

**Evaluation of Geospatial Interpolation Techniques for Enhancing Spatiotemporal Rainfall Distribution and Filling Data Gaps in Asir Region, Saudi Arabia.**

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**Abstract:** Providing an accurate spatiotemporal distribution of rainfall and filling data gaps are pivotal for effective water resource management. This study focuses on the Asir region in the southwest of Saudi Arabia. Given the limited accuracy of satellite data in this arid/mountain-dominated study area, geospatial interpolation has emerged as a viable alternative approach for filling terrestrial records data gaps. Furthermore, the irregularity in rain gauge data and the yearly spatial variation in data gaps hinder the creation of a coherent distribution pattern. To address this, the Centered Root Mean Square Error (CRMSE) is employed as a criterion to select the most appropriate geospatial interpolation technique among 51 evaluated methods for maximum and total yearly precipitation data. This study produced gap-free maps of total and maximum yearly precipitation from 1966 to 2013. Beyond 2013, it is recommended to utilize ordinary Kriging with a J-Bessel semivariogram and simple Kriging with a K-Bessel semivariogram to estimate the spatial distribution of maximum and total yearly rainfall depth, respectively. Additionally, a proposed methodology for allocating additional rain gauges to improve the accuracy of rainfall spatial distribution is introduced based on a cross-validation error (CVE) assessment. Newly proposed gauges in the study area resulted in a significant 21% CVE reduction.

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