

Towards a Resilient Future: CENTAUR's Integrated Approach to Climate-Security and Early-Warning Systems

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1. Introduction

The impacts of climate change on human lives and security are continuously growing. Over the past 50 years, disasters have increased **fivefold**. Major floods alone have more than **doubled** in the last two decades (WMO, 2021). Between 2000 and 2019, there were **3,068** disasters in Asia, **1,756** in the Americas, and **1,192** in Africa (UNDRR, 2020).

2. Objectives

CENTAUR - Copernicus ENhanced Tools for Anticipative response to climate change in the emergency and security domain - is a Horizon Europe R&D project addressing today's societal challenges. It develops and demonstrates new service components for the **Copernicus Emergency Management Service (CEMS)** and **Support to EU External and Security Actions (SESA)**. The project focuses on two different application domains:



Flood-related threats to population, assets and infrastructures in **urban areas**.



Water and food insecurity as precursors of political instability, conflict and forced displacement.

Operational Benefits



Emergency Management

- Improve event prediction, impact detection, and damage estimation to support more effective response and recovery.
- Provide an early warning system with alerts triggered by threshold-based crisis indicators.



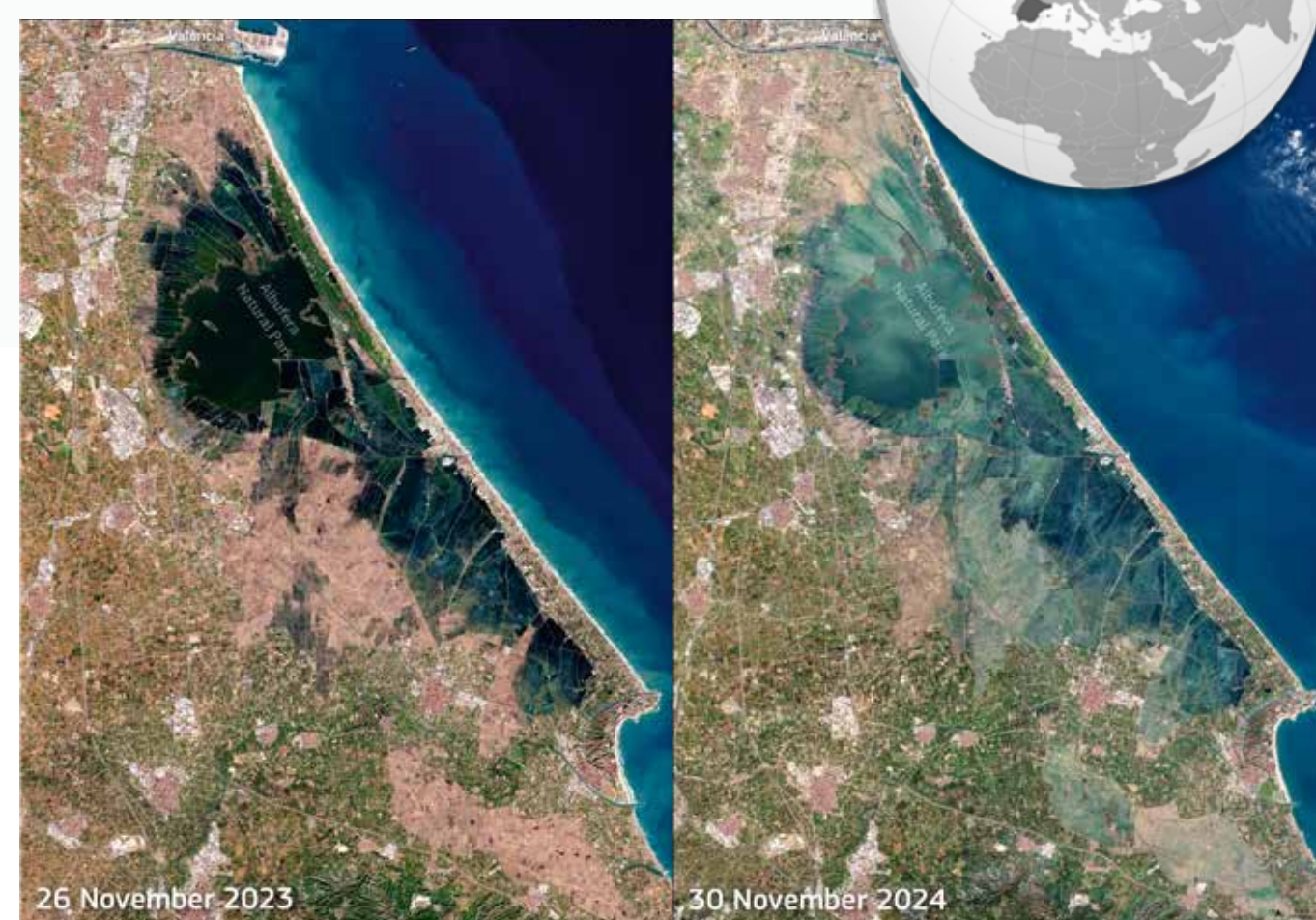
Security

- Enrich the CSS – SESA current portfolio by integrating new vulnerability and fragility indexes.
- Improve early warning services to monitor social unrest, population movements, and conflicts over food and water insecurity.

Urban Flood – Valencia Use Case

CONTEXT & BACKGROUND

- Severe flooding** occurred between 29 Oct – 3 Nov 2024
- Requested **CEMS activation (EMSR773)**
- Resulted in **200+ fatalities**
- Caused **extensive damage** to infrastructure and buildings
- Worst-hit areas:** southern Valencia, **Magro**, **Turia** river basins, and **Poyo** riverbed



WFS – Somalia Use Case

CONTEXT & BACKGROUND

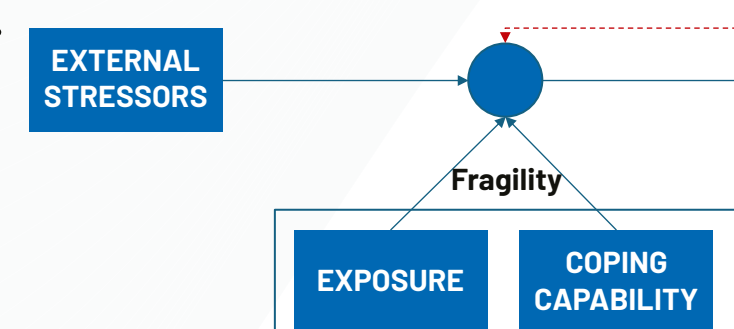
- Ranked **2nd most climate-affected country globally**
- Hit by **prolonged droughts** and **failed rainy seasons**
- Over **70% of the population in poverty**, reliant on **rainfed agriculture and pastoralism**
- Crisis worsened by **political instability, extremism, and civil unrest**
- High risk of **displacement, conflict, and food insecurity** from environmental shocks

INDICATORS

- WFS-ID-1:** Current precipitation deficits
- WFS-ID-2:** Future precipitation deficits
- WFS-ID-3:** Probabilities of drought aggravation and recovery
- WFS-ID-4:** Current drought impact on vegetation productivity
- WFS-ID-5:** Future drought impact on vegetation productivity
- WFS-ID-6:** Agricultural drought risk zone map
- WFS-ID-7:** IDPs camps status indicator
- WFS-ID-8:** Populations at risk of food insecurity
- WFS-ID-9:** Populations at risk of water insecurity
- WFS-ID-10:** Number of people living in conflict-affected areas

INDEXES

DCPI & DDPI: The **Drought Conflict Prediction Index (DCPI)** and **Drought Displacement Prediction Index (DDPI)** forecast, respectively, the number of **conflicts** and **displaced people** expected in each region of a country for the upcoming month.



The model has a **retroaction**, as the **number of conflicts** is influenced by the **current conflict**.

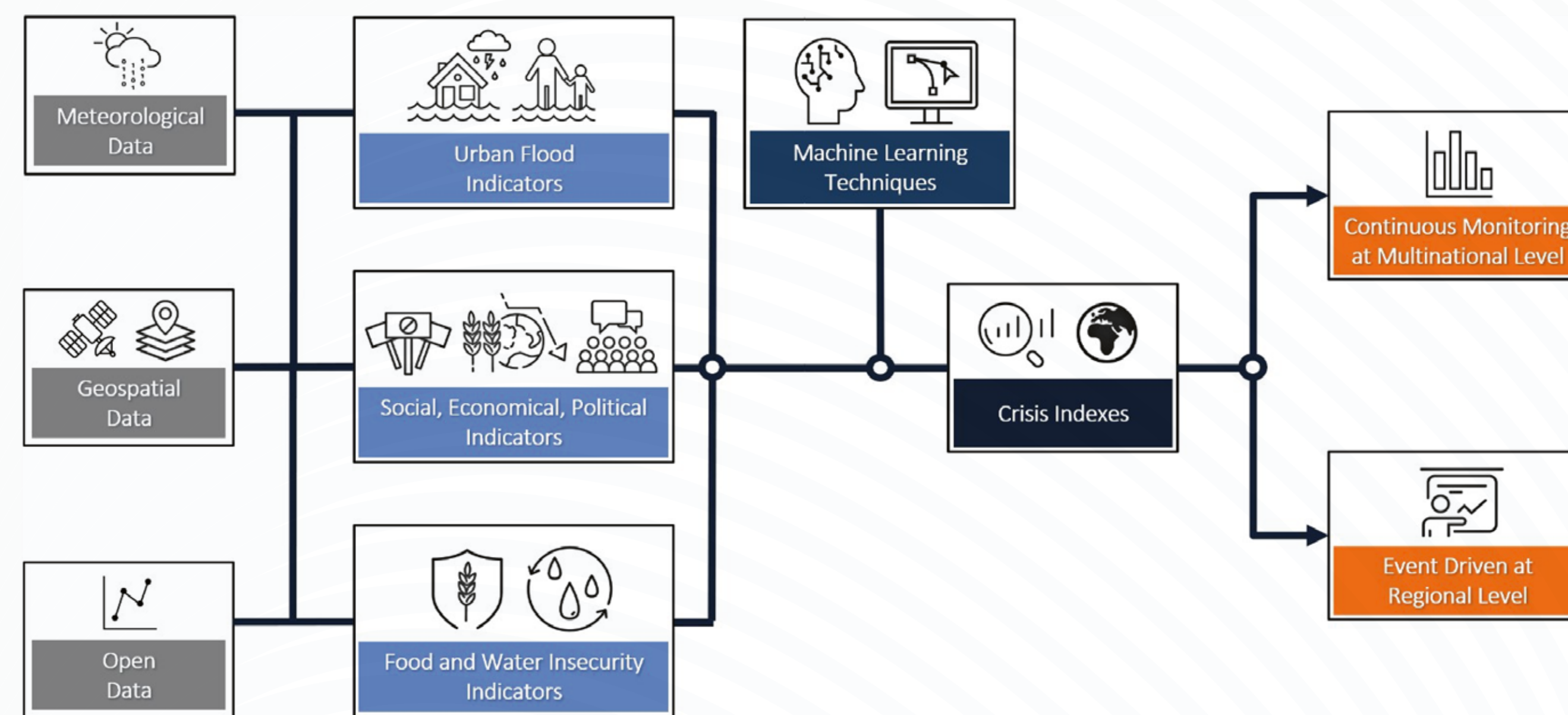
3. Methodology

CENTAUR applies a structured, multi-layered methodology to improve crisis understanding and response:

- Data** – Multidimensional datasets as the base layer.
- Indicators** – Thematic information derived from time series and model-based combinations.
- Crisis Indexes** – Advanced integration of flood, food, and water security data with socio-economic and political indicators.

These layers power a **dual-mode system** which enables both:

- Continuous monitoring** at regional and local levels, and
- Early warning** when key risk indicators and crisis indexes exceed defined thresholds.



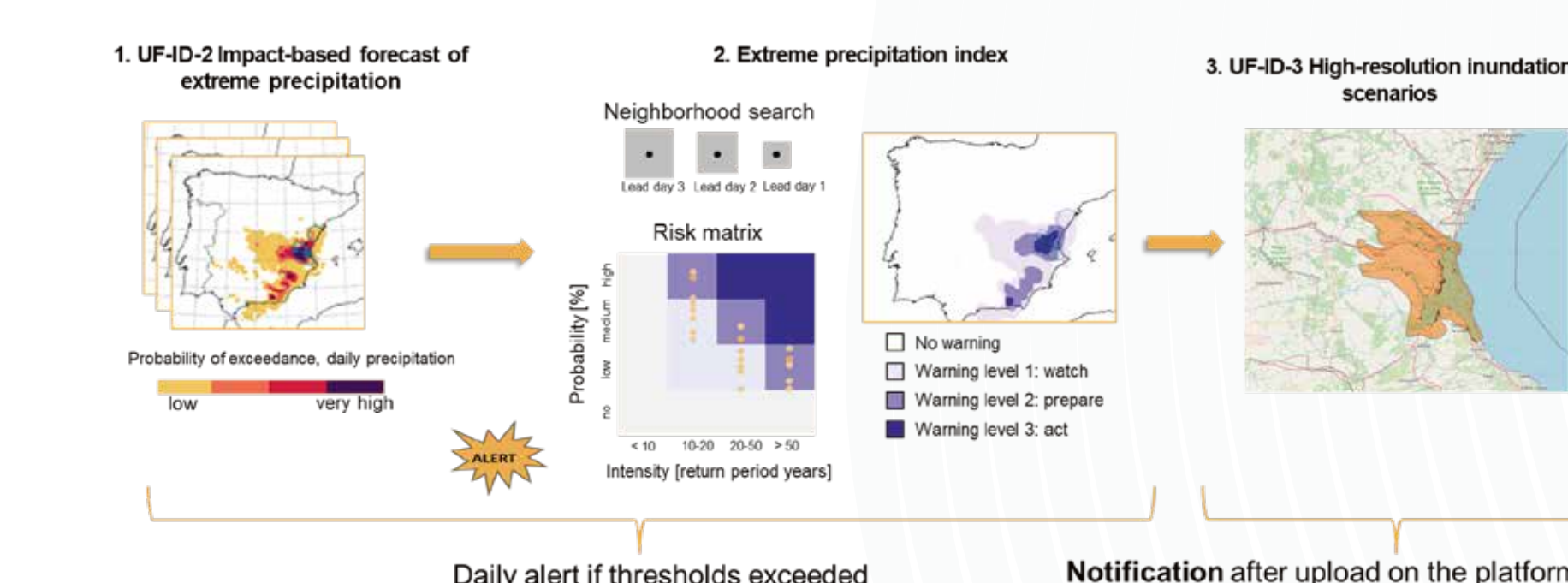
INDICATORS

- UF-ID-1:** Static map of precipitation associated to return period
- UF-ID-2:** Forecast of return period
- UF-ID-3:** High-resolution urban flood risk maps for various return periods
- UF-ID-4:** Inferred InSAR urban flood extent
- UF-ID-5:** Enhanced urban flood damage assessment
- UF-ID-6:** Social/Traditional media indicators for Urban Flooding Map
- UF-ID-7:** Flood Hazard indicator
- UF-ID-9:** Assets and financial resources
- UF-ID-10:** Public services and government support
- UF-ID-13:** Ability to evacuate
- UF-ID-14:** Economic impact of floods

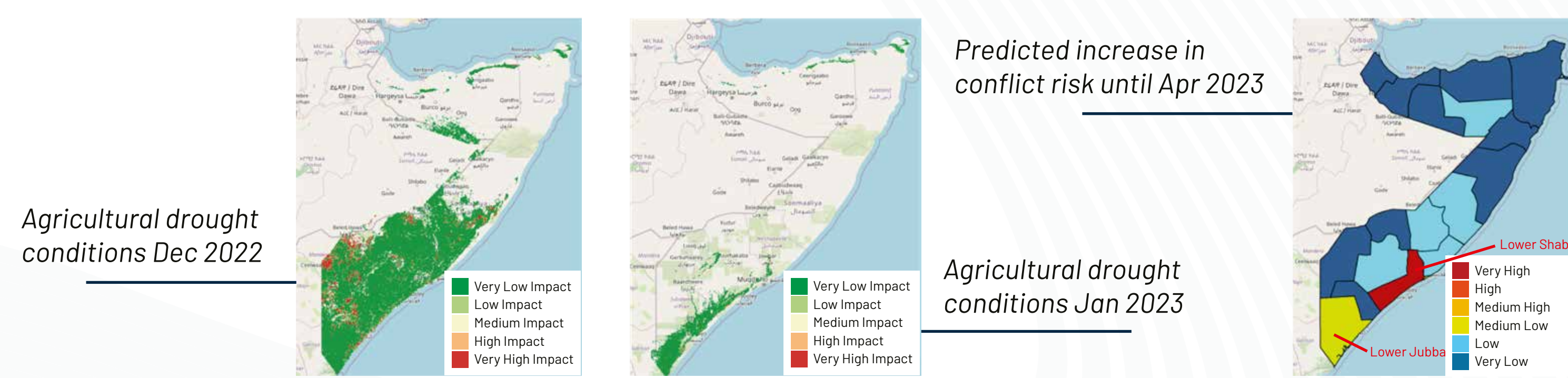
INDEXES

- UF-IX-01:** Flood Early Warning Index
- UF-IX-02:** Flood Impact Index
- UF-IX-03:** Medium High Vulnerability Zones

Flood Early Warning Index predicts an extreme precipitation event and the most probable impacted urban areas with 3-day lead time (**UF-ID-2**). The alert is triggered based on the probability of extreme precipitation around the area of interest, as determined by the risk matrix. Each alert level corresponds to a flood map (**UF-ID-3**), which shows the potential impact of the event.



Warning: March 2023: Drought conditions over past months associated with increased risk of conflict escalation in Lower Shabelle and Lower Jubba region of Somalia (CENTAUR Risk Monitor)



Early Warning and Risk Mapping

CENTAUR's Early Warning System (EWS) automatically generates alerts and identifies regions at risks of increased food insecurity, violent conflict, and or displacement. The functionalities are illustrated above for a warning that the system would have issued in March 2023. The maps show that some regions in Somalia – such as Lower Shabelle and Lower Jubba – are at heightened risk of violent conflict in the coming month, linked to ongoing drought in the previous months.

Understanding Severity and Context

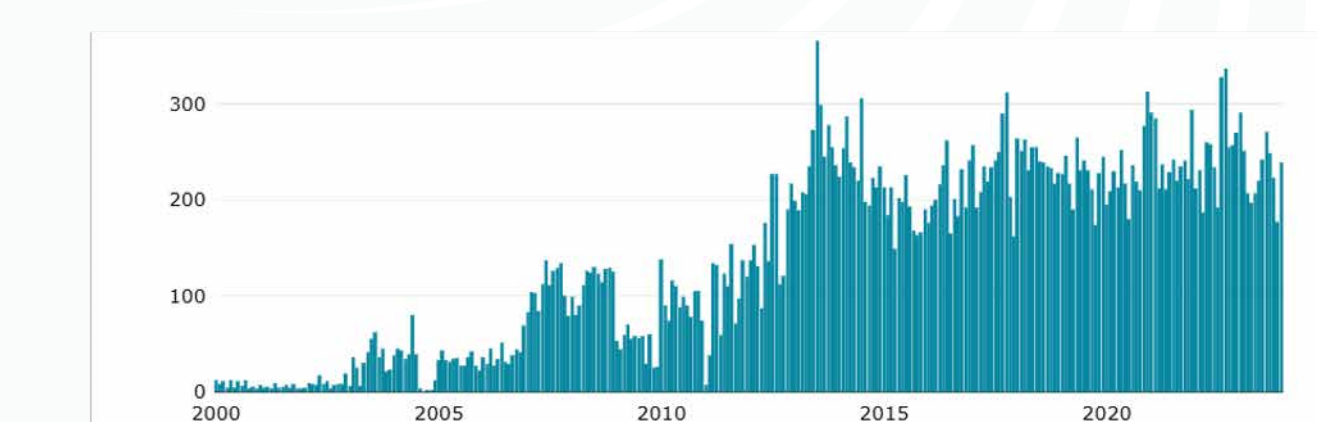
Dynamic risk maps show where drought is most intense – and where it's likely to escalate into crises. A customisable dashboard compares projected and historical risks, enabling targeted, timely interventions.

Investigating Underlying Drivers

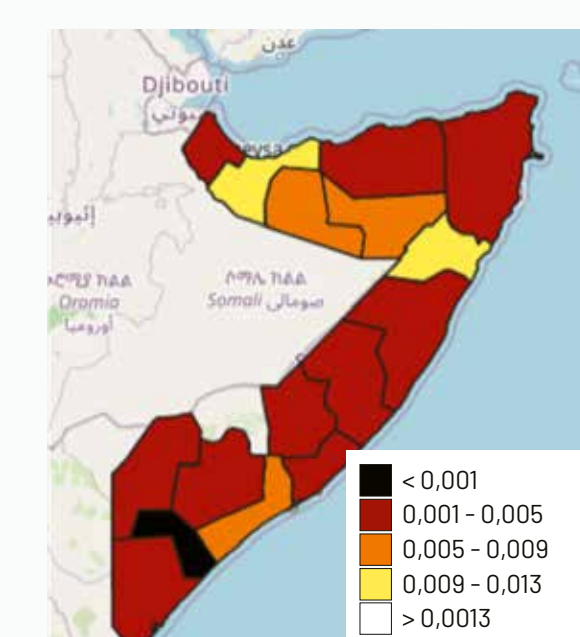
By layering data (e.g., road access), CENTAUR reveals why some drought-hit areas face more conflict risk than others – supporting smarter, context-aware response.

Enabling Informed, Timely Action

CENTAUR's suite of tools provides actionable insights to guide preparedness and early response activities.



Paved road access



4. Use Cases

CENTAUR explores **8 use cases** across two domains – **Urban Floods and Water & Food Security** – to test and validate its conceptual model and indicators.

- Cold cases:** Past, well-documented crisis events.
- Hot cases:** Ongoing or future events during the project lifecycle.

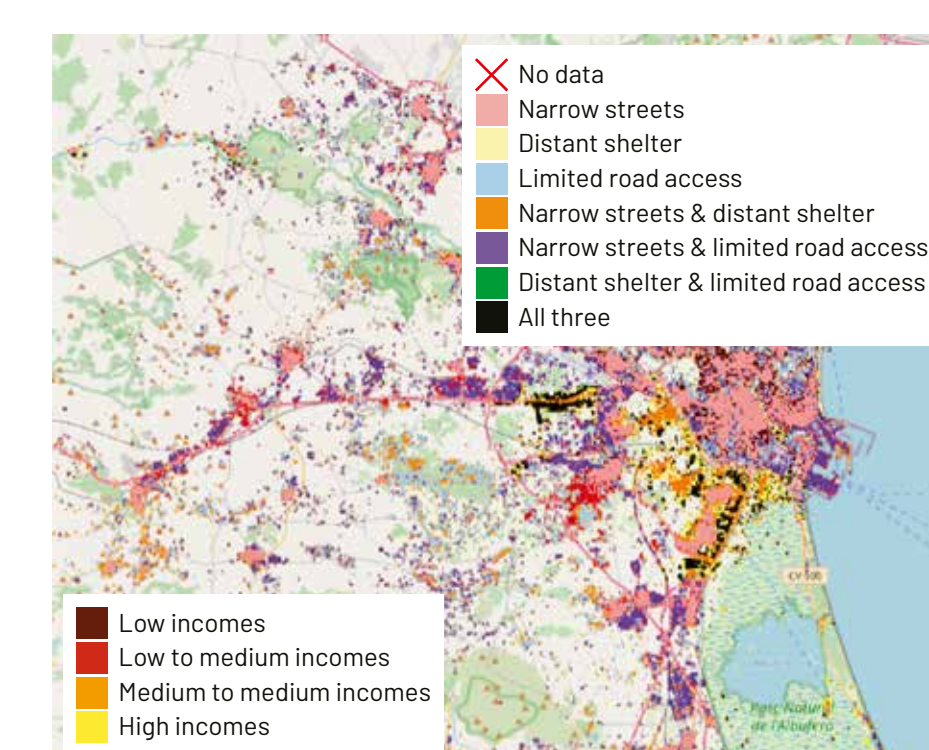


A **validation phase** follows both, focusing on:

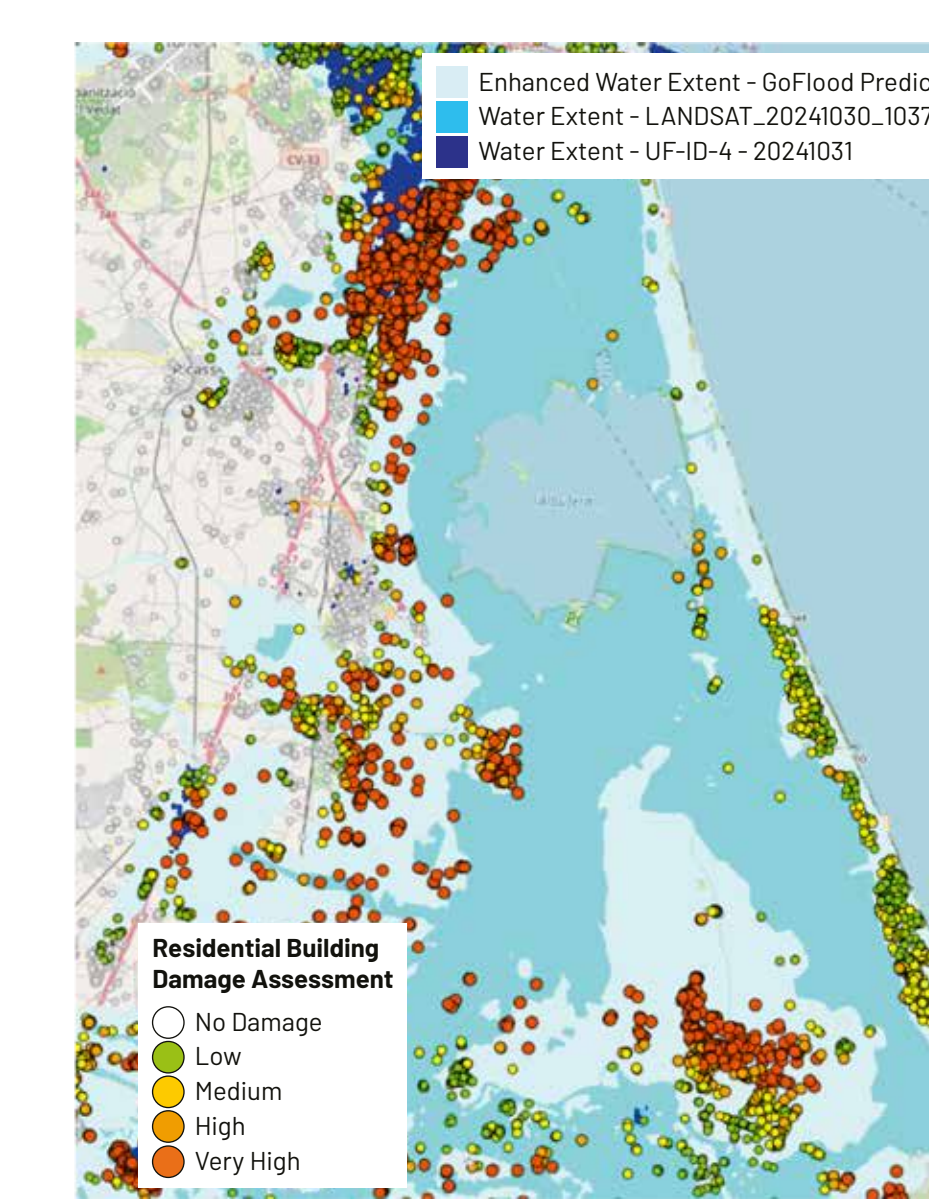
- Technical performance** of the proposed solutions.
- Feedback from Authorised Users and Copernicus Entrusted Entities**, gathered through workshops and questionnaires, to ensure alignment with operational needs.

UF-ID-9,10,13 are the socioeconomic vulnerability indicators which assess the population's capacity to cope with urban flooding, based on:

- Average income of the local population
- Proximity to the nearest fire station, hospital, or police station
- Road accessibility within the affected area

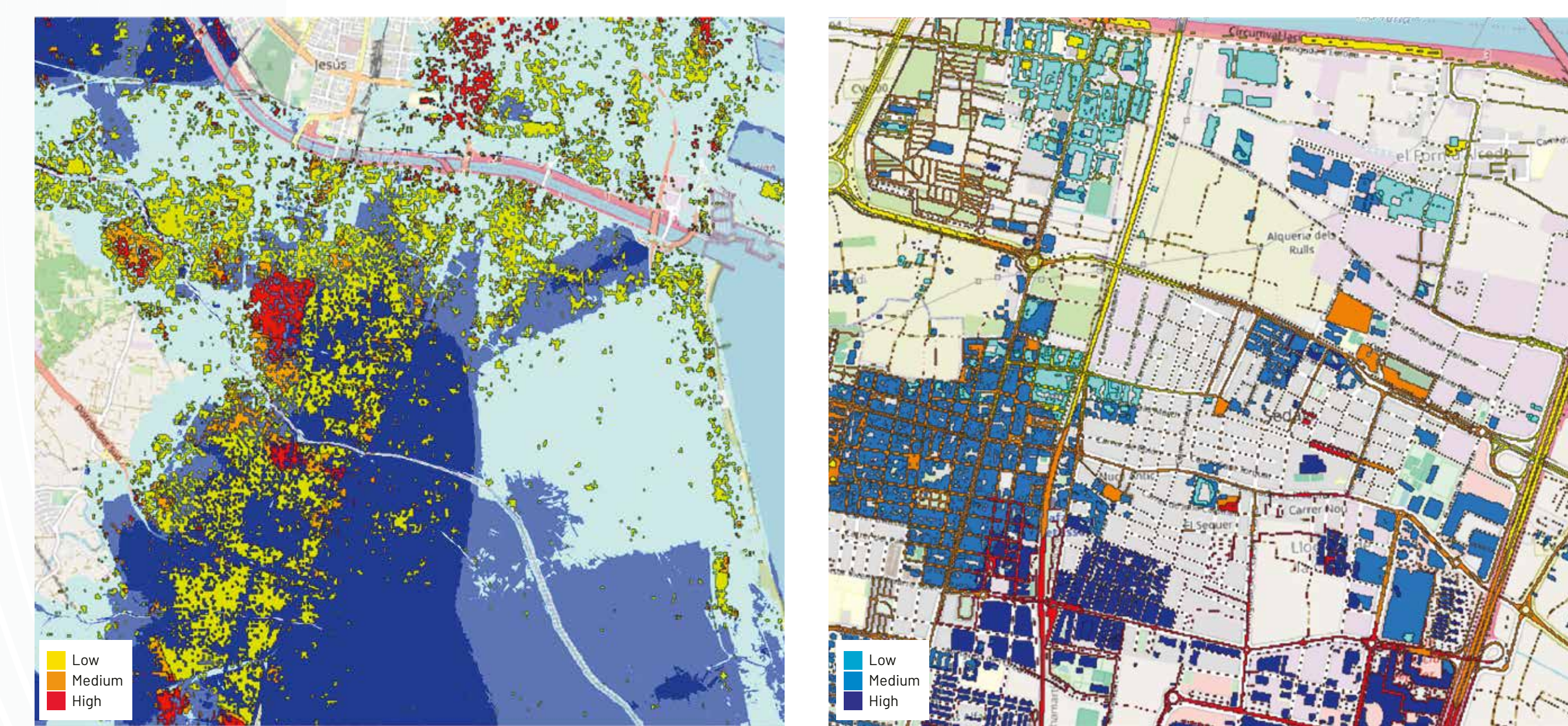


UF-ID-5 is an urban flood indicator that combines outputs from the GFA, INFLOS, and FLORIA models to produce detailed flood maps for the occurred event. Water depth is color-coded, and damage to roads and buildings is assessed based on local flood depth, providing a clear indicator of urban flood impact.



The **Flood Impact Index (FI)** raster layer estimates the potential impact of a specific flood event within the Area of Interest distinguishing between different types of impact. It consists of 3 components:

- General-FI** provides a detailed evaluation of physical flood impacts using corrected flood depth measurements.
- Human-FI** integrates socio-economic and demographic factors to highlight community vulnerabilities.
- Asset-FI** assesses the risk to critical infrastructure and assets.



5. Consortium



6. Acknowledgements



To stay in touch!

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7. References

- World Meteorological Organization (2021). WMO atlas of mortality and economic losses from weather, climate and water extremes (1970–2019).
- UNDRR report: The human cost of disasters: an overview of the last 20 years (2000–2019).
- Schaik, L., Bakker, T. (2017). Climate-migration-security: Policy Brief Making the most of a contested relationship. Planetary Security.
- Image 1.** Flood in Salarolo 2023 (Ravenna, Italy) author unknown, retrieved through Emilia Romagna Meteo.
- Image 2.** retrieved through Unsplash
- Image 3.** <https://unsplash.com/it/foto/brown-wooden-boat-on-brown-sand-during-daytime-8wuQldN7A4>
- Image 4.** European Union, Copernicus Sentinel-2 imagery of 26 November 2023 and 30 November 2024
- Image 4.** NASA Earth Observatory. (2011, March 21). Drought in Somalia. <https://earthobservatory.nasa.gov/images/47944/drought-in-somalia>

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