

Integrating Probabilistic Flood Impact Forecasting into Early Warning Systems: A Web-Based Visualization Tool

Markus Mosimann^{a,b,c,*}, Martina Kauzlaric^{a,b,c}, Olivia Martius^{a,b,c}, Andreas Paul Zischg^{a,b,c}

^a Institute of Geography, University of Bern, Hallerstrasse 12, 3012 Bern, Switzerland

^b Mobiliar Lab for Natural Risks, University of Bern, Hallerstrasse 12, 3012 Bern, Switzerland

^c Oeschger Center for Climate Change Research, University of Bern, Hochschulstrasse 4, 3012 Bern, Switzerland

* Corresponding author (markus.mosimann@unibe.ch)

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Abstract:

Advancements in web infrastructure enable the transfer of large amounts of data via the web, making it feasible to integrate insights gained from flood modelling into early-warning systems and even near real-time applications. The proposed web tool, developed using insights from Mosimann et al. (2023) and Mosimann et al. (2024), leverages hydrological forecasts, such as those issued by the Federal Office for the Environment in Switzerland (FOEN 2024), to map predicted floods. It offers an interactive map that visualizes potential flooding areas based on different members of a probabilistic forecast, enabling users to explore a range of flood scenarios. The new web tool, built using standard HTML, JavaScript, and CSS, is accessible through standard web browsers; however, access is restricted to selected stakeholders due to its prototype status.

The key features displayed include flood depths, temporal information, hazard classes indicating flood severity for human life and infrastructure, and estimations of potential damage, including the number of potentially exposed buildings, population, and workplaces. The development of tools like www.risksensitivity.ch and www.flooddynamics.ch, alongside collaborations with emergency responders, governmental authorities, and insurance companies, has demonstrated the potential of such comprehensive visualizations to significantly enhance awareness and understanding of anticipated flood events. While initial user feedback supports this claim, more systematic user experiments will be conducted to provide robust evidence.

The tool facilitates proactive decision-making by providing near-real-time information on probable flood threats, thereby supporting early warning and strategic planning in flood risk management. It utilizes GeoServer as an interface to transfer requested flood information from a PostgreSQL database with PostGIS extension, where results from precomputed flood scenarios are stored, directly to the client side. In addition to its integration with the web tool, GeoServer can function as an API, enabling the implementation of forecasts into any stakeholder-specific environment. Machine learning methods could be explored in future developments, particularly to handle the large datasets and enhance predictive capabilities. However, they were not (yet) applied in this context due to their lack of transferability and the significant time required to set up such models for the main river network of Switzerland.

The tool also addresses the challenges of providing probabilistic flood hazard and impact information. To help stakeholders navigate uncertainties in the forecasts, the tool visualizes probabilistic data and offers various outputs tailored to stakeholder needs, which can be explored through 2D maps, charts, and tabular summaries. It serves as a proof of concept for implementing the surrogate flood model approach in near-real-time flood warning systems and illustrates the potential for forecasting systems to meet the diverse needs of stakeholders. For example, insurance companies might focus on potential damage to plan resource allocation, while emergency responders prioritize information on population and the areas likely to experience severe flood intensities.

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