Discussion of "Probability Distribution of Low Streamflow Series in the United States" by Charles N. Kroll and Richard M. Vogel

March/April 2002, Vol. 7, No. 2, pp. 137–146.
DOI: 10.1061/(ASCE)1084-0699(2002)7:2(137)

Vijay K. Minocha[1]

[1]Assistant Professor (Environmental Engineering), Dept. of Civil Engineering, Delhi College of Engineering, Bawana Road, Delhi-110042, India. E-mail: vkminocha@indiatimes.com

The discusser appreciates the exhaustive studies undertaken by the authors in comparing the performance of the various probability distributions for low streamflow series. The authors are to be commended for their work in developing a performance measure, average weighted orthogonal distance statistic, for comparing the goodness of fit of different probability distributions. Though the efforts of the authors are laudable, the discusser is bringing forward certain observations, which need to be further clarified.

1. The authors have used the L-moment ratio diagram to identify the distribution and have used statistic "AWOD" to compare the goodness of fit of various distributions. In view of the discusser, the choice of probability distribution should not solely be based on L-moment ratio diagrams. The authors should have reaffirmed the choice of distribution using a goodness of fit measure as given by Hosking and Wallis (1997), that works directly with the L-moment statistics. This approach involves computing summary statistics from the data and testing whether their values are consistent with randomly simulated series of data based on the chosen distribution.
2. The authors have chosen the distributions based on how well the distribution fits the available data. Although the chosen distribution should be consistent with the data, but the choice of distribution should not solely be based on the distribution fitting a particular data. Even if the distribution fits a particular data well, the future values may not necessarily follow the identified distribution. Hence it is preferable that the chosen distribution should yield reasonably accurate quantile estimate even if the model's assumptions are changed in a plausible way.
3. The authors have not discussed the predictive performance and uncertainty involved in the estimated quantile estimates by the chosen distribution. The discusser is of the opinion that before final recommendation of the probability distribution, the distribution should have been checked for the accuracy of quantile estimates by estimating the bias and RMSE of the estimates using simulation procedure as given by Hosking and Wallis (1997). Upadhyaya and Kumar (1999) have used this procedure for another study.

References

Hosking, J. R. M., and Wallis, J. R. (1997). *Regional frequency analysis an approach based on L-moments*, Cambridge Univ. Press, New York.

Upadhyaya, P. C., and Kumar, A. (1999). "Use of L-moments for flood estimation at ungauged sites." *Proc., National Workshop on Challenges in Management of Water Resources and Environment in the Next Millennium*, Delhi, India, 83–89.

Closure to "Probability Distribution of Low Streamflow Series in the United States" by Charles N. Kroll and Richard M. Vogel

March/April 2002, Vol. 7, No. 2, pp. 137–146.
DOI: 10.1061/(ASCE)1084-0699(2002)7:2(137)

Charles N. Kroll, A.M.ASCE,[1] and Richard M. Vogel, M.ASCE[2]

[1]Associate Professor, Environmental Resources and Forest Engineering, SUNY College of Environmental Science and Forestry, Syracuse, NY 13210. E-mail: cnkroll@esf.edu

[2]Professor, WaterSHED Center, Civil and Environmental Engineering, Tufts Univ., Medford, MA 02155. E-mail: richard.vogel@tufts.edu

We appreciate the opportunity to clarify the issues raised by V. K. Minocha on our above referenced paper. Below each of the three points raised in the discussion are addressed.

1. The first point raised was that "The authors should have reaffirmed the choice of distribution using a goodness of fit measure as given by Hosking and Wallis (1997), that works directly with the L-moment statistics." Hosking and Wallis (1997, p. 78) state, "Given a set of sites that constitute a homogeneous region, the aim is to test whether a given distribution fits the data acceptably closely." We make no such claim of homogeneity in our analysis. Recently Peel et al. (2001) concluded, "For very heterogeneous regional data, exhibiting a large range in the distributions shape parameter [such as the lowflow data in our study], the curve of best-fit [and not the sample mean, as in Hosking and Wallis] is useful for distribution selection." The AWOD statistic employed in this study is an approach that evaluates the curve of best-fit without being forced to make subjective choices regarding the best-fit curve (as one does with LOWESS). It should be noted that one premise of the AWOD is that the penalty function for L-CV, L-skew, and L-kurtosis ratios are the same in absolute value, i.e., missing a distribution's theoretical L-skew ratio by 1 is the same penalty as missing the L-kurtosis ratio by 1. Since these are unitless descriptors with similar magnitudes, we concluded that such weighting was justified.
2. The discusser's second claim is an important point, yet appears unfounded. He suggests choosing a distribution based on its ability to provide "accurate quantile estimates even if the model's assumptions are changed in a plausible way." While the lack of moment stationarity is very important for watershed managers, ignoring this assumption requires a large leap of faith. Based on a Mann-Kendall trend test that accounts for the spatial correlation of low-flow series, Douglas et al. (2000) found a significant upward trend in 7-day

annual minimum flows in a few regions of the United States, but generally no significant trends were observed. We are not aware of published methodology to perform an analysis that assesses goodness of fit under nonstationary conditions, but agree that such an analysis would be a noble pursuit. In our analysis, an implicit assumption is the stationarity of the L-moment ratios over time.

3. In this paper we never address the issue of quantile estimation, only issues of distributional fit. There are numerous ways to assess the uncertainty of quantile estimators, but that was not a goal of this paper and thus they are not discussed here.

References

Douglas, E. M., Vogel, R. M., and Krol, C. N. (2000). "Trends in floods and low flows in the United States: Impact of spatial correlation." *J. Hydrol.*, 240(1-2), 90–105.

Hosking, J. R. M., and Wallis, J. R. (1997). *Regional frequency analysis an approach based on L-moments*, Cambridge University Press, New York.

Peel, M. C., Wang, Q. J., Vogel, R. M., and McMahon, T. A. (2001). "The utility of L-moment ratio diagrams for selecting a regional probability distribution." *Hydrol. Sci. J.*, 46(1), 147–155.

Discussion of "Testing Hydrologic Time Series for Stationarity" by Huey-Long Chen and A. Ramachandra Rao

March/April 2002, Vol. 7, No. 2, pp. 129–136.
DOI: 10.1061/(ASCE)1084-0699(2002)7:2(129)

Vijay K. Minocha[1] and Gaurav Malhotra[2]

[1]Assistant Professor, Dept. of Civil Engineering, Delhi College of Engineering, Bawana Rd. Delhi, 110042, India. E-mail: vkminocha@indiatimes.com and vminocha@rediffmail.com

[2]UG Scholar, Dept. of Civil Engineering, Delhi College of Engineering, Bawana Road, Delhi, 110042, India.

The discussers appreciate the exhaustive studies undertaken by the authors in developing their segmentation algorithm and exploring the use of tests for segmentation of data for evaluating the results in terms of stationarity of hydrologic time series. The writers are of the view that the primary aim of testing the stationarity of a series is to determine its amenability to time-series analysis. The discussers opine that stationarity of the raw data series per se is not of vital importance for final application of stochastic models. It is desired that efforts should be directed toward reducing the nonstationary series to stationarity by using suitable differencing and/or transformations (e.g., log, square root, power, etc.) and thus making it amenable to time-series analysis. For instance, Chander et al. (1980) have used the Box-Cox transformation for converting hetroscedastic (nonstationary) hydrologic time series to homoscedastic (stationary) series, which has yielded superior forecasting results.

It is strange to note that there are six series, namely, streamflow of Kamalazoo River at Fennville, Mich., temperature series of Aledo, Ill., and Evansville, Ind., and precipitation series of Urbana, Ill., Aledo, Ill., and Indianapolis, where the number of segments identified by all the tests are the same for the standardized and differenced standardized series. Therefore, first-order differencing has not induced stationarity in these series and hence is apparently superfluous. Test procedures are available for the selection of the appropriate differencing filter to obtain stationary time series (Franses and Koehler 1998; Koreisa and Pukkila 1998) and these may be applied apart from the aforestated transformations.

Further, in five of the cases, shown at serial numbers 1–5 in Table 1 here, which is derived from the results given in Table 1 of the original paper, differencing has resulted in the conversion of a series apparently identified as stationary to one that is nonstationary. In all cases enumerated in Table 1 differencing has even increased the number of stationary segments relative to the standardized series. Therefore, the discussers opine that a better understanding of the underlying process and data is required instead of mechanically carrying out differencing.

If differencing or transformation of the series does not make it stationary, then it can be justifiably concluded that the series under investigation is for all practical purposes nonstationary and hence not suitable for time-series analysis.

Further, the discussers have certain reservations on methodology as applied by the authors, and are bringing out certain points for consideration.

1. Out of the three tests used by the authors in the segmentation procedure, Tests 1 and 4 involve the assumption that the process under consideration is described by an autoregressive (AR)(p) model. It is not clear whether an appropriate

Table 1. Cases of Increased Number of Segments due to Differencing

Sno.	Station	Series	Period (year)	Test 1		Test 4		Test 5	
				DS	S	DS	S	DS	S
1	Urbana, Ill.	Temperature	1902–1992	2	1	—	—	3	2
2	Ft. Wayne, Ind.	Temperature	1948–1992	—	—	2	1	—	—
3	Minneapolis	Temperature	1891–1992	2	1	—	—	—	—
4	Ft. Wayne, Ind.	Precipitation	1948–1992	—	—	—	—	2	1
5	Region 2, Ill.	PDSI	1895–1933	—	—	3	1	—	—
6	Minnesota River at Clinton, Iowa	Streamflow	1874–1993	—	—	—	—	4	3
7	Minneapolis	Precipitation	1891–1992	—	—	3	2	4	3
8	Region 8, Ill.	PDSI	1895–1993	—	—	4	3	—	—
9	Region 2, Ohio	PDSI	1895–1993	—	—	4	3	—	—