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Assessment of vulnerability of urban slums to extreme precipitation events using remote sensing data in Hyderabad/India

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Approximately 40% of the 6 million population of the city of Hyderabad (Andhra Pradesh state, India) is currently living in slums – a situation which is worryingly typical to many rapidly growing cities in the developing world. Informal settlements are highly dynamic forms of urban fabric, whose development seldom follows rules and guidelines imposed by city administration. When confronted by natural disasters such as floods, such areas are often scourged by water- and vector-borne diseases such as dysentery, cholera or malaria. The projected increase in frequency and intensity of extreme precipitation events (in excess of 80 mm rainfall per day) in the region over the next century significantly raise the risk of urban floods, causing loss of health and life in the least resilient parts of the city.

In order to assist urban decision makers to identify the areas most vulnerable to extreme floods we have developed a vulnerability assessment technique which combines automated detection of informal settlements using high resolution satellite imagery and surface flow accumulation modelling.

The very dynamic nature of informal settlements pose a real challenge to their reliable identification and monitoring and constitute a significant data availability problem in a developing country context. To generate data, we applied a lacunarity-based approach to urban fabric classification which is not sensitive to spectral variability caused by diversity of roof materials in slums. The method is capable to identify informal settlements using such parameters as dwelling size and internal structure of housing blocks using high resolution panchromatic imagery from QuickBird satellite and has been successfully validated during field research phase in Hyderabad.

The slum location map is combined with the output of custom-developed orography-based flow accumulation model which represents the risk for every cell in the city to get flooded in case of extreme precipitation event which exceeds operation limits of urban artificial drainage networks. The resulting dataset represents a vulnerability assessment map which can be used to identify particularly endangered areas for adaptation planning.

The use of satellite imagery and exclusive reliance on open source software turns the implemented methodology into a politically unbiased and cost-efficient integrated solution which can be used in many a developing city worldwide to assess the vulnerability of population residing in low-quality informal settlements to extreme rainfall events. We were able to make a spatially explicit statement showing that approximately 20% of the slums in Hyderabad are located in flood-prone low-lying areas. This information will help the authorities in charge to identify critical points of intervention within the drainage system and to design appropriate adaptation measures.

The methodology is currently being integrated into a broader Climate Assessment Tool for Hyderabad (CATHY) – a decision support system aimed at assisting urban decision makers in meeting the challenges of changing climate on the Indian subcontinent and in Hyderabad particularly.