The statistical methods applied within the nonstationarity detection can be categorized by the type of nonstationarity detected, mean, variance, or distribution and whether the nonstationarity is representable of a smooth or abrupt change in the statistical properties of the dataset order analysis.

II. Results (cont.)

4. Distribution-based nonstationarity type detects a nonstationarity where there has been a significant change in the underlying distribution of the data, which can be caused by a change in the parameters of the same distribution (e.g., going from one normal distribution to another) or from one distribution type to another (e.g., going from a normal distribution to a beta distribution). The Cornish-Fisher, Helbergos-Simmer, LiPaGo, and Energy Division methods are distribution-based.

5. Smooth versus abrupt nonstationalities are categorized by whether they represent abrupt or smooth changes in the data. Hence, a smooth transition refers to a gradual change in the mean, variance, or distribution and sudden change in the mean, variance, or distribution in the annual instantaneous peak discharges recorded at a USGS gauge site.

The distribution method system detected nonstationarities for the Brazos River near Palo Pinto, TX stream gauge (two types from the statistical checks detect a nonstationarity in 1943).

Results: A script was run against the gauges’ annual instantaneous peak flow for unimpaired streams from the USGS. A nonstationarity was assigned if two or more statistical checks found a nonstationarity in the same year of a gauge.

Density-Based Clustering of Applications with Noise (DBSCAN) was used to geographically cluster all unimpaired gauges based on spatial densities (Ester et al., 1996). This density-based clustering technique was chosen due to its effective performance on spatially sparse data.

A geographic clustering result and a change point detection in 1943 are separated out of the natural noise in the data and were geographically dispersed.

A geographic clustering result and a change point detection in 1943 are separable out of the natural noise in the data and were geographically dispersed.

Urban and unimpaired gauges were selected if two or more statistical methods detected a change in the same year at the gauge.

Future efforts should examine how spatial patterns in nonstationarity clustering evolve geographically over time. Statistical methodologies should be applied to other hydrometeorological records such as minimum discharge, precipitation, and sea level.

Future efforts should look at more hydrologic data (e.g., low flow [drought] conditions). This will allow for focused analysis on the potential reasons for changes in gauge data, whether they are climatic or human-induced changes.

Future efforts should examine long-term persistence of these conclusions and how this analysis may vary over time.

IV. Conclusions/Recommendations

1. The number of nonstationary gauges in the continental United States is small and a larger sample size would allow for more statistical confidence.

2. Future efforts should look at more hydrologic data (e.g., low flow [drought] conditions). This will allow for focused analysis on the potential reasons for changes in gauge data, whether they are climatic or human-induced changes.

3. Best practice guidance should focus on the attribution of nonstationarities detected in the annual maximum discharges to specific nonstationary drivers.

4. Statistical methodologies should be applied to other hydrometeorological records such as minimum discharge, precipitation, and sea level.

5. Additional analysis should examine long-term persistence of these conclusions and how this analysis may vary over time.

6. Future efforts should examine how spatial patterns in nonstationarity clustering evolve geographically over time.