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Increasing flood warning time on European scale

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and EFAS team

European Commission, DG Joint Research Centre
Institute for Environment and Sustainability

3rd HEPEX workshop, Stresa, 27-29th Juin 2007



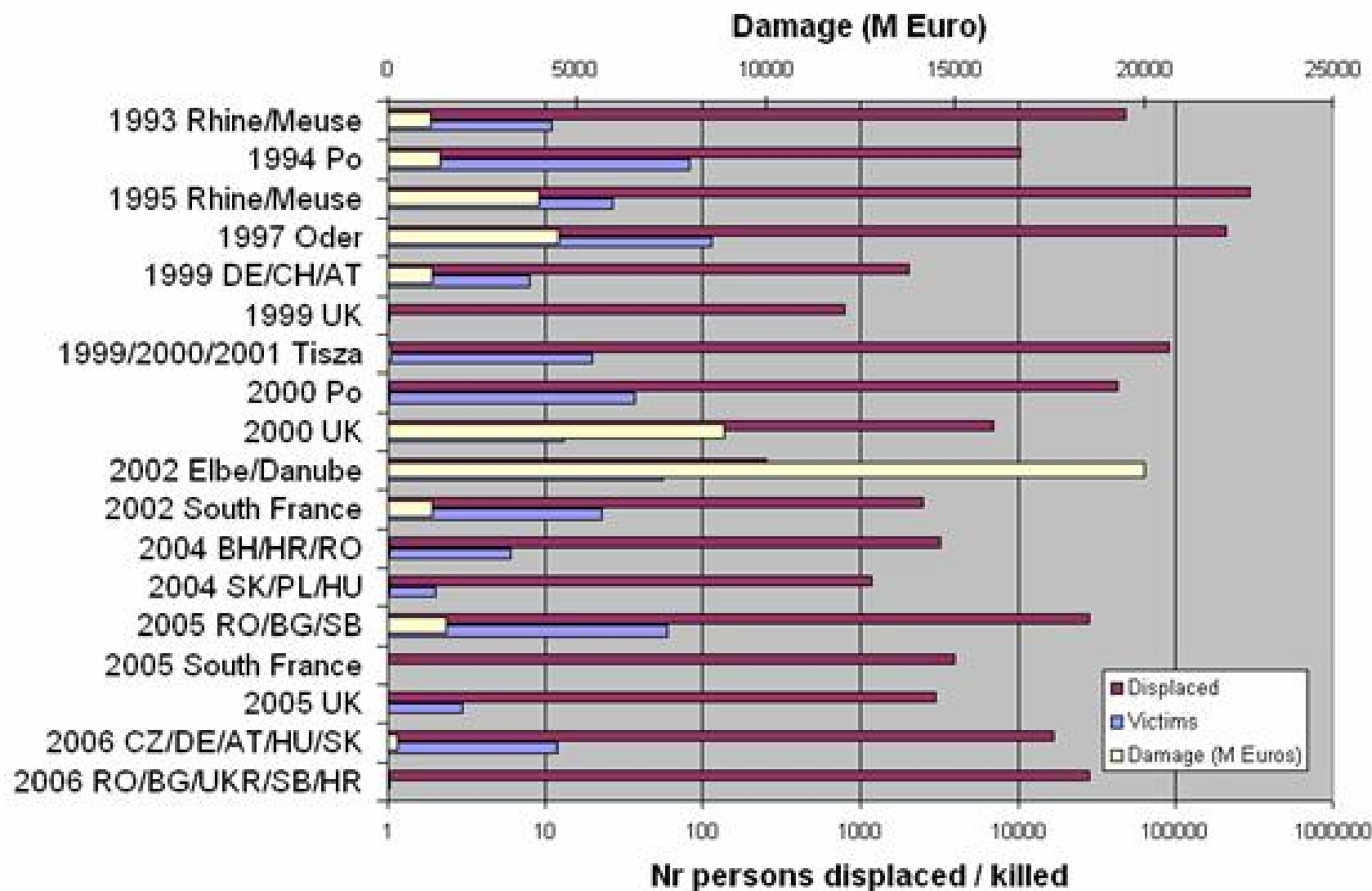


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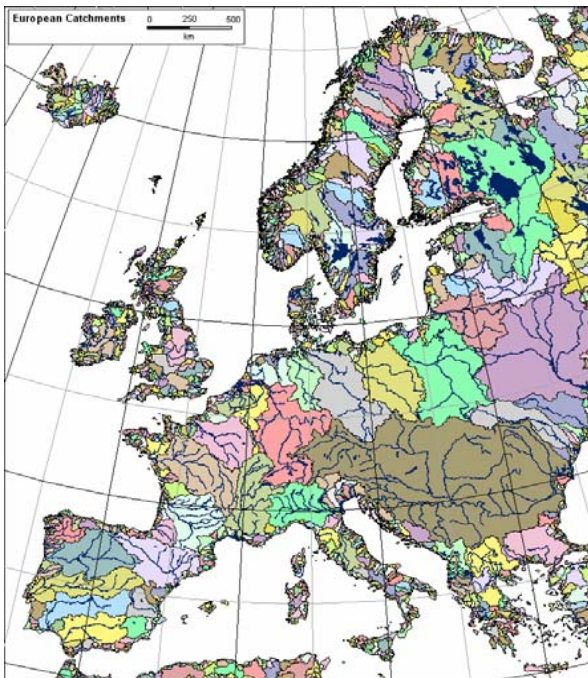
Major floods since the 90ies





European Flood Alert System (EFAS)

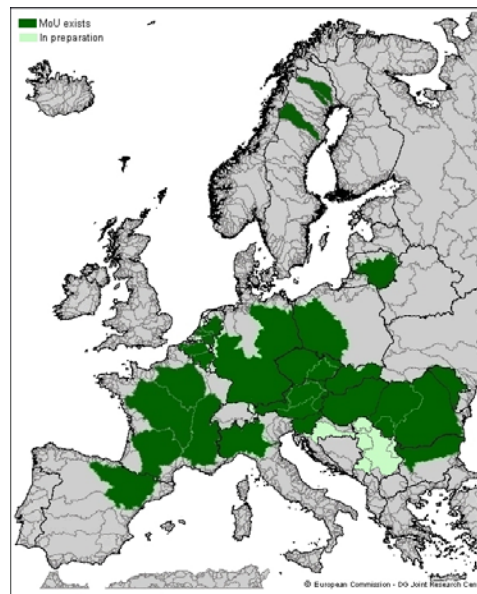
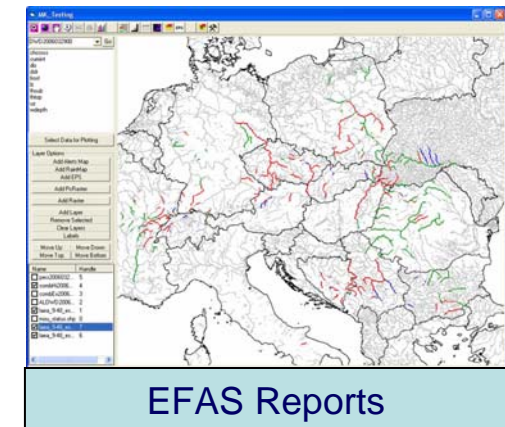
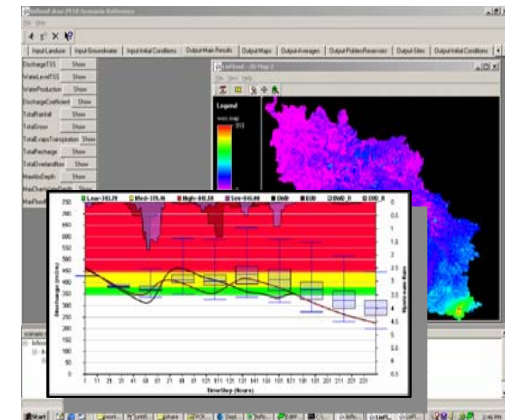
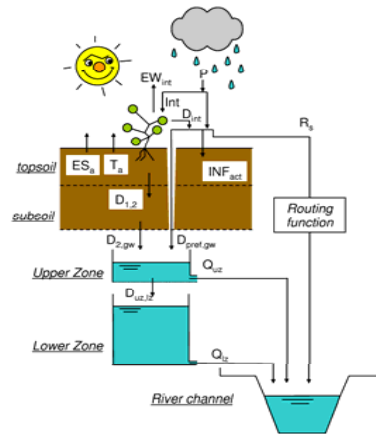
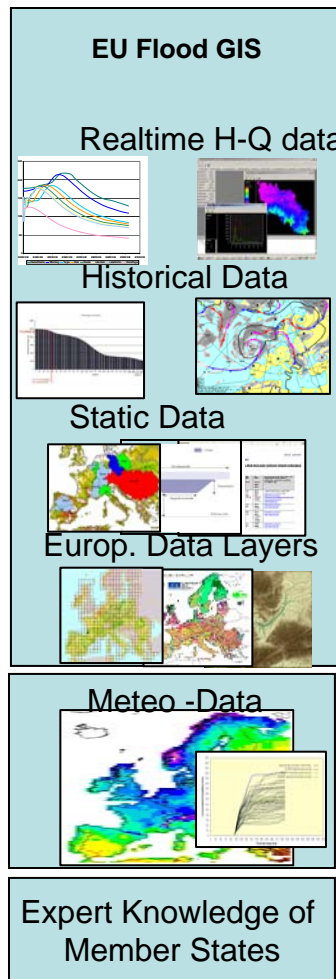
Complementing Member States activities towards preparedness for flood events



- extend warning time > 3 days by using multiple weather forecasts including EPS
- forecasting for entire river basins and the whole of Europe
- information exchange platform for operational services

EFAS set-up

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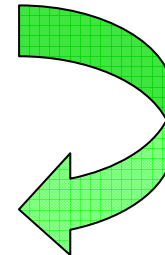
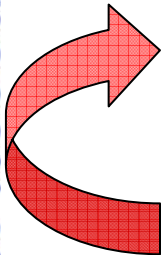




Development and testing strategy

- Pilot study – EFFS (2000-2003)
- Survey of customer needs (2003)
- Prototype development
- Testing (with NHS, research)
- Draw experience from research projects
- Transfer of operational system to MS (2010)

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Customer needs (Survey 2003)

- increase leadtime for 1-2 days ($LT_{\text{current}}+2$)
- information from upstream countries (qualitative and quantitative)
- quantitative information from EPS results (already explored and interpreted)
- support in understanding probabilistic results



Prototype development (1)

Keep it robust and reliable

Develop around existing boundary conditions

- hydrological rainfall-runoff model: LISFLOOD
- European data sets
- limited meteorological observational data in real-time
- no hydrological real-time data

Collect high-resolution data for pilot areas

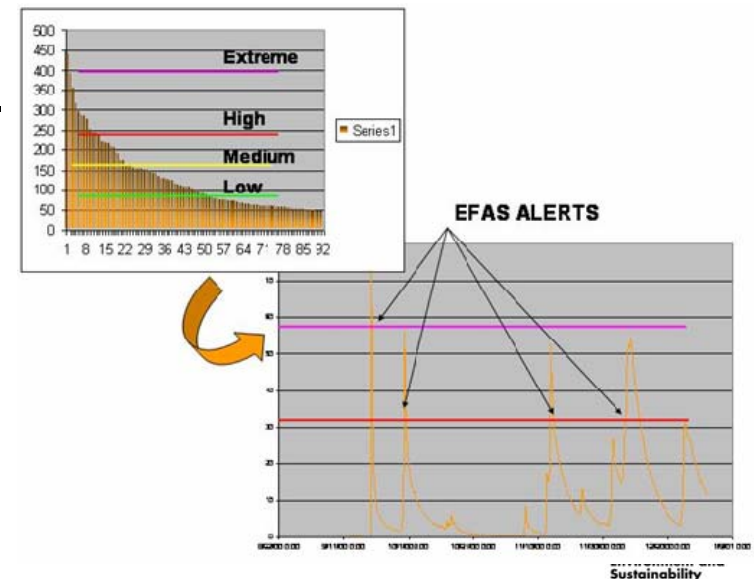
Data collection on European scale (EU-FLOOD-GIS and ETN-R)



Prototype development (2)

Threshold exceedance compared to model consistent climatology

1. Simulation of long-term timeseries (same model, same parameter set, same maps)
2. Calculate thresholds from long-term series
3. Apply these thresholds to the forecasts

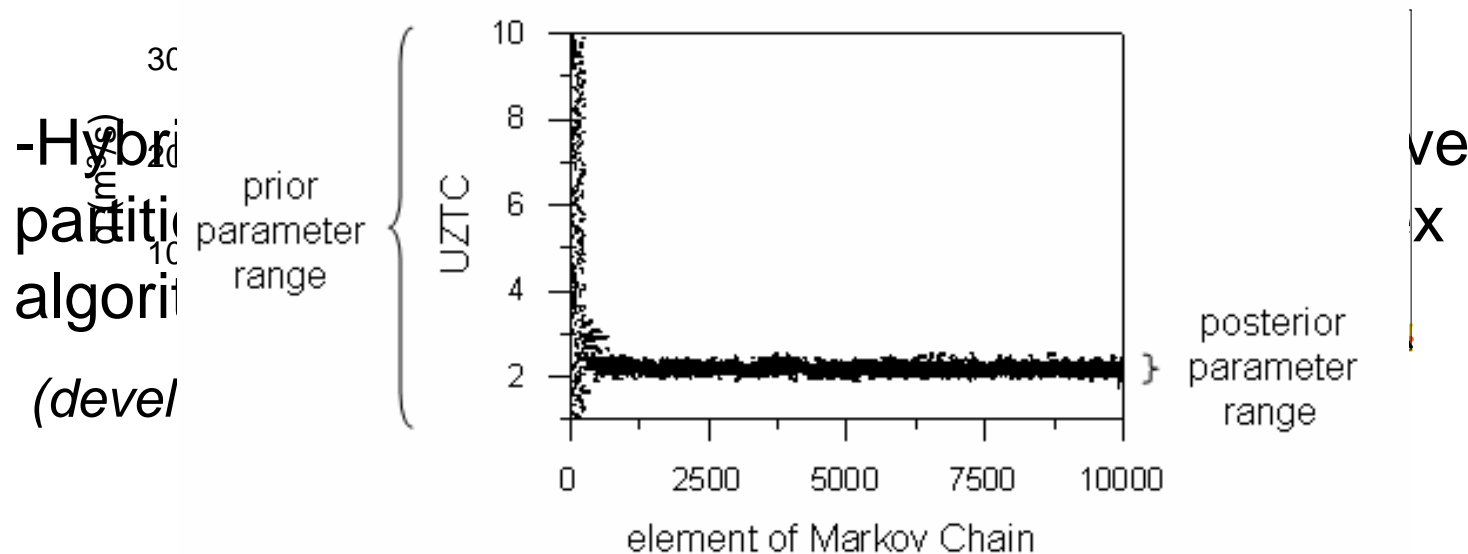




Prototype development (3)

Calibration & Validation

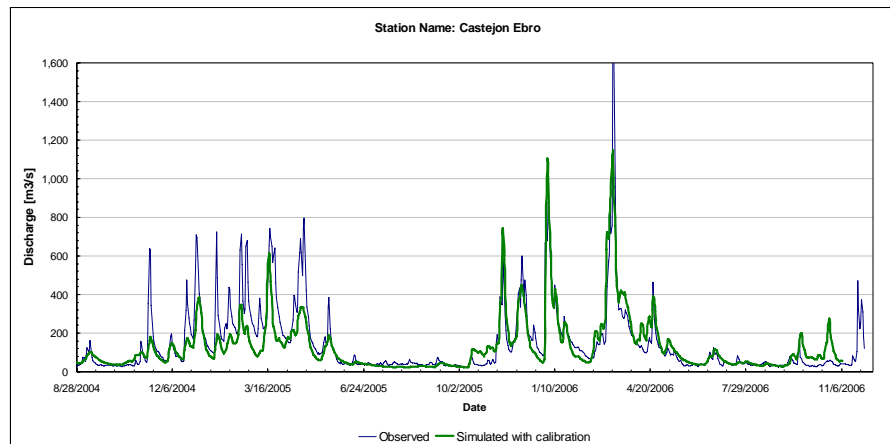
- Manual calibration
- Shuffled Complex Evolution Metropolis (SCEM-UA)
(developed and tested by L. Feyen)





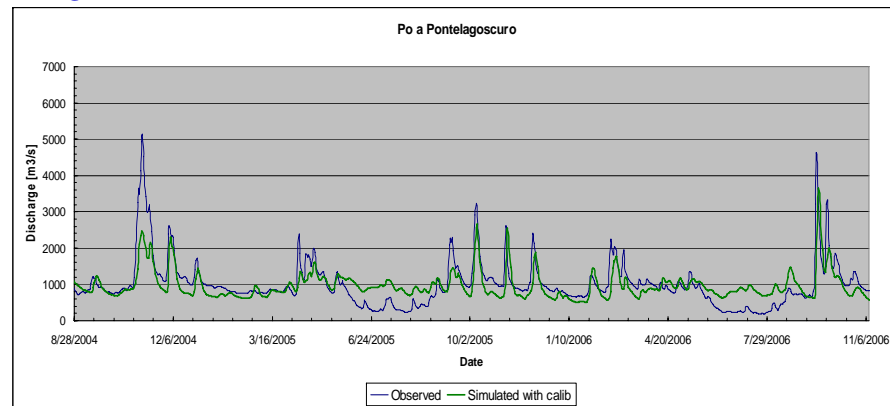
Validation: Problems in heavily controlled rivers, e.g. Ebro & Po and where little data are available, no info on irrigation, lake&reservoir operations

Ebro



Station Name	Nash Sutcliffe coefficient
Castejon (Ebro)	0.7
Zaragoza (Ebro)	0.69
Zaragoza (Gallego)	-0.45
Seros (Segre)	-1.1
Tortosa (Ebro)	0.39

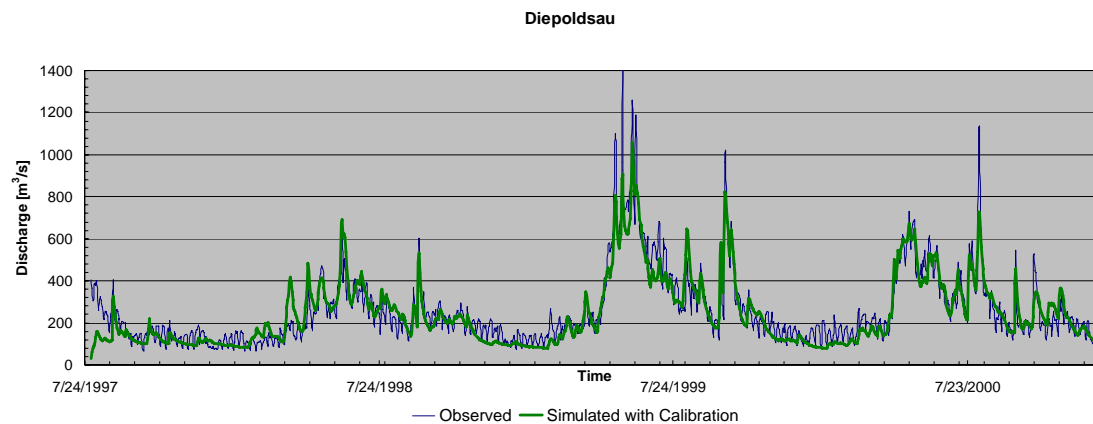
Po



Station Name	Nash-Sutcliffe coefficient
Po a Carignano	0.4
Sesia a Palestro	0.21
Tanaro a Montecastello	0.55
Pizzighettone (Adda)	-0.1
Spessa (Po)	0.5
Vigevano (Ticino)	0.52

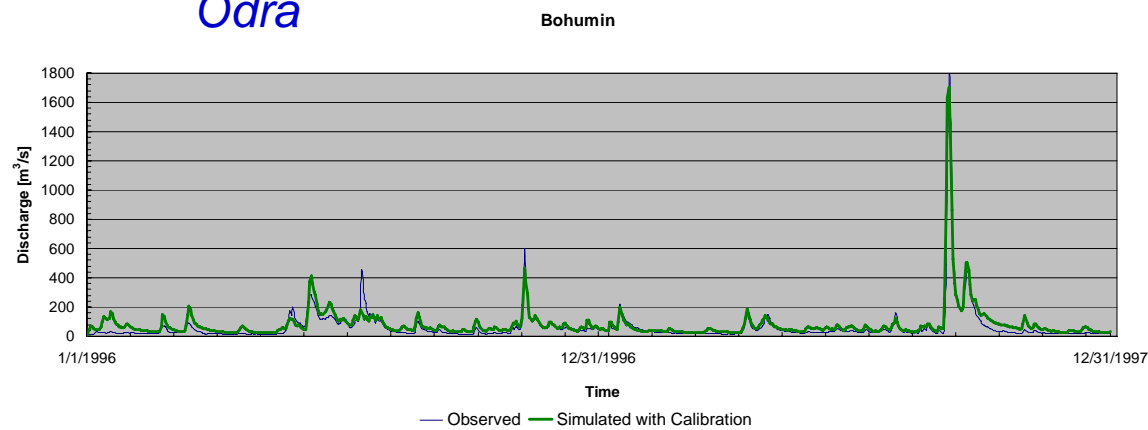
Validation results: Good results where sufficient data for calibration are available

Rhine



Station Name	Nash-Sutcliffe coefficient
Rekingen	0.81
Diepoldsau	0.85
Worms	0.74
Maxau	0.61
Rees	0.76
Frankfurt	0.91
Fremersdorf	0.89

Odra

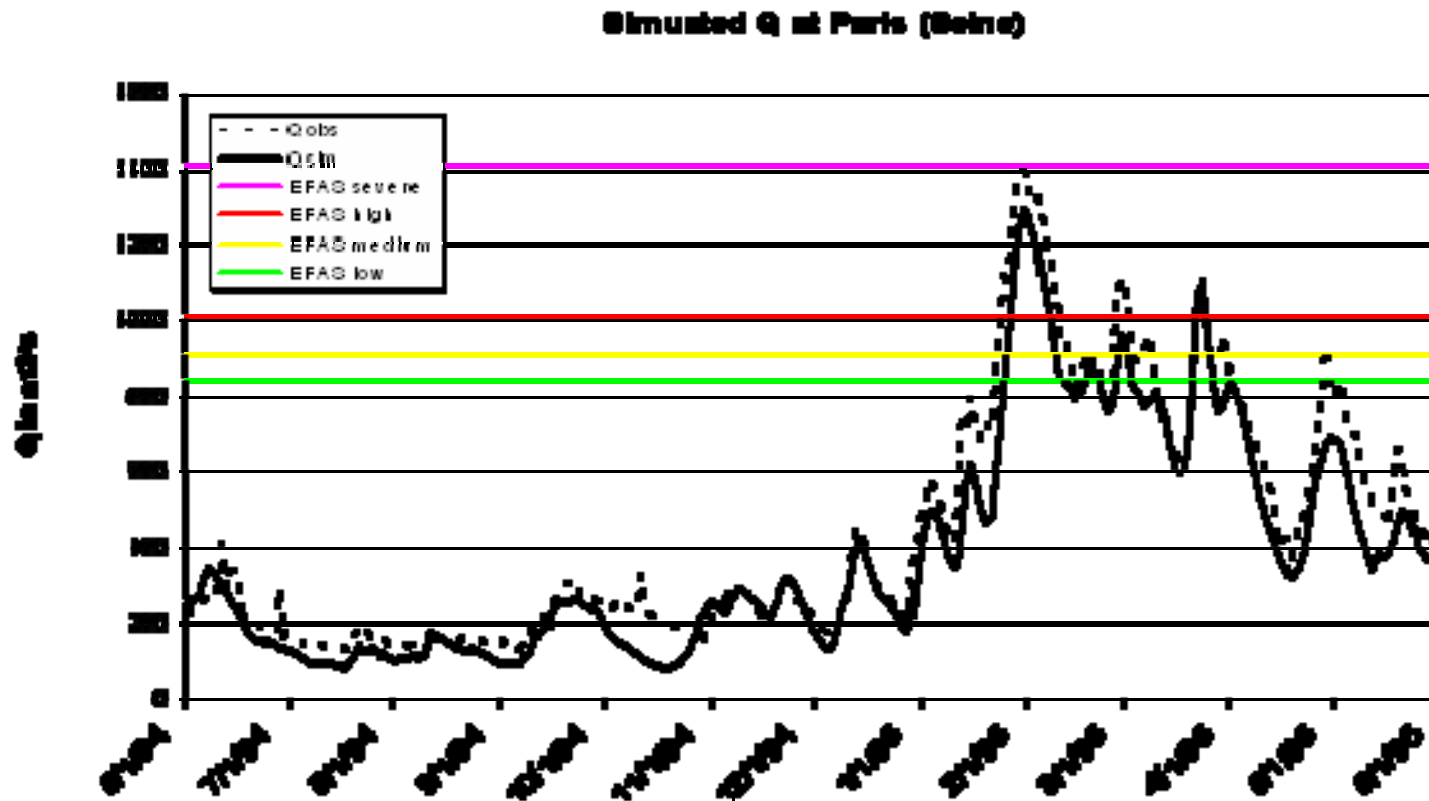


Station Name	Nash-Sutcliffe coefficient
HOHENSAATEN	0.5
Slubice	0.59
Polecko	0.62
Scinawa	0.43
Olawa	0.09
Miedonia	0.76
Bohumin	0.89
Svinov	0.91



Validation results: Seine flood 1995

Seine near Paris

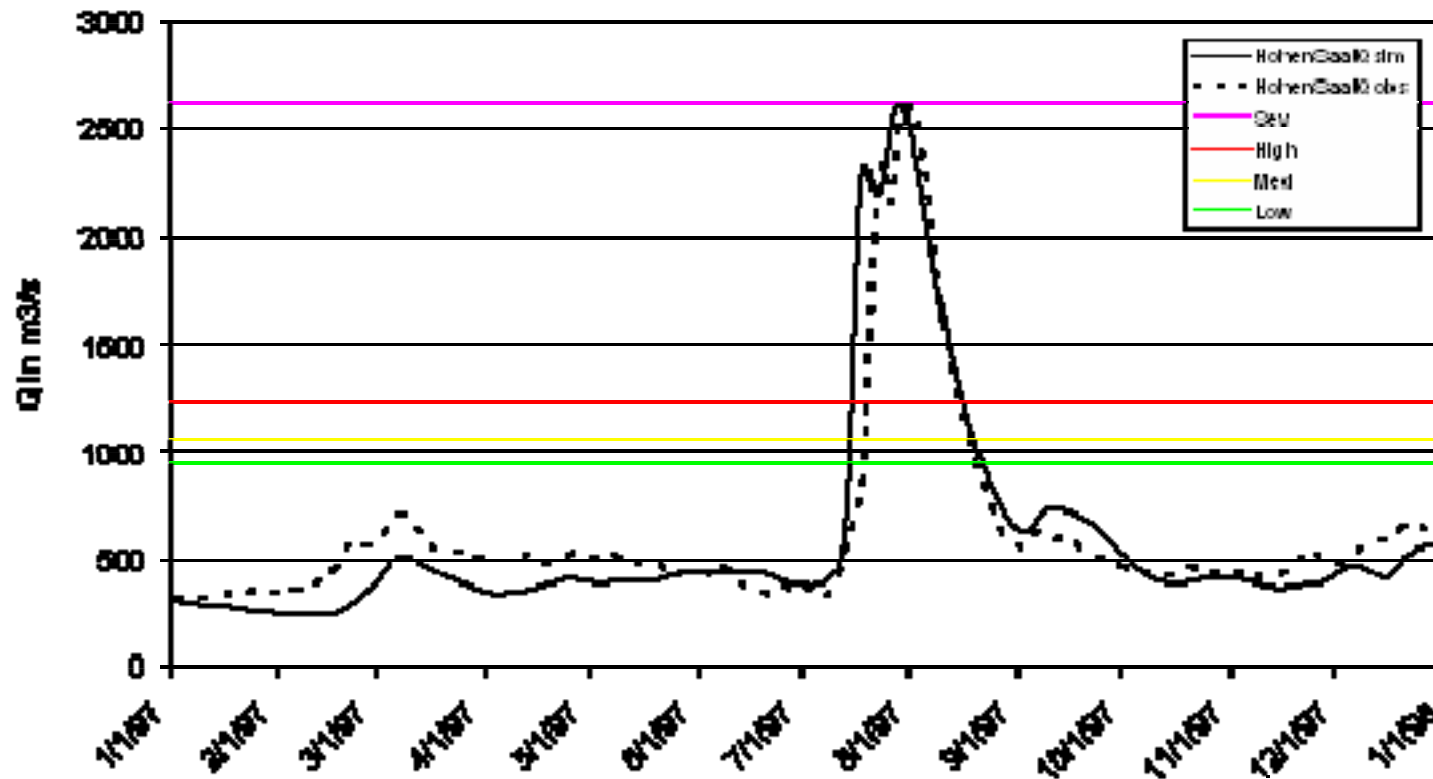




Validation results: Oder flood 1997

Oder near Hohensaaten

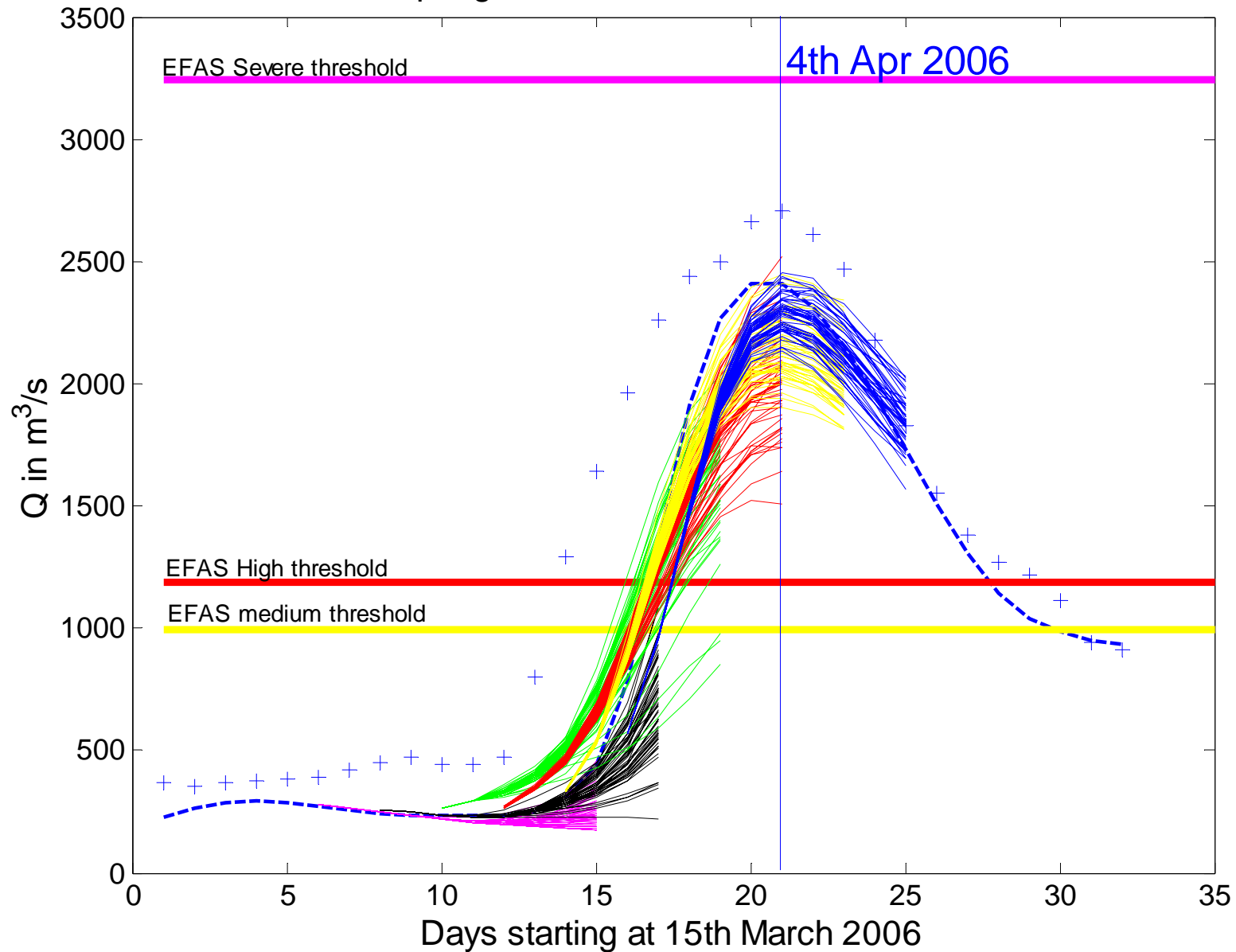
Observed and Simulated Q at Hohensaaten (Oder)





Forecasting results: Elbe flood March/April 2006

2006 spring floods in the Elbe, Station Dresden

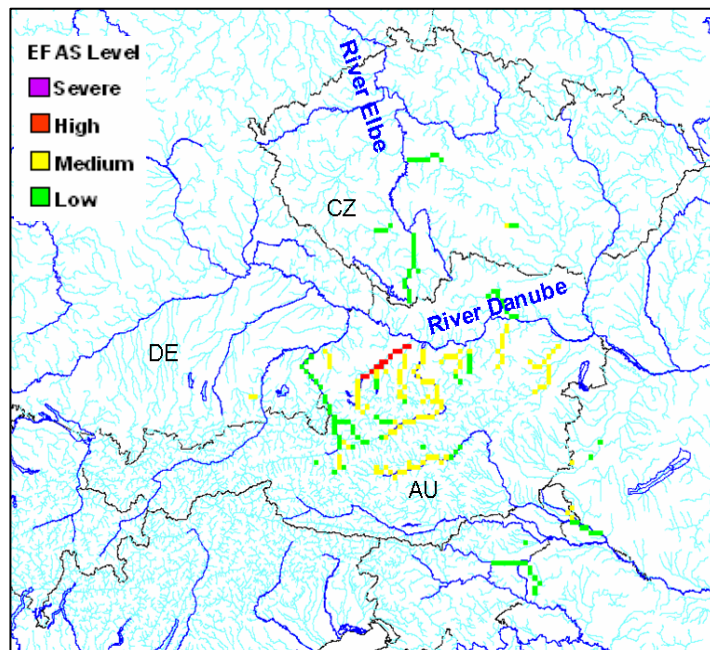




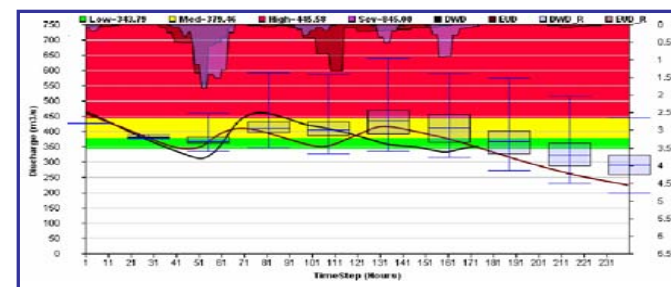
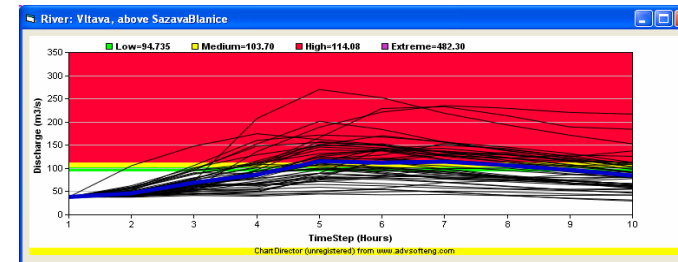
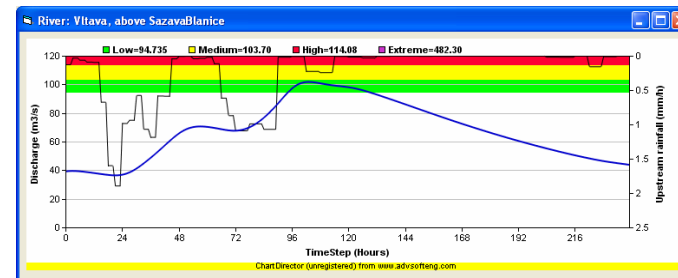
Prototype development (4)

Visualisation of results (threshold exceedance)

Maps

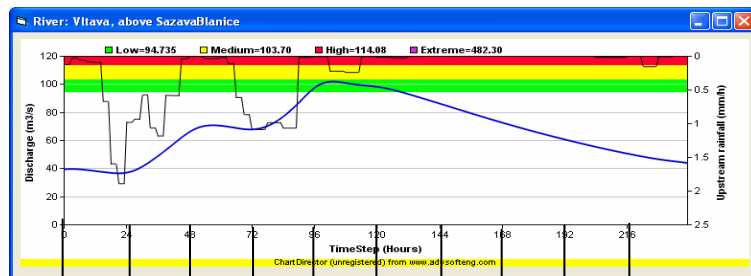


Time series





Simplifying information

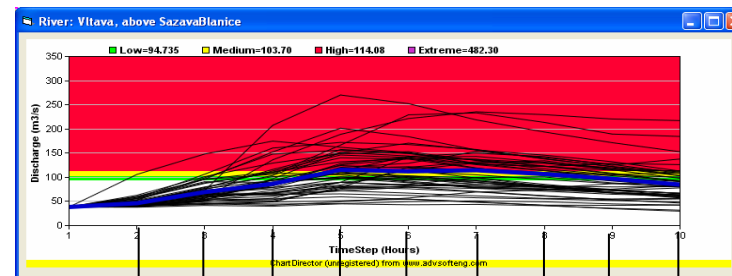


7	8	9	10	11	12	13	14	15	16

Forecast Day

EPS > HAL

EPS > SAL



8	9	10	11	12	13	14	15	16
	1	8	22	24	22	17	14	5

Date of this report: 2005101500

Forecast Day	15	16	17	18	19	20	21	22	23	24
DWD										
ECMWF										
EPS > HAL										
EPS > SAL										



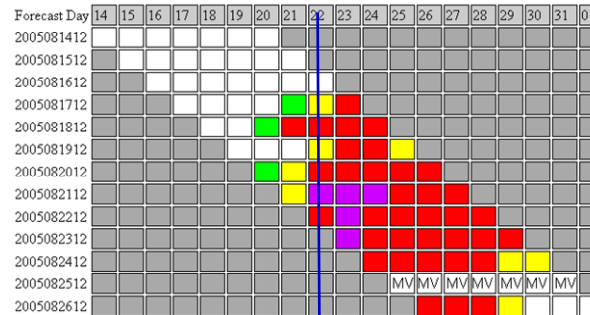
Prototype development (5)

Methodologies

Persistence

- Looking back in time
- Identify pattern and rules to reduce FA

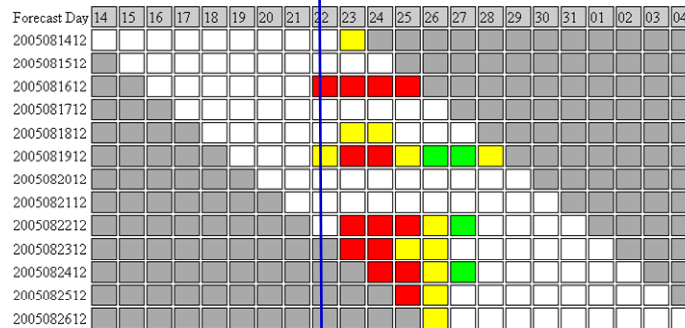
DWD



EFAS-EPS High threshold exceedance map
Forecasted on: 19.08.2005 12:00
Forecasted for: 23.08.2005
(4 days in advance)

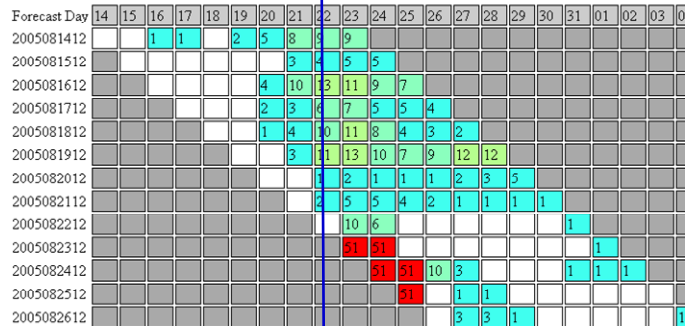


ECMWF

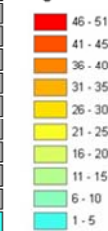


EFAS Level
Severe
High
Medium
Low

EPS > HAL

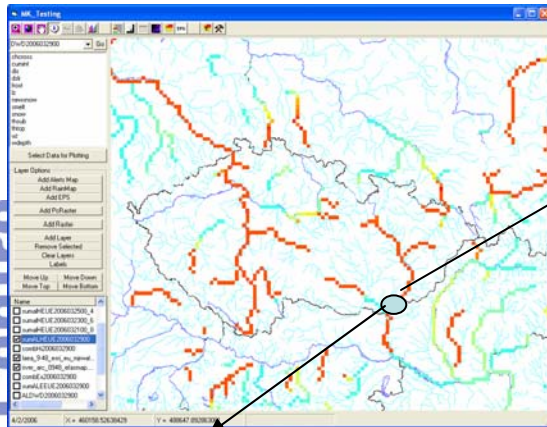


Number of EPS simulations above EFAS
High alert level



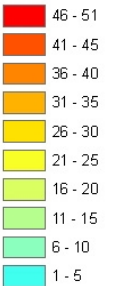


Forecasting results: Morava flood March 2006



EPS > HAL

Forecast Day	18	19	20	21	22	23	24	25	26	27	28	29	30	31	01	02	03	04	05	06	07
2006031800										1											
2006031812										1											
2006031900										1	1										
2006031912											3										
2006032000										4	15	19									
2006032012										5	11	18									
2006032100											12	25	31								
2006032112										9	22	26	28								
2006032200										1	20	31	37	32							
2006032212										6	27	28	22	22							
2006032300											17	29	31	18	14						
2006032312										5	26	36	34	31	26						
2006032400											27	40	36	28	29	32					
2006032412											28	33	29	29	25	20					
2006032500											25	46	44	42	43	40	22				
2006032512											33	40	39	38	36	29	16				
2006032600											41	48	46	46	46	42	21	9			
2006032612											33	45	45	47	45	41	20	10			
2006032700											2	46	47	49	50	50	40	28	18		
2006032712											36	50	51	51	51	49	36	27			
2006032800												39	49	51	51	51	51	48	34	29	
2006032812												36	51	51	51	51	51	51	42	38	
2006032900												51	51	51	51	51	51	51	50	47	34



ECMWF

Forecast Day	18	19	20	21	22	23	24	25	26	27	28	29	30	31	01	02
2006031800																
2006031812																
2006031900																
2006031912																
2006032000																
2006032012																
2006032100																
2006032112																
2006032200																
2006032212																
2006032300																
2006032312																
2006032400																
2006032412																
2006032500																
2006032512																
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2006032700																
2006032712																
2006032800																
2006032812																
2006032900																

EFAS Level

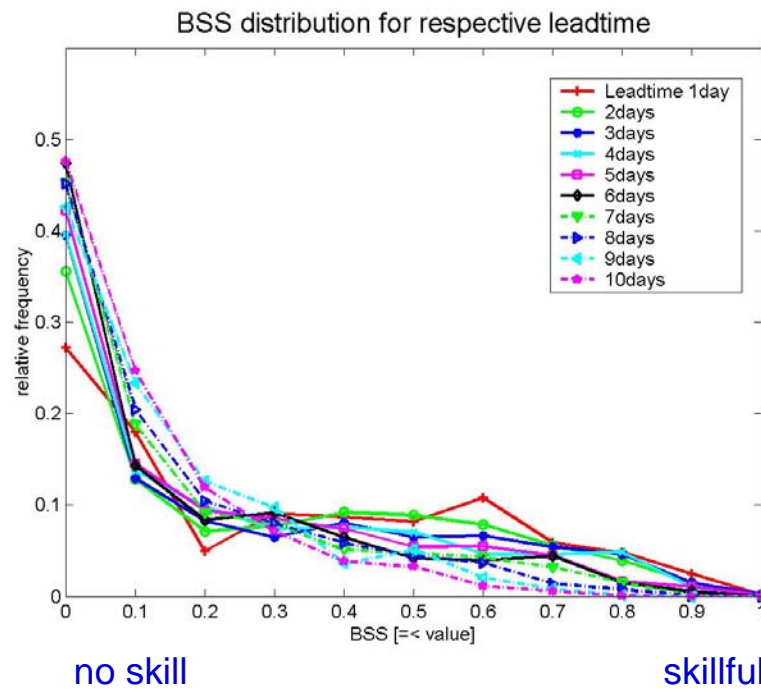




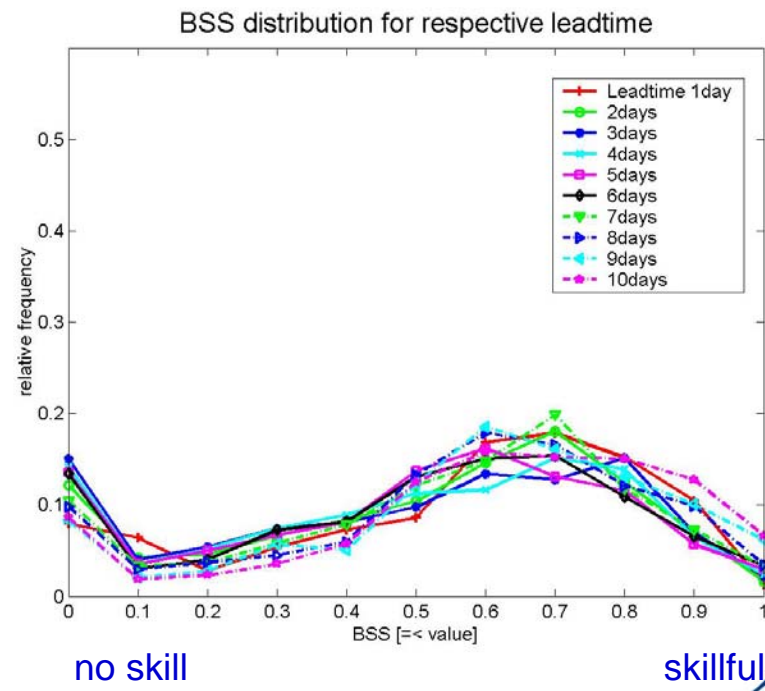
Brier skill score with & without persistence

- Probabilistic score, needs sufficient data
- Compares performance of model against climatology

BSS : no persistence



BSS : persistence 5 EPS





Summary

- Encouraging results since pre-operational in 2005 (80 % of all forecasts correct, throughout positive feedback on probabilistic results)
- Close collaboration hydrological services
- Lack of data on European scale one of the major problems to be addressed
- Statistical analysis of 2 years probabilistic and deterministic forecasting yield positive results
- In depth analysis of case studies in pilot catchments (Danube floods 2005, spring floods in Elbe and Danube 2006)



Way forward

- High-resolution data collection (EU-FLOOD-GIS & ETN-R)
- Optimise automatic calibration for Europe
- Improve input
 - bias corrections of meteo fields, downscaling
 - incorporate satellite data (snow extent, LAI, ...)
- Incorporate exploratory research into operational system
- Lots of hard work before we come to the transfer (2010)

Photo with courtesy of U. Hoehne



Working together to be better prepared in the future