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Delineation of flood-prone areas and the identification of residential hotspots for two African cities

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This work employs two GIS-based frameworks for identifying the urban residential hot spots. This is done by overlaying a map of potentially flood prone areas (the topographic wetness index, TWI) and a map of urban morphology types (UMT) classified as residential. The topographic wetness index (TWI, Qin et al. 2011) allows for the delineation of a portion of a hydrographic basin potentially exposed to flood inundation by identifying all the areas characterized by a topographic index that exceeds a given threshold. The urban morphological types (Pauleit and Duhme 2000, Gill et al. 2008, Cavan et al. 2012) form the foundation of a classification scheme which brings together facets of urban form and function. The application of the UMTs allows the delineation of geographical units. The distinction of UMTs at a 'meso'-scale (i.e. between the city level and that of the individual units) makes a suitable basis for the spatial analysis of cities.

The TWI threshold value depends on the resolution of the digital elevation model (DEM), topology of the hydrographic basin (i.e. urban, peri-urban or rural) and the constructed infrastructure (Manfreda et al. 2011). This threshold value is usually calibrated based on the results of detailed delineation of the inundation profile for selected zones. In this study, the TWI threshold is calibrated based on the calculated inundation profiles for various return periods for selected zones within the basin through a Bayesian framework. The Bayesian framework enables the probabilistic characterization of the threshold value by calculating the complementary probability of false delineation of flood prone zones as a function of various threshold values. For a given return period, the probability of false delineation is calculated as the sum of the probability of indicating a zone flood prone which is not indicated as such by the inundation profile and the probability that a zone is indicated as not flood prone but indicated as flood prone by the inundation profile. Applying the above-mentioned procedure, taking into account all available information on the inundation profiles for various zones within the basin, leads to a probability distribution for the TWI threshold value.

In the next step, the urban residential hot spots to flooding are delineated in the GIS environment by overlaying the map of TWI and the UMT units classified as residential for various percentiles of the TWI threshold. Differences in exposure characteristics can be assessed for a range of different residential types, including for example between condominium/multi-storey, single storey stone/concrete and areas predominantly associated with mud/wood construction. For each percentile value considered, the delineated flood-prone residential areas and the number of people potentially affected to flooding are calculated. Moreover, the potential dependence of the estimated threshold percentiles on the flooding return period is investigated. As a demonstration, the urban residential hotspots to flooding are delineated for 16th, 50th and 84th percentiles of the TWI value for the cities of Dar es Salaam and Addis Ababa.

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