



Rijkswaterstaat  
*Ministerie van Verkeer en Waterstaat*

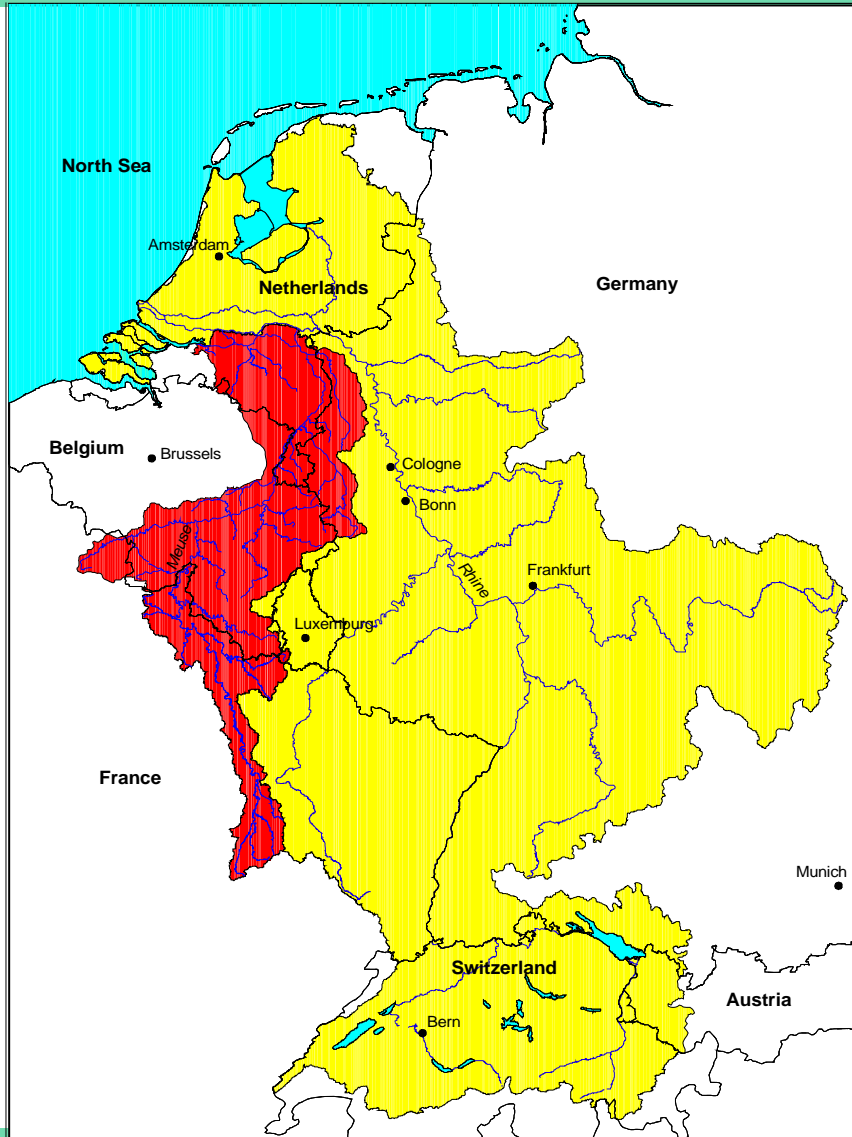
# Visualising and communicating probabilistic flow forecasts in The Netherlands

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Management  
Division Crisis Management &  
Information Supply



# Content

- The basins
- Forecasting in The Netherlands
  - Organisation
  - Tools
- FEWS NL for the rivers
- Visualisation of ensemble forecasts
- Implementation of ensemble forecasts in the operational process



Rijkswaterstaat



## Characteristics

	Rhine	Meuse
Basin surface	185.000 km <sup>2</sup>	36.000 km <sup>2</sup>
Length	1.320 km	935 km
Type	snowmelt + rain	rain
Q mean	2.300 m <sup>3</sup> /s	230 m <sup>3</sup> /s
Q peak	13.000 m <sup>3</sup> /s	3.000 m <sup>3</sup> /s



## Forecasting organization

- Daily forecasts for the Rhine (365 d/y)
- No regular forecasts for the Meuse
- Flood forecasts when fixed levels are exceeded
- Centre for Water Management is responsible for forecasts on the national borders
- Regional services are responsible for forecasts on the inland branches and in the coastal area
- Centre for Water Management publishes flood reports for the entire river



## What instruments did we use for river stage forecasting in 1995?

- till January 1999: statistical model LOBITH (for daily forecasts as well as for flood forecasts)



## Model LOBITH

- statistical model based on multiple linear regression
- input: water levels, discharges, observed and forecasted precipitation
- output: water level forecasts for the gauging station Lobith for the next 4 days



## Development of FEWS NL

- Start of the project in 1996
- Financed by 2 EU frame work projects
- Cooperation with BfG (D) and FOEN (CH)
- Contracts to Deltares (formerly Delft Hydraulics) and SMHI





## New aspects

- Combination of hydrological and hydraulic models
- Medium range forecasts (4 – 10 days)
- Introduction of multiple weather forecasts
- Use of ensemble weather forecasts
- Client server / multi user
- Rhine and Meuse in one application
- Simulation for the entire basin
- Improvement through data assimilation techniques

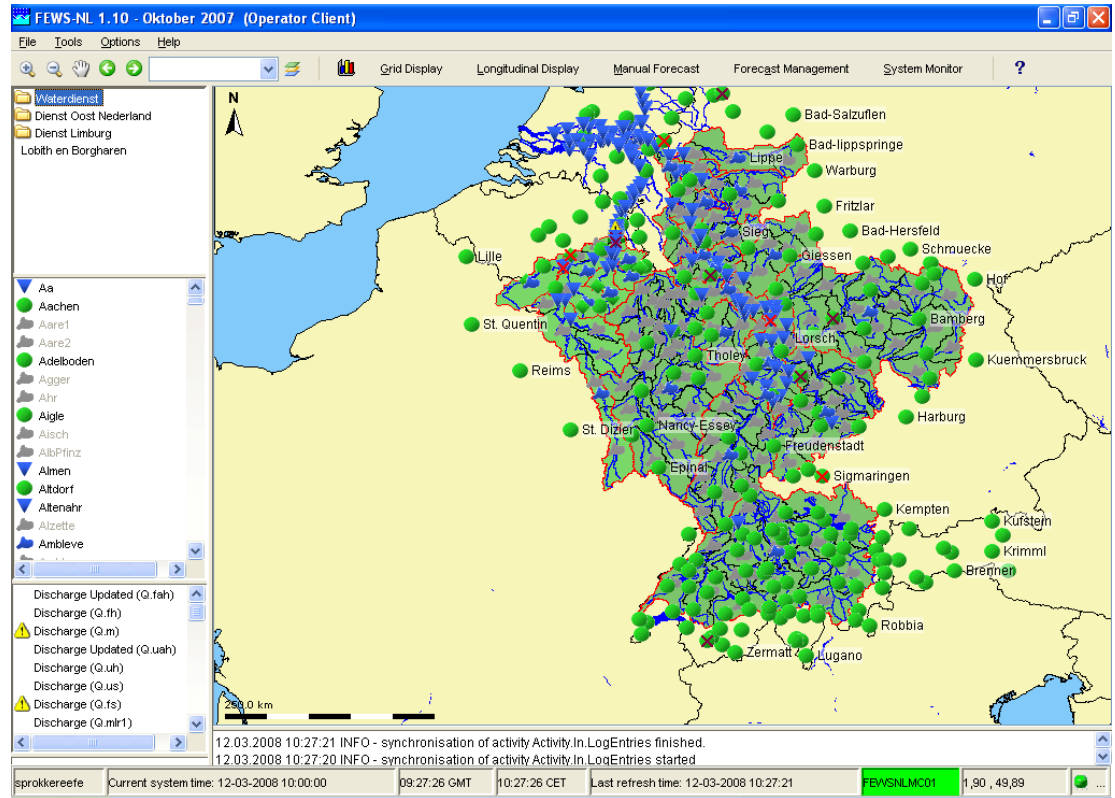


# Observations

- Water stages from appr. 60 gauges
- Precipitation and air temperature at appr. 700 stations

## Planned

- Data from precipitation radar
- Observed soil moisture
- Potential evaporation

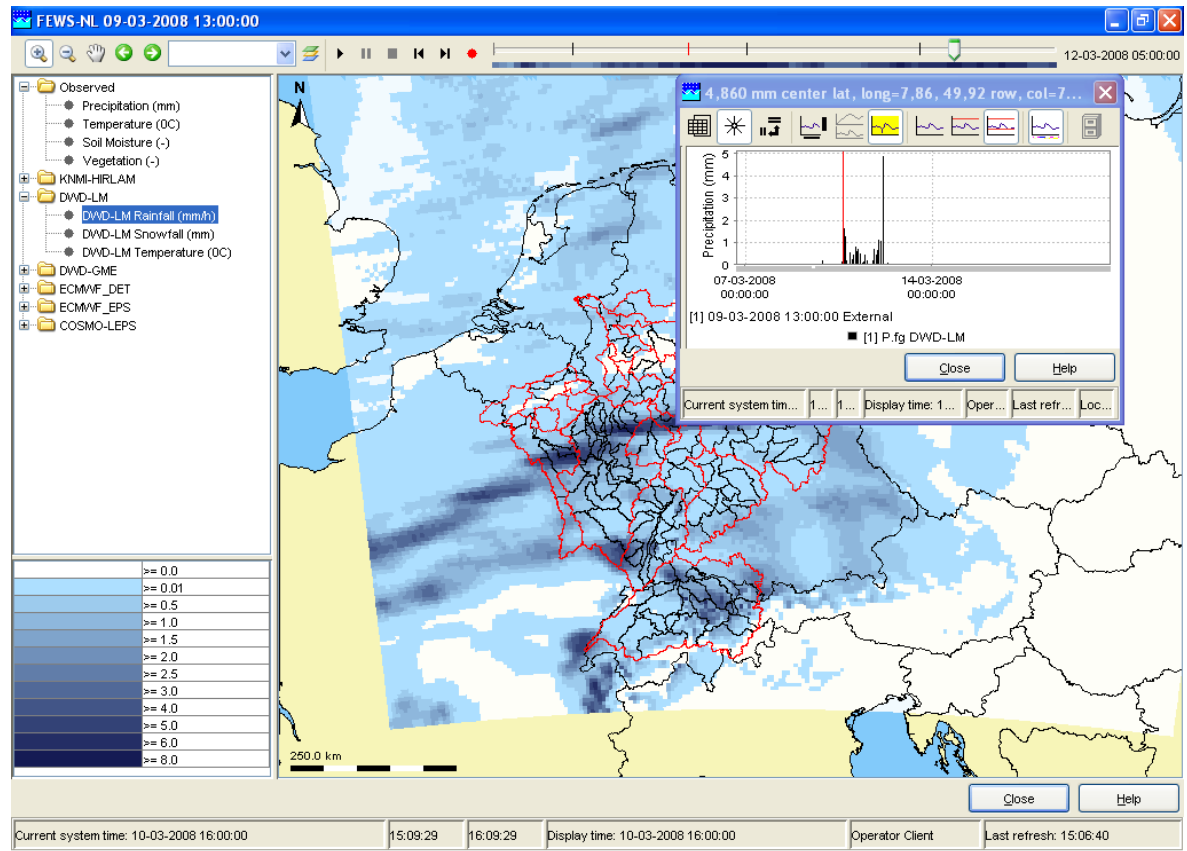




# Weather forecast data

## Numerical Weather Prediction grids

- KNMI-HIRLAM
  - 48 hrs lead time
- DWD-LM2
  - 78 hrs lead time
- DWD-GME
  - 174 hrs lead time
- ECMWF deterministic
  - 240 hrs lead time
- ECMWF ensemble
  - 240 hrs lead time
  - 51 ensemble members
- COSMO LEPS
  - 160 hrs lead time
  - 16 ensemble members



LM2 Forecast: 09-03-2008 13:00 UTC

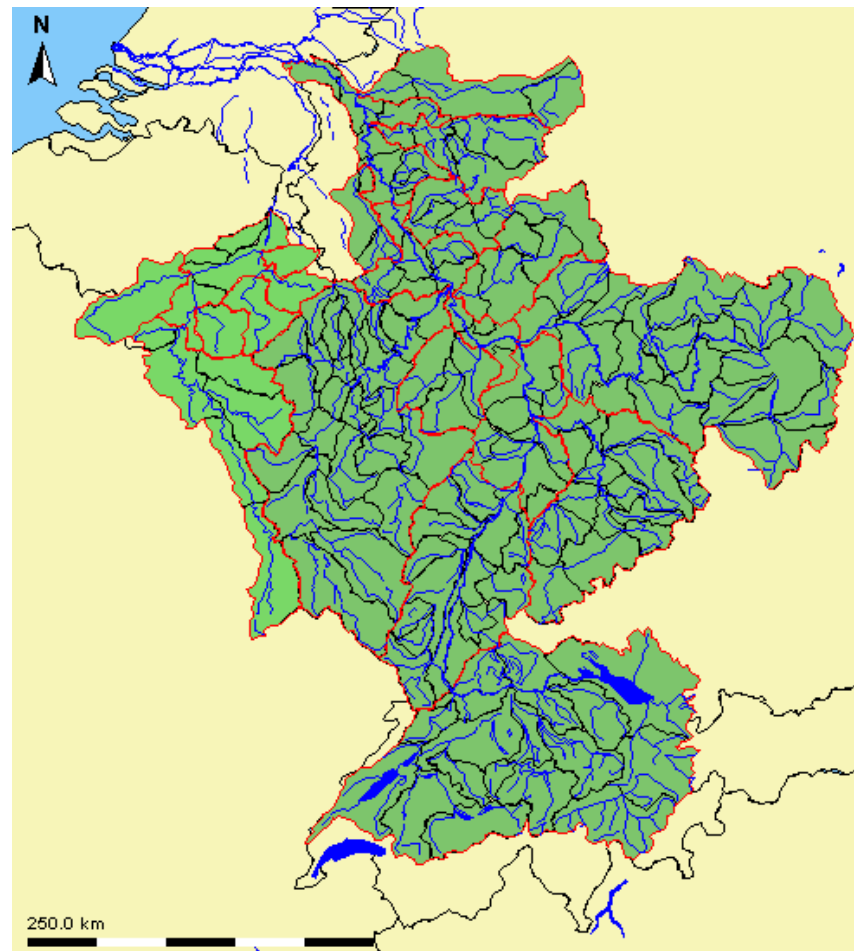
## Forecasting Models

### HBV Hydrological Model

- Rhine 134 catchments
- Meuse 15 catchments

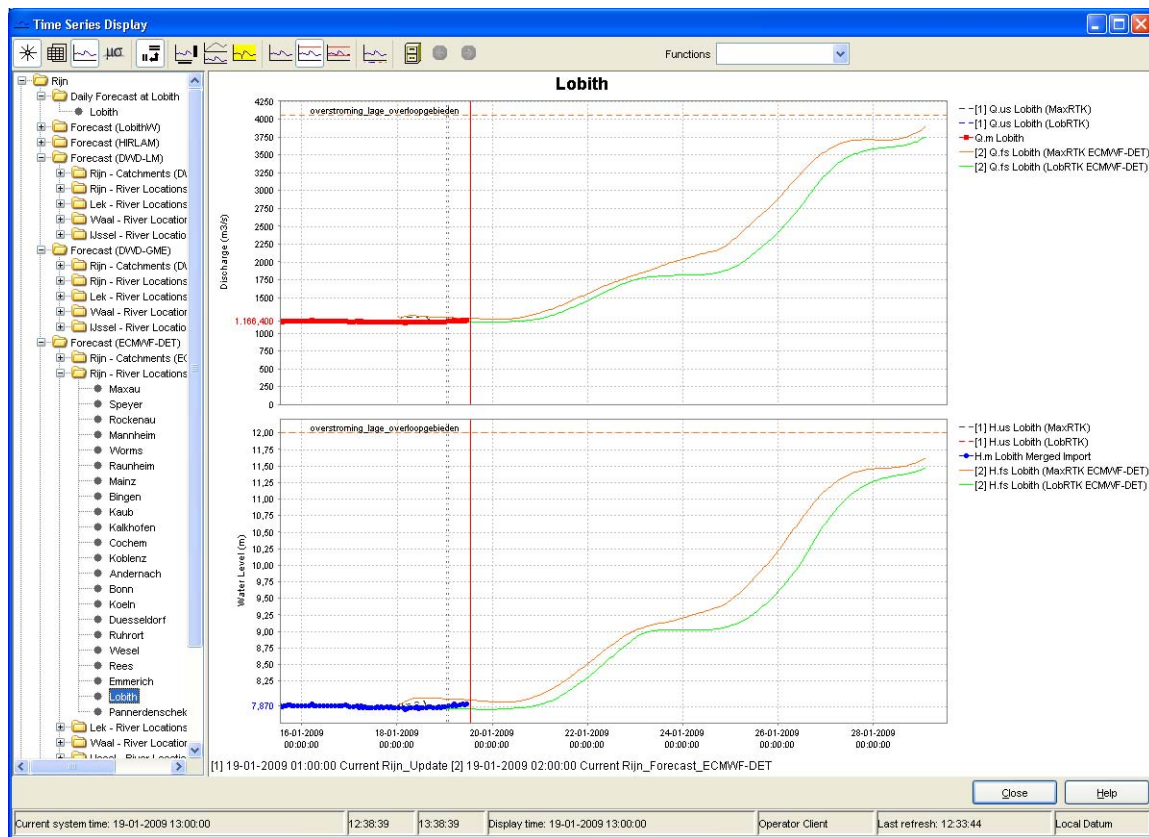
### Sobek hydraulic model

- Rhine Maxau-Lobith
- Meuse Chooz-Borgharen



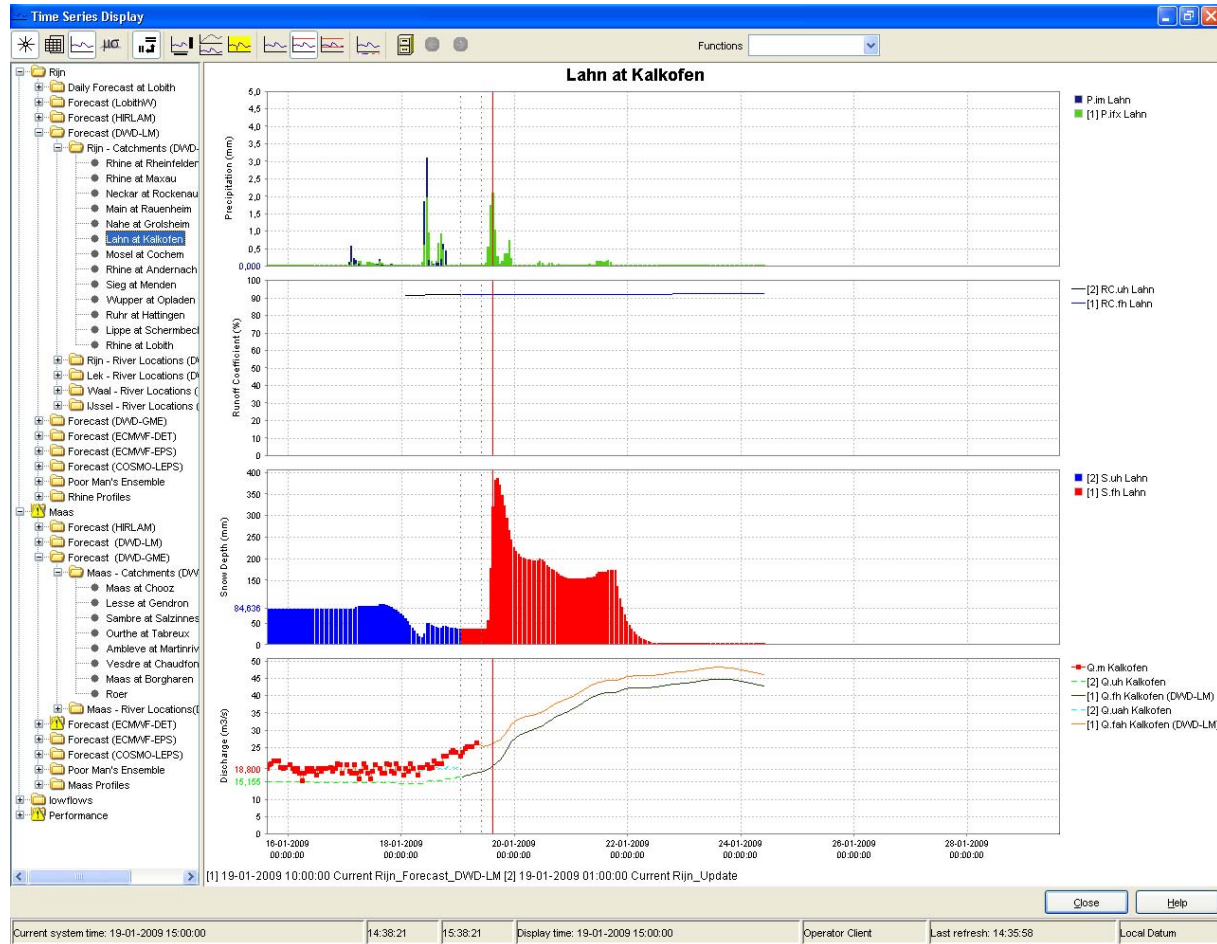


# Forecasting results deterministic



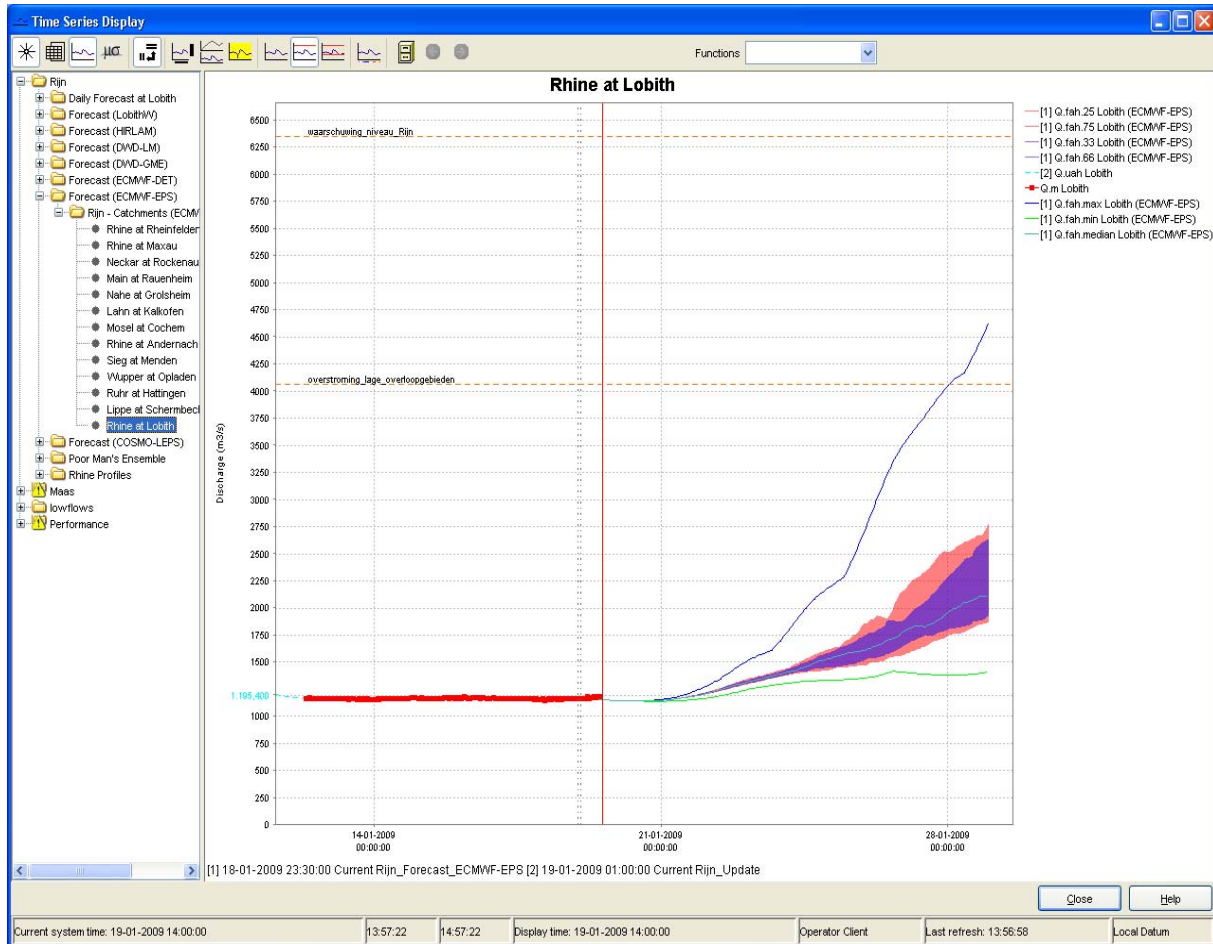


# Deterministic with additional information



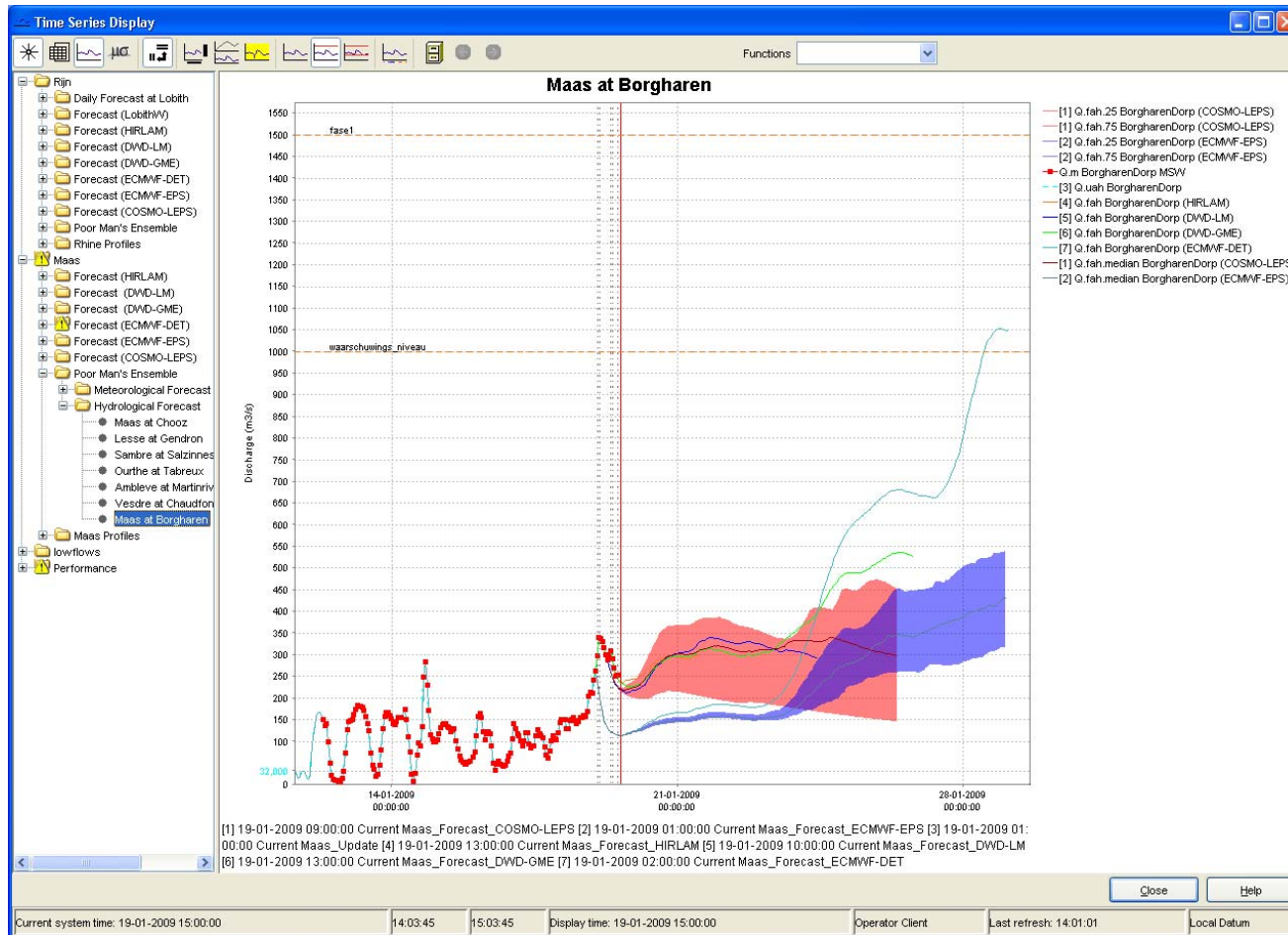


# Forecasting results probabilistic





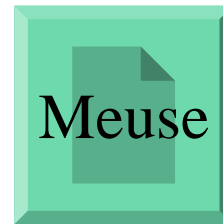
# Poor Man's Ensemble







## Exceedance of thresholds





## Use of ensemble forecasts in the operational process

- Visual interpretation of the poor men's ensemble (uncertainty)
- Early Warning  
Pre-alert when within the next 10 days at least one of the four deterministic models and/or at least 50% of the ensembles predict water levels above the pre-warning level (for the Rhine 1 meter below the actual warning level)

For the Meuse the considered forecasting period is 4 days.



## Communication of the results

- Daily reports to clients
- Website for designated users



# Daily reports to clients by e-mail

**Fews Maas Bericht (RTF-indeling)**

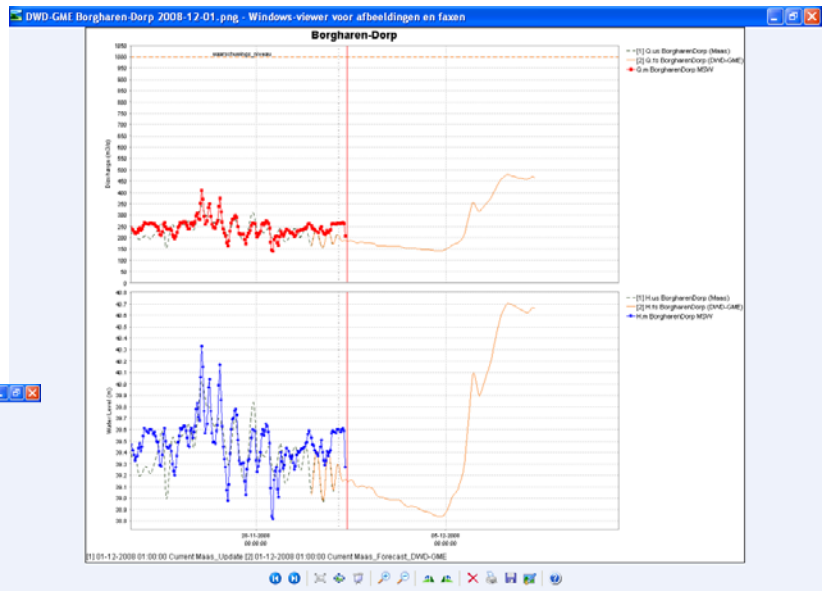
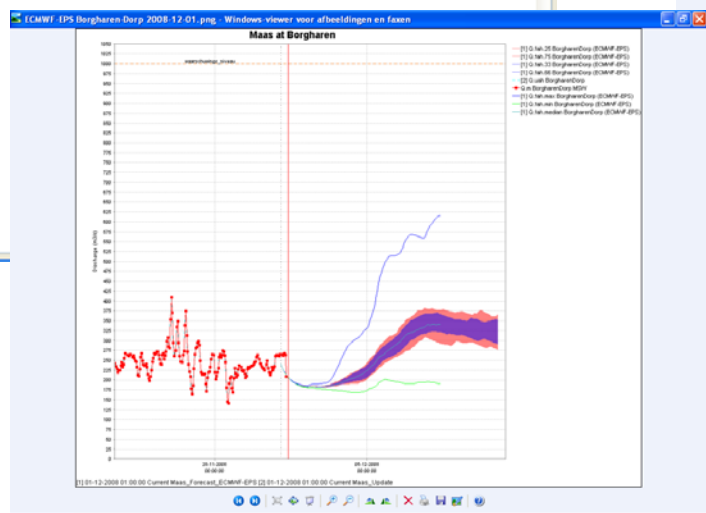
Van: Infocentrum Binnenwateren  
Verzonden: ma 01-12-2008 9:20

Aan: Akerboom, Ron (CG); Aubel, Pepin van (DLB); Bakker, Hans (DLB); Boland, Leonie (WD); Bont, Jo de (DLI); Bultveld, Hendrik (WD); DLB Vullwaterwach: Eddy; Ensink, Prive; Ensink, Eddy (DLB); Falkenberg, Sebast (DLB); Gogh, Wilfried van (WD); Hans Vermeulen, Hendrik, Jos (DLB); HFC; Infocentrum Binnenwateren; Klavers, Henry (SGO); Koon Raagheir, Langerheem, Helmut van de (WD); WD LCW; Moonen, Jan (DLB); Adriaens, Peter (DLB); Pas, Bas van de (Deltares); Rolf van Yeen; Roode, Mirjam van (DLB); Salmons, Jan (DLB); Sies, Rico (BWD); Sprikkereef, Eric (WD); Telstra, Jero Telstra, Jan (DLB); Veen, Rolf van der (DLB); Verhulst, Erik (WD); Veuglers, Henry (DLB); Waard, Tone de (DLB); Weijden, Marcel van der (WD);

CC: Onderwerp: Fews Maas

*Dit is een automatisch gegenereerd bericht met het pre-operationele systeem (FEWS NL). De voorspelling dient enkel ter indicatie. Voor nadere uitleg kunt u contact opnemen met het Infocentrum Binnenwateren, tel +31-320-290 808*

**Infocentrum Binnenwateren**  
Telefoon (0320) 29 88 88 (van 07:00 tot 16:30)  
Fax (0320) 29 85 80  
E-mail [infocentrum@wvz.nl](mailto:infocentrum@wvz.nl)  
Internet [www.infocentrum-binnenwateren.nl](http://www.infocentrum-binnenwateren.nl)  
Postadres Postbus 17, 6500 AA Lelystad





# Website [www.waterbericht.nl](http://www.waterbericht.nl)

**Waterstandsgrafieken**  
> Afgelopen 9 dagen  
> Verwachting

**Afvoerggrafieken**  
> Afgelopen 9 dagen  
> Verwachting

**Indicatieve voorspelling**  
> **Indicatieve afvoervoorspelling**

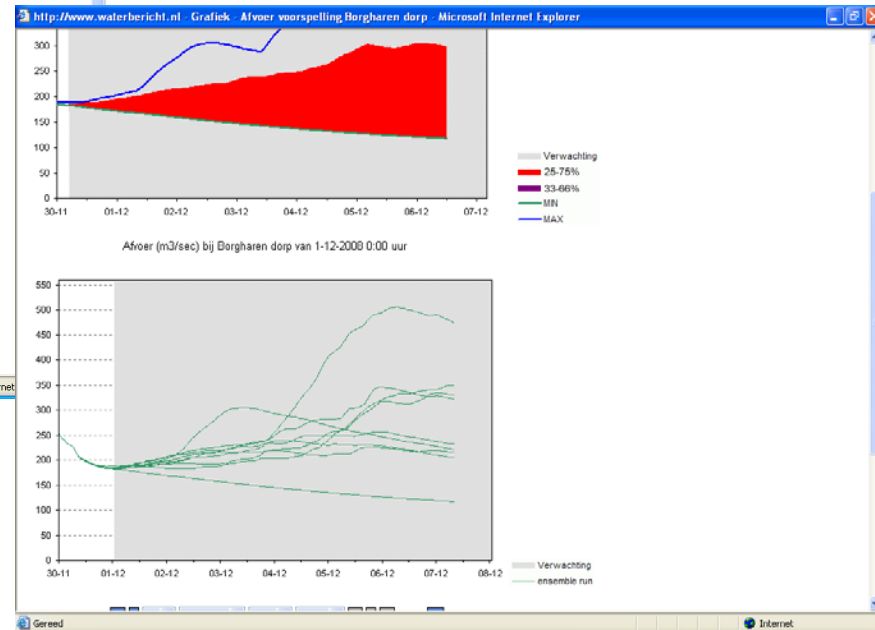
**Neerslagkaarten**  
> Gemeten met radar  
> Verwachting

**Relevante links**  
> Actuele waterdata  
> Neerslaginformatie van het KNMI  
> Info en burn  
> Binnenwateren  
> Waterland net  
> Overstromingsstrategie Rijn en Maas  
> Droogtestudie  
> Aqualarm  
> Watermarkt  
> Waterbase

## Indicatieve afvoervoorspelling voor Lobith en Borgharen d.m.v. ensembles

De verwachte afvoer wordt op verschillende manieren berekend. Op deze pagina wordt de verwachte afvoer voor Lobith en Borgharen gepresenteerd als resultaat van ensemble modellen. Een ensemble van verstoerde (neerslag)toestanden is een veelgebruikte methode om onzekerheid in modelberekeningen in kaart te brengen. Meer informatie over **onzekerheden in afvoervoorspelling** en **verspreiding van voorspellingen door ensemble berekeningen** is te vinden in het onderdeel **Achtergronden**.

De verwachte afvoer voor Lobith is afkomstig van het **ECMWF** model en beslaat een periode van 10 dagen. De verwachte afvoer voor Borgharen is afkomstig van het **COSMO LEPS** model en beslaat een periode van 7 dagen. Voor het bekijken van de indicatieve afvoervoorspelling klikt u op een punt in de kaart of selecteert u een station uit de onderstaande lijst.





## The Questions

- When did our institute start thinking about exploring EPS for forecasting purposes? – During the EFFS project (1998)
- What triggered us to start exploring EPS? Results of the cases in EFFS.
- What strategy was used for this? Joint research with Delft Hydraulics, BfG, FOEN
- What was needed to implement EPS? Development of a new forecasting system. New hardware. Training of staff.
- How long was the testing phase? We are still testing.
- How was the transfer from the testing to the operational phase? The transfer is not yet completed. Just a small group of staff works with the ensembles.
- When did we start the operational production of EPS based forecasts? We did not.
- How did we prepare our staff for the EPS based forecasts? Training given by the MET office.
- To what extent does our staff use the EPS based forecasts? For visual interpretation of the uncertainty and for pre warning (level over thresholds)