Summer School on Climate Impacts Modelling for Developing Countries: Water, Agriculture and Health

(9 September 2011)

Session IV: Water

Towards a pan-African flood alert system?

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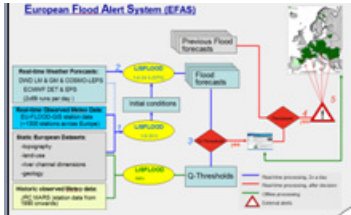
Institute for Environment and Sustainability



Session IV: Water

Towards a pan-African flood alert system



Why a flood forecasting system for Africa?

Floods in Northern Hemisphere Africa 2007

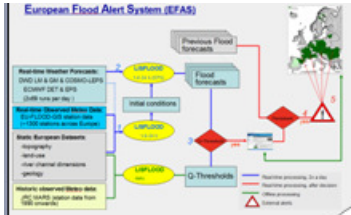
- ~ 650,000 homes destroyed
- 1.5 million people affected
- 200 people drowned
- substantial economic losses

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)

Outline



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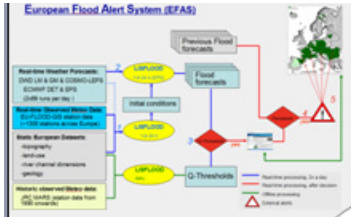
Towards a pan-African flood alert system



How and by whom are floods in Africa managed today?

- 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)



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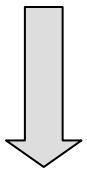
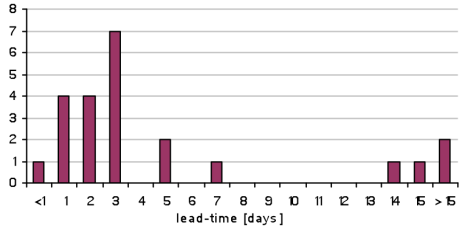
Main findings:

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

2. There are needs for:

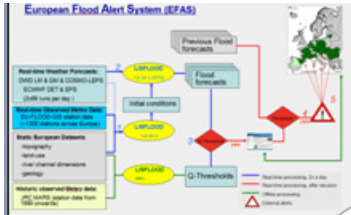
- a (complementary) flood forecasting and early warning system for medium-ranged forecasts
- technical expertise
- increased funds





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



Session IV: Water

Towards a pan-African flood alert system



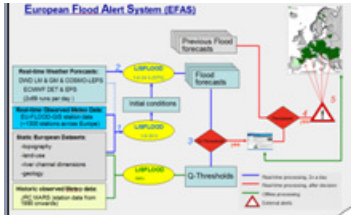
This presentation should give …

1) an overview about the current status of flood forecasting in Africa
2) a rough idea about the European Flood Alert System (EFAS)
3) an example of an African application

For whom is this PPP of interest?

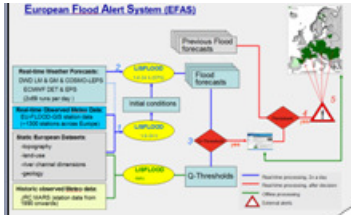
People that are interested in flood forecasting or hydrological modelling

Outline



European Flood Alert System (EFAS)

- Land Management and Natural Hazard Unit, Joint Research Centre, EC
- developed since 2003; pre-operational since 2005
- currently 34 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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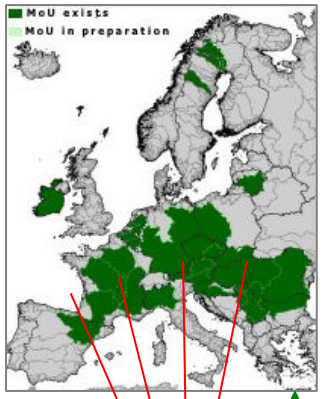
Towards a pan-African flood alert system



How does the European Flood Alert System (EFAS) work?



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

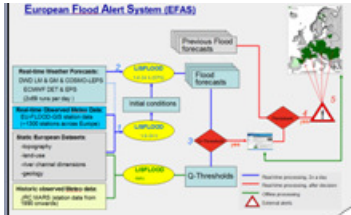
Q-Thresholds

3 Q>Threshold yes

Persistent 4 yes

5

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



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Towards a pan-African flood alert system

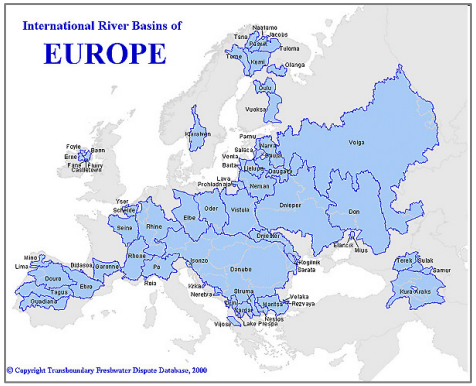


Does EFAS have an potential for African basins?

(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 / contacts

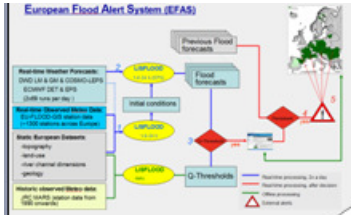
ECMWF

ADDIS ABABA UNIVERSITY

GLOWA Volta

SWALIM
Somalia Water and Land Information Management

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



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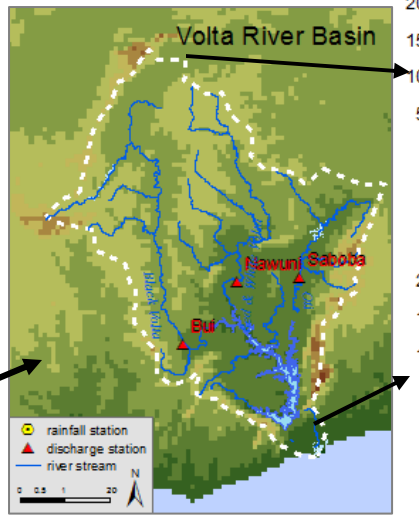
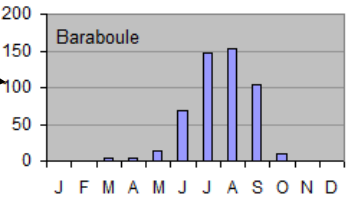
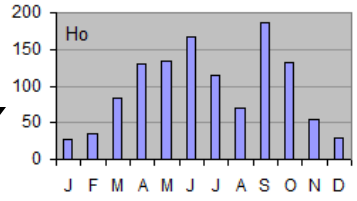
Towards a pan-African flood alert system



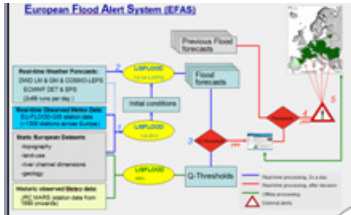
Study area: Volta River Basin







- **Ghana, Burkina Faso, Togo**
- **394,000 km²**
- **altitude ranges from 600 m to sea level**
- **climate:**
  - **north: dry (Sahelian influenced), 300 – 500 mm, short uni-modal rainfall pattern**
  - **south: wet (oceanic influenced), 1200-1500 mm; long, slightly bi-modal pattern**



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Which data are used?

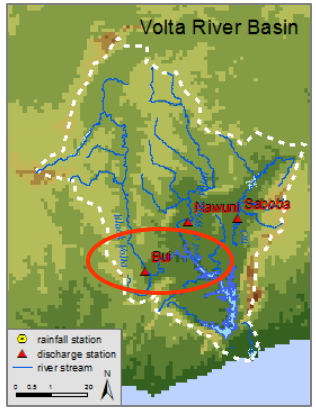
Meteorological data

- CMORPH (2003-2010)
- ERA-interim (1989-2009)
- GSMaP-MKV (2003-2009)
- GPROF (1998-2010)
- PERSIANN (2000-2010)
- PERSIANN-CCS (2006-2010)
- RFE 2.0 (2001-2010)
- TRMM-TMP 3B42 (1998-2010)

} near-real-time SRFE for calibration and validation

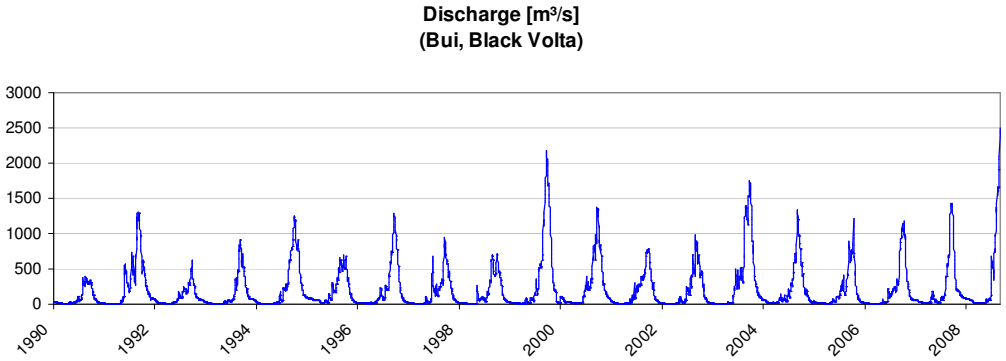
- EPS (Events: 1999, 2003, 2007, 2008)

} meteorological forecasts for hydrological hindcasting



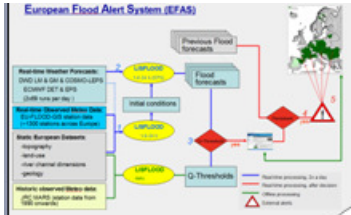
Hydrological data

- Bui (Black Volta)
- Nawuni (Red & White Volta)
- Saboba (Oti)



Many static data

(such as land cover, soil information, …)



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How was the study executed?

(1) **uncalibrated test run**

→ first impression on model behaviour for this catchment

(2) **simple sensitivity analysis**

→ identify sensitive parameters for model calibration

(3) **automatic calibration** (2004 – 2007)

→ adjustment of the model

- Shuffle Complex Evolution algorithm (SCE-UA)
- Shape (r) & quantity (NSeff)
- visual and statistical comparison (correlation, CRPS, spread-skill relationship, rank histogram, ROC)

(4) **validation** (2002-2003)

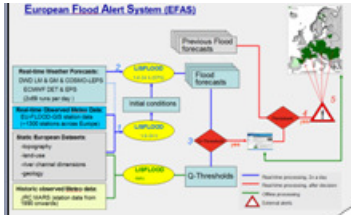
→ verify the performance of the model after calibration

(5) **thresholds**

→ derive warning levels (for low, medium, high and severe flood)

(6) **hindcasting**

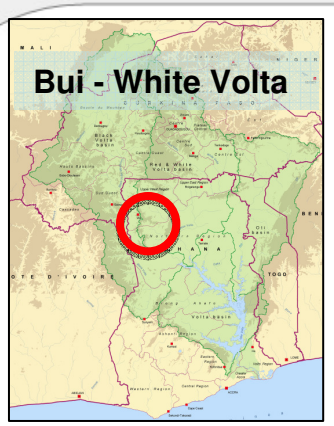
→ test how good the system would predict floods



Session IV: Water

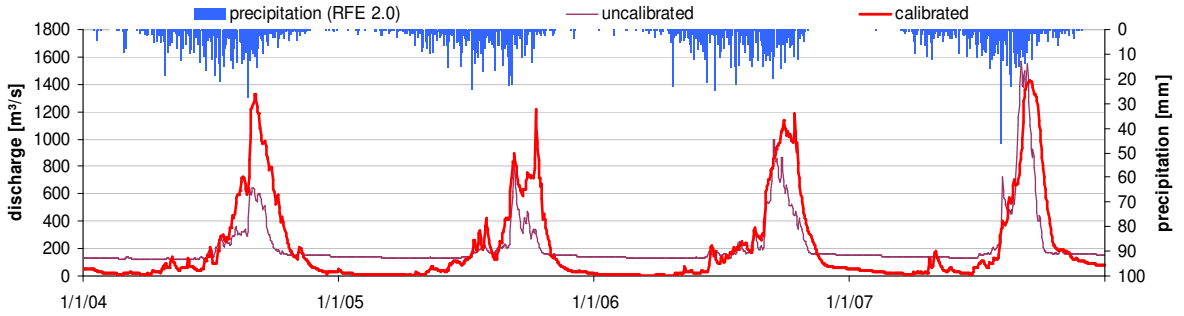
Towards a pan-African flood alert system



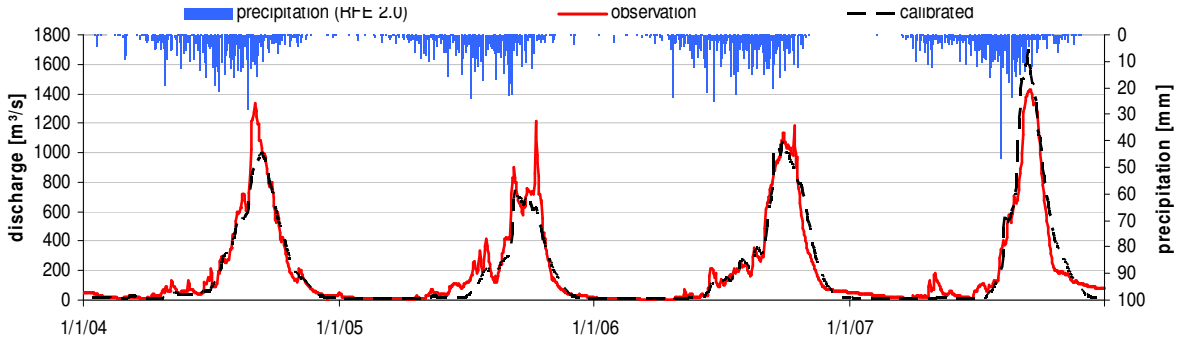


Goodness of fit parameters	Different meteorological data sources						
	ERA-interim	CMORPH	PERSIANN	TRMM-TMP	RFE	PERSIANN CCS	CMORPH 8 km
RMSE [-]	160	223	354	186	86	245	137
Nash-Sutcliff [-]	0.76	0.77	0.32	0.84	0.92	0.51	0.89
correlation [-]	0.90	0.89	0.61	0.93	0.96	0.80	0.95

1. uncalibrated →

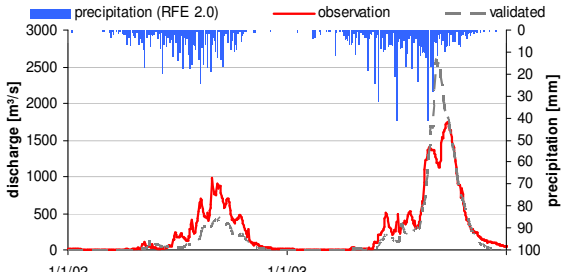


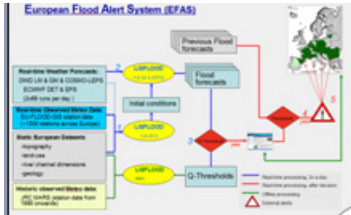
2. calibrated →



Goodness of fit parameters	RFE		
	uncalibrated	calibrated	validated
RMSE [-]	227	86	216
Nash-Sutcliff [-]	0.63	0.92	0.7
correlation [-]	0.76	0.96	0.9

3. validated →





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Towards a pan-African flood alert system

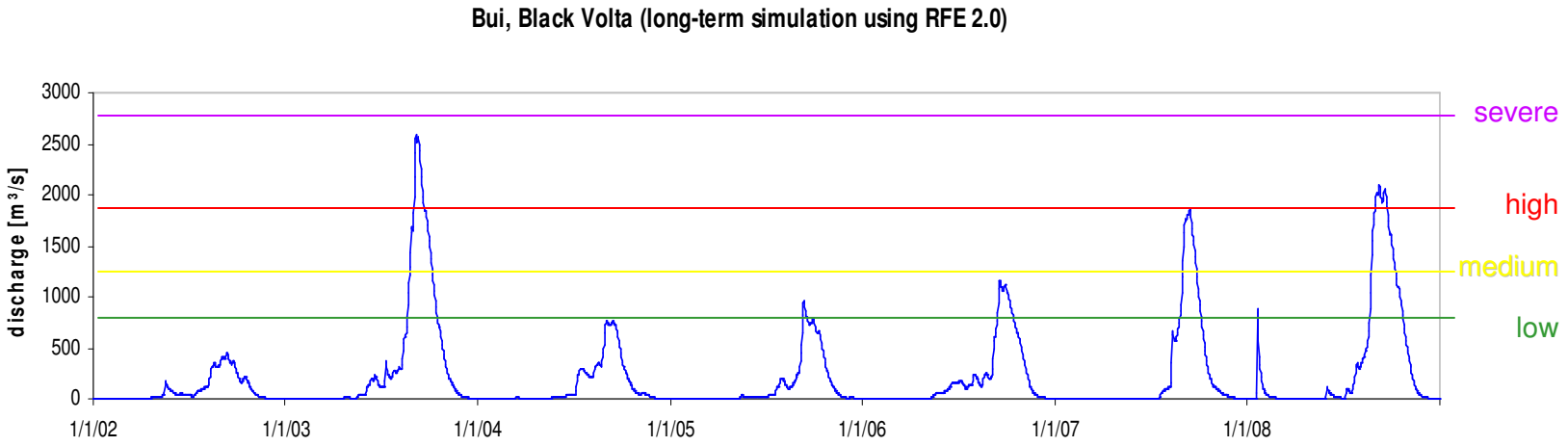


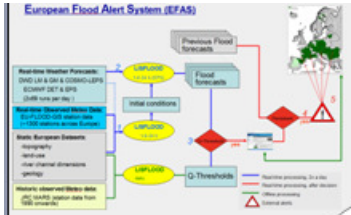
How to derive thresholds?

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.

translated into return periods:

severe = 20
high = 5
medium = 2
low = 1





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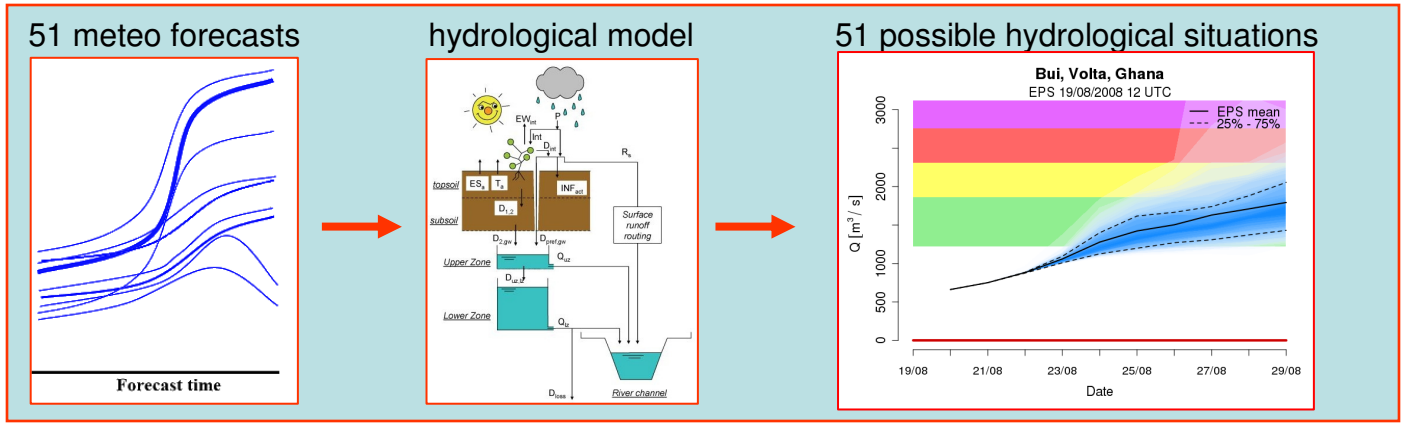
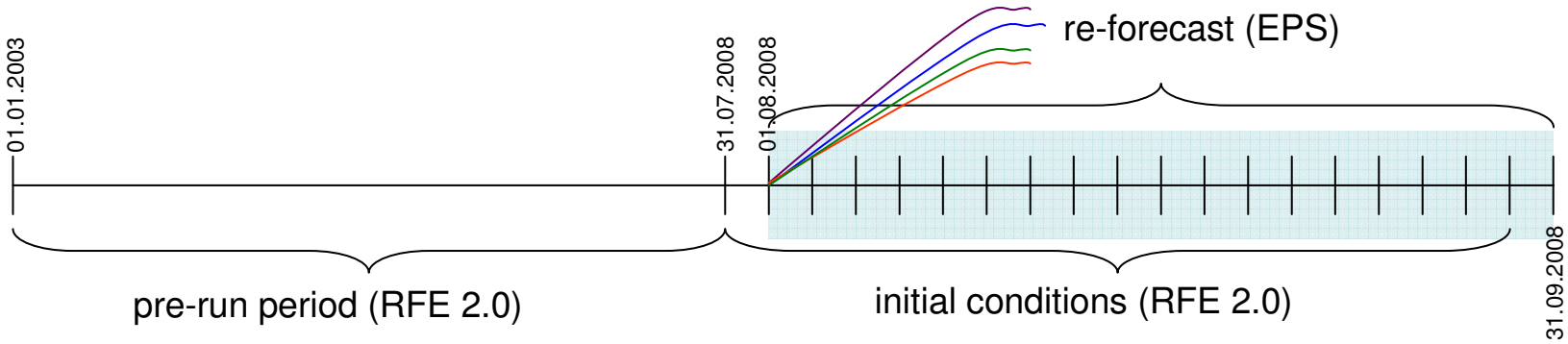
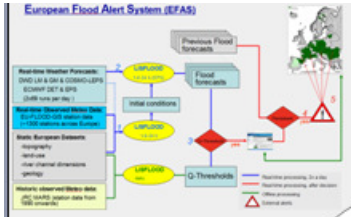
Why are we calculating hindcasts?

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





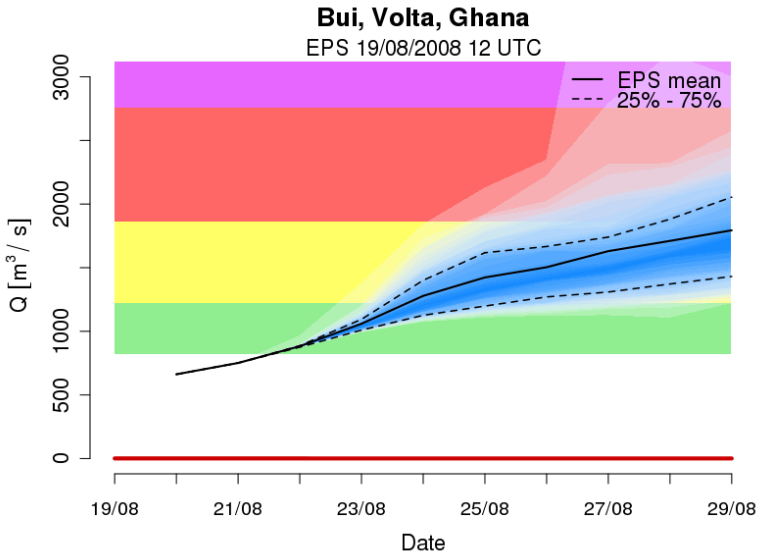


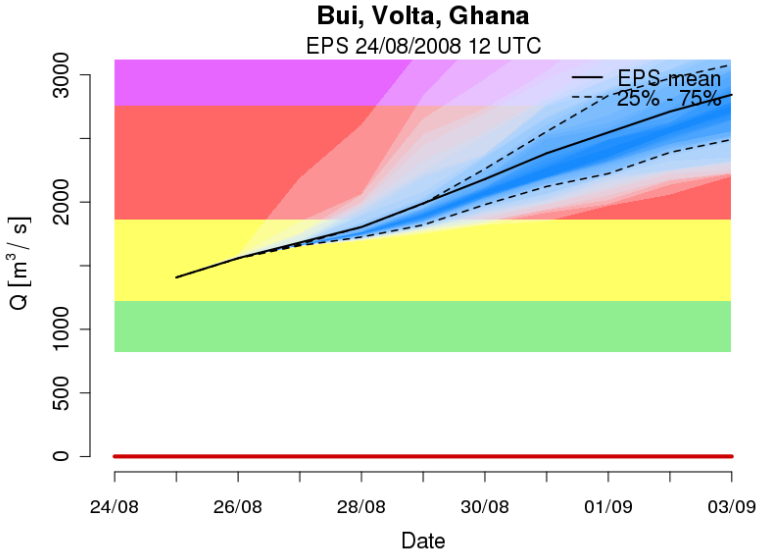
Session IV: Water

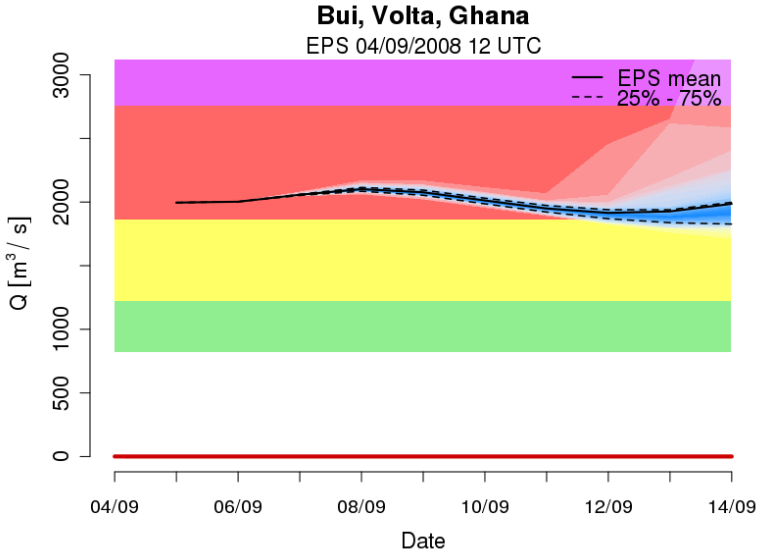
Towards a pan-African flood alert system

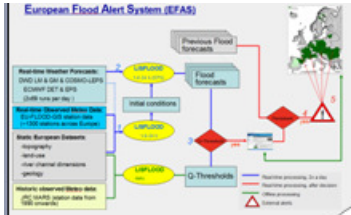


Outline









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Hindcast: Bui

	August																														
	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	01	02	03	04	05	06	07	08	09	10
8/11/08	0	0	0	0	1	1	4	3	4	9																				
8/12/08		0	0	0	0	0	1	3	6	11	25																			
8/13/08			0	0	0	0	0	0	0	1	5	23																		
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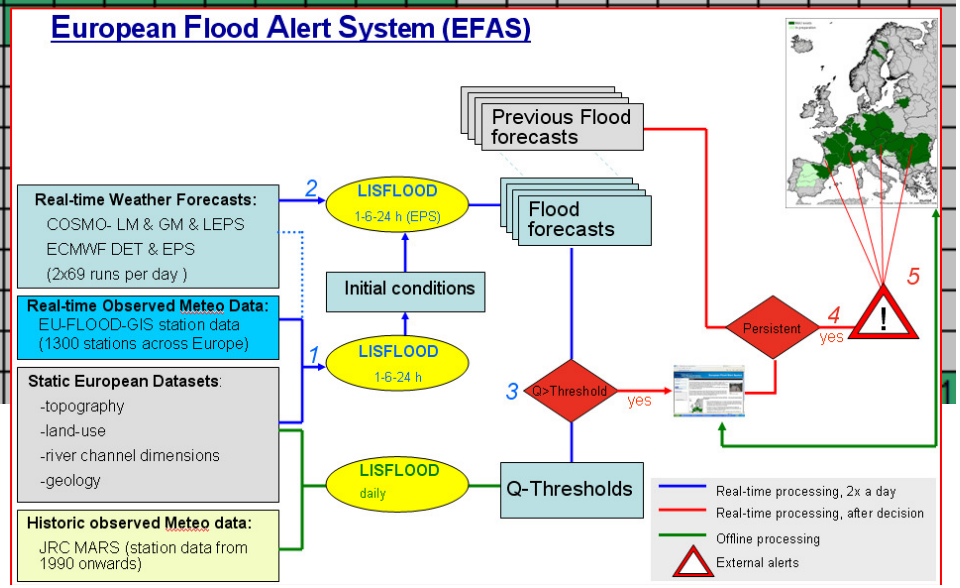
proxy hydrological record exceeds the threshold

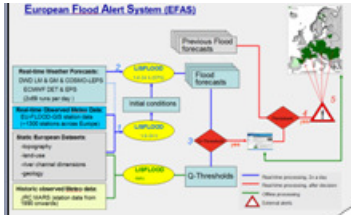
forecasts exceed the threshold



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

Outline

- Introduction
  - Why a FFS
  - current status
  - "hot spots"
  - objectives
- European Flood Alert System
  - in Europe
  - in Africa
- Case study: Volta
  - study area
  - data
  - approach
  - results
    - calibration / validation
    - thresholds
    - hindcast
- Take home messages
- Discussion



Session IV: Water

Towards a pan-African flood alert system



1. **Questionnaire has revealed that there are a significant number of flood forecasting initiatives ongoing in Africa, but information are not easily accessible.**

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**

in Juba-Shabelle:

→ 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)

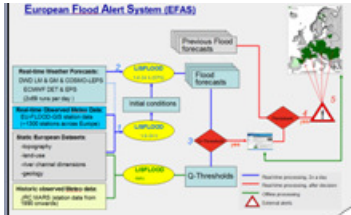
in Volta:

→ even the quantity is well predicted

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



Session IV: Water

Towards a pan-African flood alert system



Thank you for your attention!

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