The road towards GloFAS 3.0 Recent developments in the Global Flood Awareness System

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The Global Flood Awareness System

- **GloFAS** is an operational system for flood early detection

- It provides ensemble streamflow forecasts for the future 30 days in all the world's large rivers

- Jointly developed by JRC & ECMWF with support from national hydro-met services and universities

- Daily runs since 2011 in pre-operational mode

- Used by development agencies, international aid organizations, DG ECHO ERCC, national hydro-met services, private sector (e.g. insurance). Currently more than 3000 registered users.
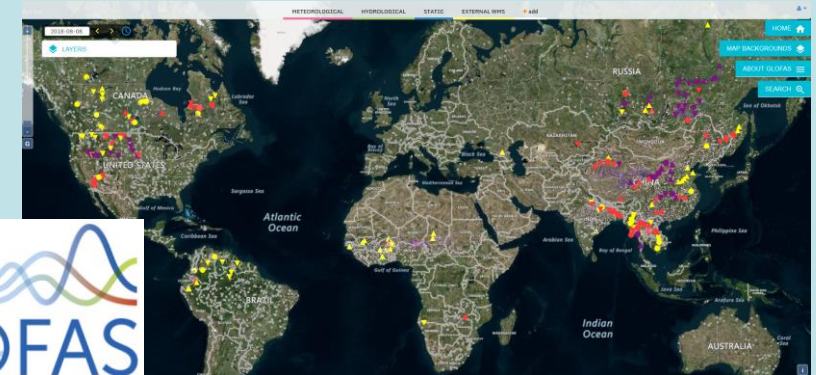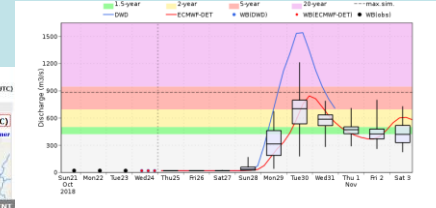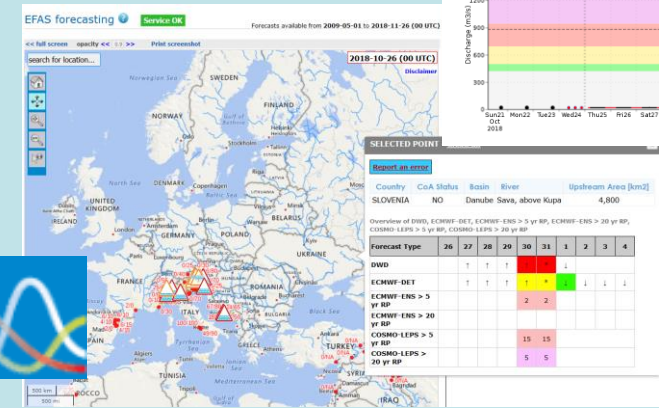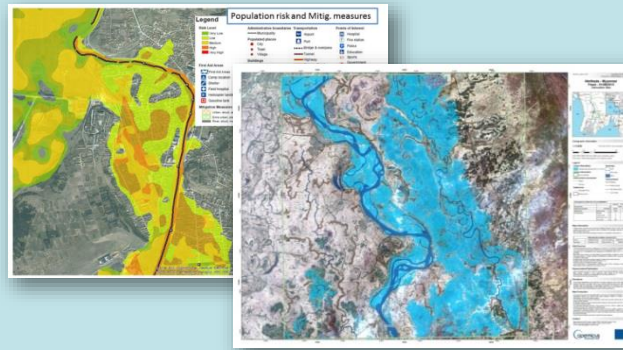
- **http://www.globalfloods.eu**
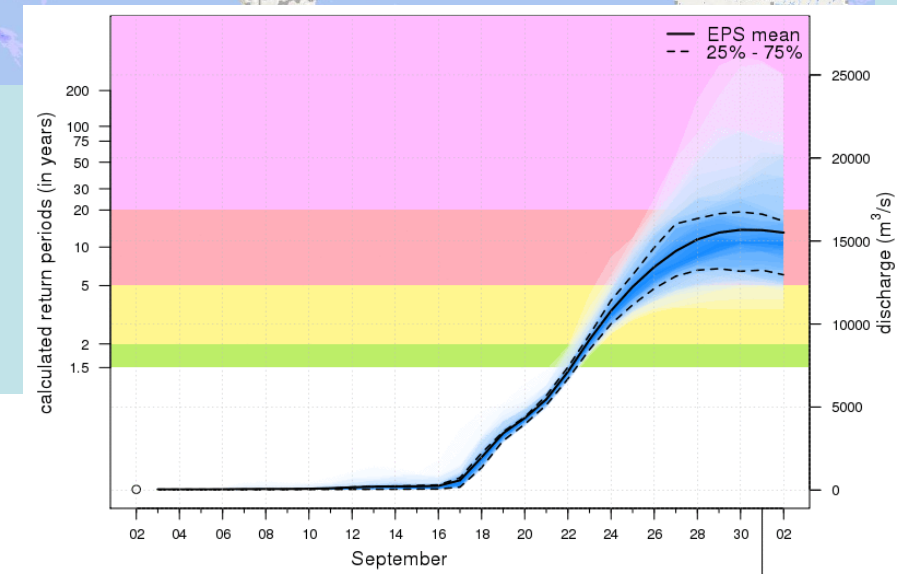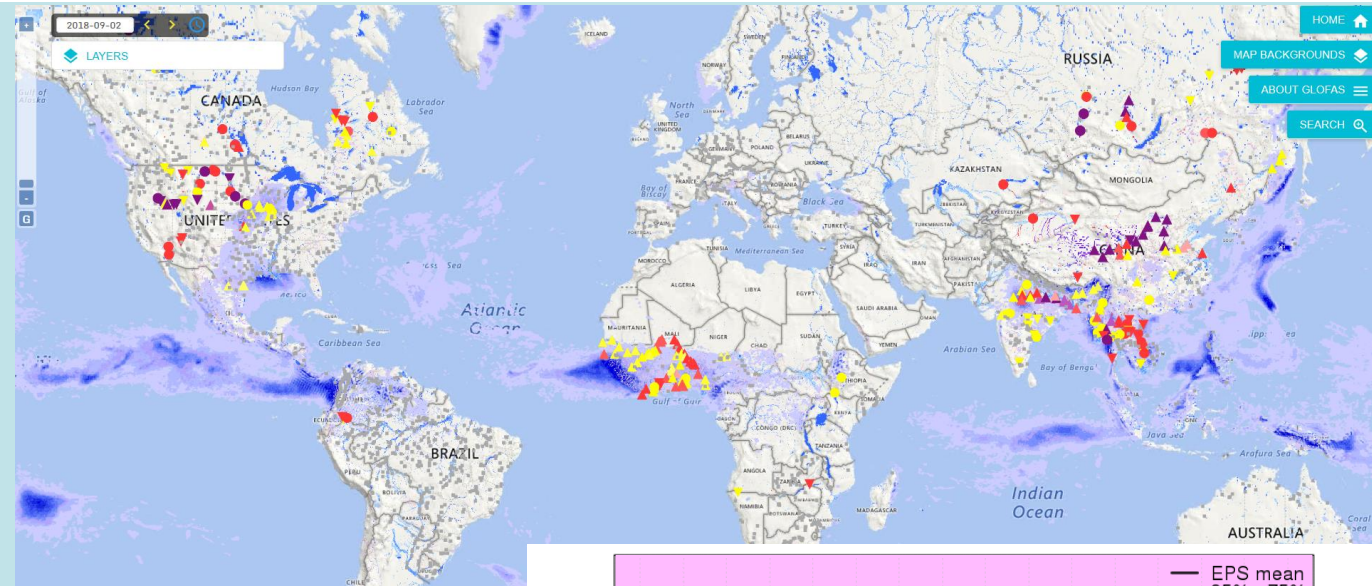
GloFAS and the Copernicus Programme

Copernicus is the European Union's Earth Observation Programme

Atmosphere (CAMS)
Marine (CMEMS)
Climate (C3S)
Emergency (EMS)
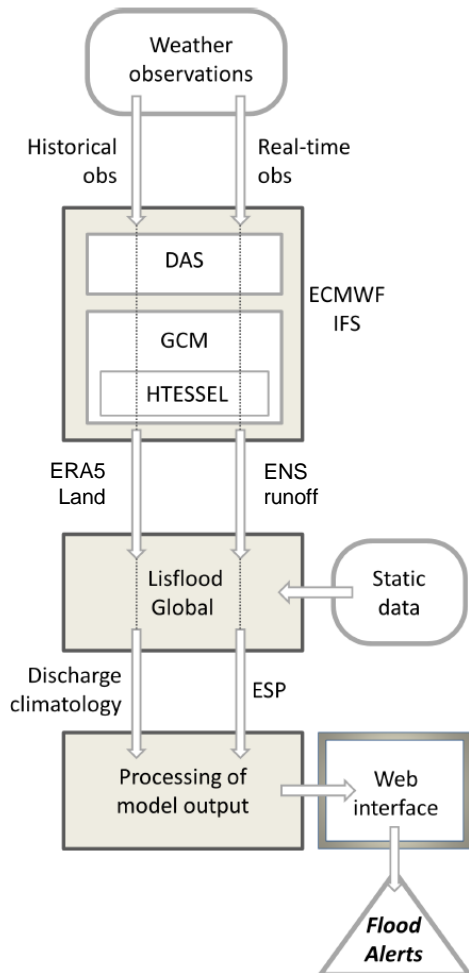**Land (CLMS)**
Security
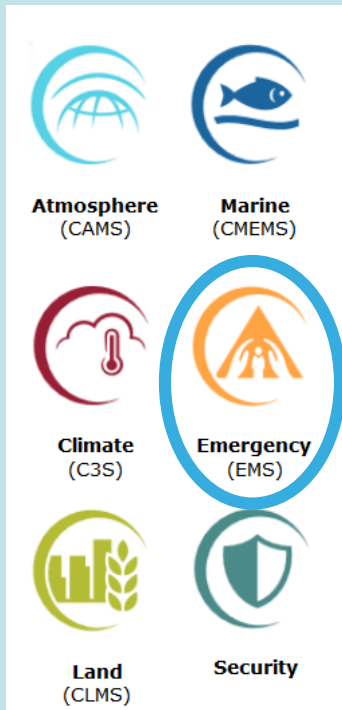
Mapping

Early warning

- ✓ Floods (EFAS, **GloFAS**)
- ✓ Droughts (EDO, GDO)
- ✓ Forest fires (EFFIS, GWIS)

EFAS

GLOFAS
Global Flood Awareness System

Copernicus
Europe's eyes on Earth

European Commission

Schematic view

(Alfieri et. al, HESS 2013)

Input data

Global spatial information

Hydrological model

HTESSEL + LISFLOOD

Output

River streamflow forecast

2, 5, and 20 year flood return periods

ECMWF-ENS

Ensemble weather predictions (51 members)

Grid resolution: 0.1° (~ 10 km)

Temporal resolution: 1 day
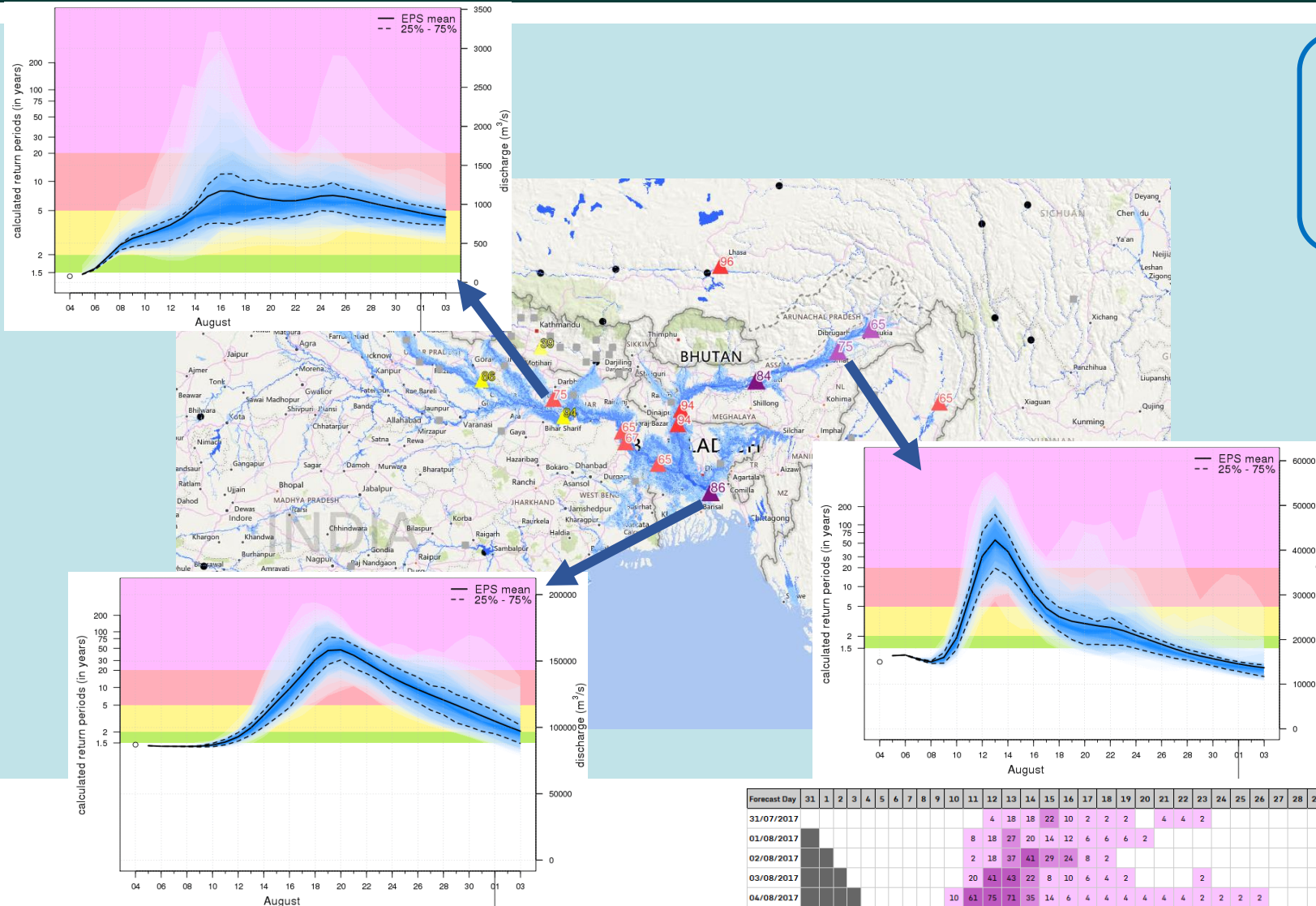
Flood warnings

European Commission
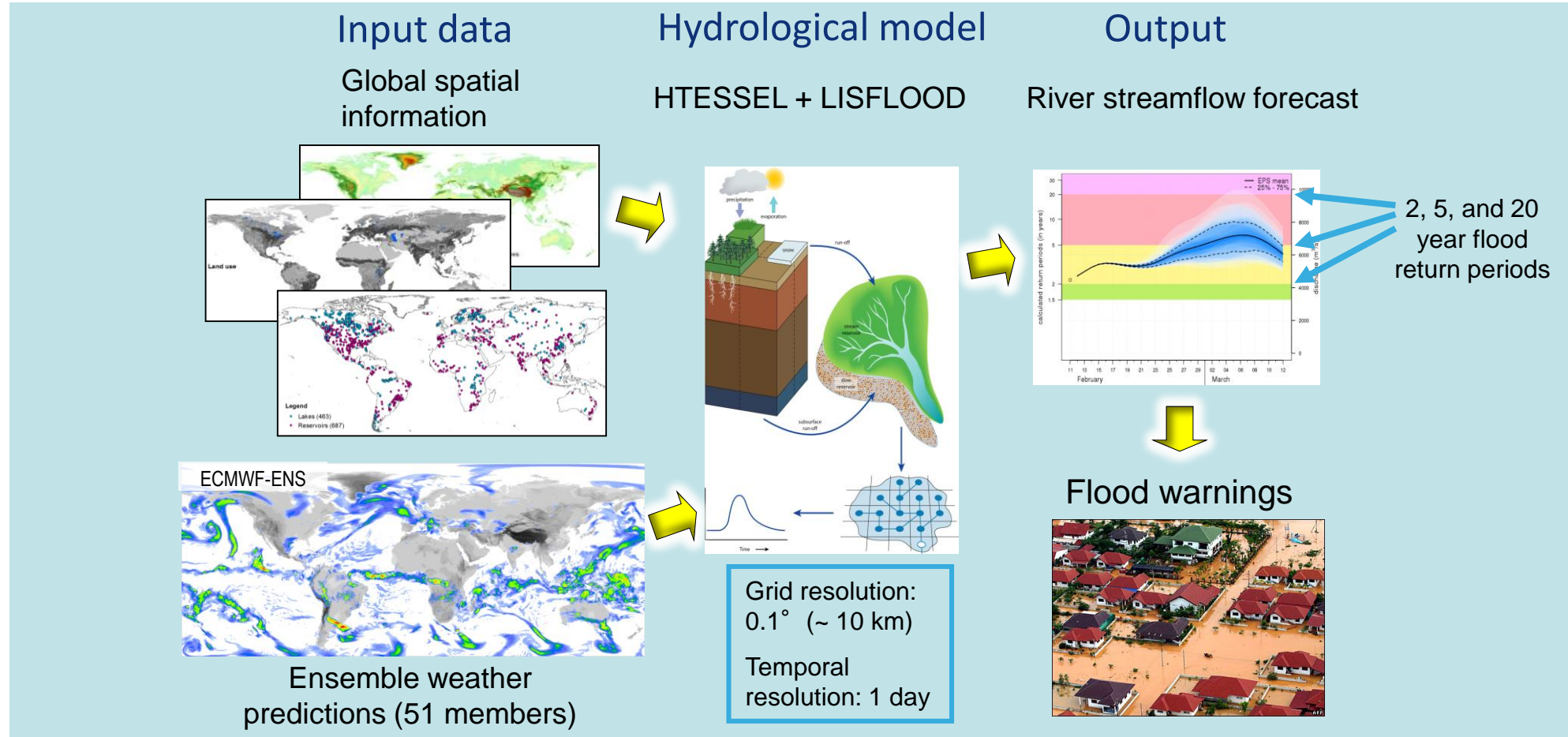
Floods in Bangladesh – August 2017

Monsoon rains caused landslides and floods that killed about 1300 people and affected over 45 million people across India, Nepal and Bangladesh.
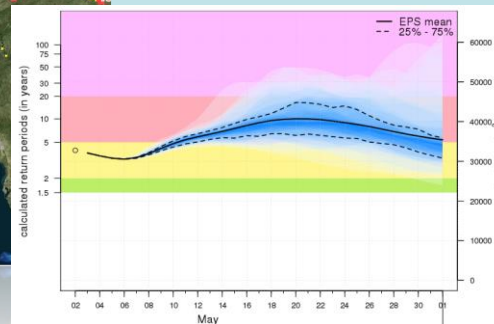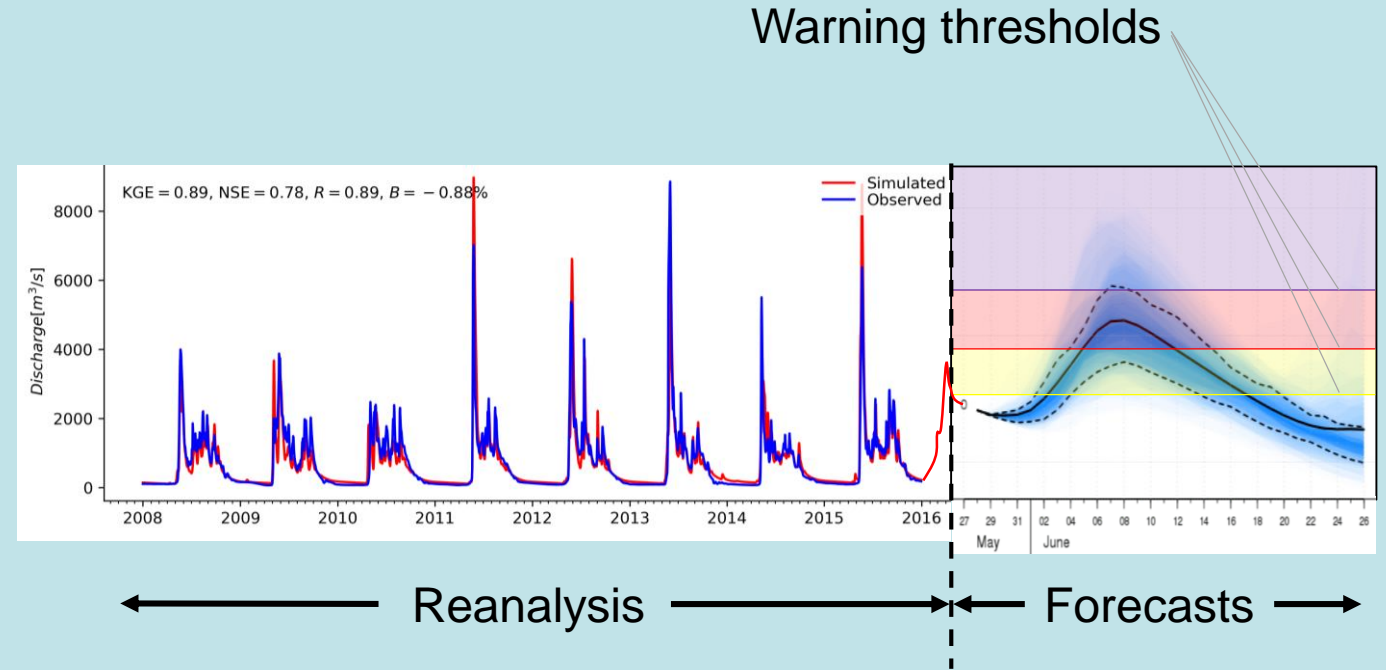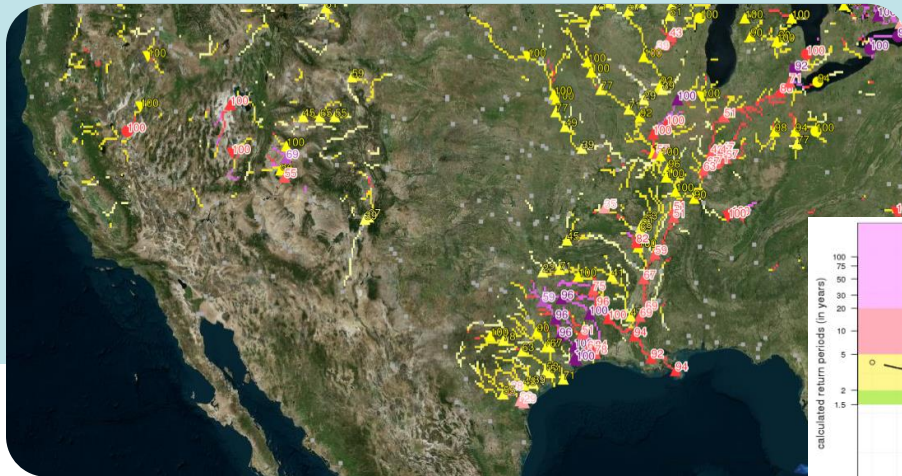
GloFAS forecasts

- 28 July: signs of a potential major event, 12 to 18 days ahead of the flooding along the major rivers.

- 7 August: Activation of the GFP community

- 10 August: request for pre-tasking the acquisition of satellite images to the Copernicus EMS

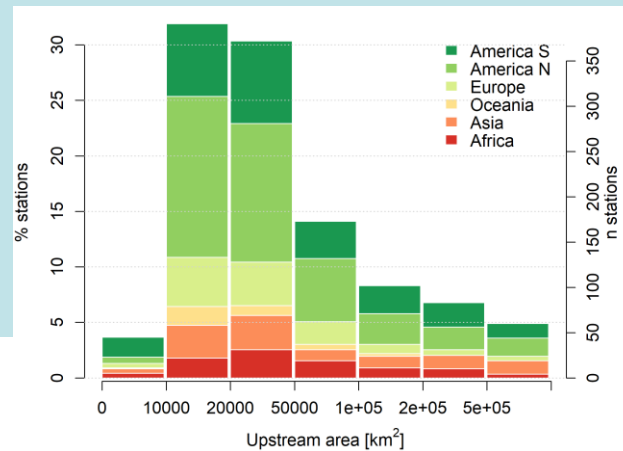| Forecast Day	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
31/07/2017												4	18	18	22	10	2	2		4	4	2								
01/08/2017											8	18	27	20	14	12	6	6	6	2										
02/08/2017											2	18	37	41	29	24	8	2				2								
03/08/2017											20	41	43	22	8	10	6	4	2				2							
04/08/2017										10	61	75	71	35	14	6	4	4	4	4	4	4	2	2	2					

Ongoing research topics

- Improving hydrological reanalysis and initial conditions
- Improving streamflow predictions
- Improving early flood detection (warning thresholds)
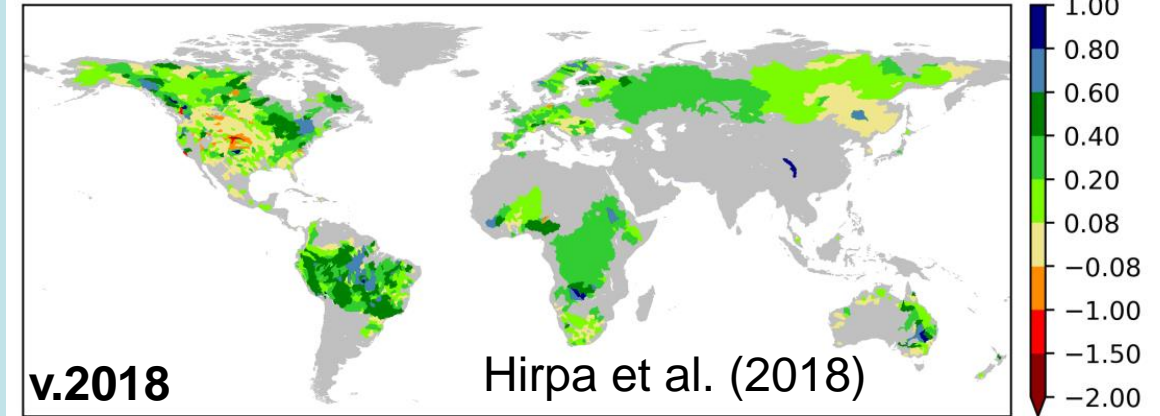- Improving layout and product visualization

Warning thresholds

Reanalysis ← → Forecasts

GloFAS 3.0 model setup
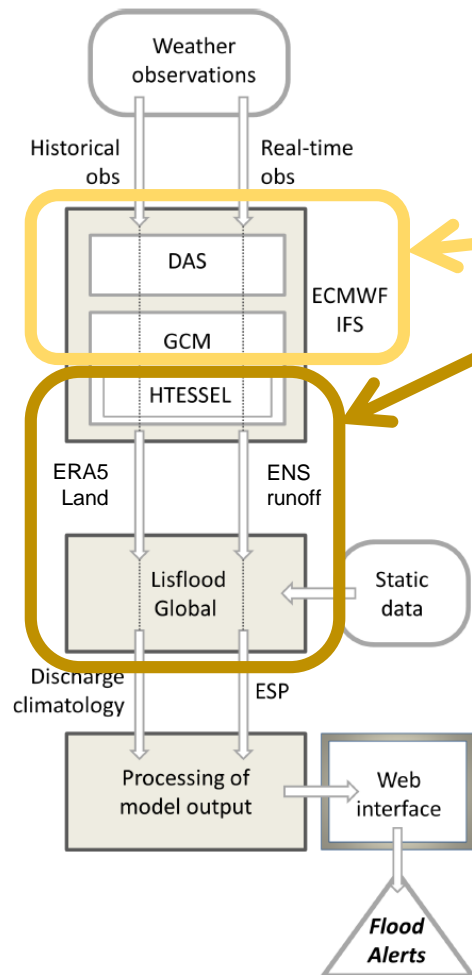
	v.2018	v.2019
Meteo input	ECMWF Reforecasts	ERA5
Hydrological model	HTESSEL + LISFLOOD*	LISFLOOD
Calibrated stations	1287	1226

KGE Skill Score (calibration period)

v.2018   Hirpa et al. (2018)

Calibration length [years]

v.2019

Calibration results - KGE

Skill gain = 0.24

v.2018

v.2019
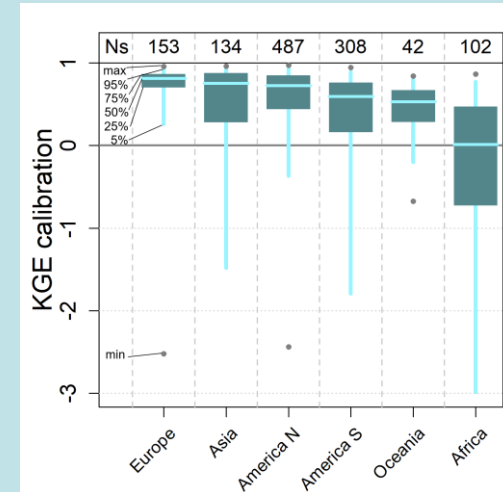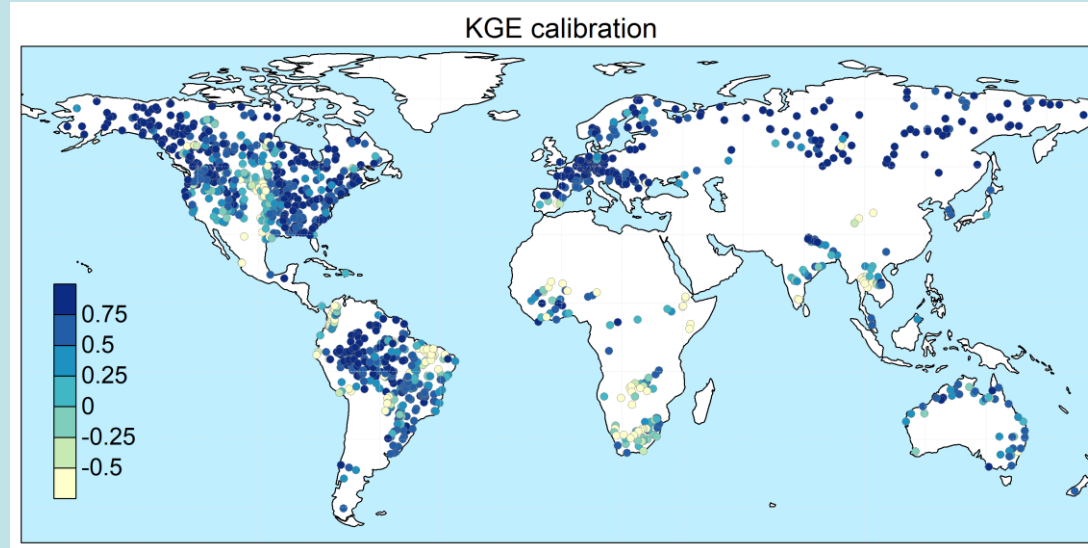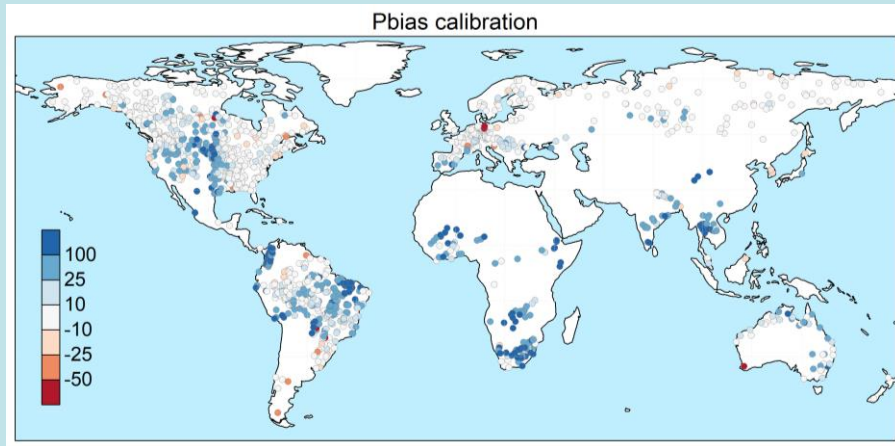
KGE>0
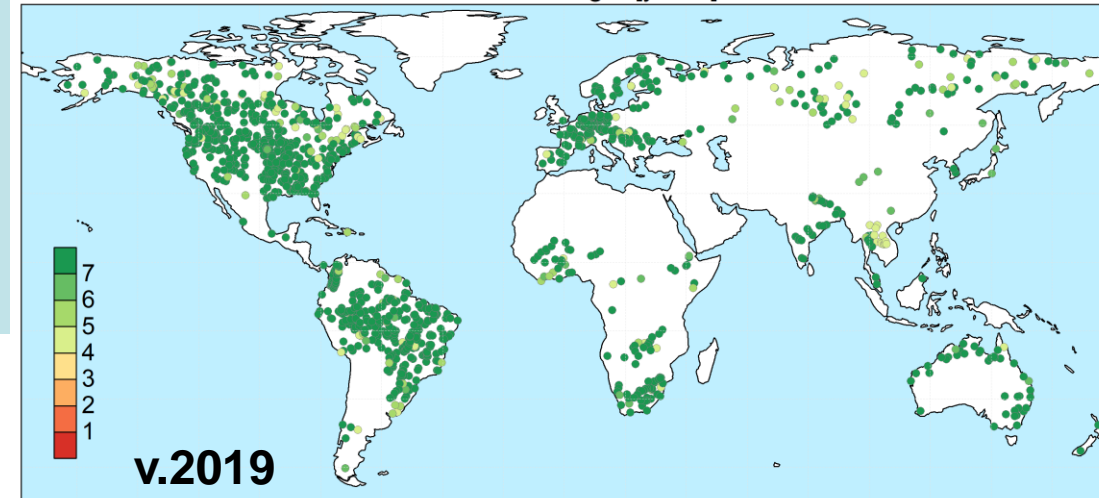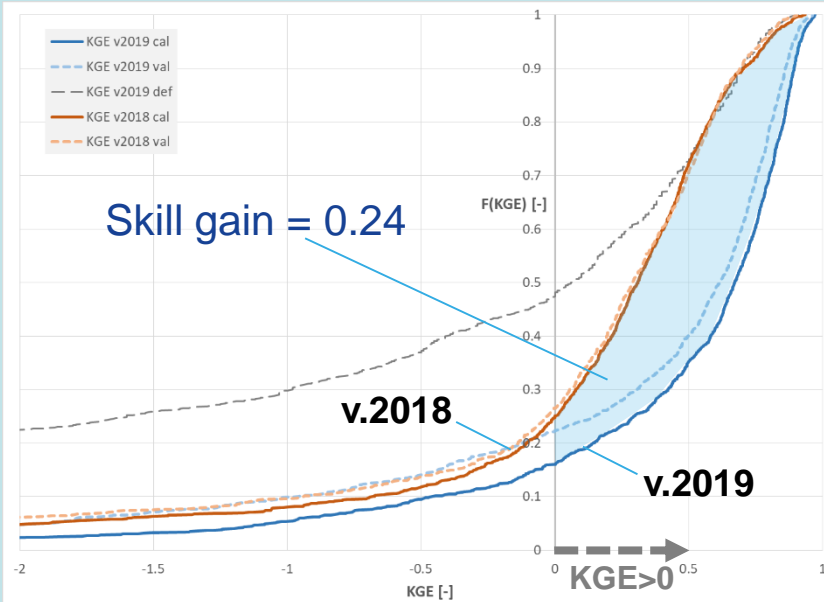
- 8 model parameters
- >320,000 model runs

- Substantial improvement compared to the previous calibration round
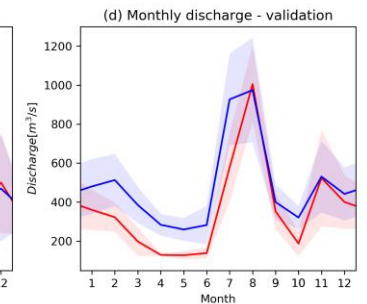- Need to improve in Africa and south Asia (both skills and station density)
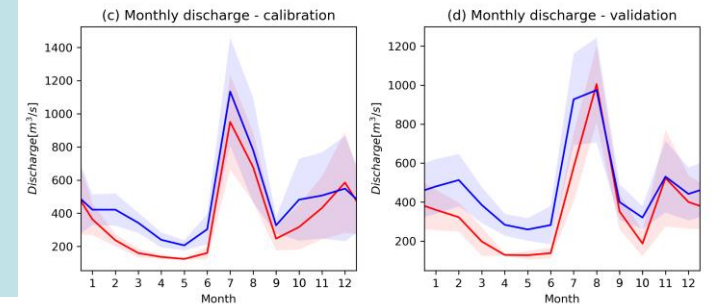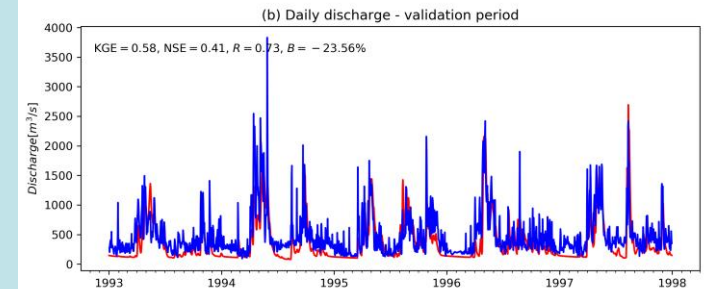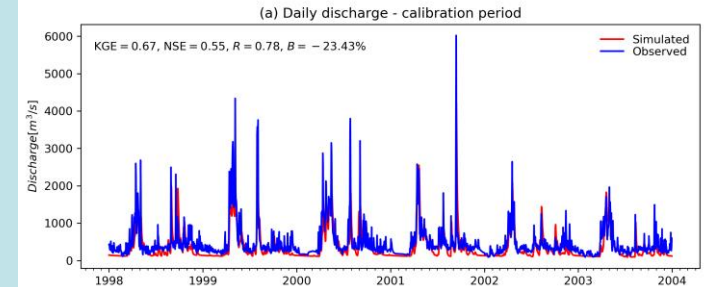

KGE calibration

Calibration results - bias

Pbias calibration

- Large differences in the bias compared to the previous version, indicating differences in the meteo input

- Smaller absolute bias

- Median scores in calibration:
  KGE=0.67
  r=0.8
  NSE=0.42
  PBias=8%
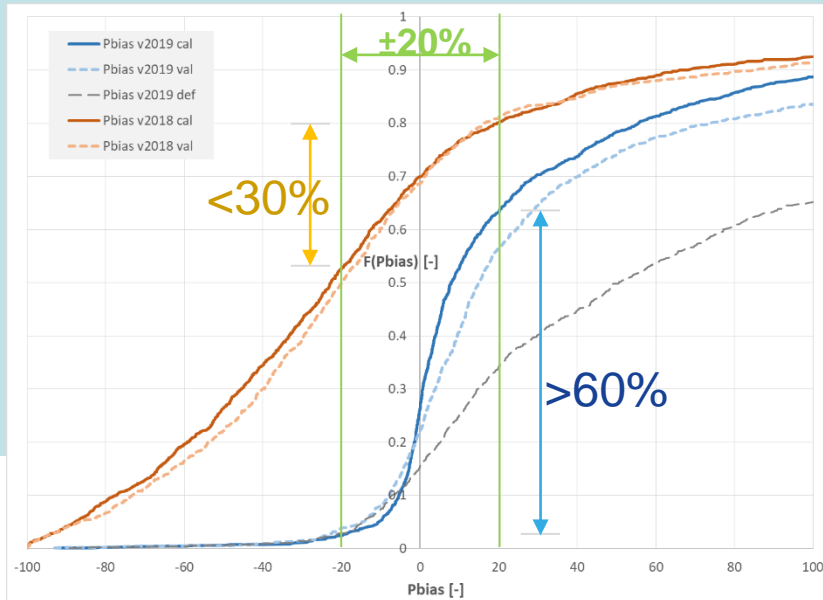
G0651: Ishikari at Ishikari-Ohashi (Japan)

ERA5 vs. ENS forecasts
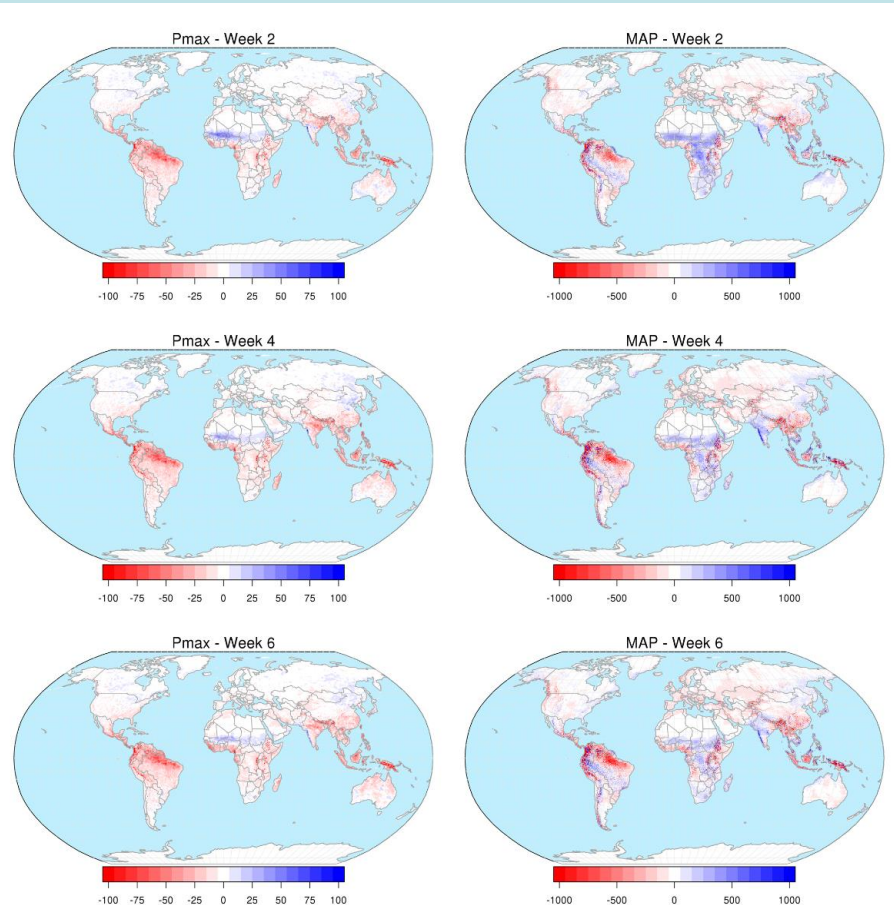
Precipitation
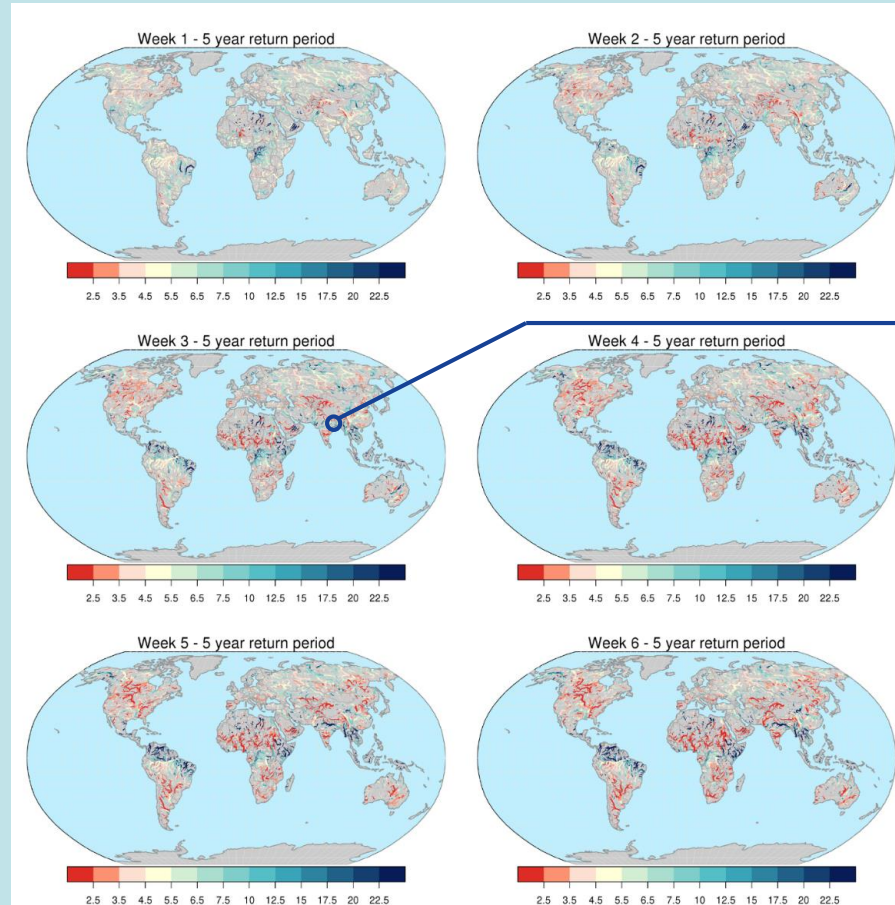
5-year peak discharge

In this river section, a 5-year return period event corresponds to ~10 year return period at 3-week lead time

- The correction factor is very location specific

- Differences tend to increase with the lead time

- Results can already be used to better interpret current GloFAS forecasts over long ranges

Range dependent flood thresholds

Ganges at Hardinge Bridge
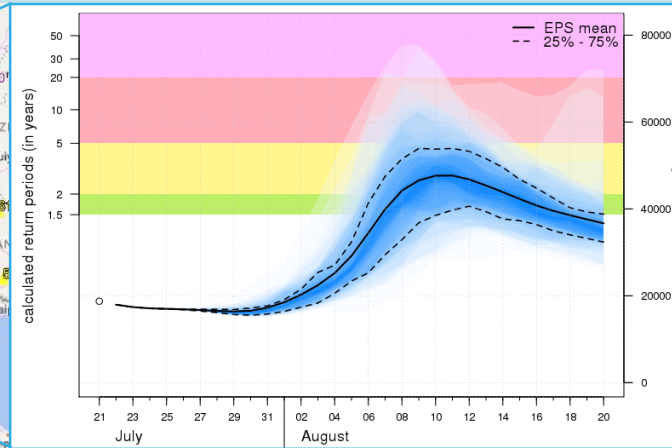
2 weeks later
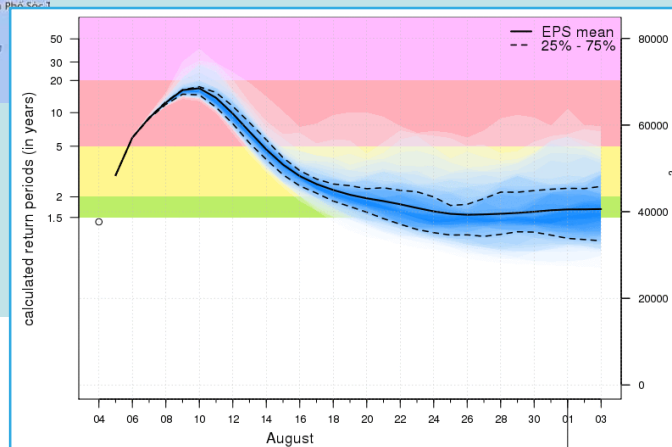
Forecasts became more severe as the event approached

Can we systematically anticipate this behavior for the entire river network?

Range dependent flood thresholds

Validity of fixed thresholds

ERA5-based fixed thresholds are statistically consistent with the entire 6-week streamflow forecasts only in 27% of grid points (20-year return period)

See Alfieri et. al, Journal of Hydrology X, 2019

Disaster response and mitigation

- Collaboration with '**Forecast-based Financing**' Red Cross Pilot Projects

- GloFAS forecasts are used as a trigger for early actions

- Uganda: First FbF humanitarian action in Nov. 2015 for foods during wet season

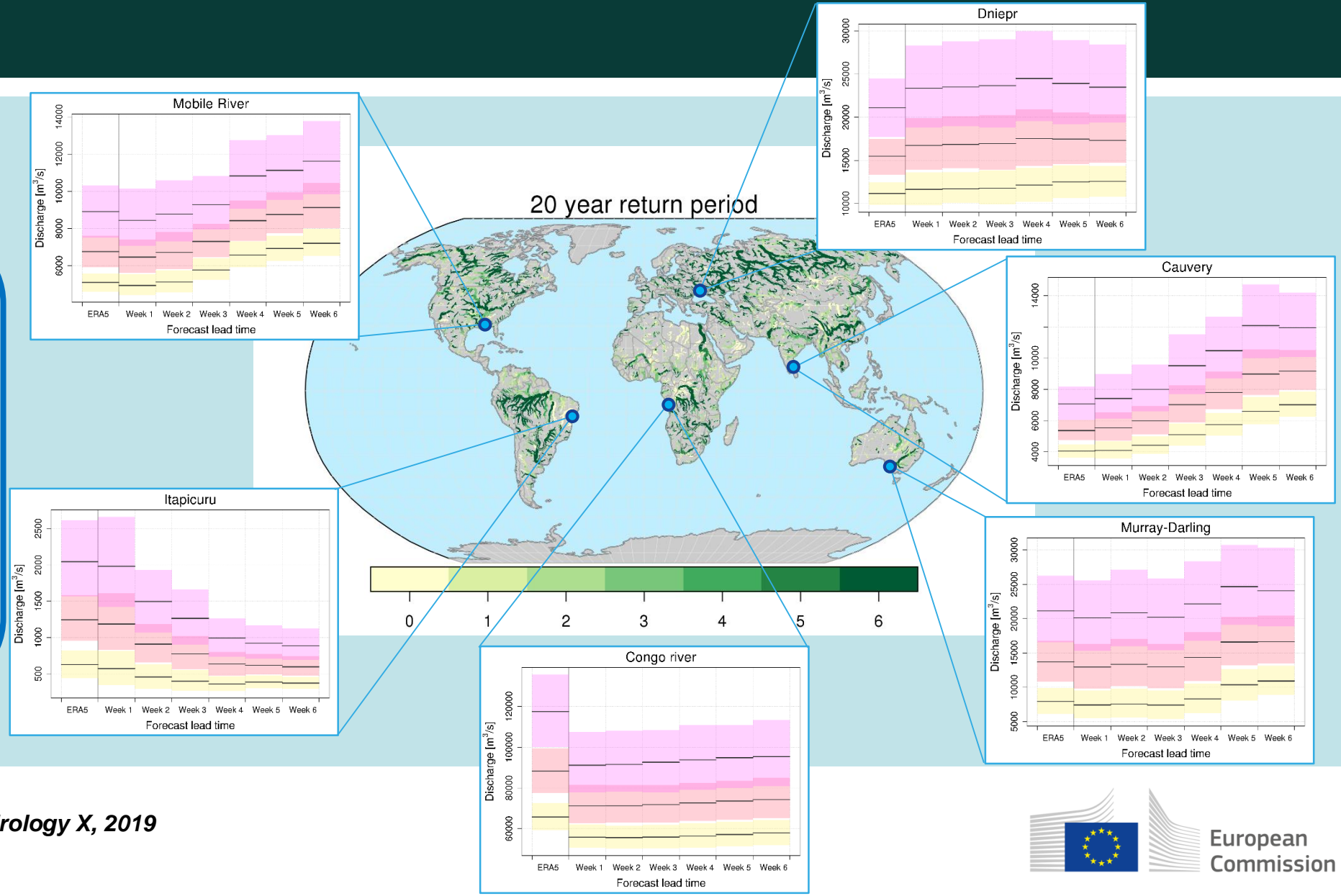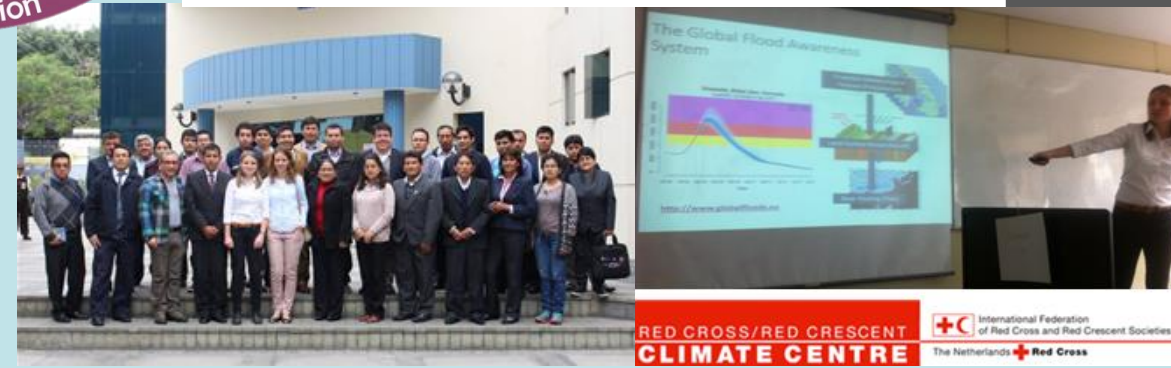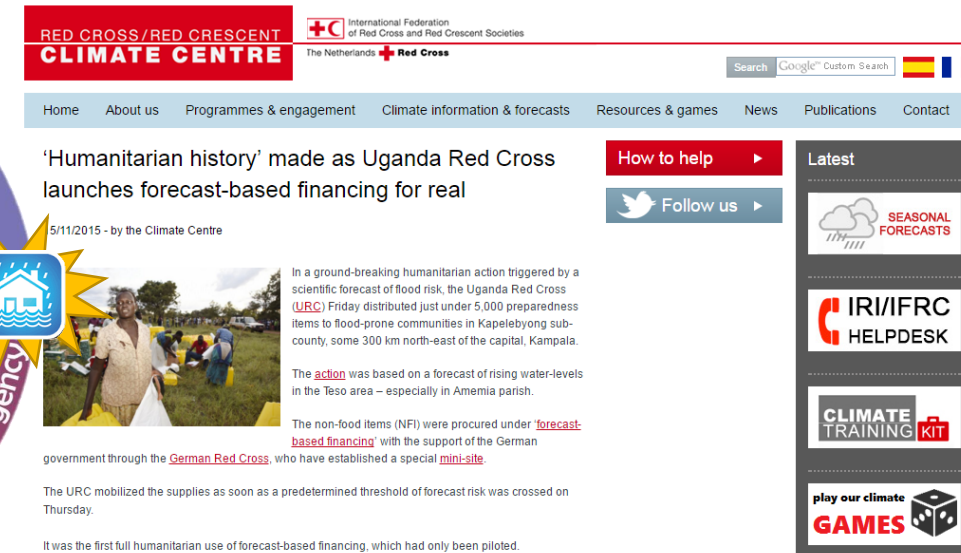- Nepal, Bangladesh and other FbF pilot projects (>10)

- **Capacity Building** in Peru: Flood Forecasting in North Peru is high priority because of El Niño

'Humanitarian history' made as Uganda Red Cross launches forecast-based financing for real

5/11/2015 - by the Climate Centre

In a ground-breaking humanitarian action triggered by a scientific forecast of flood risk, the Uganda Red Cross (URC) Friday distributed just under 5,000 preparedness items to flood-prone communities in Kapelebyong sub-county, some 300 km north-east of the capital, Kampala.

The action was based on a forecast of rising water-levels in the Teso area – especially in Amemia parish.

The non-food items (NFI) were procured under 'forecast-based financing' with the support of the German government through the German Red Cross, who have established a special mini-site.

The URC mobilized the supplies as soon as a predetermined threshold of forecast risk was crossed on Thursday.

It was the first full humanitarian use of forecast-based financing, which had only been piloted.

University of Reading

European Commission

The JRC global flood hazard maps

- Hydrological input: GloFAS streamflow climatology (ERA-Interim 1980-2014)
- Based on 2D hydrodynamic modelling and freely available data
- 30'' resolution (~1km)
- return periods from 10 to 500 years
- Validated against satellite observations and other global flood models
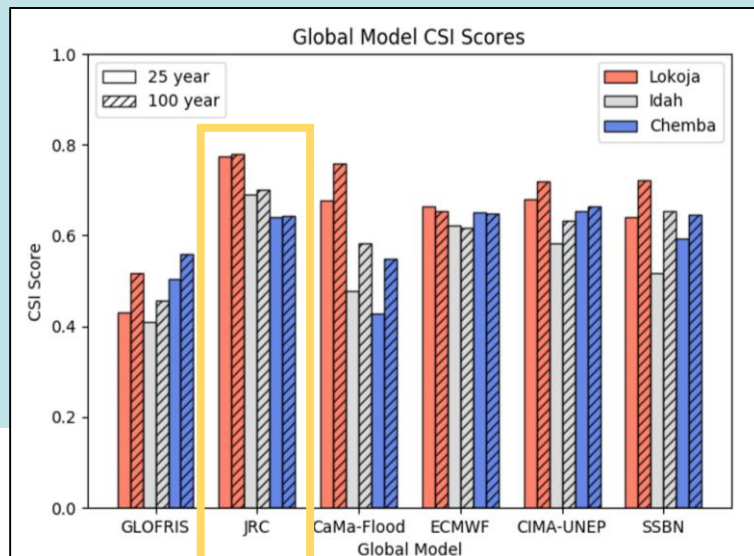
Flood hazard map for the Amazon River, 100 year return period (Dottori et. al, AWR 2016)

Global Model CSI Scores

Validation against satellite observations and other global flood models (Bernhofen et al., ERL 2018)
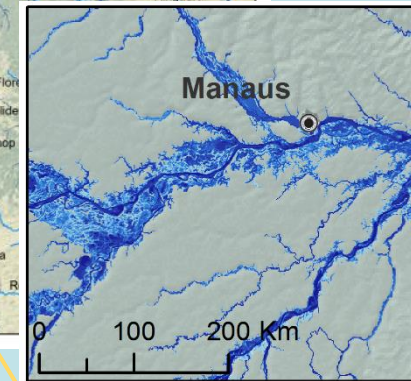
JRC flood inundation (30" resolution)
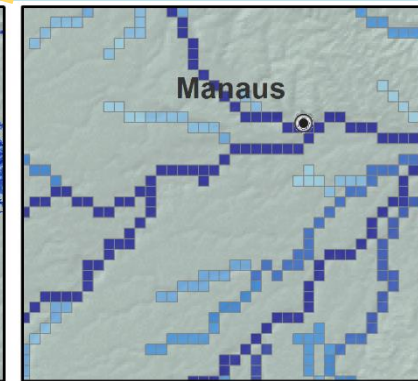
GloFAS river network (0.1° resolution)

- Freely available for download at
http://data.jrc.ec.europa.eu/collection/floods

European Commission

GloFAS in the web

- GloFAS website with forecasts, news and more:

  http://www.globalfloods.eu

- GloFAS Webinars:

- https://www.youtube.com/channel/UCV76vM-bU2cksErBz8D1vRw

- Twitter @globalfloods_eu
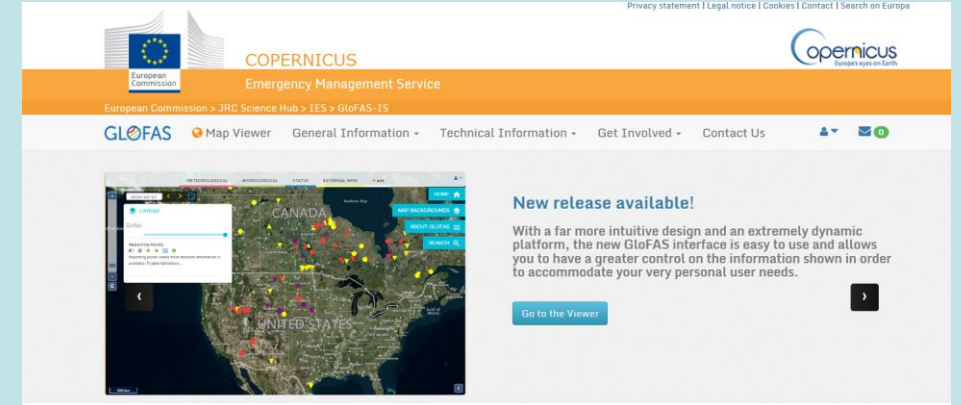
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Thank You!

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