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Stress testing approaches for High-Impact-Low-Probability floods: A review

Highlighted by the July 2021 floods in central Europe, climate change contributes to an increase in the occurrence of devastating and unprecedented flood events. The floods exhibited magnitudes far exceeding the commonly used worst-case scenario of the 1-in-100-year flood, illustrating that this standard may no longer be adequate. However, the lack of data on the physical mechanisms and anthropogenic responses limits the ability to anticipate and prepare for unprecedented floods. This review will show the multitude of different approaches used in the state-of-art literature to analyze hypothetical High-Impact-Low-Probability floods. The review is limited to studies considering very extreme pluvial and riverine floods including their human-centric impacts. A systematic SCOPUS keyword search coupled with a large language model filtering out irrelevant studies left 96 papers which are considered relevant. The scientific works are delineated by how physical boundary conditions are derived, floods are modeled, impacts are quantified and based on their overarching framing. Predominantly, studies use univariate statistics to create the physical boundary conditions. However, a variety of approaches are used, including counterfactuals, weather generators, and reforecasts. Approximately 60% of studies are limited to exposure assessment. Where, impacts are estimated studies are framed as cost-effectiveness analyses, cascading impact assessments, and some even consider post disaster recovery. Additionally, we identify stress-test approaches for High-Impact-Low-Probability floods which are still lacking, but could provide valuable scientific insight.

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