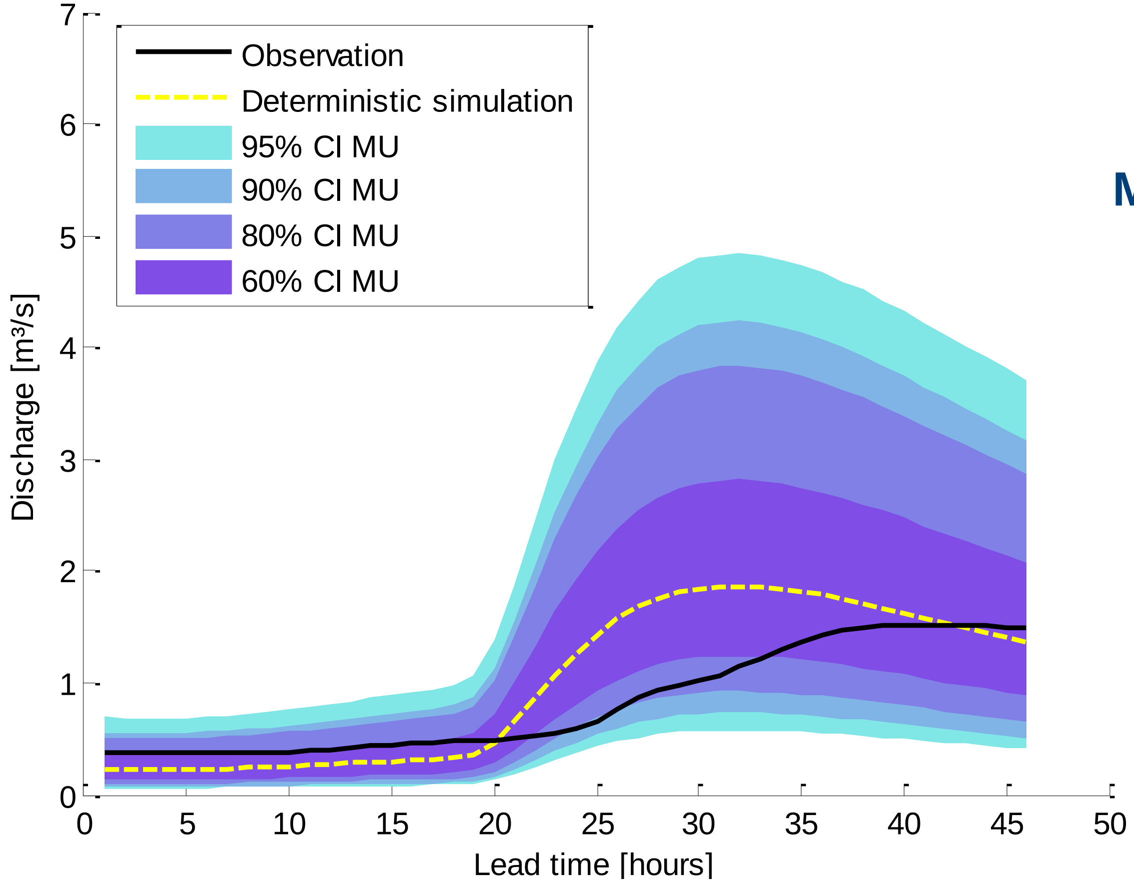
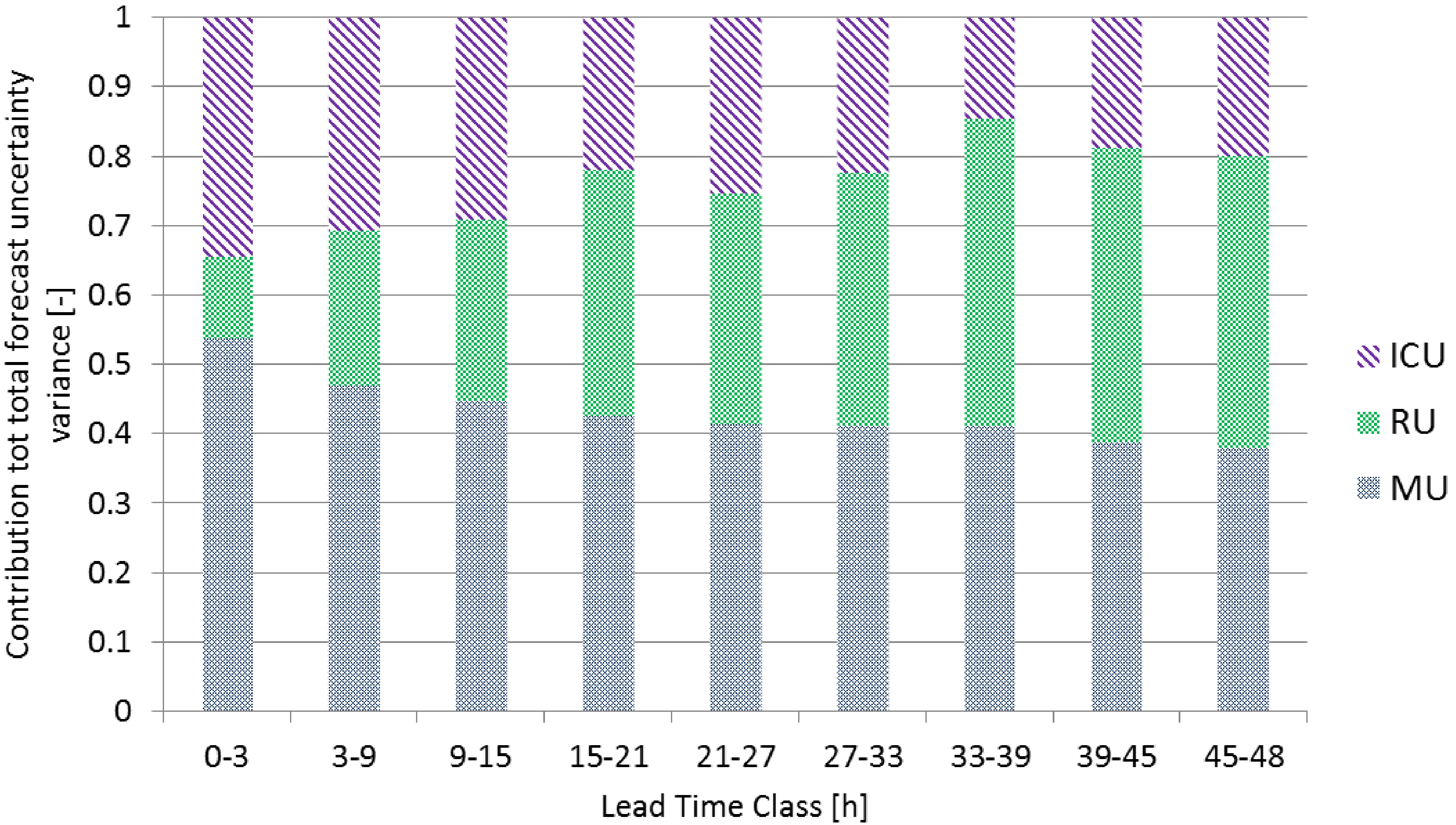
# Results

Single Event: Time of forecast 05/11/2012 06:00h.




**Model Uncertainty**

# Results

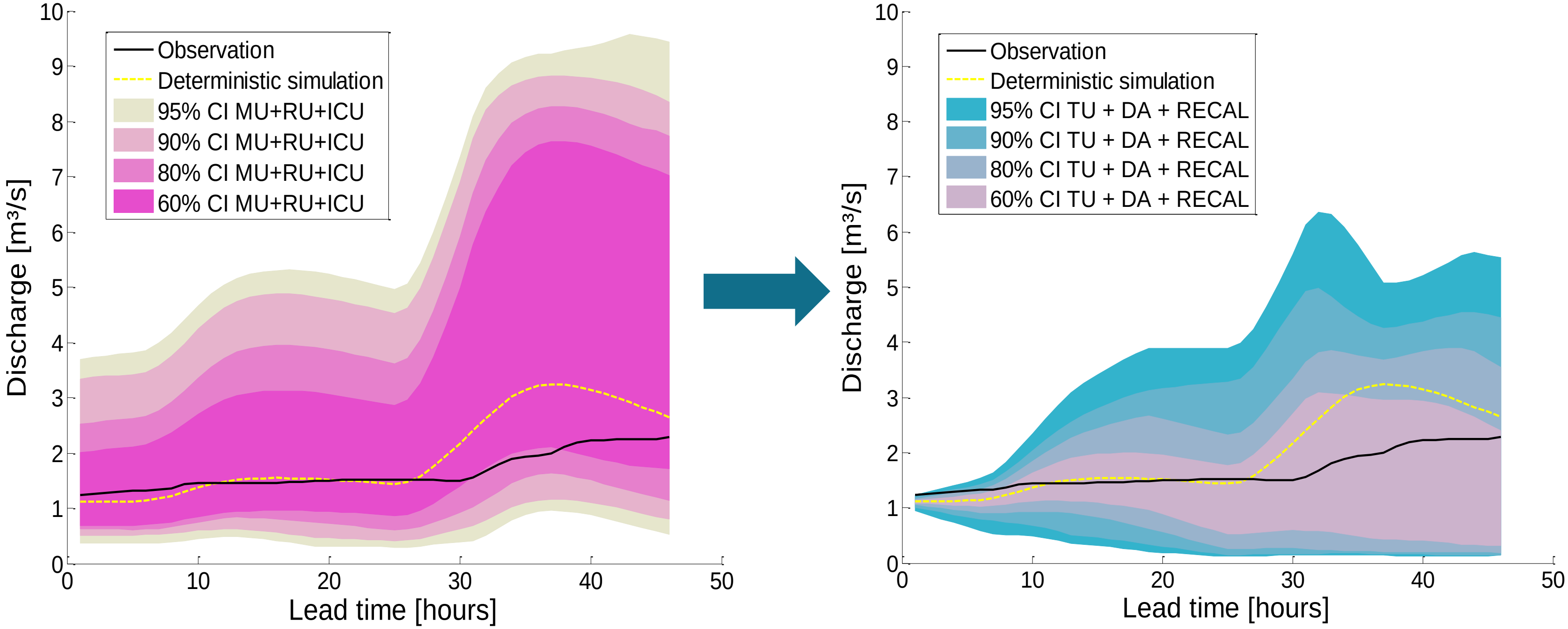


Contribution tot total forecast uncertainty variance [-]
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0-3
3-9
9-15
15-21
21-27
27-33
33-39
39-45
45-48
Lead Time Class [h]
ICU
RU
MU

# Next steps

- Recalibrating NAM model to reduce model parameter uncertainty
- Improve initial conditions by DA and updating soil moisture state

TOF: 10/11/2010 06:00h




Van Steenbergen, N., Willems, P. (in revision). Uncertainty decomposition and reduction in river flood forecasting: Belgian case study. Journal of Flood Risk Management.

# Conclusions

- Methodology to identify most important sources of uncertainty in (hydrological) flood forecasting
- Easy to apply methodology
- Model uncertainty and uncertainty in initial conditions were found to be most important uncertainty sources.
- Model recalibration
- Application of DA on hydrological output
- => Identification of most important improvement actions

# Thanks for your attention !

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