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Identification of optimal number of rain gauges and their locations based on different statistical approaches: A case study in Dublin based on hourly and daily rainfall data

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Availability of accurate rainfall data at both spatial and temporal scale is a challenging issue for hydrologists. The spatial variability of rainfall is found to increase considerably for shorter rainfall events, making the analysis difficult. To account for the spatial variation of rainfall for short-term extreme rainfall events, a dense rain gauge network needs to be installed at a watershed or city scale to make the data actionable for increasing urban resiliency to rainfall related issues (e.g. flooding). In most scenario increase in number of monitoring rain gauges permits to apprehend the spatio-temporal variation of rainfall, however, higher number of gauges increases the cost of installation, operation, and maintenance. Further, denser network does not necessarily decrease the uncertainty in rainfall variability as some of those rain gauges may provide redundant information. Hence, it is important to optimize a rain gauge network by eliminating redundant gauges from the network as well as by identifying important locations to install new rain gauges with higher influence to reduce uncertainty. Several studies has attempted to develop an optimized rain gauge network based on different statistical approaches. Shih (1982) considered covariance factor among rain gauges to design the rain gauge network, Bastin et al. (1984) used krigging to design the rain gauge network, Krstanovic and Singh (1992) considered Shannon entropy to identify locations where new gauges needs to be added and to decide which gauges needs to be removed, Patra (2001) used coefficient of variation to identify the optimal number of rain gauges, Putthividhya and Tanaka (2012) designed an optimal rain gauge network based on the station redundancy and the homogeneity of the rainfall distribution, Adhikary et al. (2015) proposed a kriging based geostatistical approach to optimize rainfall network, whereas Pardo Igúzquiza (1998) and Mishra and Coulibaly (2009) considered simulated annealing to randomly search for optimal location of measurement gauges. The present study identifies redundant rain gauges and influential ungauged locations in greater Dublin area based on hourly and daily rainfall data obtained from institutional (Met Eireann) and private (Weather Undergroung) rainfall stations by considering covariance factor, krigging, Shannon entropy and annealing approaches. Comparison of results obtained from each of the approaches are performed for hourly and daily scale rainfall time series.

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