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Evidencing Transitions to Nonstationary using Extreme Precipitation Return Periods

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An increasing occurrence and intensity of extreme hydrometeorological and climate events (EHCEs) is challenging traditional infrastructure design. Historical records of extreme precipitation around the world proves raising vulnerabilities of the natural and the human-built environments as population and the environment change. A shift in the paradigm stationarity is gaining adepts in engineering, leading to a more resilient and secure infrastructure. Our goal is to develop a conceptual framework based of statistical modeling procedures that evidence and quantify the requirements of data as we transition from the stationary to the nonstationary paradigm. We focus on precipitation's stochastic behavior and occurrence of daily maxima within a time-interval that enables the use of the Extreme Value Distribution (EVD) to estimate return periods (years) and the associated return levels (of precipitation). Our objective is (1) to identify the "breaking points" in the historical record that evidences a shift in precipitation's behavior based on trend analysis; (2) we estimate the return levels of maximum precipitation based on Generalized Value Theory (GEV) for the pre- and post-shift, as well as all the historical record (e.g. 1950-2013); and (3) to estimate the sample size needed to reproduce the expected return levels within defined confidence intervals. Based on GEV's properties the driving hypotheses are also three folded, stating that (1) precipitation occurrence is inversely related to the expected sample size; (2) the sample size suggests the expected degrees of freedom needed to reduce the variance of the return levels or the data required to estimate return levels under nonstationary conditions; (3) that the sample sise will be different in all cases, indicating two different (pre and poste stationary) regimes. To test these hypotheses, we used a gridded daily precipitation product (1950-2013) in the Northern High Plains, India and Mexico. The return periods of maximum daily precipitation were obtained monthly timespans. GEV's parameters and its suitability were estimated using the maximum likelihood method and the Kolmorov-Smirnov test, respectively. Results evidence that sample size has more dependence on the queue type of the distribution of maximum precipitations than with the return period.