Improving Flood Forecasting at Large Scales Using Multi-Mission Earth Observation and Modelling: EO4FLOOD

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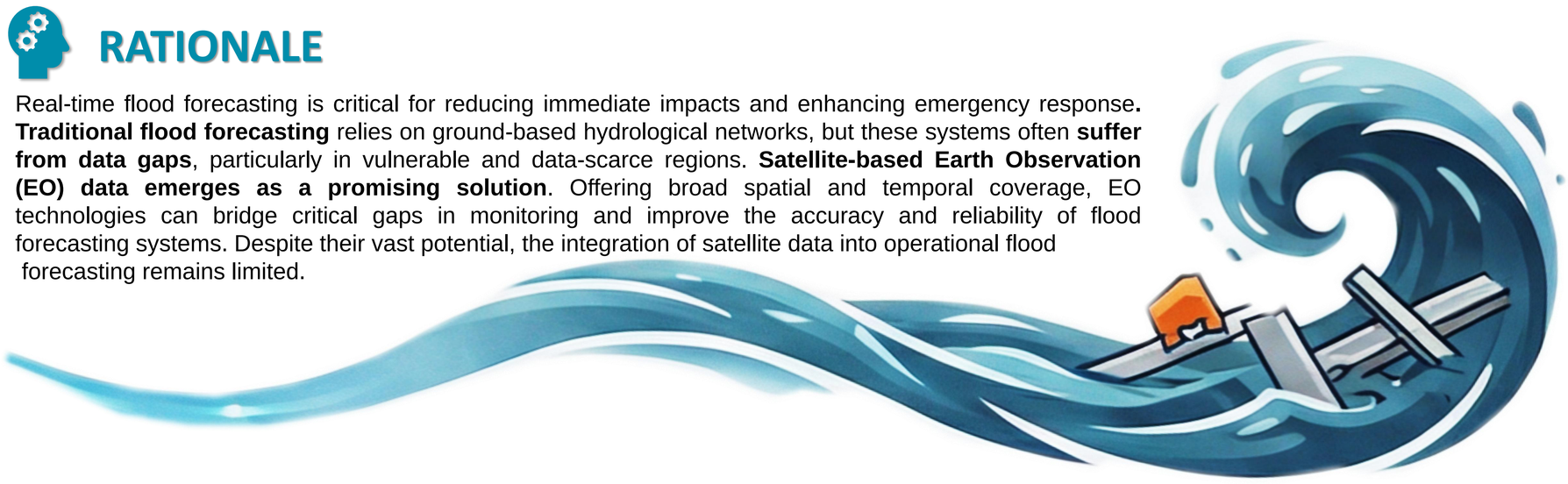
SCAN ME

CMWR 2026
June 28 – July 2
Bologna, Italy

RATIONALE

Real-time flood forecasting is critical for reducing immediate impacts and enhancing emergency response**. Traditional flood forecasting** relies on ground-based hydrological networks, but these systems often **suffer from data gaps**, particularly in vulnerable and data-scarce regions. **Satellite-based Earth Observation (EO) data emerges as a promising solution**. Offering broad spatial and temporal coverage, EO technologies can bridge critical gaps in monitoring and improve the accuracy and reliability of flood forecasting systems. Despite their vast potential, the integration of satellite data into operational flood forecasting remains limited.



IMPACT OF FLOODS

In the period 2000-2024, **floods caused the most internal displacements** (EM-DAT, https://public.emdat.be/data):

- 1.8 billion people
- 180 countries
- 135’000 deaths
- 973 billion US$ losses
- 338’000 injured

OBJECTIVE OF THE PROJECT

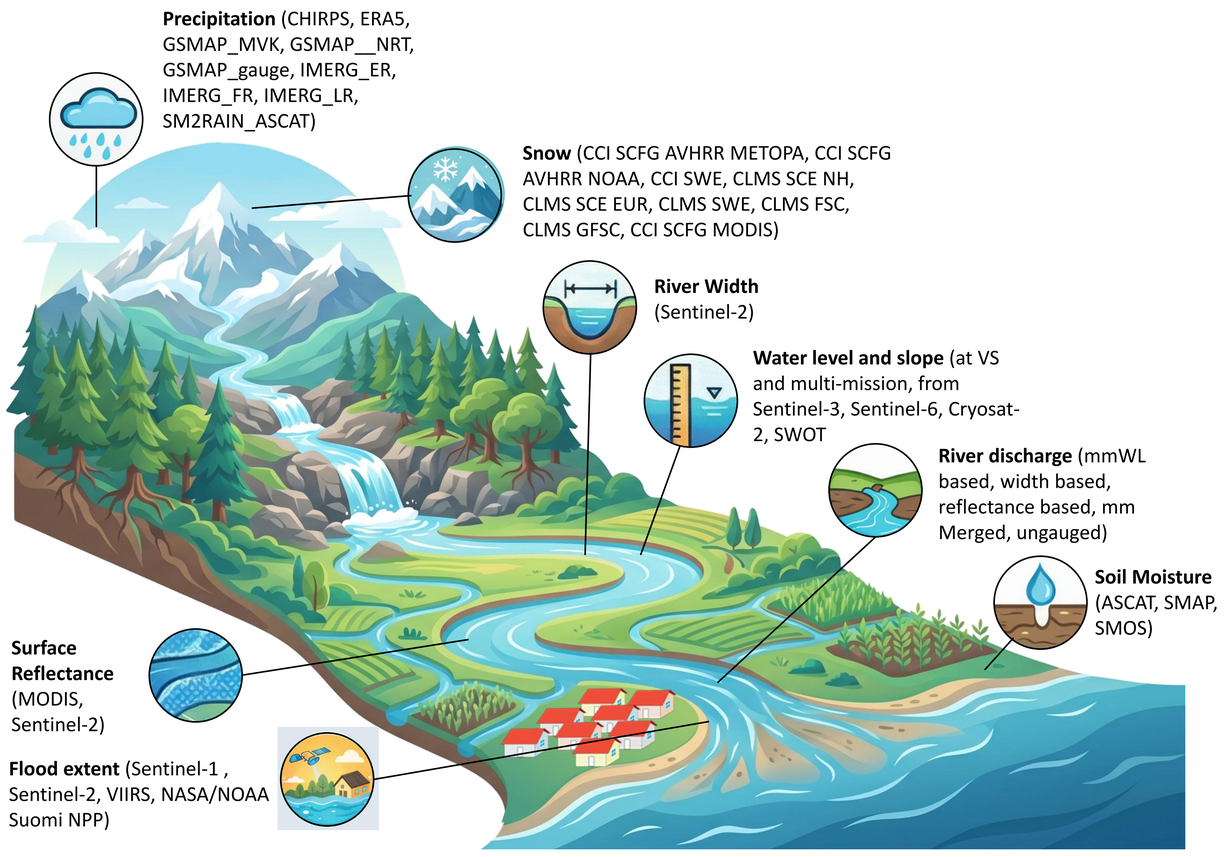
The project EO4FLOOD aims to develop a new generation of flood forecasting systems that synergistically integrate cutting-edge EO data, advanced hydrological models and AI tools.

PILLAR 1 - DEVELOPMENT OF AN ADVANCED EO DATASET

EO4FLOOD – EO dataset for Hydrology
The dataset is publicly available on ZENODO platform: https://zenodo.org/records/17787732

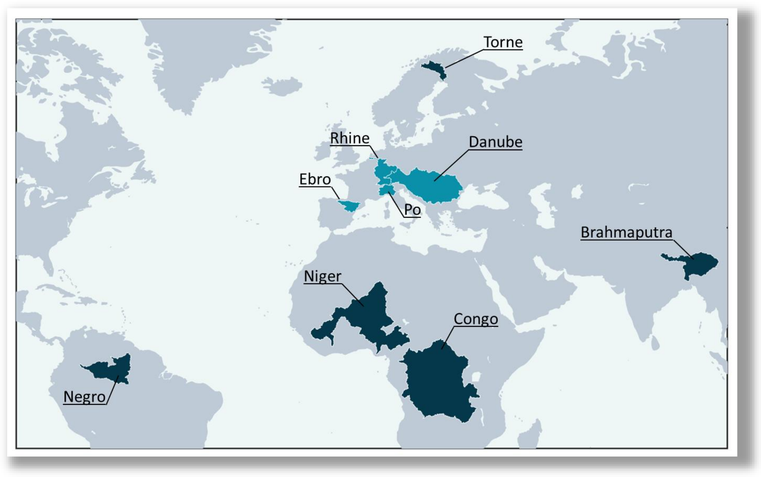
Tarpanelli et al. (2026) The Potential of EO Data for Enhanced Flood Monitoring and Forecasting: A Consortium Assessment *Surv Geophys* 47, 317–358. https://doi.org/10.1007/s10712-026-09935-w

The EO dataset integrates high-resolution satellite products from ESA and non-ESA missions, providing global coverage of critical variables such as precipitation, soil moisture, snow, flood extent, water level , river width, reflectance indices and river discharge.



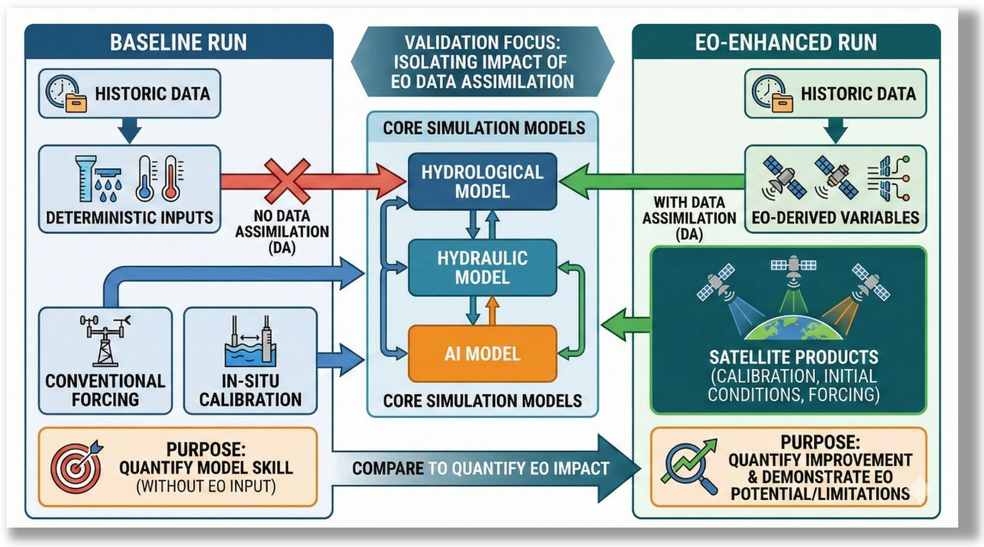
TESTING BASINS

The testing modelling framework will be implemented over selected areas within five specific basins (**Torne**, **Negro**, **Congo**, **Niger** and **Brahmaputra**) . The dataset of EO will be provided also in the bigger European basins like **Po**, **Danube**, **Rhine** and **Ebro**.



PILLAR 2 – INTEGRATION OF THE EO DATASET INTO FLOOD FORECASTING MODELS

The EOdataset is integrated into combinations of hydrological, hydraulic and hybrid AI models to predict floods up to 7 days in advance. This integration enables more accurate and timely predictions that can be crucial for effective disaster preparedness and response, also assessing predictive uncertainty.



Pillar 2 focuses on pursuing three objectives to demonstrate the effectiveness of using EO products to enhance the quality of flood forecasting:

Objective 1: The role of EO forcings for historical reference periods

Objective 2: The contribution of single or multiple EO-derived variables to calibration and/or validation of hydrological and hydraulic models

Objective 3: Impact of data assimilation on better constraining initial conditions of forecast models (biases, divergence, etc.) with operational EO forcings (and NRT experiments)

BASIN	MODELS		
	RAINFALL-RUNOFF	HYDRAULIC	HYBRID AI
Congo	MGB	DassFlow 1D/2D	
Negro	MGB DHI-GHM HYPE	DassFlow 1D/2D	
Niger	HYPE DHI-GHM MGB	HEC-RAS LISFLOOD-FP Mike+	
Brahmaputra	DHI-GHM	HEC-RAS	
Torne	HYPE	LISFLOOD-FP	DHI-AI

The objectives are reached through a series of experiments carried out from different models to different basins according the following Table.

PILLAR 3 – DEMONSTRATION FOR SCIENCE AND SOCIETY

The case studies will show how the integration of EO data and models can improve flood forecasting and risk management. The initiative is addressed to explore the impact of human activities contributing to better disaster preparedness and policy-making.

- IMPACT OF DAMS IN THE RIVER REGIME
- IMPACT OF LAND-USE CHANGES ON FLOOD OCCURRENCE.
- STUDY POPULATION TRENDS AND FLOOD DYNAMICS AND THEIR COMBINED IMPACT ON FLOOD EXPOSURE

ACKNOWLEDGEMENT
EO4FLOOD project is supported by the European Space Agency (Contract No. ESA AO/1-12101/24/I-EB). Please, visit the website **www.eo4flood.org** for more information or contact:

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