The SEED-FD Project's Objectives

SEED-FD

Vanessa Pedinotti, Magellium

HORIZON-CL4-2023-SPACE-01-32:
Copernicus for Emergency Management

Published:
22/12/2022

Budget:
3 M€

Kick-Off:
01/01/2024

Duration:
3 years
[Jan 2024 – Dec 2026]

Consortium :

- Magellium (France, prime), ECMWF (science leader)
- CNR-IRPI (Italy)
- ICPAC (Kenya,Intergovernmental Authority on Development (IGAD) Climate Prediction and Application Center
- IIASA (Austria, International Institute for Applied Systems Analysis)
- VORTEX.IO (France)
- POLIMI (Italy, POLITECNICO DI MILANO)
- DesignData (Germany)
- JRC (EU)

ASIA

Indonesia – Deadly Floods and

ASIA

Afghanistan – Devastating Flash

EUROPE

Germany – Thousands Evacuate

Summary of the Exceptional Cévennes Weather Episode: Up to 864 mm in Ardèche

Cyril BONNEFOY

In an already very wet context at the beginning of autumn, a new Cévennes weather episode with heavy rains in the south began on October 16, peaking in intensity on October 17 with up to two and a half months' worth of rain in the Cévennes. A look back at this exceptional event.

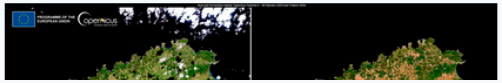
Severe drought persists in Sicilia

Image of the day | 5 January, 2024

Despite the onset of the rainy season, Sicilia (Italy) continues to be affected by a severe drought. Th
leading to bare soil bec
shortage is affecting ce
agricultural irrigation. C
water, are facing a critic

Ibiza and Formentera hit severely by drought

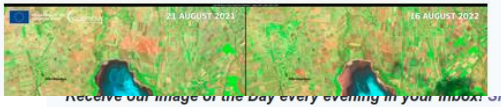
Image of the day | 12 March, 2024



The recent drought in t
created significant cha
overall ecosystem. Erra
the islands have result
struggle to irrigate thei
could cause economic
by

The impact of drought on Lake Pikrolimni, Greece

Image of the day | 30 August, 2024



Receive our Image of the Day every evening in your inbox! Sign up here

Northern Greece is f
drought. The area ha
three years, leading
on local biodiversity.
satellites between Au
progressive drying o
for

Severe drought in Ecuador

Date: 25/10/2024

Location: Ecuador
Credit: European Union, Copernicus Sentinel-2 imagery

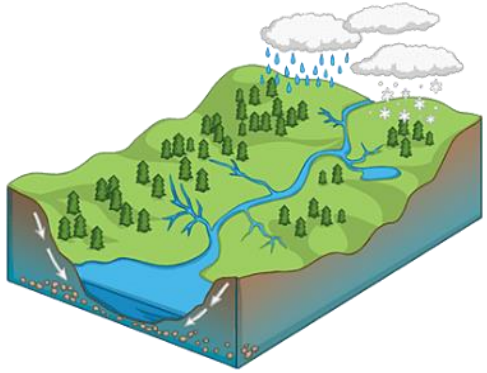
Image of The Day | Water | Drought | Energy

Ecuador is in the midst of its worst drought in more than 60 years. The ongoing crisis has dropped water reserves to critical levels, impacting electricity service in a country which relies on hydroelectric plants for seventy ...

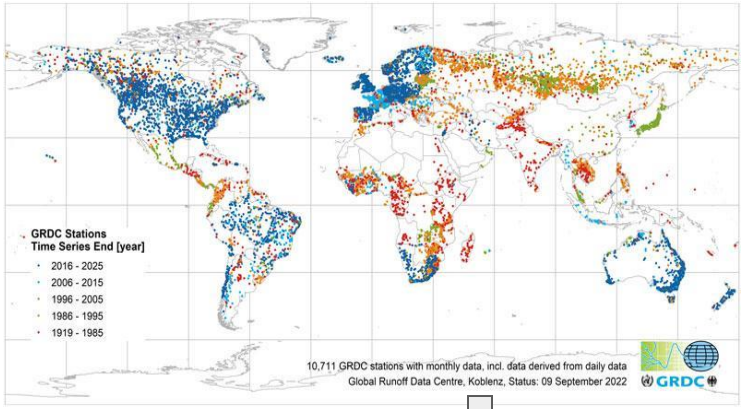
Show more

Monitoring and forecasting continental water dynamics for F&D

Floods

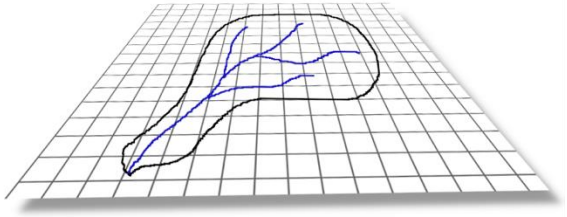


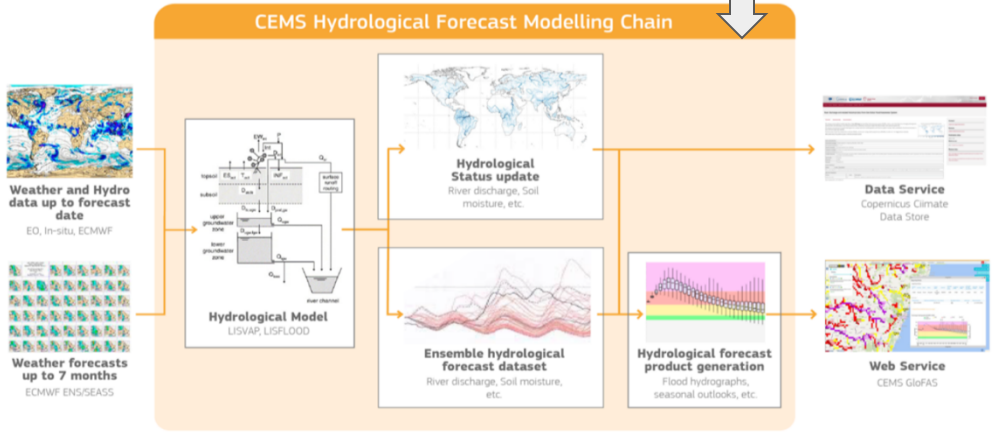
Droughts



In-situ observations

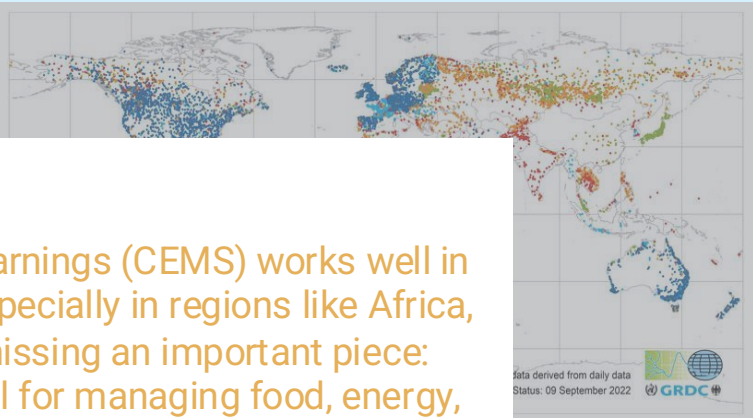
Models



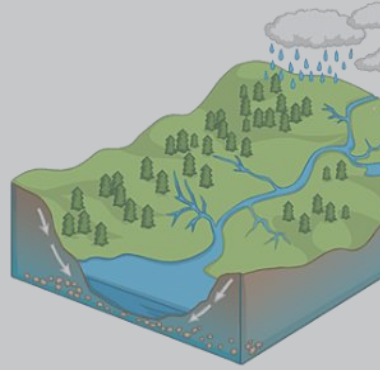


Monitoring and forecasting continental water dynamics for F&D

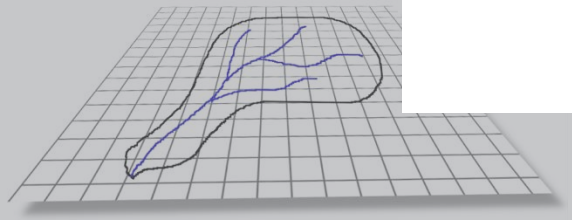
Floods



In-situ observations



Mode

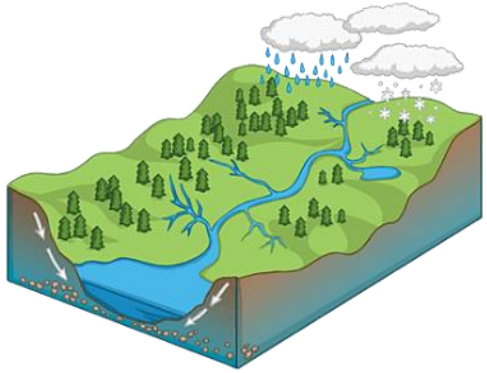


The current global system for flood warnings (CEMS) works well in some areas but struggles in others, especially in regions like Africa, South America, and Asia. It's also missing an important piece: drought forecasts, which are essential for managing food, energy, and water supplies.

SEED-FD will address 3 CEMS-EWS critical gaps, taking the opportunity of daily delivery of millions of hydrological-relevant data across the world by Copernicus space missions.

Monitoring and forecasting continental water dynamics for F&D

Floods



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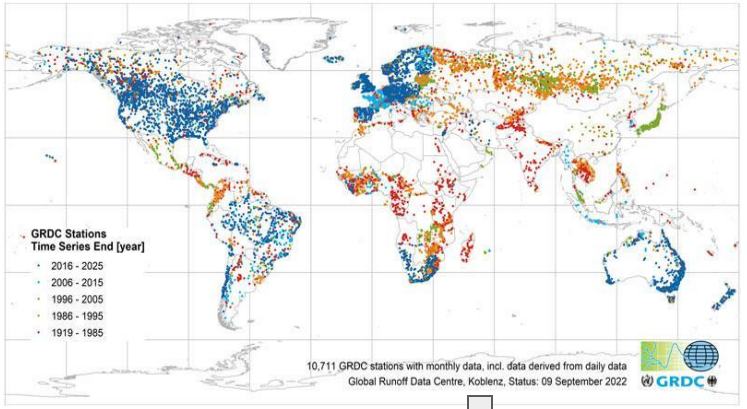

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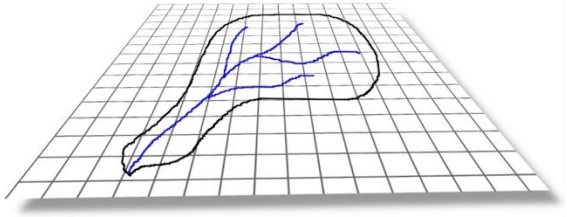
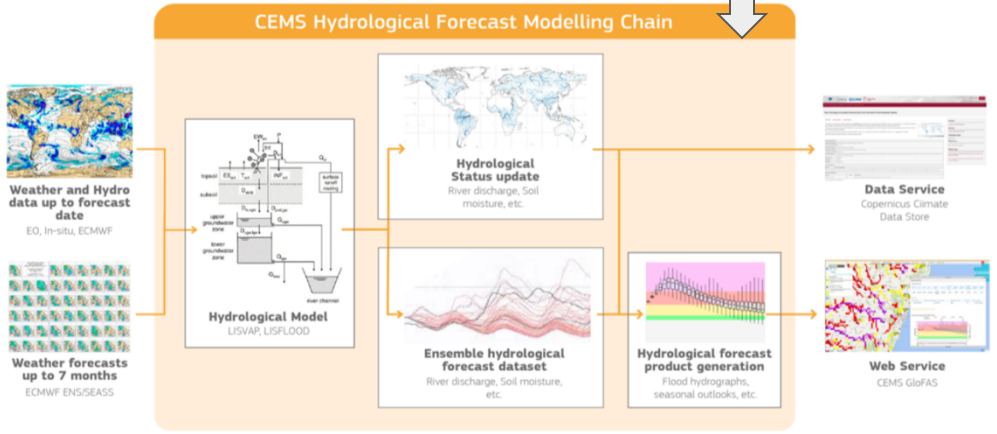
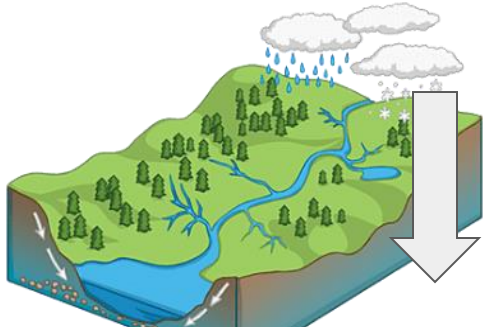


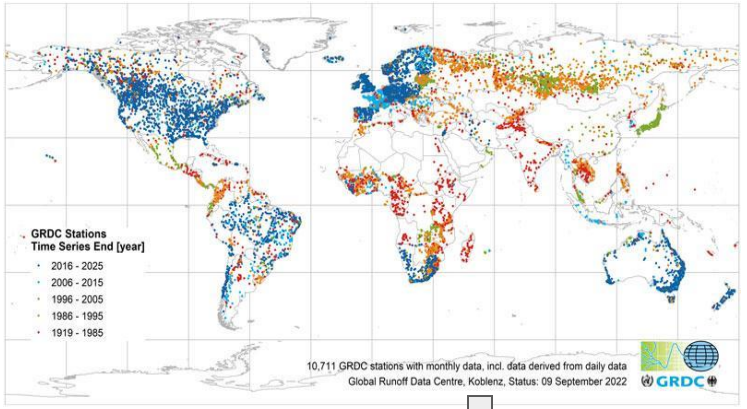


Monitoring and forecasting continental water dynamics for F&D

Floods



Models



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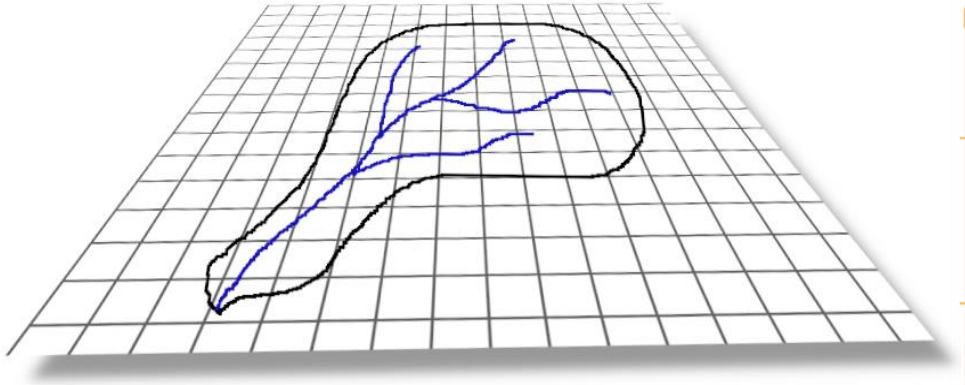
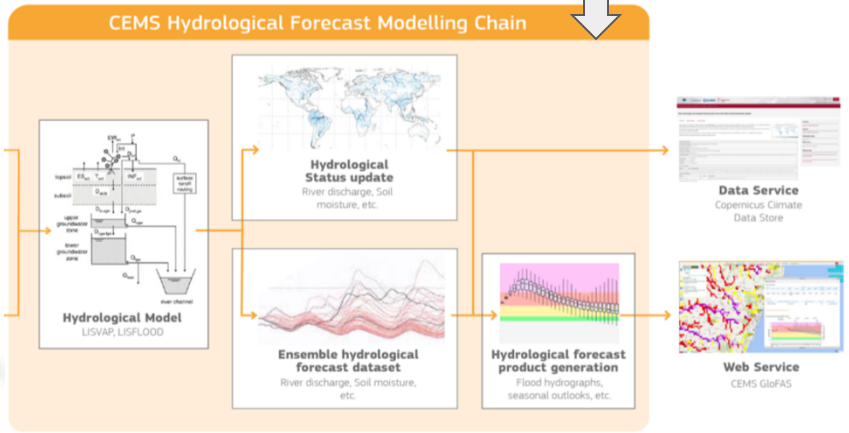
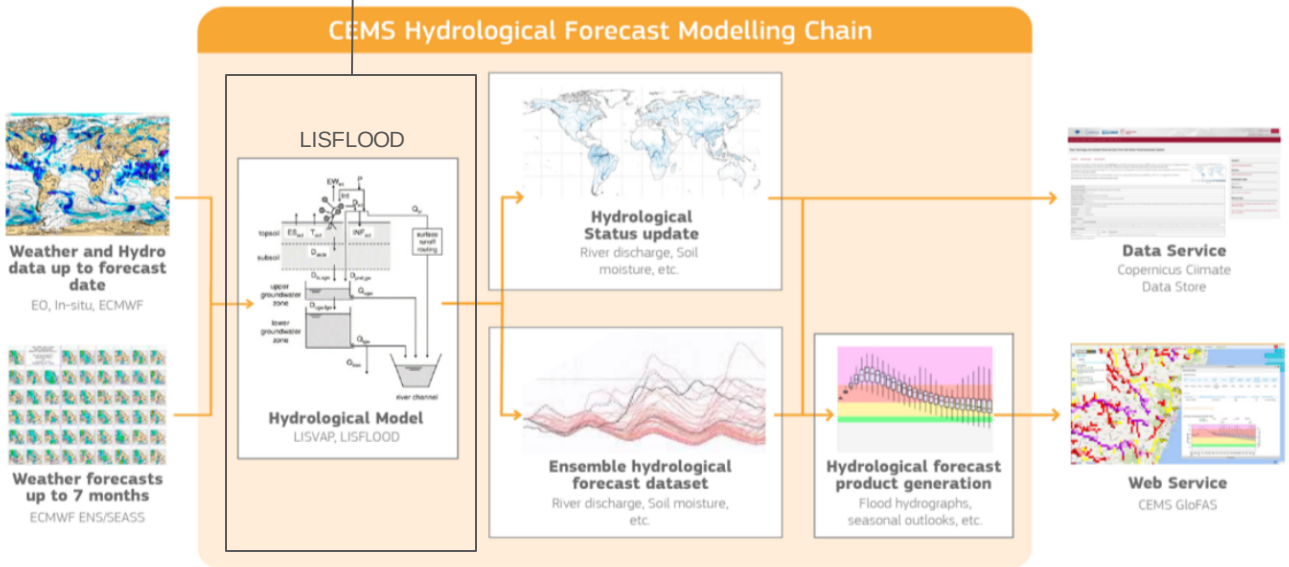




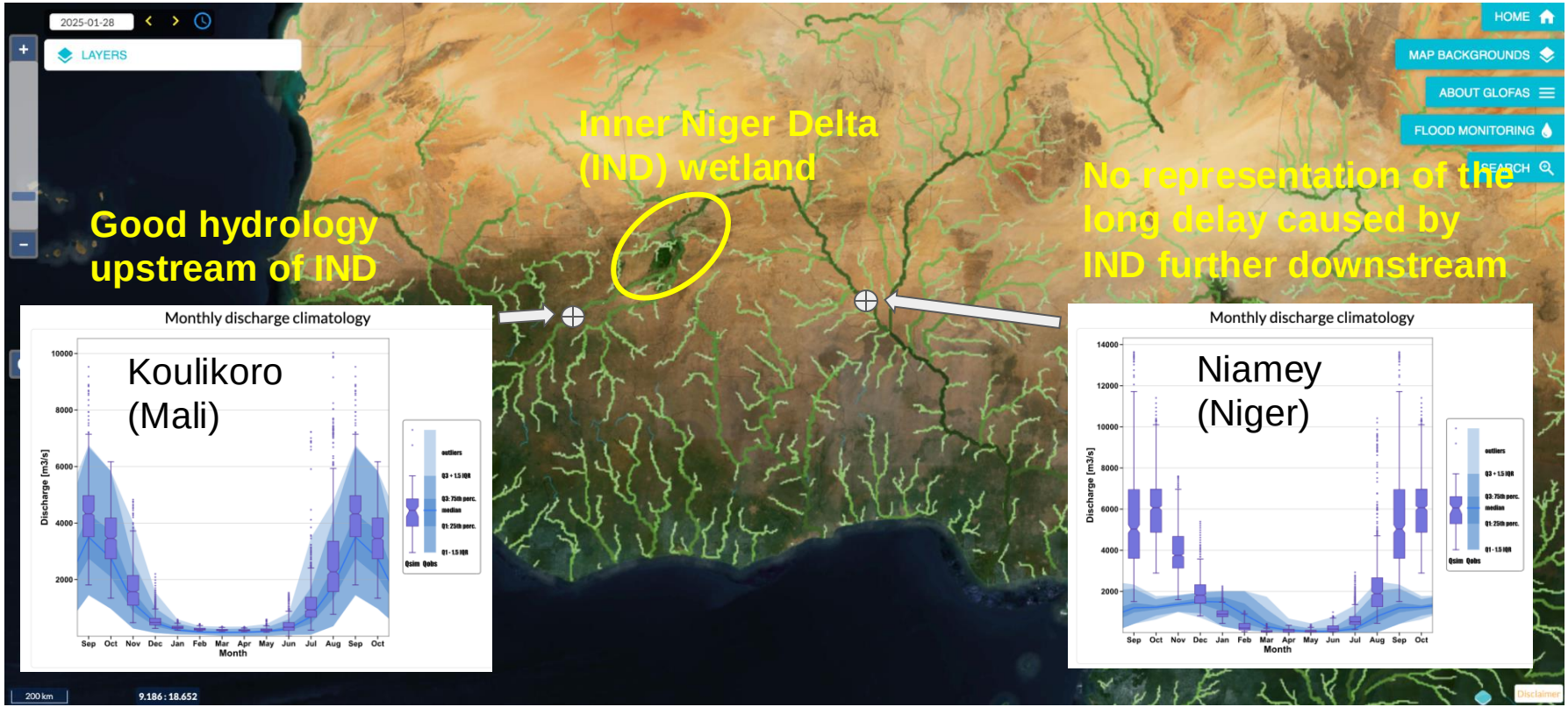
CEMS-HFMC 1st gap : model representation of complex processes

- originally developed for European applications
- does not yet resolve many complex
  - processes and challenges associated with data scarce regions such as wetlands, reservoirs operation rules, groundwater flows, evaporation and specific routing.



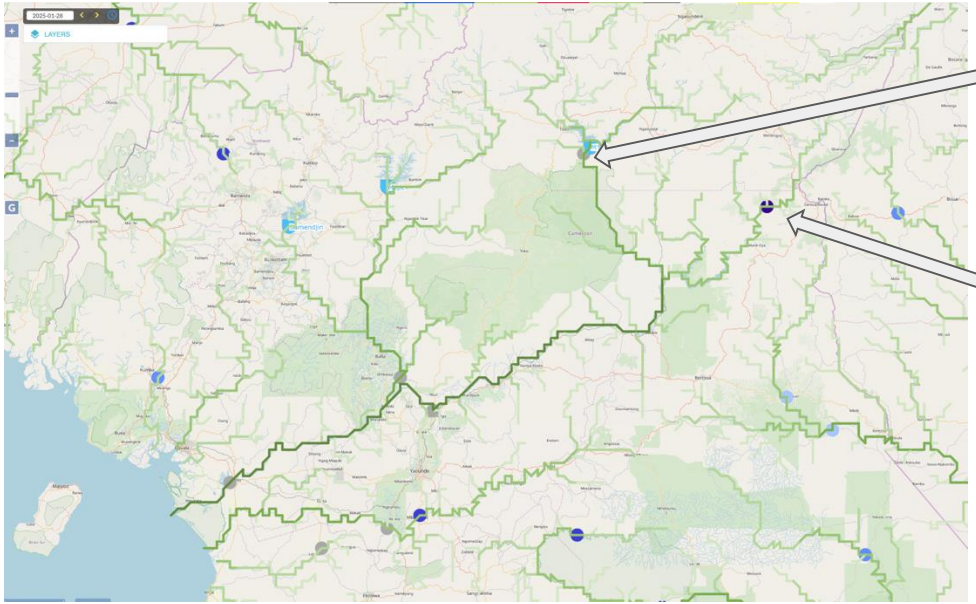
CEMS-HFMC 1st gap : model representation of complex processes

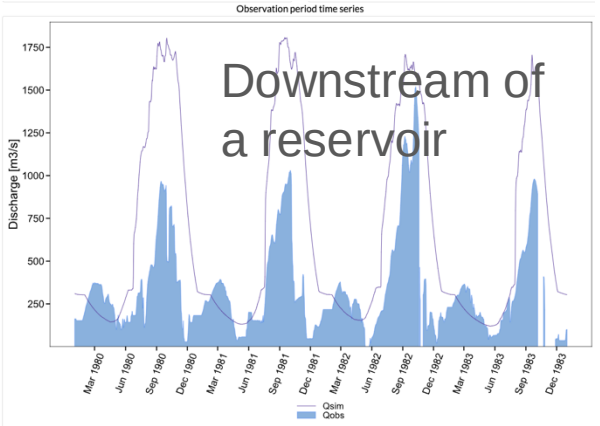
No wetland (floodplain) representation in GloFAS (for example the Inner Niger Delta)

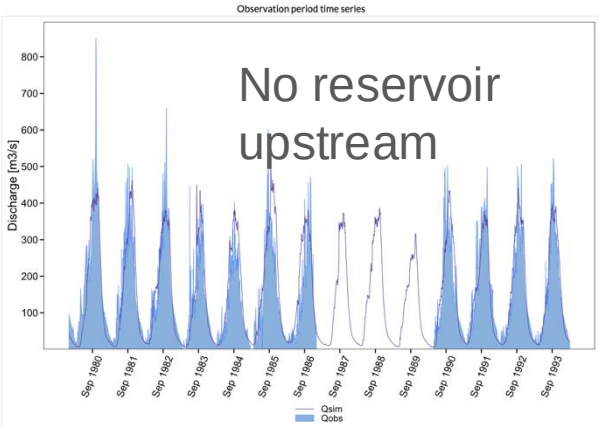


CEMS-HFMC 1st gap : model representation of complex processes

Reservoir modelling problem example in Cameroon



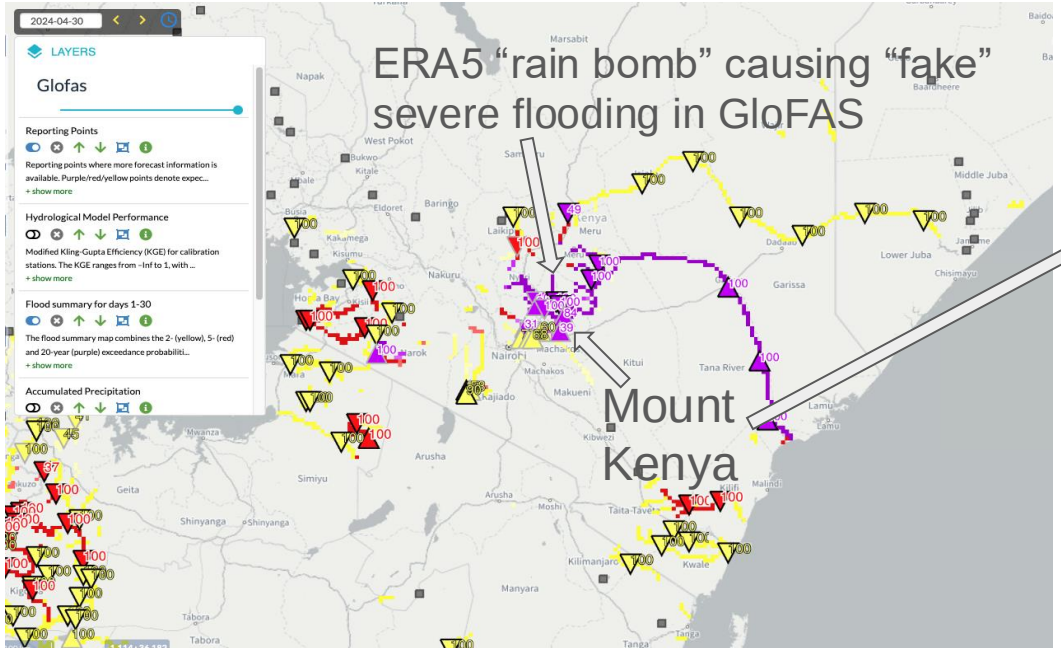


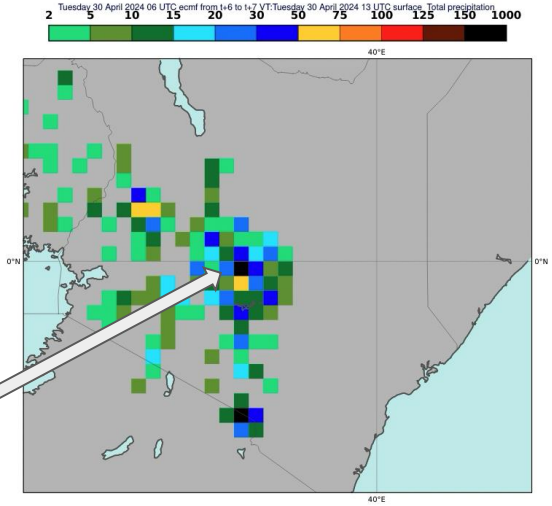


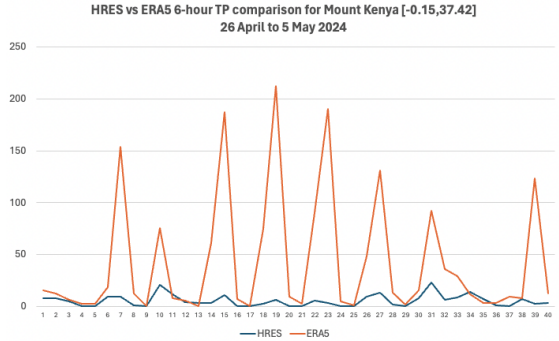
CEMS-HFMC 1st gap : model representation of complex processes

Meteo forcing quality issues - “Rain bombs” in ERA5

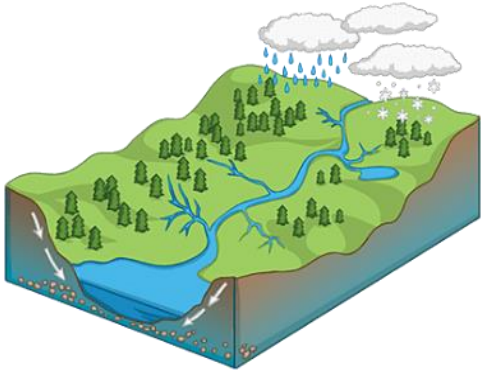
Rare, unrealistic, extreme high precipitation at single grid points over complex orography mainly in the tropics

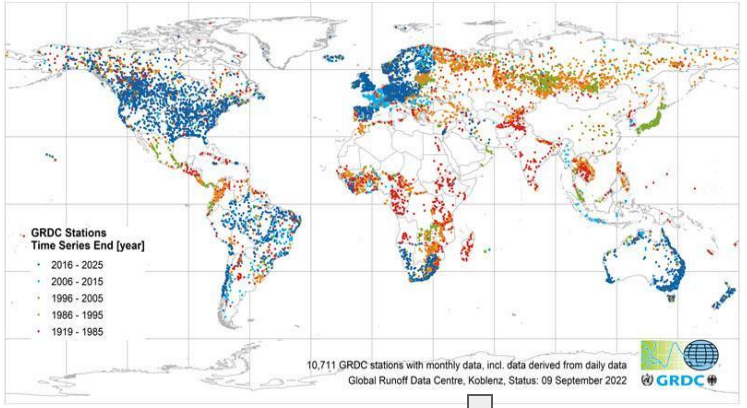






Monitoring and forecasting continental water dynamics for F&D

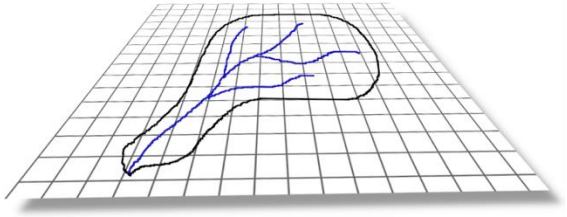


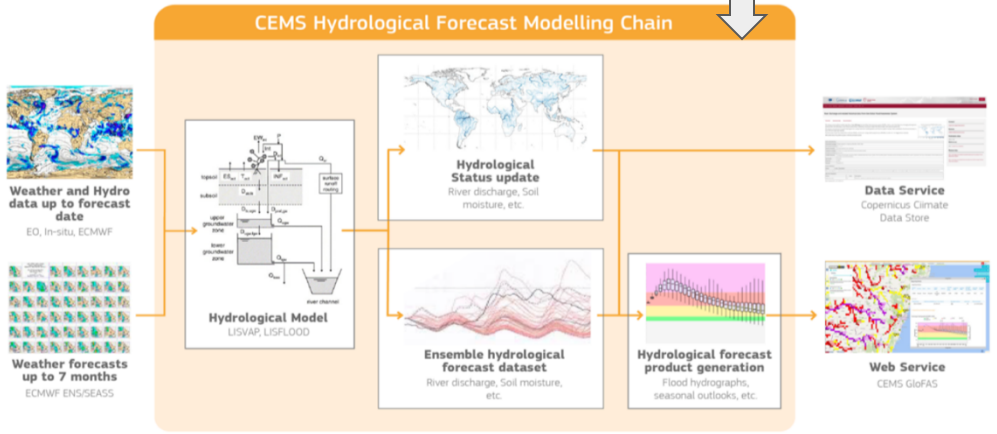


In-situ observations

Droughts

Models





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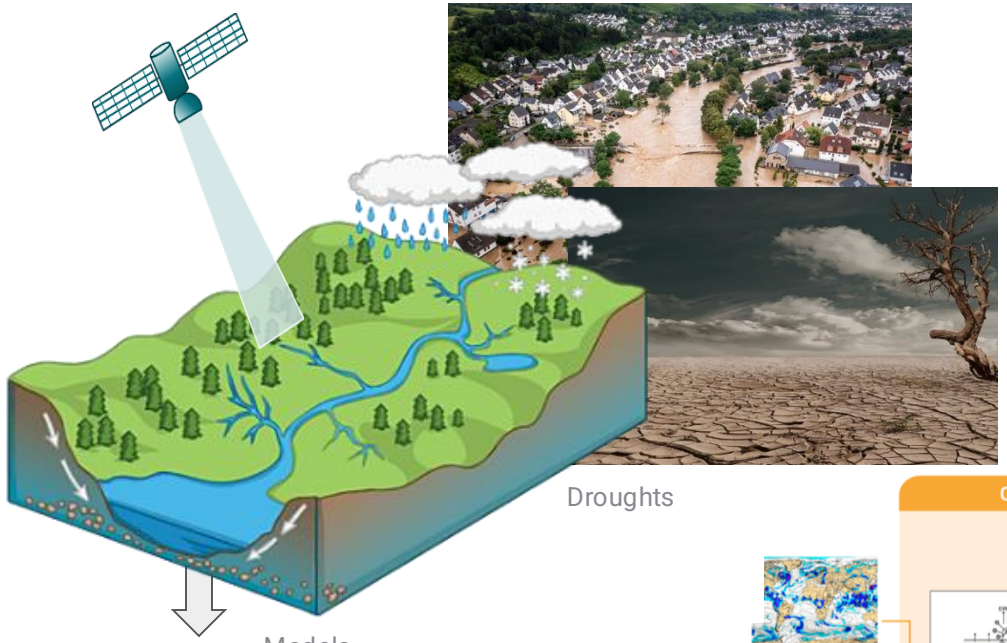
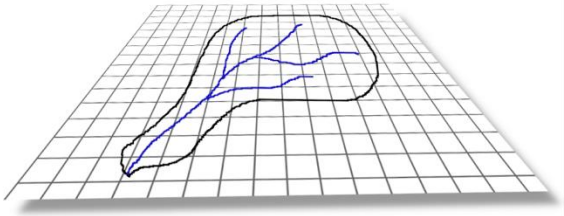
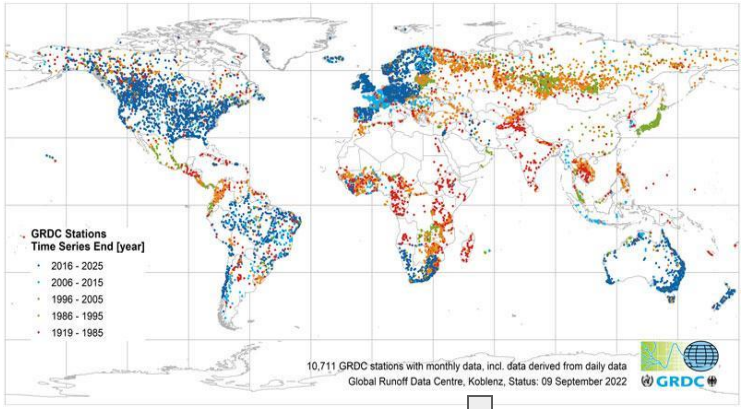


Droughts

Models





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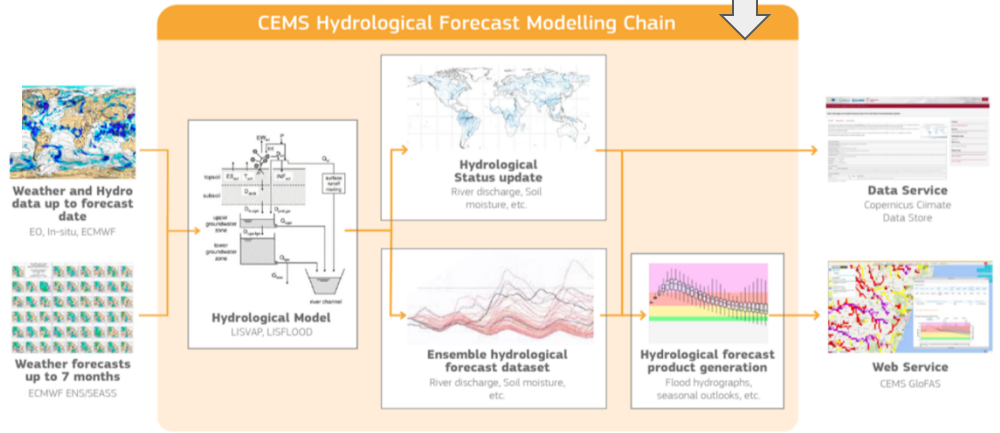
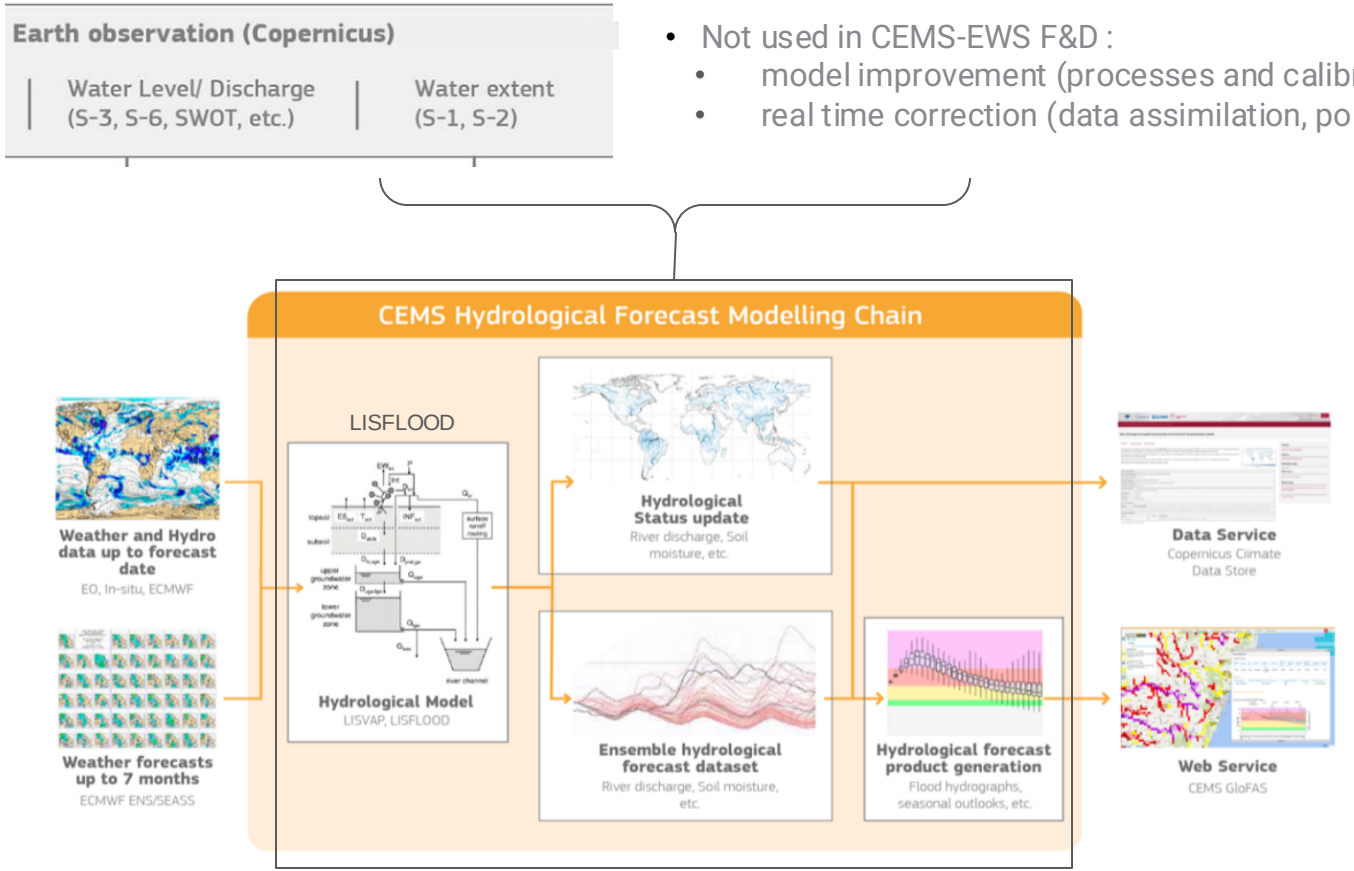
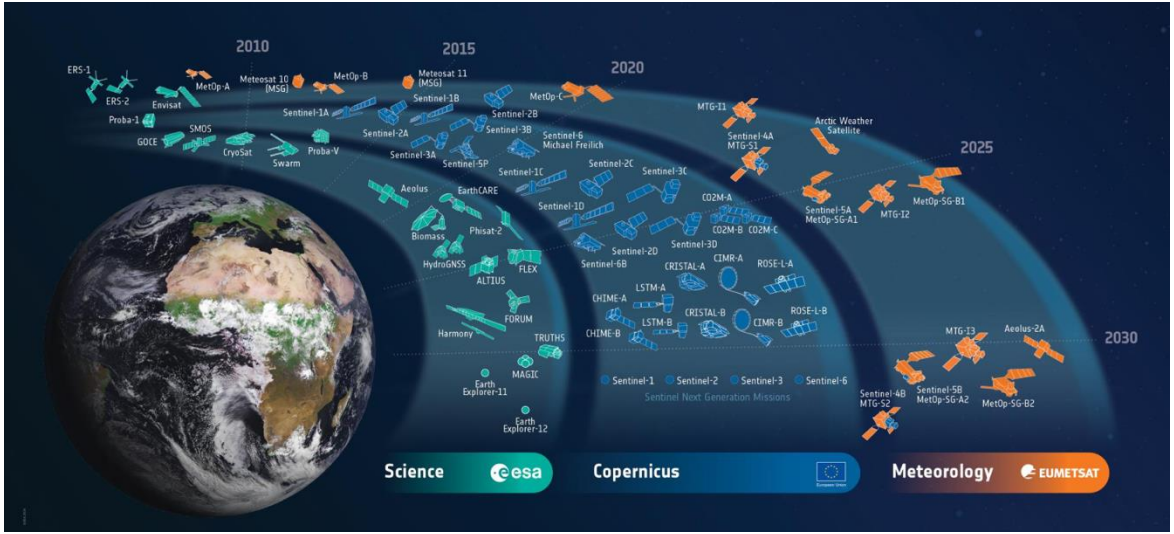


CEMS-HFMC 2nd gap: no use of EO data despite their extensive deployment



- Not used in CEMS-EWS F&D :
  - model improvement (processes and calibration)
  - real time correction (data assimilation, post-processing)

CEMS-HFMC 2nd gap: no use of EO data despite their extensive deployment

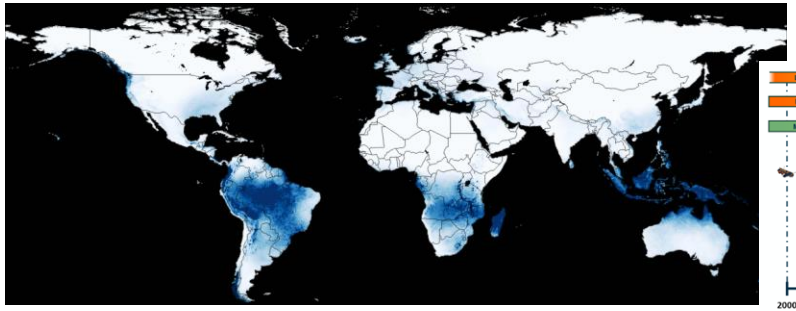


Past data: Satellite archives and retrieval algorithms provide records of water levels, rainfall, and soil moisture, helping us understand historical trends and improve model calibration.

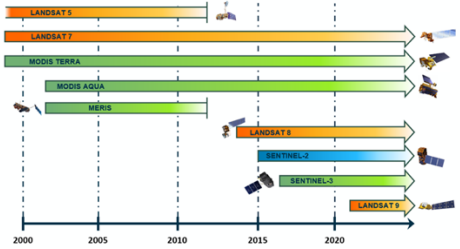
Real-time data: Current satellite missions, such as Copernicus, deliver daily global information on rivers, reservoirs, and soil conditions. This enables near real-time monitoring of floods and droughts.

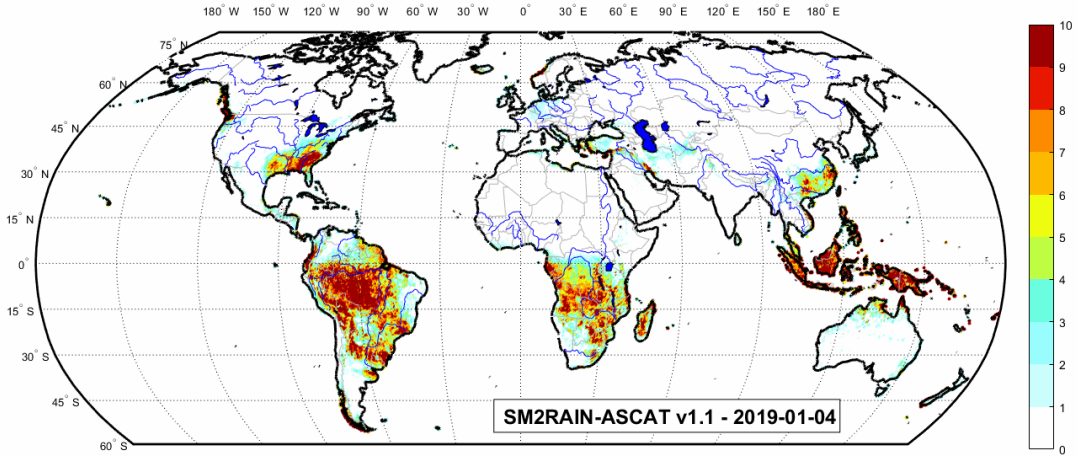
Impact: By integrating these datasets, SEED-FD enhances hydrological forecasts, reducing errors and ensuring timely alerts, even in data-scarce regions.

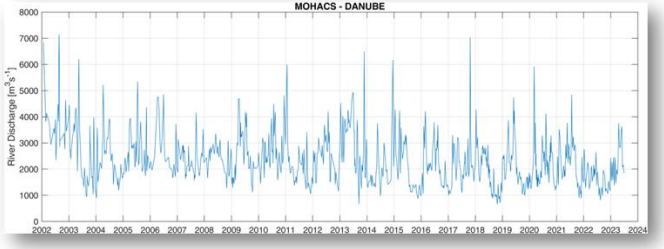
CEMS-HFMC 2nd gap: no use of EO data despite their extensive deployment



EO-BASED RIVER DISCHARGE, 3-day, >100 sites, available from 2002 to 2023







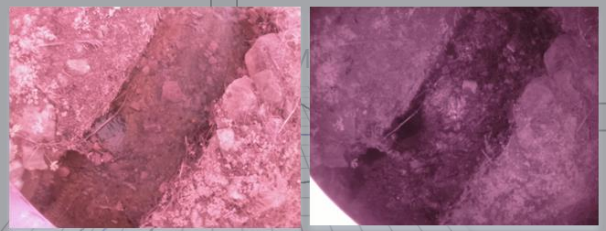
GLOBAL PRECIPITATION, daily, 10 km, available from 2007 to 2024

CEMS-HFMC 2nd gap: no use of EO data despite their extensive deployment

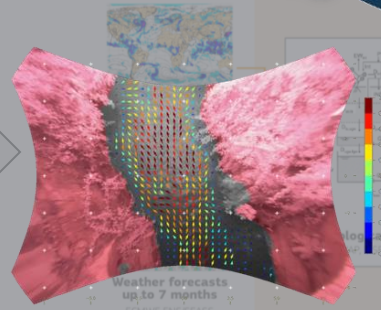
The micro-station : a multi parameters device

Wide angle camera with night vision

Wide angle shot

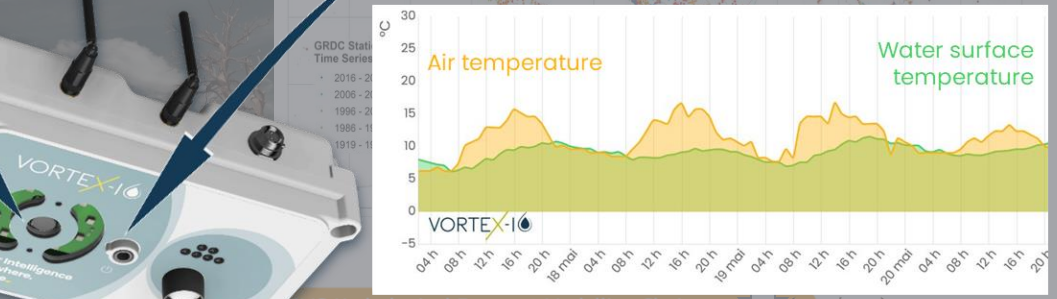


Daylight vision | Night vision



Surface velocity field
(Patented algorithm VtxFlow)

Infrared thermal sensor



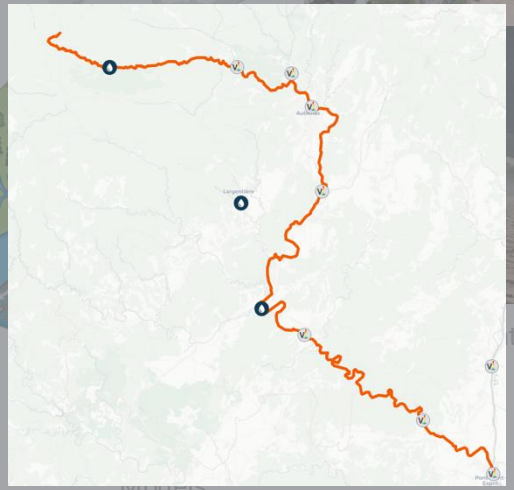
Surface temperature (24h/24h)

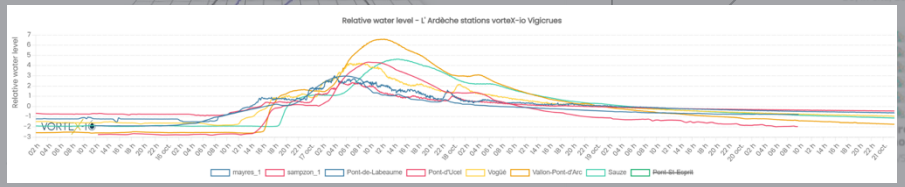
LiDAR sensor

Water surface height (24h/24h)

CEMS-HFMC 2nd gap: no use of EO data despite their extensive deployment

Measurements during flood event in France (Ardèche) Oct. 2024

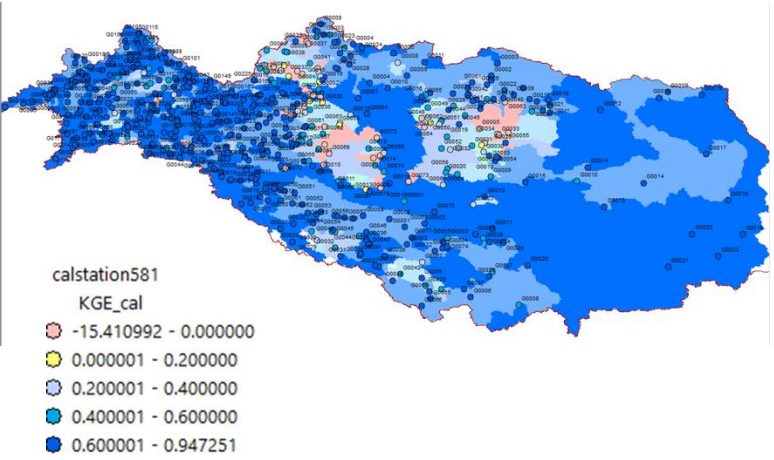


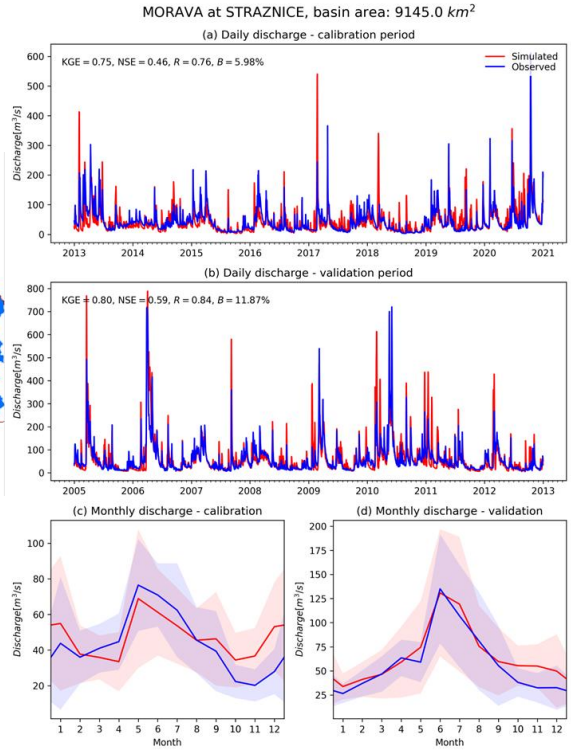


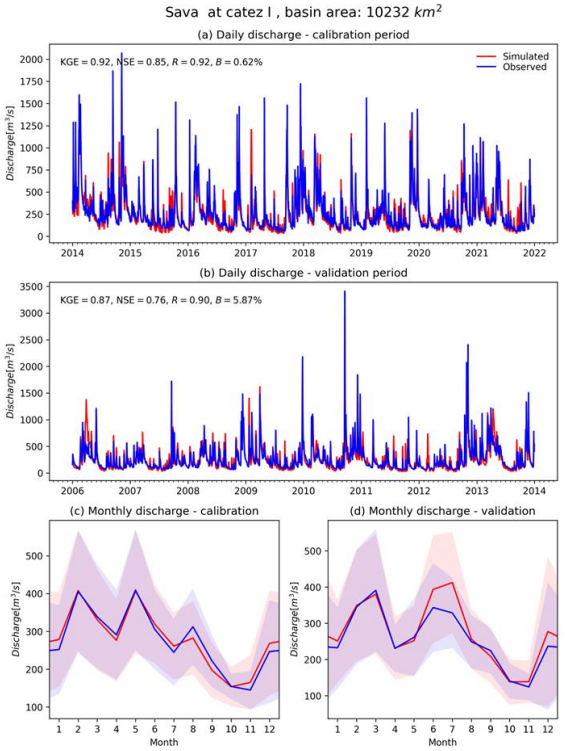
Measurements during flood event in France (Briollay) Jan. 2025

CEMS-HFMC 2nd gap: no use of EO data despite their extensive deployment

First results of calibration

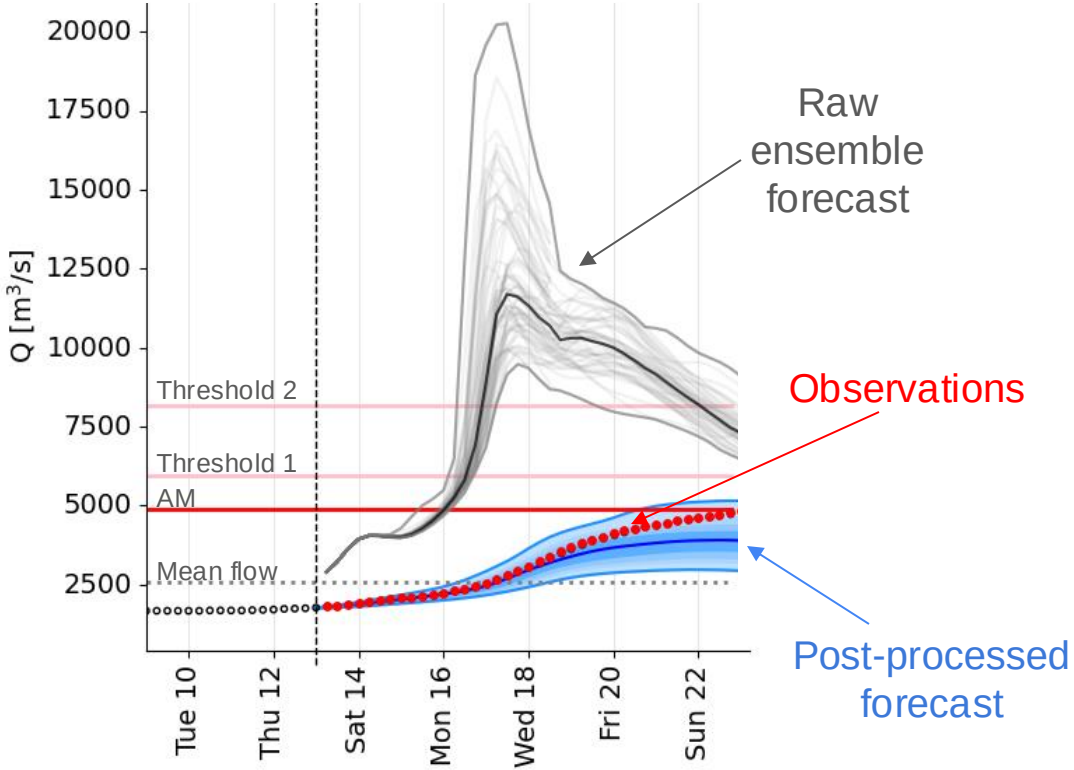






CEMS-HFMC 2nd gap: no use of EO data despite their extensive deployment

No post-processing is currently available in GloFAS due to lack of near real-time data

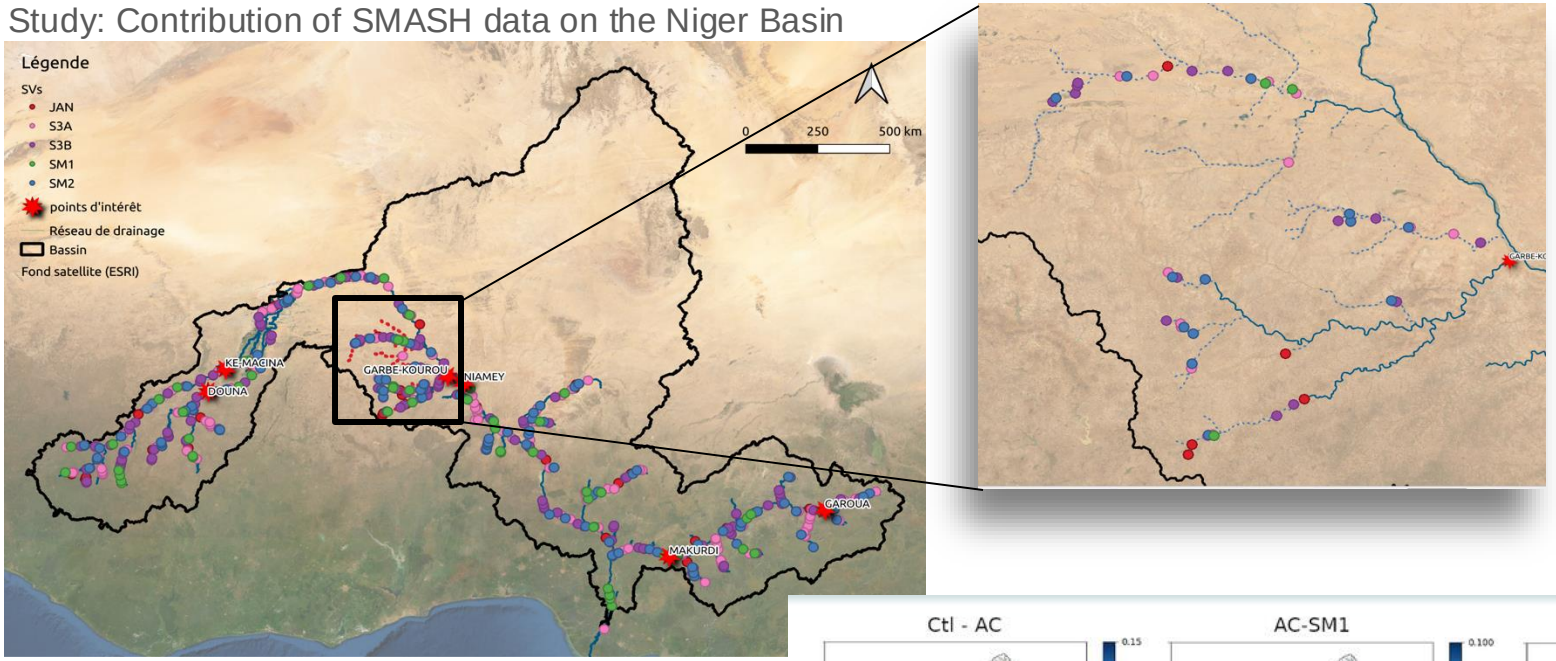


EO data could provide the necessary observations!

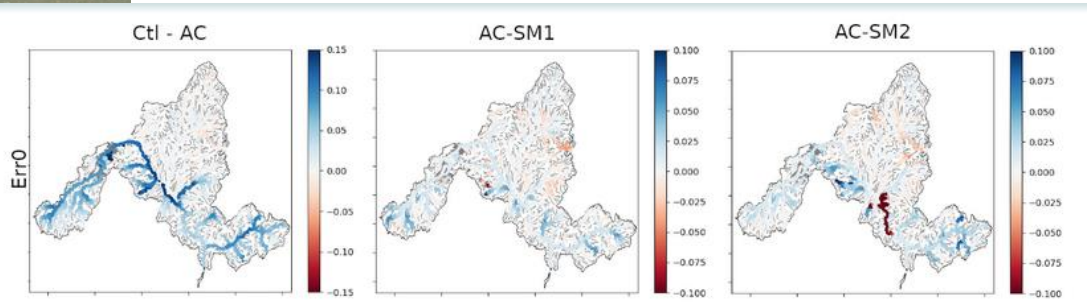
Post-processing is already in EFAS where observations are available

CEMS-HFMC 2nd gap: no use of EO data despite their extensive deployment

Study: Contribution of SMASH data on the Niger Basin

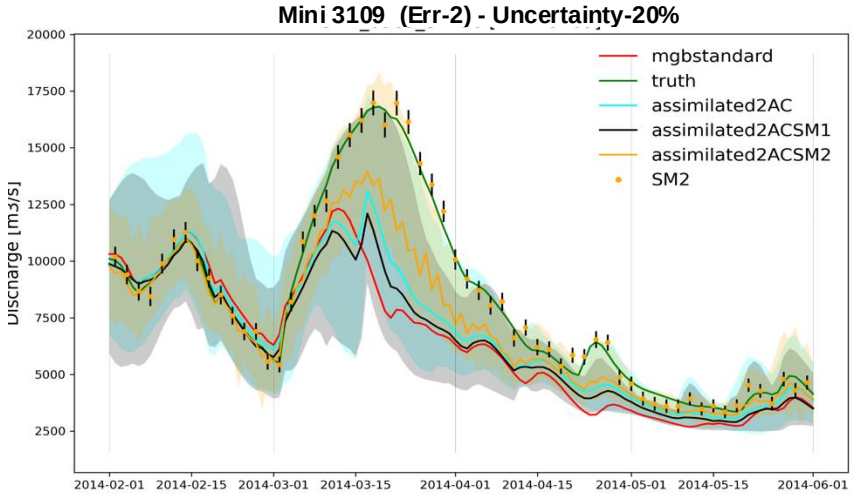


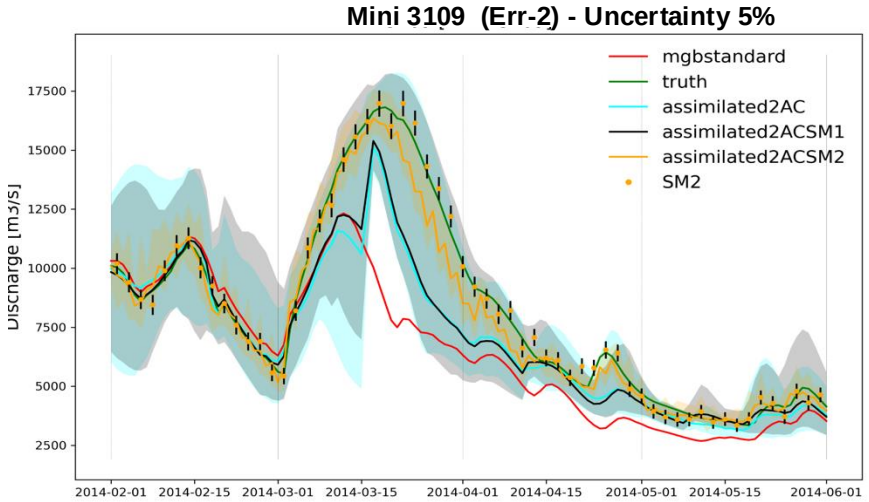
Data assimilation in the MGB regional model (difference of NRMSE)

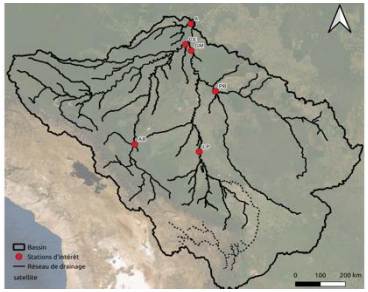


CEMS-HFMC 2nd gap: no use of EO data despite their extensive deployment

Study: Contribution of SMASH data on the Madeira Basin







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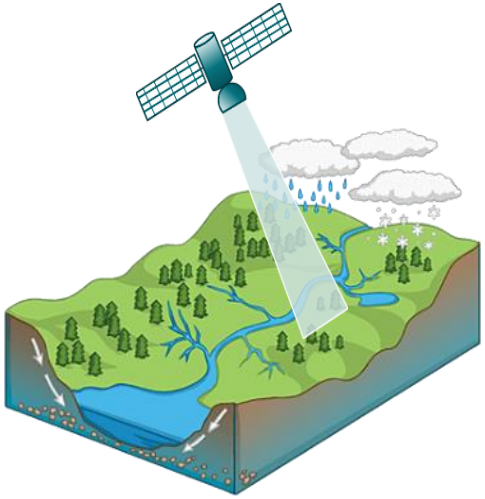
bias=-16.28 ; r2=0.79 ; nrmse=0.82 ; kge=0.66
th: pbias=-20.37 ; r2=0.75 ; nrmse=0.98 ; kge=0.61
th: pbias=-12.85 ; r2=0.93 ; nrmse=0.53 ; kge=0.75

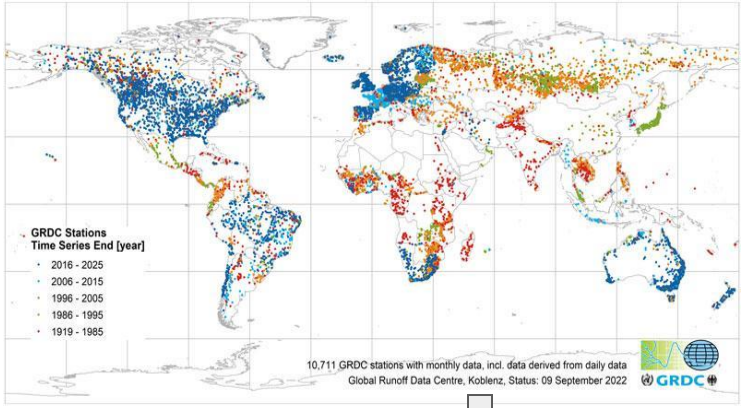
s/truth: pbias=-21.11 ; r2=0.63 ; nrmse=1.00 ; kge=0.61
a2AC/truth: pbias=-13.62 ; r2=0.86 ; nrmse=0.67 ; kge=0.71
a2ACSM1/truth: pbias=-12.73 ; r2=0.88 ; nrmse=0.61 ; kge=0.73
a2ACSM2/truth: pbias=-3.77 ; r2=0.98 ; nrmse=0.18 ; kge=0.93

Very different contribution depending on the data assimilated and basin studied

Monitoring and forecasting continental water dynamics for F&D

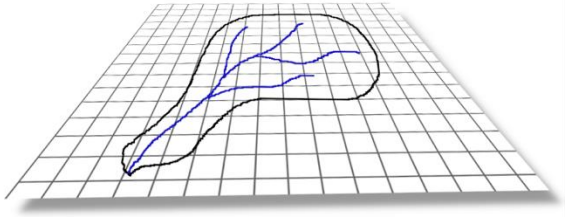


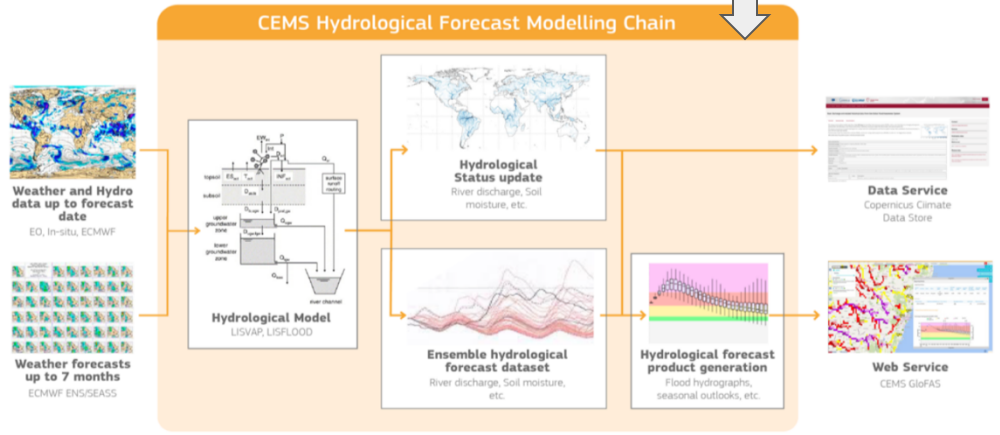
Droughts



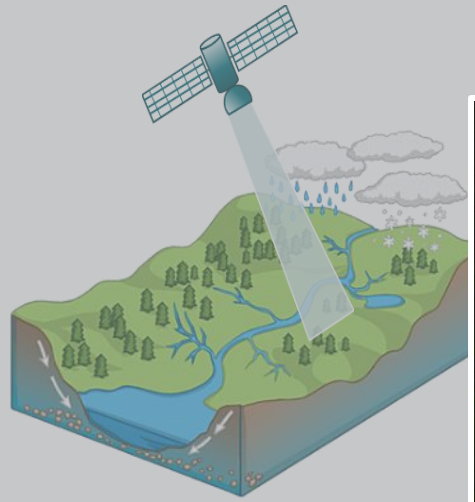
In-situ observations

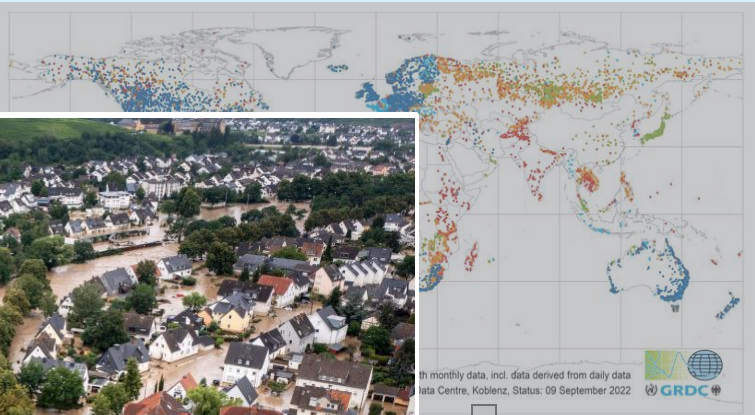
Models





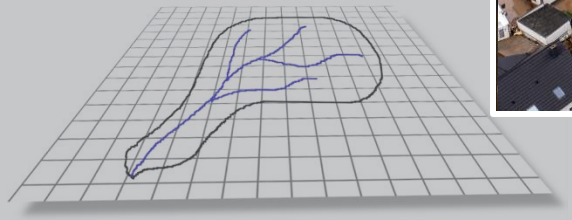
Monitoring and forecasting continental water dynamics for F&D

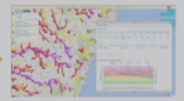


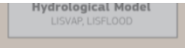


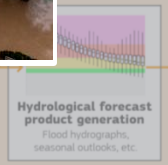
In-situ observations

Models

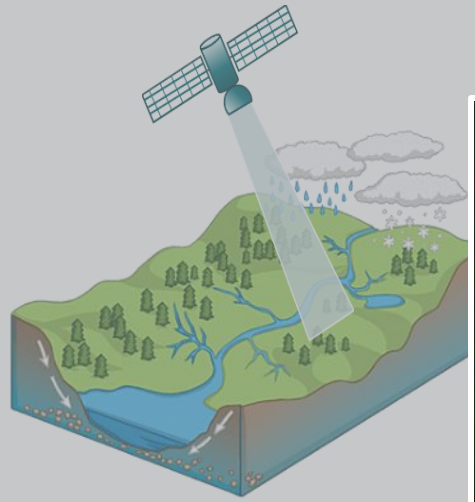


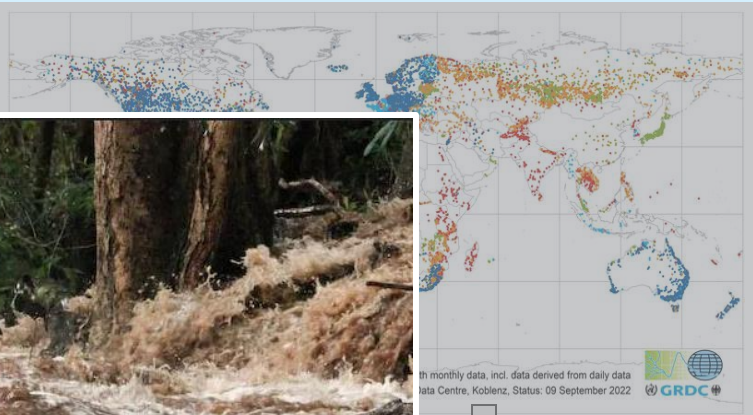






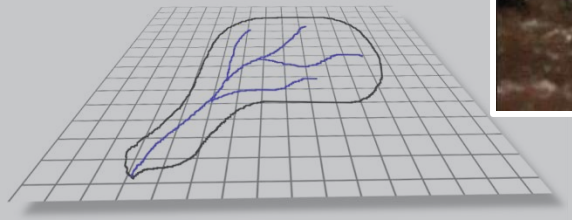
Monitoring and forecasting continental water dynamics for F&D

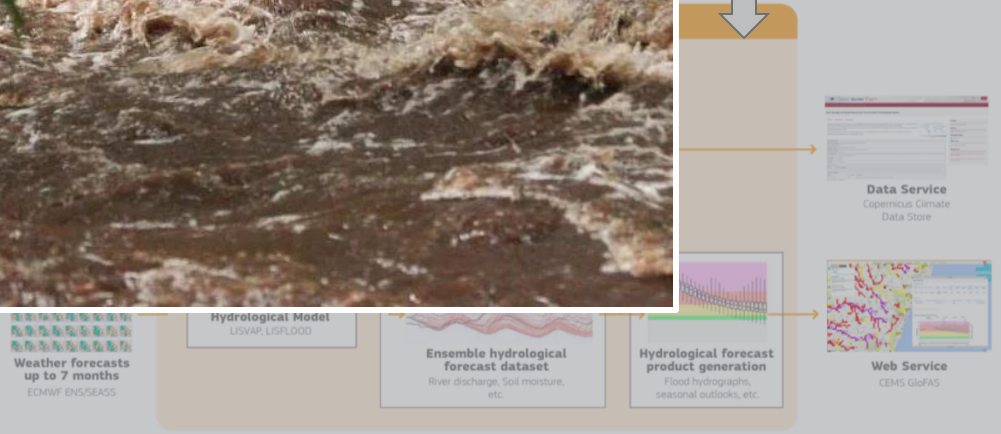




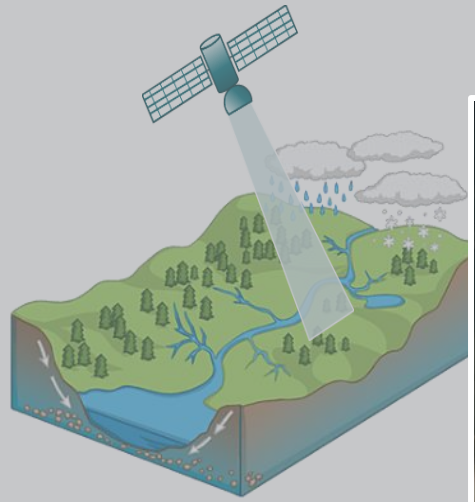
In-situ observations

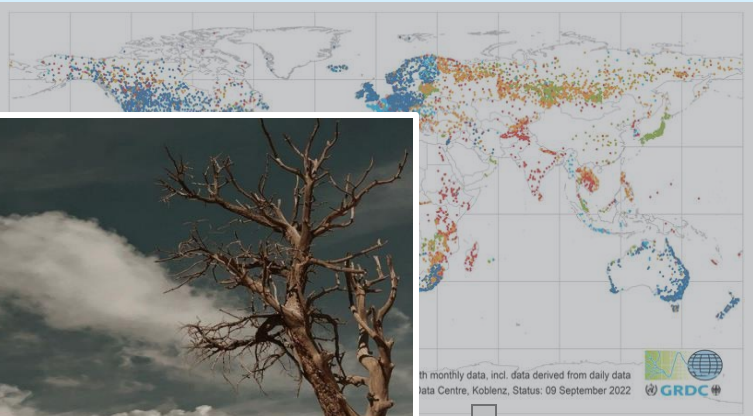
Models





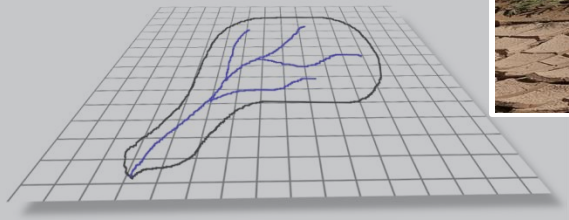
Monitoring and forecasting continental water dynamics for F&D

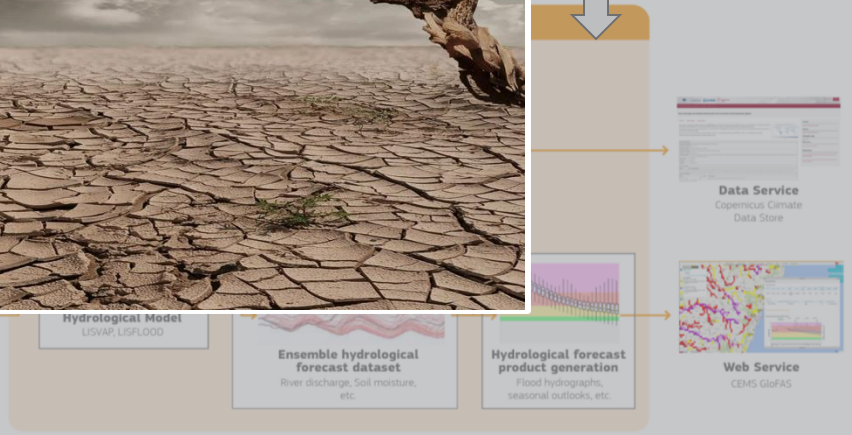




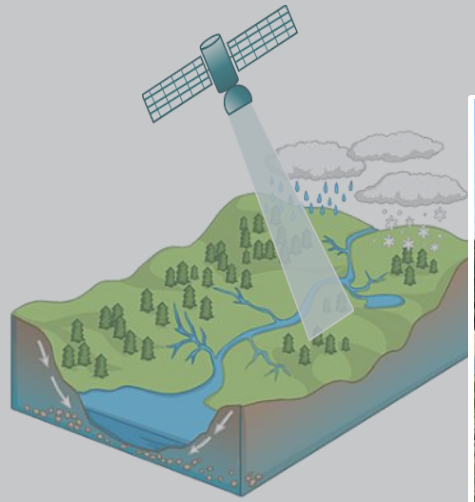
In-situ observations

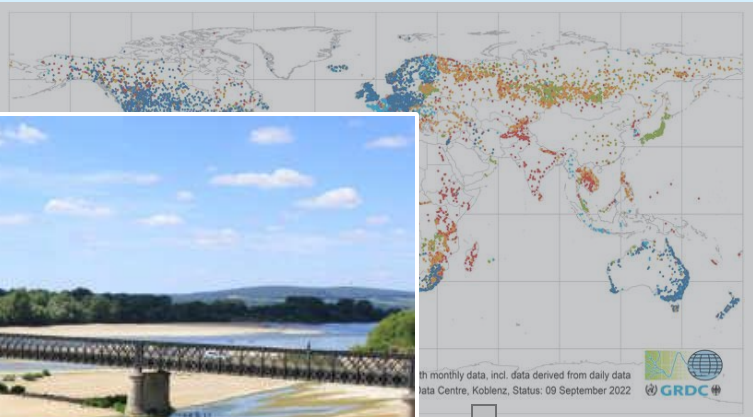
Models





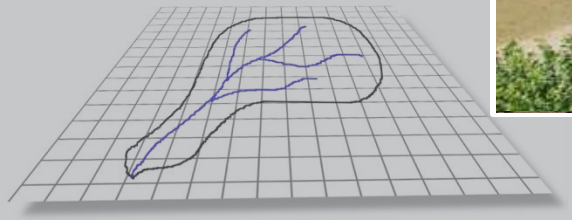
Monitoring and forecasting continental water dynamics for F&D





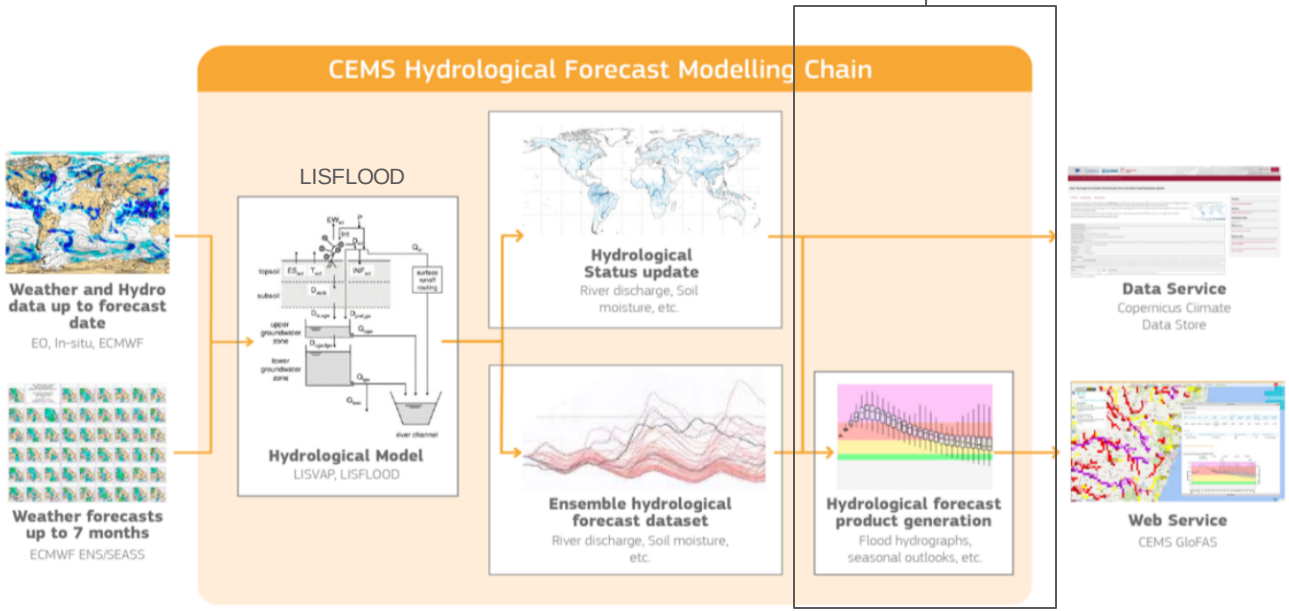
In-situ observations

Models



CEMS-HFMC 3rd gap : some types of real extreme events are not detected

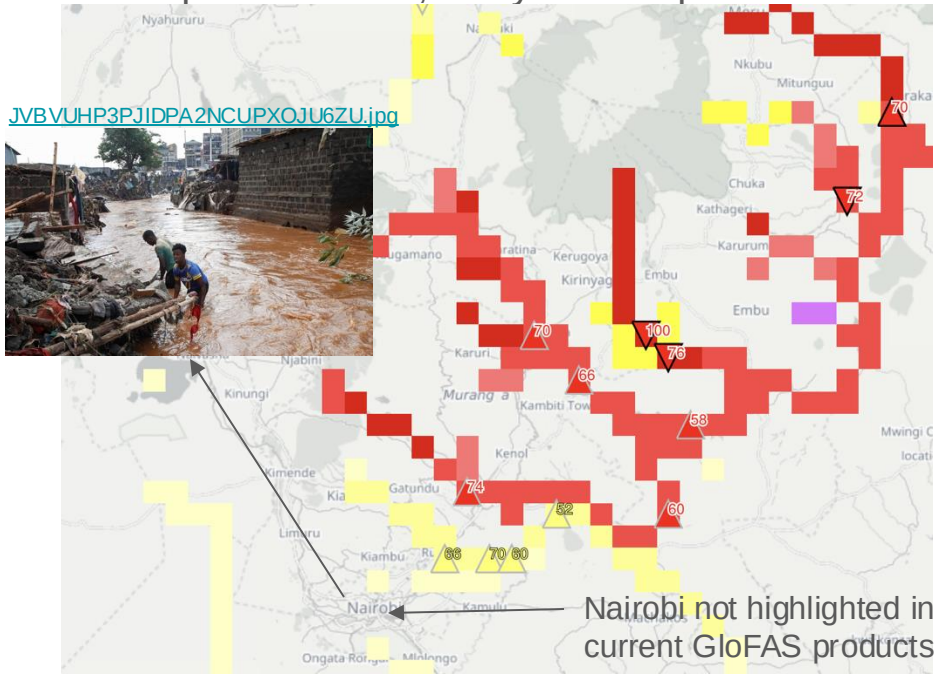
Important real-life extreme events are not in CEMS-EWS portfolio



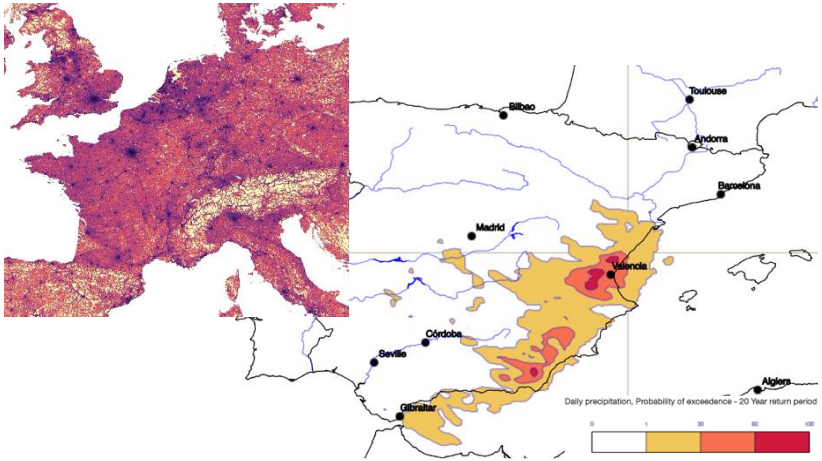
CEMS-HFMC 3rd gap : some types of real extreme events are not detected

CEMS-Floods GloFAS currently has no forecast product for flash floods.

Example of Nairobi, Kenya 25th April 2024



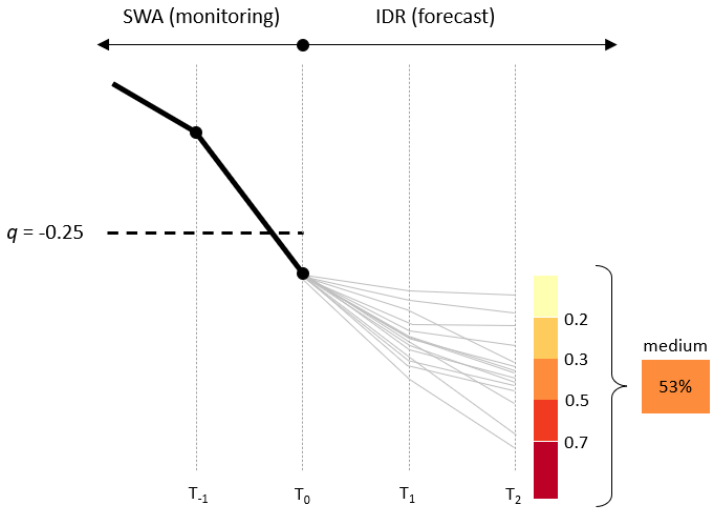
New flash flood product combining rainfall data, vulnerability & exposure information



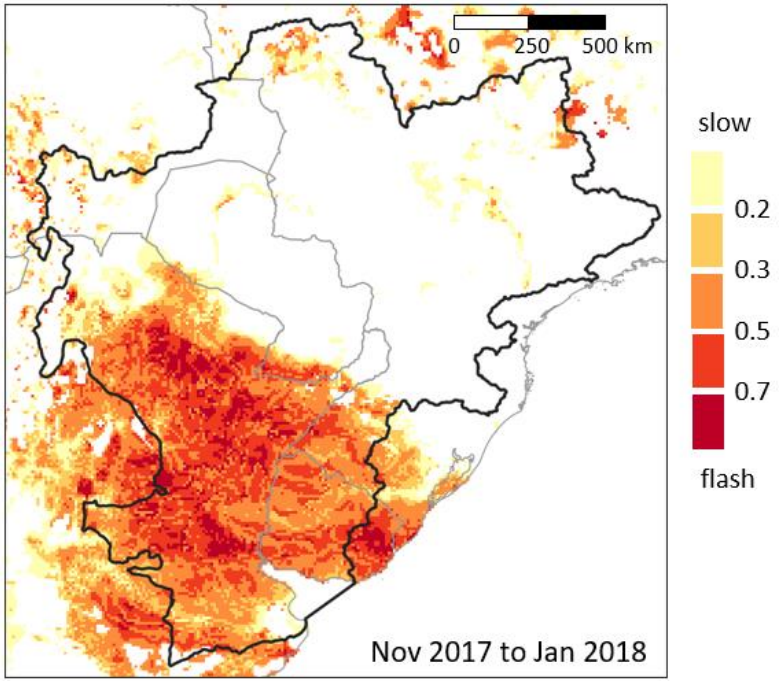
CEMS-HFMC 3rd gap : some types of real extreme events are not detected

CEMS currently lack a monitoring and forecasting tool for flash drought.

NEW flash drought early warning



SWA = Soil Wetness Index Anomalies
IDR = Initial Development rate

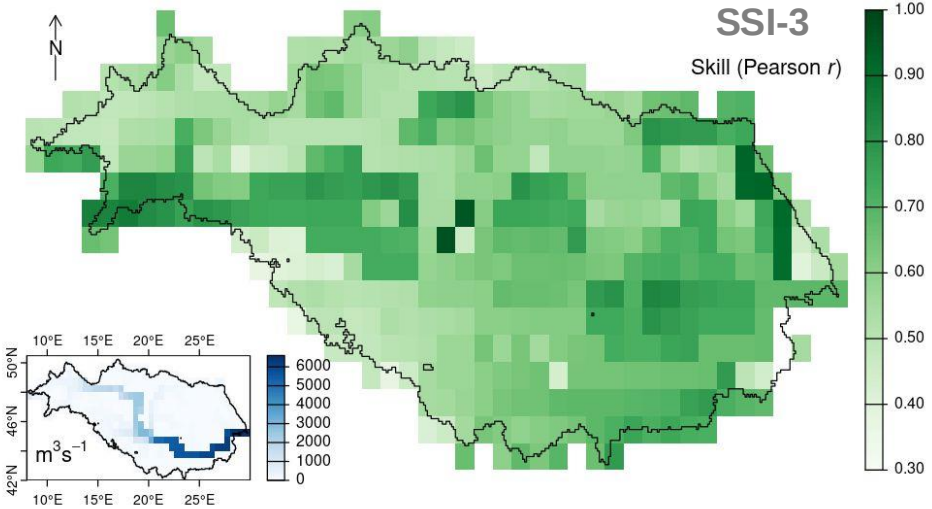


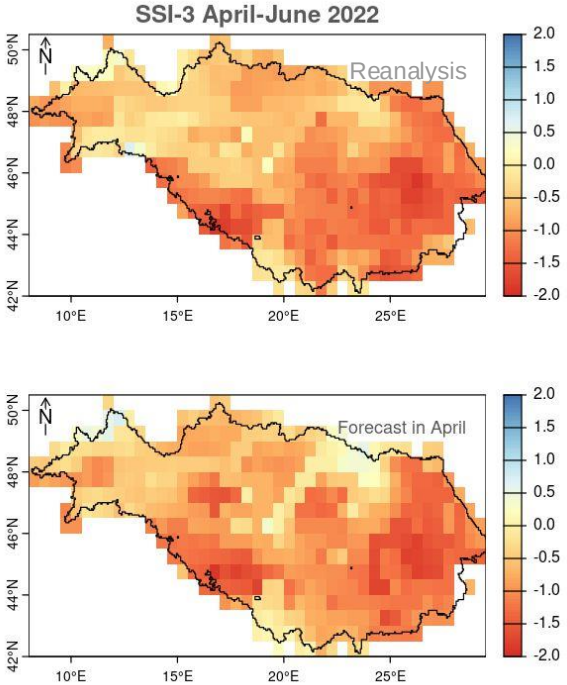
Example La Plata river basin

CEMS-HFMC 3rd gap : some types of real extreme events are not detected

Expansion of the CEMS forecast capability with hydrological drought information.

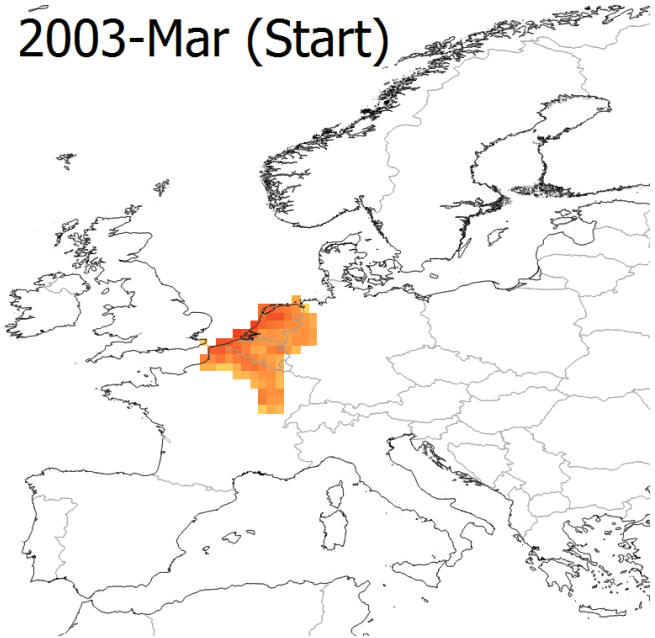
NEW SSI (Streamflow Standardize index) seasonal forecast.



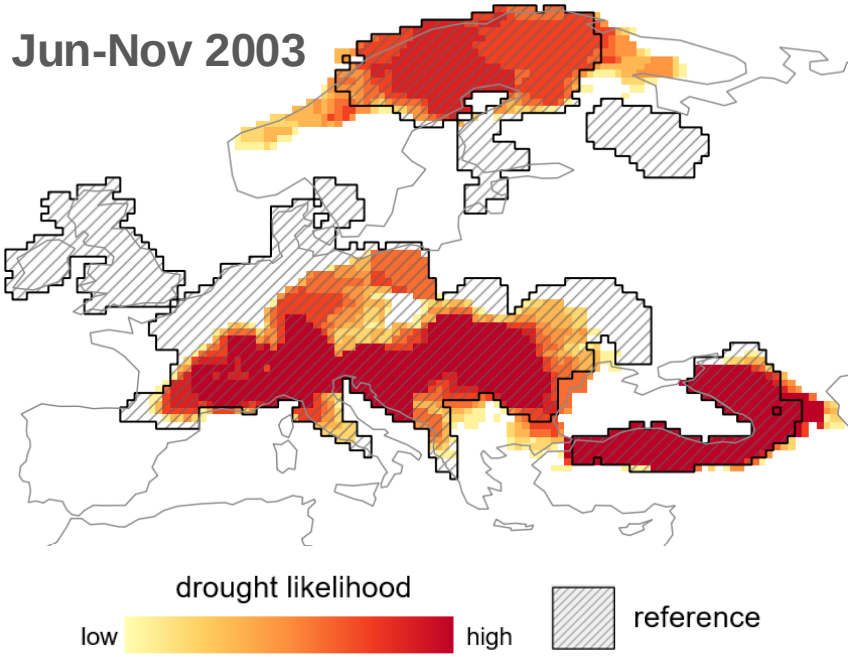


CEMS-HFMC 3rd gap : some types of real extreme events are not detected

NEW drought seasonal forecast tool based on 3D tracking of drought events.



Tracking of the 2003 European drought



Example of forecast 6-month ahead

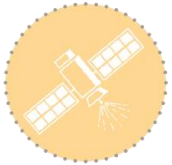
Specific Objectives (SO)

Global Objective: Enhance the quality and portfolio of the CEMS EWS for floods and droughts

Enhance the CEMS hydrological model for better representing the range of hydro-climatic processes worldwide

SO1

SO2



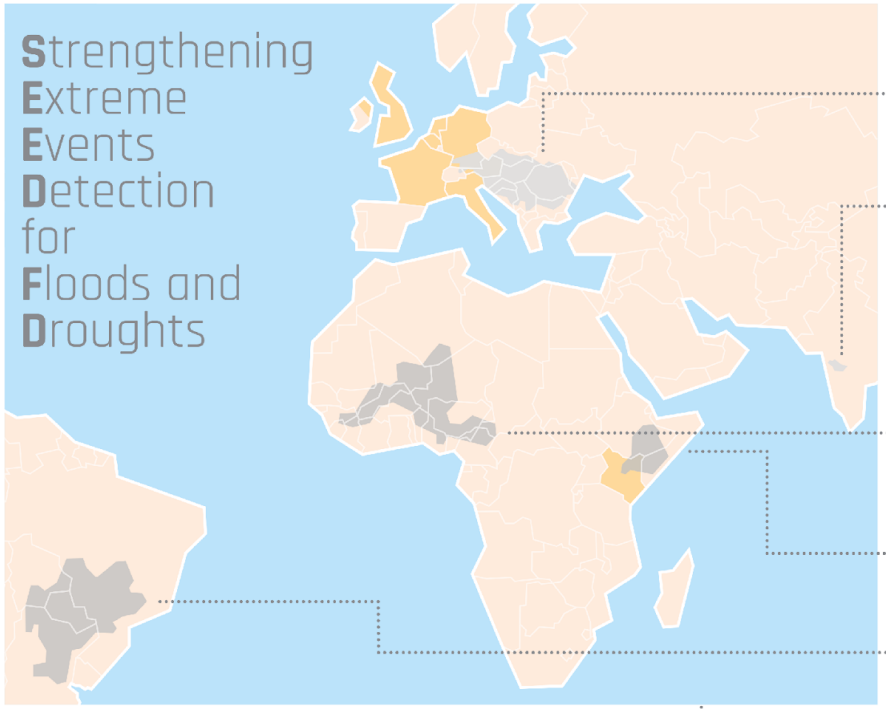
Demonstrate the added-value of using information from satellite data and innovative in-situ micro-sensors for higher quality CEMS hydrological simulations and forecasts globally

Expand the CEMS EWS forecast product portfolio for floods and droughts by developing/ prototyping new extreme hydrometeorological event detection algorithms applicable worldwide

SO3

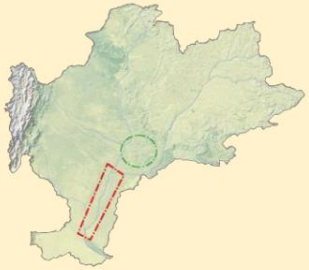
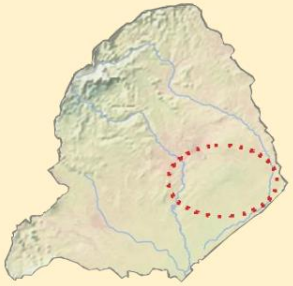
Study and validation basins

Strengthening
Extreme
Events
Detection
for
Floods and
Droughts



	FLOODS	DROUGHTS
DEVELOPMENT		
DANUBE Major transboundary heavily regulated basin - temperate climate	Flood caused by heavy rainfall, melting snow, or a combination of both	Intensification of droughts with climate change
BHIMA Heavily managed surface and groundwater system - tropical climate	Monsoon flooding, high inter- and intrannual variability	Multi-years droughts due to limited interannual storage
VALIDATION		
NIGER Data scarce semi-arid area with monsoon season and large wetlands	Multiple flash floods in urban areas each year	Consecutive failed rainy seasons and decades of increasing desertification of the Sahel
JUBA-SHEBELLE Data scarce semi-arid area, global hot spot for droughts	Occasional floods due to heavy rains in the headwaters	Currently facing worst drought in history
PARANÁ Tropical transnational basin, axis for waterway movement	High population density, vulnerable to flash floods	Multi-year droughts, lowest water levels in 80 years
WORLD Extreme hydrological events across the globe	Flash flood events that devastate populated areas and infrastructure	Long-term impact on population, food and energy security worldwide

Study and validation basins

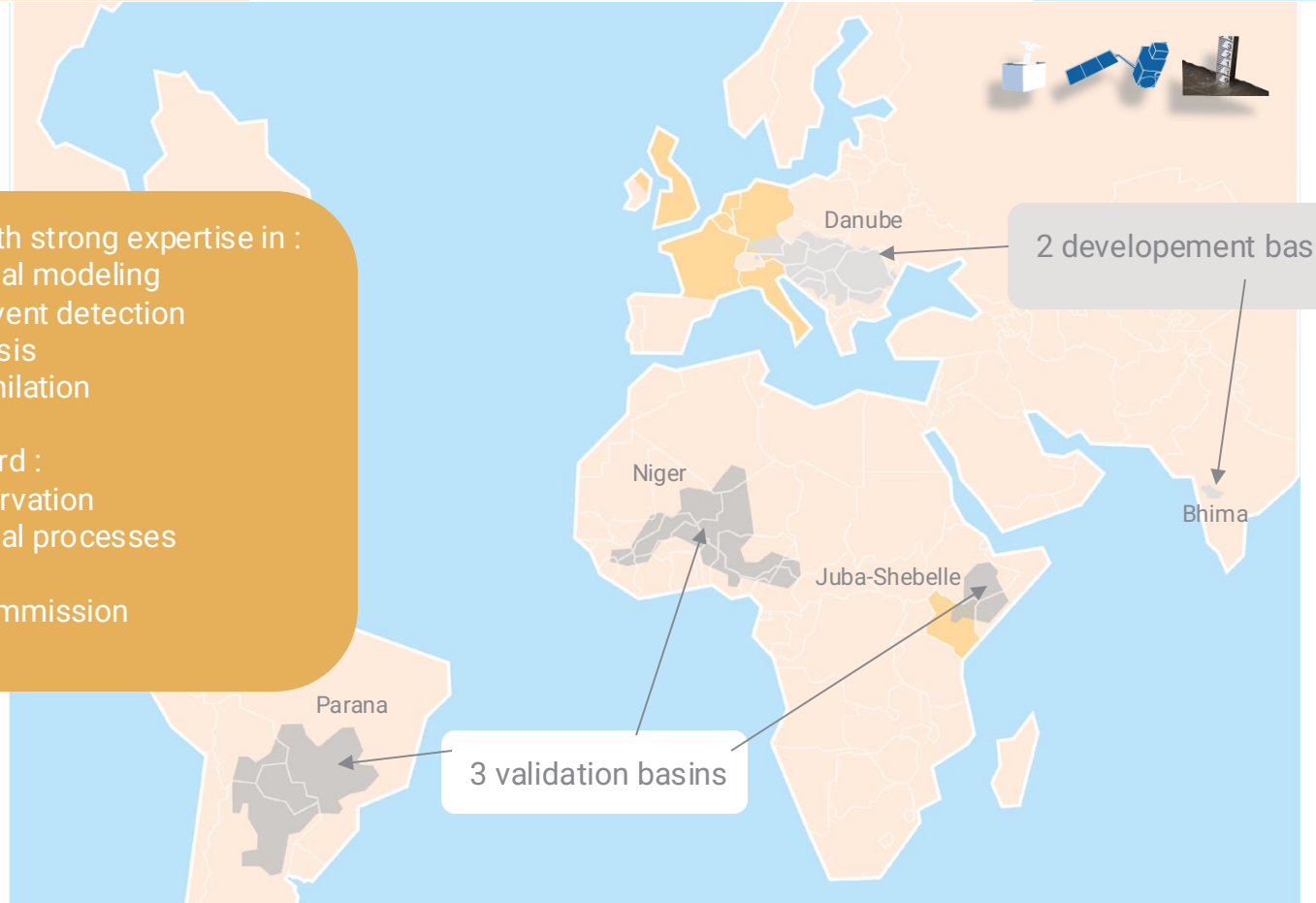
SEED-FD Use Case Summary			
	NIGER 	**PARANA** 	**JUBA-SHEBELLE** 
Lead	Magellium	Vortex	ICPAC
Area(s) of interest	Inner delta (red dot square) Niamey (red triangle)	Corriente province (red) Iguassu area (green)	Lower reaches of the Juba-Shebelle rivers in Somalia (red)
Notable events	Flooding in Niamey (07/2020, 06-08/2021,09/ 2022)	Multi-year drought (2019-present) Flooding in the Corriente province (2016) Flooding in the Iguassu area (2022)	Floods (05/2018, 05/2019, 10-11/2019) Multi-year drought (2019-present)
Specific application	Fluvial transportation	Flash flood prevention	Food production

The SEED-FD project on a map

9 partners with strong expertise in :
- Hydrological modeling
- Extreme event detection
- Data analysis
- Data assimilation

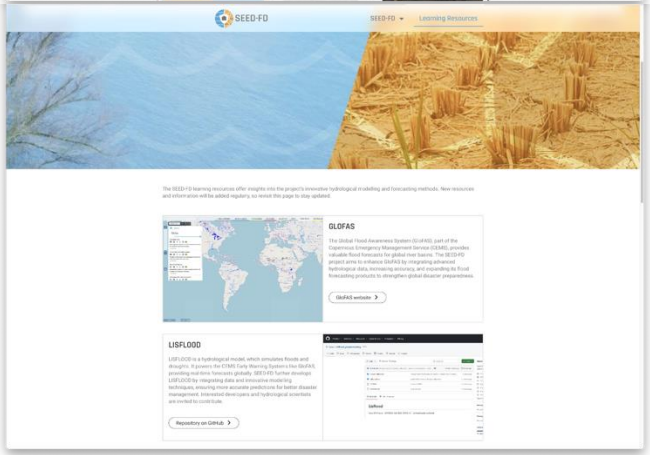
Advisory Board :
- Earth observation
- Hydrological processes

European Commission



Multiple sources of data (Eo and non-EO)

Project communication



SEED-FD
@seed_fd Follows you

SEED-FD is a #HorizonEurope project aiming to enhance global predictions of extreme hydrological events like #floods and #droughts

Science & Technology · seed-fd.eu · Joined July 2024

22 Following 33 Followers

Followed by ECMWF

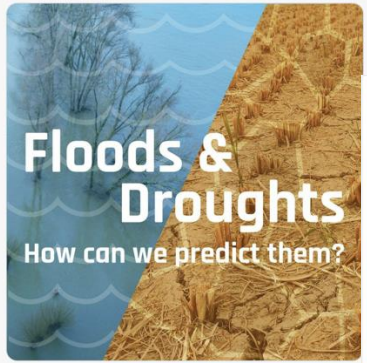
Posts Replies Media

SEED-FD @seed_fd · Sep 6

🌍 How can we ensure global protection from extreme weather?

SEED-FD supports the UN's mission by enhancing Europe's Copernicus EWS for floods & droughts with advanced satellite tech & hydrological models.

💡 Join us and learn more: seed-fd.eu #Hydrology #seed_fd



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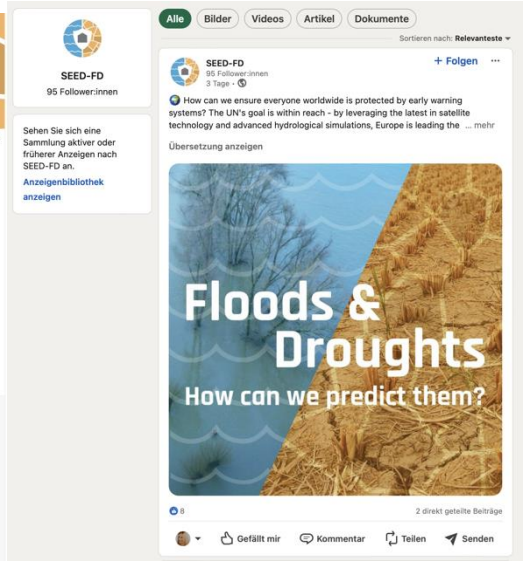

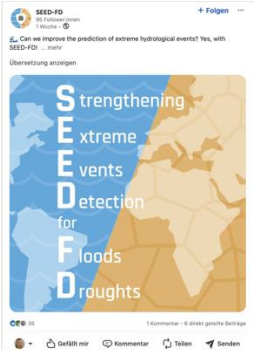

‘Everyone, everywhere in the world protected by an EWS’

Local authorities, water security and humanitarian agencies will benefit from real-time and quantitative global forecasts of floods, droughts and new extreme events.

Scientists will have access to new or improved tools for hydrological modeling, data assimilation, data processing and forecasting of floods and droughts.

Better synergy between Copernicus services - integrating Copernicus satellite data into the CEMS EWS and adding new and innovative in-situ observations.

Use real case studies to raise awareness of flood and drought prevention with a wider audience.

SEED-FD

Consortium:

- Magellium (France, prime)
- ECMWF (science leader)
- CNR-IRPI (Italy)
- ICPAC (Kenya,Intergovernmental Authority on Development (IGAD) Climate Prediction and Application Center
- IIASA (Austria, International Institute for Applied Systems Analysis)
- VORTEX.IO (France)
- POLIMI (Italy, POLITECNICO DI MILANO)
- DesignData (Germany)
- JRC (EU)