DERISC

Deep learning based Extreme Rainfall and flood warnIngs through Seamless foreCasting

DURATION
1/09/2022 – 1/12/2026

BUDGET
741 404 €

PROJECT DESCRIPTION

Context

The extreme precipitation event of July 2021 and the ensuing floods caused 41 deaths and over 2 billion euro in damages in Belgium alone. An **impact-based early warning system** can improve preparedness and reduce the societal and economic impacts of such extreme precipitation events, as it allows local authorities, emergency services and industry to make better-informed, timely decisions.

Early warning systems require forecasts for weeks ahead, as provided by global numerical weather prediction (NWP) models. However, such models generally fail to capture precipitation extremes, in part due to their limited spatial resolution. Km-scale NWP models, integrated in seamless observation-driven short-term prediction systems such as RMIB's Project IMA, better represent these extremes, making them more suitable for high-resolution (urban) flood models. However, their time horizon is limited to 1-2 days, making them unsuitable for early warnings and proper management of extreme events.

This project aims to meet the need for a consistent and calibrated ensemble forecasting system by seamlessly combining models at different time horizons, and to integrate them in impact models.

Objectives

1. The realization of a real-time **deep learning** (**DL) based** multimodal quantitative precipitation estimate (**QPE**)
2. The creation of a **seamless precipitation forecast** product that is:
   - frequently updated, to ingest the most recent **observations**;
   - probabilistic and **ensemble**-based,
   - **sharp** and **calibrated**
   - based on **state-of-the-art** ensemble prediction systems: pySTEPS nowcasting, ACCORD's limited area NWP, and ECMWF's medium-range ensemble forecasts.
3. Integration of these forecasts in **hydrological models** to enable **impact-based** early warnings for extreme precipitation events.

Methodology

This project leverages the deep learning (DL) approach, highly effective for data fusion of multimodal observations, by extending it to the fusion or blending of three types of forecasts in a residual learning paradigm:

- Nowcasts based on multimodal observations,
- Short-range (0-3 days) NWP
- Medium-range (0-2 weeks) global NWP forecasts

We will integrate nowcasts for the first time driven by a multimodal DL-based QPE in our seamless prediction system.

Downscaling, calibration and blending will be considered in a single framework, and different DL architectures such as Unets and GANs will be compared.

The coupling to hydrological models will be implemented relatively early in the project, to ensure that impact models can optimally use the ensemble forecasts at their full resolution and time range, and to enable impact-based validation.

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Impact on science and society

By increasing the forecast reliability and sharpness at longer forecast lead times, we ensure that mitigating actions can be made in a more timely and effective manner at all decision levels, thereby reducing the impact of these extreme events. The improved precipitation forecasts can also promote the sustainable exploitation of resources by enabling more efficient water management such as smart water buffering. While the focus of the project is on extreme precipitation events, the methodology developed will be transferable to other weather variables.

Embedded in the research groups of the two FED-tWIN researchers for "DEEP" and "EXPRIMA", the project bridges the two objectives, culminating in an end-to-end system: from multimodal observations, through AI and physical multi-modelling, to accurate impact-based warnings. It will support and strengthen scientific collaborations between RMI, KU Leuven and VUB.

Research results and valorization perspectives

The project will lead to several **peer-reviewed publications** in open-access journals. We will also present our research findings at international **conferences** and during a **final workshop**. These findings will also be presented in a more accessible way during **science shows, podcasts or other outreach events** for the general public.

By improving the RMI's seamless prediction system, this project is expected to have a substantial societal and economic impact. More accurate **operational weather forecasts and warnings** delivered by the RMI will directly benefit all its users including the general public through media, the RMI App and website, as well as economic actors such as agriculture, transport and the renewable energy sector.

We will share a **minimum viable seamless forecast product** for hydrological models early in the project. For other test users, we will provide an **interactive dashboard.** After thorough validation, these forecasts will be made available through the **RMI's open data portal**, in accordance with the EU's Open Data Directive.

Providing accurate precipitation forecasts from long to short lead times allows stakeholders to issue early warnings, reduce impact by managing flood control reservoirs by controllable weirs and other hydraulic infrastructure, and warn local authorities in case of a flash flood. This will help *prevent deaths, injuries or damages due to extreme precipitation events.*

In order to maximize the impact of this project, stakeholders are involved early in **workshops** and **surveys** through which they identify their needs and contribute to the design of the forecasting system.

CONTACT INFORMATION

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LINKS

http://derisc.meteo.be