GFZ Helmholtz Centre for Geosciences



KrischiMeier - stock.adobe.com

Assessment of flood risks

Flood damage has increased significantly in recent decades worldwide, but also in Germany. This increase is a consequence of climate change, changes in land use and population and economic growth. The contribution of the various factors to the increase in damage varies depending on the region and flood type. River floods are influenced by climate change differently than flash floods, i.e., very fast floods, and flooding caused by heavy rainfall in urban areas.

Our key messages

- Analyses of gauge records over the past few decades show positive trends in flood peaks in large parts of Germany. These trends can essentially be explained by climate change.
- Climate change is increasing the frequency of convective weather patterns and the intensity of localised heavy rainfall. This increases the risk of flooding in cities and flash floods in mountain ranges in particular.
- Whether extreme precipitation leads to disasters ultimately depends on society. There are numerous ways (e.g., early warning, structural precautionary measures) to limit the risk of flooding and prevent disasters.
- Scientists at the GFZ have developed risk models that can be used to simulate the occurrence and effects of flooding. These simulations are important tools for the prediction and risk assessment of flood events.

GFZ Helmholtz Centre for Geosciences
www.gfz.de/en

Contact
Prof. Dr. Bruno Merz
bruno.merz@gfz.de

Models for risk assessment

Flood models are powerful computer models that simulate how floods occur, spread and cause damage. develops, spreads and causes damage. They can be used for river floods, flash floods in small catchment areas and localied flooding in cities caused by heavy rainfall. They are important tools for risk assessment, forecasting and adaptation to climate change.

Flood models of GFZ

RWG – Weather generator for generating long synthetic climate timeseries

s. Website

Risk analyses require the estimation of rare events that only once every 1,000 years, for example. The observations are usually only a few decades long. The statistical extrapolation to rare events is therefore subject to great uncertainties. A weather generator is a model that generates arbitrarily long time series of realistic climate data. This means that for a region several thousand years of climate data can be generated in hourly resolution. The longer the time series, the more likely they are to depict extreme events that are possible but have not yet been observed. The GFZ weather generator can depict the current climate, but also possible future changes due to climate change.

RIM2D – Model for simulation of inundation

s. Website

Hydrodynamic models calculate the propagation of floods and provide detailed information on the extent, water depth and flow velocity. RIM2D is a hydrodynamic model that can be used for flooding caused by heavy rainfall in cities, for flash floods and for river flooding. The outstanding feature of RIM2D is the high speed at which floods are simulated. This means that many scenarios can be simulated in short time, even at high spatial resolution. This also makes it possible to predict flood areas and thus provide new information for disaster management.

HOWAS21 and FLEMO – Data and models for damage estimation

s. Website

Data and models for flood damage deliver important information for risk analyses. They are also required for cost-benefit analyses as part of climate change adaptation measures. With the HOWAS-21 database, the GFZ has several thousand data sets on historical, building-specific flood damage. These form the basis for the FLEMO damage models, which make it possible to estimate flood damage for private households and trade/industry. The special feature of the FLEMO models is that they can take into account a number of factors, such as the damage-reducing effect of private precautions, and that they automatically quantify the resulting uncertainties.

Contact persons
Weather generator: Dr. Sergiy Vorogushyn
RIM2D: Dr. Heiko Apel
Damage data/models: Dr. Heidi Kreibich

Section 4.4: Hydrology
https://www.gfz.de/en/section/hydrology/overview

10/2026