An Interdisciplinary Framework for Flood Forecasting, Ground Motion Detection, and Community Resilience in Palmer Township, Pennsylvania

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1. Introduction and Objectives

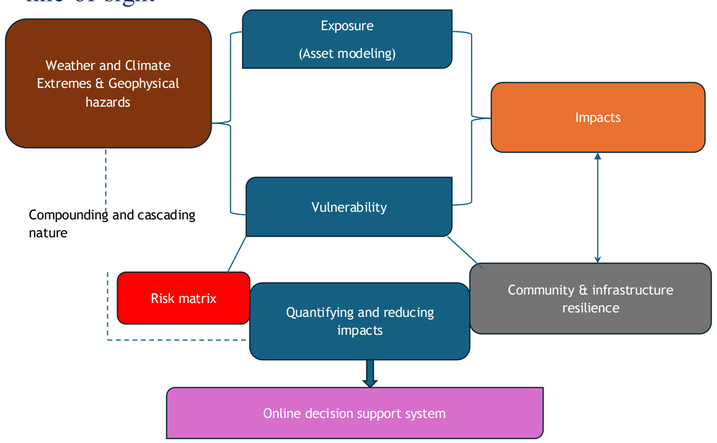
- 13.8% of properties projected to be vulnerable to Persistent flooding and surface runoff in the Major Flood factor zone (Like Palmer), within 30 years (First Street, 2022)
- Comprehensive framework to assess environmental risk, infrastructure vulnerability, and community resilience
- Integrated Climatologic-EO–hydrologic–vulnerability–AI framework to map current and future flood and land-movement risks in Palmer Township

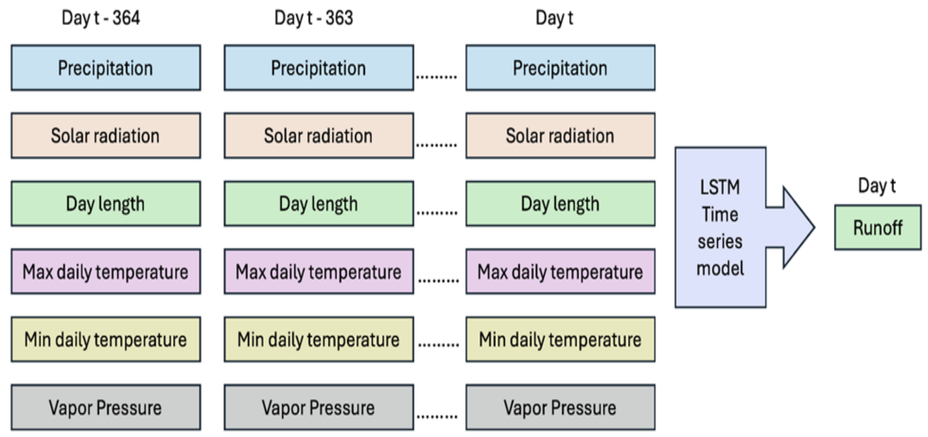
2. Objectives

To develop a community-driven framework backed by scientific studies in which flood is considered a weather-and climate-induced extreme event, land displacement is treated as a geophysical hazard

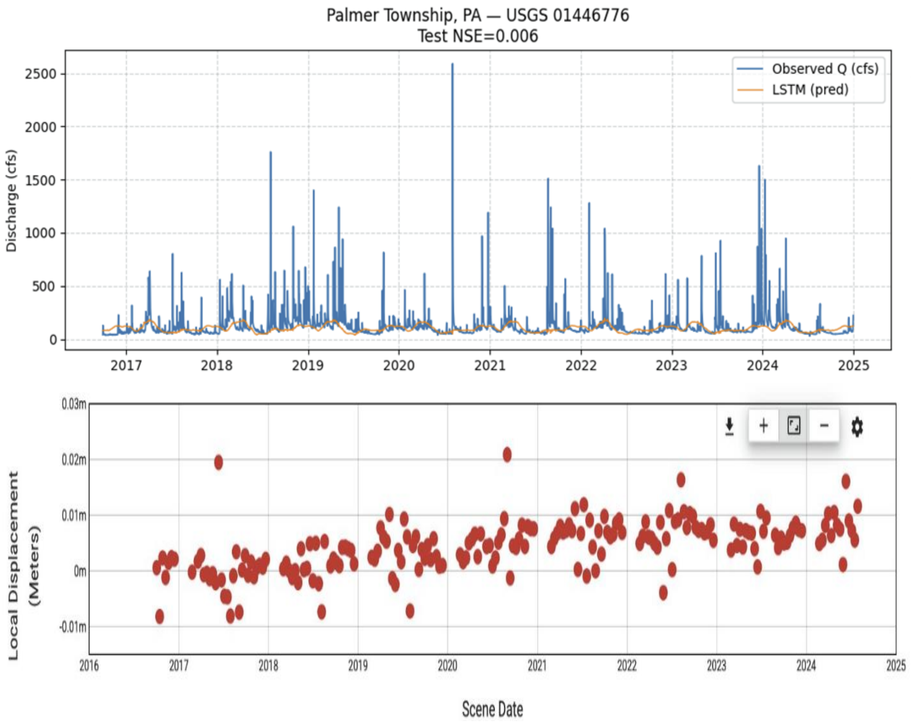
3. Materials & Methods

- Rainfall–runoff modelling framework - employs an LSTM neural network in a many-to-one configuration (J. Liu et al., 2024)
- OPERA Surface Displacement from Sentinel-1 validated product (Version 1) using a hybrid PS and DS approach, quantifies surface displacement in the radar line-of-sight





4. Results

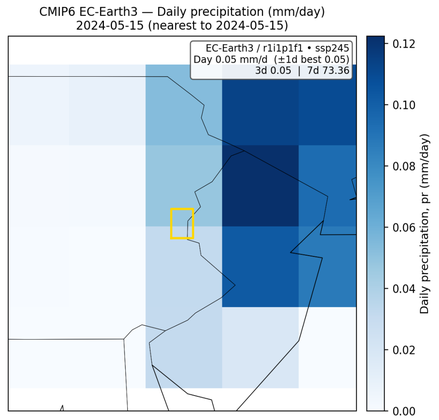


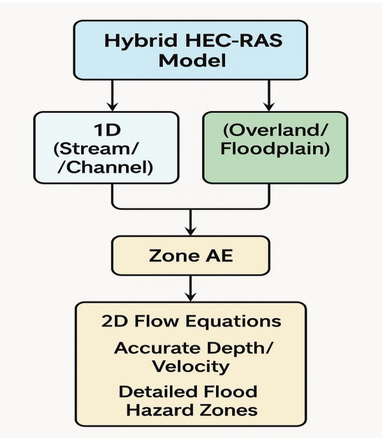
- **Modelled hydrograph** reproduces the overall timing and magnitude of discharge events - LSTM's capability to internalise nonlinear runoff responses
- **Proof-of-concept** successfully demonstrates the feasibility of using data-driven rainfall–runoff models to complement process-based hydrologic simulations and support flood-forecasting applications within Palmer Township

• **Rainfall-triggered deformation:** OPERA Sentinel-1 time series shows a sharp LOS jump from ~0.0006 mm (9 Jul 2023) to ~0.0095 mm (21 Jul 2023) immediately after the **10 & 16 July** flood events—well above the usual ±1–3 mm background scatter

• ***Likely mechanism:*** Intense rainfall/inundation likely altered pore-pressure and soil saturation, producing a **~0.009 mm positive LOS** signal (subtle uplift or motion toward the sensor) that stands out as an anomalous, flood-induced ground response

5. Ongoing Works





- **CMIP6** EC-Earth3 daily precipitation (mm day⁻¹) for the nearest model day to 2024-05-15 (member r11i1p1f1, SSP2-4.5). Legend summary: same-day 0.05 mm day⁻¹, ±1-day best 0.05, 3-day 0.05, 7-day 73.36. this panel shows typical day-scale underestimation with stronger multi-day accumulation—illustrating why regime-based calibration is emphasised over same-day totals (Eyring et al., 2016; Döscheret al., 2022). – Underperformed by: *Bamikole Akinsehinde*
- Aim to implement, coupled 1D–2D HEC-RAS model to simulate river–floodplain hydraulics and explicitly represent critical structures such as bridges and culverts inside 2D flow areas - Underperformed by: Chengye Li

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