# Urbanization, climate change, and flood risk assessment in Egyptian Cities

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The increasing flood risk due to rapid urbanization, climate change, and mismanagement have called for integration between flood risk management and spatial planning processes, which is increasingly used to enhance cities' resilience against the growing flood risk. In Egypt, Flood Risk Management (FRM) faces crucial challenges; the deficiency of flood risk assessments and mapping, outdated information needed for sufficient response and recovery, funding constraints, the ineffectiveness of mitigation measures, and the lack of adequate coordination between the entities responsible for FRM. Additionally, FRA is not an obligatory part of spatial plan-making. Thus, the urban development has been directed towards flood-prone areas, which led to increasing the flood risk consequences.

This study aims to (1) understand the impacts of these three factors on flash flood risk in different climatic regions in Egypt (**Figure 1**); (2) Development of customized methodology for flood risk assessment and vulnerability index in arid urban areas; (3) Assessing the flood risk maps in urban areas using different tools, namely a 2D rainfall-runoff- inundation model (RRI) and Machine Learning (ML) Algorithms. The proposed methodology integrates remote sensing data such as DEM, Rainfall, Satellite Images with a 2D hydrological model and ML approach. The remotely sensed data have been used for urban growth evaluation, LULC classification, and flood inundation maps. The RRI model and both Machine learning methods (LightGBM & CatBoost) combined with geographic information systems (GISs) environment were utilized.

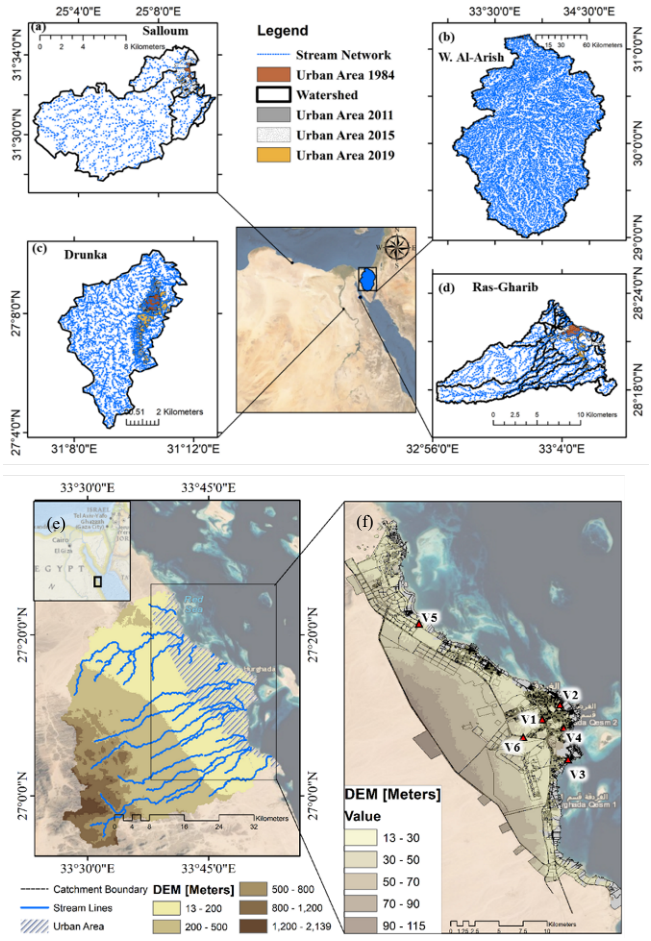


**Figure 1** Location maps showing the target cities and related wadi catchments and stream network developed from DEM (Sentinel-2) by GIS: a) Salloum, b) Wadi Al-Arish, c) Drunka, d) Ras Gharib, e) the Hurghada catchment area, and f) Hurghada city.

The results show a significant increase in urban development, resulting in increased prone areas for flood hazards over time.

However, the degree of this hazard is mainly related to event intensity and urban growth directions. Mismanagement affects urban growth in planned and unplanned development, whether by losing control over sprawl growth or deficiencies in approved plans(**Figure 2**). (Saber et al., 2020).

The introduced methodology proved to be an economic tool to overcome the scarcity of data, fill the gap between urban planning and FRM, and produce comprehensive and high-quality flood risk maps that aid decision-making systems (Abdrabo et al., 2020). The RRI model shows good agreement results, but it has some limitations in simulating the urban conditions

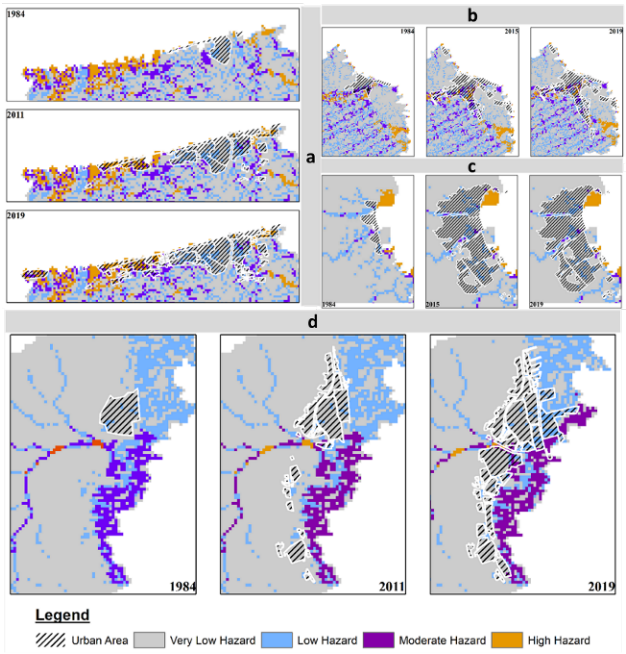


**Figure 2.** Flood inundation maps (RRI model) Inundation maps showing the hazard levels affecting the urban areas over time from 1984 to 2019 in (a) Al-Arish, (b) Ras Gharib, (c) Sallum, and (d) Drunka cities).

The ML approach delivers a high accuracy (97%) in predicting the flood zones in Hurghada (**Figure 3**) (Saber et al., 2021).

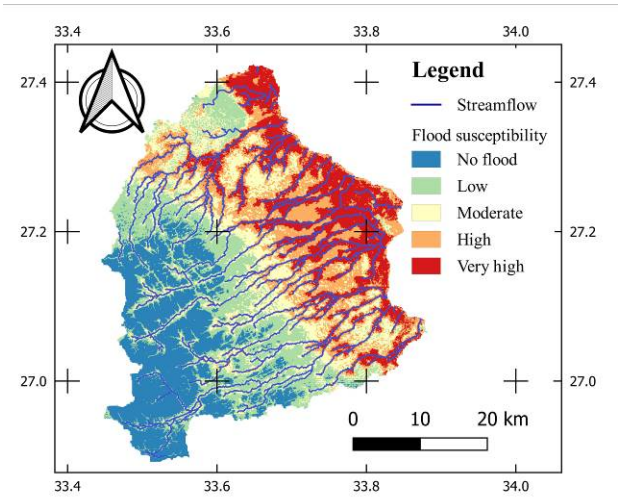


**Figure 3.** Flood Susceptibility map (Machine learning) for Hurghada using LightGBM Algorithm.

An urban planning approach such as Low Impact Development (LID) and Nature-Based Solutions (NBS) are recommended for flood mitigations in urban areas. The outcomes of this study can be used as a reference to guide and assist planners and officials in flood risk assessment and mitigation.

**References**:


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