Supporting flood disaster response using multi-sensor Earth Observation data

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Introduction

The Earth is increasingly experiencing devastating floods, highlighting the severe impacts of climate change and exposing vulnerabilities in land use and population safety. In order to support flood disaster response the German Aerospace Center (DLR) has developed various components to support flood disaster response using multi-sensor Earth Observation (EO) data.

Methodology

A workflow has been established to support operational flood disaster management with different rapid mapping products:

On a global level, an automatic multi-sensor system for ***systematic flood detection*** is used. It consists of deep learning-based modular processing chains to extract the water extent from radar (e.g. Sentinel-1) and optical (e.g. Sentinel-2, Landsat) satellite data.

A global high-resolution seasonal ***reference water product*** computed based on fused Sentinel-1/2 time-series data is used to distinguish permanent surface water from temporary flooded areas.

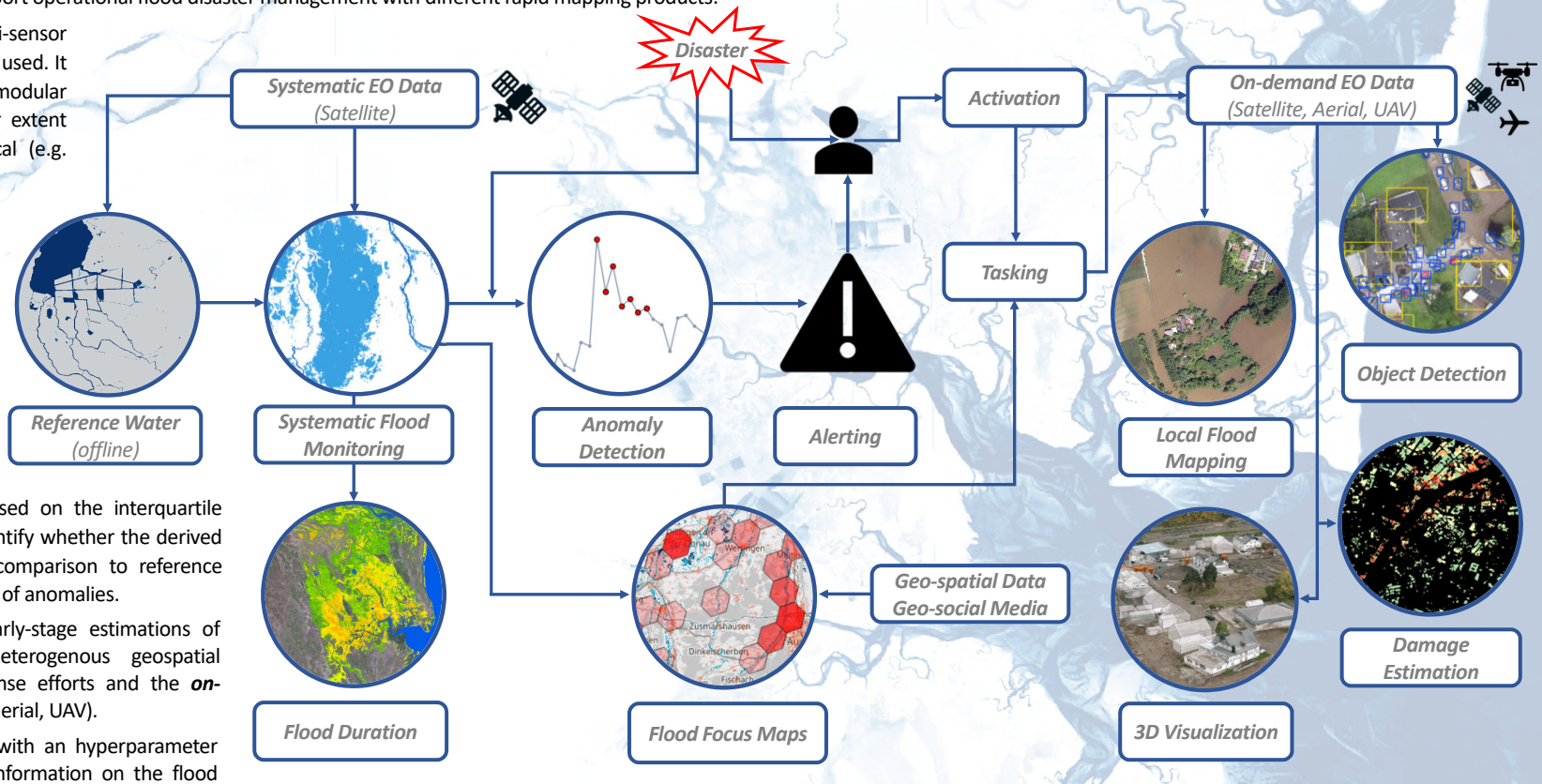
The system also provides information about the ***flood duration*** on a pixel level by combining single-temporal flood masks over time.

An ***anomaly detection*** mechanism based on the interquartile range (IQR) criterium is installed to identify whether the derived water extent is of abnormal size in comparison to reference periods. End users can be alerted in case of anomalies.

To enhance situational awareness, early-stage estimations of impacted regions derived from heterogenous geospatial indicators can aid to ***prioritize*** response efforts and the ***on-demand tasking*** of VHR data (satellite, aerial, UAV).

A log-linear pooling method coupled with an hyperparameter optimization routine is used to fuse information on the flood extent with data from geo-social media and geospatial data on exposed assets (e.g. building distribution, population density, hazard zones) in ***flood focus maps***.

Tasked VHR EO data are analysed using AI-based approaches to perform ***local flood mapping***, ***object detection*** (buildings, cars), ***damage estimation*** (buildings, infrastructure), and ***3D-visualization*** for an improving situation assessment.



Conclusion

A workflow has been established to support users involved into operational flood disaster management with rapid mapping products based on multi-scale and multi-temporal EO data. While systematically acquired EO data are used to provide a global and continuous monitoring of flood situations, the analysis of VHR EO data with deep learning-based approaches enable the identification of relevant local crisis information. Rapidly identified disaster hotspots help to guide emergency actions, to allocate limited resources effectively, and to task VHR sensor platforms over the disaster affected areas.

Bereczky, M., Wieland, M., Krullikowski, C., Martinis, S., Plank, S. (2022): Sentinel-1-based water and flood mapping: Benchmarking Convolutional Neural Networks against an operational rule-based processing chain. IEEE JSTARS, 15, 2023-2036.
Martinis, S., Groth, S., Wieland, M., Knopp, L., Rättich, M. (2022): Towards a global seasonal and permanent reference water product from Sentinel-1/2 data for improved flood mapping. Remote Sensing of Env., 278, 2022.
Wieland, M., Martinis, S. (2019): A modular processing chain for automated flood monitoring from multi-spectral satellite data. Remote Sensing, 11, 2330, 1-23.
Wieland, M., Schmidt, S., Resch, B., Abdecker, A., Martinis, S. (2025): Fusion of geospatial information from remote sensing and social media to prioritise rapid response actions in case of floods. NHESS, 121, 8061–8088.