

INLINE – Integrated pan-European rainfall and floods impact forecasts for cooperation in emergency management

Integration of Developments from WP3 into the CEMS-Floods European Flood Awareness System (EFAS)

Milestone 12

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1 Introduction and scope

An objective of the INLINE project is to integrate a selection of the project's products and functionalities, developed in work package 3, into the CEMS-Floods European Flood Awareness System (EFAS). Integration into EFAS ensures the long-term legacy of INLINE, either by directly incorporating developments into the real-time forecast system, or by demonstrating their feasibility to inform future CEMS-Floods activities.

Three INLINE developments will be integrated: 1) an updated version of the river flash flood impact products, 2) a user configurable flash flood notification service, 3) a neural network method for rainfall nowcasting. The first development will be integrated into the real-time EFAS forecast system because it forms an update to forecast products which are already produced in real-time. The second and third developments will be demonstrated within the EFAS web infrastructure and ECMWF's high performance computing facility respectively, to demonstrate the feasibility of producing them.

All these developments will be worked on simultaneously and will be delivered by November 2026. The update to the river flash flood impact products will be scheduled for release into EFAS. We are currently aiming to release the products as part of the version 6.1 release, which is scheduled for the end of November 2026, however this could change if there are delays to the major release of version 6.0.

2 Updated River Flash Flood Impact Products

Currently, EFAS has 5 real time radar-based river flash flood impact forecast products available to users in its web interface:

- River flash flood impact.
- River flash flood impact 0-5h catchment summary.
- River flash flood impact 6-24h catchment summary.
- River flash flood impact 25-48h catchment summary.
- River flash flood impact 49-120h catchment summary.

These products were developed during the TAMIR and EDERA projects, and they are created in three main steps: 1) creating a rainfall forecast by blending probabilistic radar rainfall nowcasts with ECMWF NWP ensemble forecasts, 2) calculating the flash flood hazard by accumulating the rainfall on a gridded river network and comparing against climatological thresholds, 3) calculating the river flash flood impact by intersecting the flash flood hazard with exposure information about population and critical infrastructure. More information about the workflow to create these products is given on the [CEMS-Floods wiki](#).

However, the layers in their current configuration on the EFAS web interface have limitations, which EFAS partners have said prevents them from using them effectively:

- 5 different layers is very confusing to navigate – it would be much simpler to have one layer.

- The layers are only available for the past 5-days – meaning it is not possible to analyse past events.
- The layers are very slow to display on the EFAS web interface.

INLINE will address these limitations through the following developments:

- Merging the 5 layers into a single layer.
- Delivering the products in GDAL compliant vector format, such as ESRI Shapefile or GeoJSON, which allows the products:
 - To be displayed for any past date for which the products are available.
 - To display faster on the EFAS web interface.

The revised merged product will have the following features which can be navigated through a single time slider (Figure 1):

- 0-5 hours lead time>
 - The user will be able to animate 1-hour timesteps.
 - When the user zooms out in the EFAS web interface, they will only see catchments. These catchments will allow a user to quickly identify at risk areas.
 - When the user zooms further in, river vector segments will appear, shaded according to their impact matrix classification. These segments can be used to identify specific at-risk locations. Segments upstream and downstream of the shaded segments will be displayed in grey, to give the user a better overview of the river network in the affected area. The catchments will remain displayed, but their transparency will be increased.
 - The user can click either the catchment or the river vector and a pop out window will appear, giving more information about the location, impact matrix and forecasted impacts.
- Lead times 6-120 hours
 - The user will be able to view catchments which summarise the flash flood risk over three lead time range: 6-24 h, 25-48 h and 49-120 h.
 - The shaded river vector product will not be available for these ranges because the spatial uncertainty at these longer lead times is too great to confidently highlight specific at-risk river segments.

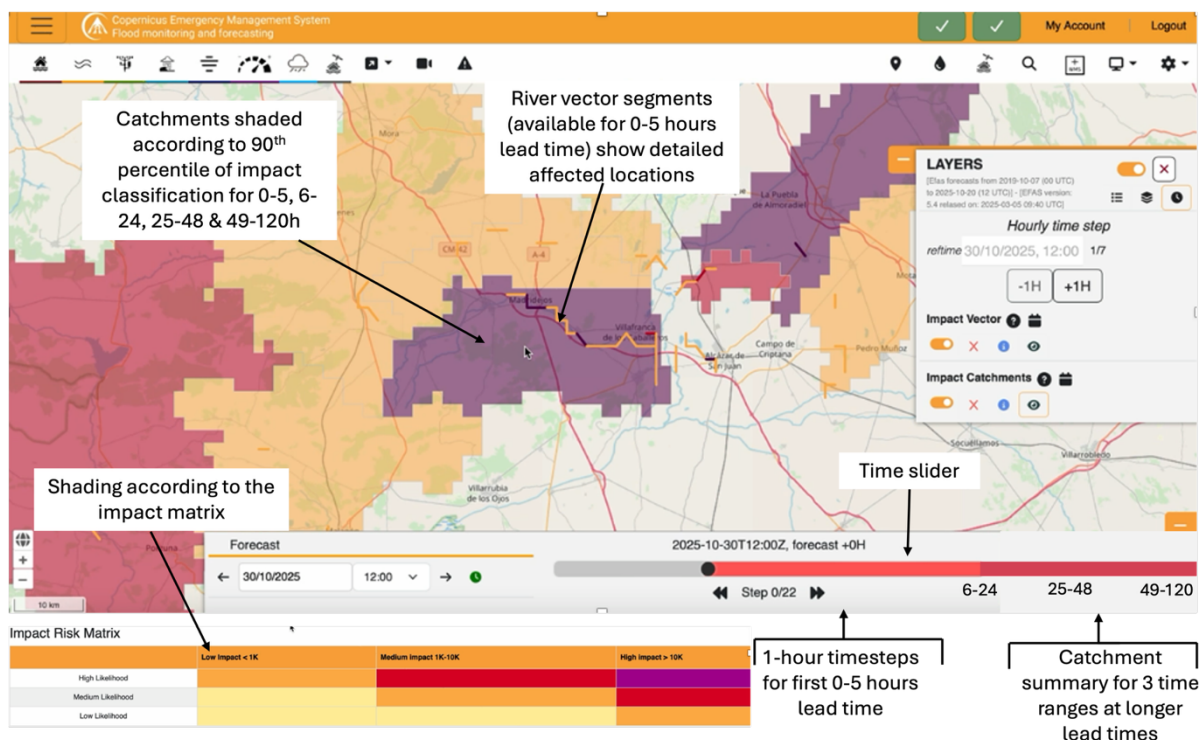


Figure 1 Mock up of the merged river flash flood impact product which will be developed for integration into EFAS.

3 User Configurable Notifications

Based on UPC and ECMWF efforts to develop user-configurable notifications done in work package 3, ECMWF have implemented a user configurable notification service, allowing users to specify their desired criteria for receiving flash flood notifications. At present, the user defined notification service allows users to specify the following:

- Which forecast products they are interested in
- Lead time
- Impact level
- Area of interest

Rule Name

Something to identify by...

Layer

☒ River Flash Flood Impact
☐ Urban Flash Flood Hazard

Leadtime

☐ 0-6H
☐ 7-24H
☐ 7-48H
☐ 25-48H
☐ 49-120H

Minimum impact level - selected **High**

Low

Medium

High

Extreme

Optional thresholds [Click to toggle](#)

Region of interest

Upload a region of interest file

Freehand

NUTS Level 0

NUTS Level 1

NUTS Level 2

NUTS Level 3

Clear



Figure 2 User configurable flash flood notification form available within the EFAS web platform.

This notification service has been developed within the EFAS web infrastructure (Figure 2). Work is underway to extend the notification service to allow users to upload their own exposure data and specify the exposure thresholds used in the calculation of the impact level (Figure 3). An option will be added to the form (Figure 2) allowing a user to upload the exposure dataset, such as local population, the data will be stored in database. The user will also be asked to specify the thresholds used to define the low, medium and high exposure categories on the x-axis of the impact matrix (Figure 3). The uploaded exposure data and the user-defined thresholds will then be passed to the software used to calculate the river flash flood impact. The software will re-compute the river flash flood impact product by intersecting the river flash flood hazard forecast with the user defined exposure data and thresholds. The product will be compared against the notification criteria specified by the user, if the forecast product meets the criteria then a flash flood notification will be issued to the user.

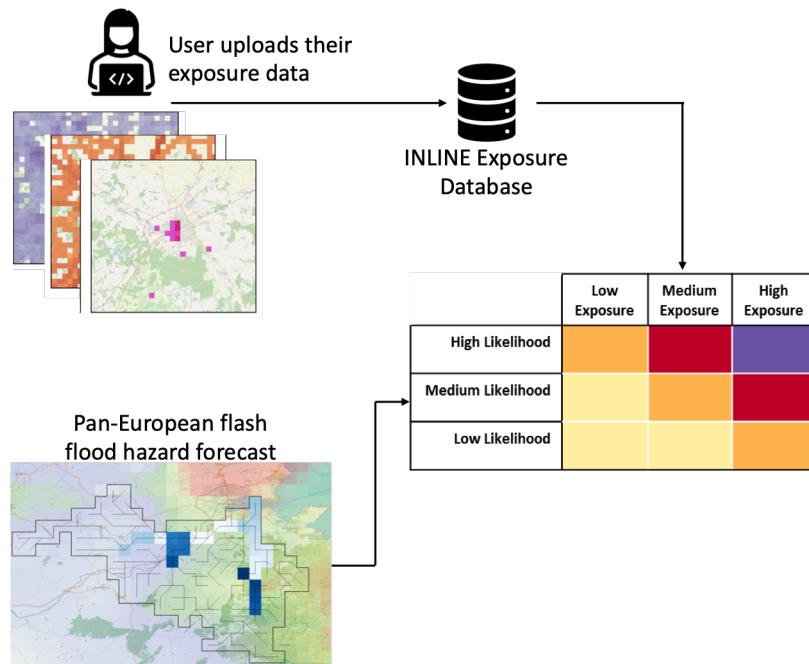


Figure 3 Workflow for users to upload their own exposure data to calculate the river flash flood impact.

4 Neural Network Method for Rainfall Nowcasting

In task 3.1, FMI have implemented a rainfall nowcasting method based on a convolutional neural network called SimVP ([Gao et al., 2022](#)). The method generates pan-European deterministic nowcasts of rainfall at 15-minute time steps up to 3-hours ahead.

The software to generate these nowcasts will be transferred from FMI to ECMWF. ECMWF will then implement the software and run it on ECMWF's high performance computing facility (HPCF) for a selection of past events. The results will be compared against those produced at FMI to ensure that the software is producing the correct results.

It must be noted that the software will not be implemented into the real-time suite to produce real-time forecasts. This is due to insufficient resources on ECMWF's HPCF to produce the forecasts in near real time.

References

Gao, Z., Tan, C., Wu, L., and Li, S.Z. 2022. SimVP: Simpler yet Better Video Prediction, *IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, New Orleans, LA, USA, 2022, pp. 3160-3170, doi: 10.1109/CVPR52688.2022.00317.