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Towards establish a continental Early Warning System for flood Preparedness: A study case of South America's data-scarce countries

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Across Latin America, floods are one of the major hazards, and their impacts are exacerbated by climate change and poor societal preparedness. The latter is mainly due to the lack of methods that could provide insights about where and when extreme events could happen and what their hydraulic response might be. The data-scarcity and lack of open-source tools are one of the main barriers to improving resilience in the context of flooding. Nonstructural measures such as early warning systems are typically based on empirical approaches relating rainfall thresholds in order to inform about potential floods at country or continental scales. Nevertheless, this ignores the hydraulic behavior and rainfall-runoff mechanics. This research presents the first steps to establish an open-source Early Warning System (EWS) by employing a hydrodynamic model (Hydropol2D) integrated with quasi-global rainfall estimations from PERSIANN PDIR-Now and numerical weather predictions from the Global Forecast System (GFS). The model is capable of running at multiple spatial scales, combining near real-time flood modeling (as a Digital Twin) which shares the current system states as a base scenario for the forecasting system (as an EWS). Additionally, the model features a graphical interface for monitoring current hydraulic conditions and predicting future flooding based on rainfall forecasts. From one year of initial modeling results as a system warm-up, we observed the model's speed viability due to its parallel computing capability. The integration of freely available rainfall data and real-time gauge stations of flow stages and discharge shows the potential of the model as a Digital Twin at a continental scale. However, the model still lacks a recursively parameters updating routine to improve output accuracy, and regular calibration and validation procedures are necessary for each point of interest. Furthermore, the inclusion of evapotranspiration and soil moisture remote sensing data needs to be considered due to their impact on long-term hydrological modeling. These initial steps to combine a Digital Twin and an EWS could strengthen resilience where data is limited, empowering vulnerable communities through participatory adaptation and enhanced capacity. The open-source, customizable platform is accessible for organizations to implement early warning systems within areas with growing risks.