DESTINATION EARTH

MACHINE LEARNING DEMONSTRATOR FOR RAINFALL-INDUCED FLOODS

HydroLogic | Koninklijk Nederlands Meteorologisch Instituut, Ministerie van Infrastructuur en Waterstaat | Weather Impact

Providing water managers with insights into pluvial flood risks

This machine learning demonstrator enhances Destination Earth capabilities by adding high-resolution machine learning flood forecasts, with a specific focus on pluvial (rainfall-induced) flooding. These forecasts will help water authorities, emergency services, and municipalities take timely action to reduce damage and save lives.

The final product gives end users insights into flood risks based on the latest and most accurate rainfall forecasts. Rainfall nowcasts are blended with the Weather-Induced Extremes Digital Twin (Extremes DT) simulations to increase short-term forecasting and capture the full range of uncertainty. By including ensemble members, a range of possible flood scenarios is generated. This gives the end users insight into both the potential flooding and the uncertainties.

Traditional numerical flood models are too slow to provide high-resolution forecasts in operational contexts. By combining machine learning models with extreme weather simulations from the Extremes Digital Twin, we enable timely, probabilistic flood forecasting at a scale and speed suitable for decision-making.

Enhanced short-term rainfall forecasts

Accurate rainfall predictions are essential for flood forecasting. To improve short-term accuracy, a machine learning algorithm blends nowcasts with forecasts from the Extremes DT. This approach enhances the reliability of rainfall forecasts, which are a critical input for anticipating flood risks.

Real-time probabilistic flood forecasts

Machine learning models trained on detailed hydrodynamic simulations enable real-time, high-resolution flood forecasting by drastically reducing computation time.

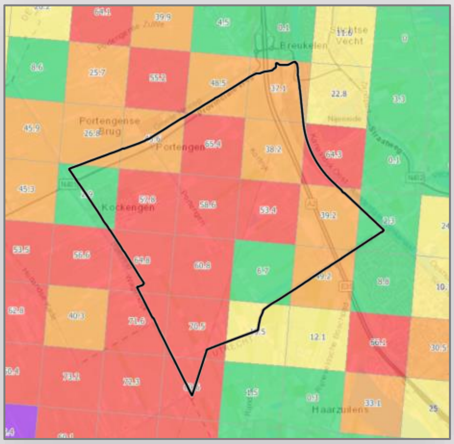
Insight into uncertainty

To support effective decision-making, an ensemble of rainfall scenarios is used as input for flood forecasting. This ensures that the full range of possible outcomes is considered. By incorporating all ensemble members, the system provides a clearer picture of flood risks, addressing a key need identified by end users.

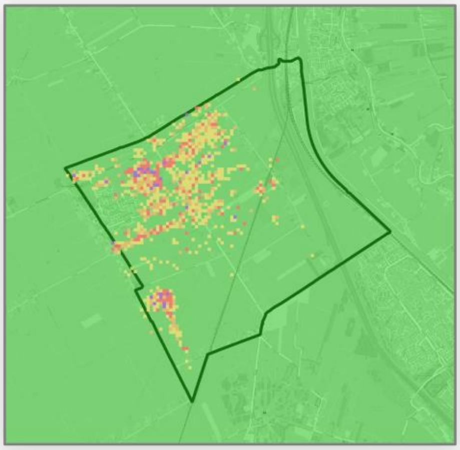
Digestible information for end users

Simplify interpretation for end users by providing specific dashboards. The result is a user-oriented forecast system that delivers operational clarity.

Current probobalistic flood forecasts



Flood forecasts needed by end users



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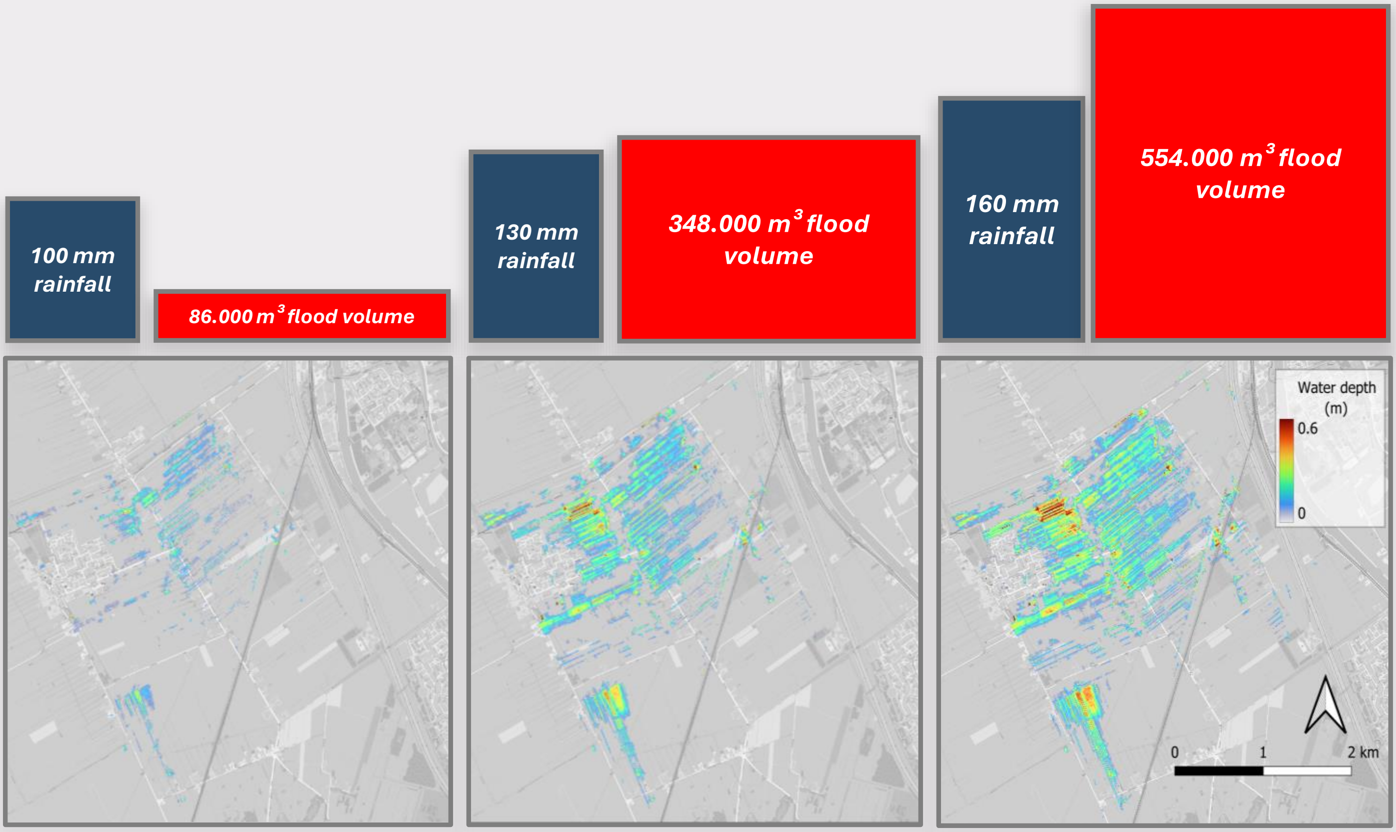

This figure shows flood simulations for varying amounts of rainfall, highlighting the inherent uncertainty in rainfall forecasts, especially for extreme events. Predicting localized, high-intensity precipitation is complex, and even small differences in forecasted rainfall can lead to major variations in flood extent and severity. As demonstrated in the figure, this uncertainty in rainfall directly translates into large differences in flood volumes.

End users

In this project, the end-users are members of an existing community that focuses on the impacts of extreme precipitation within the Netherlands. This community includes practitioners and stakeholders who are directly involved in managing water-related risks. To ensure the solutions developed are both technically robust and practically applicable, the project emphasizes co-creation with this community.

This collaborative approach helps align the project outcomes with the real-world needs and challenges faced by water risk managers. To demonstrate the model's capabilities and validate its broader applicability, the project will be implemented across six study areas. Four of these are in the Netherlands, while the remaining two are situated internationally in South Africa and New Zealand. These international case studies provide an opportunity to assess the model's scalability and adaptability to diverse topographies.

Harnessing latest developments in:

Rainfall nowcasting

Blending Extremes DT with nowcasts from the Deep Generative Model for Radar (DGMR), developed by DeepMind.

Flood forecasting

Building on 25 years of experience in flood forecasting in operational applications.

Machine learning

Using state of the art machine learning techniques to blend rainfall forecasts and predict flood risks.

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