A Comparative Physical Assessment of intensified Global Flood Susceptibility
Assessing Global Flood Susceptibility Through Multi-Parameter Integration

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RESEARCH PROBLEMS

1. Current global flood assessments fail to comprehensively quantify susceptibility using diverse physical drivers.
2. Non-linear interactions among physical flood drivers are often inadequately captured by conventional modeling approaches.
3. A systematic comparison of AHP, statistical, and machine learning models for global flood mapping is lacking.
4. The dynamic intensification and spatial expansion of global flood hotspots remain poorly quantified.

RESEARCH OBJECTIVES

1. To present the first comprehensive global physical assessment of flood susceptibility using diverse methodological frameworks.
2. To quantify global flood vulnerability patterns and identify critical hotspots where compound physical factors create elevated risks.
3. To systematically compare Multi-Criteria Decision-Making (AHP), statistical (FR), and machine learning (SVM, RF) approaches to determine the most robust predictive framework.

METHODOLOGY

- **Data:** Nine critical biophysical parameters (topographical, meteorological, land surface, and soil characteristics) were used as input factors.
- **Validation:** Models were validated against a comprehensive inventory of 5,105 historical flood events from the Dartmouth Flood Observatory (DFO).
- **Modeling Approaches:** Four models were implemented and compared: AHP, Frequency Ratio (FR), Support Vector Machine (SVM), and Random Forest (RF).
- **Performance Metric:**
  Evaluation used the Area Under the Curve (AUC) of the Receiver Operating Characteristic (ROC) curve.

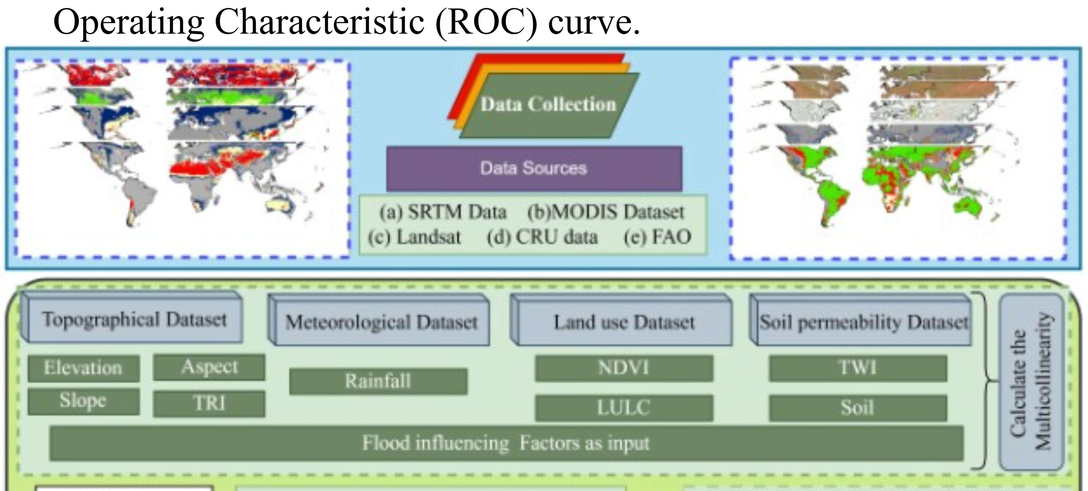

Fig.1 Technical route of the research

KEY RESULTS

1. **Global Susceptibility and Hotspots**

- The **Random Forest (RF)** model achieved the highest predictive performance (**AUC = 0.85**).
- Approximately **25%** of the Earth's land surface exhibits **high to very high flood susceptibility**.
- **Hotspots:** Concentrated vulnerability was identified in the Ganges-Brahmaputra Delta, Yangtze/Yellow/Pearl River basins, and the Amazon Basin.

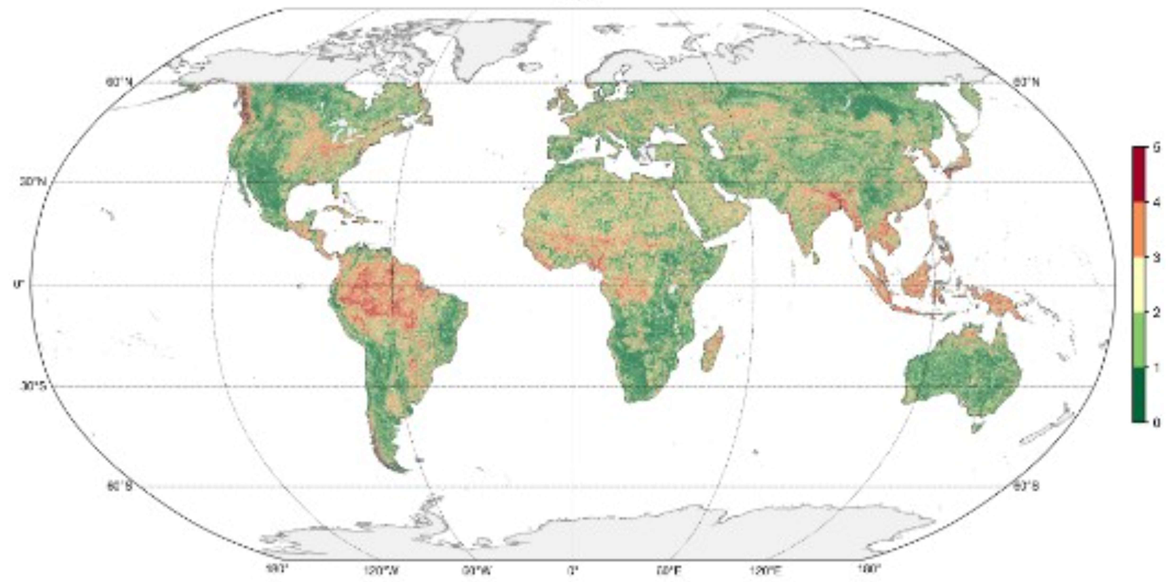

Fig 2 Flood susceptibility map showing global spatial patterns of flood risk vulnerability according to best model Random Forest AHP

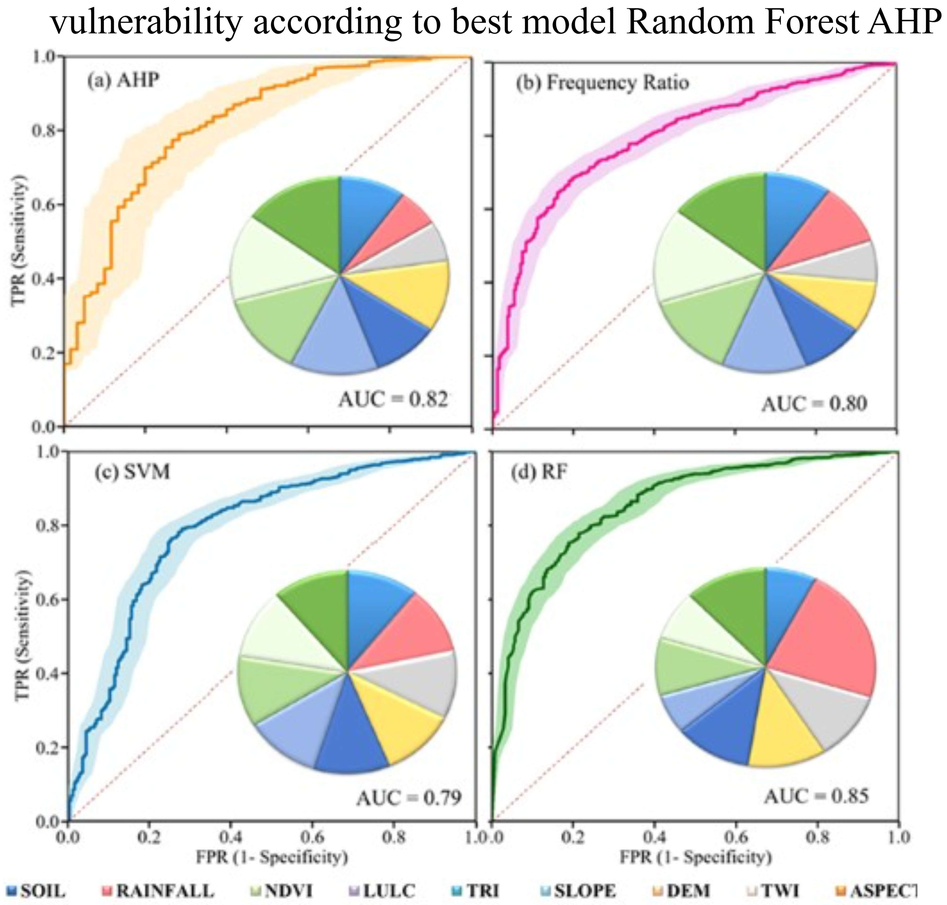

Fig. 3 Feature importance across models-based ROC curves and corresponding AUC values for four flood susceptibility models: (a) AHP, (b) FR, (c) SVM, (d) RF

- The RF model showed high importance for rainfall (22%) and land surface factors.

- **Temporal Trends:** High and Very High susceptibility zones have expanded by approximately 7% globally (2000–2022).

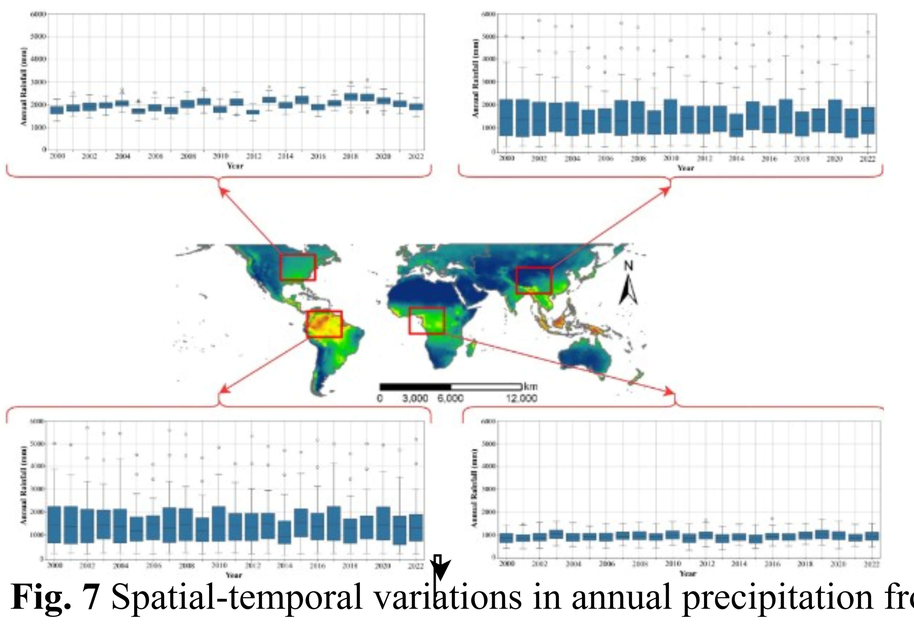

Fig. 4 Fig. 7 Spatial-temporal variations in annual precipitation from 2000 to 2022 in the most important tropical and subtropical regions.

CONCLUSION

- **Advanced Modeling is Key:** The superior performance of the RF model confirms the need for advanced machine learning to capture the complex, nonlinear interactions that drive compound vulnerability amplification.
- **Dynamic Intensification:** Flood susceptibility is dynamically intensifying due to combined climate change effects and rapid urbanization in vulnerable regions.
- **Targeted Adaptation:** The findings provide essential spatial intelligence to prioritize and target climate adaptation investments in global flood hotspots, particularly the high-density South and East Asian River basins.