Joint Research Centre

UN-SPIDER Regional Workshop

"Building Upon Regional Space-based Solutions for Disaster Management and Emergency Response for Africa"

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"Heading Towards a Pan-African Flood Forecasting and Early Warning System"

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Introduction

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
- aid for national authorities and international organisations (World Food Programme & European Commission MIC)

Current Status on Flood Forecasting and Early Warning

Background:

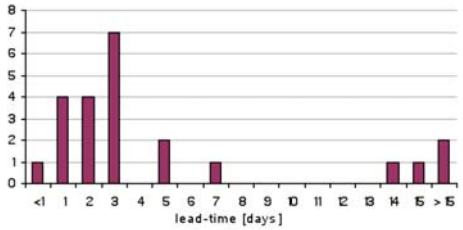
- sources: scientific literature + institutional websites + questionnaire
- questionnaire:
  - http://efas-is.jrc.ec.europa.eu/africa_questionnaire_en.php
  - content: area of activity, forecasting techniques, input data, lead-time, usage, collaboration / links, needs, etc.
  - ~ 500 were distributed to institutions that were suspected to deal with flood management in Africa (2/3 within Africa, 1/3 outside of Africa)
  - 65 questionnaires from 53 institutions returned (49 African institutions)

Current Status on Flood Forecasting and Early Warning

Main findings:

1. There are many institutional flood forecasting initiatives ongoing in Africa, but information are not easily accessible

2. There are needs for:
   - a (complementary) flood forecasting and early warning system for medium-ranged forecasts
   - technical expertise
   - increased funds



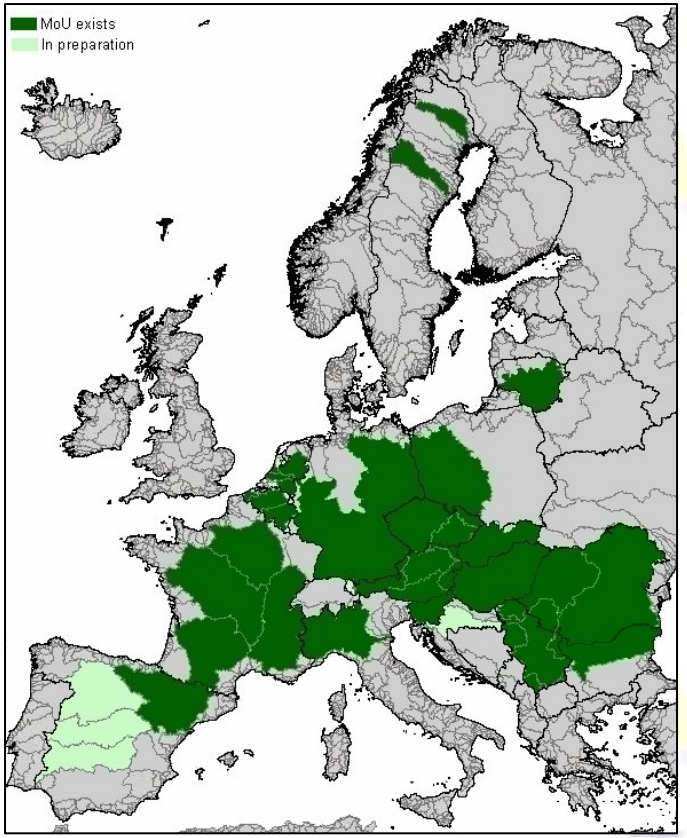
Strength of the European Flood Alert System (EFAS)!

3. Dissemination of existing flood forecasts and warnings to end-users and the public could be improved

A Complementary Flood Forecasting System

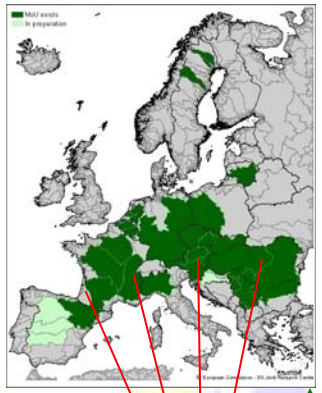
European Flood Alert System (EFAS)

- 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



A Complementary Flood Forecasting System

European Flood Alert System (EFAS)



Real-time Weather Forecasts:
DWD LM & GM & COSMO-LEPS
ECMWF DET & EPS
(2x69 runs per day)

Real-time Observed Meteo Data:
EU-FLOOD-GIS station data
(~1300 stations across Europe)

Static European Datasets:
-topography
-land-use
-river channel dimensions
-geology

Historic observed Meteo data:
JRC MARS (station data from 1990 onwards)

2 LISFLOOD 1-6-24 h (EPS)

1 LISFLOOD 1-6-24 h

LISFLOOD daily

Initial conditions

Previous Flood forecasts

Flood forecasts

Q-Thresholds

3 Q>Threshold yes

Persistent 4 yes

5

Real-time processing, 2x a day
Real-time processing, after decision
Offline processing
External alerts

A Complementary Flood Forecasting System

Potentials of EFAS for African basins

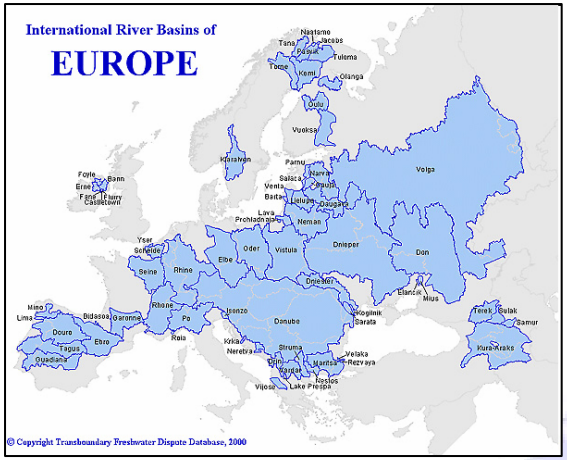
(1) probabilistic flood warning system for large-scale river basins

(2) can cope with a limited amount of input data

(3) increases the lead times to up to 15 days

(4) clear, concise and unambiguous visualization and decision support products

(5) expert knowledge + commitment of partners



SWALIM
Somalia Water and Land Information Management

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

ECMWF

A Complementary Flood Forecasting System

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)**
- **climate: 2 rain seasons (Gu, Deyr), ~ 500 mm annual precipitation, 23 – 30 ° C**
- **hydrological condition: annual discharge: Juba > Shabelle, progressive discharge reduction**

A Complementary Flood Forecasting System

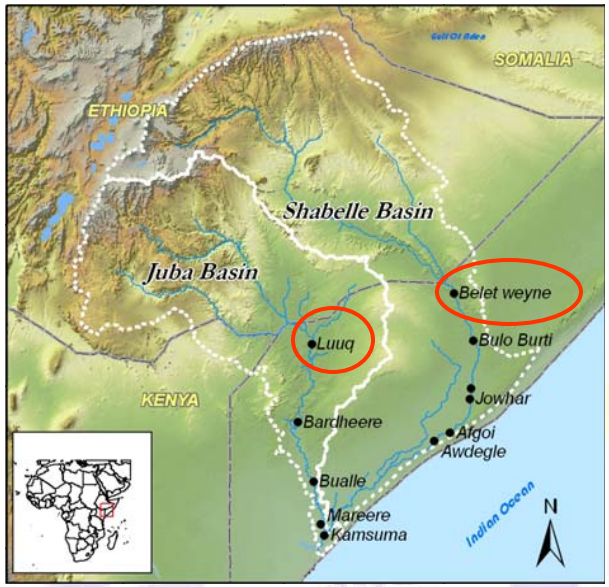
Available data

Meteorological data

- **ERA 40 (1959 – 2002)**
- **CHARM (1960 – 1996)**
- **ERA interim (2002 – 2009)**
- **RFE (2001 – 2008)**
- **EPS-Vareps (Events: 1977, 1981, 2005, 2006)**

calibration, validation

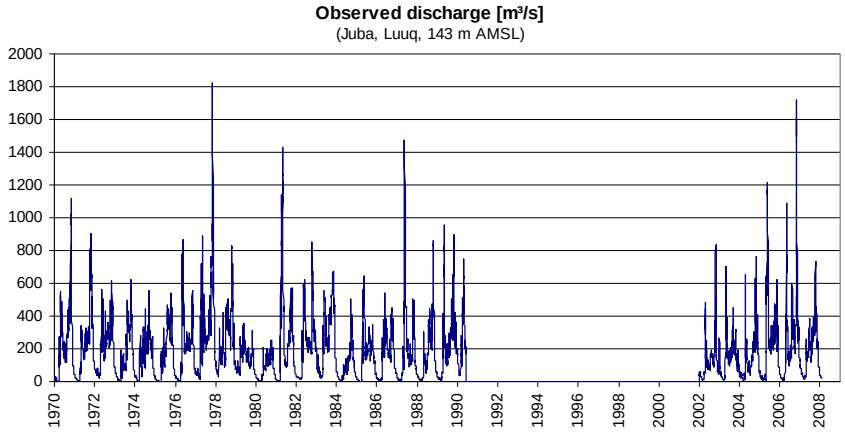
hindcasting



Hydrological data

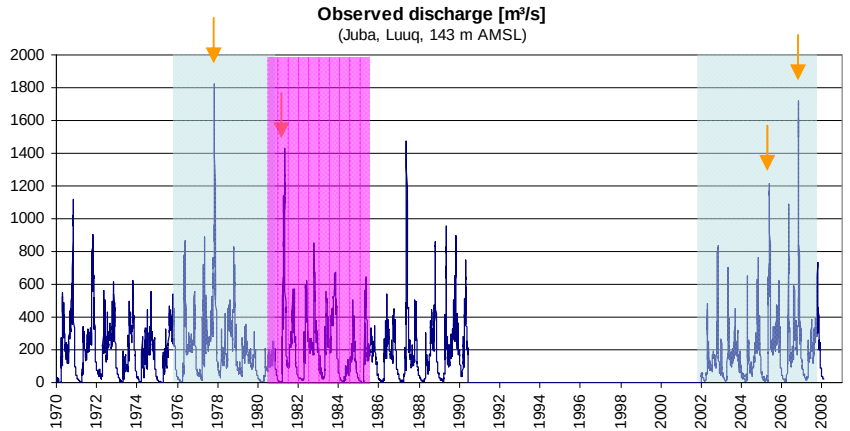
- **Luuq (Juba)**
- **Belet Weyne (Shabelle)**

  → 1970 – 1990; 2002 – 2007



A Complementary Flood Forecasting System

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)

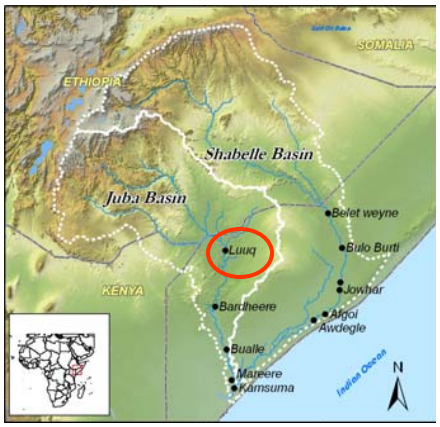
(5) thresholds (CHARM: 1960 - 1996; ERA-40: 1959 – 2007; RFE/ERA-interim: 2001-2007)

- percentage, factor on average, delivered thresholds & return periods

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

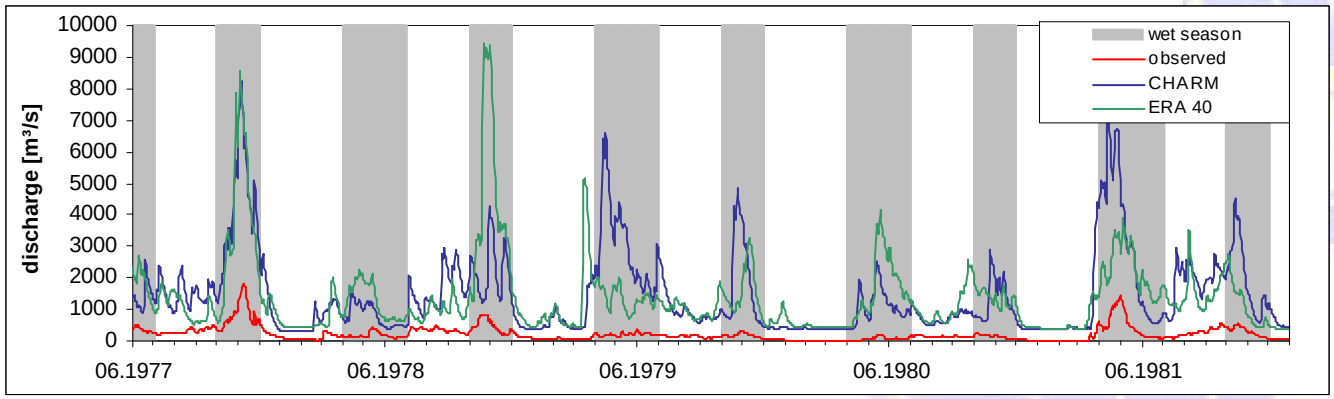
A Complementary Flood Forecasting System

(1) - (3): Calibration

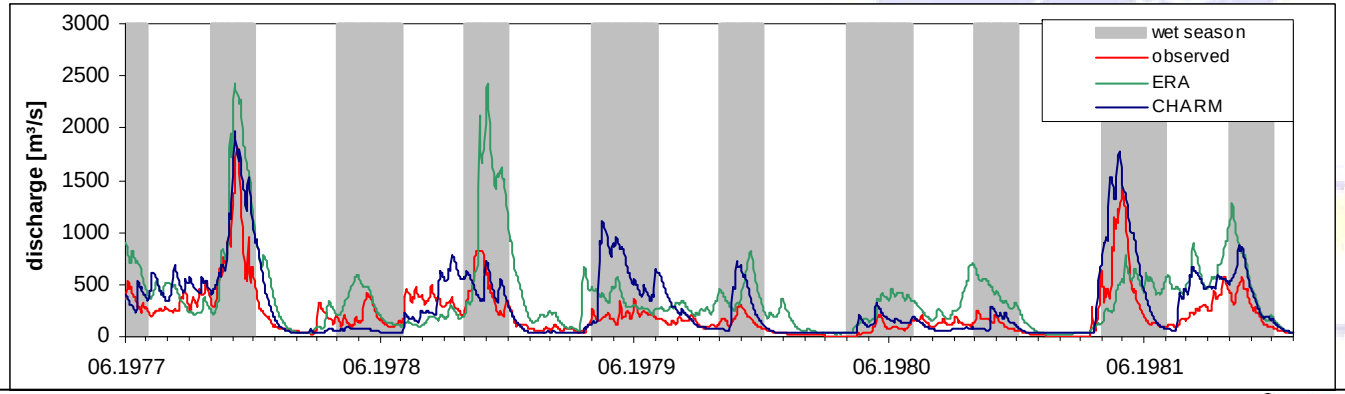


Luuq	parameter setting	WBF	R
ERA 40	uncalibrated	7.2	0.55
	calibrated	2.1	0.57
CHARM	uncalibrated	6.8	0.73
	calibrated	1.3	0.81

(1) uncalibrated →



(2) + (3) calibrated →



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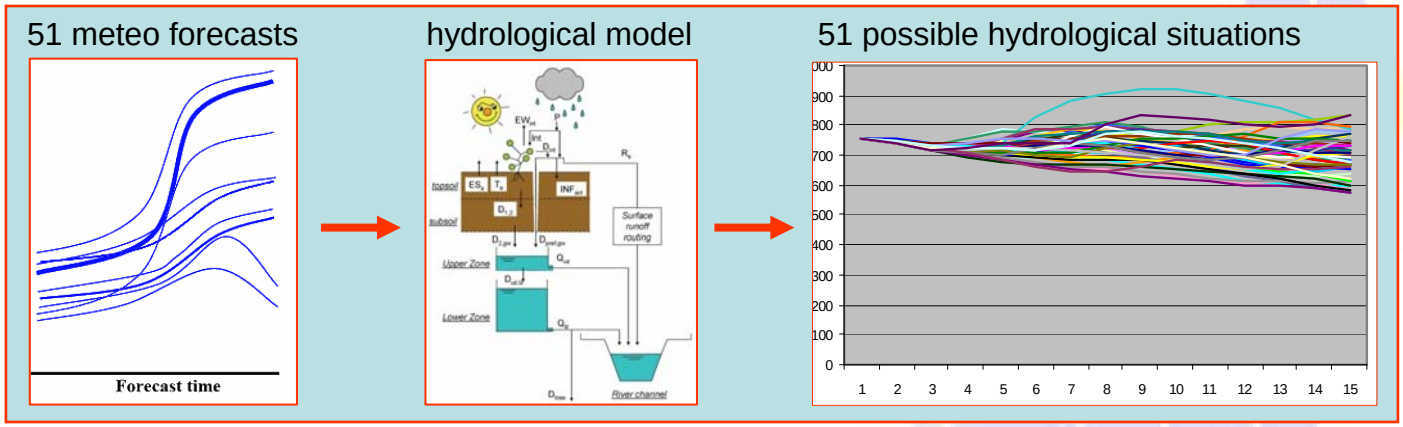
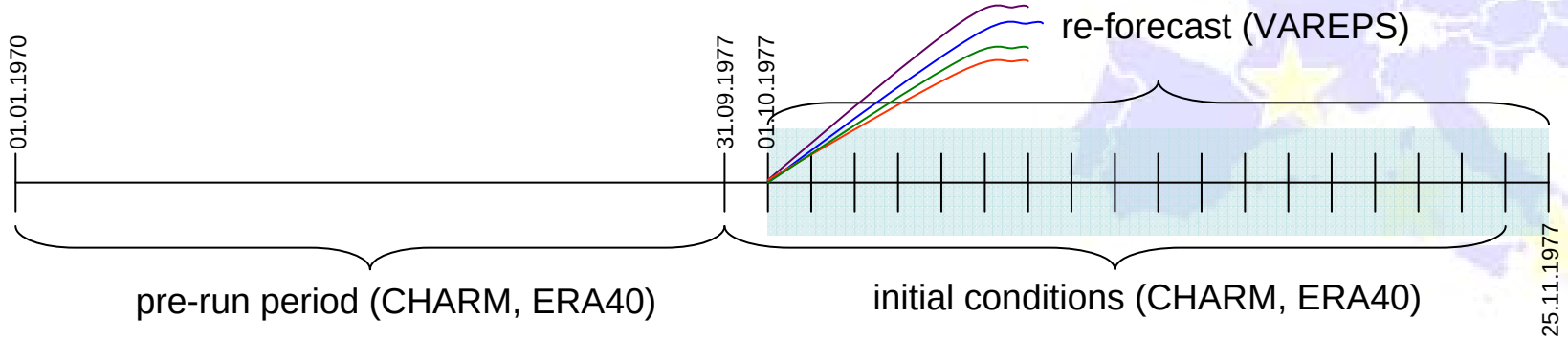
Hindcasting (6)

- **retrospective analysis**
- **to determine the potentials of the hydrological model to produce flood forecasts**
- **procedure:**





A Complementary Flood Forecasting System

Hindcasting: Belet Weyne

Number of EPS above EFAS alert level					
1 -10	11 - 20	21 - 30	31 - 40	41 - 45	46 - 51

	simulated	observed
low	1014	249
medium	1304	327
high	1496	378

medium

	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
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	1	1	2	4	7	9														
10/23/1977				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	1	1	1	1	1												
10/25/1977						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	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	51	51	51	51	51	51	47	36	27	10							
10/29/1977										0	0	0	0	0	51	51	51	51	51	51	51	51	51	47							
10/30/1977											0	0	0	0	51	51	51	51	51	51	51										
10/31/1977												0	0	0	51	51	51	51	51	51	51										
11/1/1977													0	51	51	51	51	51	51	51	51										
11/2/1977													51	51	51	51	51	51	51	51	51										
11/3/1977														51	51	51	51	51	51	51	51										
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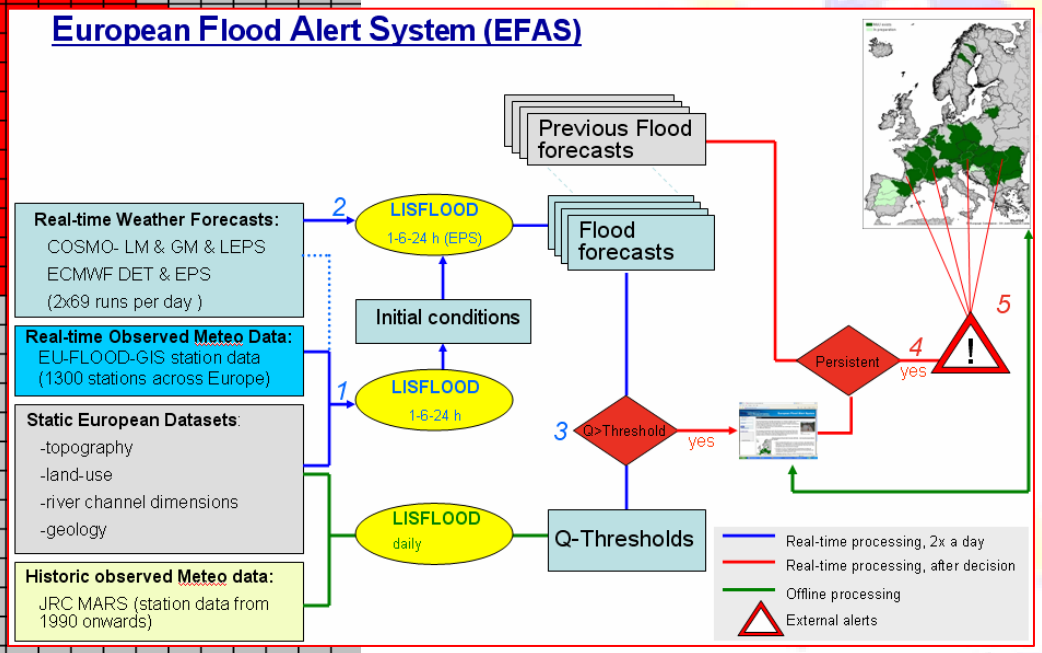
proxy hydrological record exceeds the threshold

forecasts exceed the threshold

→ **EFAS-methodology has potential to process flood forecasts for African basins**

European Flood Alert System (EFAS)



A Complementary Flood Forecasting System

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 EFAS-methodology can be revealed
- 7 out of 8 flood events have been detected successfully
  - high accuracy in terms of timing and magnitude
  - lead-time is on average around 6-8 days (for floods exceeding the high alert threshold)
- system has been assessed as skilful

Take-home messages

1. **Questionnaire has revealed that there are a significant number of flood forecasting initiatives ongoing in Africa , but information are not easily accessible.**
   - → **In order to prevent repetitive work and enhance collaboration, the outcome of the questionnaire will be made accessible in future**

2. **EFAS-methodologies have shown a potential to process medium-ranged flood forecasts for African basins with a high accuracy in terms of timing and magnitude**
   - → **flood events have been detected successfully in more than 85 % of all cases**
   - → **Average lead-time: 6-8 days (for floods exceeding the high alert threshold)**

3. **The JRC is working towards a Pan-African Flood Alert System**
   - → **more case studies are planned in different river basins**
   - → **hydrological model is being adjusted**
   - → **different satellite products will be tested**

“Heading Towards a Pan-African Flood Early Warning System”

Thank you for your interest!

JRC
EUROPEAN COMMISSION

for further questions do not hesitate to contact:

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