URBAN FLOOD ASSESSMENT TARGETING FLOOD RISK MITIGATION: A CASE STUDY FOCUSING ON CHANGING ENVIRONMENTS

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Among natural disasters, flooding has become a frequently significant catastrophic event causing considerable damage in urban environments in a global context. The anthropogenic changes in urban areas, along with climate change, have intensified urban floods (UFs). Metro Colombo area, Sri Lanka, is highly susceptible to UFs due to its geographical location, congested urban expansions, drainage deficiencies, lowered retention abilities, etc. Within the study, a qualitative, in-depth flood risk assessment is conducted based on a hazard assessment, vulnerability assessment, and exposure assessment for administrative units of Divisional Secretariat Divisions (DSDs). Under each assessment, six or seven influential elements were selected and assessed based on the remote sensing satellite imagery data and census data as published by the Department of Census and Statistics, Sri Lanka (DCS). Extracted data was used to develop criteria maps for influential elements, utilizing ArcGIS Pro, spatial data processing software. Utilizing the generated maps, hazard indices, vulnerability indices, and exposure indices were calculated, and by merging them, risk indices for DSDs were calculated.

In a subsequent study, the influential nature of changing land use patterns due to the effects of urbanization and changing climatic conditions was analysed for aggravating UFs. Reduced infiltration, disturbance to man-made drainage or natural runoff pathways, refilling of retention and detention areas, etc., have directly influenced the intensification of effects in urban flood events. Within this section of the study, land use changes were assessed from 2003 to 2023, using remote sensing satellite imagery, and a relationship between change in runoff coefficient and flood occurrences was generated. Subsequently, a projected climate assessment was undertaken for two (2) shared socio-economic pathways (SSP 1-2.6 and SSP 5-8.5) to execute a quantitative comparison of the exceedance probabilities of several threshold precipitation limits. A pilot study was undertaken for "Madiwela South Diversion" using HEC-RAS software to identify the inundation areas and depths for "with and without" measure scenarios.

The method successfully presented a satisfactory hazard map with four main flood hazard levels, and 11.36% of the total research area was reported as "high hazard". From the generated risk map, Colombo DSD indicated the highest risk index of 0.54, following Kesbewa, Kaduwela, and Thimbirigasyaya, with risk indices of 0.34, 0.29, and 0.28, respectively. These calculated risk index values can be utilized to reduce future flood risk by prioritizing high-risk-rated administrative divisions in executing flood mitigation measures. Through the assessment for evaluating the effect of land-use change, results revealed that standardized runoff coefficient and flood frequency are highly correlated, having an 82% correlation coefficient at a 0.90 significant level, indicating that the change in the runoff coefficient is highly related to flood occurrence. Further, Blue-Green Infrastructure (BGI) was proposed in the study as a sustainable attempt at flood mitigation.

Keywords: Flood hazard, Flood risk, Flood vulnerability, Inundation mapping

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Aim & Objectives

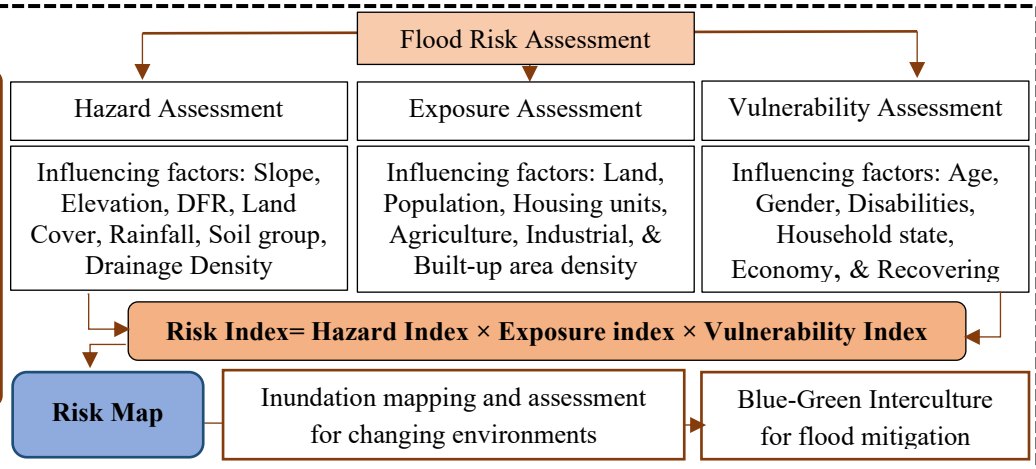
Aim

To execute a comprehensive flood risk assessment in formulating sustainable urban flood mitigation approaches ensuring the Built environment safety.

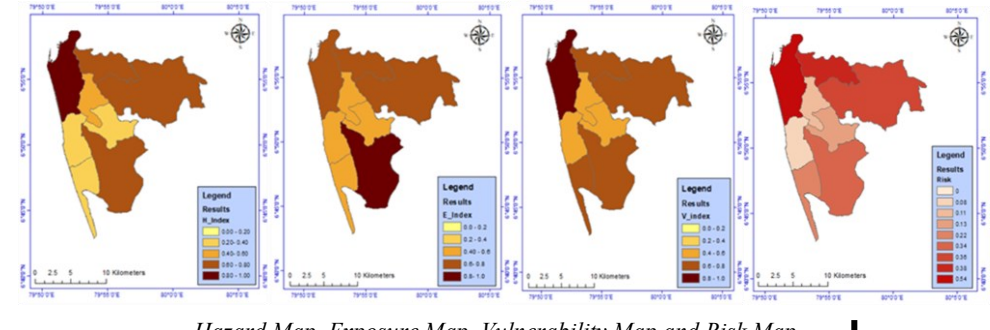
Specific Objectives

- To execute quantitative flood hazard assessment, vulnerability assessment, exposure assessment together leading to a structured risk assessment.
- To evaluate the effect of changing environment in aggravated urban flooding.
- To execute flood mapping to determine, inundation areas and inundation depths.

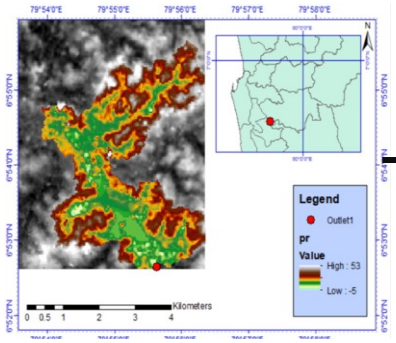
Methodology



Results



Hazard Map, Exposure Map, Vulnerability Map and Risk Map



Colombo indicated a highest risk index of 0.54.

Standardized runoff coefficient and flood frequency showed a correlation of 82%.