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Title of Thesis: Thermal model of electric motor in hybrid electric bus

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ABSTRACT

Accurate estimation of rainfall depths is the first significant step in all the hydraulic and hydrologic studies. In many cities around the world, rainfall networks suffer either from a inadequate number or redundant stations, other stations are not located in their appropriate locations. All of these issues cause uneconomic networks and/or inaccurate rainfall estimates. Thus this research objective is to present a method for optimizing the rain gauge networks aiming to determine the optimal number of stations and the best combination between the existing rain gauges, to achieve an acceptable error in extreme rainfall estimation.

Optimization procedures of the previous studies vary in their methodologies, their considered variables, their optimization indicator as well as the considered rainfall characteristics. The optimization method in this study is based on the comparison between the maximum daily rainfall depths at high return periods deduced using the entire rain gauges network and that deduced using an "optimal" number of rain gauges. The methodology is applied on the existing rain gauges network of the Walnut Gulch Experimental Watershed (WGEW), Arizona, USA. WGEW is recognized as the most densely instrumented semiarid experimental watershed in the world (0.6 gauge/km^2) where 90 rain gauges exiting in it. The study used the maximum daily rainfall depths of these rain gauges from 1954 to 2015 to get the optimum number of rain gauges to achieve an acceptable relative error. The optimal number and locations of rain gauges is obtained through to approaches; the first one using a regional frequency analysis (RRFA) technique and the second using an at-site frequency analysis (STRFA) technique. For the RRFA method, the error is calculated by comparing the regionalized rainfall depth obtained using a sample of stations with that obtained using the entire number of stations. And for STRFA method, the error is calculated by comparing the at-site rainfall depth obtained using a sample of stations with the regionalized rainfall depth obtained using the entire number of stations. A Latin Hyper Cube Sampling

(LHS) method is used to generate samples of stations. The samples of sizes from 3 to 35 station/sample are generated. Each generated sample is analyzed to obtain the optimum set of gauges. Based on the Moment ratio diagrams, the AIC and the BIC criteria, the Gamma distribution found to be the first prioritized one to analyze the rainfall data of each sample of stations. Also, it is the only one used to analyze the data of the entire rain gauges where the region is homogenous by applying the homogeneity check. The comparison between the RRFA and STRFA was applied using three criteria at the high return periods where the required number of stations to achieve an acceptable error are obtained for each one of them. The three relative error criteria targeted determining the required number of stations corresponding to, an individual error at each site, satisfying the desired error in the maximum rainfall depth, and the relative error in the mean rainfall depth in the catchment, respectively. The required number of stations corresponding to an acceptable relative error are obtained for the three studied criteria at the 10-,25-,50-, and 100-year return period based on the RRFA and The STRFA methods.

The results showed that, a lower number of rain gauges are required based on the RRFA method compared to the STRFA method to achieve the same relative error at the high return periods. Also, the recommended locations to allocate that optimum number for the rain gauges are determined. These optimum locations determined based on the highly repeated stations in all the studied sample sizes. The highly repeated stations are determined based on the percentage of appearing in the optimum samples compared to the total number of studied sample sizes. These recommended locations are shown with the isohyetal map of the WGEW in the background.