



METIER Final Conference

“Climate – Water – Biodiversity – Land Use:
Young Scientists Tackling Complex
Environmental Challenges”

(Brussels, 4 – 6 November 2009)



MARIE CURIE ACTIONS

Early Flood Warning in Africa: Are the Methodologies of the European Flood Alert System (EFAS) Transferable to African Basins?

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A Feasibility Study in the Juba-Shabelle River Basin

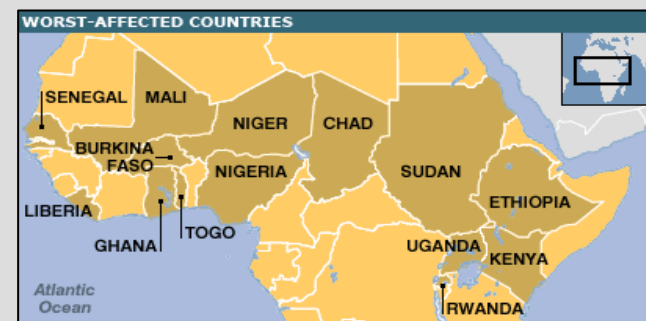
Vera Thiemig

*Land Management and Natural Hazards Unit
Institute for Environment and Sustainability*

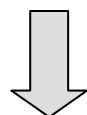
Why a flood forecasting system for Africa?

Floods in Northern Hemisphere Africa 2007

- ~ 650,000 homes destroyed
- 1.5 million people affected
- 200 people drowned
- substantial economic losses



Flood risk is likely to **increase** due to climate change and urban growth!



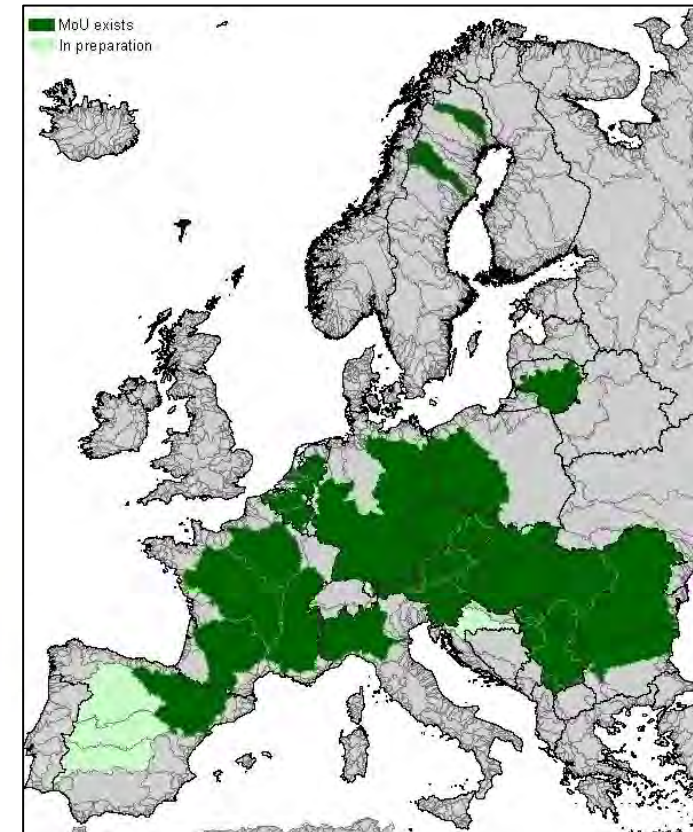
Benefits of a flood forecasting system:

- gain in response time
- **better planning and organizing** of prevention, protection and mitigation measures and aid for national authorities and international organisations

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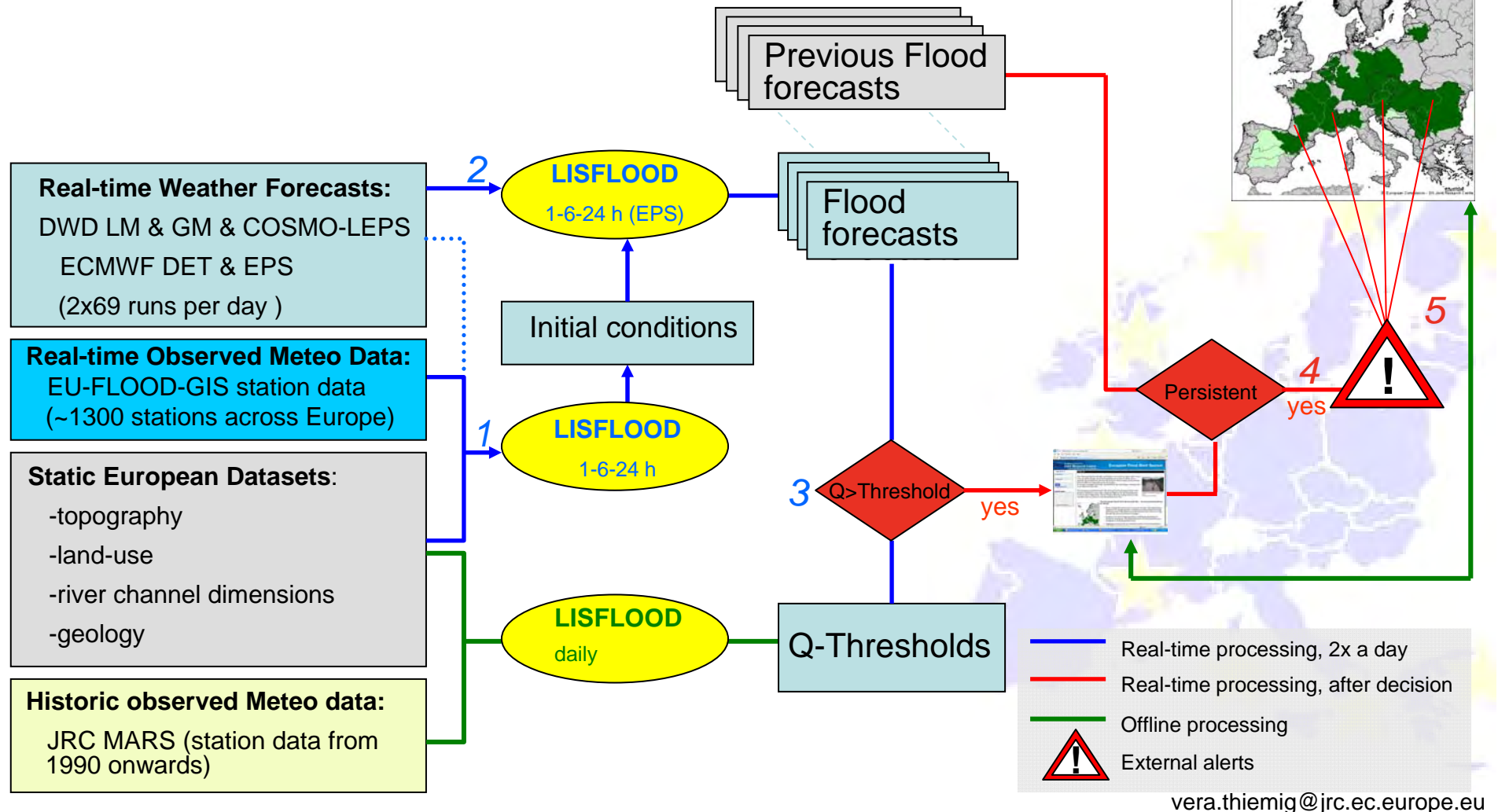
European Flood Alert System (EFAS)

- Land Management and Natural Hazard Unit,
Joint Research Centre, EC
- developed since 2003; **pre-operational** since 2005
- currently 25 partner institutions (MoU)
- **probabilistic flood alert system**, for **large-scale river basins**, with **extended lead time** up to 10 days (lead times of most national systems: 2-3 days)
- **complementary system** to the already existing national ones



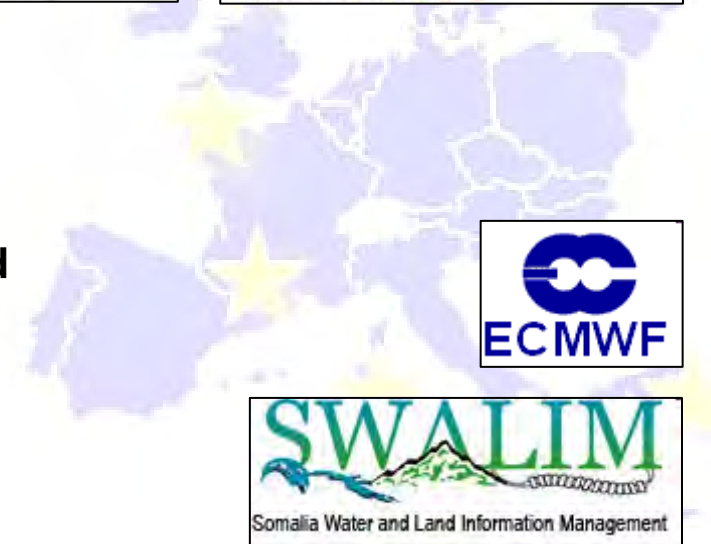
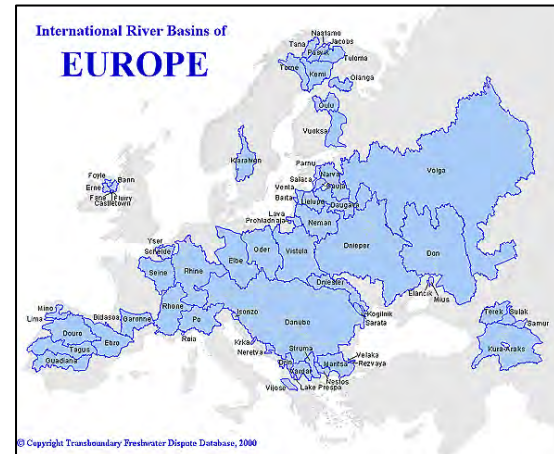
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European Flood Alert System (EFAS)



Potentials of EFAS for African basins

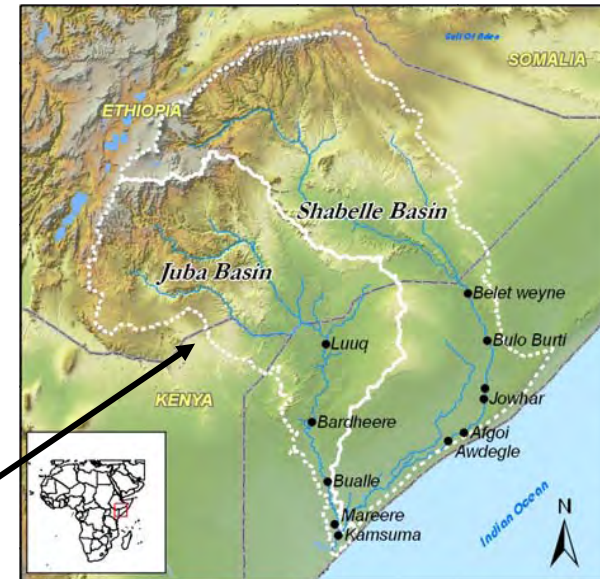
- (1) probabilistic flood warning system for **large-scale** river basins
- (2) can cope with a **limited** amount of input **data**
- (3) **increases** the **lead times** to up to 10 days
- (4) clear, concise and unambiguous visualization and decision support **products**
- (5) expert **knowledge** + commitment of **partners**



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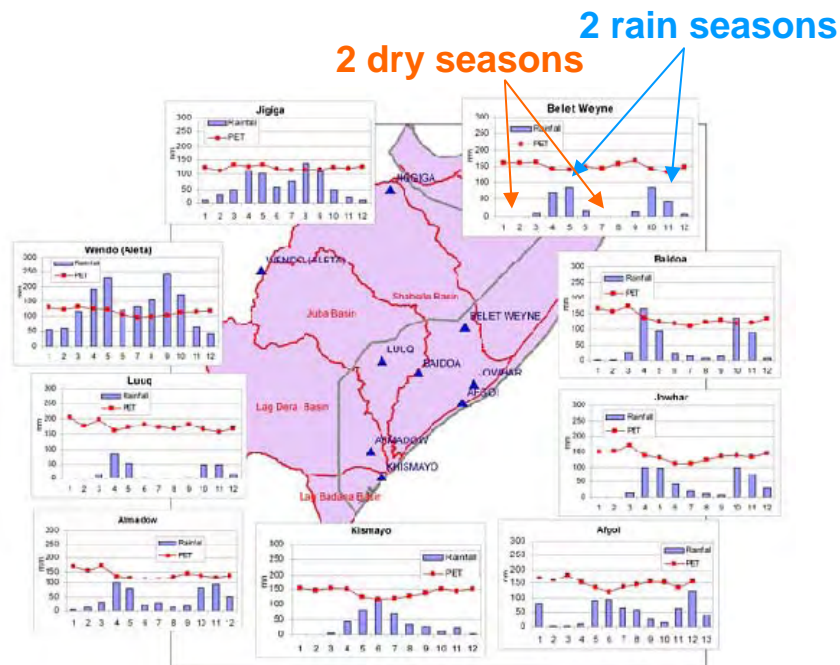
Study area: Juba-Shabelle river basin



- Ethiopia, Somalia & Kenya
- 1,100 km (J), 1,700 km (S)
- 783,000 km²
- altitudes range from 3000 m to sea level
- **land cover:** mainly natural vegetation (riparian forest, bush lands and grasslands)

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Study area: Juba-Shabelle river basin

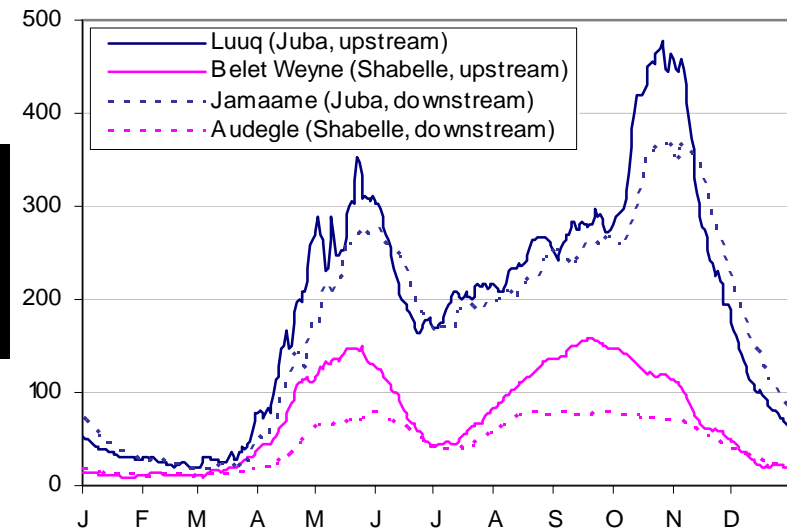


Climate:

- 2 rain seasons (Gu, Deyr)
- precipitation: ~ 500 mm/ a
- 23 – 30 °C
- EPT: 1,500 – 2,000 mm/ a

Hydrological conditions:

- annual discharge: Juba > Shabelle
- progressive discharge reduction:
 - (1) lack of confluences
 - (2) natural losses
 - (3) withdrawals



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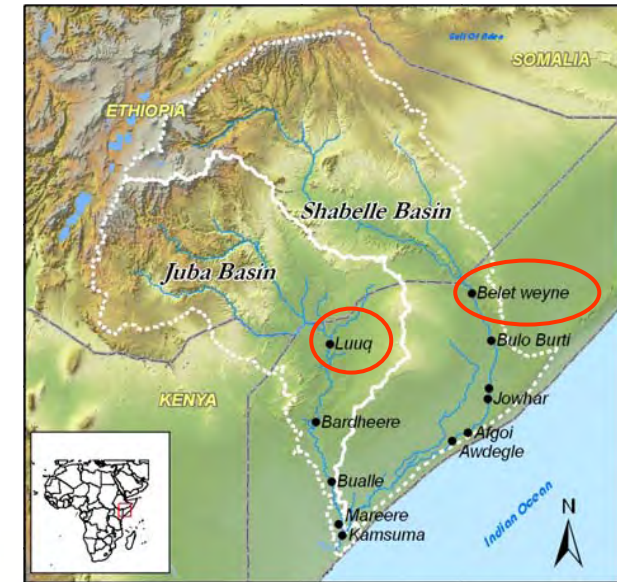
Available data

Meteorological data

- ERA 40 (1959 – 2002)
- CHARM (1960 – 1996)
- ERA interim (2002 – 2007)
- RFE (2001 – 2007)
- EPS-Vareps (Events: 1977, 1981, 2005, 2006)

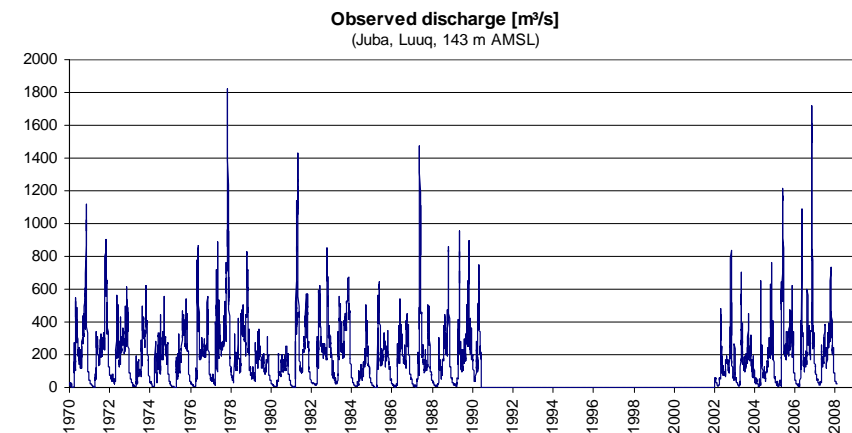
calibration,
validation

hindcasting



Hydrological data

- Luuq (Juba)
 - Belet Weyne (Shabelle)
- 1970 – 1990; 2002 – 2007



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Procedural approach

(1) uncalibrated test run

(2) manual calibration

- trial-and-error method
- quantity & shape
- visual and statistical comparison (water balance factor, correlation)

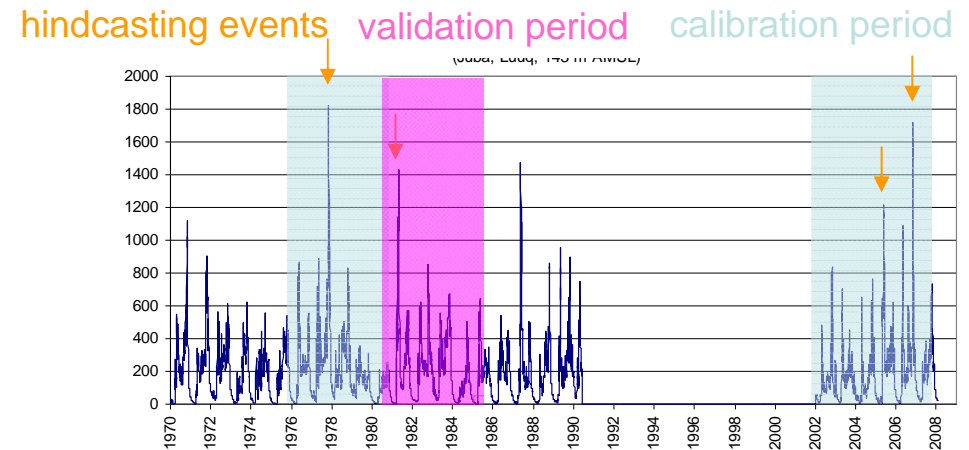
(3) automatic calibration (1976 – 1981; 2001 – 2007)

- Shuffle Complex Evolution algorithm (SCE-UA)
- shape
- visual and statistical comparison (correlation, CRPS, spread-skill relationship, rank histogram, ROC)

(4) validation (1982 – 1987)

(5) thresholds (CHARM: 1960 - 1996; ERA-40: 1959 – 2007; RFE/ERA-interim: 2001-2007)

(6) hindcasting (flood events: autumn 1977, spring 1981, spring 2005, autumn 2006)



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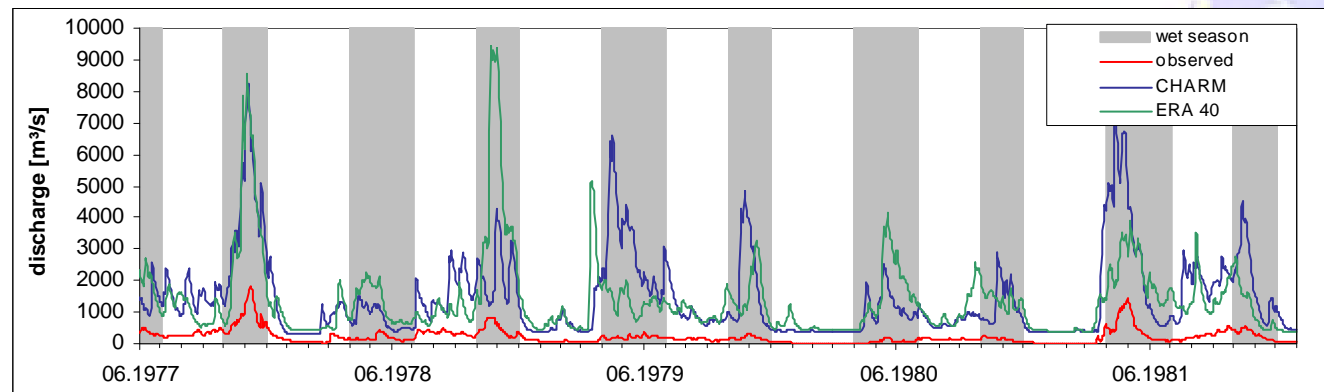


(1) - (3): Calibration

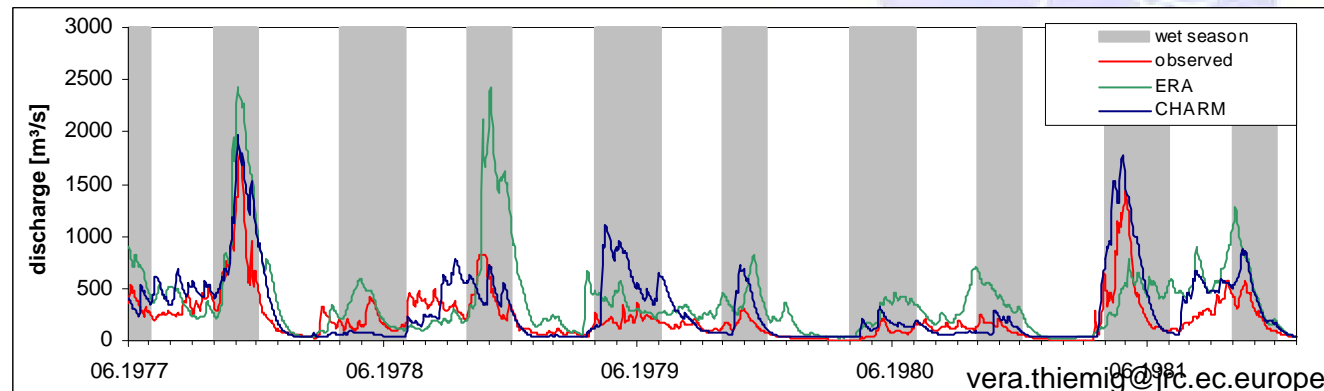


Luuq	parameter setting	WBF	R
ERA 40	uncalibrated	7.2	0.55
	calibrated	2.1	0.57
CHARM	uncalibrated	6.8	0.73
	calibrated	1.3	0.81

(1)
uncalibrated →



(2) + (3)
calibrated →







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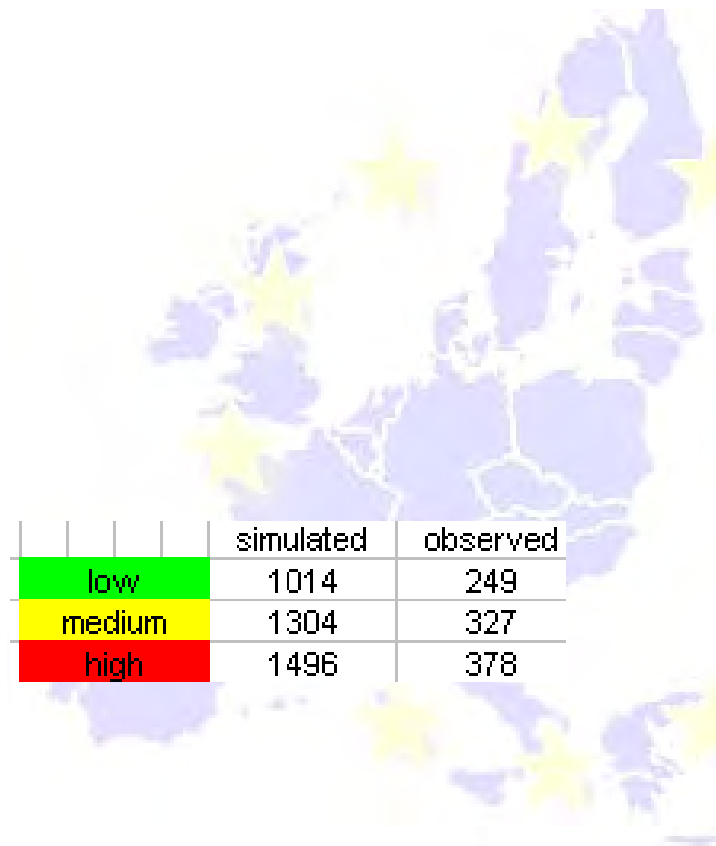
(4) Validation

Luuq	parameter setting	WBF	R
ERA 40	calibrated	2.1	0.57
	validated	2.0	0.54
CHARM	calibrated	1.3	0.81
	validated	0.64	0.60

(5) Derivation of different alert thresholds

EFAS threshold	Colour	Hazard description
S (severe)		Very high probability of flooding, potentially severe flooding expected
H (high)		High possibility of flooding, bankfull conditions or higher expected.
M (medium)		Water levels high but no flooding expected.
L (low)		Water levels higher than normal but no flooding expected.

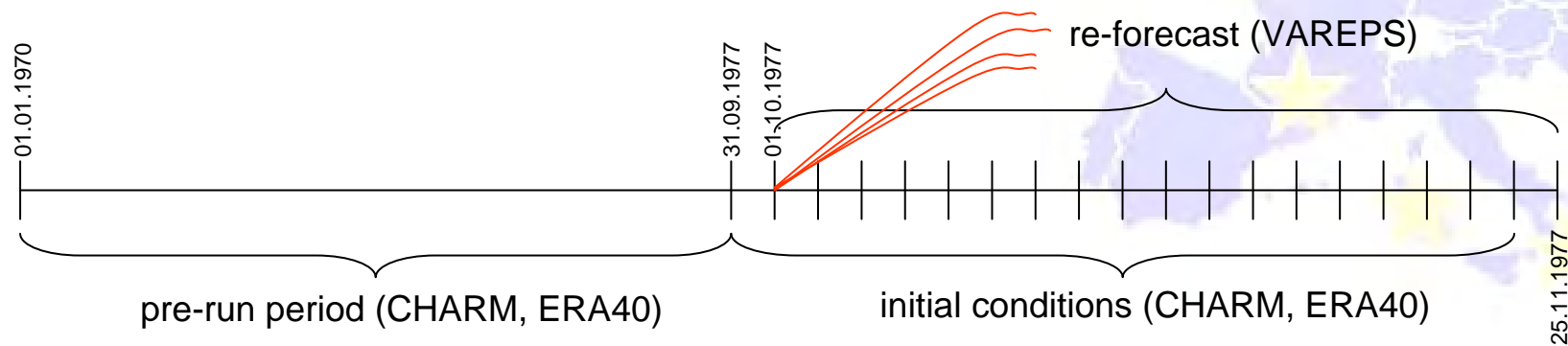
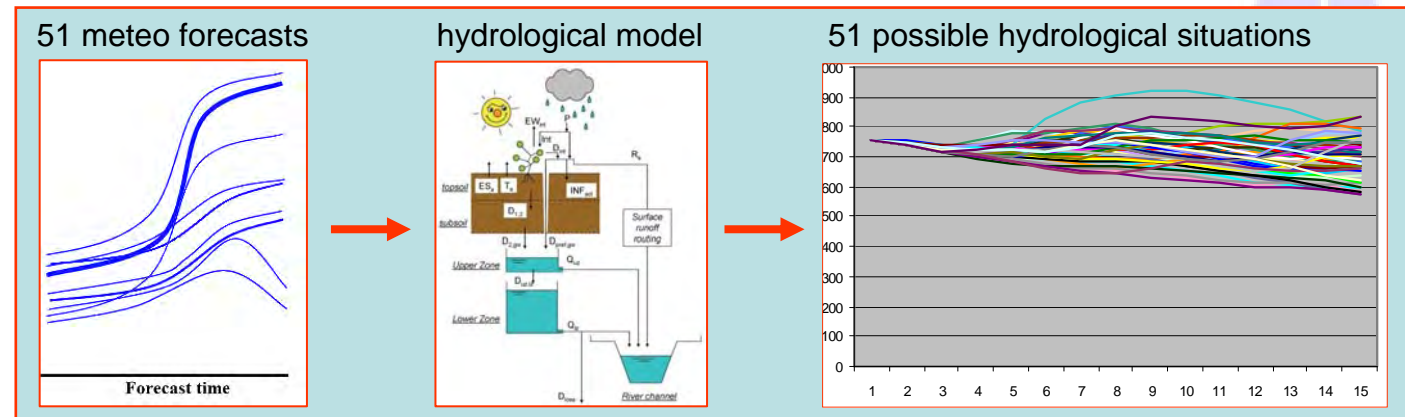
	simulated	observed
low	1014	249
medium	1304	327
high	1496	378



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Hindcasting (6)

- **retrospective analysis**
- to determine the **potentials of the hydrological model** to serve as a flood forecasting system
- **procedure:**



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Hindcasting: Belet Weyne

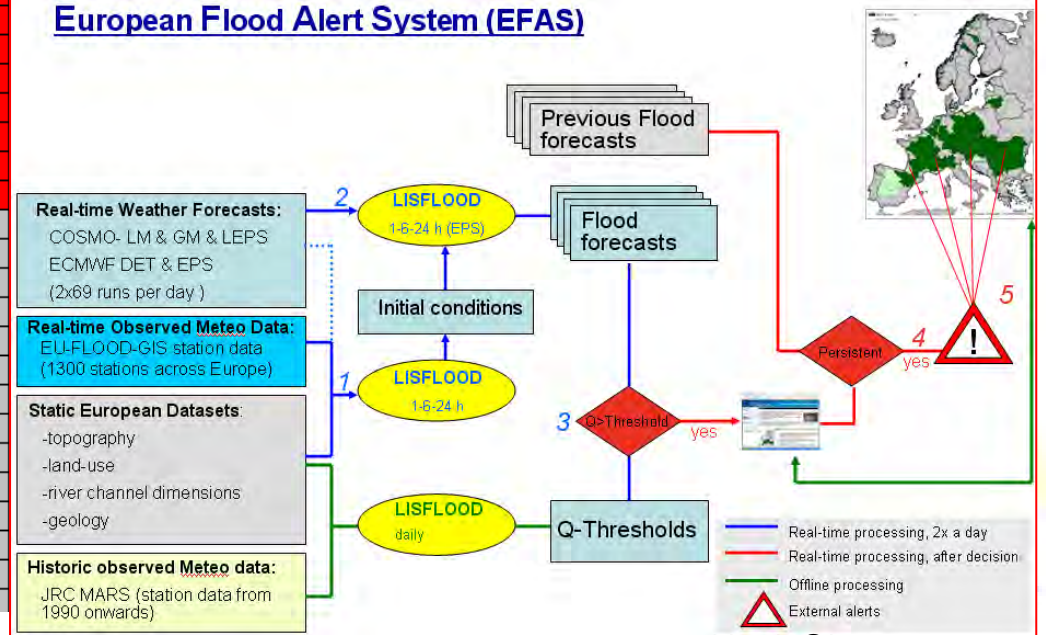
Number of EPS above EFAS alert level						low	simulated	observed
1 - 10	11 - 20	21 - 30	31 - 40	41 - 45	46 - 51	medium	1014	249
						high	1304	327
							1496	378

	October											November																								
	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22		
10/20/1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1																					
10/21/1977		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1																				
10/22/1977			0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	7	9																	
10/23/1977				0	0	0	0	0	0	0	0	0	0	0	0	1	3	4	3																	
10/24/1977					0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1																
10/25/1977						0	0	0	0	0	0	0	0	0	0	2	9	18	21	20	19	16														
10/26/1977							0	0	0	0	0	0	0	0	0	4	12	21	25	22	20	15	13													
10/27/1977								0	0	0	0	0	0	0	0	0	11	16	17	11	3	2	0													
10/28/1977									0	0	0	0	0	0	0	51	51	51	51	51	51	47	36	27	10											
10/29/1977										0	0	0	0	0	0	51	51	51	51	51	51	51	51	51	47											
10/30/1977											0	0	0	0	0	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
10/31/1977												0	0	0	0	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
11/1/1977													0	0	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	
11/2/1977															51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
11/3/1977																51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
11/4/1977																	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
11/5/1977																		51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
11/6/1977																			51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
11/7/1977																				51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
11/8/1977																					51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
11/9/1977																						51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
11/10/1977																																				
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observations exceed the threshold

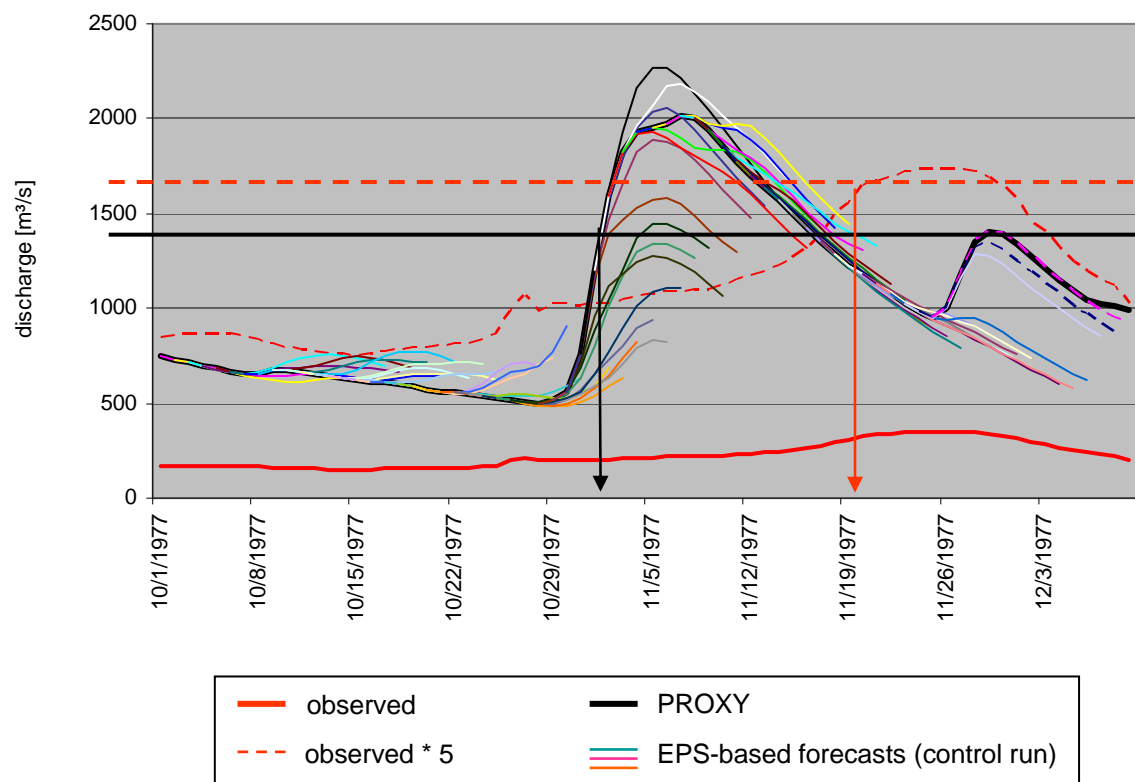
forecasts exceed the threshold

European Flood Alert System (EFAS)



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Hindcasting: Belet Weyne



hindcasts \leftrightarrow observations

- reflects the shortcomings of the calibration:
 - overestimation of the water balance
 - time shift
- in order to assess the applicability of the method the aftereffects of the calibration have to be excluded

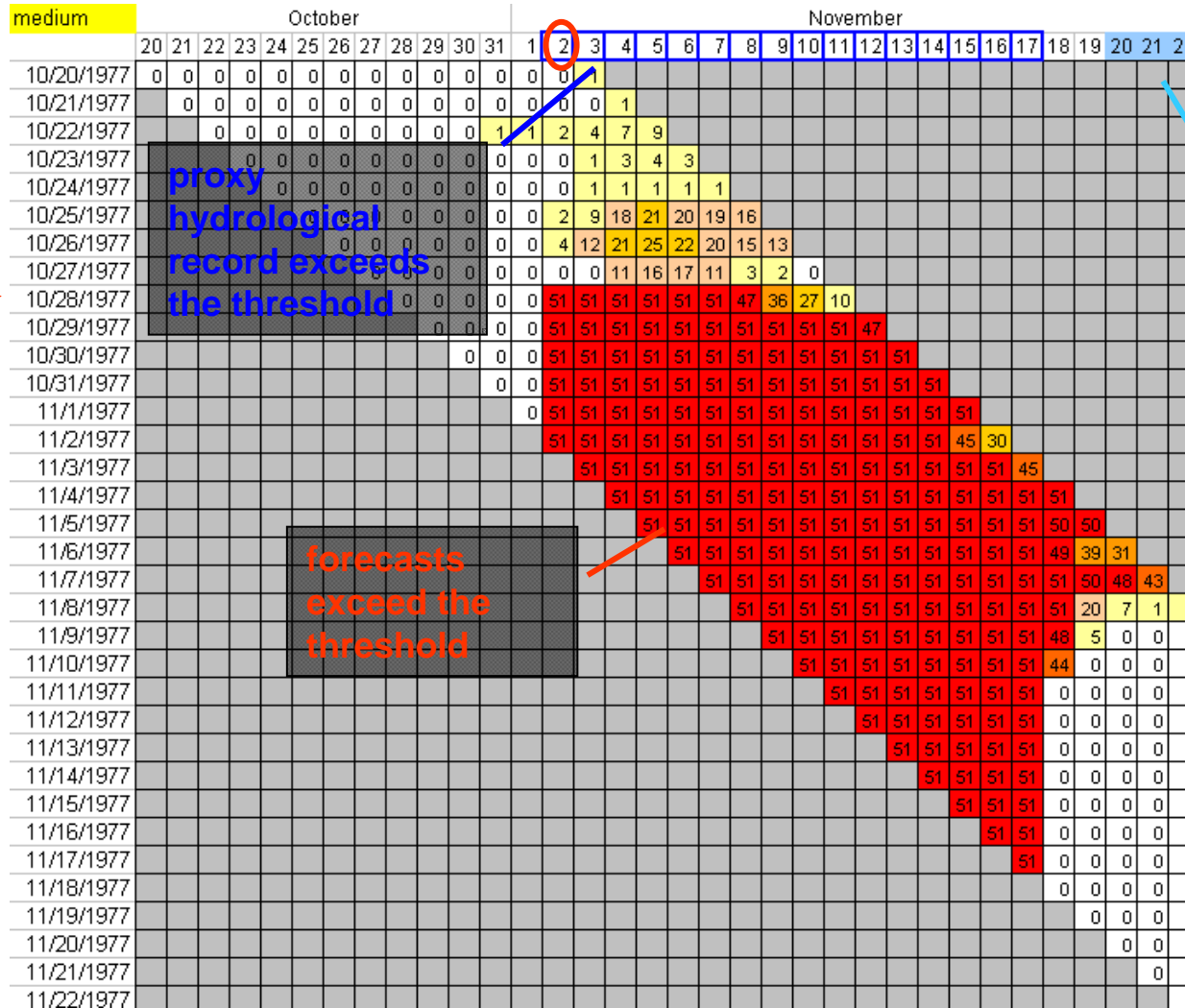
hindcasts \leftrightarrow proxy hydrological record

- performance depends solely on the meteorological data and the hydrological model

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Hindcasting: Belet Weyne

Number of EPS above EFAS alert level						low	simulated	observed
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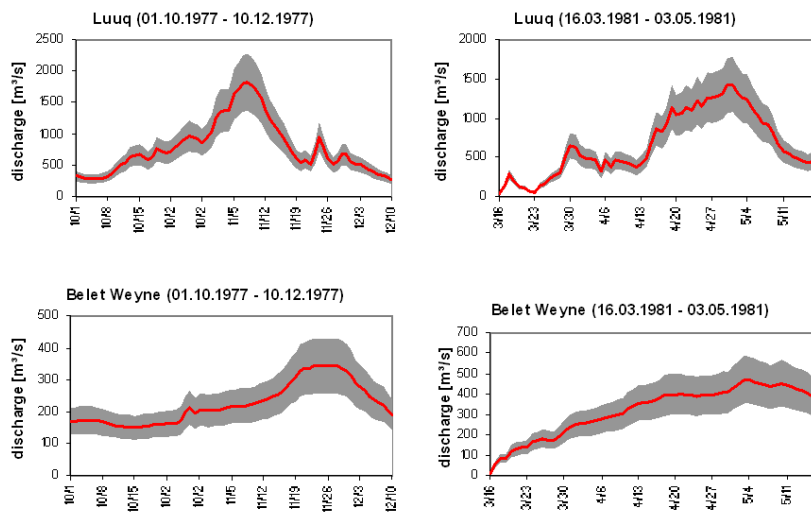
Different sources:

(a) input data

meteorological data

observed discharge records

static maps



(c) water management

(b) model

model structure and relations

- Interception, infiltration & evapotranspiration
- channel transmission losses

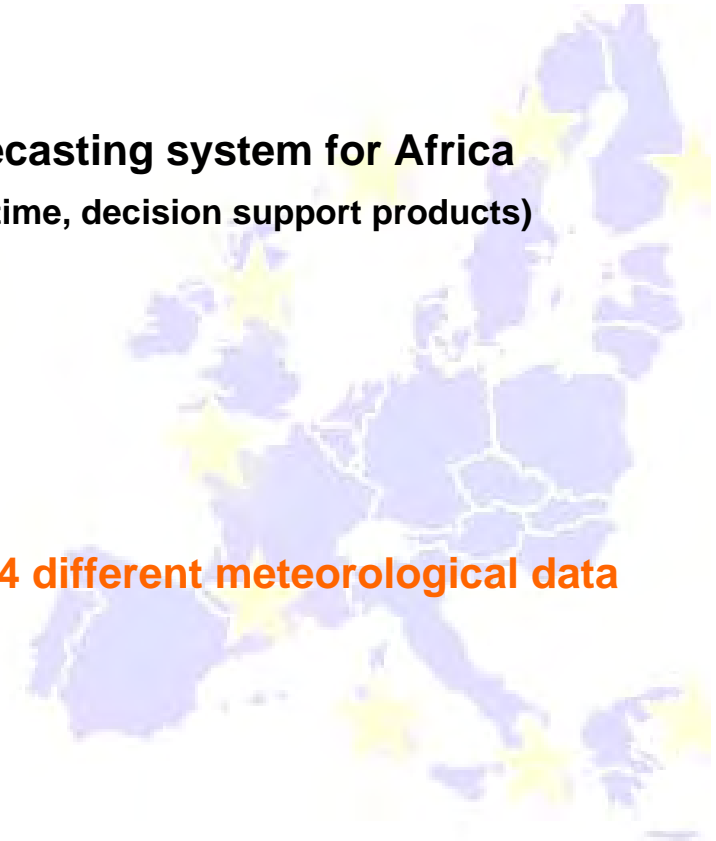
estimation of the calibration parameter values

Belet Weyne	parameter setting	WBF	R
ERA-40	calibrated	15.9	0.71
	alternative	9.9	0.70
CHARM	calibrated	19.2	0.88
	alternative	10.7	0.86

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Key question: Are the methodologies of the European Flood Alert System transferable to African basins?“

- **EFAS has a potential** to serve as a early flood forecasting system for Africa (large scale, limited amount of input data, extended warning time, decision support products)
- **challenge to collect data** (for set-up, testing and verification)
- LISFLOOD has been calibrated independently for **4 different meteorological data sets** (ERA-40, CHARM, ERA-interim, RFE)



Results show:

- the **calibration is not yet satisfactory**
- hindcasts adopt the shortcomings of the calibration
- comparing hindcasts with proxy hydrological record the transferability of the method can be revealed
- **system has been assessed as skilful**

This encourages the JRC to continue the research on this pilot study!

- model adjustments are planned / in process
- improvements on the input data
- strengthening the relations with the African institutions



Early Flood Warning in Africa: Are the Methodologies of the European Flood Alert System (EFAS) Transferable to African Basins?

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A Feasibility Study in the Juba-Shabelle River Basin

Thank you for your interest!

for further questions concerning this pilot study do not hesitate to contact:

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