Hydrology and Earth System Sciences Discussions

Interactive comment on "A global evaluation of streamflow drought characteristics" *by* A. K. Fleig et al.

S. Vicente Serrano (Referee)

svicen@posta.unizar.es

This paper addresses some important topics in the study of hydrological droughts: the threshold used to select the different drought episodes and the different procedures to combine "dependent" droughts. Also an approach to determine the probability of drought duration and magnitude is shown by means of the use of different distributions of probability.

The paper shows clear objectives; it is well structured and it explains and addresses with a high degree of detail the methods to identify mutually dependent droughts. The comparison of different methods and their application to catchments with different characteristics and located in different regions is a good contribution. The authors provide some quantitative and objective analysis about the criteria to select mutually depen-

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

EGU

dent droughts and to filter minor droughts. Following these approaches it is possible to obtain series of drought duration and magnitude not affected by short low flows, which are not really droughts, or by an unreal splitting of the drought periods. The paper deserves to be published in the HESS journal because it is a good contribution about these subjects.

Major comments:

1. Authors use a fixed threshold to select the drought episodes (by means of different percentiles). They also indicate that this approach can be a problem in the rivers with a marked seasonality. For this reason they suggest the use of different seasonal thresholds in some basins.

I think that to have a better identification of the drought episodes it would be more convenient the use of a non-fixed threshold (i.e., following a moving-threshold procedure). I think that the application of a standardised procedure to the river discharges previous the pooling procedure would be more convenient to avoid seasonality. This procedure could be based on the weekly/bi-weekly averages following a moving average procedure. For this purpose, the daily river discharge could be subtracted to the moving weekly/bi-weekly average for each day.

New series of differences in relation to average would be obtained and, therefore, seasonality would be eliminated. Following this approach, the drought periods could be identified independently of the streamflow regime. I think that this approach would be more correct because the drought is usually described as a deficits in the water resources (precipitation, river discharges, soil moisture, reservoir storages,...) in relation to the average.

2. After the evaluation of the pooling procedures the authors deal with a frequency analysis to determine the probability of drought episodes of a given duration/magnitude. I think that more details, analysis and discussion are needed about this subject.

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

EGU

In the Page 2445 (3rd paragraph) the authors indicate that they obtain the PDS following two thresholds based on percentiles: Q90 and Q70. They also filter the minor droughts according a duration/magnitude rule. Nevertheless, the authors do not explain if they use the whole series of drought duration/magnitude based on the 90 and 70 percentiles to obtain the probabilities or if they set a threshold to model exclusively the extreme drought events.

If the whole events obtained from Q90 and Q70 are included, it is possible that they not be modelled correctly by means of a GP distribution since the series would include non-extreme events. The adequate selection of the thresholds to obtain PDS is an important task since the results (probabilities and return periods) may change as a function of the selected threshold. This has been addressed previously by Vicente-Serrano and Beguería (2003), Beguería (2005) and Lana et al. (in press). I think that this subject should be taken into account by the authors when they calculate the probabilities and return periods of droughts of different duration and magnitude.

Page 2446, 1st paragraph: The L-moment diagrams are widely used to select the best distribution to model the PDS (i.e., Hosking and Wallis, 1997). I would recommend to include some examples of these diagrams to be sure about the best selection (distribution of probability) in PDS modelling. Also more details about the method used to calculate the parameters of the distributions should be added. Do the authors use conventional moments, maximum likelihood or L-moments?. I recommend the use of the last method due to its robustness and versatility (see Hosking and Wallis, 1987). More details about the GP distribution should be included (see Hosking and Wallis, 1987, 1997).

Page 2446, last paragraph: I think that the non-exceedence probability is not the best approach to show the drought risk. I recommend the use of return periods, exceedance probabilities or the probability that an event of magnitude/duration X will occur at least once in a period of t years.

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

EGU

In summary, I would suggest to focus the paper in those topics related to the pooling procedures, the filter of minor droughts and the creation of "true" drought duration/magnitude series. In my opinion these topics deserve an independent study without the need to include the frequency analysis of drought series. A more complete analysis and details about the pooling procedures in the different basins would be preferable than to join this to the frequency analysis of the drought magnitude/duration series.

Minor comments:

Page 2429, 1st paragraph: It is necessary to include more references about the drought concept and its nature as a natural hazard (See i.e., Obasi, 1994; Wilhite, 1993; Dracup et al. 1980). The authors list different drought types: meteorological, agricultural (authors indicate soil moisture drought) and hydrological drought. This has been previously addressed, between others, by Wilhite and Glantz (1985).

Page 2430: 1st paragraph: The authors indicate that "it can be expected that more detailed information can be obtained from a drought characteristic operating...on daily time resolution". The authors should indicate what information could be derived using daily series. Drought is the best example of a "penetrating" natural hazard, which is opposite to "instantaneous hazards" such as floods, earthquakes, tsunamis, etc. To be identified, drought needs of long water deficits during months or seasons. A water deficit of some days can not be considered as a drought. For this reason, monthly records are usually used to analyse droughts (The time scale -monthly or daily- does not involve different problems in relation to the threshold level method used to obtain the drought duration/magnitude series. Therefore, the methods proposed in the paper could be also used to obtain drought duration/magnitude series from monthly records).

Page 2431, 1st paragraph: A most complete description of the PDS and BM approaches should be included or some references about this topic be added (i.e. see Hershfield 1973; Smith 1990 and 2003; Reiss and Thomas 2001). Also the use of

the PDS is recommended because it allows to include more cases in the sample, resulting in much accurate estimation of parameters of a given distribution of probability (Madsen et al. 1997).

Page 2432, Figure 2: It would be interesting to include the variability of the hydrological regimes (measured by means of standard deviations or coefficients of variation). Variability can be more important than average in some regions/seasons.

Pages 2437-2439: The section 3.3 should be moved to the discussion.

Page 2444, Last paragraph: I think that the calculation of the number of extreme events occurring in a given time interval has not interest for the drought management. The duration/magnitude of the drought events are the most important parameter. I recommend to delete the stochastic analysis about the number of droughts and to focus the analysis in the duration/magnitude.

Page 2444, Last paragraph: Authors indicate that GP distribution can be shown to be the limit distribution of scaled excesses over a certain limit and is thus suited to model PDS of magnitudes. I would recommend to include some references about this subject. i.e. Pickands (1975) showed that the series generated by exceedances over a threshold tend to converge to a Generalized Pareto (GP) distribution. The same in the page 2445 for GEV and AMS: i.e.: Alexander et al. (1969), Kirkby (1969).

Page 2445, 3rd paragraph: Why do the authors use the 5-day IT-method as a pooling procedure to derive the PDS when previously they have indicated that the MA-procedure is the most flexible approach?.

References:

Alexander, G.N., Karoly, A. and Sust, A.B., (1969): Equivalent distributions with applications to rainfall as an upper bound to flood distributions. Journal of Hydrology 9: 322-373

Beguería, S., (2005): Uncertainties in partial duration series modelling of extremes

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

EGU

related to the choice of the threshold value, Journal of Hydrology, 303: 215-230.

Dracup, J.A., Lee, K. y Paulson, E.G., (1980): On the definition of droughts. Water Resources Research. 16: 297-302.

Hershfield, D.M., (1973): On the probability of extreme rainfall events. Bulletin of the American Meteorological Society. 54: 1013-1018.

Hosking, J.R.M. and Wallis, J.R. (1987): Parameter and quantile estimation for the generalized Pareto distribution, Technometrics, 29, 339-349.

Hosking, J.R.M. and Wallis, J.R. (1997): regional frequency analysis. An approach based on L-moments. Cambridge University press, London, 224 pp.

Kirkby, W. (1969): On the random occurrence of major floods. Water Resources Research 5: 778-784.

Lana, X., Burgueño, A. Martínez, M.D. and Serra, C. (in press): Statistical distributions and sampling strategies for the analysis of extreme dry spells in Catalonia (NE Spain). Journal of Hydrology. Available in : http://www.sciencedirect.com

Madsen, H., Rasmussen P.F. and Rosbjerg D., (1997): Comparison of annual maximum series and partial duration series methods for modeling extreme hydrologic events. 1. At-site modeling. Water Resources Research, 33, 747-757.

Obasi, G.O.P., (1994): WMO's role in the international decade for natural disaster reduction. Bulletin of the American Meteorological Society. 75: 1655-1661.

Pickands, J., 1975: Statistical inference using extreme order statistics, Annals Statistic, 3, 119-131.

Reiss, R.D. and Thomas, M. (2001): Statistical Analysis of Extreme Values, from Insurance, Finance, Hydrology and Other Fields, 2nd edition, 464 p. Birkhäuser.

Smith, R.L., 1990: Extreme value theory. In W. Ledermann (ed.), Handbook of appli-

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

EGU

cable mathematics, vol. 7, pp. 437-472, Chichester, Wiley.

Smith, R.L., 2003: Statistics of extremes, with applications in environment, insurance and finance, Dept. of Statistics, University of North Carolina, Chapel Hill, 62 p. Available on line at: http://www.stat.unc.edu/postscript/rs/semstatrls.pdf

Vicente Serrano, S.M. and S. Beguería-Portugués, (2003): Estimating extreme dry-spell risk in the middle Ebro valley (Northeastern Spain): A comparative analysis of partial duration series with a General Pareto distribution and Annual maxima series with a Gumbel distribution. International Journal of Climatology, 23, 1103-1118.

Wilhite, D.A., (1993): Drought assessment, management and planning: Theory and case studies. Kluwer. Boston.

Wilhite D.A. y Glantz, M.H., (1985): Understanding the drought phenomenon: the role of definitions. Water International 10: 111-120.

Interactive comment on Hydrology and Earth System Sciences Discussions, 2, 2427, 2005.

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

EGU