



Increasing flood preparedness by warnings based on modelled soil moisture conditions

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Problem statement

- Research project for Flemish Governmental Authorities of Belgium (Hydrological Information Centre)
- Scientific assistance to improve flood forecasting system
- In November 2010 several floods occurred in Belgium
- Cause: high rainfall intensities + high soil moisture
- Question: How to quantify this soil moisture content and can we find a simple trigger to warn us in case of possible flood situations.

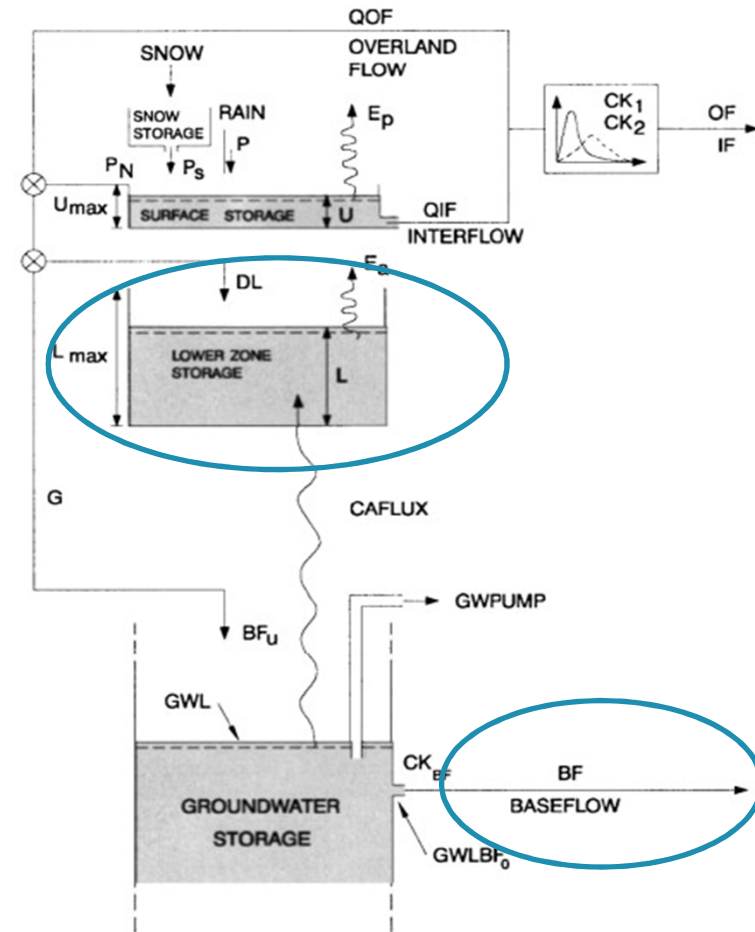
Introduction

- Soil moisture important factor in initiation of river floods
- + high rainfall intensities

- Real time information on soil moisture conditions is very limited (variable nature)
- In situ measurements are inadequate
- => Use of hydrological models

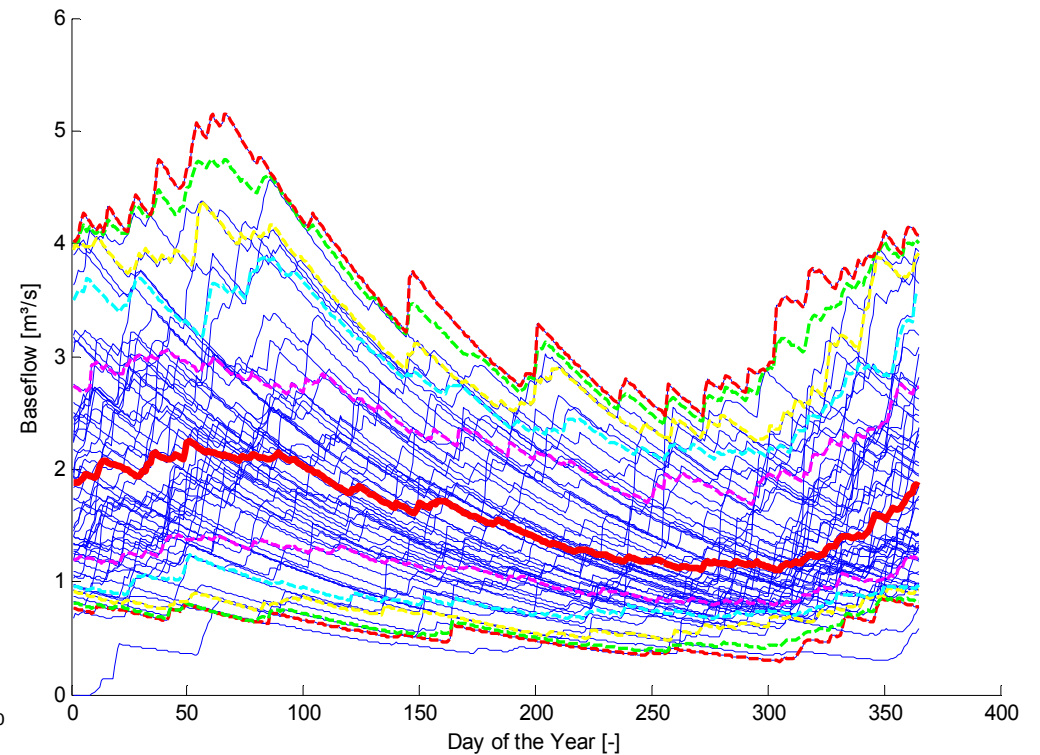
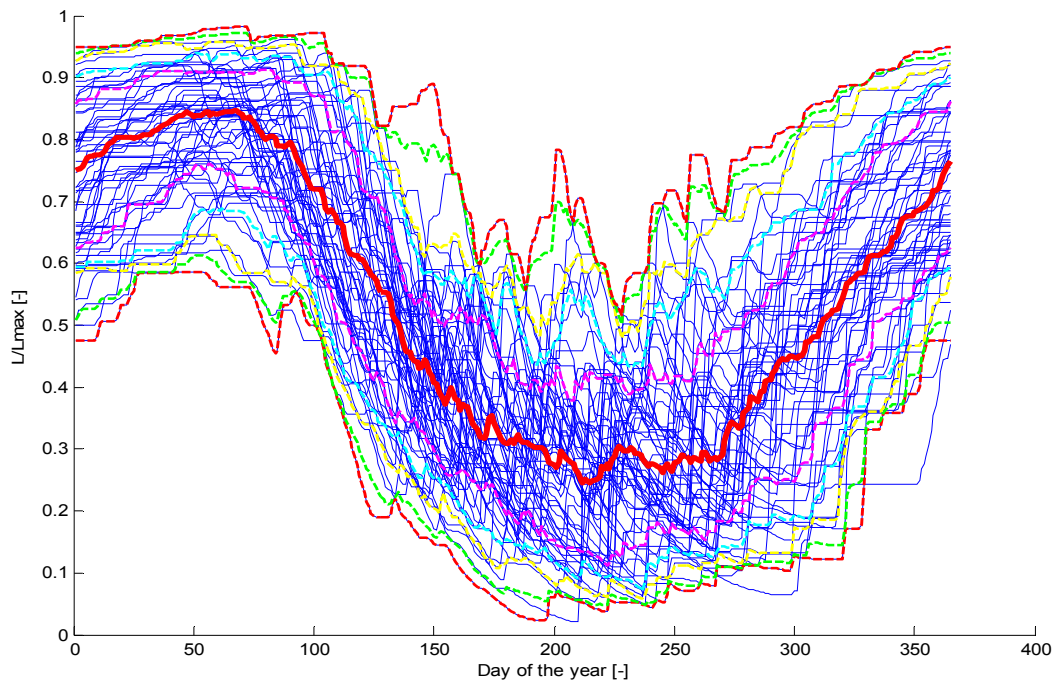
Hydrological models

- NAM model of DHI
- Soil Moisture Indicators (SMI)
 - L/L_{max}
 - Baseflow (BF)
- +200 models
- Covering Flanders region of Belgium
- Flood forecasting system


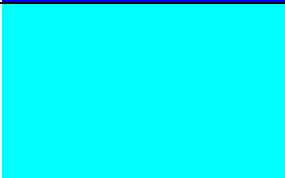





Assessment of soil moisture state

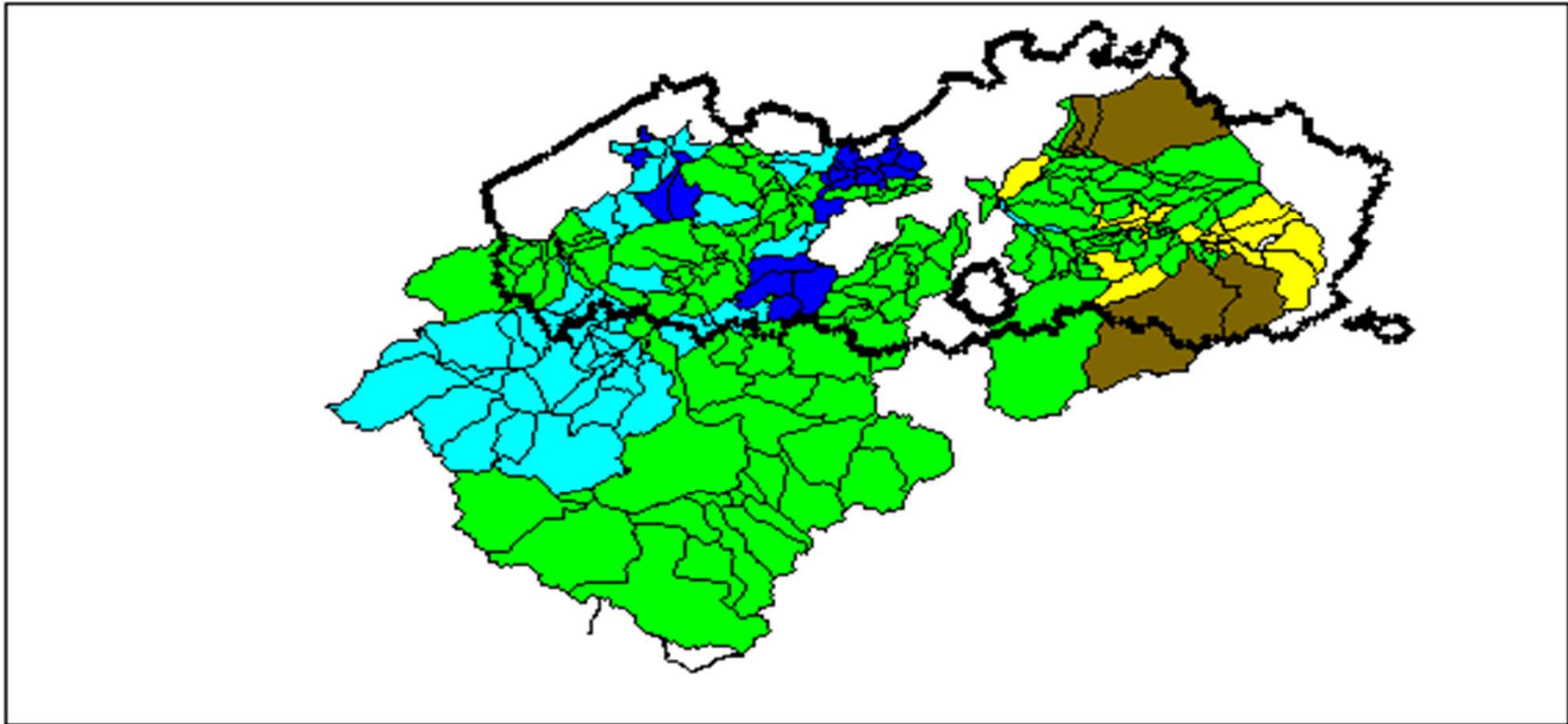
- Long term simulation (+50y.)
- Comparison of the soil moisture state at specific day of the year



Assessment of soil moisture state

Category	Criterion	Colour code
Extremely wet	$L/L_{max} > L/L_{max\ 95\%}$ $BF > BF_{95\%}$	
Wet	$L/L_{max\ 95\%} \geq L/L_{max} > L/L_{max\ 90\%}$ $BF_{95\%} \geq BF > BF_{80\%}$	
Normal	$L/L_{max\ 80\%} \geq L/L_{max} > L/L_{max\ 20\%}$ $BF_{80\%} \geq BF > BF_{20\%}$	
Dry	$L/L_{max\ 20\%} \geq L/L_{max} > L/L_{max\ 5\%}$ $BF_{20\%} \geq BF > BF_{5\%}$	
Extremely dry	$L/L_{max\ 5\%} \geq L/L_{max}$ $BF_{5\%} \geq BF$	

Assessment of soil moisture state



Flood preparedness

- Combination of SMI and Rainfall
- Exceedance probability of discharge threshold for next 2 days

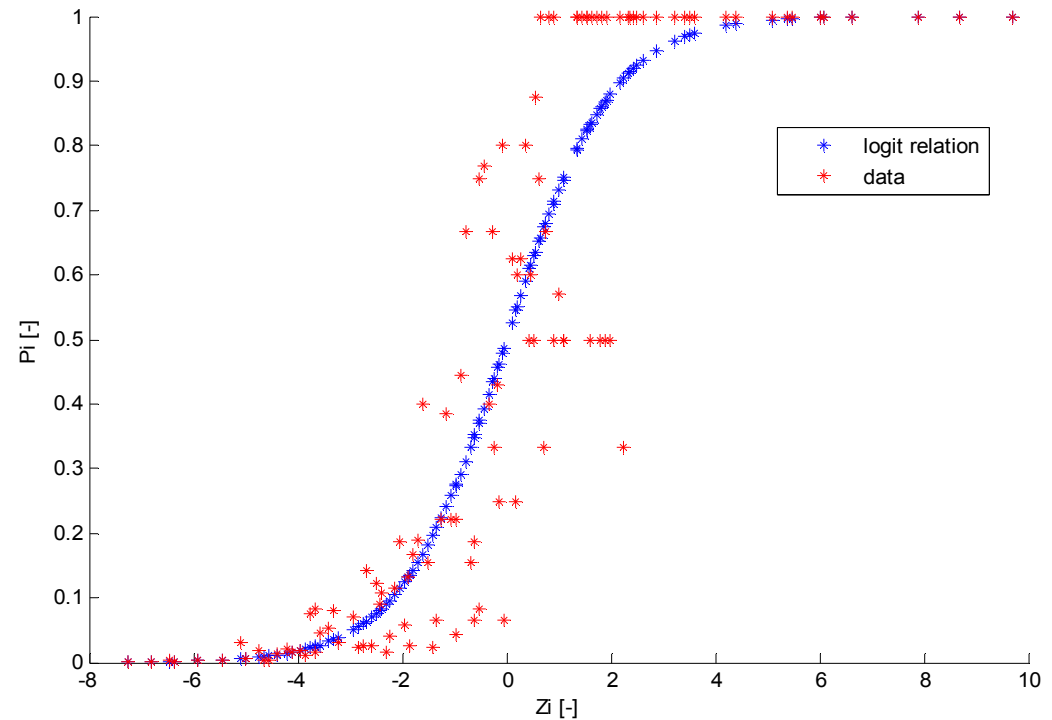
- Use of logit function

- $P_i = \frac{1}{1+e^{-Z_i}} = P(Q > Q^*)$

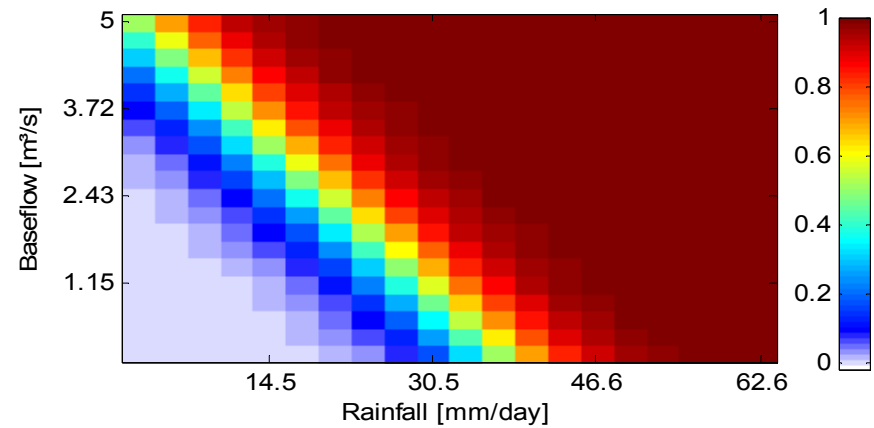
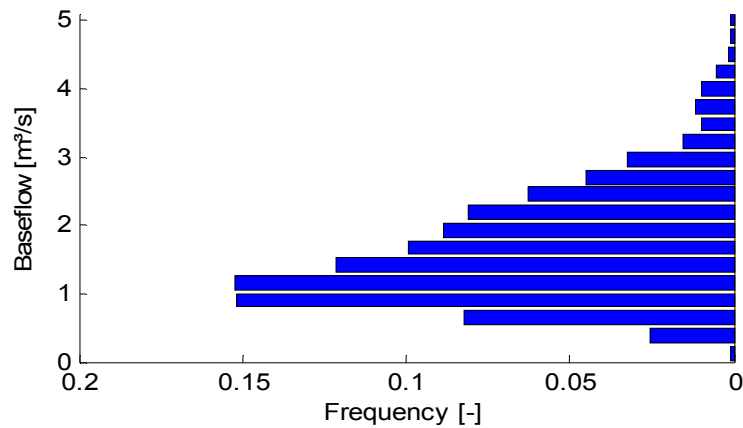
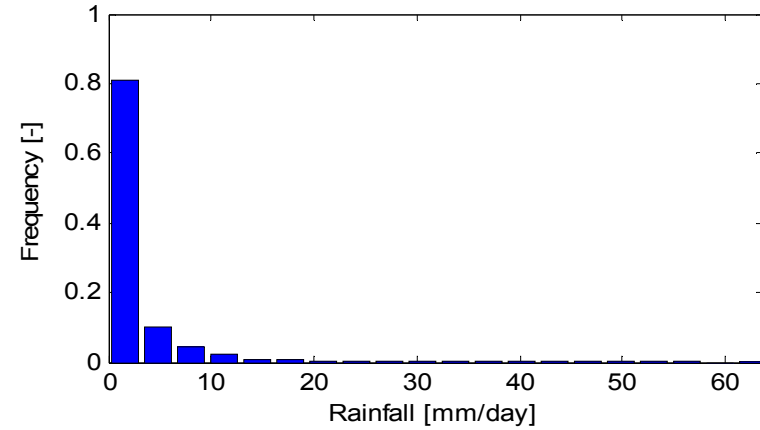
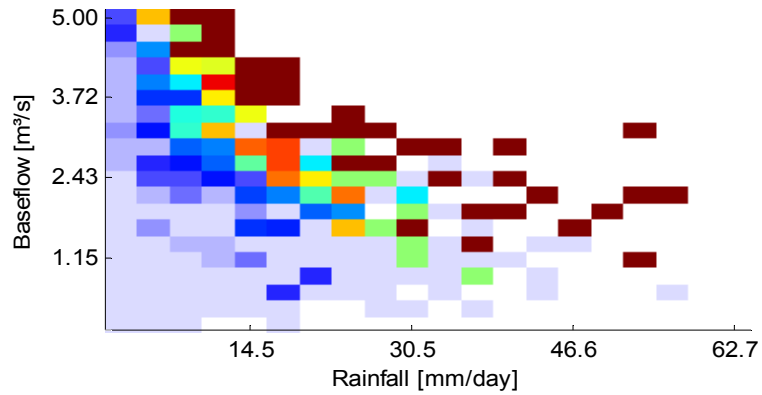
- $Z_i = \beta_0 + \beta_1 SMI + \beta_2 R$

BF or
L/Lmax

rainfall



Flood preparedness



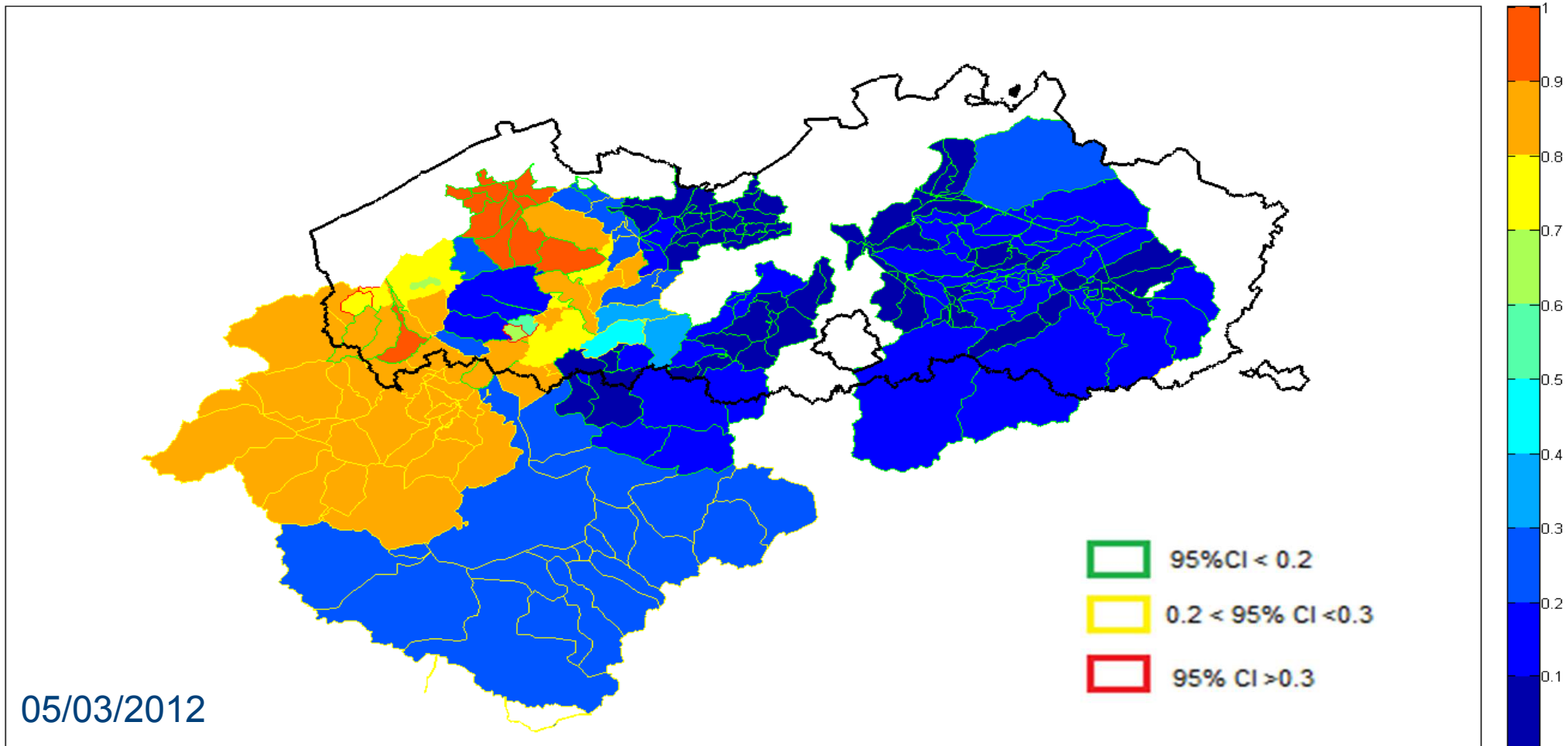
Flood preparedness

Catchment	BF & R	L/L _{max} & R
Gete	0.18	0.26
Poperingevaart	0.13	0.16
Heulebeek	0.15	0.14
Mark	0.07	0.13
Average	0.13	0.17

RMSE => Baseflow

Flood preparedness

- Exceedance probability of discharge threshold + indication of width confidence interval



Conclusion

- Method to assess the soil moisture state for the time of the year
- Method to map the exceedance probability of a certain discharge threshold based on SMI and rainfall
- Indication in which areas floods can be expected
- Increase preparedness of flood crisis management bodies
- Currently in operational use at Hydrological Information Centre (Antwerp, Belgium) SMIT

- *Van Steenbergen, N., Willems, P. (in revision) Increasing river flood preparedness by real-time warning based on soil saturation conditions, Journal of Hydrology.*

Questions ?

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