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Design water demand of irrigation for a large region using a high-dimensional Gaussian copula

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Spatial and frequency distributions of precipitation should be considered in determining design water demand of irrigation for a large region. In Guangdong province, South China, as a study case, an eight-dimensional joint distribution of precipitation for agricultural sub-regions was developed. A design procedure for water demand of irrigation for a given frequency of precipitation of the entire region was proposed. Water demands of irrigation in the entire region and its sub-regions using three design methods, i.e. equalized frequency (EF), typical year (TY) and most-likely weight function (MLW), were compared. Results demonstrated that the Gaussian copula efficiently fitted the high-dimensional joint distribution of eight sub-regional precipitation values. The Kendall frequency was better than the conventional joint frequency to analyze the linkage between the frequency of precipitation of the entire region and individual sub-regions. For given frequencies of precipitation of the entire region, design water demands of irrigation of the entire region among the MLW, EF and TY methods slightly differed, but those of individual sub-regions of the MLW and TY methods fluctuated around the demand lines of the EF method. The alterations of design water demand in sub-regions were more complicated than those in the entire region. The design procedure using the MLW method in association with a high-dimensional copula, which simulated individual univariate distributions, captured their dependences for multi-variables, and built a linkage between regional frequency and sub-regional frequency of precipitation, is recommended for design water demand of irrigation for a large region.