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

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

GloFAS Map Viewer: http://www.globalfloods.eu/
6 services use Earth Observation data to deliver ...

Sentinels & Contributing Satellite Missions

In-situ measurements

... added value products

Source: ESA
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/
Early warning for preparation of aid assistance

European/World-wide comparable information

Complement National/regional services

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

Meteorological Data Centre
Hydrological Data Centre
Computational Centre
Dissemination Centre

Not directly funded

University of Reading
Hydrological forecasting modelling overview

Hydro-Meteorological Initial Conditions

Meteorological Forecasts forcing
- e.g. ECMWF ENS, HRES, DWD, COSMO-LEPS

Hydrological Modelling
- e.g. Lisflood, HTESSSEL, simplified runoff accumulation

Post-processing
- e.g. probability of exceedance at different lead time, graphs, maps

Web interface
- e.g. visualisation, background information

Input Observations
- satellite and in situ

Input Data Sets
- e.g. topography, soil, river network…

Thresholds
- from reference climatology
EFAS products

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

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

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

Impact mapping for rapid risk assessment

Seasonal hydrological anomalies outlooks once a month for next 8 weeks

Affected River Network

Medium
High
Severe
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)

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

Figures are provided by Alessandro Fuccello (Italian Airforce)
EFAS in action – Floods in Emilia-Romagna (Italy)

- Strong signal in ENS and HRES with good agreement

ENS-Meteogram
Montebignone, Italy 43.93°N 11.93°E (ENS land point) 606 m
High Resolution Forecast and ENS Distribution Saturday 11 May 2019 00 UTC

ENS-median
~100 mm

125+ mm
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)

Emergency Response Coordination Centre (ERCC) – DG ECHO Daily Map | 18/03/2019

Tropical Cyclone IDAI Impact Overview

© European Union, 2019. Map produced by JRC. The boundaries and the names shown on this map do not imply official endorsement or acceptance by the European Union.
GloFAS in action – Cyclone IDAI (Mozambique)

Shaded pixels: 20-year flood exceedance probability

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

25 Feb 2019 (D+12)

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)

Shire river, Malawi, ~150,000 km² catchment

Very first weak sign (discharge peak at 8-9th March 12 days ahead)
GloFAS in action – Cyclone IDAI (Mozambique)

28 Feb 2019 (D+9)

Hydrograph: Shire River at Chiromo (Malawi)
GloFAS in action – Cyclone IDAI (Mozambique)

6 Mar 2019 (D+3)

Hydrograph: Shire River at Chiromo (Malawi)
GloFAS in action – Cyclone IDAI (Mozambique)

9 Mar 2019 (D+12)

Hydrograph: Shire River at Chiromo (Malawi)

Hydrograph: Pungwe River at Beira
GloFAS in action – Cyclone IDAI (Mozambique)

10 March 2019 (D+11)

Hydrograph: Pungwe River at Beira
GloFAS in action – Cyclone IDAI (Mozambique)

Hydrograph: Pungwe River at Beira

16 March 2019 (D+5)
GloFAS in action – Cyclone IDAI (Mozambique)

20 March 2019 (D+1)

Hydrograph: Pungwe River at Beira

20 March 2019, at Buzi (J. Rungo, FATHUM)
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

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