

***Interactive comment on***  
**“Intensity-Duration-Frequency and spatial  
analysis of droughts using the Standardized  
Precipitation Index” by M. Mohseni Saravi et al.**

**Anonymous Referee #2**

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The aim of the paper is to analyze historical drought events occurred in the Karoon river basin (Iran) between 1972-1999. In particular, drought occurrences are analyzed in terms of the Standardized Precipitation Index (SPI), based on rainfall data recorded at 29 stations, aggregated at 3, 6 and 12 months. Once that drought characteristics are determined with respect to each station, a spatial analysis is carried out by interpolating local values through GIS software. Furthermore, probability distributions are fitted to drought duration and magnitude series in order to derive drought duration vs. return period (TDF) and drought magnitude vs. return period (TMF) curves.

General comments

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The paper does not provide a substantial contribution with respect to the state of the art in the field of drought analysis, since it only applies a well consolidated approach for drought monitoring and characterization to a specific case study. Although the applied methods are, in general, consistent with the purpose of the study, however the authors are strongly invited to carefully revised some misleading statements reported in the manuscript, as well as to rethink some applications which, in my opinion, do not lead to proper conclusions with regard to the spatial pattern of drought events within the region under study (see specific comments below). Moreover, the scientific results could be described in a more concise and well-structured way, for instance by synthesizing the most significant values in few tables in order to lighten the discussion. Finally, some parts of the manuscript should be rearranged so that the overall organization of the work is improved. In particular, the methodological part (Section 2) and the applications (Section 3) have to be clearly distinguished in order to avoid useless repetitions. I believe that the paper is worth publishing only after major revisions.

Specific comments

Abstract

Row 14 p. 1348: The term “relationships” referred to the TDF and TMF curves is rather ambiguous, since the reader may think about derivation of analytical expressions, which is not an objective of this study. This term is repeated somewhere else in the manuscript.

1. Introduction

Several published works cited in the manuscript do not appear in the references (e.g. Girux, 2001; Zenvettor, 2000; Abenza, 1999), while in other case the publication year does not match with the references (e.g. Dalezios et al., 1991 or 2000? Hayes et al., 1998 or 1999?). Rows 23-24 p. 1350: The authors state that one of the purpose of the study is to assess the SPI capability to monitor historical droughts in the Karoon basin. This objective would imply a comparison with other monitoring tools, but none of this

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has been carried out.

## 2. Materials and methods

This section should be devoted to the description of the adopted data and methods only. Therefore, I suggest to remove any recall to the applications from the subparagraphs within this section (e.g. Fig.4 at row 23 p. 1352, Table 3 at row 2 p. 1353, etc.), as the same tables and figures are explained in depth in Section 3.

### 2.3 Analysis with the Standardized Precipitation Index

Rows 8-9 p. 1352: I do not agree with the statement that "Calculation of the SPI ... requires the good fit of a Gamma frequency distribution as the most likely probability function". In other words, it seems that SPI can be computed only if goodness of fit tests reveal that the Gamma distribution fit the data better than other distributions, which is not clearly true. Such a misinterpretation arises from the fact that McKee et al. (1993) assumed aggregated precipitation gamma distributed or that many available algorithms for SPI computation adopt a gamma distribution, but this is not a necessary condition. Row 1 p. 1353: Details on the Mean Relative Deviation test should be added or proper citations should be reported.

### 2.4 Spatial extent of droughts

The usefulness of iso-duration and iso-intensity drought maps, where the longest drought duration (Figs. 12-13) and peak intensities (Figs. 14-15) are plotted respectively, is, in my opinion, rather questionable, since they cannot provide objective elements to identify the most drought-prone areas within the region. In particular, the longest drought duration does not necessarily correspond to the most adverse drought event, as even the authors observe afterwards in section 3.1 and conclusions. Similar considerations apply to the peak intensity values as well. This is clearly due to the fact that drought is a multivariate event characterized by its duration, magnitude, and intensity, which are mutually correlated. Separate analysis of drought characteristics cannot

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reveal the significant correlation relationships among drought characteristics. At most, maps of the spatial distribution of return period of historical drought characteristics related to a specific event, as the one occurred in 1999, could be more meaningful.

TDF and TMF drought curves do not provide additional information to what is expected. Thus, I will invite the authors to neglect these applications rather than emphasize them, as in the conclusions.

### 3.1 Historical analysis of droughts

The first sentence "As said before, calculating the SPI ... requires a good fit of a Gamma frequency distribution to precipitation data" has to be removed for what has been previously mentioned. Sentence at rows 8-9 "Thus we believe that the SPI can be used effectively for analyzing drought ..." has to be removed as well. The number of drought events, namely the number of consecutive dry months preceded and followed by at least one wet month, identified for each station should be added to Table 2, in order to understand if drought duration and magnitude sample series adopted for parameters estimation of the considered probability distributions are long enough to get reliable results.

## 4. Discussion and conclusions

Details related to the drought event of 1999 should be anticipated in the introduction or after the description of the study area (section 2.1) Some conclusions are rather obvious as, for instance "The 12-month SPI iso-duration map ... shows greater durations than those based on the 3-month SPI". Then, sentence beginning at rows 28 p. 1360 seems in contradiction with the one before. Please rephrase it! Row 4 p. 1361: Sentence "These extreme droughts occur approximately only two or three times in 100 years (how can you say that? Provide evidence!), and are valuable tools for water resources managers ...". Besides, extreme droughts cannot clearly be considered as valuable tools ... please rephrase or delete! At rows 14-19 p. 1361, the authors correctly point out that extrapolation of drought events corresponding to high values of

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return periods is more uncertain when dealing with small samples. However, they state that precipitation record considered in the study is long enough (28 years) to avoid this uncertainty. Additional information has to be provided in order to support this conclusion (at least number of drought events for each station and number of dry months falling in each drought class as reported in Table 1, from moderate to extremely dry). Overall, I consider the conclusions rather poor.

#### Technical corrections

##### 1. Introduction

Rows 26 p. 1350: Replace “in plotting drought maps of the Karoon basin” with “by plotting maps of drought features related to the Karoon basin”.

##### 2.4 Spatial extent of droughts

Table 2 which shows SPI drought characteristics identified on historical series is often recalled with a wrong progressive number (e.g. as Table 1 at row 9 p. 1353, as Table 3 at row 24 p. 1353 and at rows 6 and 12 p. 1354, and so on). The same mistake also occurs in section 3. Rows 14-15 p. 1353: I suggest to delete the following redundant sentence “Considering the ... each time scale”. Rows 24 p. 1353: Replace “excluding the 3 and 6 month SPI” with “for 3 and 12-month SPI”

##### 3.1 Historical analysis of droughts

Rows 8-9 p. 1355: replace “JAMAB (Water Resources Development, Consulting Engineers of Iran) findings (1999)” with “JAMAB findings (Water Resources Development, Consulting Engineers of Iran, 1999)”. Row 20 p. 1355: Replace “during this time frame” with “for this time scale”. Row 28 p. 1355: Replace “of this time scale” with “at this time scale”.

##### 3.2 Results of TDF and TMF drought analysis

Sentence at rows 8-9 p. 1357 must be rephrased.

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##### 3.3 Spatial extent of droughts

Sentence at rows 12-14 p. 1357 is redundant with respect to previous information.

##### 4. Discussion and conclusions

All the works cited in this paragraph do not match with the corresponding ones in the References. Check carefully ! Row 7 p. 1360: Replace “influenced” with “affected” Rows 14-16 p. 1360: “The results show ...”. Something is missing in this sentence. Row 26 p.1360 and Row 4 p. 1361: Table 3 must be Table 2.

#### References

The following references do not appear in the manuscript: Bazrafshan. and Khalili (2000); Dupigny and Lesley (2001); Guttman, (1999); Hayes (2000); Wilhite (2000).

The following reference must be moved at the end of the list: Water Resources Development Annual Report, Consulting Engineers of Iran (JAMAB, in Persian), 1999.

Mahdavi, (1998) comes first Maleki Nezhad (2001).

Mckee et al. (1993) comes first Mckee et al. (1995).

Wilhite (2000) comes first Wilhite and Glantz (1985).

Table 1. Replace “Drought category” with “Classes or Classification”

Figure 1. Add “in terms of SPI” at the end of the caption.

Figure 5. In the legend 3-month comes first 6-month.

For the sake of comparison: 1) the same cross-hatching must be used in Figures 7-9 to indicate drought classes. 2) Figures 10 and 11 should have the same legend (I will also suggest to use few simple classes, for instance: 30-35 %, 35-40 %, ..., 55-60 %). Similar considerations apply to all the remaining figures.

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