



PROGRAMME OF  
THE EUROPEAN UNION

Copernicus  
Europe's eyes on Earth



Implemented by  
European  
Commission



Emergency  
Management

#EUSpace

# Forecast products of the Global Flood Awareness System

Ervin Zsoter

GFP, Budapest, 2025-09-16



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# GloFAS website



global-flood.emergency.copernicus.eu



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**GloFAS system upgrade to 4.0**

GloFAS v4.0 introduces several major changes to the system, including:

- Increased spatial resolution of the hydrologic model from 0.1 degrees to 0.05 degrees.
- An entirely new set of 0.05 degrees resolution input maps.
- Major improvements to the open-source hydrological model LISFLOOD.
- A new hydrologic model calibration at nearly 2000 in situ gauging stations and parameter regionalization.

[Find out more](#)

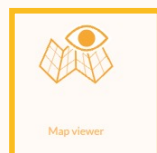
GloFAS v4.0

## Global Flood Awareness System:

The aim of the Global Flood Awareness System (GloFAS) is to support preparatory measures as well as emergency response to predicted and ongoing major flood events at global scale.

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## Services



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## News

### Latest News [News Archive](#)

Sept. 3, 2025, 4:30 p.m.

#### Release of GloFAS version 4.4

A minor release of the Copernicus Emergency Management Service (CEMS) Global Flood Awareness System (GloFAS), version 4.4, will be launched operationally on **Wednesday, 10 September 2025**.

GloFAS version 4.4 introduces several minor changes to the system, including:

...

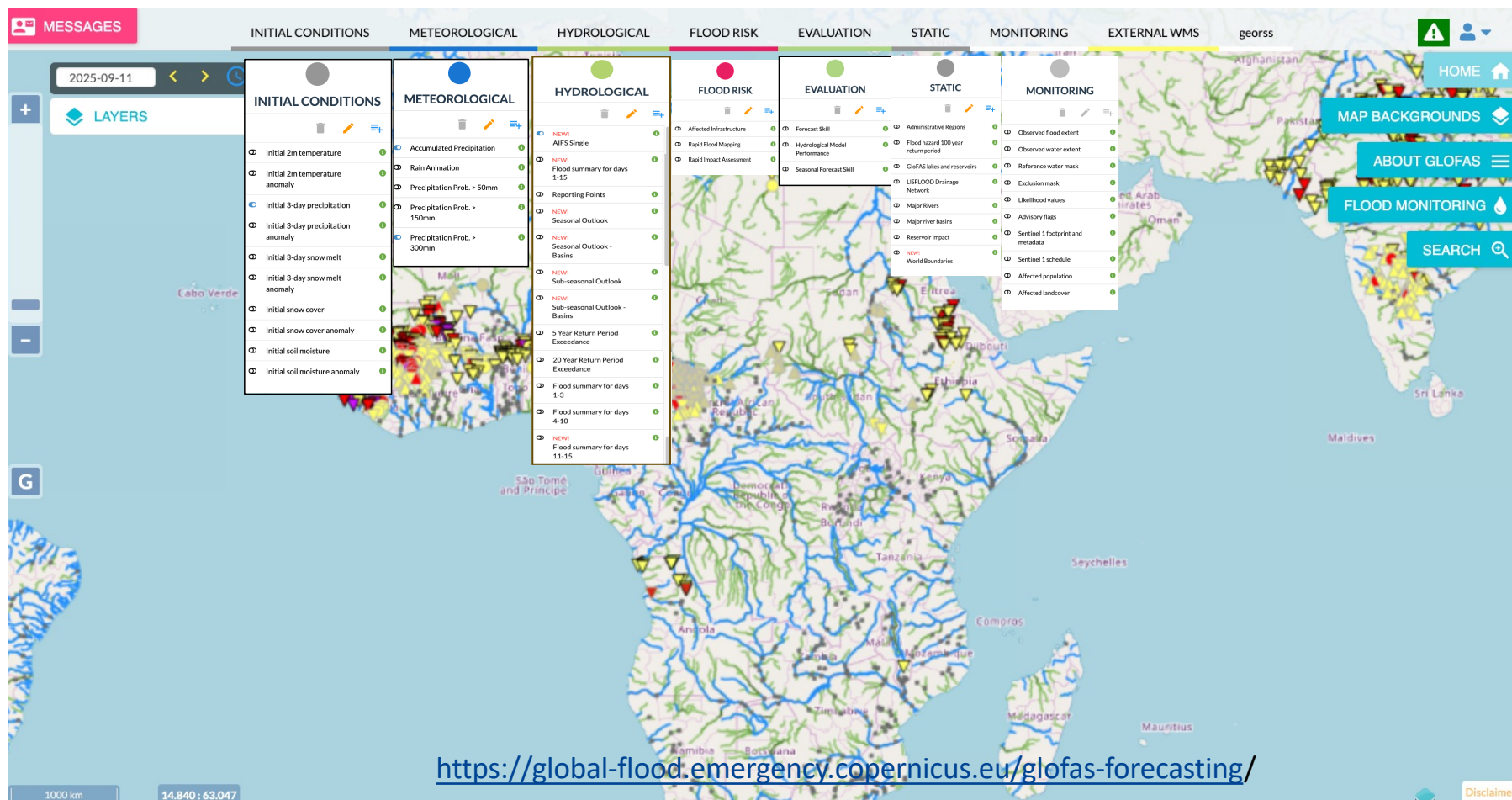
<https://global-flood.emergency.copernicus.eu/>



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# GloFAS website - layers







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# Initial condition layers



## Initial condition layers

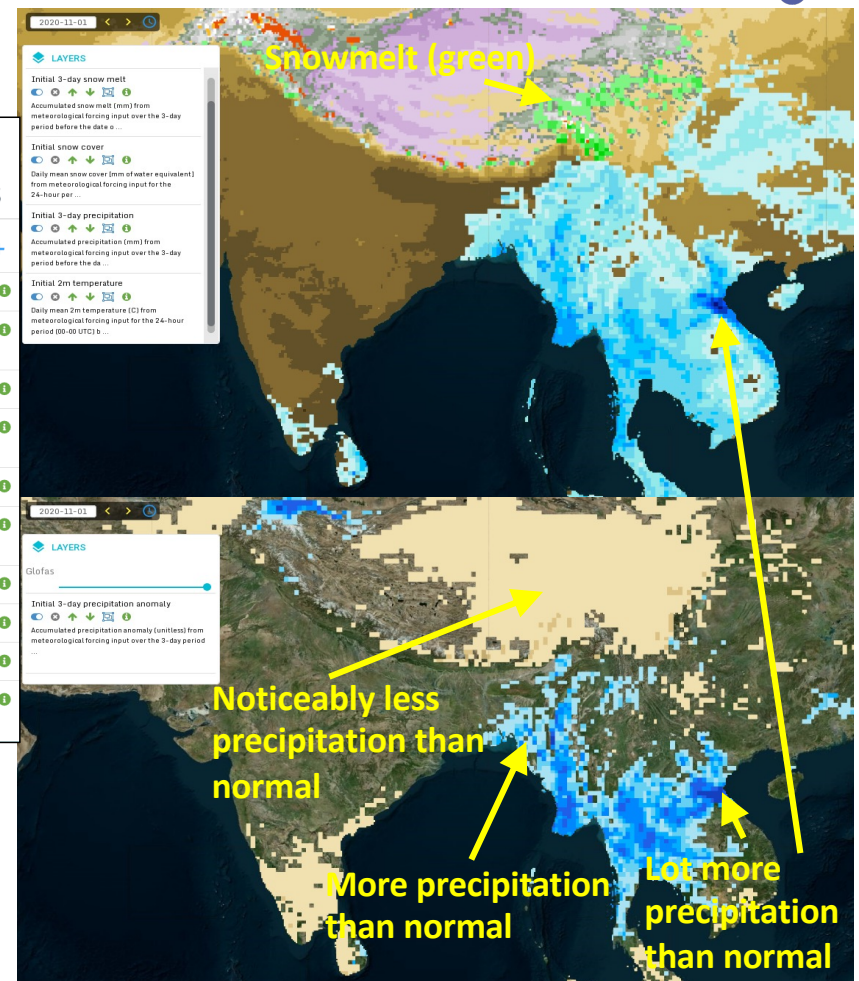
- 3-day precipitation (+ anomaly)
- 3-day snowmelt (+anomaly)
- Daily mean snow cover (+anomaly)
- Soil moisture (+anomaly)
- 2m daily mean temperature (+anomaly)

## Initial condition anomaly layers

- Reference is the ERA5 reanalysis-based climate mean (1979-2022)
- Values are expressed as anomaly (difference to the climate mean) divided by the standard deviation (1979-2022)

<https://confluence.ecmwf.int/display/CEMS/GloFAS+products>

INITIAL CONDITIONS	
Initial 2m temperature	
Initial 2m temperature anomaly	
Initial 3-day precipitation	
Initial 3-day precipitation anomaly	
Initial 3-day snow melt	
Initial 3-day snow melt anomaly	
Initial snow cover	
Initial snow cover anomaly	
Initial soil moisture	
Initial soil moisture anomaly	







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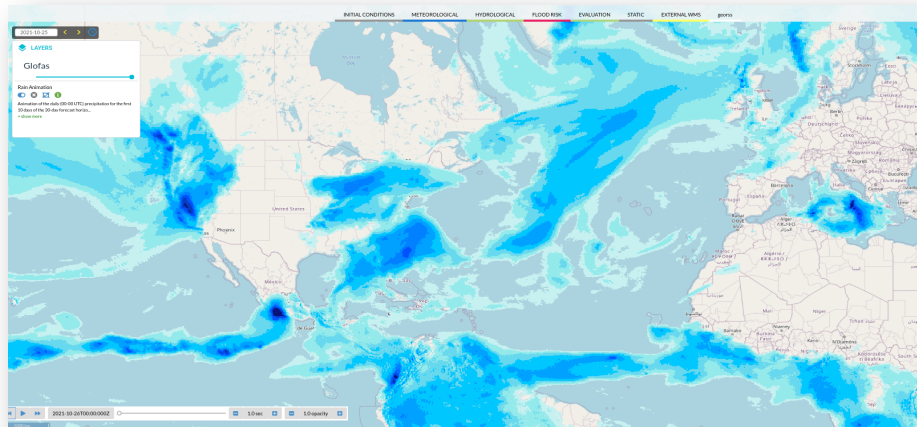










## Meteorological layers

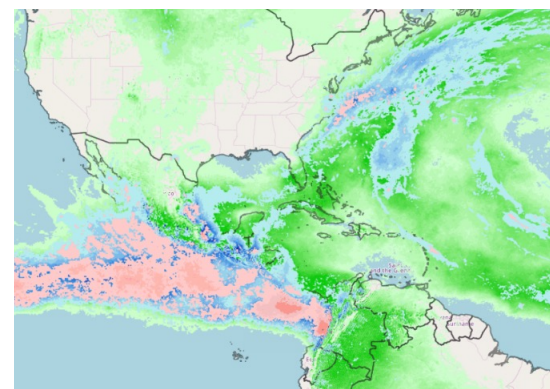
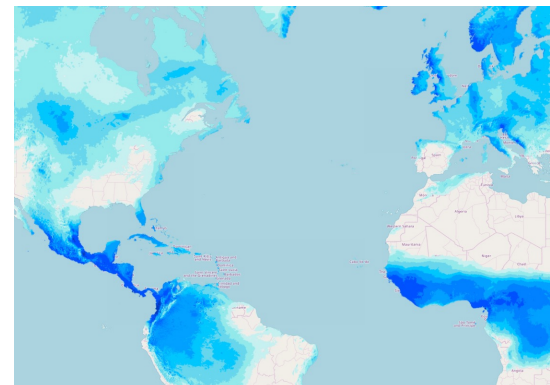


### Meteorological forecast maps

- 10-day total precipitation forecast
  - ENS-mean
  - Probabilities for 50 / 150 / 300 mm
- Daily precipitation maps (animation) of next 10 days with ensemble mean forecast to follow meteorological system evolution



METEOROLOGICAL		
  		
<input checked="" type="radio"/>	Accumulated Precipitation	
<input type="radio"/>	Rain Animation	
<input type="radio"/>	Precipitation Prob. > 50mm	
<input type="radio"/>	Precipitation Prob. > 150mm	
<input checked="" type="radio"/>	Precipitation Prob. > 300mm	



<https://confluence.ecmwf.int/display/CEMS/GloFAS+products>



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# Hydrological forecast layers

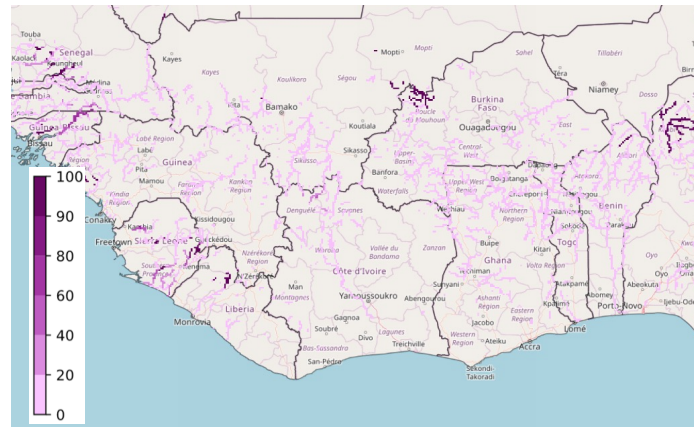
## 5- and 20-year flood probabilities (medium-range)

- Probability maps to exceed the 5-year and 20-year thresholds at any time in the 15-day forecast horizon

5-year (red)



20-year (purple)



<https://confluence.ecmwf.int/display/CEMS/GloFAS+products>

HYDROLOGICAL		
<input checked="" type="checkbox"/>	NEW! AIFS Single	1
<input type="checkbox"/>	NEW! Flood summary for days 1-15	1
<input type="checkbox"/>	Reporting Points	1
<input type="checkbox"/>	NEW! Seasonal Outlook	1
<input type="checkbox"/>	NEW! Seasonal Outlook - Basins	1
<input type="checkbox"/>	NEW! Sub-seasonal Outlook	1
<input type="checkbox"/>	NEW! Sub-seasonal Outlook - Basins	1
<input type="checkbox"/>	5 Year Return Period Exceedance	1
<input type="checkbox"/>	20 Year Return Period Exceedance	1
<input type="checkbox"/>	Flood summary for days 1-3	1
<input type="checkbox"/>	Flood summary for days 4-10	1
<input type="checkbox"/>	NEW! Flood summary for days 11-15	1



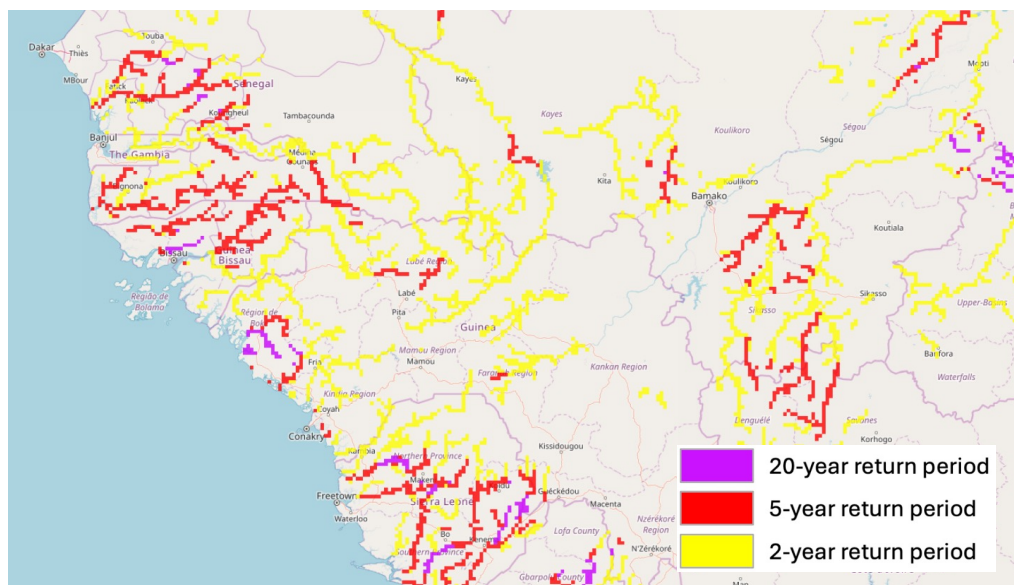
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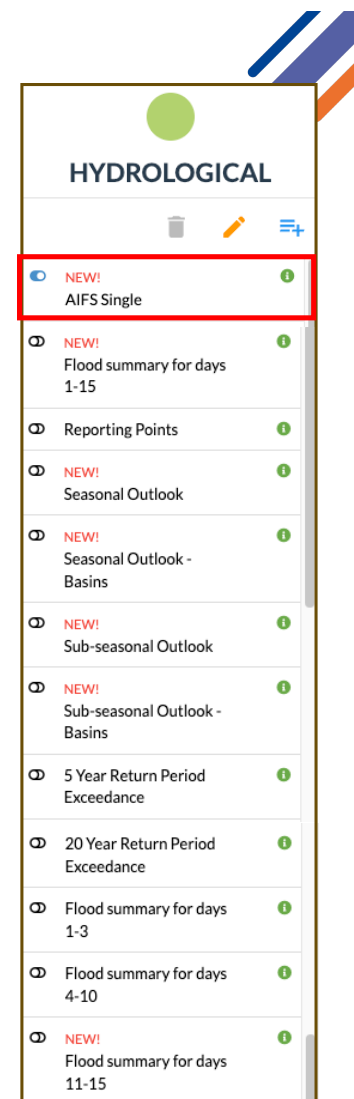
## Hydrological forecast layers

### AIFS Singe flood signal (medium-range)

- Map showing river pixels, where the river discharge exceeds the 2- (yellow), 5- (red) or 20-year (purple) thresholds in the 15-day forecast horizon



<https://confluence.ecmwf.int/display/CEMS/GloFAS+products>







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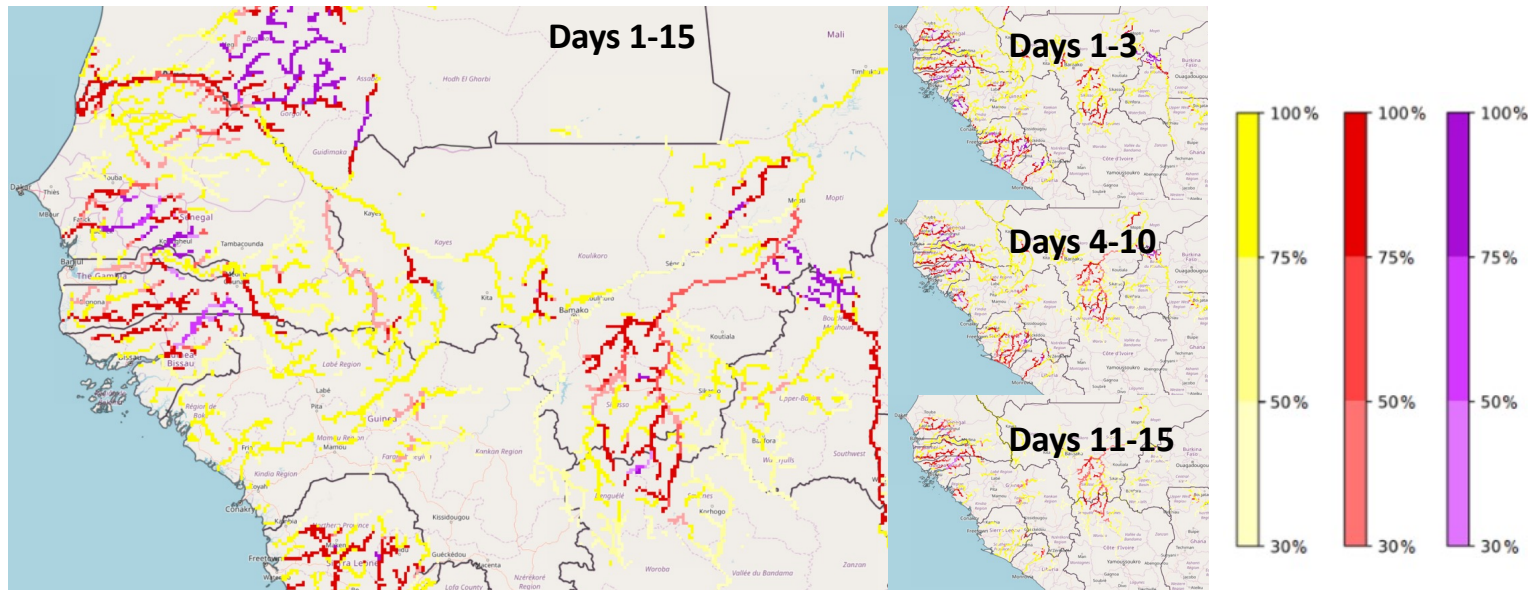


## Hydrological forecast layers

### Flood summary (medium-range)

- Combination of 2-, 5- and 20-year flood probabilities (as maximum river discharge signal in the period)
- 3\*3 coloured-coded categories
- 3+1 lead time periods

<https://confluence.ecmwf.int/display/CEMS/GloFAS+products>



HYDROLOGICAL		
	NEW!	
AIFS Single		
	NEW!	
Flood summary for days 1-15		
Reporting Points		
	NEW!	
Seasonal Outlook		
	NEW!	
Seasonal Outlook - Basins		
	NEW!	
Sub-seasonal Outlook		
	NEW!	
Sub-seasonal Outlook - Basins		
5 Year Return Period Exceedance		
20 Year Return Period Exceedance		
Flood summary for days 1-3		
Flood summary for days 4-10		
	NEW!	
Flood summary for days 11-15		



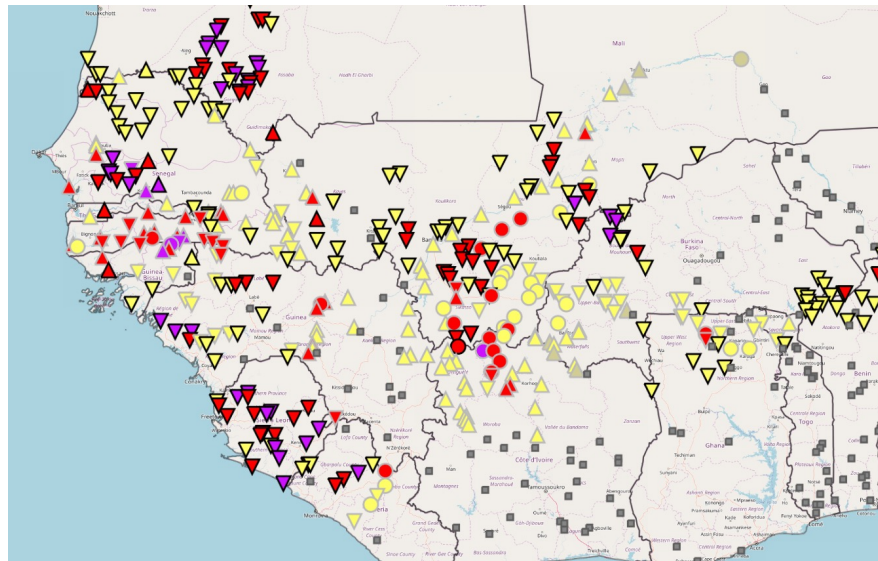
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## Hydrological forecast layers

### Reporting points (medium-range)

- Fixed and dynamic (only when floods are predicted) reporting point locations (clickable -> popup window)
- Colour and shape of markers indicate flood severity, timing and probability



<https://confluence.ecmwf.int/display/CEMS/GloFAS+products>

HYDROLOGICAL		
	AIFS Single	
	Flood summary for days 1-15	
	Reporting Points	
	Seasonal Outlook	
	Seasonal Outlook - Basins	
	Sub-seasonal Outlook	
	Sub-seasonal Outlook - Basins	
	5 Year Return Period Exceedance	
	20 Year Return Period Exceedance	
	Flood summary for days 1-3	
	Flood summary for days 4-10	
	Flood summary for days 11-15	



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# Hydrological forecast layers

## Reporting point products (medium-range)

- River discharge, precipitation, snowmelt and temperature graphs (15-day forecast with last 5 days)
- Probabilities for different flood severities (last few runs)

Forecasts Overview (2025-09-11 00:00)

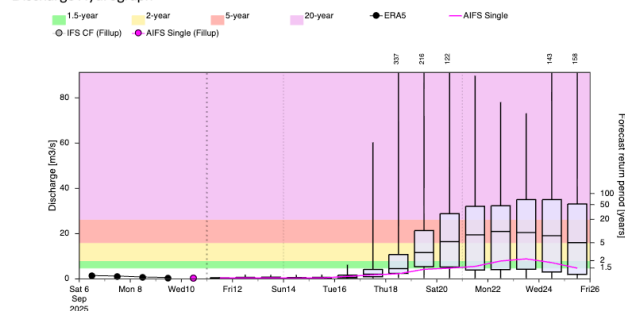
Forecast Type	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
IFS ENS									53	33	43	31	33	49	45
AIFS Single		↓	↓	↓	↑	↑	↑	↑	↑	↑	↑	*	↓	↓	

IFS ENS > 20 yr RP

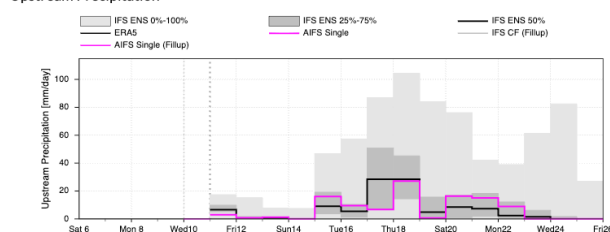
Forecast Day	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
2025-09-11															2	12	20	27	31	33	24	24
2025-09-10																2	10	18	18	16	14	
2025-09-09																	2	2				
2025-09-08															4	6	8	6	8			
2025-09-07																2	2	4				
2025-09-06								6	6	4	2			2	8	8	12					
2025-09-05							2	2	2	2		2	6	10	14							

<https://confluence.ecmwf.int/display/CEMS/GloFAS+products>

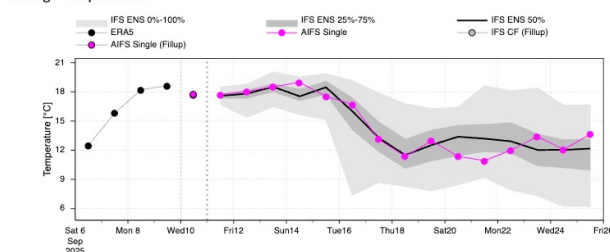
Discharge Hydrograph



Upstream Precipitation



Average Temperature



### HYDROLOGICAL

- NEW! AIFS Single
- NEW! Flood summary for days 1-15
- Reporting Points**
- NEW! Seasonal Outlook
- NEW! Seasonal Outlook - Basins
- NEW! Sub-seasonal Outlook
- NEW! Sub-seasonal Outlook - Basins
- 5 Year Return Period Exceedance
- 20 Year Return Period Exceedance
- Flood summary for days 1-3
- Flood summary for days 4-10
- NEW! Flood summary for days 11-15





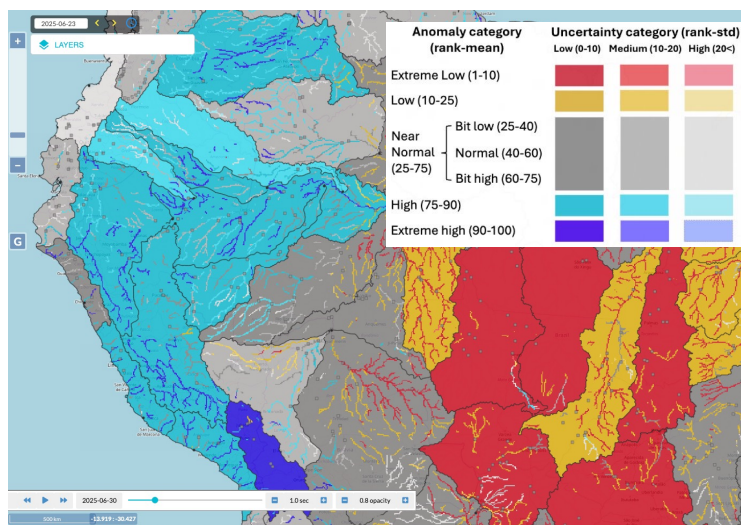
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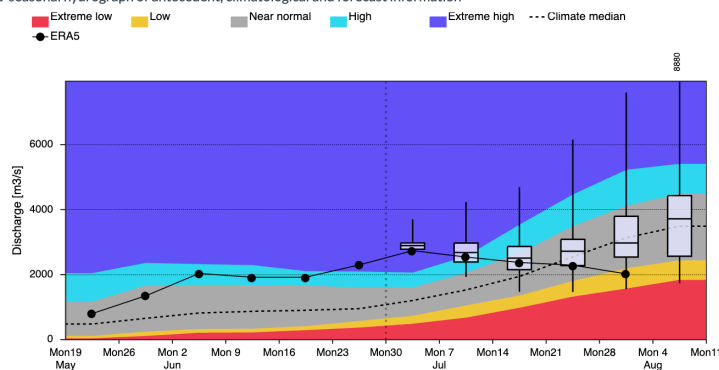
# Hydrological forecast layers

## Sub-seasonal outlook

- Weekly mean anomalies out to 6 weeks (at river pixels and aggregated basins), with 5 (+2) anomaly and 3 uncertainty categories
- Hydrographs and forecast consistency tables at fixed reporting points with simulated truth added retrospectively
- Individual maps for each lead time



Sub-seasonal hydrograph of antecedent, climatological and forecast information



Sub-seasonal forecast probability (numbers) and expected anomaly category (coloured cells) [2025-06-27]

	Jun, Mon 30					Jul, Mon 07					Jul, Mon 14					Jul, Mon 21					Jul, Mon 28					Aug, Mon 04				
	EL	L	NL	NH	H	EL	L	NL	NH	H	EL	L	NL	NH	H	EL	L	NL	NH	H	EL	L	NL	NH	H	EL	L	NL	NH	H
Jun, Fri 27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun, Thu 26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun, Wed 25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun, Tue 24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun, Mon 23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun, Sun 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun, Sat 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun, Fri 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun, Thu 19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun, Wed 18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun, Tue 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun, Mon 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun, Sun 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

<https://confluence.ecmwf.int/display/CEMS/GloFAS+products>

HYDROLOGICAL

NEW!

AIFS Single

NEW!

Flood summary for days 1-15

Reporting Points

NEW!

Seasonal Outlook

NEW!

Seasonal Outlook - Basins

NEW!

Sub-seasonal Outlook

NEW!

Sub-seasonal Outlook - Basins

5 Year Return Period Exceedance

20 Year Return Period Exceedance

Flood summary for days 1-3

Flood summary for days 4-10

NEW!

Flood summary for days 11-15



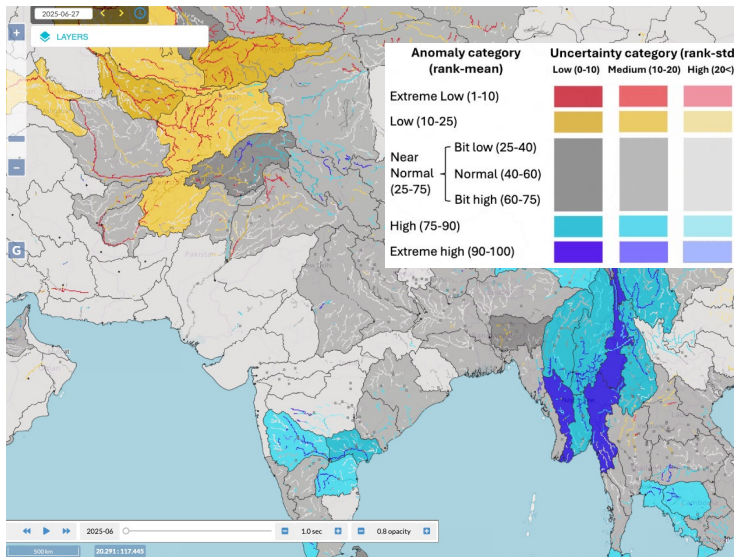
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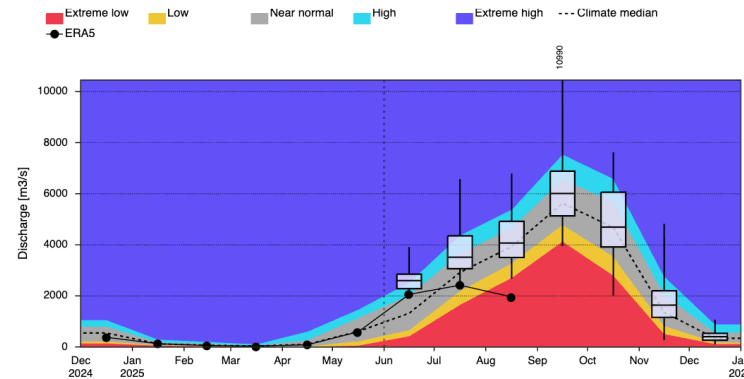
# Hydrological forecast layers

## Seasonal outlook

- Monthly mean anomalies out to 7 months (at river pixels and aggregated basins), with 5 (+2) anomaly and 3 uncertainty categories
- Hydrographs and forecast consistency tables at fixed reporting points with simulated truth added retrospectively
- Individual maps for each lead time



Seasonal hydrograph of antecedent, climatological and forecast information



Seasonal forecast probability (numbers) and expected anomaly category (coloured cells) [2025-06-01]

	June 2025						August 2025						September 2025						October 2025						November 2025						December 2025							
	EL	L	N	BH	H	EH	EL	L	N	BH	H	EH	EL	L	N	BH	H	EH	EL	L	N	BH	H	EH	EL	L	N	BH	H	EH	EL	L	N	BH	H	EH		
June 2025	0	0	0	0	8	53	0	0	12	25	56	22	25	2	14	56	25	10	21	12	2	16	12	12	23	27	8	6	30	19	18	10	23	14	6	4	14	
May 2025	0	8	16	31	21	10	4	6	34	8	14	54	25	19	2	18	10	12	29	12	17	2	10	27	29	16	10	6	6	8	18	25	14	10	19	2	12	27
April 2025	2	12	23	35	14	10	4	6	19	6	23	16	16	14	4	18	16	14	10	21	17	6	14	19	21	14	12	14	14	19	23	10	18	6	10			
March 2025	0	12	21	18	10	29	10	0	16	18	19	12	21	14	6	8	15	35	10	16	14	6	8	14	19	14	25	14										
February 2025	4	14	14	23	14	21	10	10	21	16	20	4	21	8	8	23	14	18	16	19	2																	
January 2025	12	16	8	27	6	17	14	14	14	10	25	8	15	14																								
December 2024	0	6	18	12	21	25	18																															

<https://confluence.ecmwf.int/display/CEMS/GloFAS+products>

HYDROLOGICAL

NEW!

AIFS Single

NEW!

Flood summary for days 1-15

Reporting Points

NEW!

Seasonal Outlook

NEW!

Seasonal Outlook - Basins

NEW!

Sub-seasonal Outlook

NEW!

Sub-seasonal Outlook - Basins

5 Year Return Period Exceedance

20 Year Return Period

Flood summary for days 11-15



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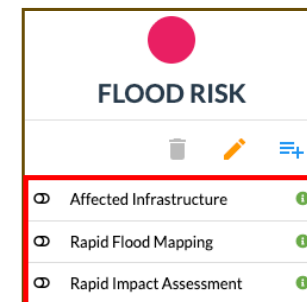


# Flood risk layers



## Rapid impact assessment

- Links river discharge signal to inundation estimates
- Extracts **flood inundation footprint** from a library of maps
- Calculates the population, land surface types and critical infrastructure exposed within the flood footprint
- Summarises impact to administration regions



The '**rapid impact assessment**' summarises the exposure and flood event information over the next 15 days per administration region



**Rapid Impact**

Rapid Impact Assessment  
NOTE: This information is EXPERIMENTAL

Myanmar/Burma, Bago

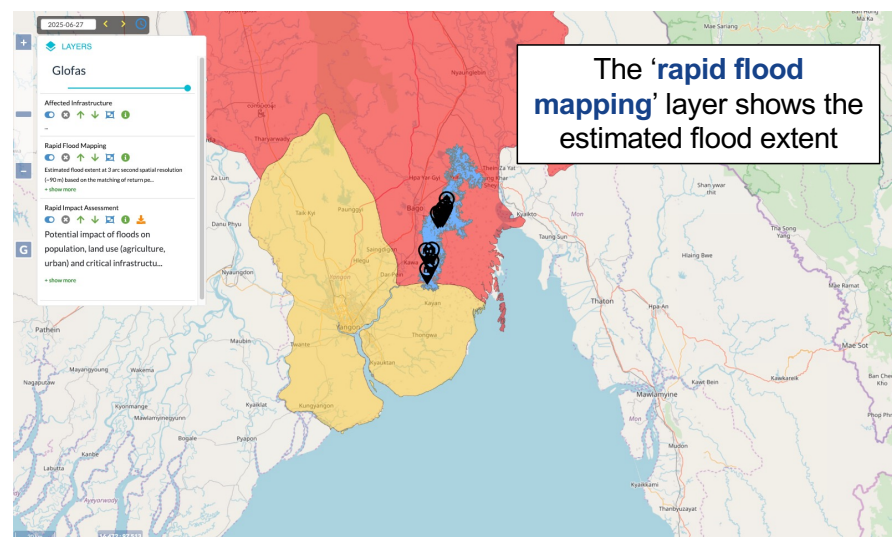
	Low Impact <100 people	Medium Impact 100-1000 people	High Impact >1000 people
Short Lead time (1-3 days)	Yellow	Red with checkmark	Red
Medium Lead time (4-10 days)	Yellow	Yellow	Red
Long Lead time (11-15 days)	Yellow	Yellow	Red

Exposure Information	Protected	Unprotected
Population affected (No. of people)	50400	50400
Population within floodplain affected (%)	NaN	NaN
Cities affected (% area affected)	N/A	N/A
Health facilities affected (No. of facilities)	0	0
Education facilities affected (No. of facilities)	0	0
Airport affected (No. of facilities)	0	0
Powerplant facilities affected (No. of facilities)	0	0
Artificial surfaces affected (ha)	400	400
Agricultural surfaces affected (ha)	81676	81676
Forest and semi-natural surfaces affected (ha)	247	247

Flood Event Information	Protected	Unprotected
Estimated mean return period (yr)	3	3
Estimated protection levels (yr)	2	2



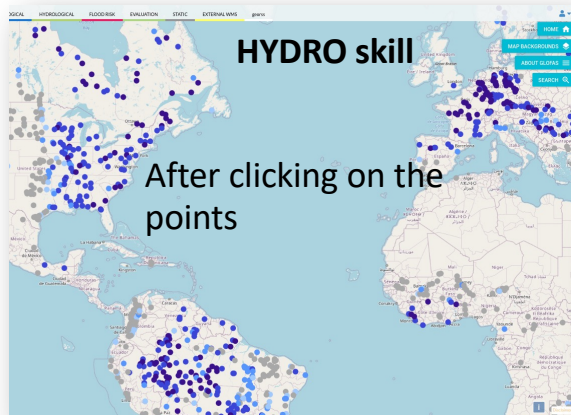




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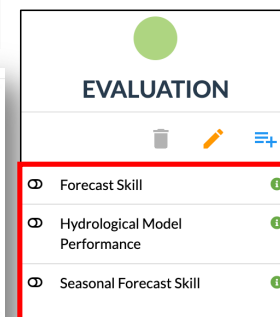
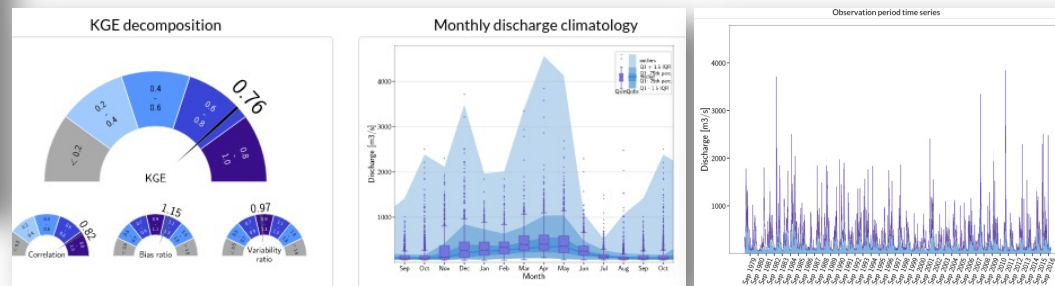


# Evaluation layers



Hydrological Model Performance

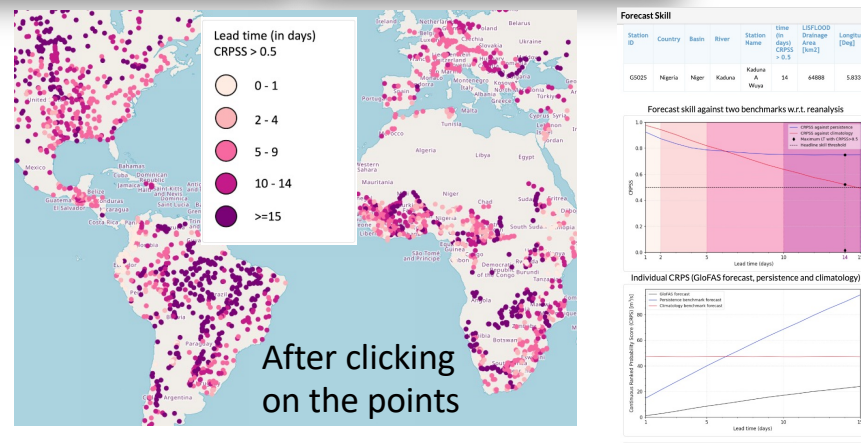
Station ID	Country	Catchment	River	Station Name	Drainage Area [km <sup>2</sup> ]	Longitude [Deg]	Latitude [Deg]	LISFLOOD Drainage Area [km <sup>2</sup> ]	LISFLOOD X [Deg]	LISFLOOD Y [Deg]
G1323	ZAMBIA	Zambezi	Lunga	Kelongwa School 60334550	19779	26.333	-13.7	19697	26.325	-13.725
Calibrated	KGE	Correlation	Bias	Variability	NSE	Number of days available	Qobs / Qsim mean [m <sup>3</sup> /s]	Qsim return periods [m <sup>3</sup> /s]		
Yes	0.74	0.8	1.15	0.93	0.54	4388 (12.02 years)	98 / 112	2-year: 405 5-year: 560 20-year: 762		



## Evaluation layers

- Forecast skill layers with **fixed reporting points**
  - Hydrological model performance
  - Forecast skill (medium-range)
  - Seasonal forecast skill
- Hydro skill vs observations, forecast skill vs reanalysis simulation

<https://confluence.ecmwf.int/display/CEMS/GloFAS+products>





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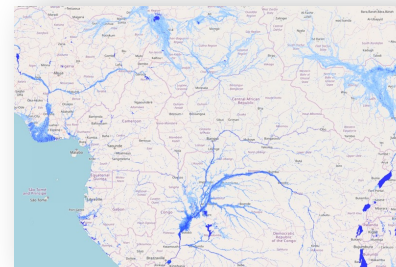
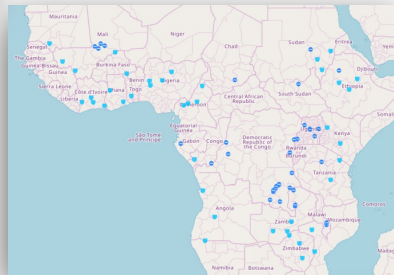
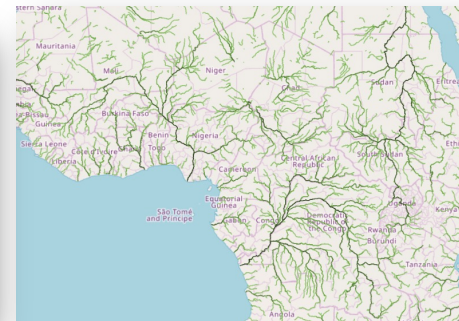
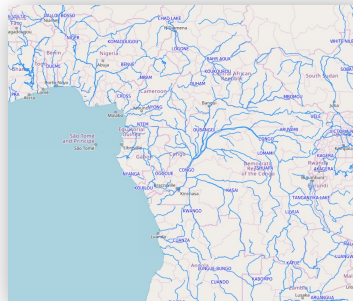
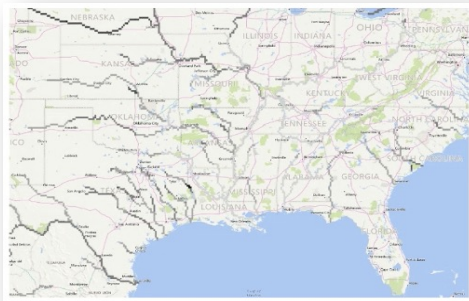


## Static layers






















### Static maps

- Hydrological model network (reservoirs, lakes, reservoir influence, river network with upstream area, ...)
- Geographical features (major rivers, administrative regions; country borders)
- 100-year flood maps



<https://confluence.ecmwf.int/display/CEMS/GloFAS+products>

STATIC		
  		
	Administrative Regions	
	Flood hazard 100 year return period	
	GloFAS lakes and reservoirs	
	LISFLOOD Drainage Network	
	Major Rivers	
	Major river basins	
	Reservoir impact	
	<b>NEW!</b> World Boundaries	



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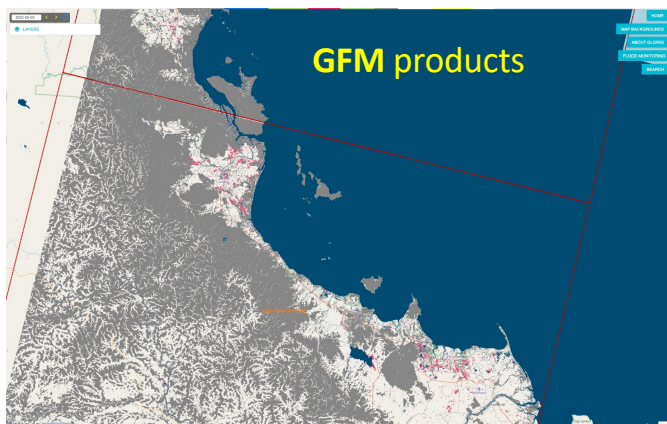


# Global Flood Monitoring (GFM) products



## Static maps

- Observed flood extent based on Sentinel-1 satellites
- With various related layers



### Observed flood extent

Observed Flood Extent
No Floodwater
Floodwater
Observed Flood Extent Footprint
Flooding detected — unusually high amount and flooded area $\geq 2 \text{ km}^2$
Flooding detected — not unusually high amount, or flooded area $< 2 \text{ km}^2$
Flooding detected — unknown significance (incomplete SAR time-series)

Further information on the **Observed Flood Extent** can be found here:

<https://extwiki.eodc.eu/GFM/PUM/Products>

MONITORING		
	Observed flood extent	
	Observed water extent	
	Reference water mask	
	Exclusion mask	
	Likelihood values	
	Advisory flags	
	Sentinel 1 footprint and metadata	
	Sentinel 1 schedule	
	Affected population	
	Affected landcover	





#EUSpace



# GloFAS data services



## CEMS Early Warning Data Store (EWDS)

## Web Mapping Service WMS-T

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Copernicus

Emergency Management Service

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CEMS Early Warning Data Store Datasets Documentation Live About CEMS

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The CEMS Early Warning Data Store provides historical and forecast information for floods and forest fires at European and global level

Search

API

Access the full data store catalogue, with search and availability features

Training

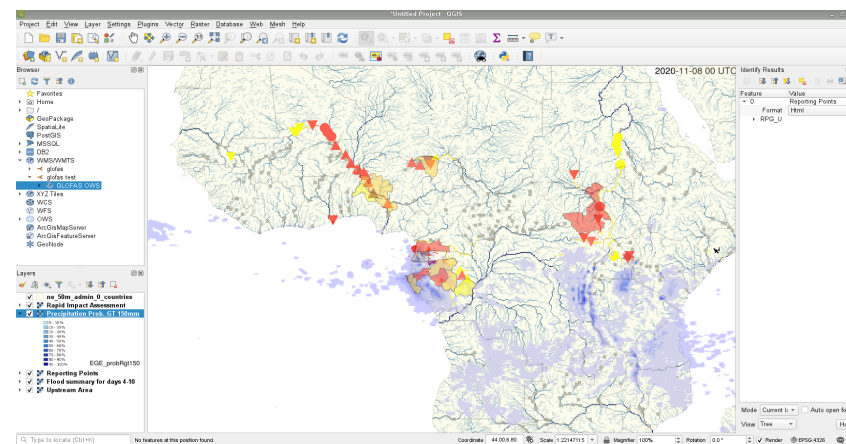
Copernicus Emergency Management Service (CEMS) data tutorials

earthkit

Open-source Python tools simplifying data access, processing, analysis, visualisation and much more

JupyterHub

Access and process data within the Data Stores Common Cloud Infrastructure (CCI)



## Data sets in EWDS

- GloFAS forecasts
- GloFAS re-forecasts
- GloFAS reanalysis
- GloFAS seasonal forecasts
- GloFAS seasonal re-forecasts



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# How to improve the usability of provided flood forecast information?

## Let us talk!



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## Possible questions

### Granularity of the provided information:

1. Are maps sufficient or users need hydrographs (detailed, time-series info) at reporting points? Should we try to simplify the provided information? More reporting point vs less or no reporting point at all.
2. How important it is to be able to 'click on' any river pixel? Is the number of reporting points in GloFAS too low, too high, optimal?
3. Is having reporting points a good way to summarise flood information on a map? Maybe other ways would be better. Maybe we should highlight regions (similar to the sub-seasonal/seasonal coloured basins)? Or maybe reporting points and basins together?
4. Is the number of provided web layers in GloFAS too high? Can the number of layers be a problem? Too many too few? What is ideal?
5. How important it is to show lead-time-specific maps, with animation as option?





## Possible questions

### Clarity of the provided information:

1. Are the GloFAS layers easy to understand, are they intuitive enough?
2. Is the level of information provided in the legends sufficient? Should we have very short legend explanation with a link to the GloFAS wiki, or we should allow longer explanations, even if that blows up the space in the layer selection window?
3. How adequate is the choice of colours and colour palettes in GloFAS? How could we improve it? Would mixing different colours in one layer be preferred over a shade of the same colour, which makes the 'reading off values from the map' very difficult? Should colour palettes be colour friendlier? And how that relate to the previous point on number of distinct colours?
4. For example, is the new sub-seasonal/seasonal product with the 5\*3 colours (i.e. categories) readable and is it easy enough to interpret? Complexity (many colours) vs information content (more categories mean more detailed forecast representation on the in products)?



## Possible questions

### How to provide information on uncertainty:

1. How important is to provide forecast uncertainty representation on products?
2. Is there any preferred way/method to show uncertainty?
3. Is it important to indicate uncertainty on map products (i.e. coloured river pixels), even if that comes with making it more complex (i.e. more colours, etc.)?
4. Or is it enough to show it in hydrographs, time series diagrams and tables for reporting points?
5. Would it be important to not show / mask / indicate, if there is too much uncertainty in the flood forecasts? A bit like in the new sub-seasonal/seasonal products where the high uncertainty is indicated?
6. Who should define, whether uncertainty is too high? Is it up to us experts, or the users should define this?



## Possible questions

### Communication of forecast information:

1. We currently provide maps and popup window products. Is this approach enough?
2. Would a notification system be crucial to have? How much is it needed? An automatic system, that sends out some text message about the upcoming flood? Email/mobile message?
3. Would an automated message be enough, or human-interpretation with a kind of short bulletin with extra info on weather/initial conditions, etc. would be crucial?
4. Does it matter if the forecast is too uncertain or the skill is too low (i.e. should such notification be sent out), as is the case in some areas of the world currently?
5. Can we send the notifications to anybody, or it must be restricted to eligible people. How could this be organised? Who should decide about who is eligible.





## Possible questions

### Forecast skill:

1. Would it be important to indicate forecast skill on products? I.e. masking or greying areas, where the skill of the provided information is low? Who and how should define the threshold for low?
2. How to calculate the skill matrix? We use CRPS currently for forecast skill and KGE for reanalysis (hydro) performance. Is it sufficient? What other metrics would be good to include or change to?
3. How important would be to show skill information related to flood, e.g. flood event-specific verification, info on flood season, systematic timing bias, etc.
4. Does the skill need to be against gauge observations? Currently we show forecast skill verified against simulated reanalysis. What to do for areas, basins which do not have observations?
5. Is it important to provide skill information for seasons, or annual info is enough?



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## Possible questions (few suggestions from Albert)

1. Albert's: How to inform users on the uncertainty of the flood predictions. Understanding that predictions become more uncertain if they are far out. When is the flood likely to begin, peak, and recede; and what is the uncertainty with timing as well as with the magnitude of a flood?
2. Albert's Flood depth forecast is important but also challenging, especially at a local level. How best to approach flood depth estimates for managers?
3. Albert's How should forecast data be translated by managers to inform the community and how can forecasting systems better help bring that message to the people.