Development of a rationalized hydrometeorological network for an urban catchment under resource-constrained scenario

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Abstract

An accurate assessment of hydrometeorological variables/ observations over an urban area is crucial to policy-makers and civic bodies to address an extensive range of water resources and environmental problems for informed decision-making related to the water distribution system and drainage networks. This necessitates the establishment of hydrometeorological monitoring networks that can efficiently obtain consistent and reliable information about the spatiotemporal variability of multiple hydrometeorological observations while being economically sustainable. However, the urban catchments especially in underdeveloped and developing countries are often subjected to spatial, environmental as well as monetary limitations which hinders the application of conventional approaches followed to set up the hydrometeorological networks. With this context, we propose a novel rationalization framework to record numerous hydrometeorological variables and acquire maximum information at an optimal cost. We have attempted to combine a multivariate statistical technique, Principal Component Analysis (PCA) with a multi-attribute decision-making method, Technique for Order of Preference by Similarity to Ideal Solutions (TOPSIS) to rank the significant hydrometeorological stations of an existing Automatic Weather Stations (AWS) network. It is observed that the set of rationalized AWS network obtained from this framework can capture the spatiotemporal information of the hydrometeorological variables considered in this study as efficiently as the entire AWS network. Additionally, the comparison of flood inundation and hazard maps derived from a 3-way coupled hydrodynamic flood modeling framework for the rationalized and original network also reflects its credibility to capture the flooding characteristics for the catchment. This proposed framework has been applied over Mumbai city, India, a major flood-prone area, and is characterized by high spatiotemporal variability of hydro-meteorological observations and space constraints due to dense population. This framework is generic and can be employed to reevaluate the prevailing hydro-meteorological networks in other catchments and help in the reduction of the maintenance cost while efficiently capturing the variability of observations.

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Background

- Mumbai City, faces incessant precipitation events owing to erratic monsoon and urban heat island effect.
- Attempt to evaluate the existing Automatic Weather Station (AWS) network over Mumbai using multivariate statistical techniques
- Based on data consistency and continuity, data recorded from 35 common significant Automatic Weather Stations for the years 2015-2018 have been considered (Rainfall, Relative Humidity)

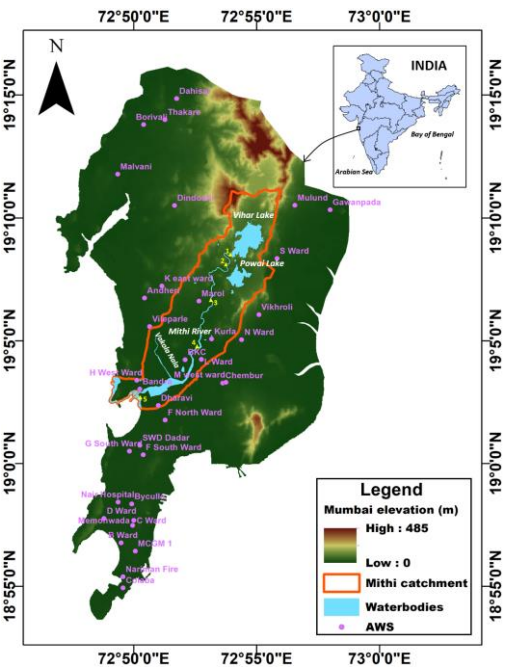

Fig : Location of study area and Autmatic Weather Stations

Framework for rationalization of AWS

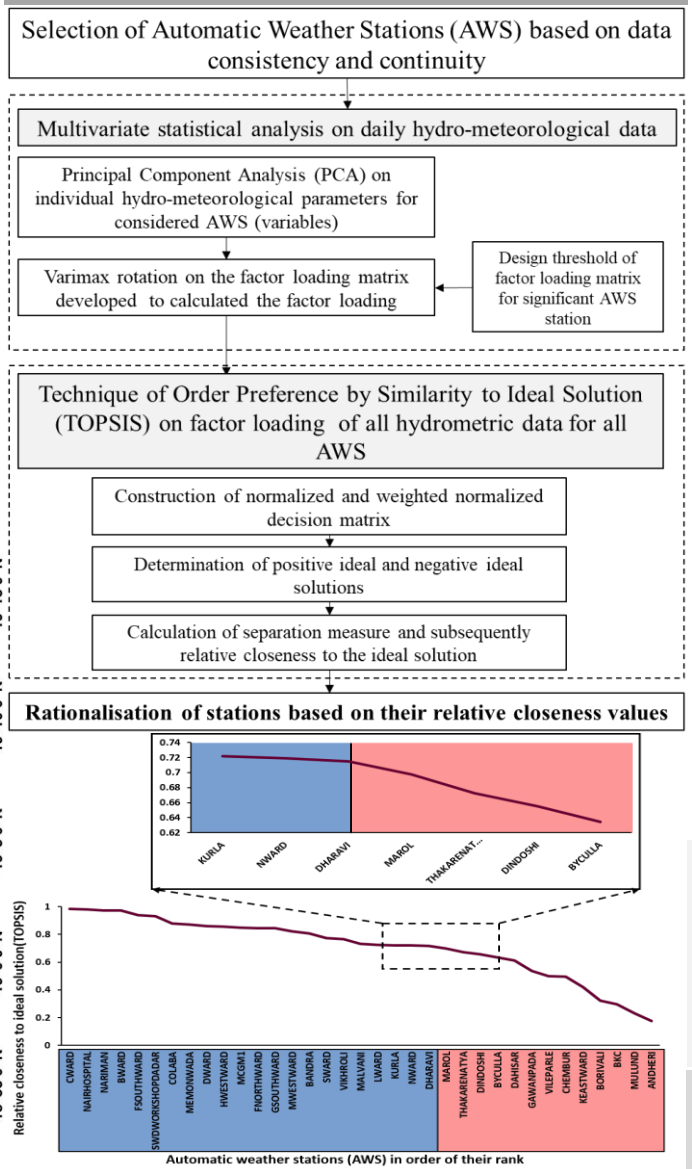

Fig: Ranking of AWS as per their ability to capture spatio-temporal variability of rainfall & relative humidity

Verification of the framework

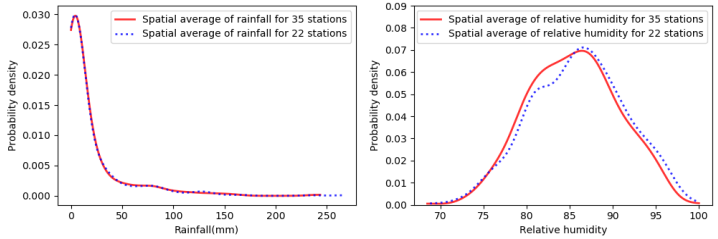

Fig: Comparison of PDFs for spatially averaged (a) rainfall and (b) relative humidity for all 35 AWS stations and TOPSIS ranked first 22 AWS stations.

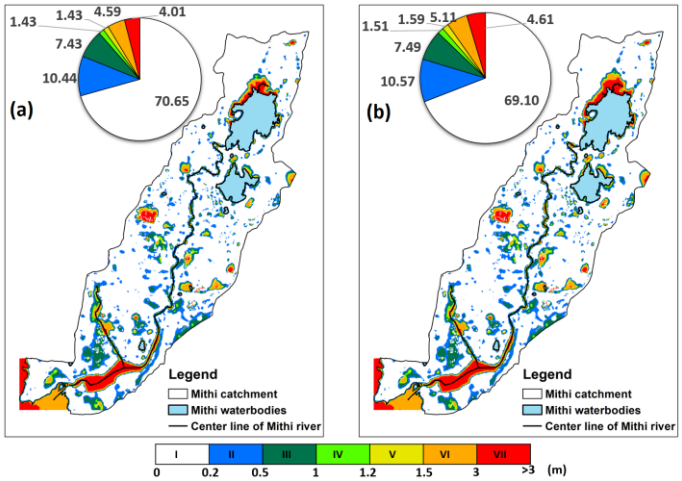

Fig: Comparison between flood inundation maps for rainfall of (a) all AWS stations within Mithi Catchment and (b) rationalized AWS stations within Mithi Catchment

- It can be deduced that the ***rainfall plays an influential role*** amongst other parameter in determining the overall temporal variability during monsoons.
- It is found that the temporal variability of rainfall and relative humidity are captured reasonably well at 22 stations
- This framework is generic and can be applied over other areas to rationalize the stations based on greater number of hydro-meteorological parameters

For more details reefer "Ghosh, M., Singh, J., Sekharan, S., Karmakar, S., Ghosh, S., Zope. 2021. Rationalization of the automatic weather stations over a coastal urban catchment: A multivariate approach, *Atmospheric Research*, Elsevier Publishing, 254, 105511."

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