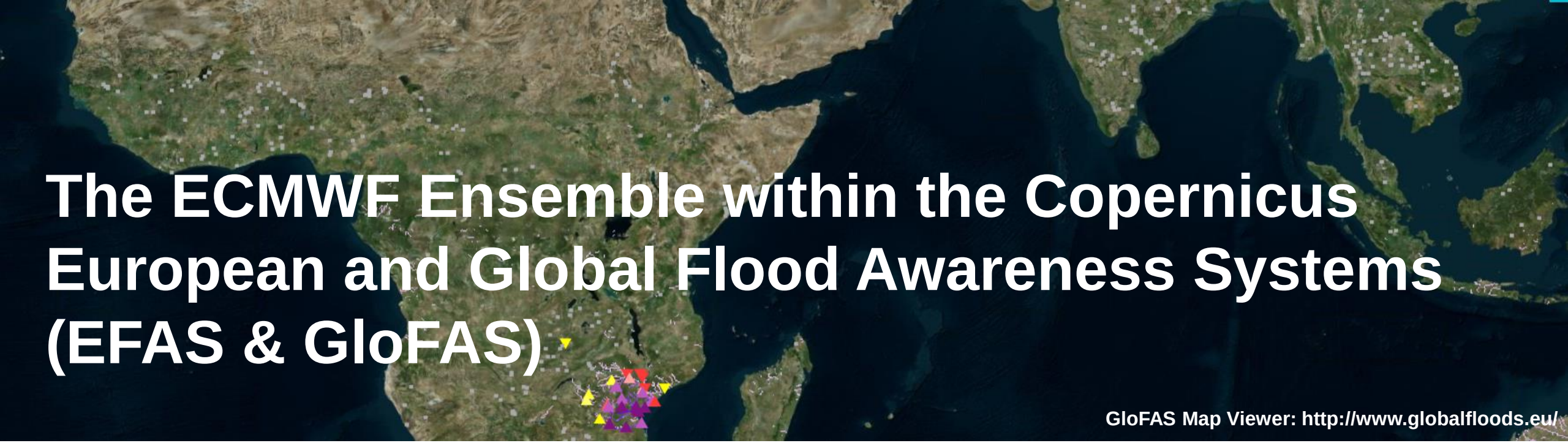


The ECMWF Ensemble within the Copernicus European and Global Flood Awareness Systems (EFAS & GloFAS)

Ervin Zsoter

With contributions from the EFAS/GloFAS team at ECMWF, at the JRC and also at the University of Reading

EFAS
European Flood Awareness System

GLOFAS
Global Flood Awareness System

ECMWF
EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

European Commission

University of Reading

opernicus
The European Earth Observation Programme

Emergency Management

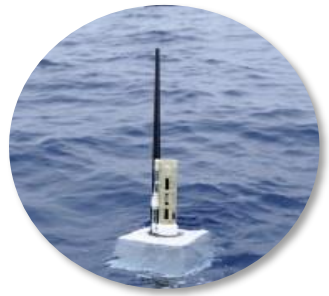
Copernicus service overview

Copernicus
Europe's eyes on Earth

6 services use Earth Observation data to deliver …

Sentinels & Contributing Satellite Missions

In-situ measurements



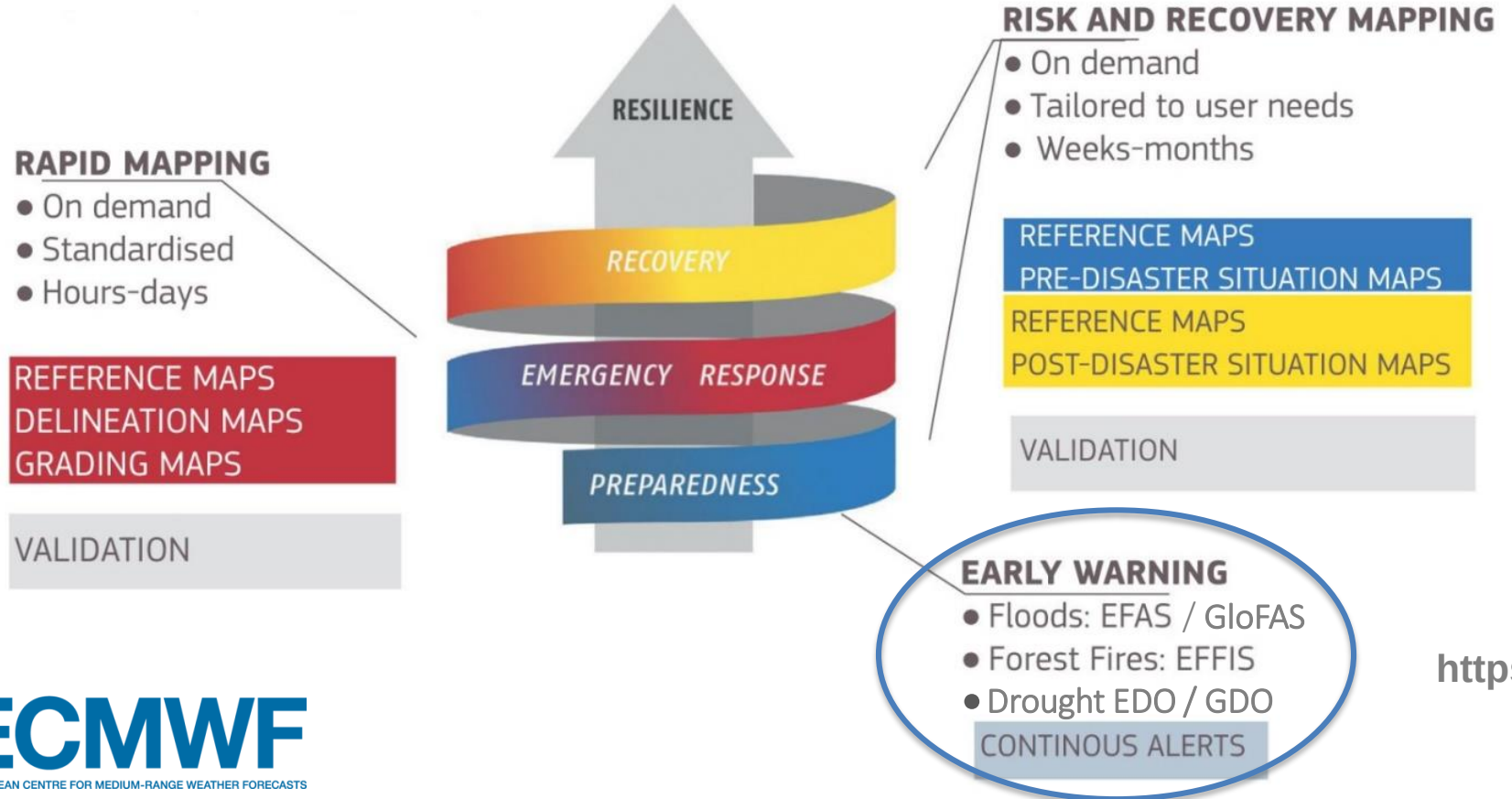
… added value products

Copernicus Emergency Management Service

EC Copernicus Emergency Management Service CEMS set-up to "*Provides information for emergency response in relation to different types of disasters as well as prevention, preparedness, response and recovery activities*."

EFAS, European domain operational since in 2012, pre-operational since 2003

GloFAS, Global domain operational from March 2018, pre-operational since 2011



https://emergency.copernicus.eu/

ECMWF
EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

copernicus
Europe's eyes on Earth

CEMS-Flood Vision

Early warning for preparation of aid assistance

European/World-wide comparable information

Complement National/regional services

EFAS

European Flood Awareness System

Forecast Day	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1
08/09/2016													2	6	10	14	16	18	16	12				
09/09/2016											2	10	22	27	35	47	51	59	63	59	47			
10/09/2016											2	2	10	18	27	29	41	47	59	65	61	41		
11/09/2016													6	12	16	20	20	25	31	37	43	35	25	
12/09/2016													4	14	24	37	47	59	65	73	75	84	76	57

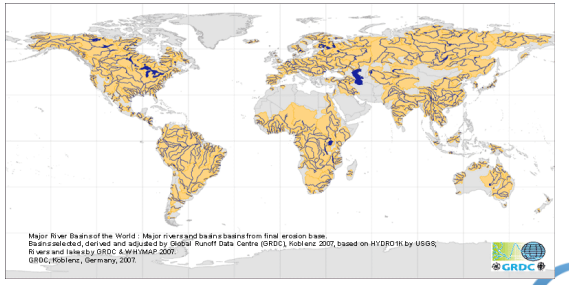
GLOFAS

Global Flood Awareness System

Knowledge transfer & exchange

Support international organisations

Improved data sharing

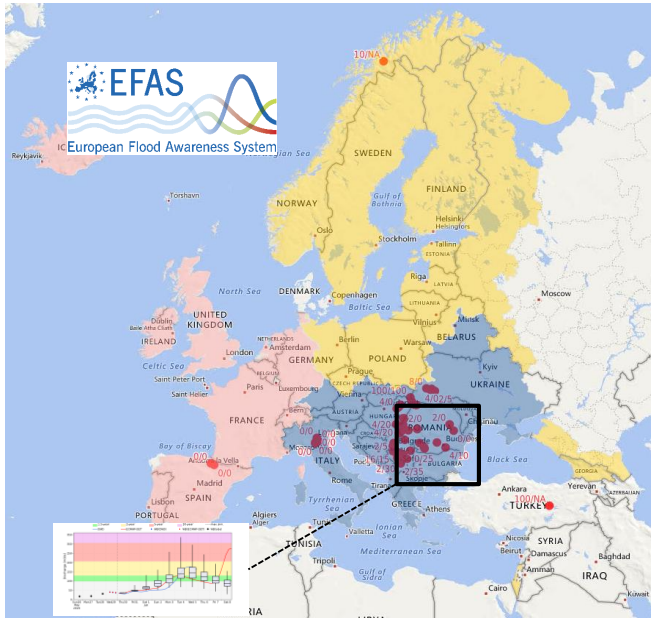


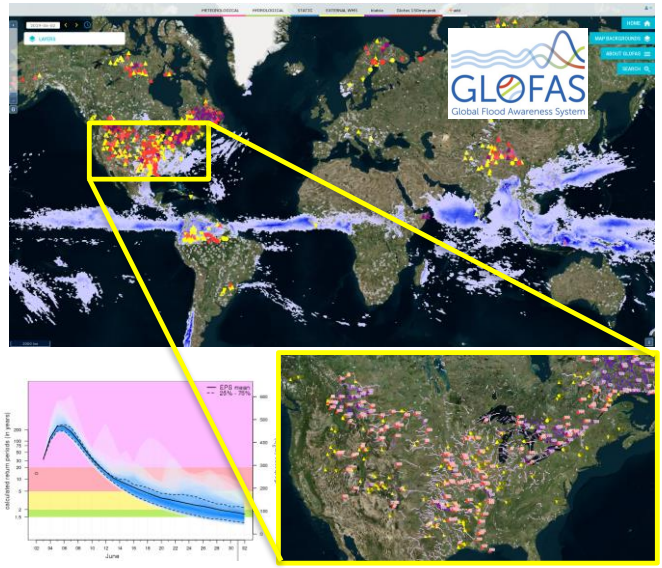
EFAS/GloFAS at a glance

- Early probabilistic flood warnings (restricted in Europe)
- Transboundary system

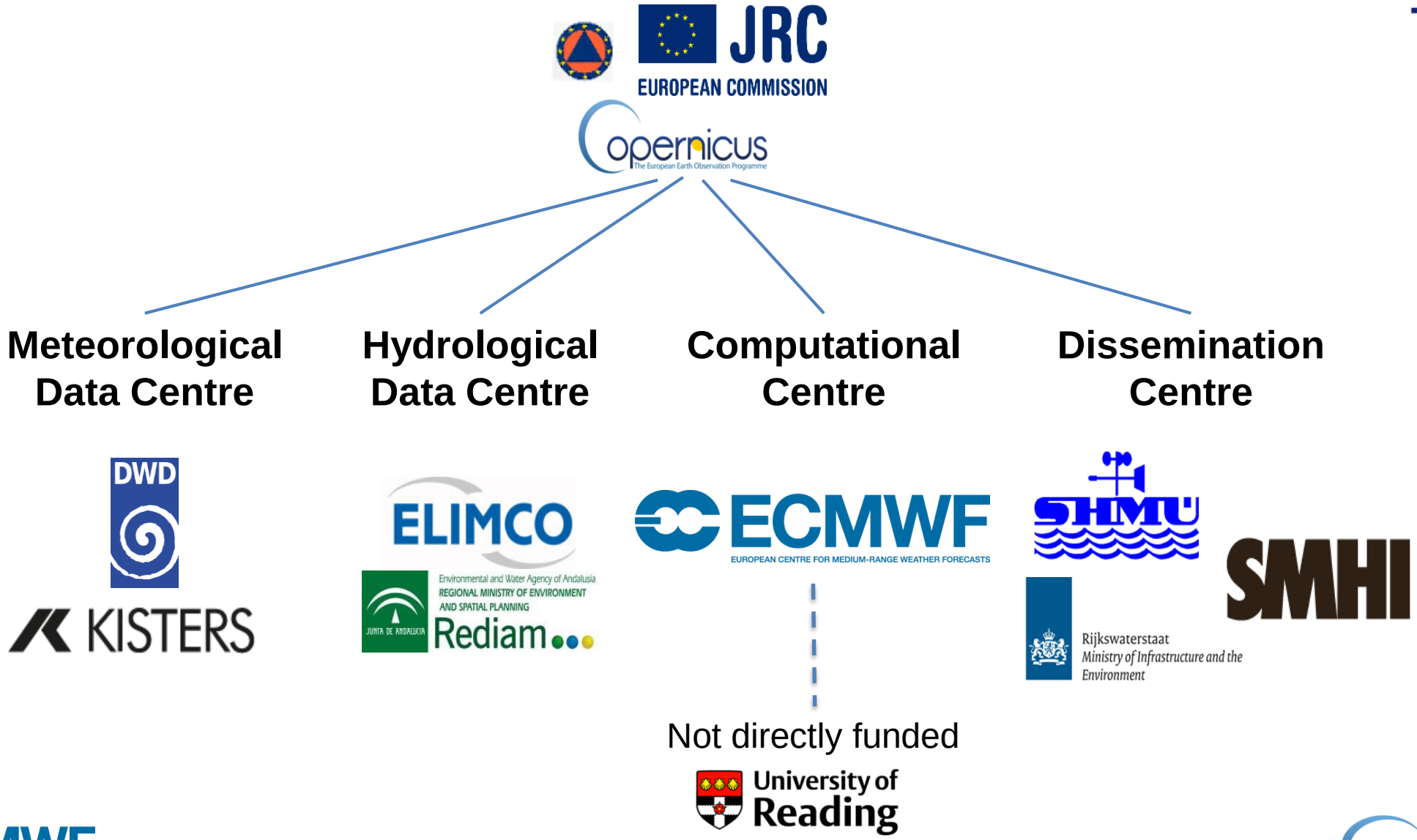
- In Europe (EFAS), ~ 70 partners (restricted) who provide:
  - Observations
  - Feedback on warning performance
  - Service delivered by the Joint Research Centre (JRC) and 4 centres

- In the world (GloFAS)
  - Over 2000 registered users
  - Special partners providing observation data
  - Service delivered by JRC and ECMWF

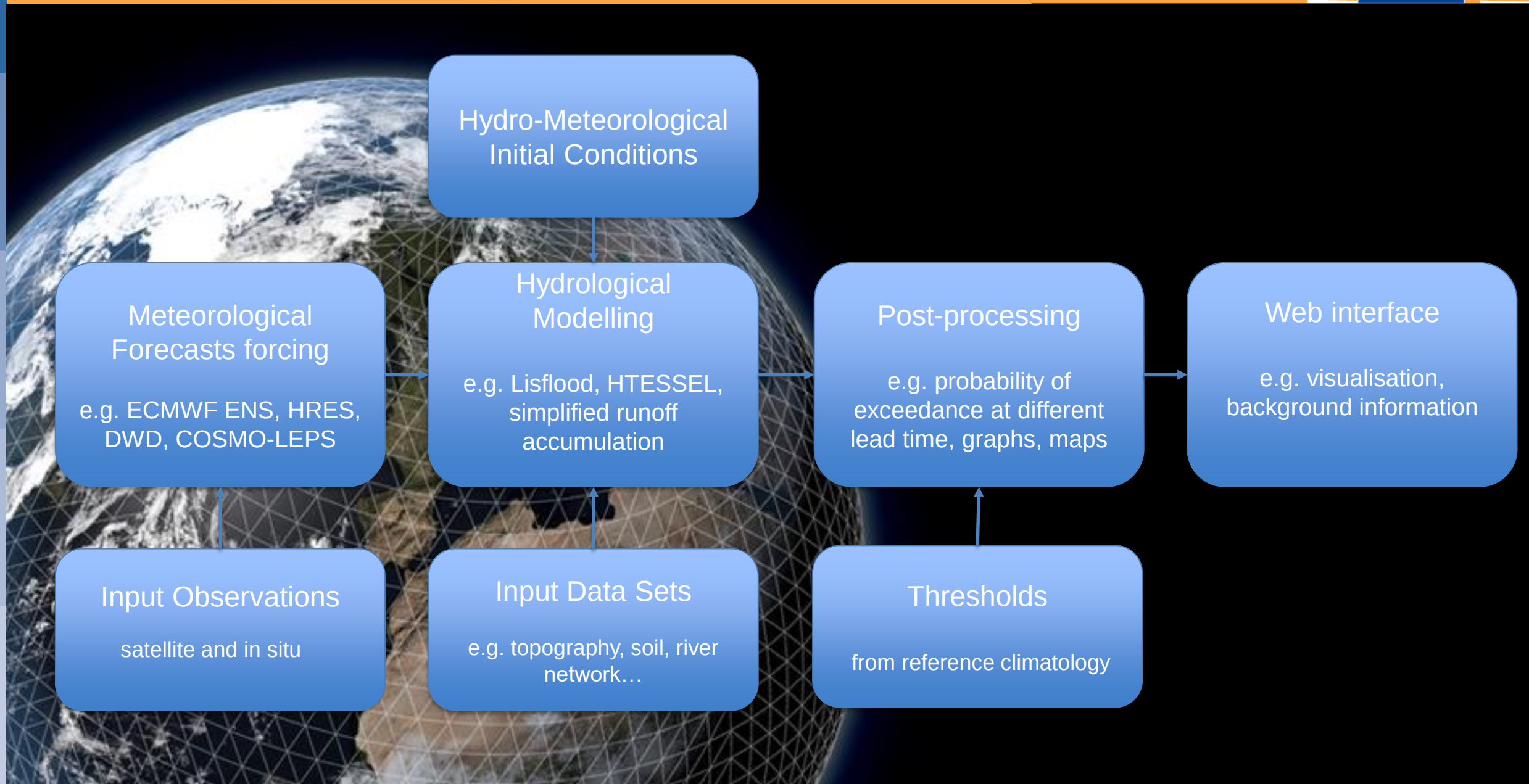




CEMS-Flood Structure and Governance

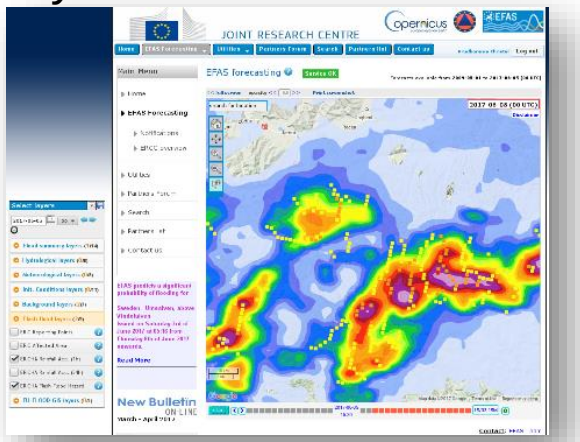


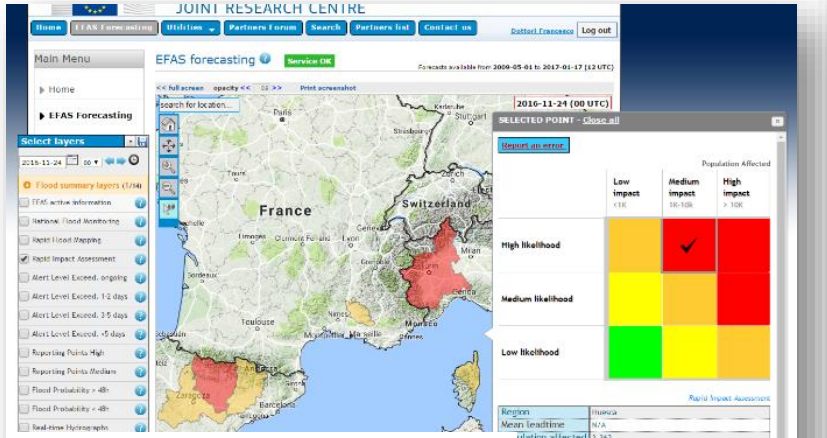
Hydrological forecasting modelling overview



EFAS products

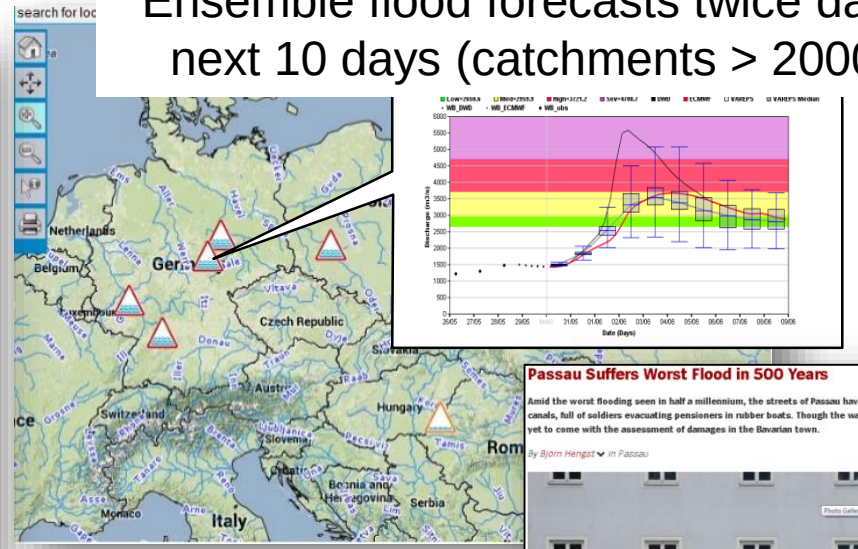
Radar-based flash-flood ‘nowcast’ every 15 minutes for next 3 hours

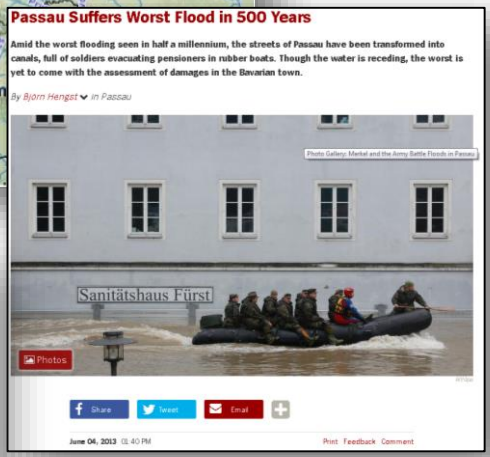




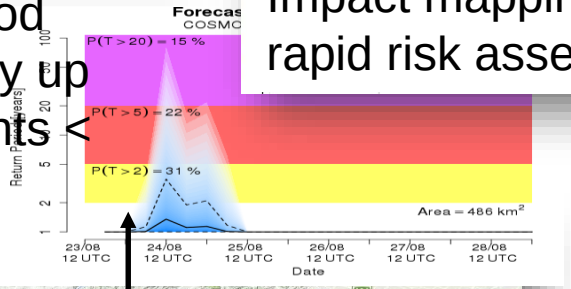
Impact mapping for rapid risk assessment

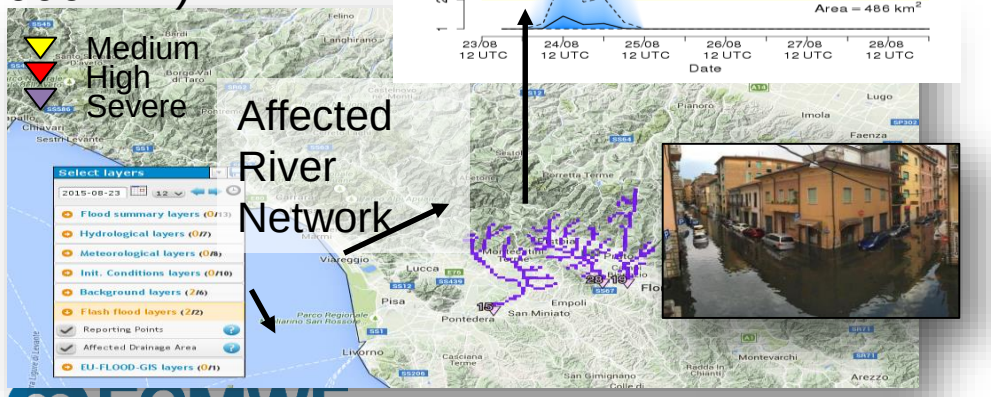
Ensemble flood forecasts twice daily for next 10 days (catchments > 2000km2)

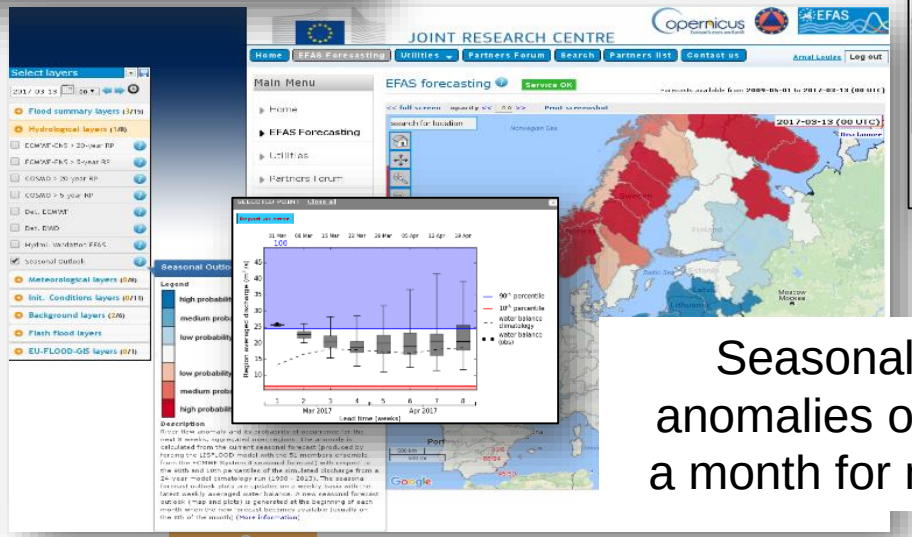




Ensemble Flash-flood forecasts Twice daily up to 5 days (catchments < 2000km2)

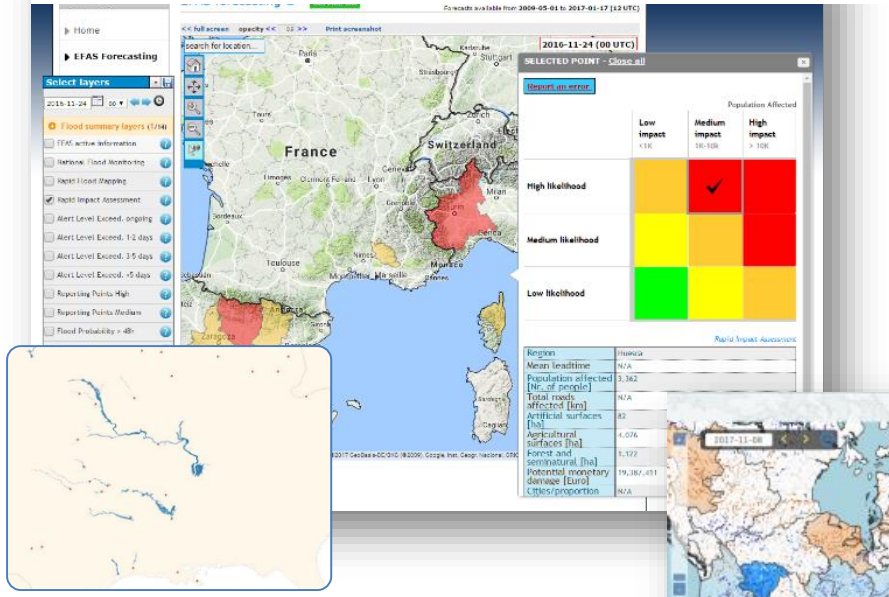




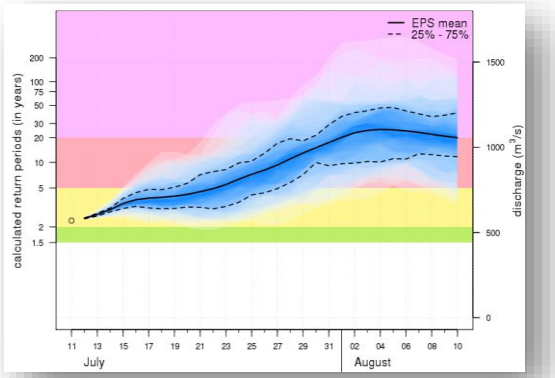


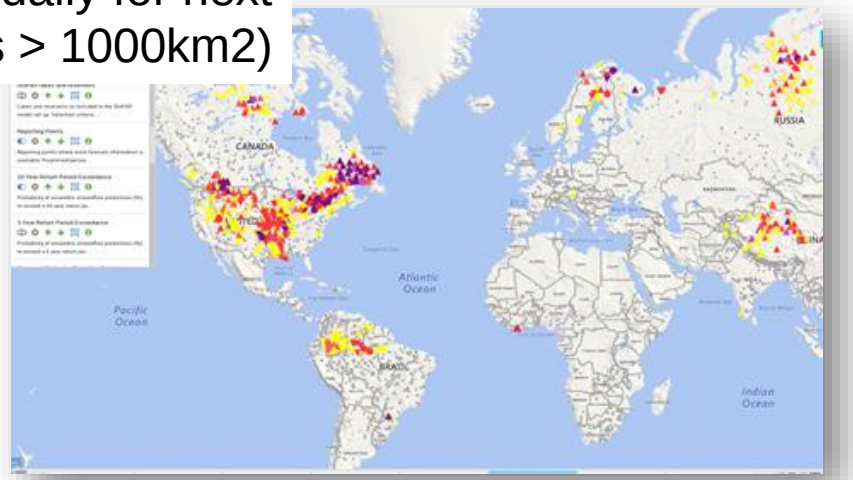
GloFAS products

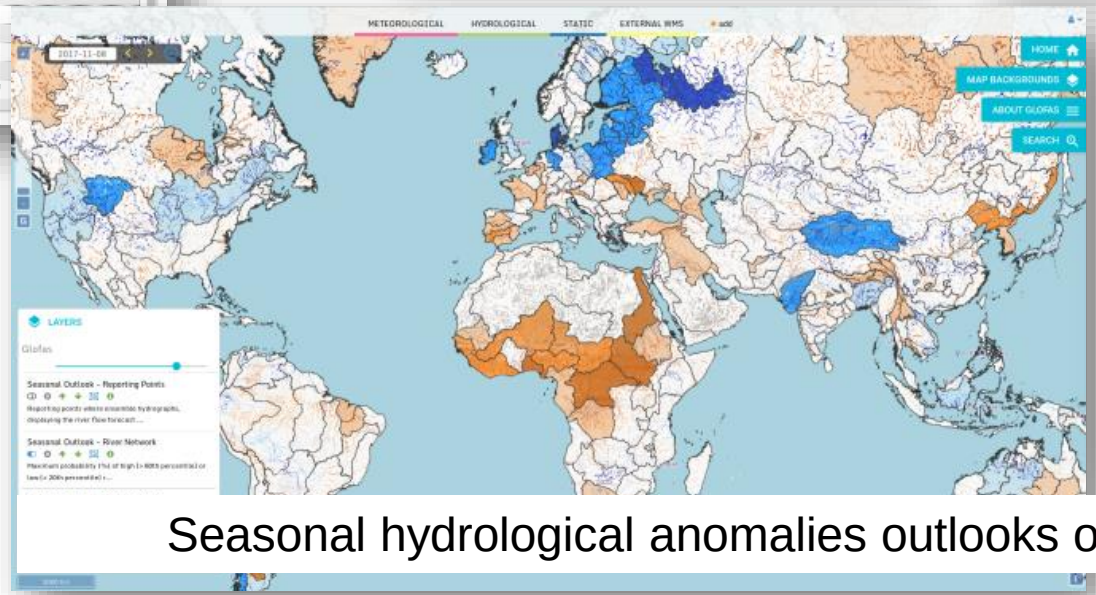
Under test: Impact mapping for rapid risk assessment, once daily for next 10 days

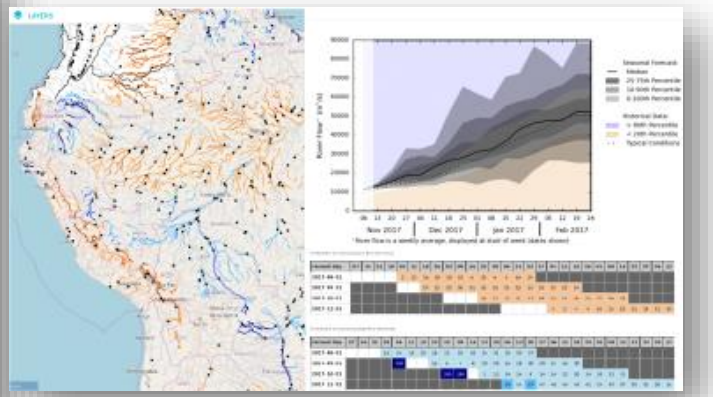


Ensemble flood forecasts daily for next 30 days (catchments > 1000km2)





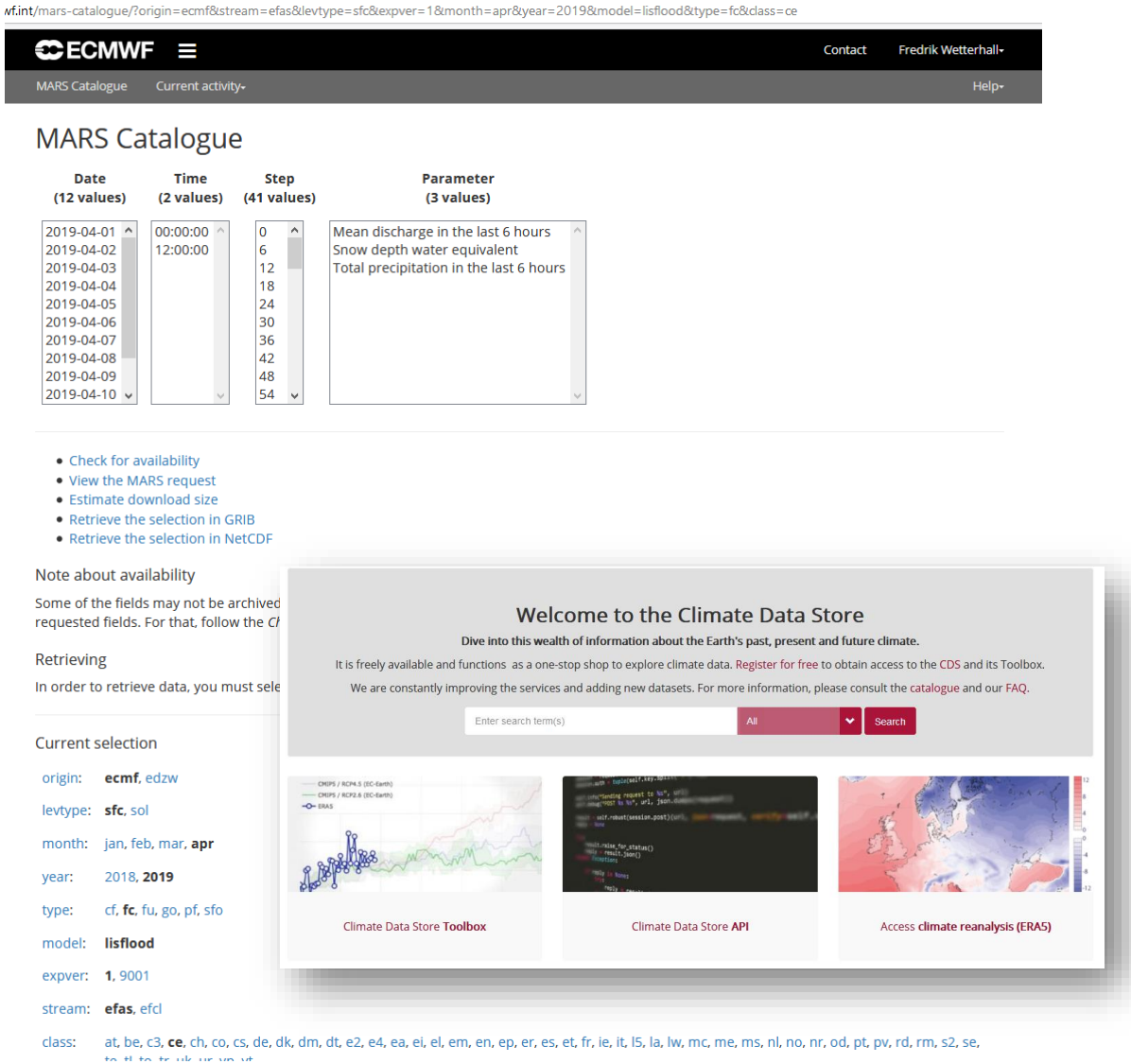




Seasonal hydrological anomalies outlooks once a month for next 12 weeks

EFAS-GloFAS data access

- EFAS data is in **ECMWF MARS** archive and also available through the Copernicus **C3S Climate Data Store** (from 9 May 2019)
  - *** Forecasts** from 2018-10-10 – NRT
  - *** Long-term run** from 1991-2018, driven by observations
  - * Discharge, soil moisture and snow water equivalent
- GloFAS will follow suit this year with MARS and CDS
- For real time EFAS and GloFAS data tailored ftp access for users requesting it
- For GloFAS in NetCDF file format for selected reporting points or areas (grids)
- GloFAS has long forecast archive (from 1997) based on the 20-year NWP reforecasts (twice a week runs)



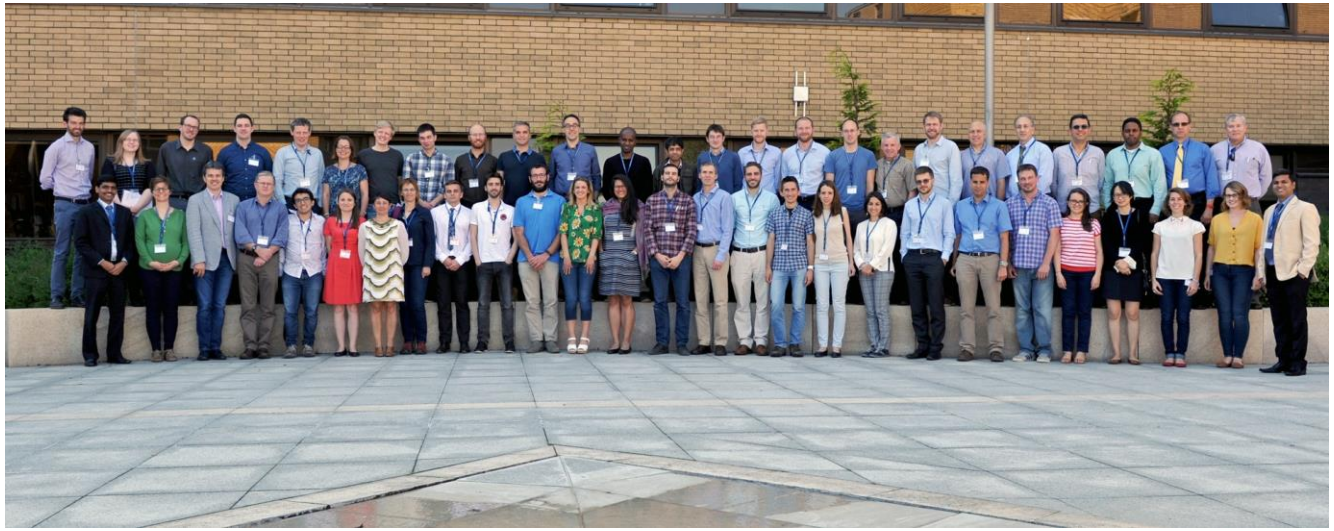
EFAS user community

- Cover most of Europe with ~70 partners (Hydromet Services, Water agencies, etc.)
- Information is restricted to the EFAS group
- Annual assembly for all the partners and developers
- To discuss progress and developments

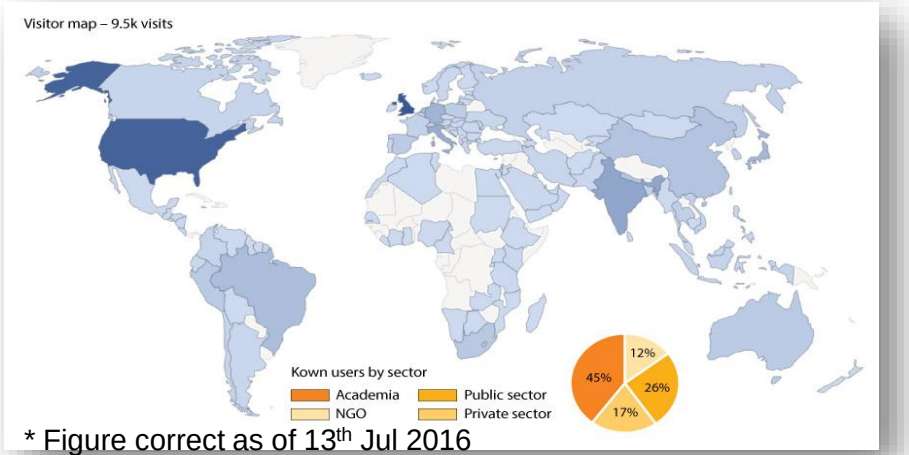
EFAS general assembly in De Bilt, March 2017

GloFAS user community

- GloFAS co-developments e.g. by Reading University (UK), RIMES (South East Asia), Cemaden (Brazil)
- Community of Users Workshops
- GloFAS relies on user feedbacks and observations (for evaluation and calibration)



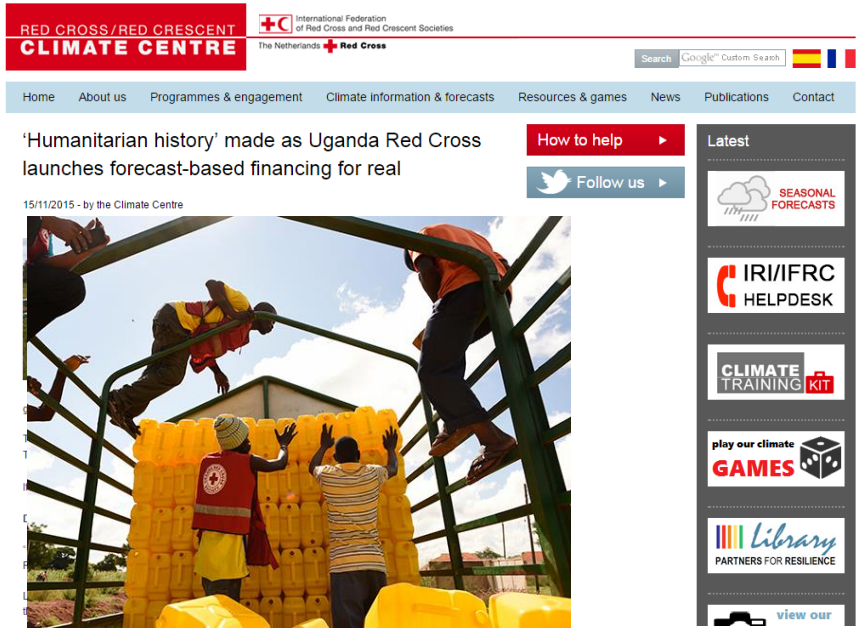
GloFAS workshop held at ECMWF, May 2018



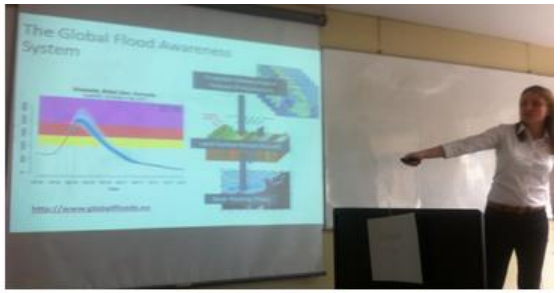
* Figure correct as of 13th Jul 2016

GloFAS collaboration and outreach

- Collaboration with ‘Forecast-based Financing’ Red Cross Pilot Projects
- GloFAS forecasts are used as a trigger for early actions
- Peru: Flood Forecasting in North Peru is high priority because of El Niño
- Uganda: First FbF humanitarian action in Nov. 2015 for foods during wet season
- Nepal, Bangladesh and other FbF pilot projects
- Regional training of hydrologists and meteorologists organised by RIMES and UN-ESCAP, held in Thailand in 2016



Participants and organisers of the training workshop 3-7 October 2016, Thailand



University of Reading

RED CROSS/RED CRESCENT CLIMATE CENTRE

International Federation of Red Cross and Red Crescent Societies
The Netherlands Red Cross

ECMWF
EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

Copernicus
Europe’s eyes on Earth

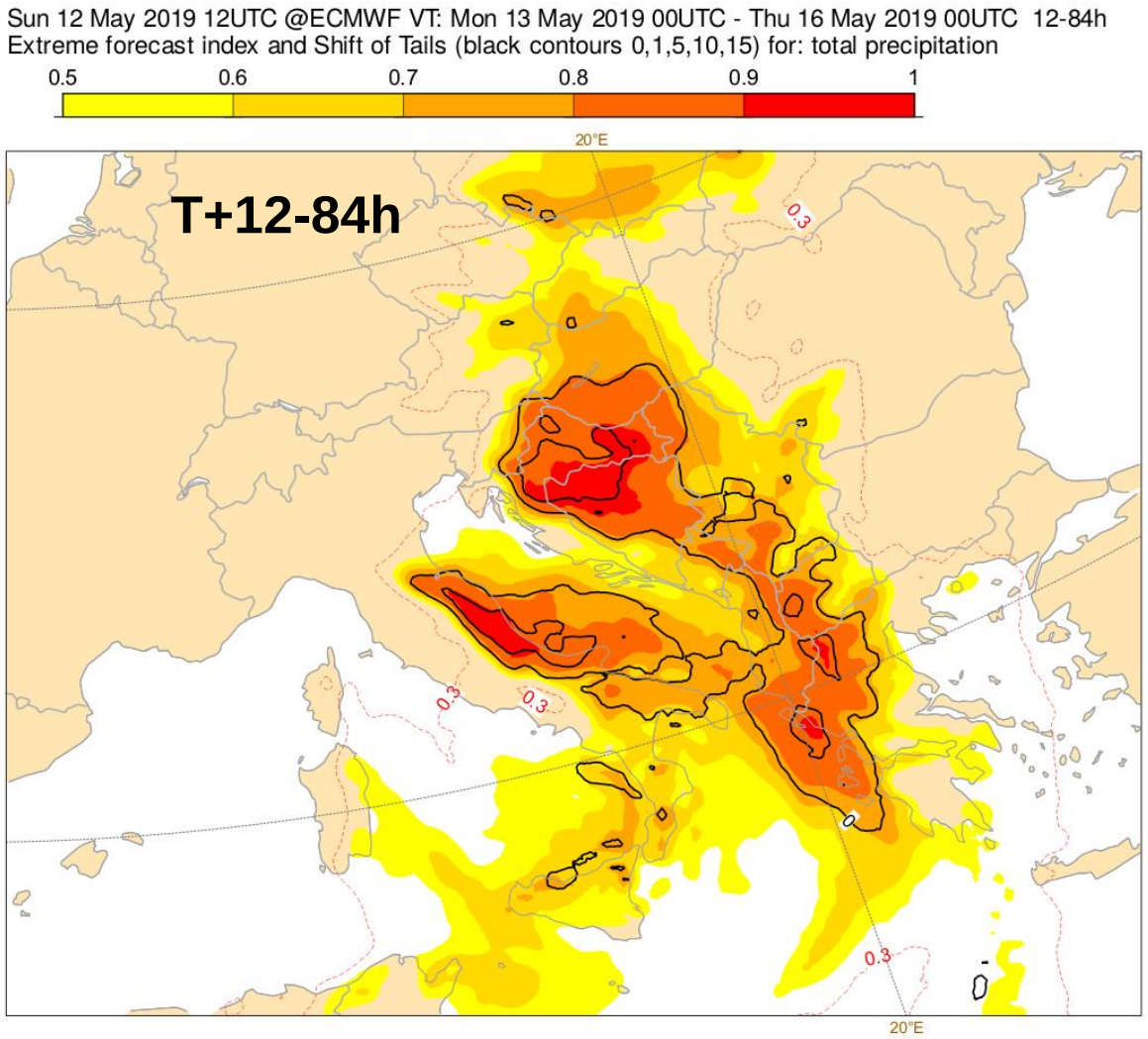
GloFAS collaboration and outreach

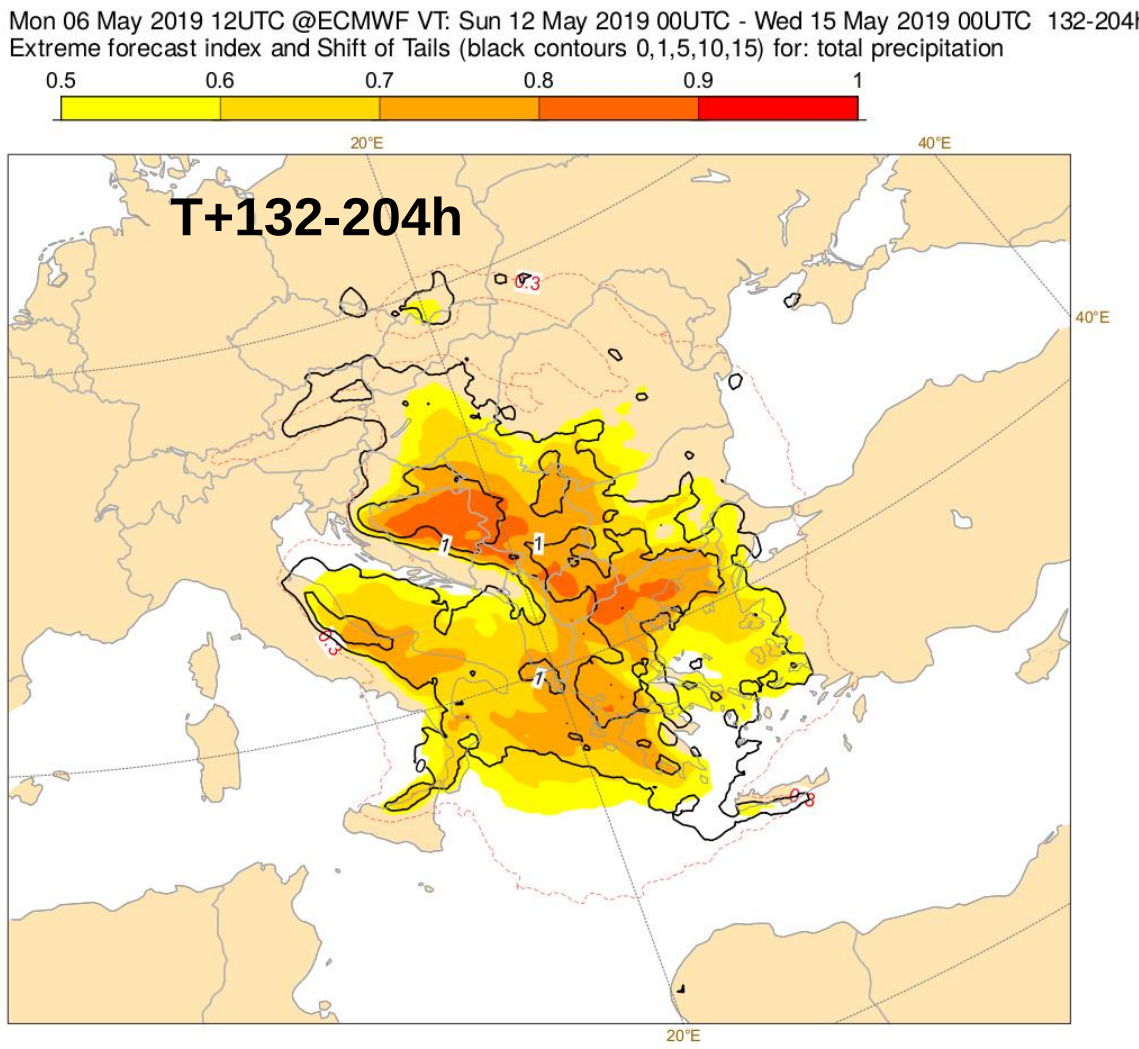
- Automatic ftp feeds for selected reporting points
  - Red Cross Red Crescent Climate Centre
  - Centro Nacional de Monitoramento e Alertas de Desastres Naturais (Brazil)
  - Flood Forecasting Centre of Bangladesh
  - UCAR (201 stations across Asia)
  - JBA consulting (India / Brahmaputra)
- Afghanistan Spatial Data Centre / IMMAP
  - GloFAS forecasts included in flood forecast layers
- US Army Engineer Research and Development Centre
  - Locally downscaled forecasts
- Thethys Streamflow Forecast Platform
  - Locally downscaled forecasts
  - Products available through WMS

EFAS in action – Floods in Bosnia-Herzegovina (May 2019)

Flooding in Bosnia, May 2019. Photo: Federalna Uprava Civilne Zaštite

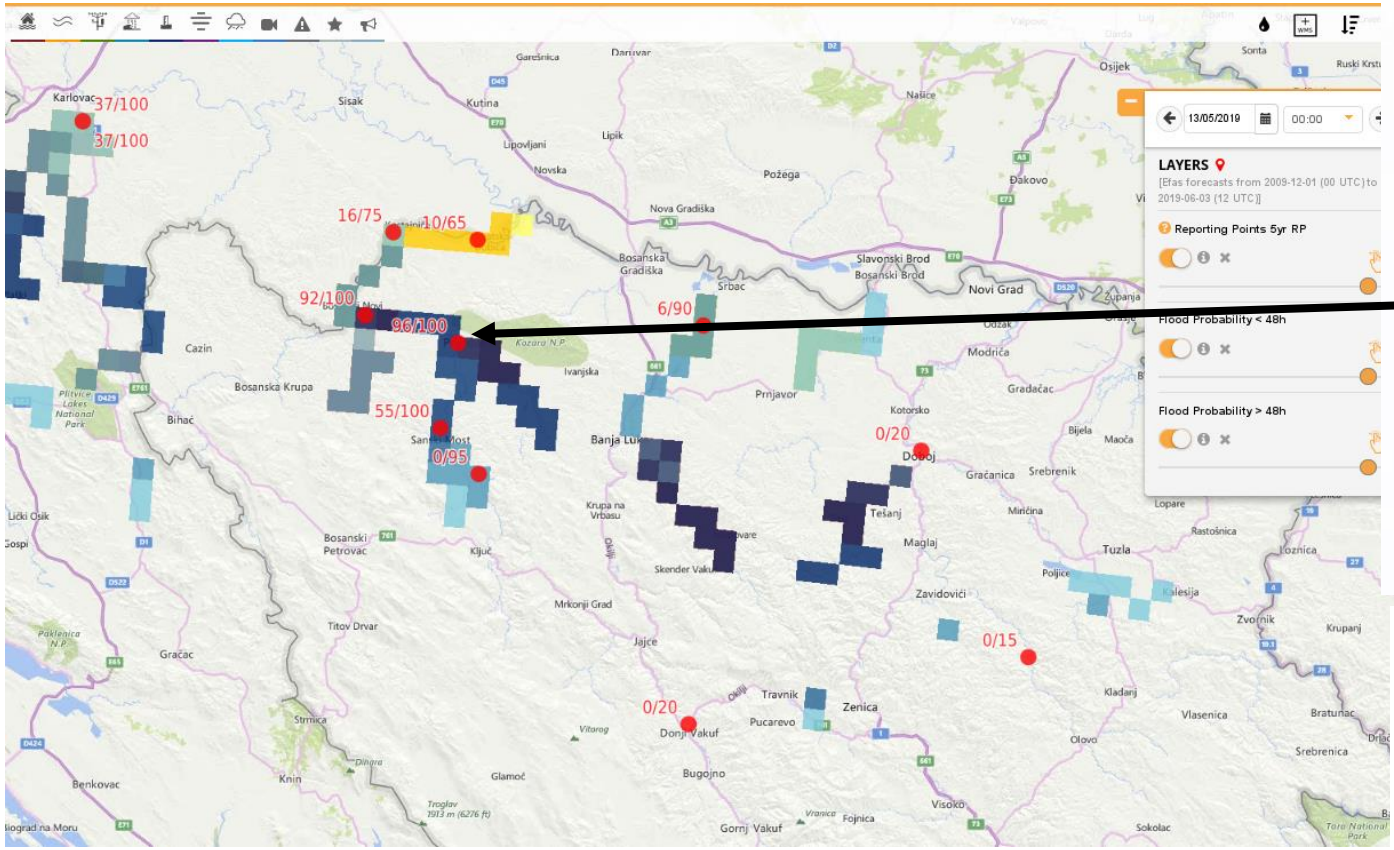
EFAS in action – Floods in Bosnia-Herzegovina (May 2019)

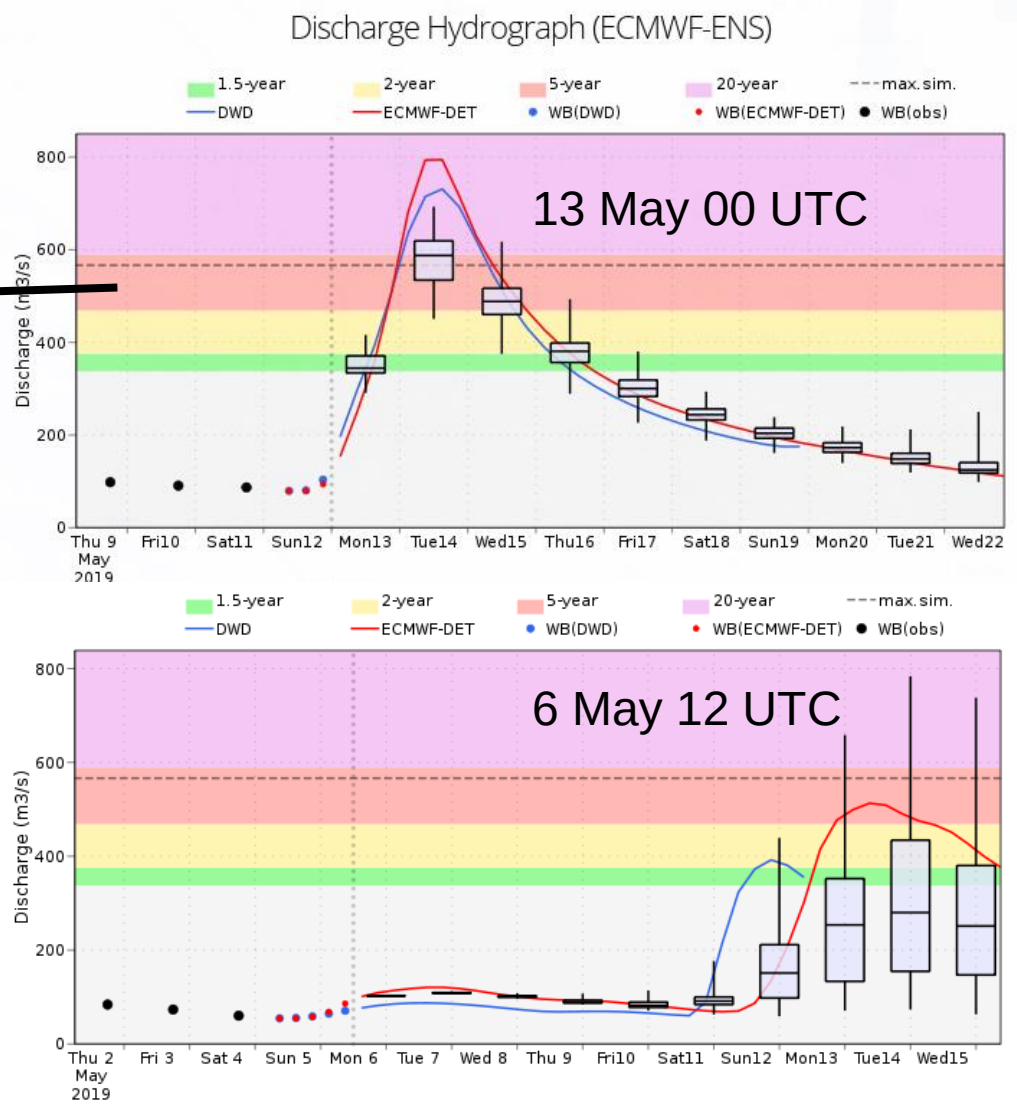




Strong precipitation EFI signal really far ahead!

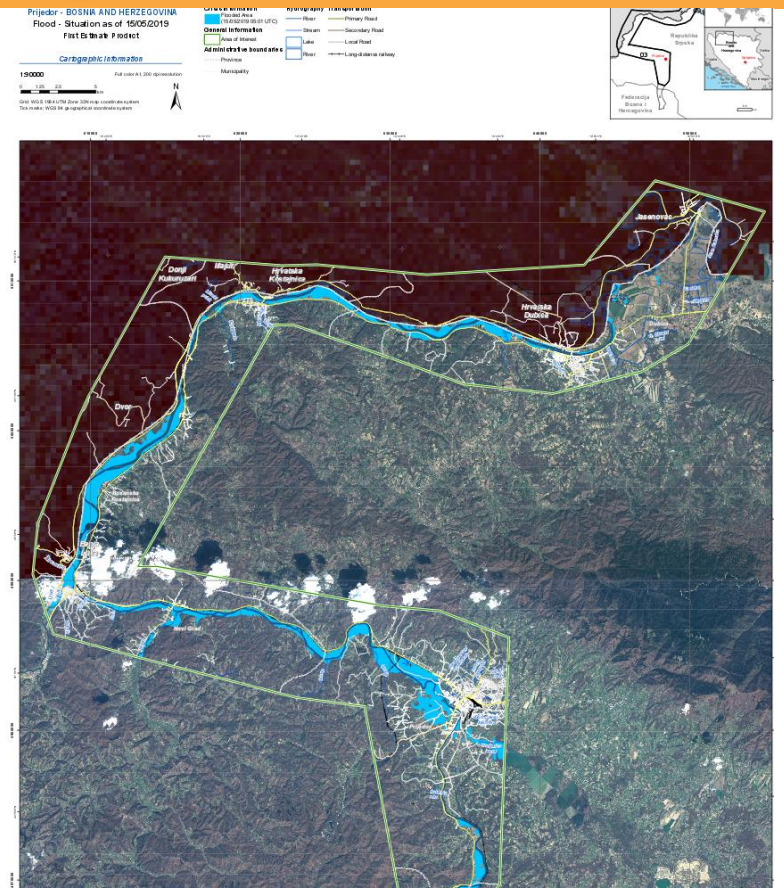
EFAS in action – Floods in Bosnia-Herzegovina (May 2019)

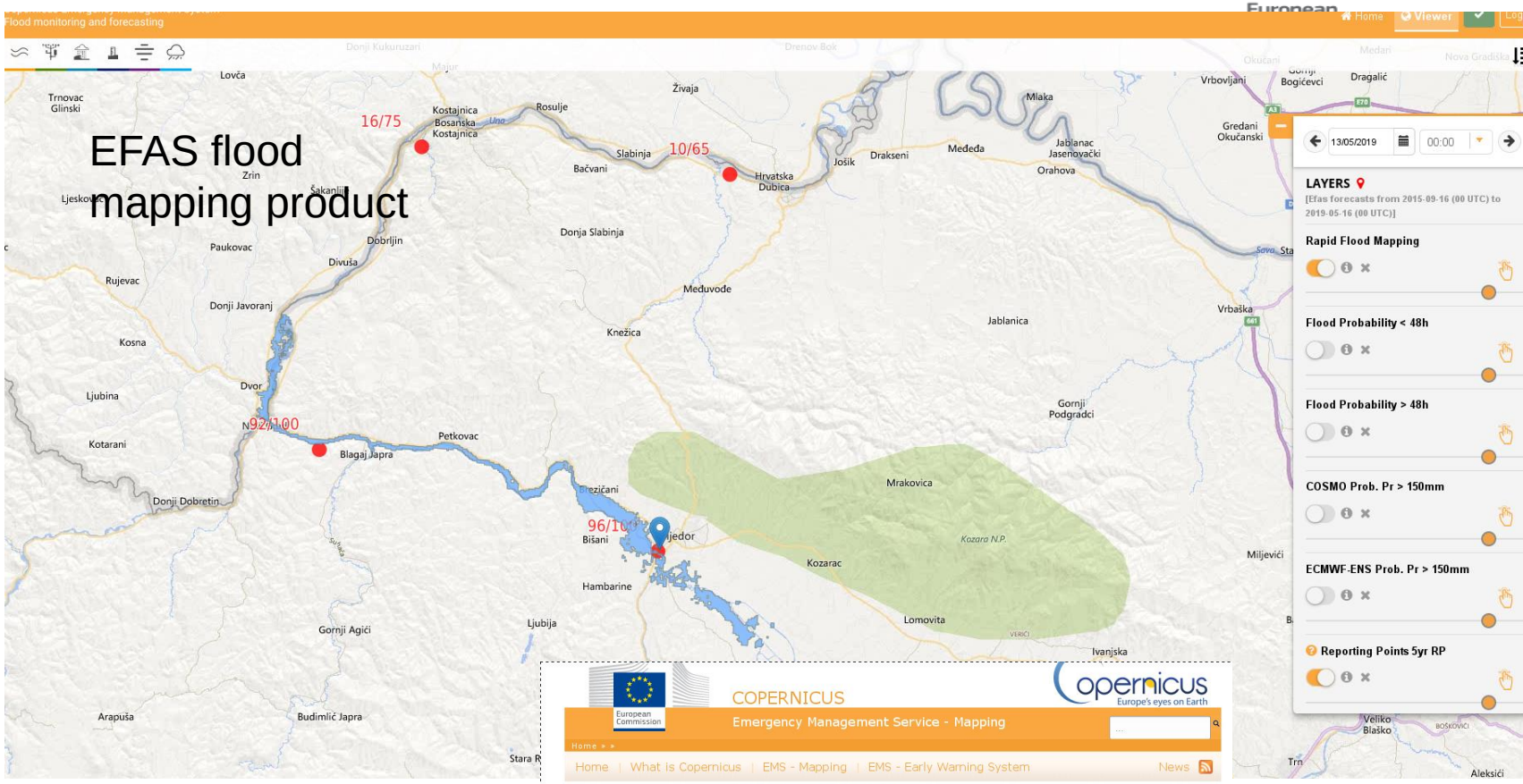




- Smaller tributaries of the Sava river were mainly flooded
- Good signal in EFAS with gradually increasing probabilities for high flood

EFAS in action – Floods in Bosnia-Herzegovina (May 2019)





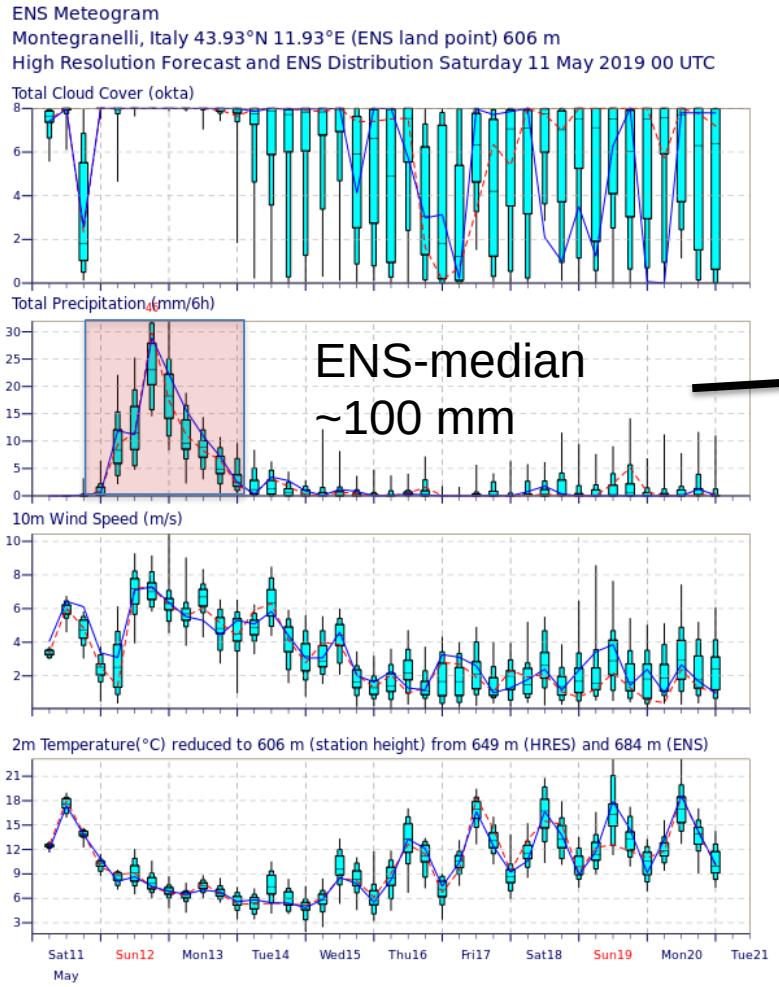
- Copernicus rapid mapping was activated for this area
- Some section of the inundated areas were missed in EFAS
- And a large area quite well captured

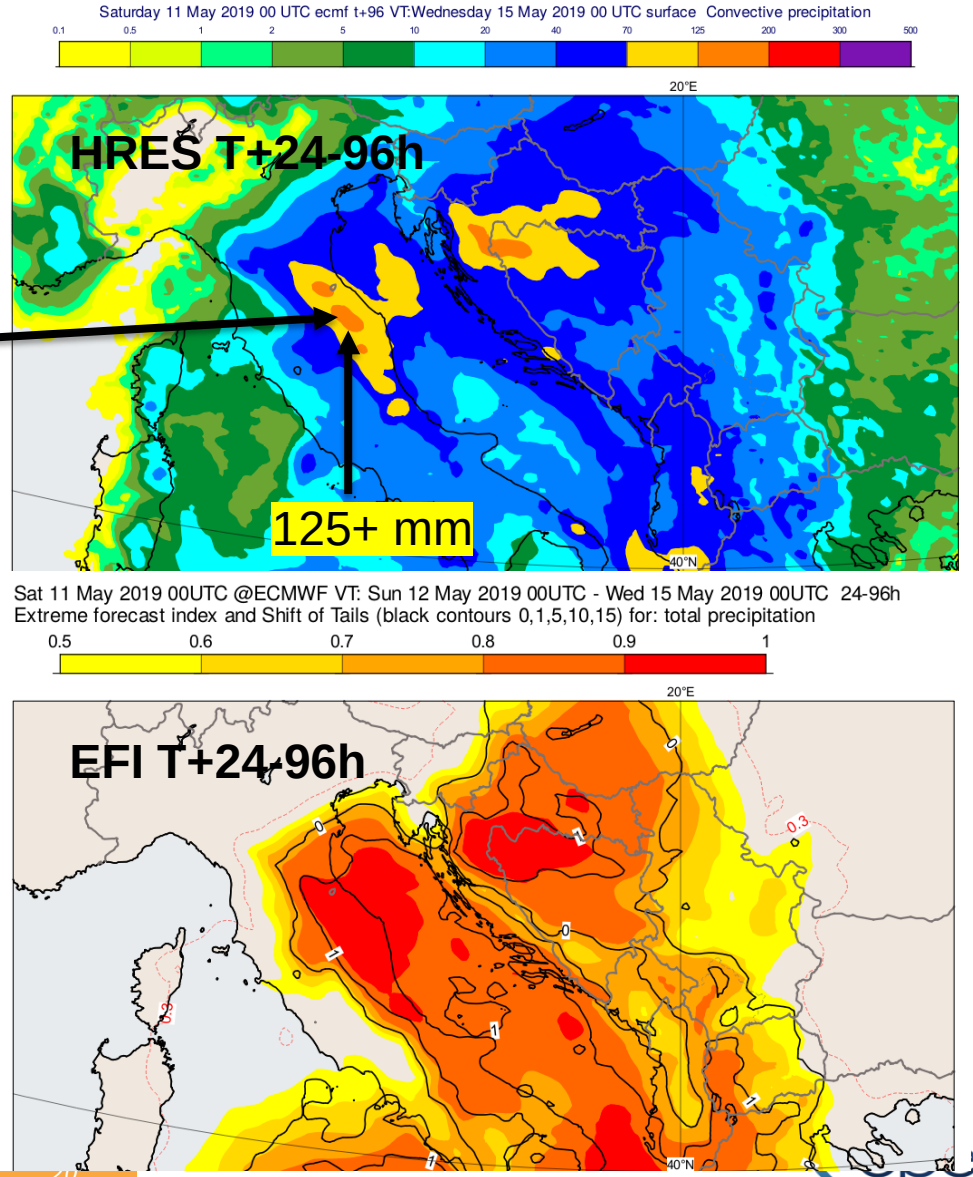
EFAS in action – Floods in Emilia-Romagna (Italy)

Worst impacted area is the Savio river near the San Marino area

Figures are provided by Alessandro Fuccello (Italian Airfo

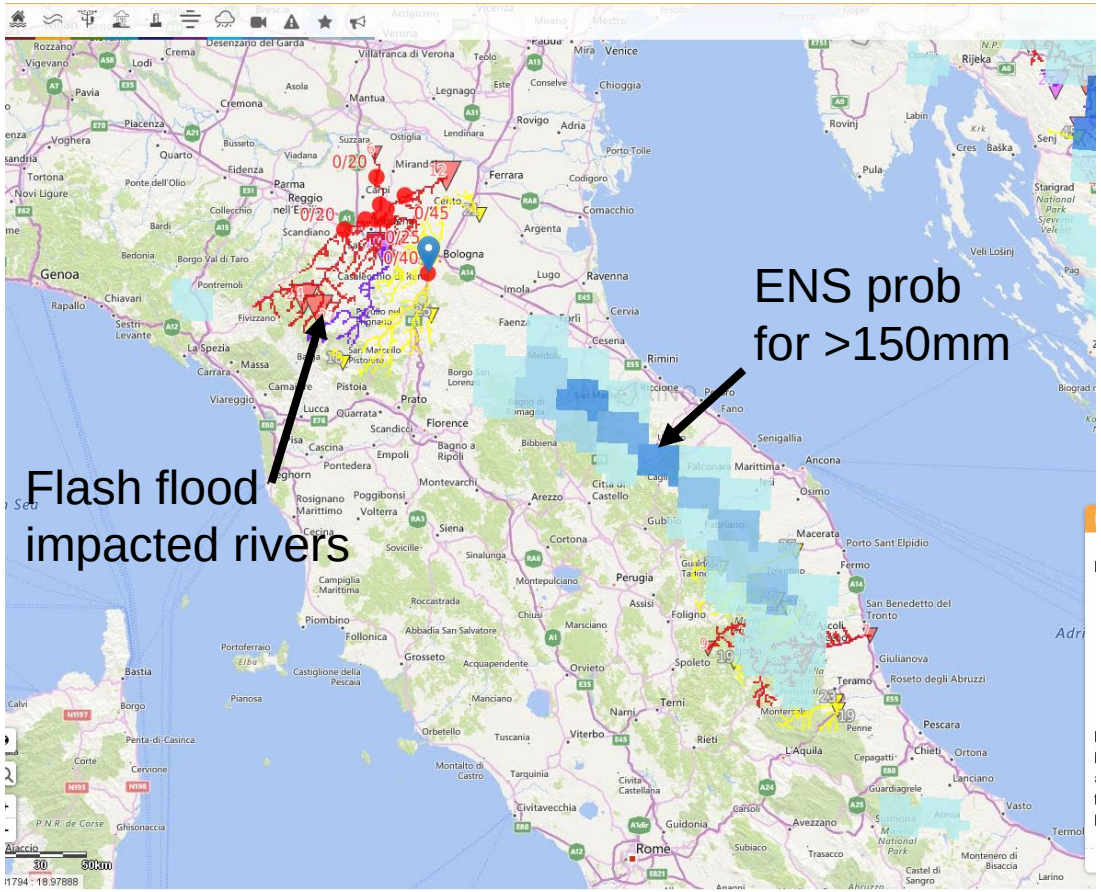
EFAS in action – Floods in Emilia-Romagna (Italy)

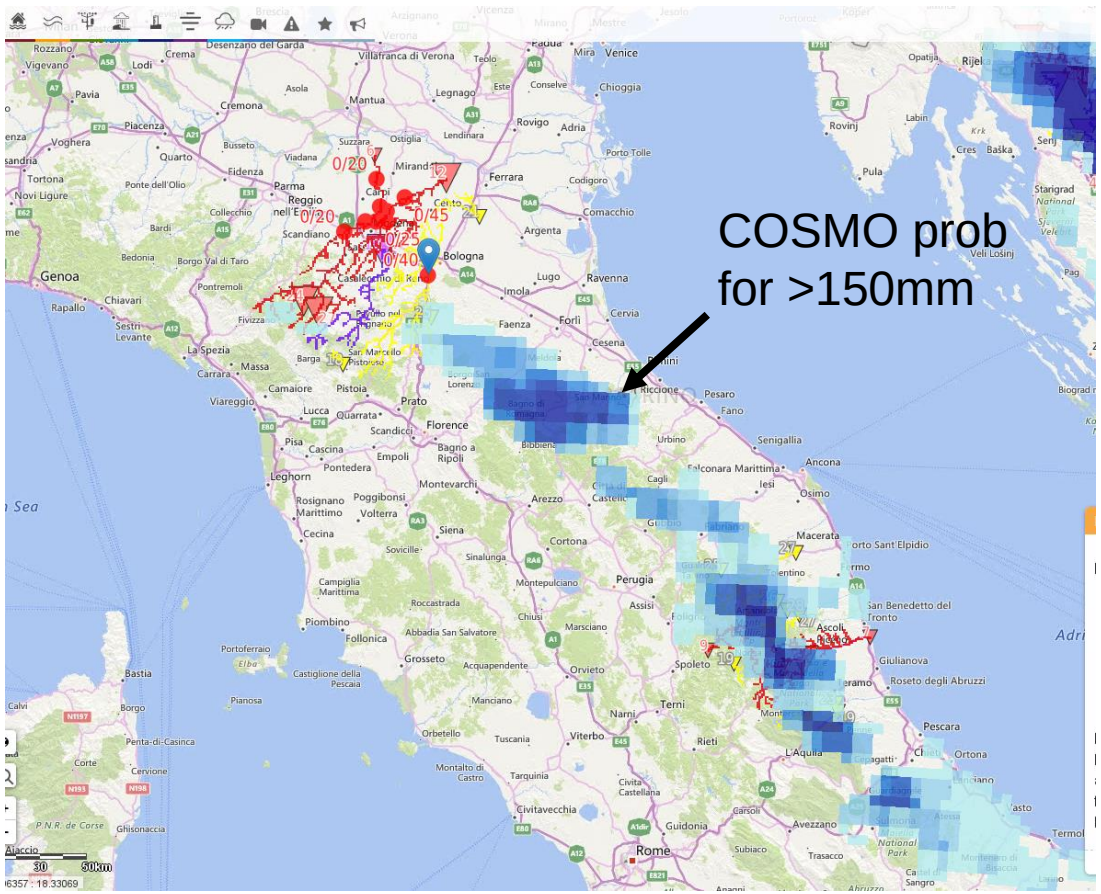




- Strong signal in ENS and HRES with good agreement

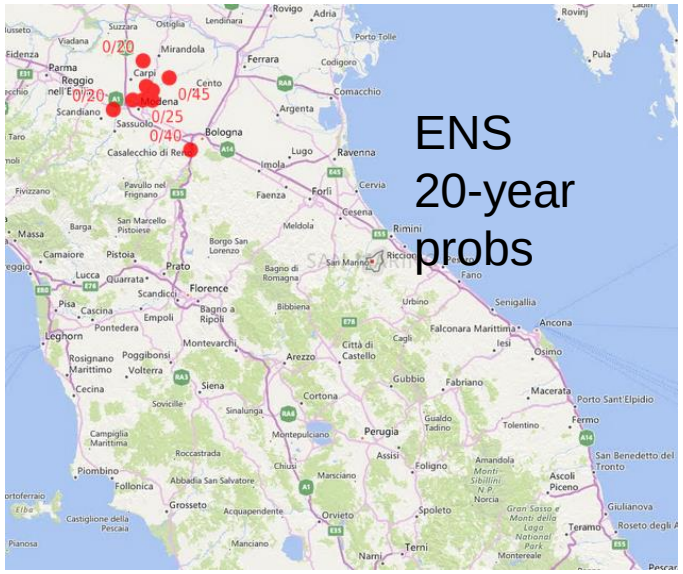
EFAS in action – Floods in Emilia-Romagna (Italy)

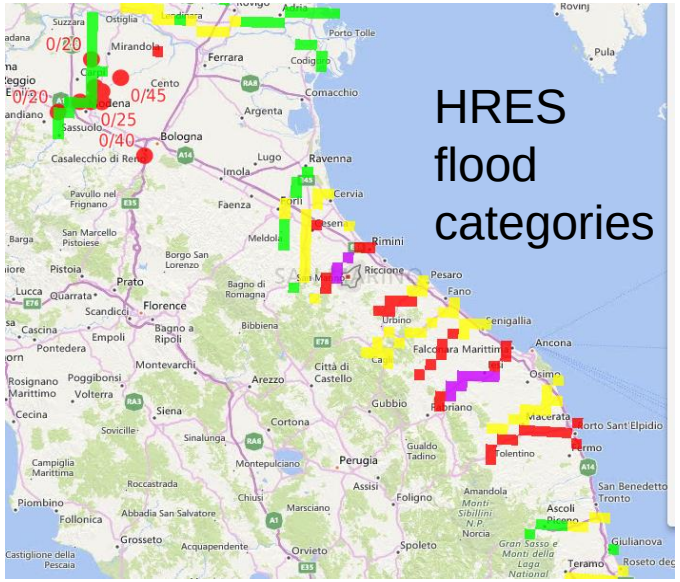


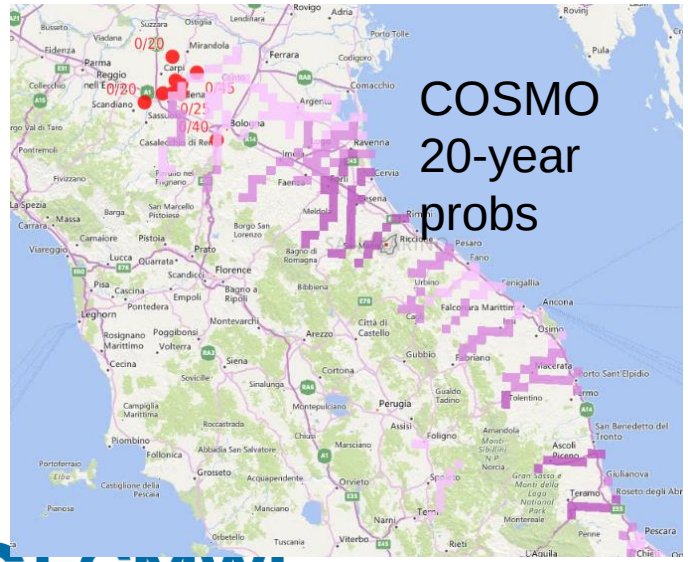


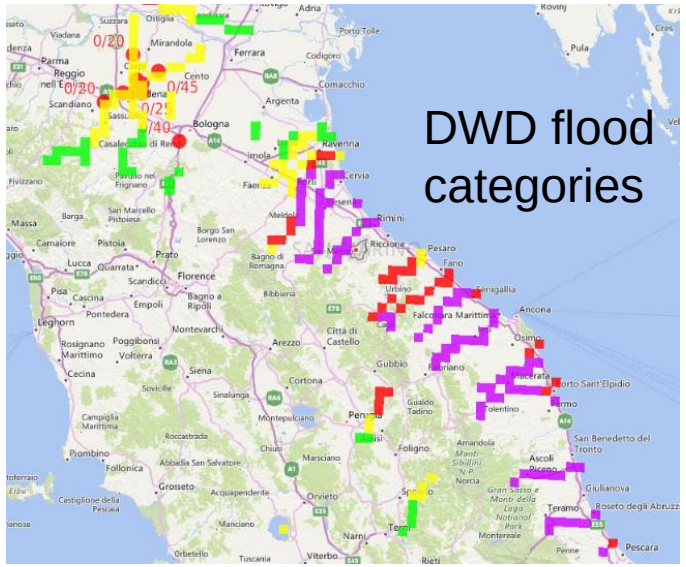
- EFAS did not have signal for the worst hit area
- COSMO provided more focussed precipitation forecast for the worst impacted Savio river

EFAS in action – Floods in Emilia-Romagna (Italy)



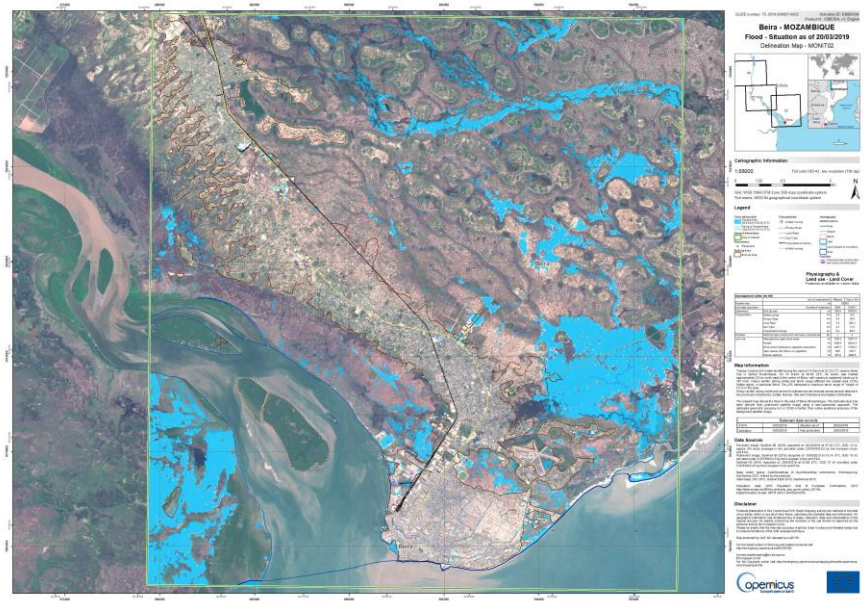


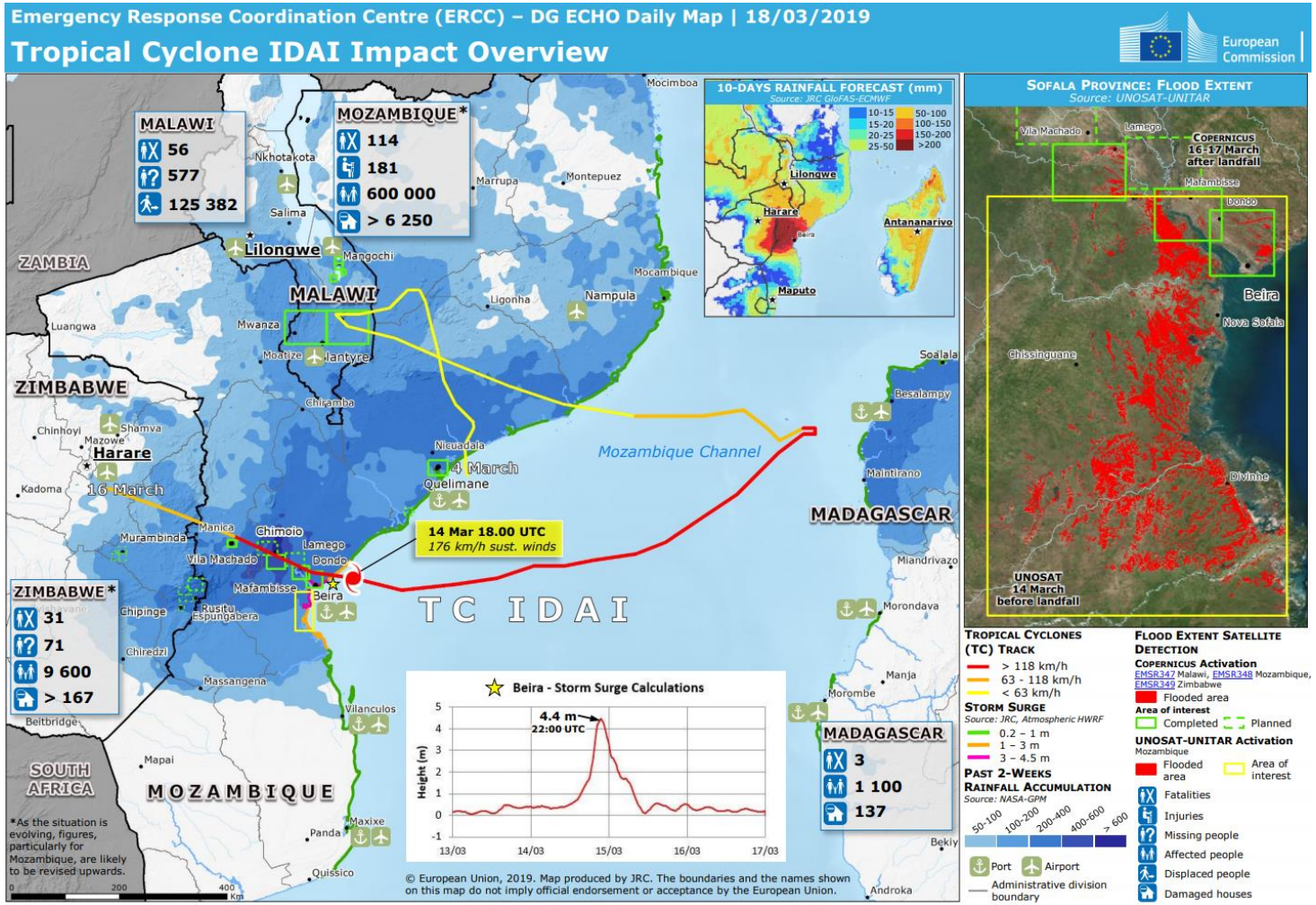




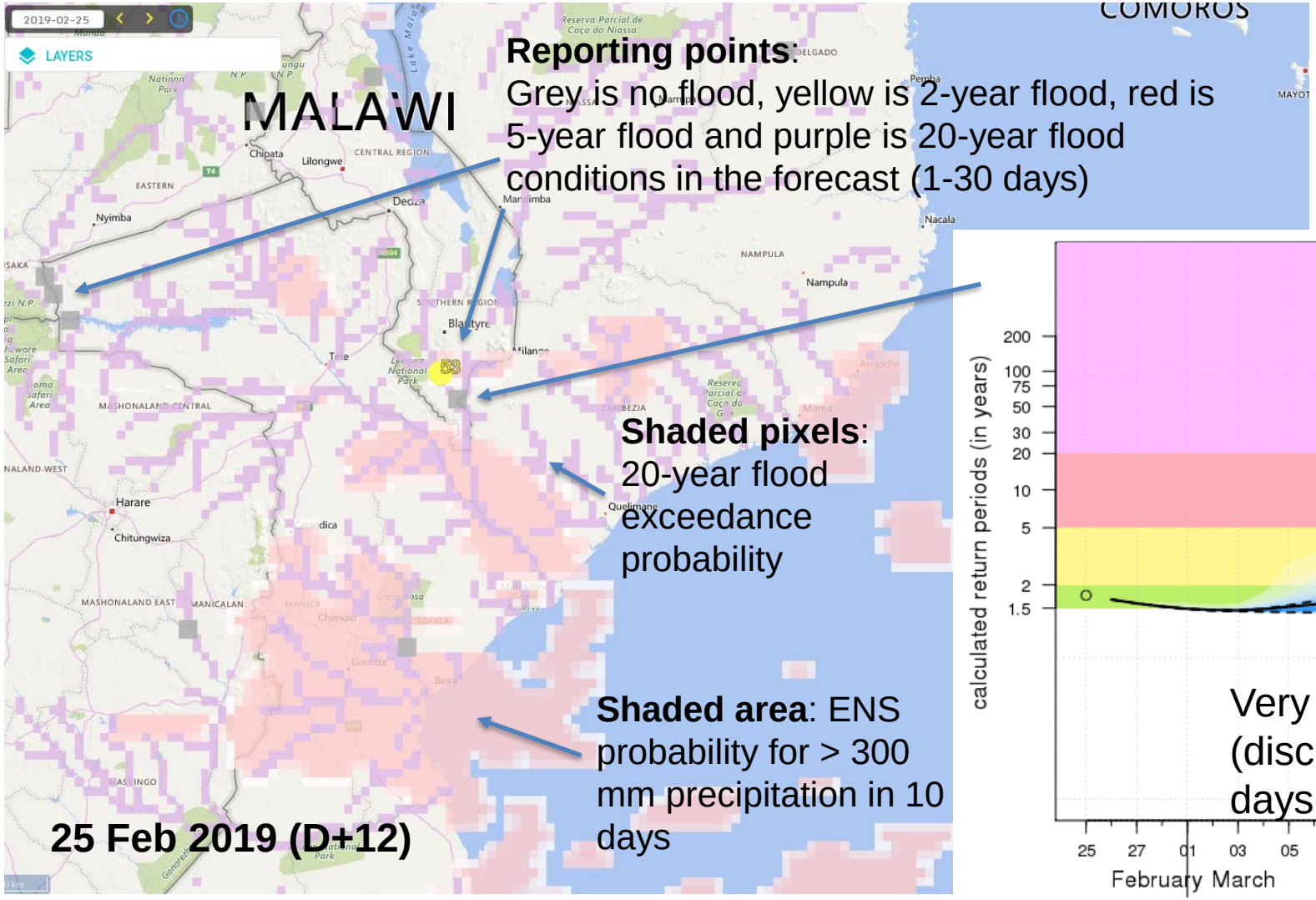
- Large uncertainty between different models
- ENS probabilities are too low (even for 5-year level), even though the precipitation was high
- For this event COSMO and DWD provided better forecasts
- Contradicting information led to no reporting points (red points with hydrograph provided)
- Fixed reporting points might help here
- These aspects of the processing of EFAS forecast information is currently under revision

GloFAS in action – Cyclone IDAI (Mozambique)





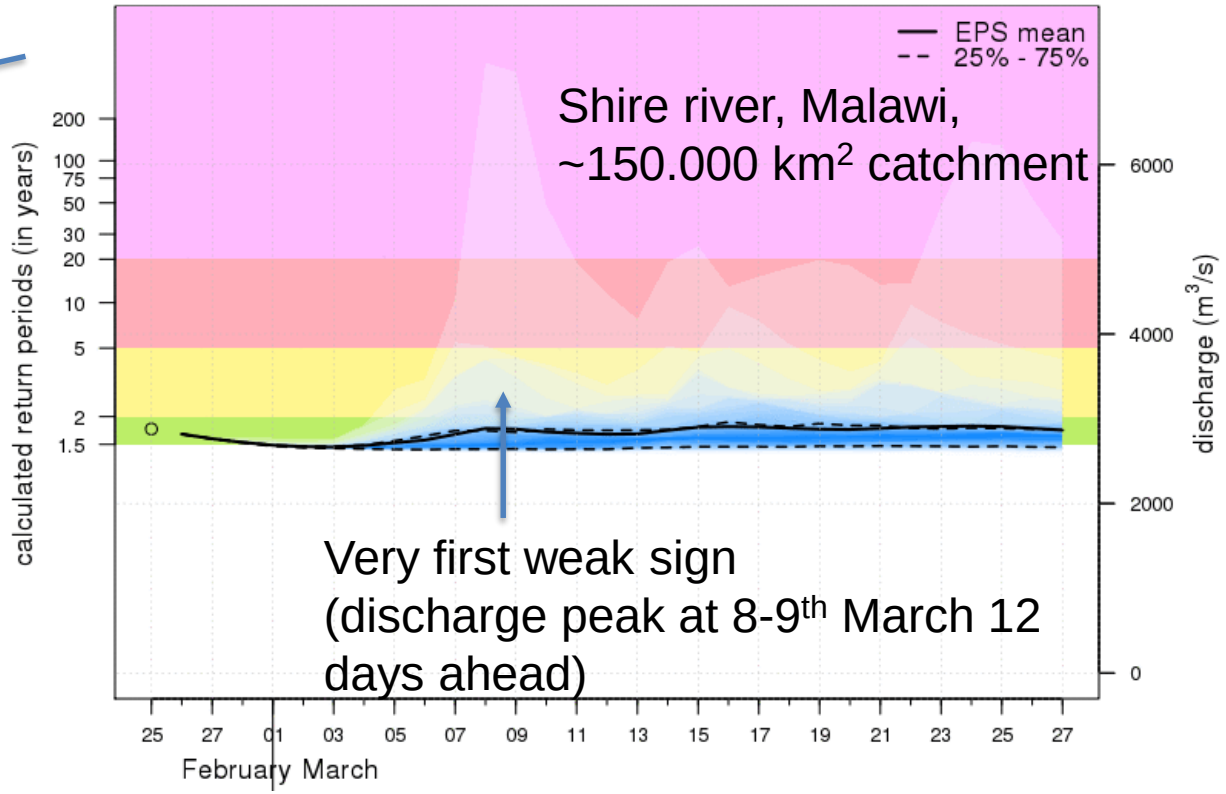
GloFAS in action – Cyclone IDAI (Mozambique)



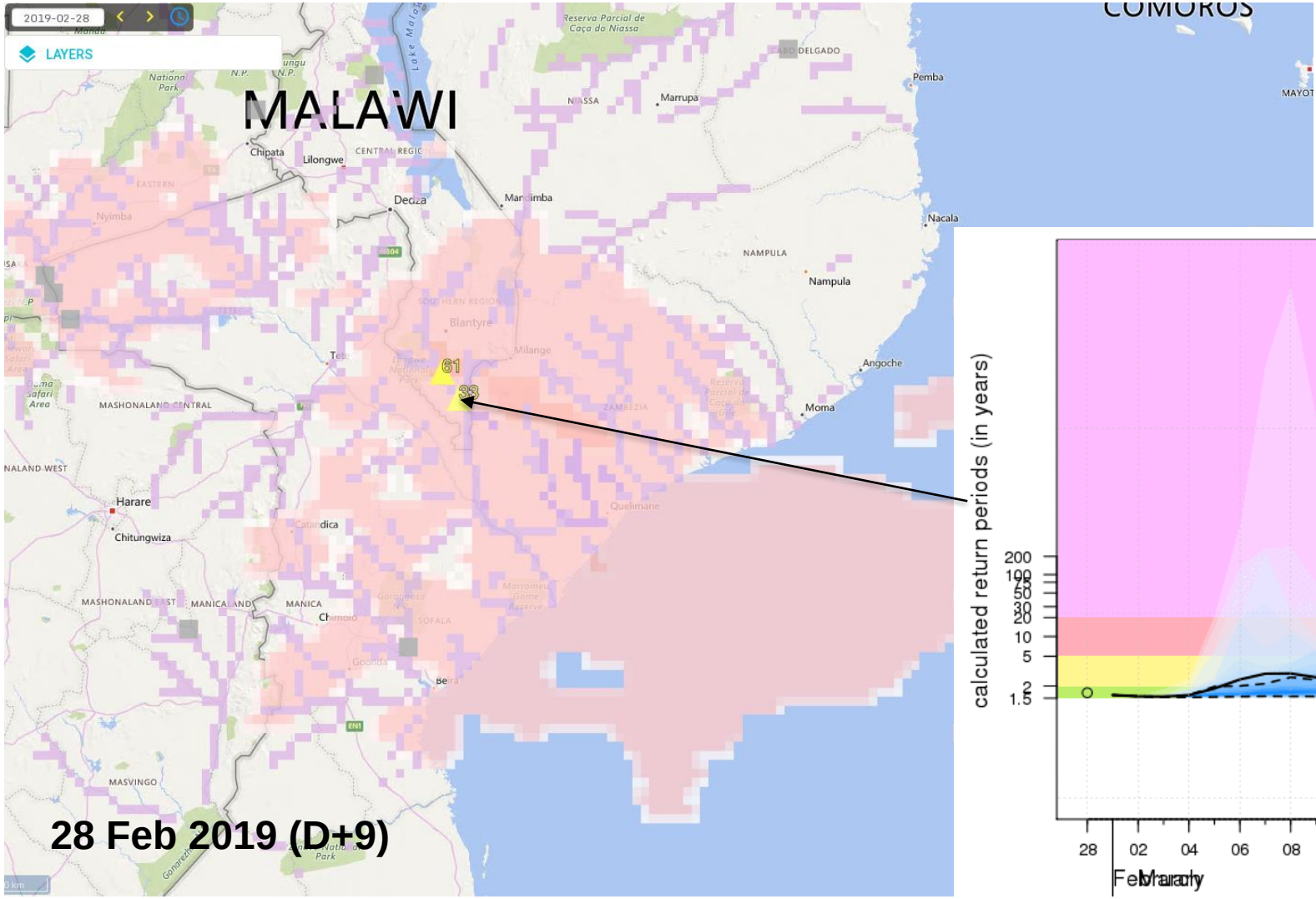
Reporting points: Grey is no flood, yellow is 2-year flood, red is 5-year flood and purple is 20-year flood conditions in the forecast (1-30 days)

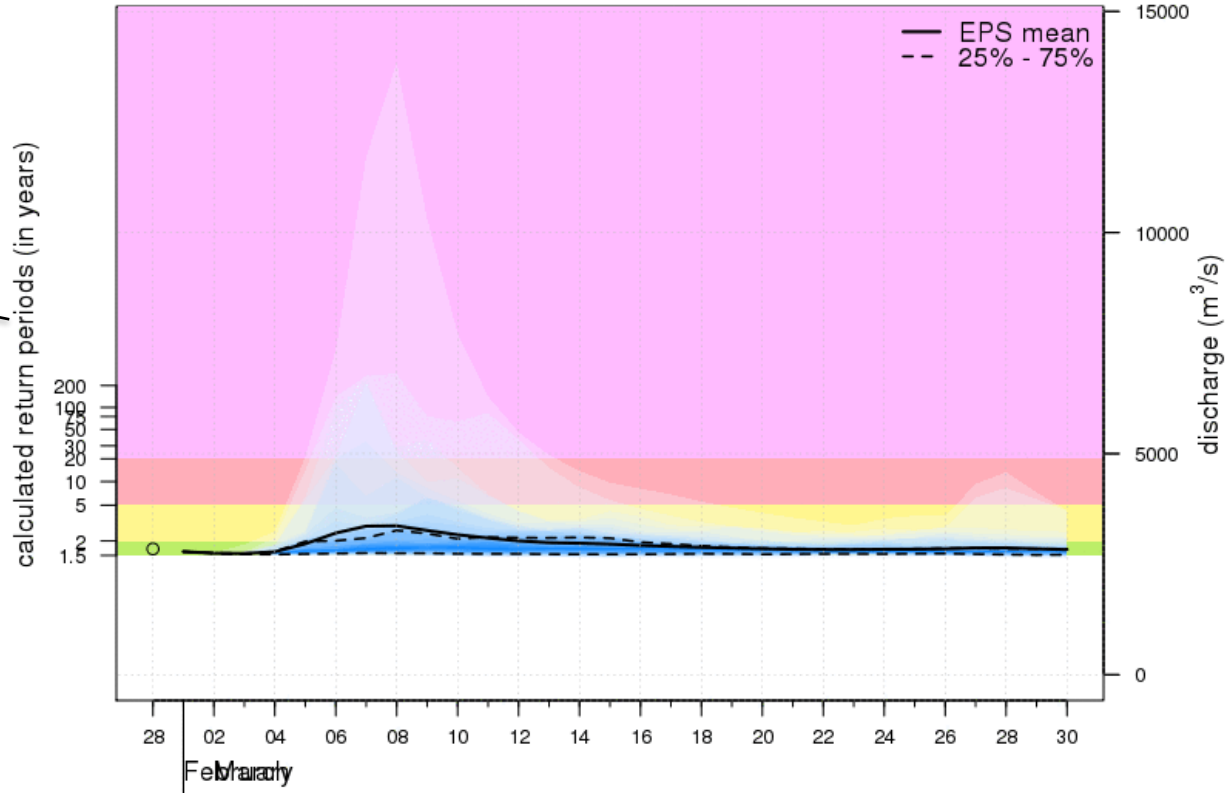
Shaded pixels: 20-year flood exceedance probability

Shaded area: ENS probability for > 300 mm precipitation in 10 days



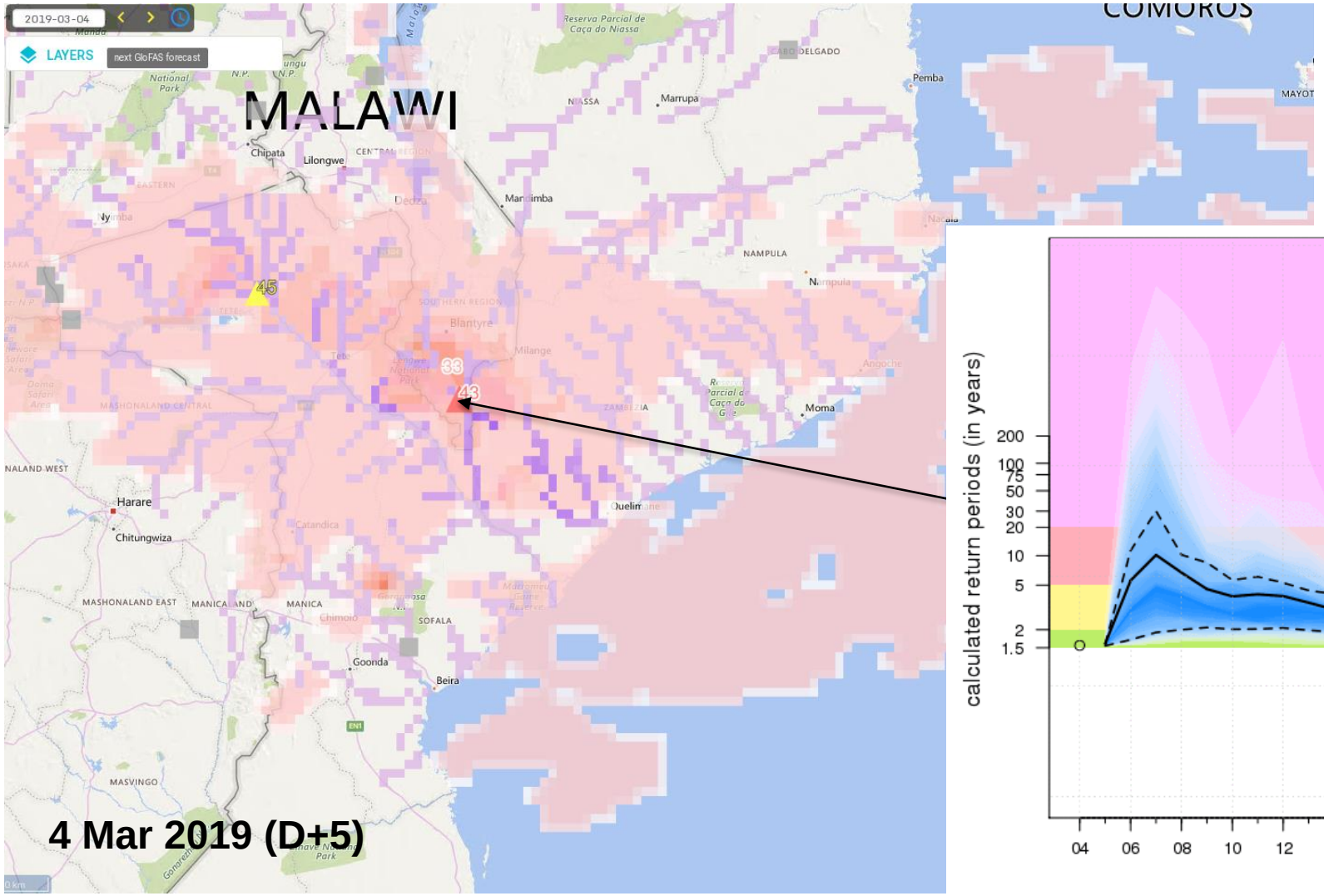
GloFAS in action – Cyclone IDAI (Mozambique)

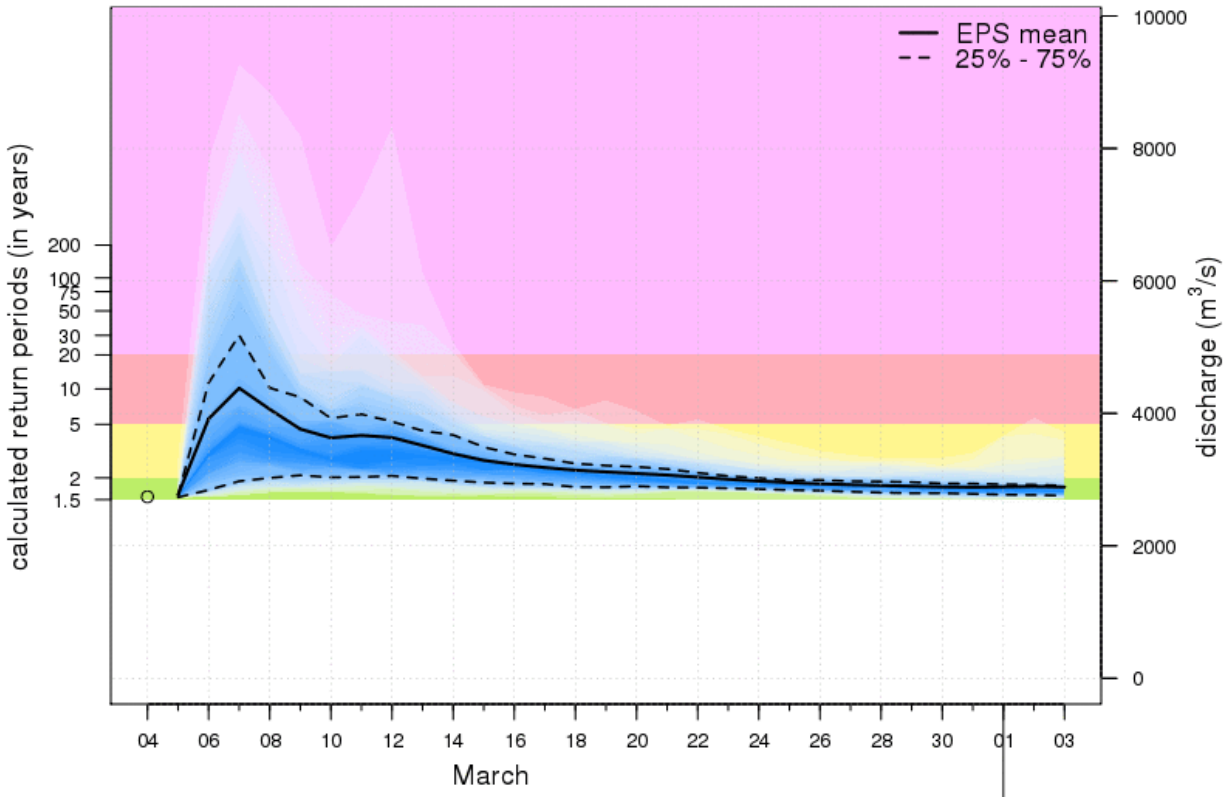




Hydrograph: Shire River at Chiromo (Malawi)

GloFAS in action – Cyclone IDAI (Mozambique)





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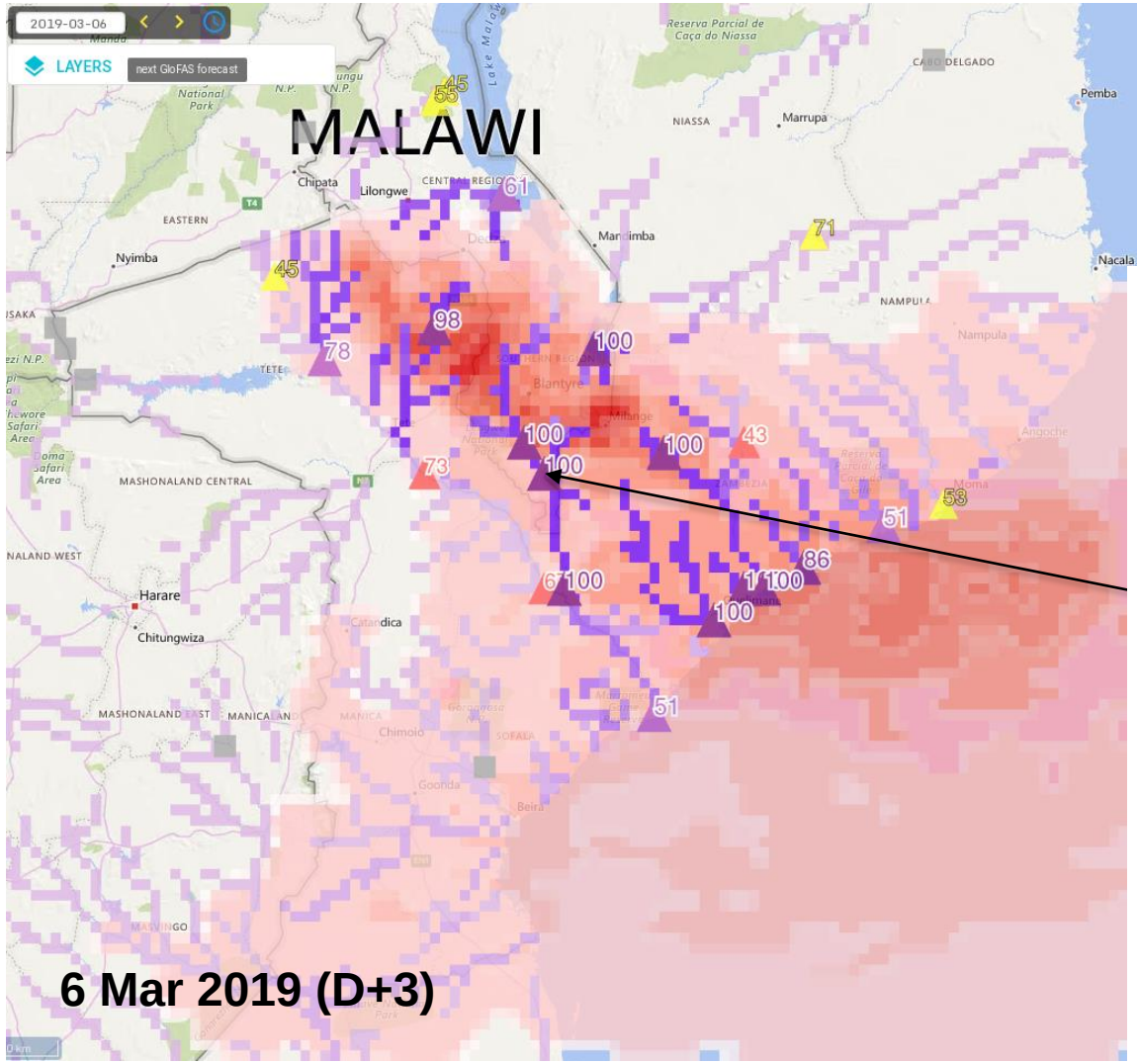

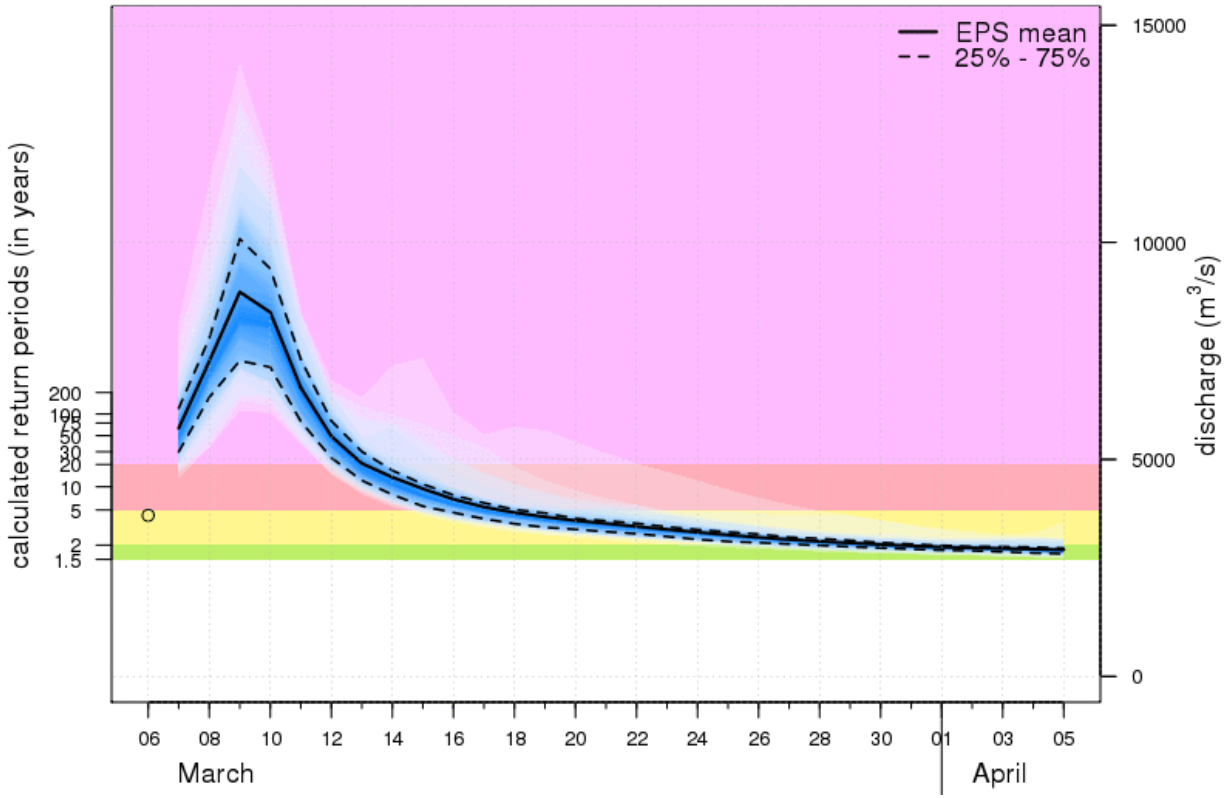

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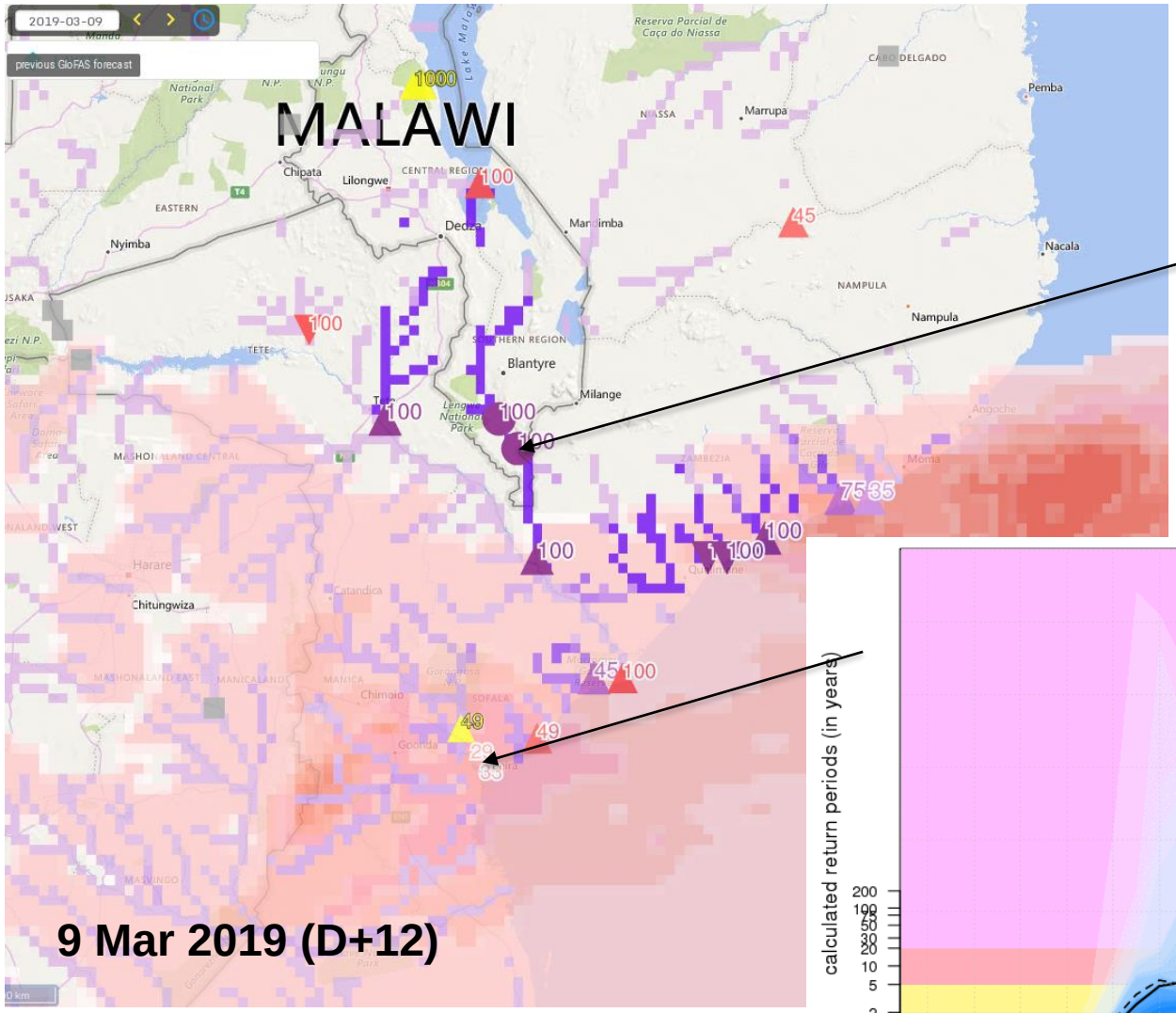

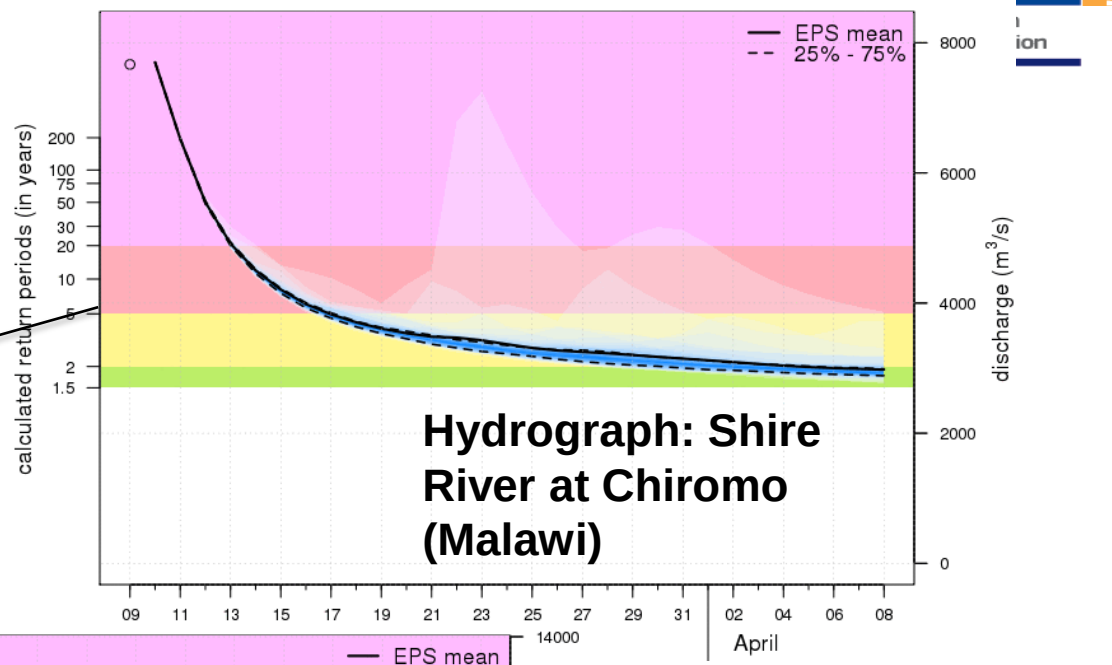

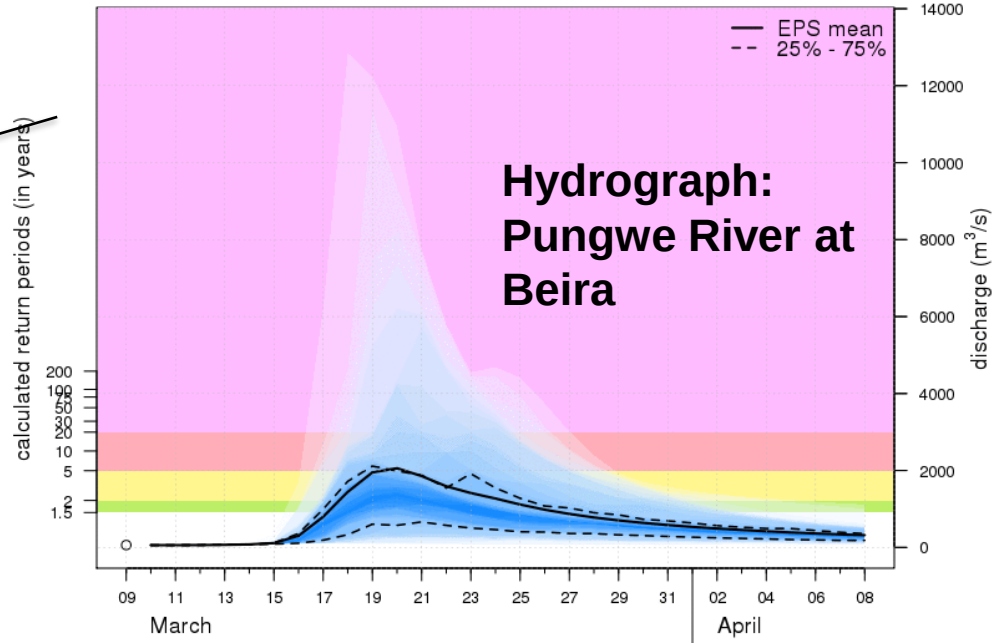

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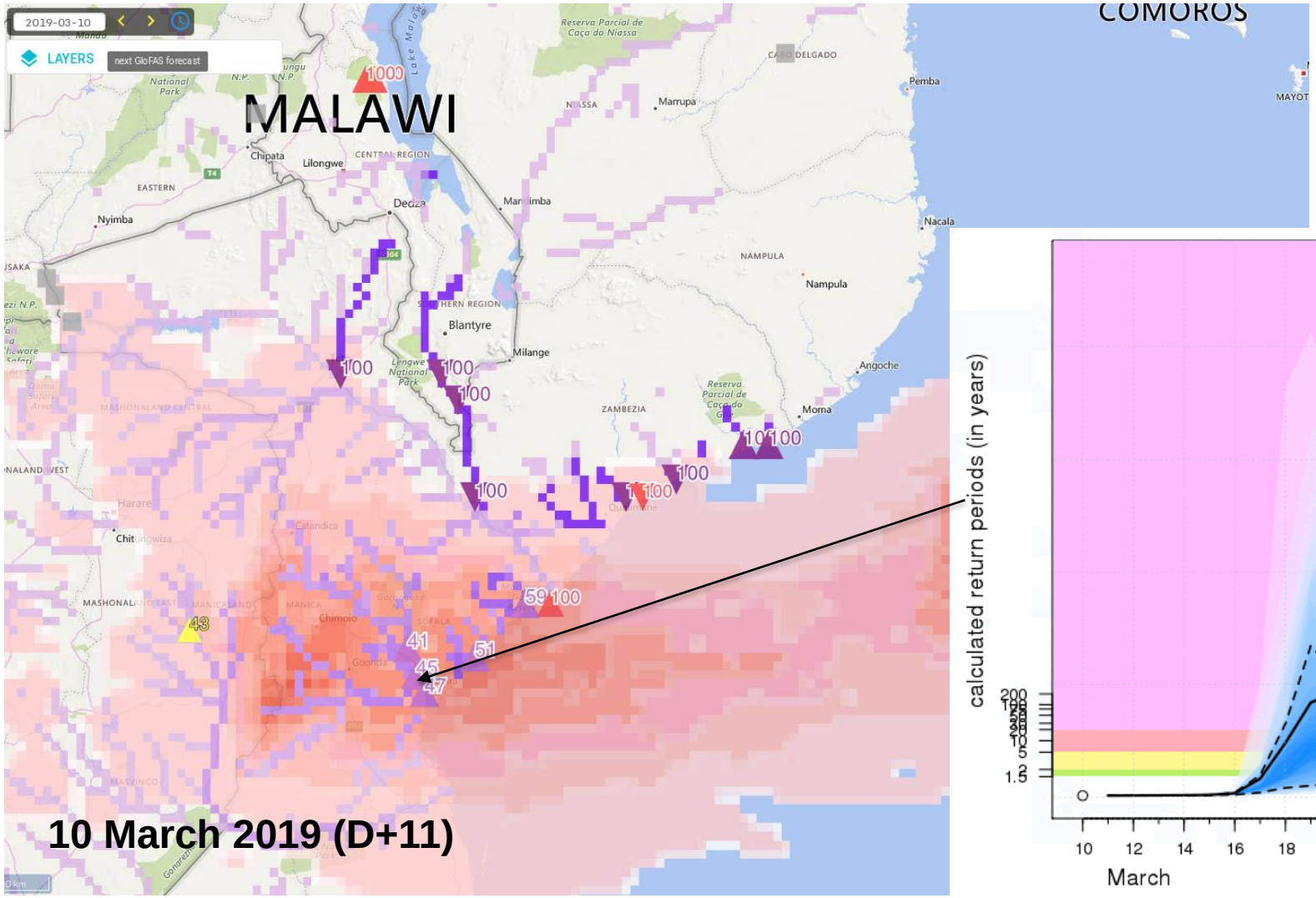
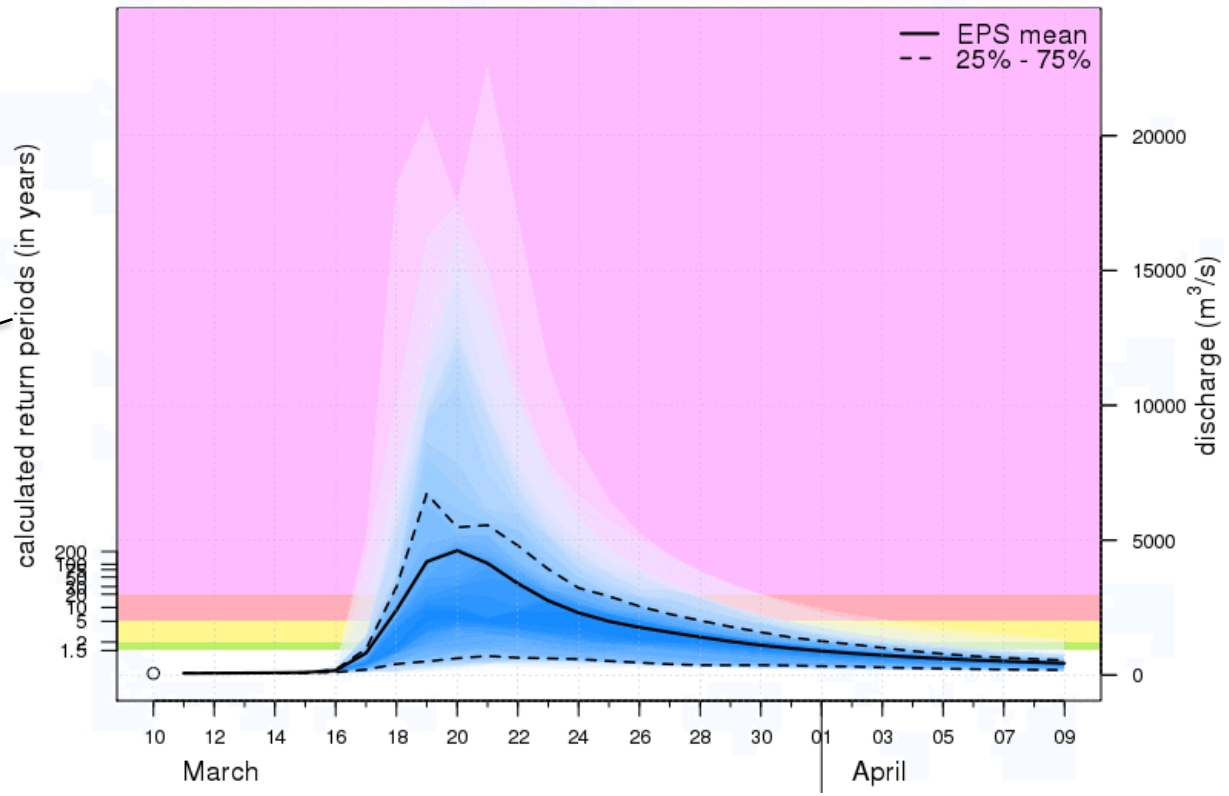
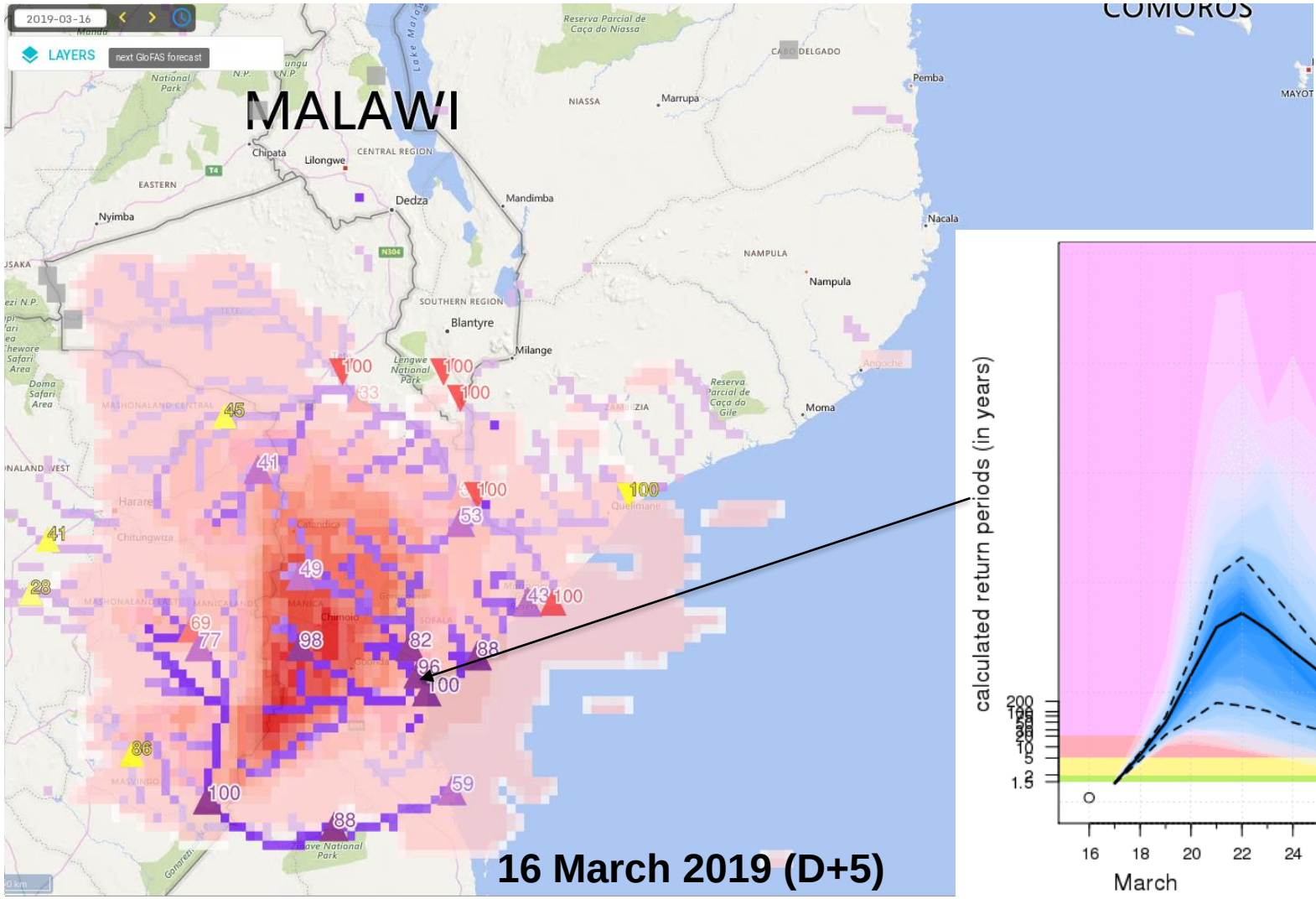


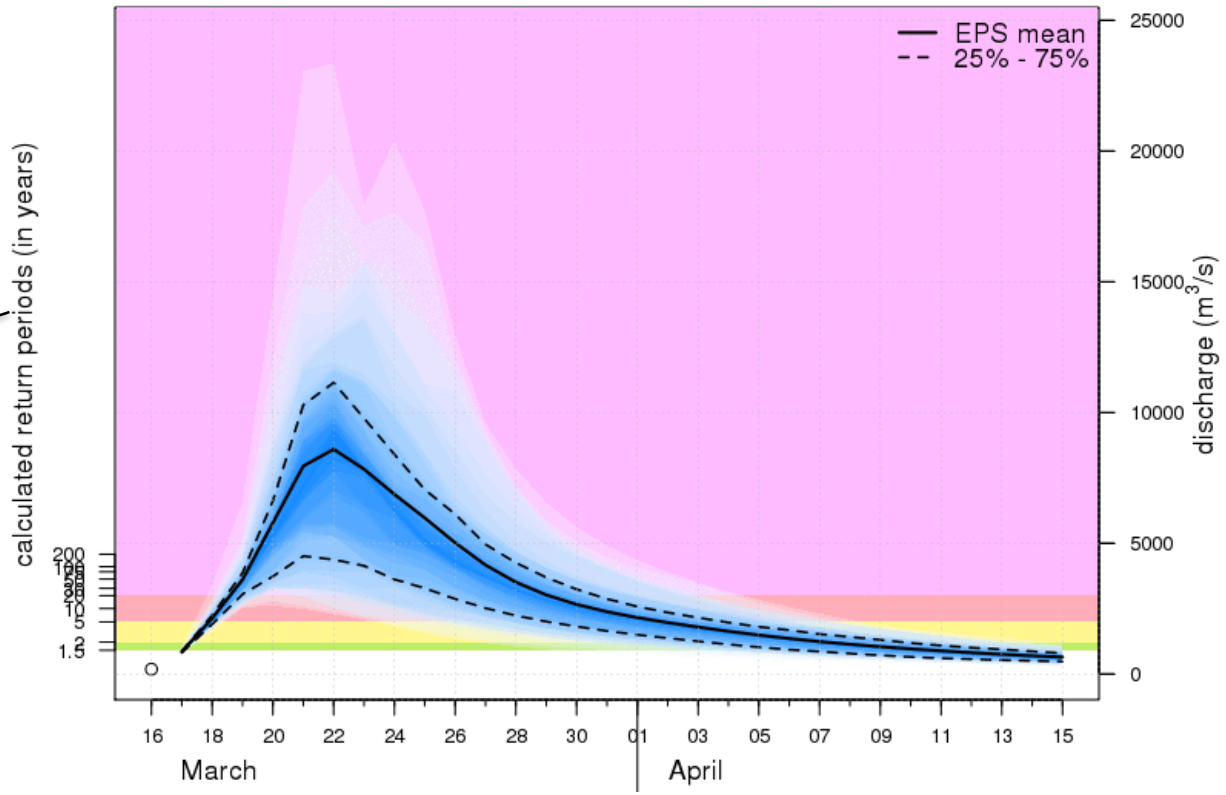
10 March 2019 (D+11)



Hydrograph: Pungwe River at Beira

GloFAS in action – Cyclone IDAI (Mozambique)





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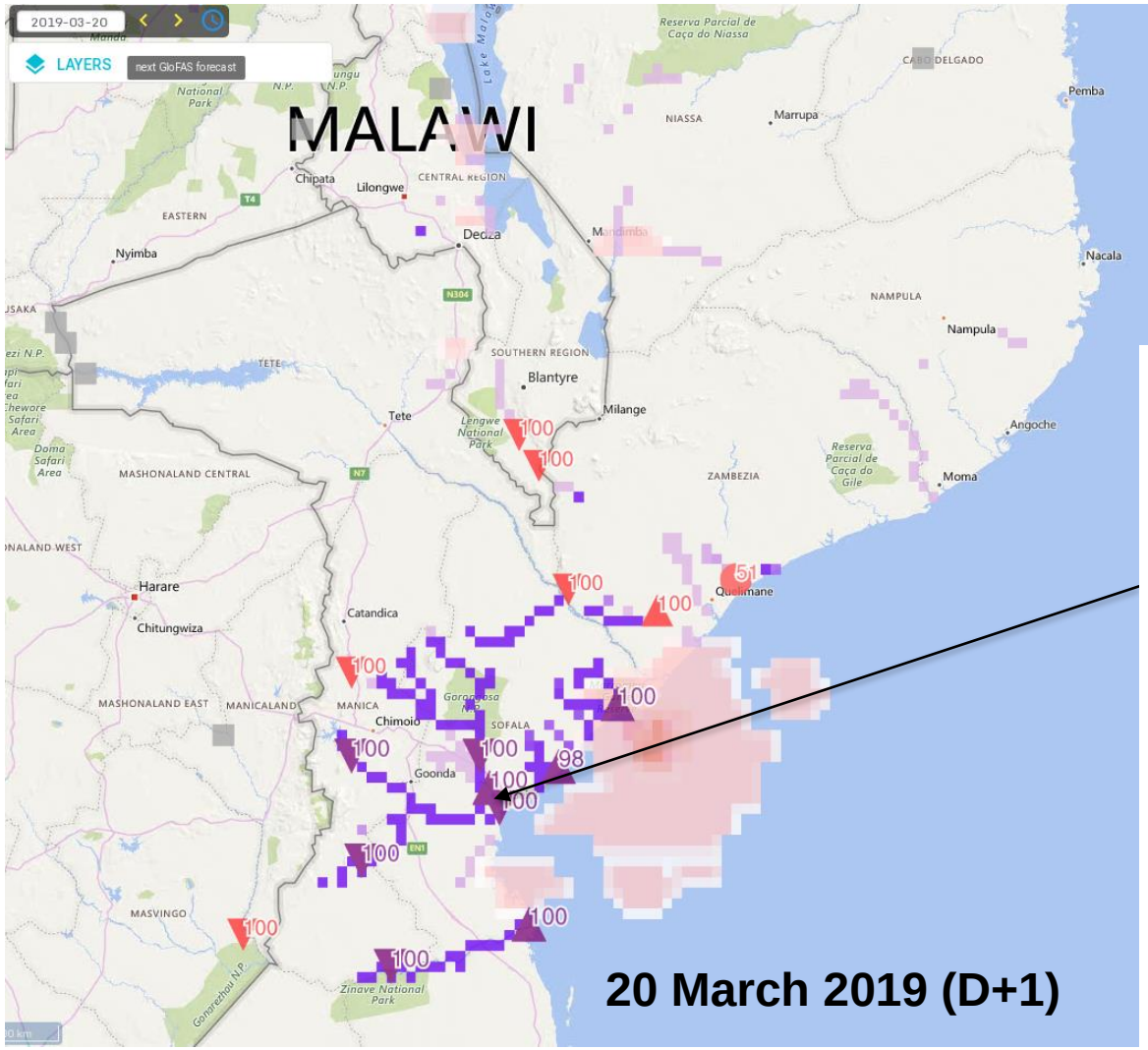
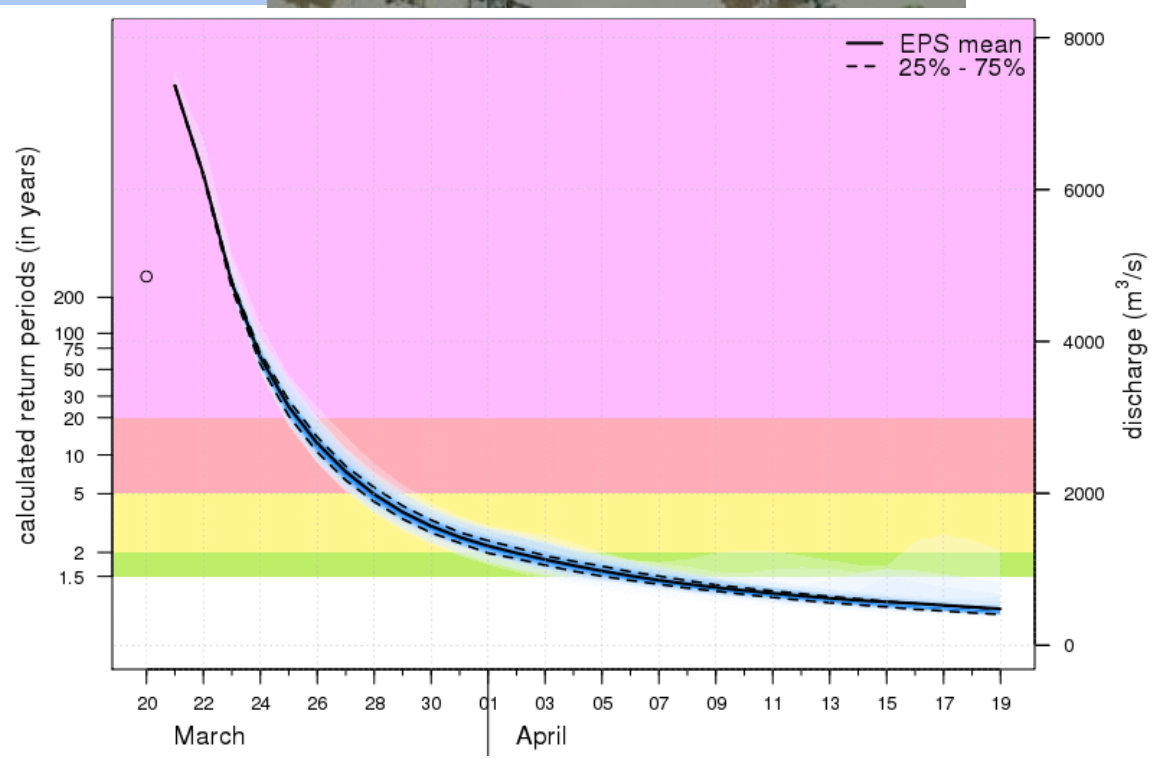


20 March 2019, at Buzi

(J. Rungo, FATHUM)



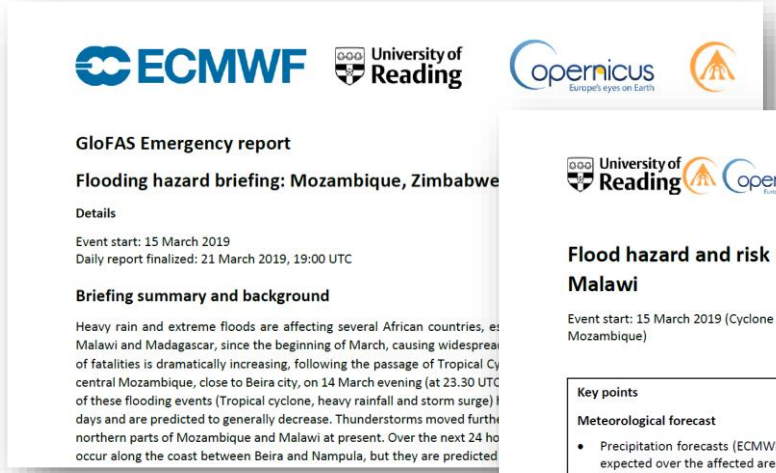
20 March 2019 (D+1)

Hydrograph: Pungwe River at Beira

GloFAS in action – Cyclone IDAI (Mozambique)

An ECMWF, University of Reading and University of Bristol collaboration response to the humanitarian disaster

- DfID (UK) requested emergency reports
- Briefs within 4 hours of forecast release
- Six reports between 21 March & 1 April
- Headline messages of future evolution
- Expert interpretation of GloFAS forecasts
- Estimation of population exposed
- Used by UN humanitarian response actors and Mozambique national agencies


ECMWF University of Reading Copernicus

GloFAS Emergency report

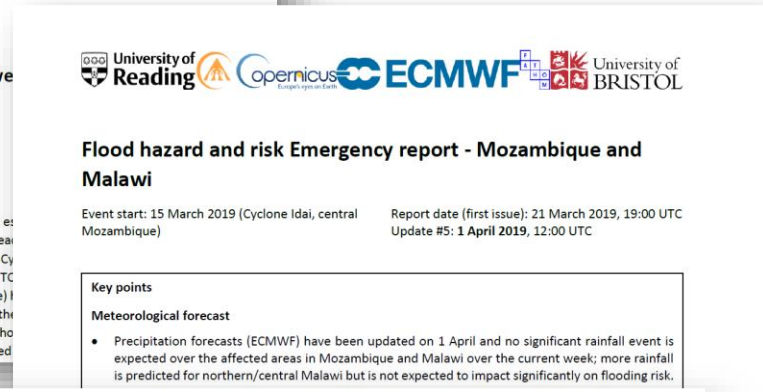
Flooding hazard briefing: Mozambique, Zimbabwe

Details

Event start: 15 March 2019
Daily report finalized: 21 March 2019, 19:00 UTC

Briefing summary and background

Heavy rain and extreme floods are affecting several African countries, es
Malawi and Madagascar, since the beginning of March, causing widesprea
of fatalities is dramatically increasing, following the passage of Tropical Cy
central Mozambique, close to Beira city, on 14 March evening (at 23.30 UTC
of these flooding events (Tropical cyclone, heavy rainfall and storm surge)
days and are predicted to generally decrease. Thunderstorms moved furth
northern parts of Mozambique and Malawi at present. Over the next 24 ho
occur along the coast between Beira and Nampula, but they are predicted


University of Reading Copernicus ECMWF University of BRISTOL

Flood hazard and risk Emergency report - Mozambique and Malawi

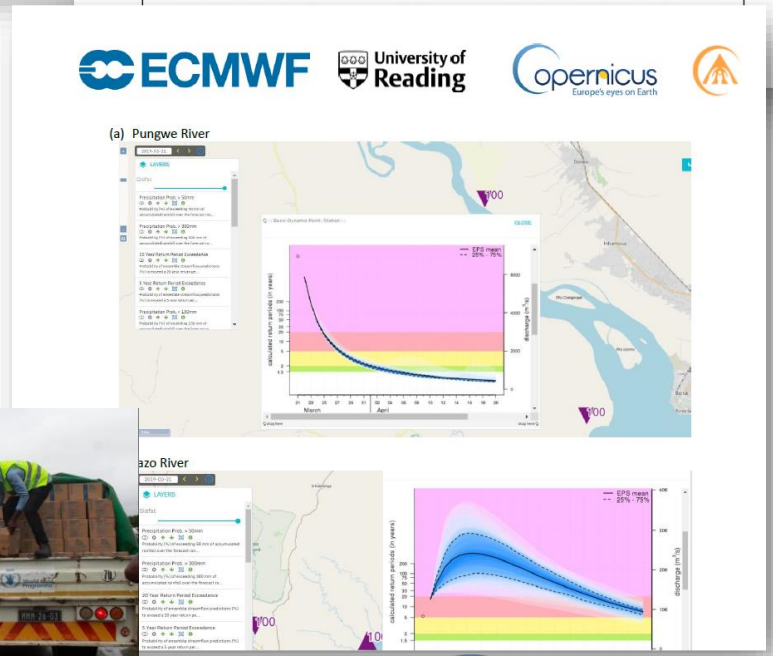
Event start: 15 March 2019 (Cyclone Idai, central Mozambique)

Report date (first issue): 21 March 2019, 19:00 UTC
Update #5: **1 April 2019**, 12:00 UTC

Key points

Meteorological forecast

- Precipitation forecasts (ECMWF) have been updated on 1 April and no significant rainfall event is expected over the affected areas in Mozambique and Malawi over the current week; more rainfall is predicted for northern/central Malawi but is not expected to impact significantly on flooding risk.


ECMWF University of Reading Copernicus

(a) Pungwe River

20 March 2019, Beira (J. Rungo, FATHUM)