



# GEOlab Meeting, January 29, 2016

POLITECNICO DI MILANO  
GEOlab

Como Campus



## GloFAS

(Global Flood Awareness System)



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# What is GloFAS?

## MAIN OBJECTIVES

- ✓ Early flood information system for preparation of aid in the case of major river floods
- ✓ Worldwide comparable catchment-based information (probabilistic forecast)

## SYSTEM SET-UP & MAIN ACTORS OVERVIEW

Ensemble meteorological forecasts



Hydrological modeling



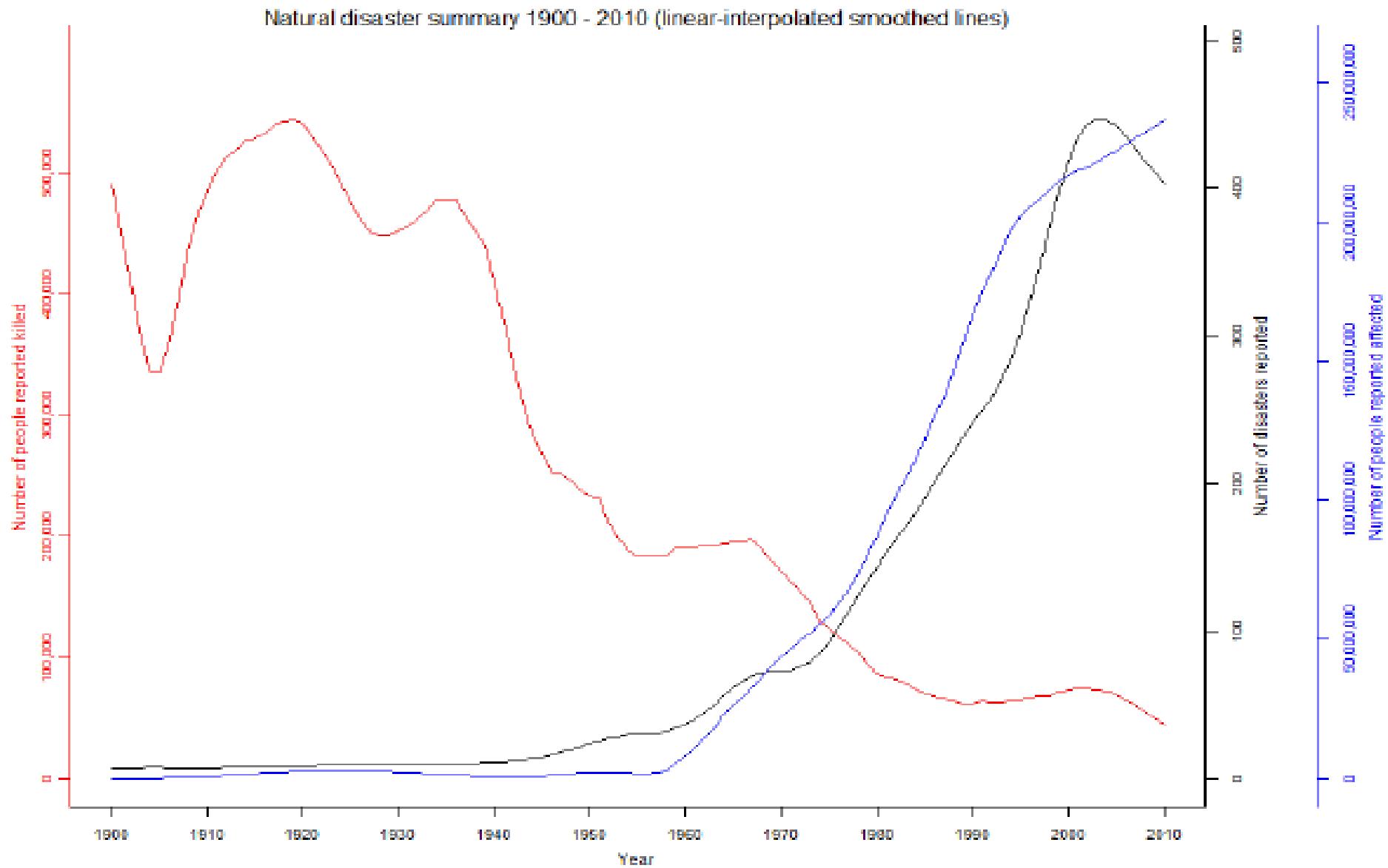
(Forecasted flood events)

Forecast Web viewer

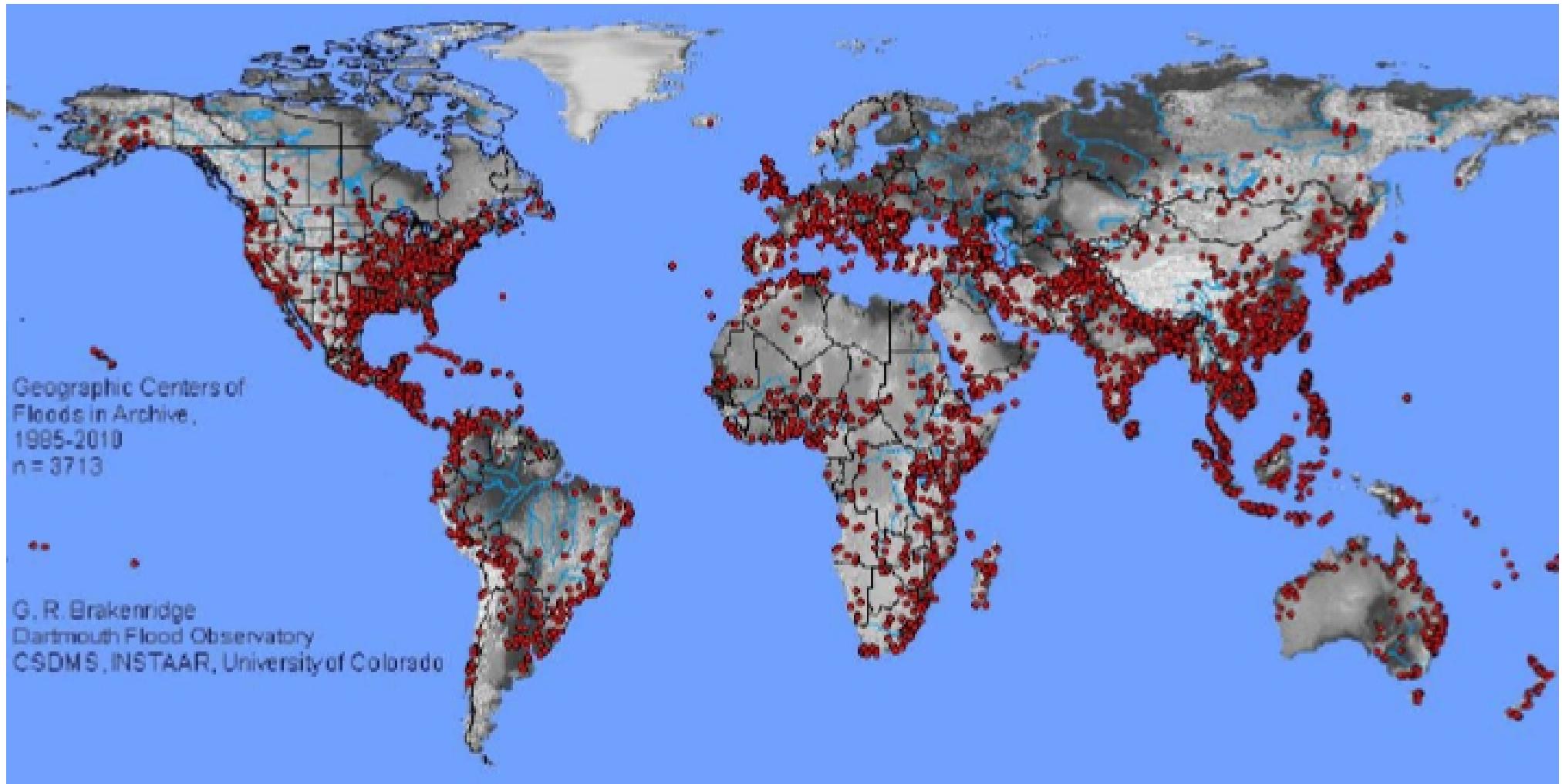


<http://www.globalfloods.eu>

# Why a Global Flood Information System?



# Why a Global Flood Information System?



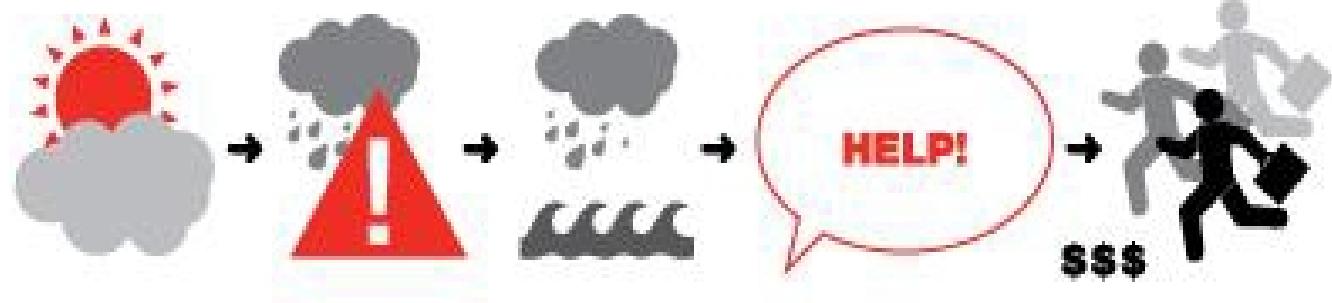
**...BECAUSE FLOOD FORECASTING IS A GLOBAL CHALLENGE!**

# What's usefull for?

RED CROSS/RED CRESCENT  
CLIMATE CENTRE

## FORECAST BASE FINANCING

**present situation:**



**...new way to provide aid to flood affected communities!**



# What's usefull for?

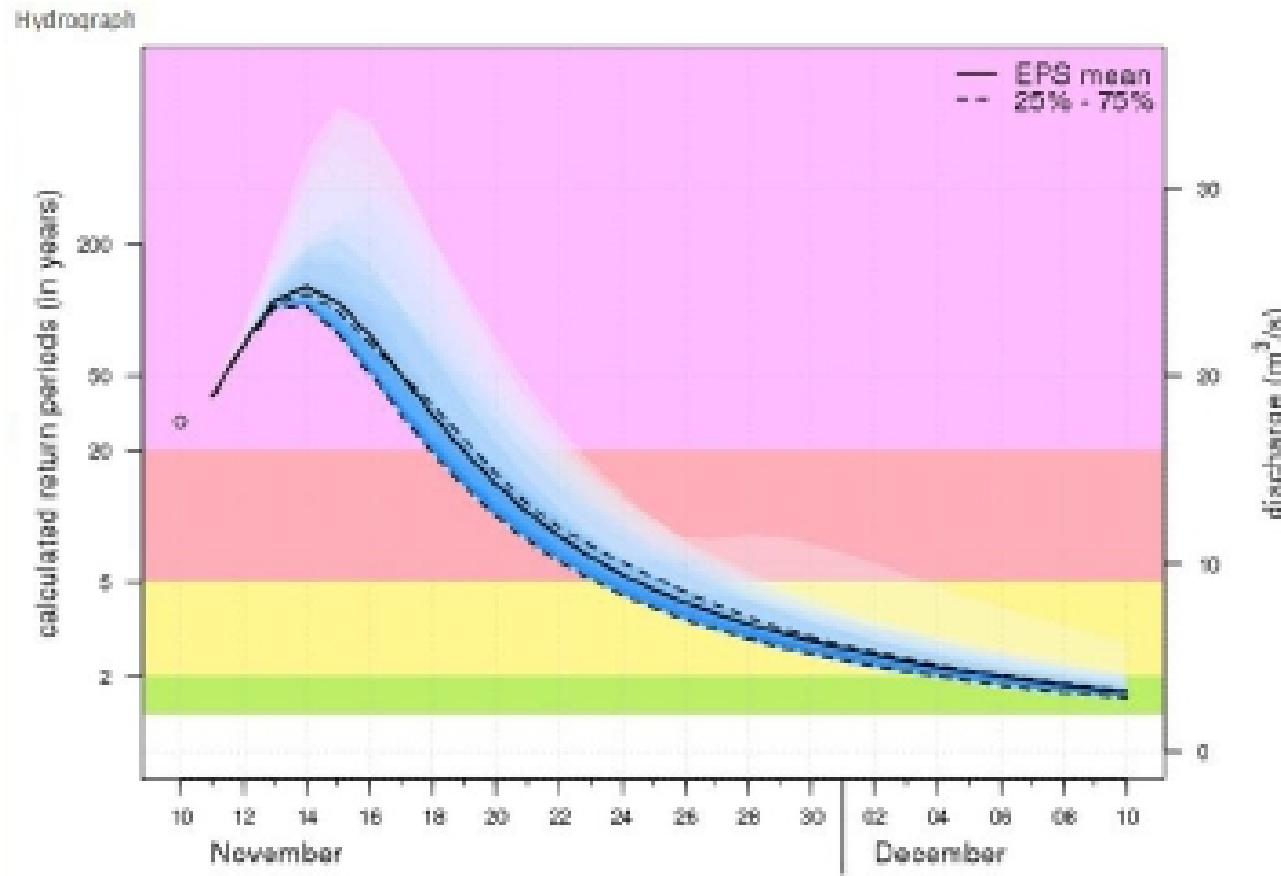
RED CROSS/RED CRESCENT  
CLIMATE CENTRE

## FORECAST BASE FINANCING



# GloFAS forecast information

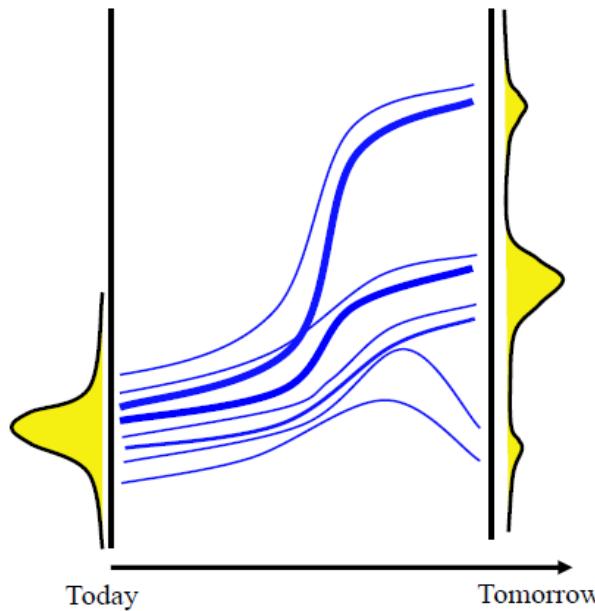
- ✓ Forecast variable: RIVER FLOW
- ✓ Forecast frequency = Forecast temporal resolution: DAILY
- ✓ Forecast lead time: UP TO 30 DAYS
- ✓ Forecast type: PROBABILISTIC



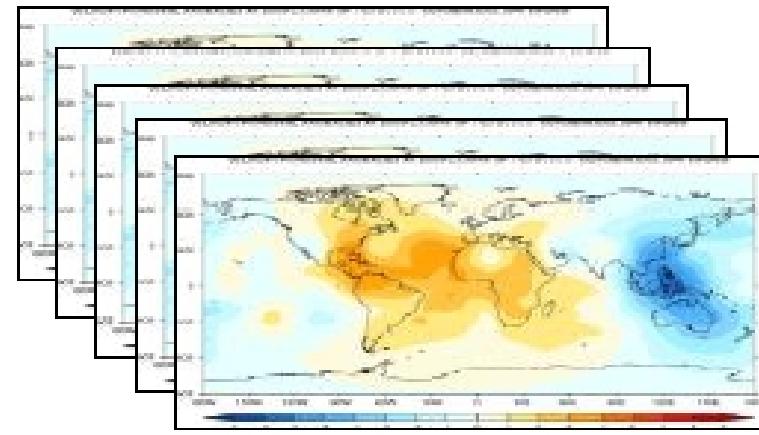
# GloFAS Model Set-Up

- ✓ **Input:** ECMWF Ensemble meteorological forecasts
  - \_ 51 ensemble members
  - \_ 15 days forecast horizon + 15 day assuming no precipitations
  - \_ Resolution = 32 km (0-10 day) and 65 km (11-15 day)

Ensemble prediction systems

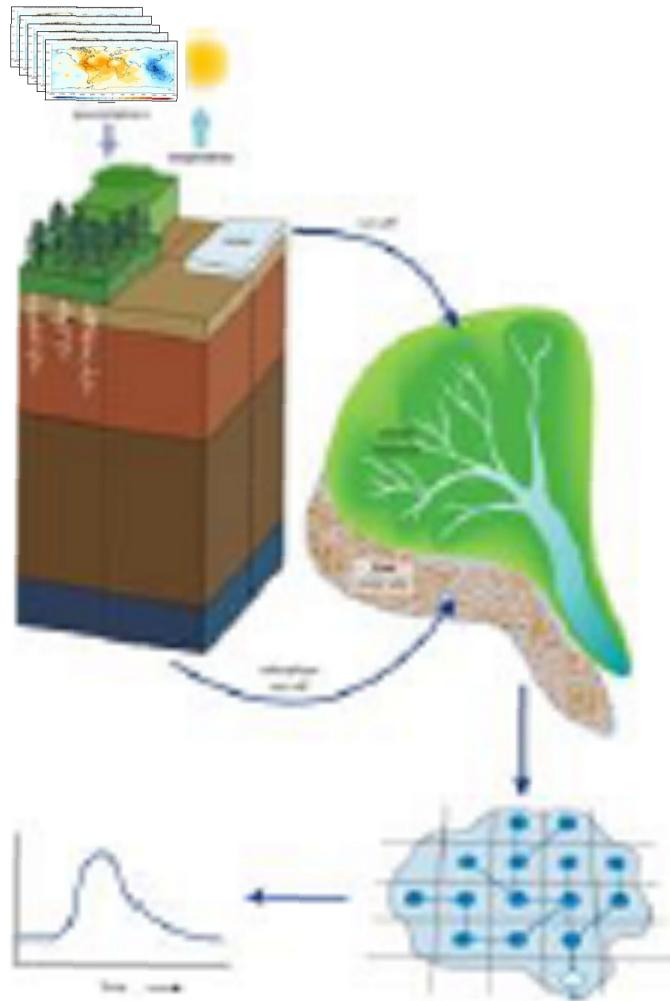


Global probabilistic  
weather forecast (ECMWF)



# GloFAS Model Set-Up

- ✓ **Hydrological model:** Cascade of



**HTESSEL** (Hydrology Tiles  
ECMWF Scheme for Surface  
Exchange over Land)

↓  
**Lisflood** (JRC)  
Groundwater and routing

- ✓ **Output:** Daily river discharge at  $0.1^\circ$  spatial resolution

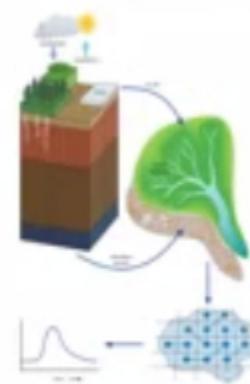
# GloFAS Model Set-Up

- ✓ **Flood thresholds:** enable to compare potential flood severity worldwide (probabilistic forecast)

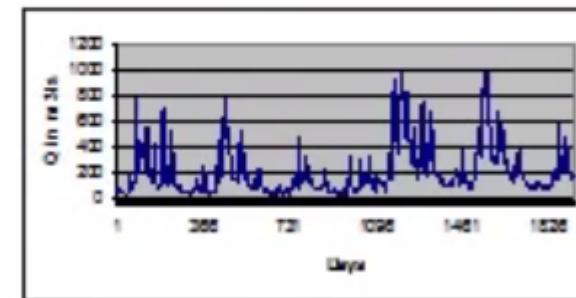
Long-term climatology



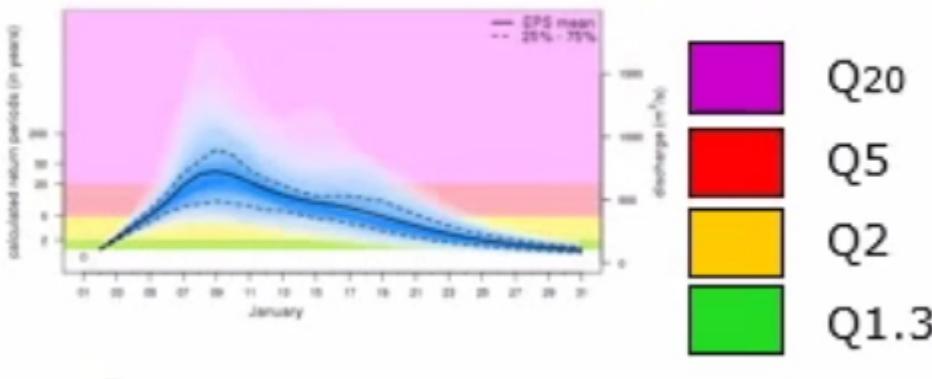
HTESSEL+Lisflood



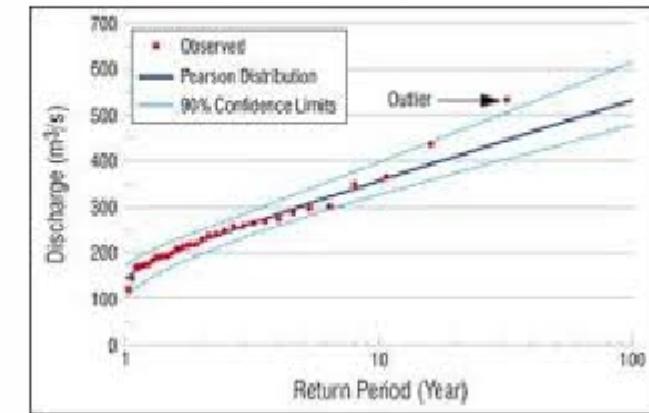
Simulated discharge time series  
for each model grid pixel



Thresholds & return period hydrographs



Return period statistics



# GloFAS Model Set-Up

## ✓ **Limitations:**

- \_ GloFAS does not provide water levels or flood extent (ongoing work)
- \_ The hydrological model is currently not calibrated (ongoing work)
- \_ Minimum upstream area for reliable streamflow predictions is 10.000 km<sup>2</sup> (due to the spatial resolution of the weather forecast) → **to give you an idea, Adda River watershed is around 7.927 km<sup>2</sup>!**

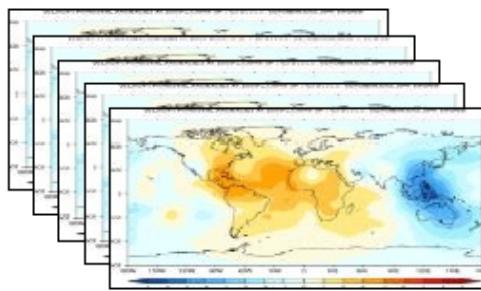
## ✓ **Recent update**

- \_ Inclusion of major lakes and reservoirs for flood routing computation

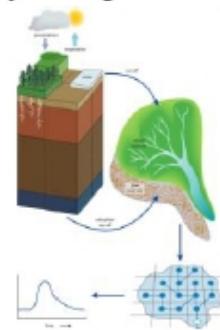
- ✓ The flood forecast output are **PCRaster** maps (<http://pcraster.geo.uu.nl>)
- ✓ Output maps also are available in **netCDF** (managed through **Rasdaman**) and benefit from new systems like **ncWMS** (<http://www.resc.rdg.ac.uk/trac/ncWMS>) and **THREDDS Data Server** (<http://www.unidata.ucar.edu/software/thredds/current/tds>)
- ✓ Output maps are processed and the result of this phase are mostly shapefiles, geo-referenced images (PNG) and XML files that are displayed using **MapServer** through **GloFAS Web viewer** (<http://www.globalfloods.eu/glofas-forecasting>)

# GloFAS Forecast Web viewer

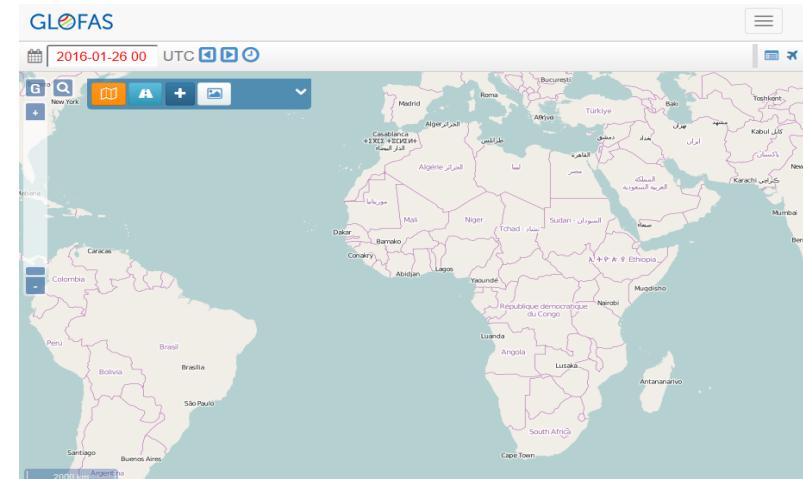
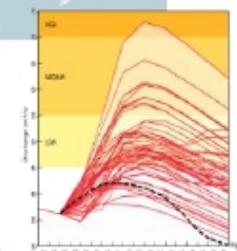
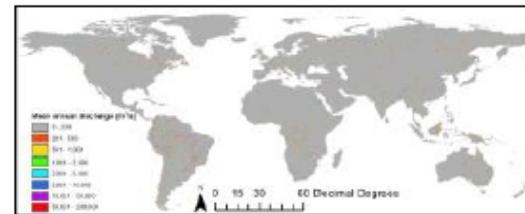
Global probabilistic  
weather forecast (ECMWF)



hydrological model



Decision support information

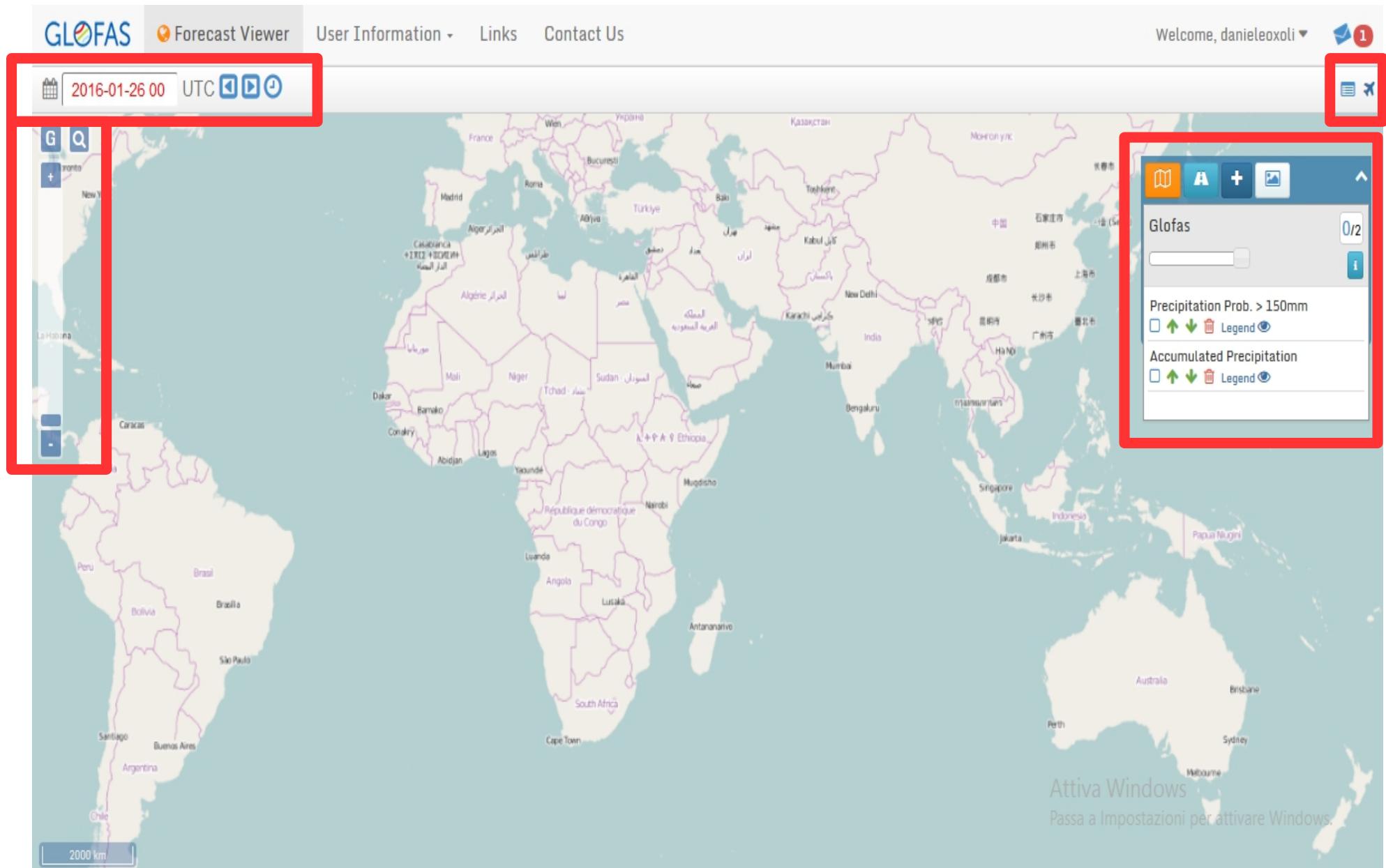


- ✓ A Web Viewer is available to access GloFAS static geospatial data as well as summary forecast maps (<http://www.globalfloods.eu/glofas-forecasting>)
- ✓ It requires users registration to access!

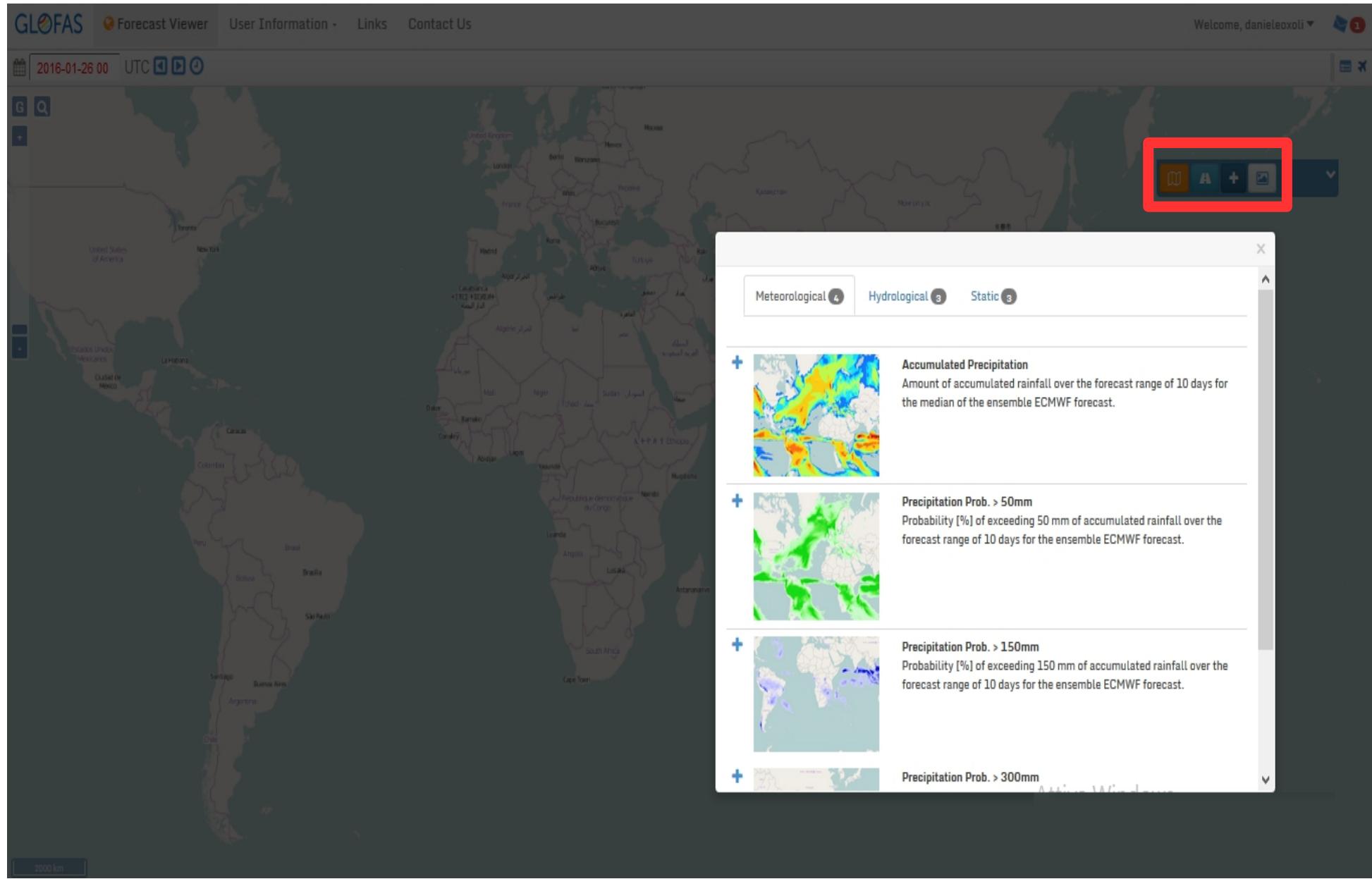
# GloFAS Web viewer

- ✓ The Web viewer is based on **Django**, **OpenLayers3**, **HTML5** (+ some **JavaScript** patterns)
- ✓ All the available geospatial data are served as **WMS** and **WFS** layers
- ✓ Available layers:
  - \_ **Meteorological Maps** (*Accumulated Precipitation, Precipitation Probability > 50,150,300 mm*) – one per day for the past 30 days
  - \_ **Hydrological Maps** (*5,20 Year Return Period Exceedance*),
  - \_ **Reporting Points**
  - \_ **Static Layers** (*GloFAS lakes and reservoirs, Major river basins, Flood hazard 100 year return period*)
- ✓ Main features:
  - \_ Meteorological / Hydrological maps selection by specifying a date
  - \_ Overlay external WMS layers
  - \_ Query static layers as well as reporting points

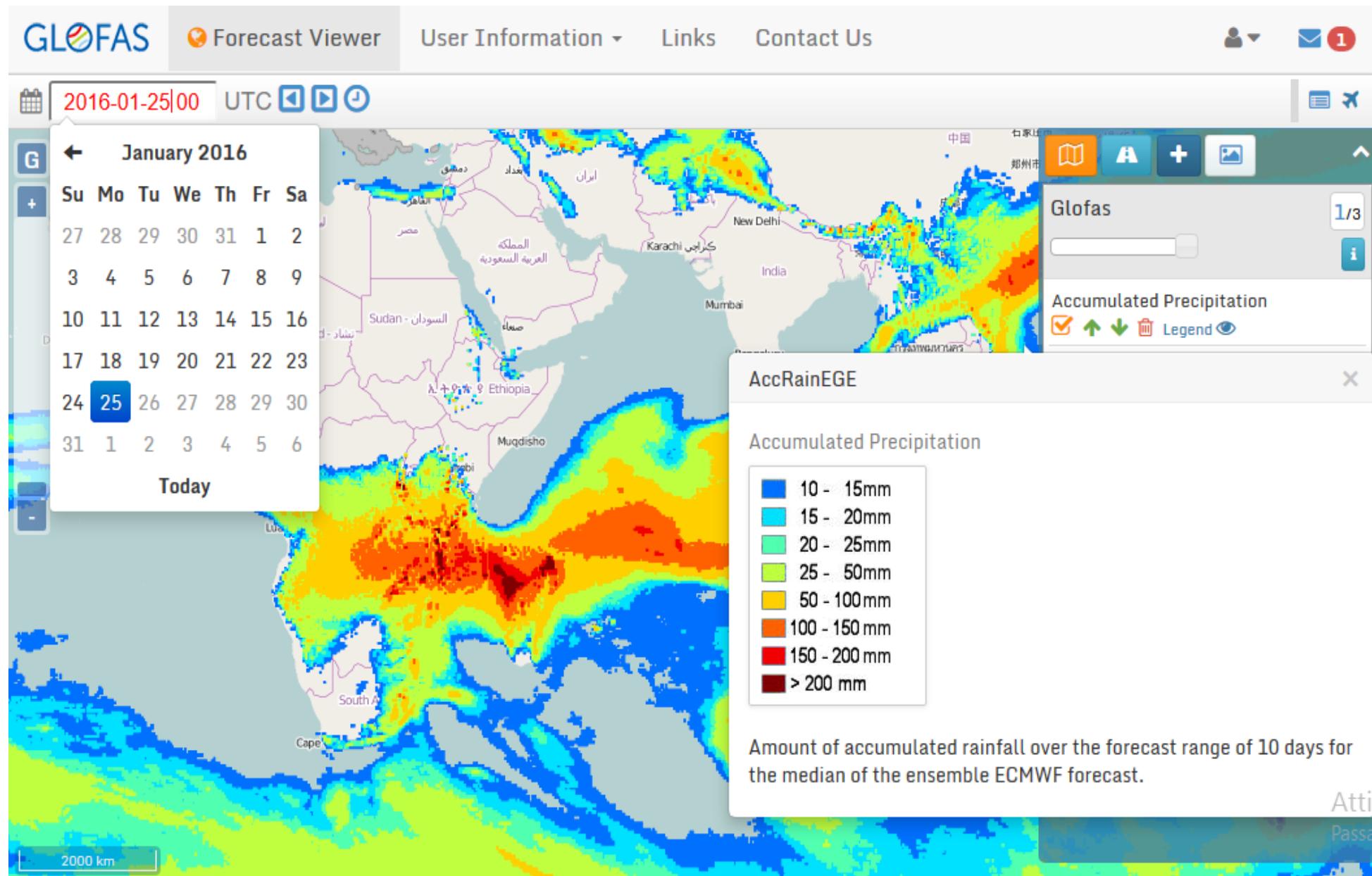
# GloFAS Web viewer – Interface



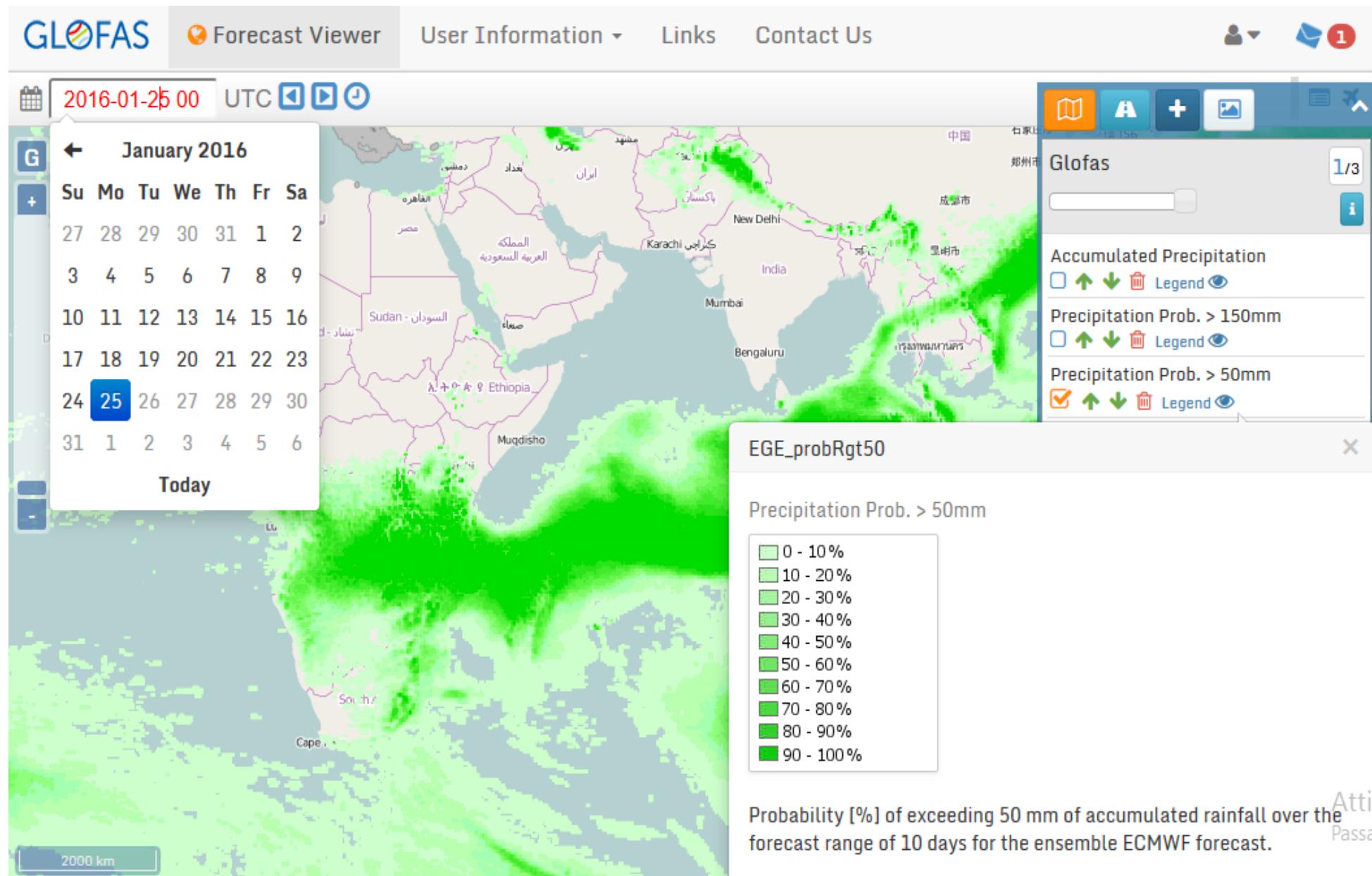
# GloFAS Web viewer – Layer control bar



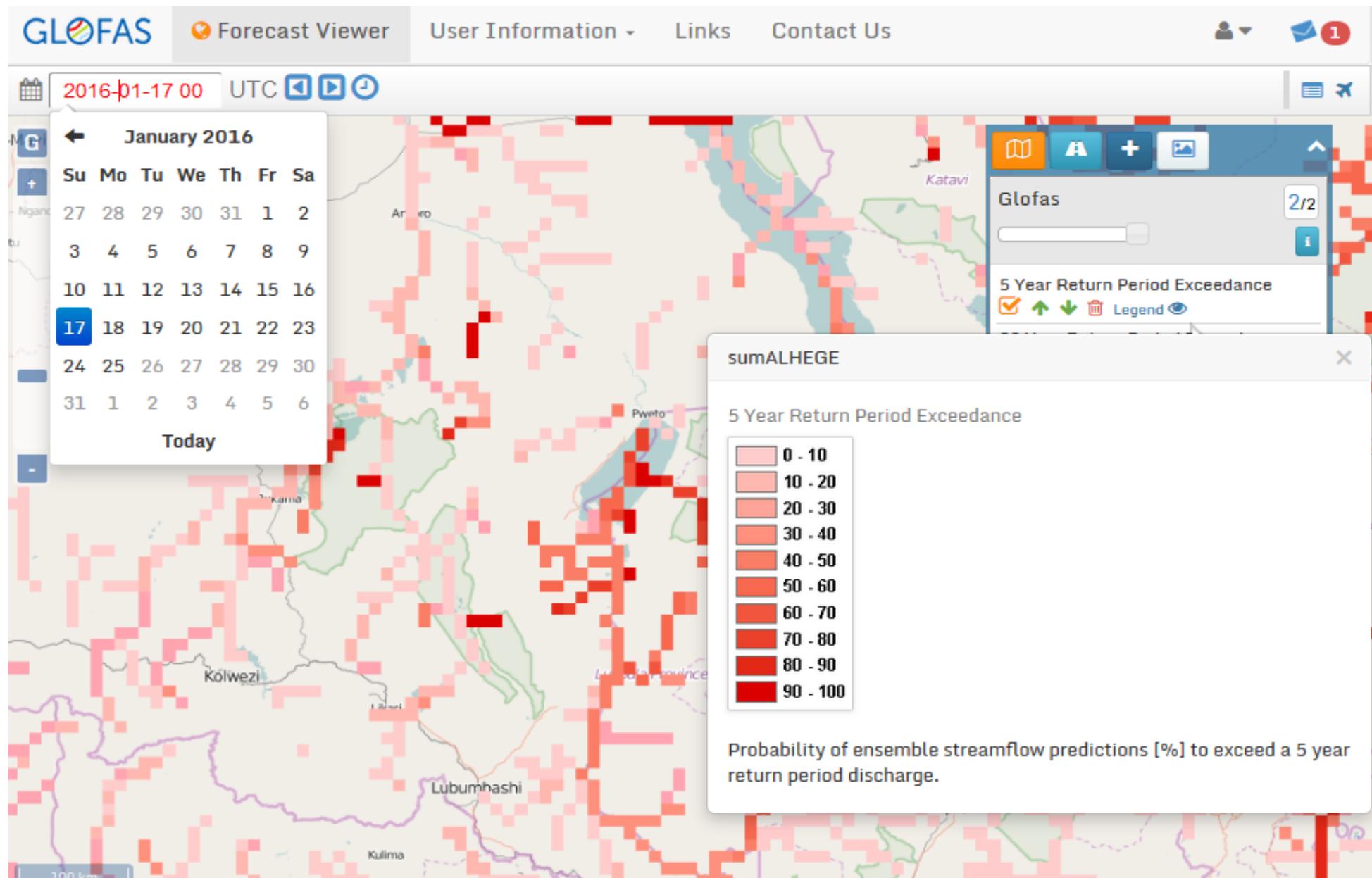
# GloFAS Web viewer – Meteorological data



# GloFAS Web viewer – Meteorological data



# GloFAS Web viewer – Hydrological data



# GloFAS Web viewer – External WMS

Add Web Mapping Service (WMS)

Link to the WMS GetCapabilities

username/password

★ Most popular WMSs used in GloFAS

+ Add

> GeoServer Web Map Service

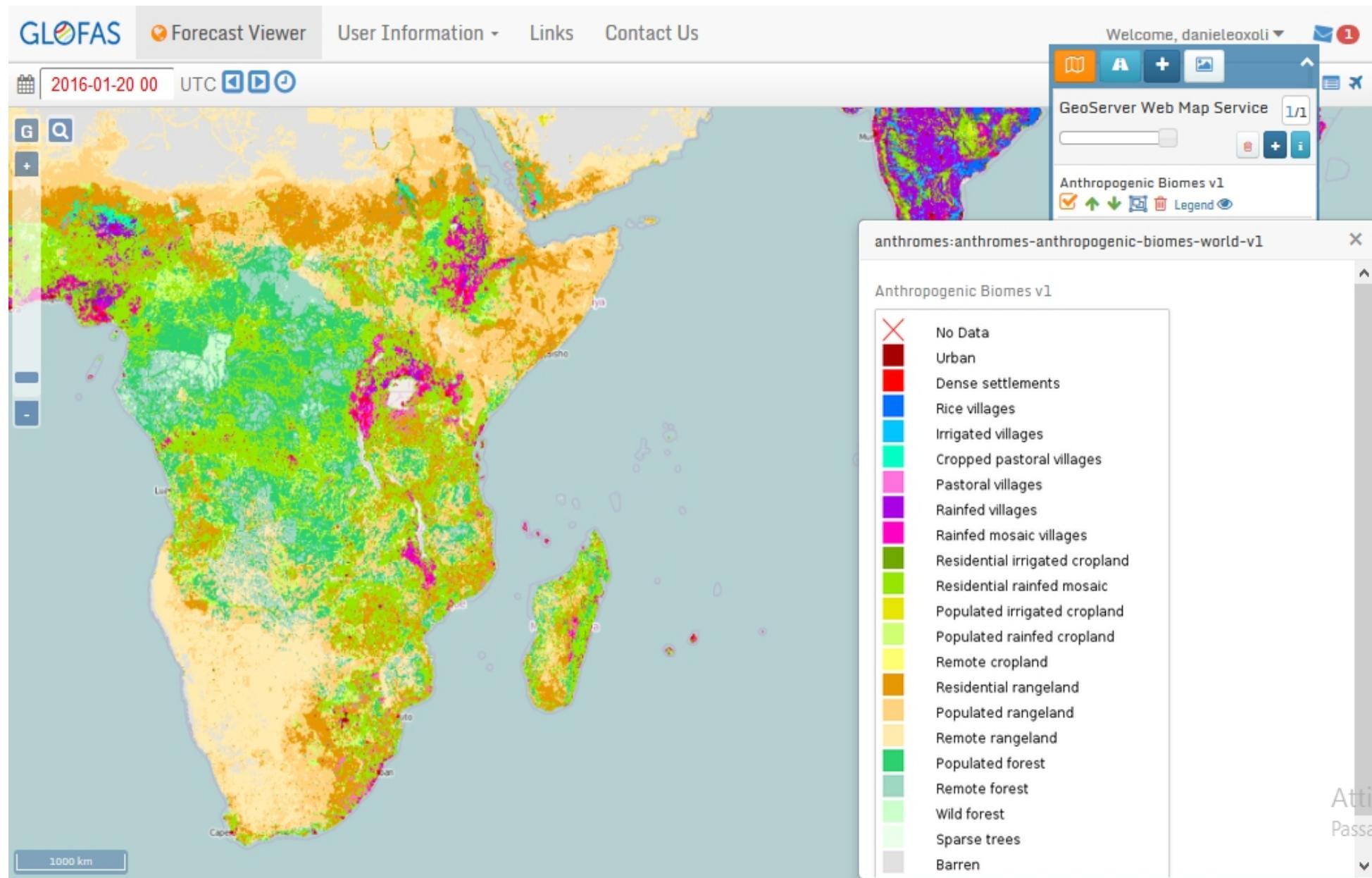
Show 10 entries Search: Clear

| Thumbnail | Title                                    | Abstract   | Info      |
|-----------|--|--|-----------|
|           | EPI 2010 Environmental Burden of Disease | The 2010 Environmental Performance Index (EPI) ranks 163 countries on 25 performance indicators tracked across ten well-established policy categories covering both environmental public health and ecosystem vitality. These indicators provide a gauge at a national government scale of how close countries are to established environmental policy goals. This proximity-to-target methodology facilitates cross-country comparisons as well as analysis of how the global community performs collectively on each particular policy issue. In this dataset scores of 100 are on target and scores of 0 show areas that require improvement. Within the Environmental Health objective, the Environmental Burden of Disease (EBD) indicator is weighted 50% and thus contributes 25% to the overall EPI score. We gave EBD a high weight in Environmental Health because it integrates the impacts of a large number of environmental stressors on human health. | Queryable |
|           | EPI 2010 Fisheries                       | The 2010 Environmental Performance Index (EPI) ranks 163 countries on 25 performance indicators tracked across ten well-established policy categories covering both environmental public health and ecosystem vitality. These indicators provide a gauge at a national government scale of how close countries are to established environmental policy goals. This proximity-to-target methodology facilitates cross-country comparisons as well as analysis of how the global community performs collectively on each particular policy issue. In this dataset scores of 100 are on target and scores of 0 show areas that require improvement. For the Fisheries category, all non-landlocked countries were required to have both the Marine Trophic Index and Trawling Intensity indicators, to which we applied an equal weight.  | Queryable |
|           | EPI 2010 Forestry                        | The 2010 Environmental Performance Index (EPI) ranks 163 countries on 25 performance indicators tracked across ten well-established policy categories covering both environmental public health and ecosystem vitality. These indicators provide a gauge at a national government scale of how close countries are to established environmental policy goals. This proximity-to-target methodology facilitates cross-country comparisons as well as analysis of how the global community performs collectively on each particular policy issue. In this dataset scores of 100 are on target and scores of 0 show areas that require improvement. For the Forestry category, if one of the two constituent indicators was missing, we substituted the other value due to the very high correlation between Forest Cover Change and Growing Stock Change. If both indicators were available, then a simple average was calculated.                                     | Queryable |
|           | EPI 2010 Water Effects on                | The 2010 Environmental Performance Index (EPI) ranks 163 countries on 25 performance indicators tracked across ten well-established policy categories covering both environmental public health and ecosystem vitality. These indicators provide a gauge at a national government scale of how close countries are to established environmental policy goals. This proximity-to-target methodology facilitates cross-country comparisons as well as analysis of how the global community performs collectively on each particular policy issue.  | Queryable |

1000 km

Attiva Windows  
Passa a Impostazioni per attivare Windows.

# GloFAS Web viewer – External WMS



# GloFAS Web viewer – Static layers

**GLOFAS** Forecast Viewer User Information Links MajorRiverBasins

2016-01-20 00 UTC

The screenshot shows a map of East Africa with various hydrological features highlighted. A modal window titled 'SELECTED POINT - Close all' displays detailed information for the Nile basin at a point near Uganda. Another modal window titled 'MajorRiverBasins' shows a world map of major river basins. A legend on the right identifies 'Glofas Lakes and reservoirs' (blue circle) and 'Major river basins' (orange circle). A third modal window titled 'GlofasLakesReservoirs' provides details about specific lakes and reservoirs included in the model.

**Major river basins**

Major river basins of the world. Source: Global Runoff Data Centre

**SELECTED POINT - Close all**

**Major river basins**

|  |              |
|--|--------------|
| Basin name                                     | NILE         |
| Calculated basin size [km <sup>2</sup> ]       | 3078088.1097 |
| Long-term mean discharge [m <sup>3</sup> /s] * | 1251.3260    |
| Mean annual runoff [km <sup>3</sup> ] *        | 39.462       |

\* of the gauging station that is nearest to the river mouth

**GloFAS lakes and reservoirs**

|                                     |        |
|-------------------------------------|--------|
| Name                                | George |
| Type                                | lake   |
| Country                             | Uganda |
| Volume reservoir [km <sup>3</sup> ] |        |
| Source                              | GLWD   |

**GlofasLakesReservoirs**

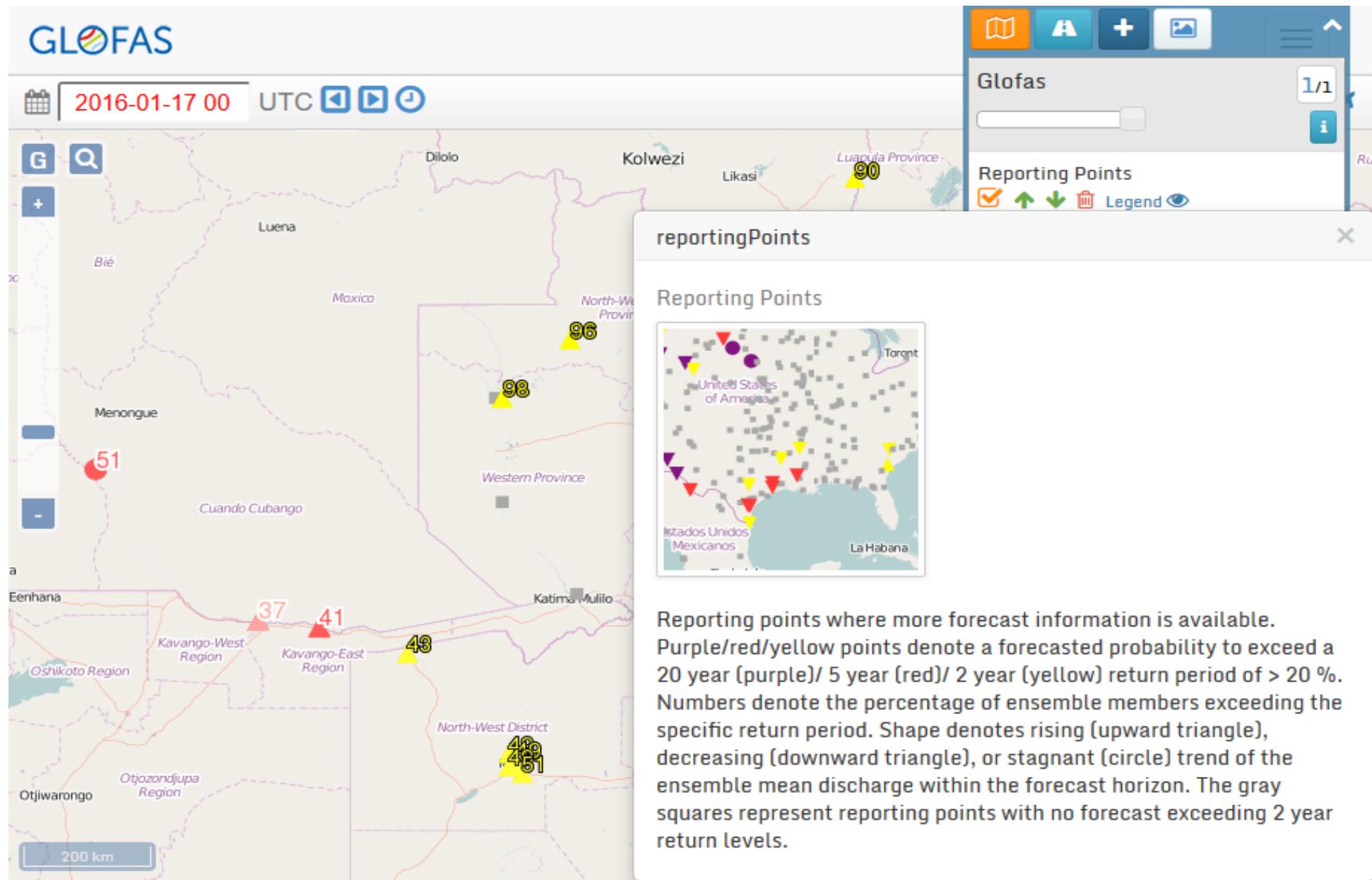
GloFAS lakes and reservoirs

- Lake
- Reservoir

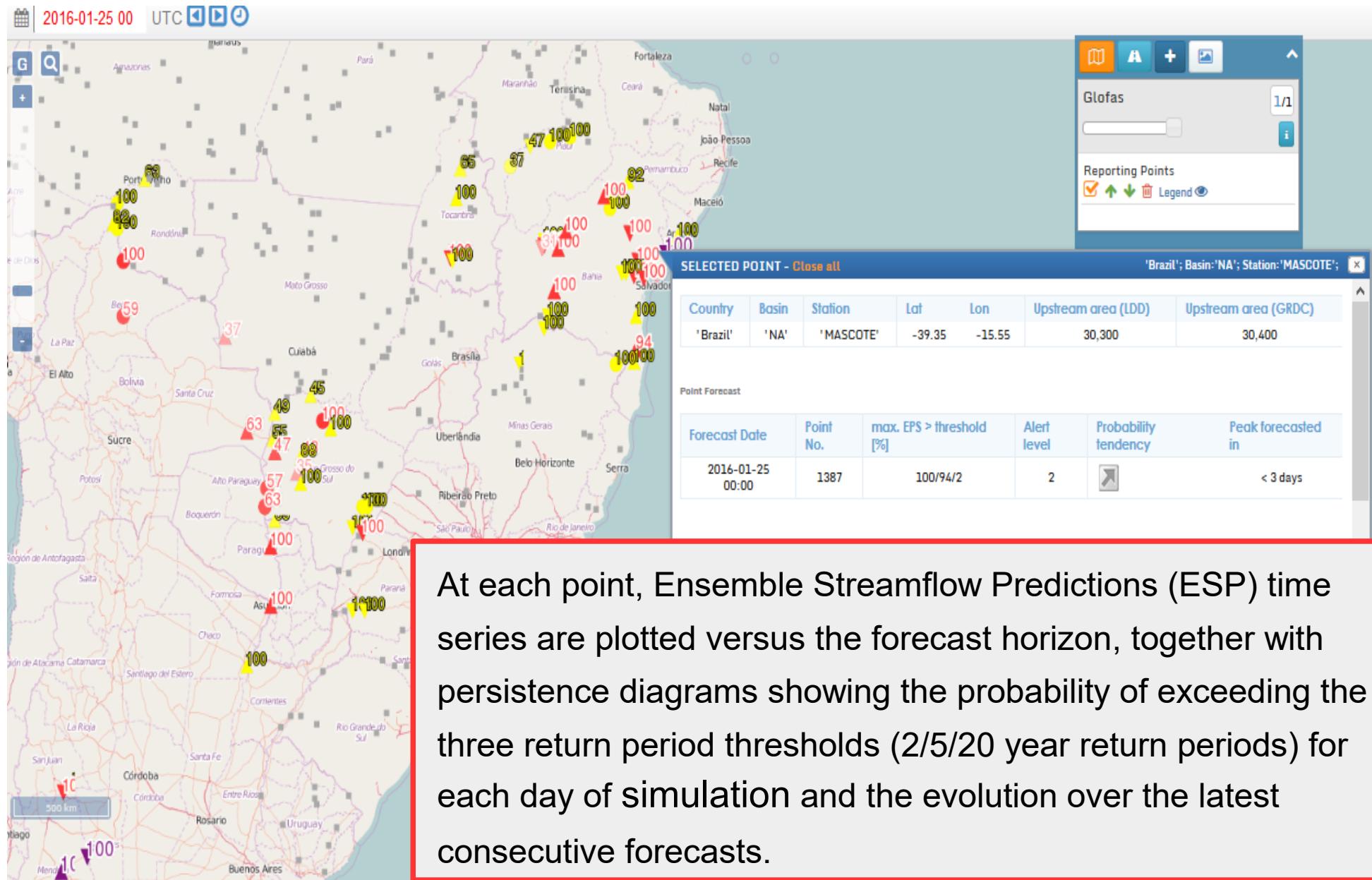
Lakes and reservoirs as included in the GloFAS model set up.  
Selection criteria are  
(1) lake surface area > 100km<sup>2</sup>;  
(2) significant impact on river discharge;  
(3) reservoir capacity > 0.5 km<sup>3</sup>.

Source: Global Lakes and Wetlands Database - Global Reservoir and Dams Database

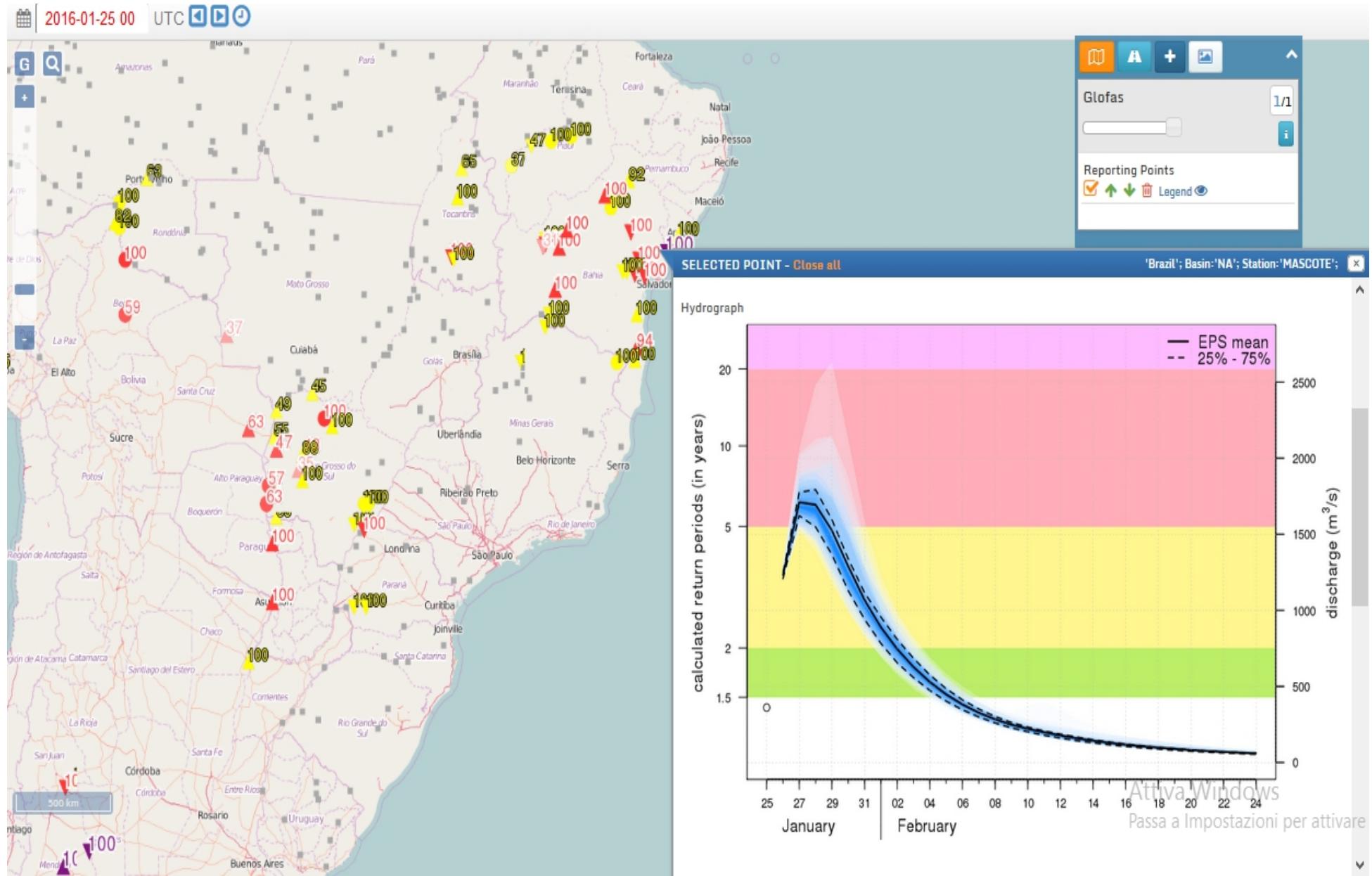
# GloFAS Web viewer – Reporting points



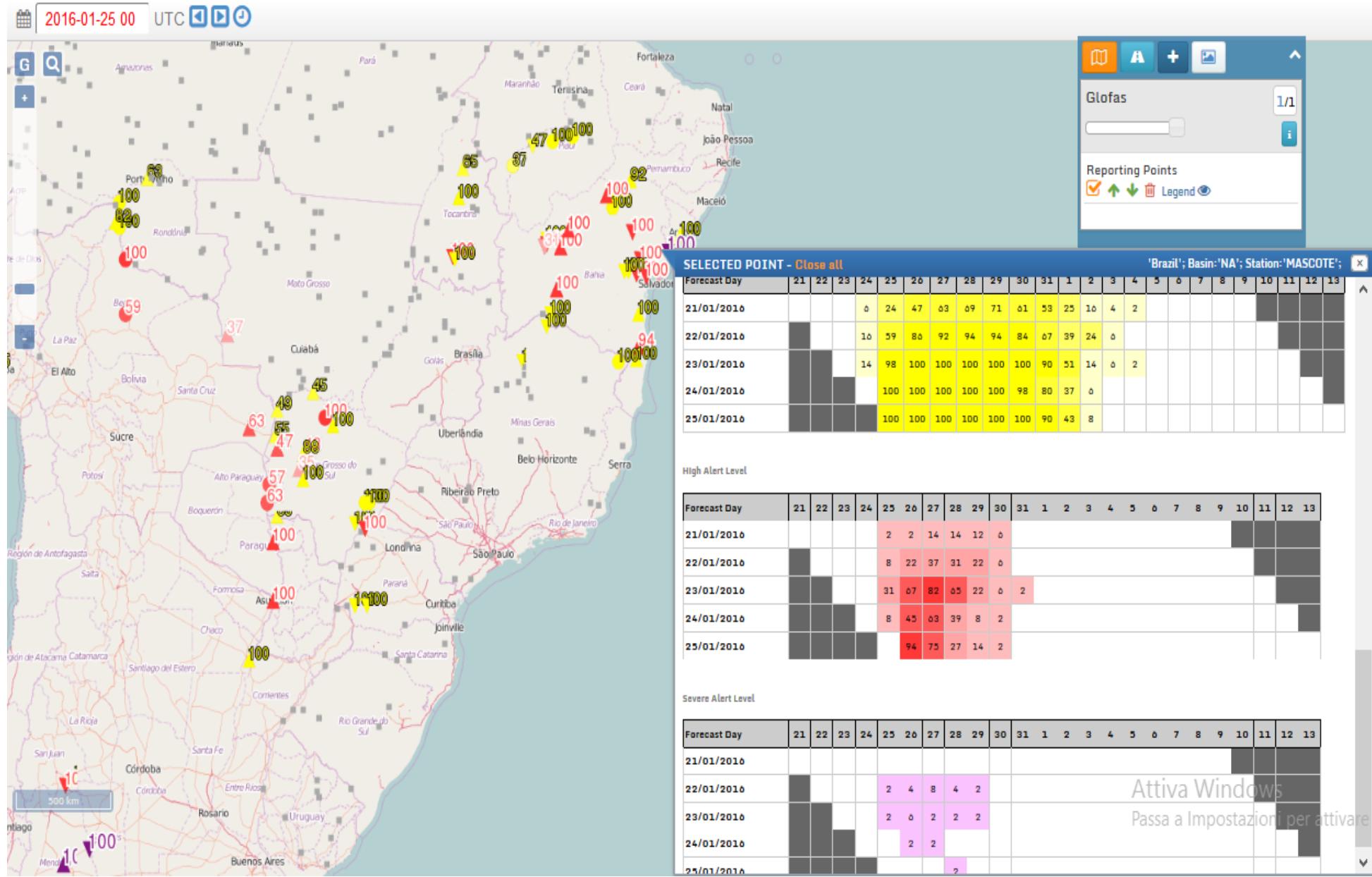
# GloFAS Web viewer – Reporting points query



# GloFAS Web viewer – Reporting points query



# GloFAS Web viewer – Reporting points query



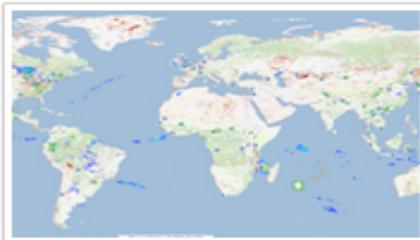
# GloFAS Hosting Machine



## **ECMWF SUPERCOMPUTER**

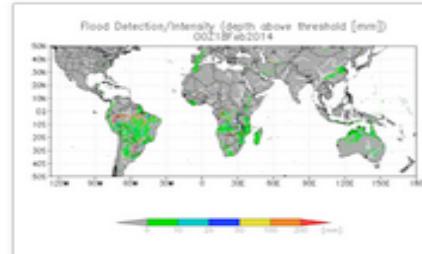
- ✓ 2 parallel computer clusters guarded in 2000 m<sup>2</sup> room
- ✓ Peak performance = 3,593 teraflops
- ✓ Compute cores (per cluster) = 84,120
- ✓ Active Storage (per cluster)= 6 petabytes
- ✓ Machine Price: 12,000,000 £/Year (Leasing)
- ✓ Machine life: 4 Years
- ✓ Electric Power Supply = 3,000,000 £/Year

# GloFAS and its brothers



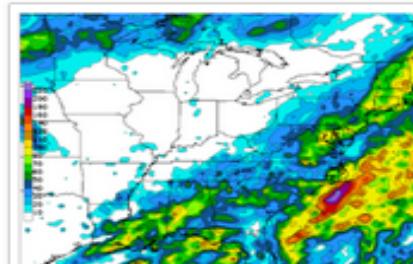
**Real-time Integrated Global Flood Map** monitoring

The Critech Web Map Viewer offers an intuitive Web interface. Real-time Integrated Global Flood Map (Experimental).



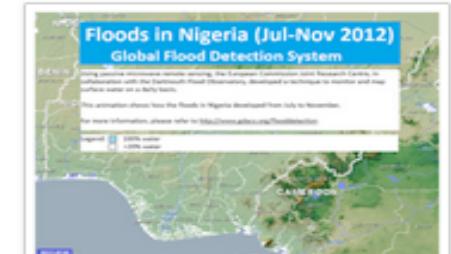
**Global Flood Monitoring System (GFMS)** prediction

it is a NASA-funded experimental system using real-time TRMM Multi-satellite Precipitation Analysis (TMPA) precipitation information.



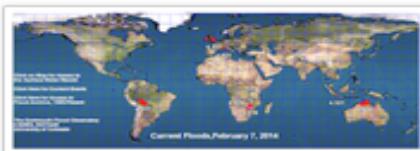
**Tropical Rainfall Measuring Mission (TRMM)** monitoring

The TRMM is a joint mission between NASA and the Japan Aerospace Exploration Agency (JAXA) designed to monitor and study tropical rainfall.



**Global Flood Detection System** monitoring

The Global Flood Detection System monitors floods worldwide using near-real time satellite data. GFDS currently monitors around 10000 areas.



**Dartmouth Flood Observatory** monitoring  
Space-based Measurement and Modeling of Surface Water For Research, Humanitarian, and Water Management Applications.



**Flood List** information

Aims to bring information about floods and flooding from around the world, with the hope that it will inspire helpful discussion and collaboration in preparing for and dealing with the effects of flooding.



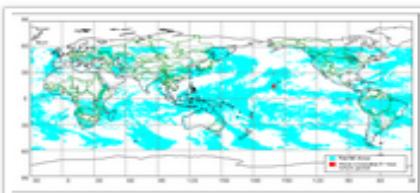
**Global Flood News** information

Monitoring of media is fairly common in many larger organisations. The use of social media in natural disasters has also demonstrated benefits. The same technologies can be used to monitor main stream and social media reports of floods.



**HEPEX** information

To demonstrate the added value of hydrological ensemble predictions (HEPS) for emergency management and water resources sectors to make decisions that have important consequences for economy, public health and safety.



**Global Flood Alert System** prediction

Global Flood Alert System (GFAS) is an attempt to make the best use of global satellite precipitation estimates in flood forecasting and warning.



# #FloodHack

#FloodHack - Help improve the Global Flood Awareness System

ECMWF | Reading | 16-17 January 2016



- ✓ “ ...We are looking for innovative ideas to improve the current system to make it easier and more flexible to use, for example to develop a lightweight version of the system to facilitate system exploitation in the field or to use other available data sources to create new features.”

# #FloodHack

✓ Challenges focused on:

- \_ DATA MODELS
- \_ DATA PROCESSING IMPROVEMENT
- \_ DATA DELIVERY AND ADDITIONAL SERVICES TO THE END USER





## #FloodHack – Data access points

### Standard protocols / interfaces

- Rasdaman – OGC WCS Web Server
- GloFAS WMS Web Server
- GloFAS SOS Web Server

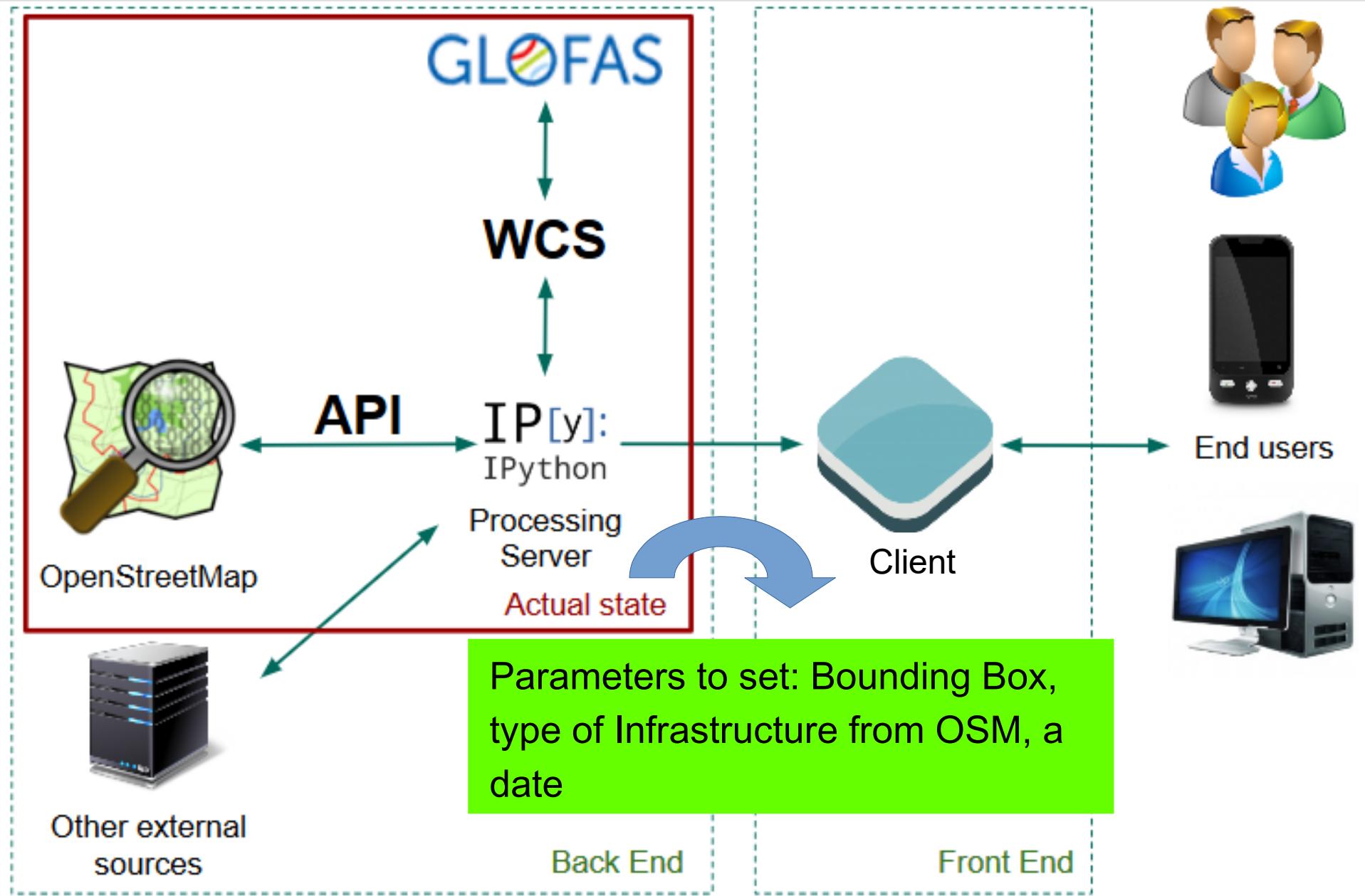
### Raw data storage

- ftp Server
- nginx Server

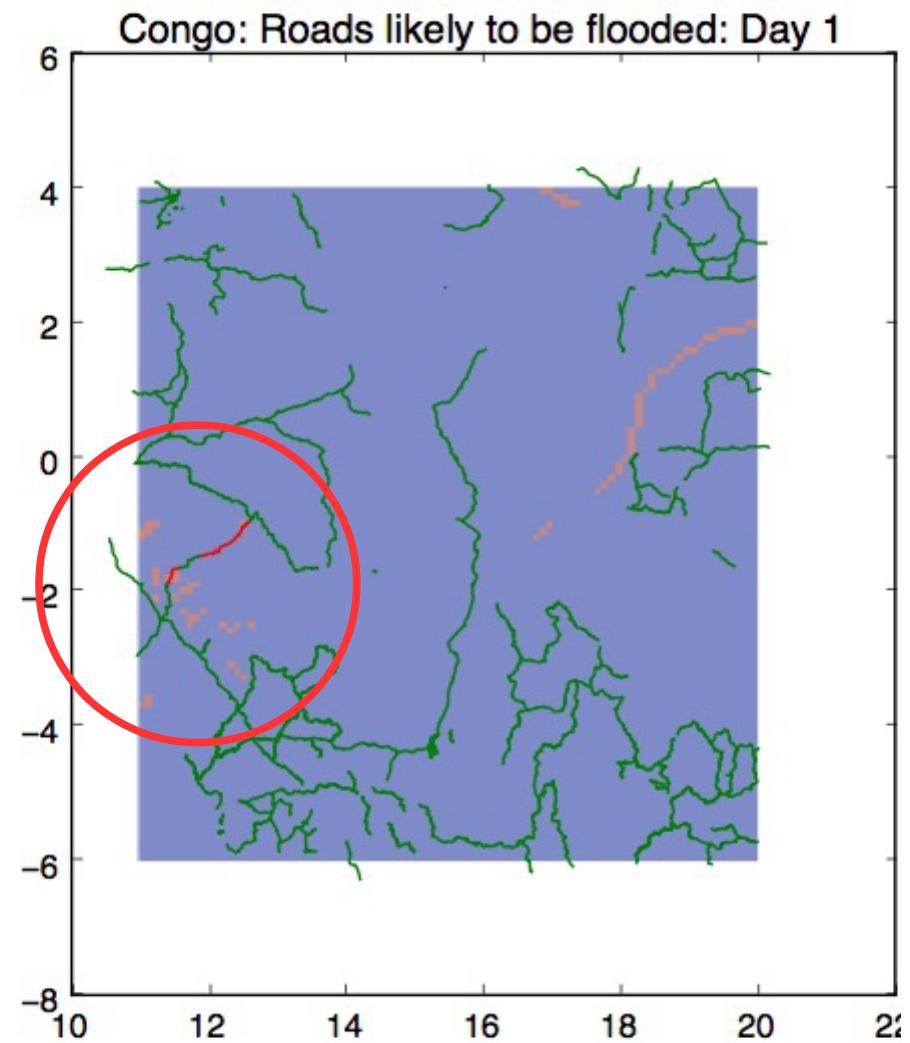
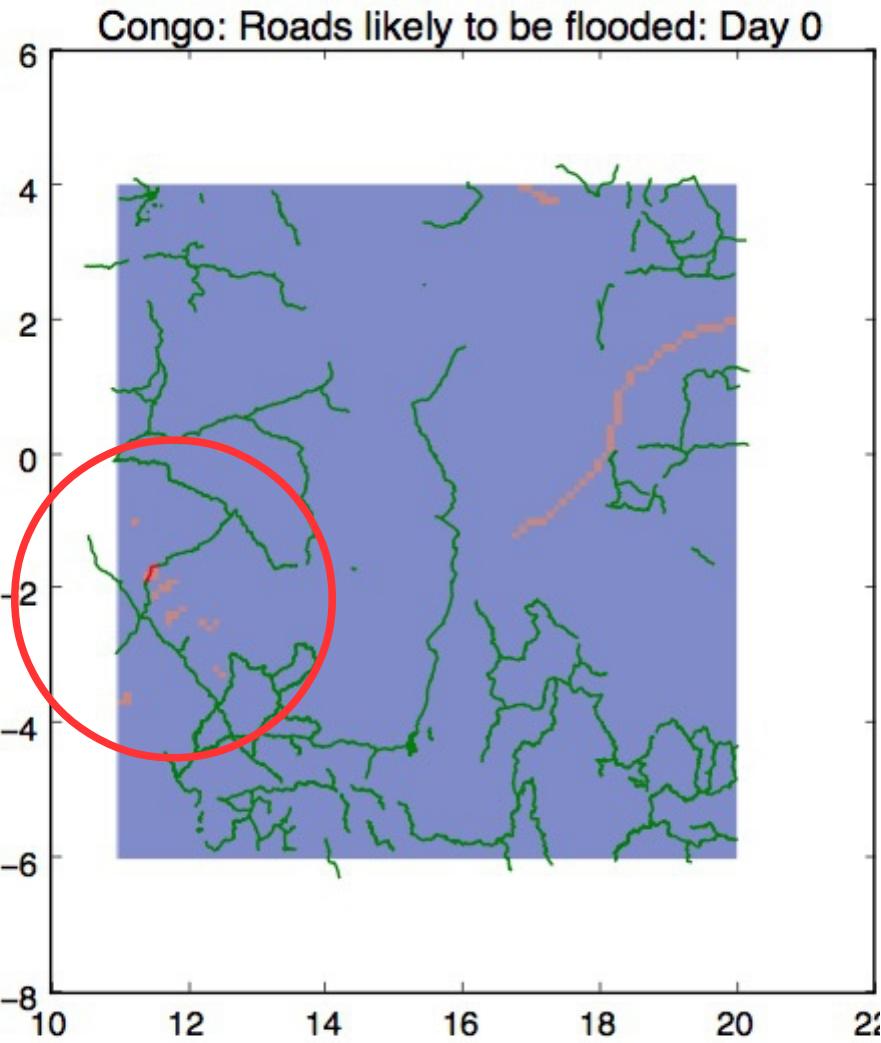
© ECMWF January 15, 2016

- ✓ Available data: GloFAS discharge data, ERA-interim reanalysis (P, T), static maps, larger catchment extract GloFAS forecasts....

# #FloodHack – my group work: GloFAQ



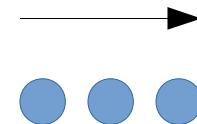
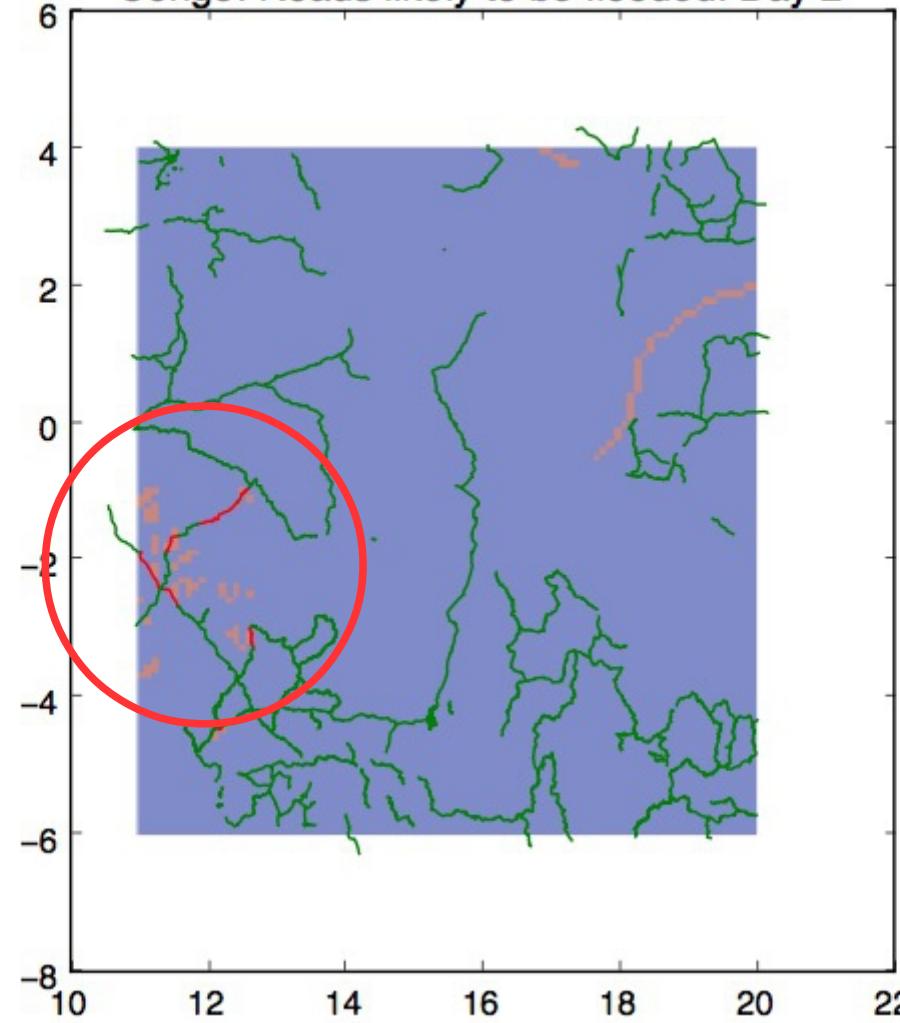
# #FloodHack – my group work



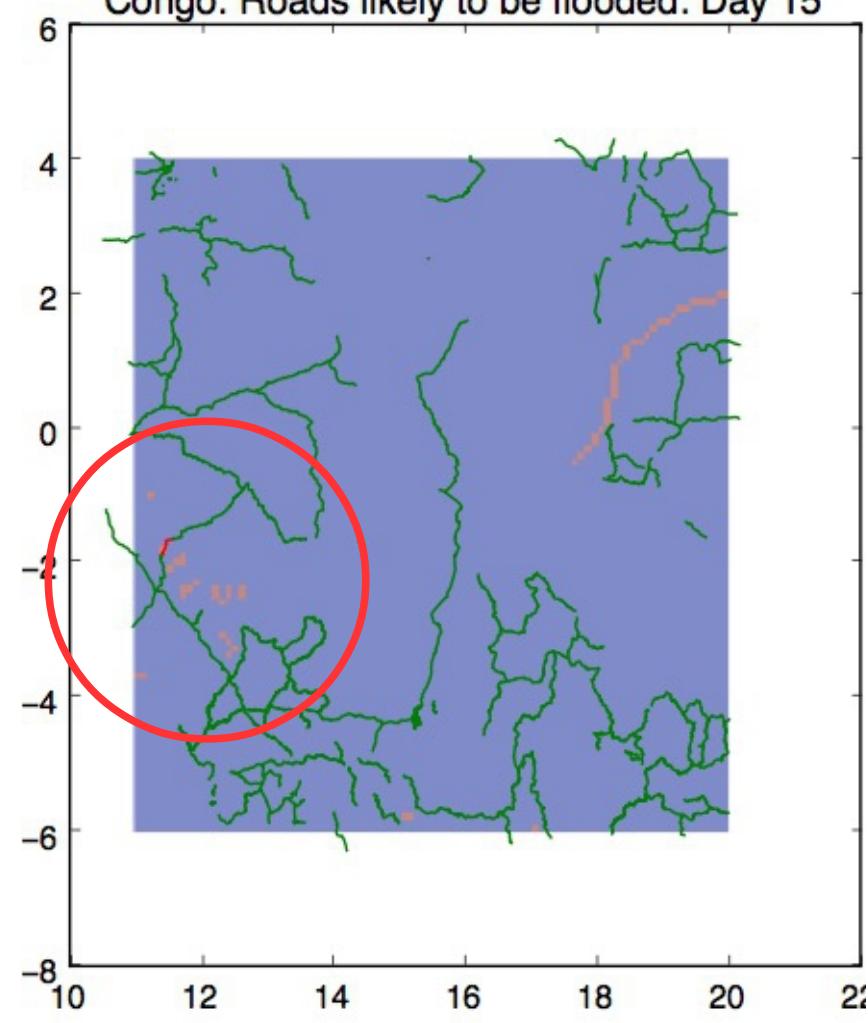
# #FloodHack – my group work: GloFAQ



Congo: Roads likely to be flooded: Day 2



Congo: Roads likely to be flooded: Day 15



# #FloodHack – Winner projects

- ✓ 1<sup>st</sup> place: **LIVE** (Logistic and Infrastructure Visual Evaluation)  
“ ...To summarise GloFAS forecast information into a 'Time to respond' map that helps decision making before/during flood emergency. This is present in a user friendly way with key statistics which could help decision making.
- ✓ 2<sup>nd</sup> place: **FloodIT**  
“ ...GLOFAS is a global product and presents coarse data (too coarse for local users, especially non-technical users to interpret). Based on a down-sampled AsterDEM, FloodIT creates a simple flood extension simulation.”
- ✓ 3<sup>rd</sup> place: **Interception**  
“ ... An educational game/online interactive platform to help inform people about what they should be doing when a flood watch/warning alert is issued in their region.”

<http://floodhack.devpost.com/submissions>

THANKS FOR YOUR ATTENTION!