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Hydrology and Earth System Sciences Discussions

Interactive comment on "Probability distribution of flood flows in Tunisia" *by* H. Abida and M. Ellouze

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Anonymous Referee 1 The objective of this study was the identification of the probability distribution that best fits flood flows in Tunisia. Regional flood frequency analysis was adopted because it yields quantile estimates with a smaller standard error than those estimated from 'at-site' data. (Mkhandi et al, 2000). The condition, of course, is that the region must be homogeneous, i.e. all locations in the region must have similar flood producing characteristics. Regional flood frequency analysis was shown to yield more accurate quantile estimates than single-site frequency analysis even for moderately heterogeneous regions (Hosking and wallis, 1988 and Potter and Lettenmaier, 1990).

Homogeneous regions are usually defined as regions having similar hydrological, climatic and physiographic characteristics, and/or flood-related variables. A homogeneous region is formed by a group of catchments that are believed to have similarities in meteorological and physiographic characteristics and therefore similarity in the hydrologic flood response. Similarities between catchments are often defined using physiographic parameters, climatic variables, and/or flood statistics. Homogeneous regions delineated on a geographical basis, however, are often not hydrologically similar. Consequently, some researchers define homogeneity in terms of flood-related variables such as normalized annual flood and coefficient of variation, which leads to non-geographical regions (Wiltshire, 1986; Burn, 1990).

Essentially, all of the approaches generally used for homogeneous region delineation are based either on some sort of geographical consideration (on the basis of general location, physiography, and weather regimes) or flood data characteristics (probability distribution, regional statistical flood parameters).

In this study, physiographic/climatic considerations and flood data characteristics were both used for the delineation of homogeneous regions. The exercise started by dividing Tunisia into three different physiographic and climatic zones, namely the North (humid to sub-humid), the centre (semi-arid) and the south (arid). In a second step, statistical tests and linear moments computed based on maximum flood flows were used to test homogeneity and identify the 'best-fit' distribution. The flow rate was chosen as the key variable because it is the output from a physical system (the watershed) characterized by complex processes, induced by an input to the system (rainfall event).

Flood frequency analysis or flood-risk estimation is an inherently statistical problem. Nevertheless, its use is sometimes criticized because it does not account for the physics of catchment processes of flood formation. But, it should be emphasized again that flood frequency analysis is focussed on the estimation of the flood peak for a given return period more than understanding physical processes and mechanisms. This does not mean that physical characteristics are neglected but they are considered to guide the statistical analysis outcome by an experienced user, acquiring a minimum knowledge on flood processes and the catchment hydrologic response as well as its variation with the physiographic characteristics and the input to the system (rainfall).

Very few studies dealt with flood frequency analysis in arid and semi-arid regions, which have their own particularities compared to humid and sub-humid zones. Furthermore, due to the lack of observed hydrological/hydrometeorological data, and for improved understanding of hydrological processes in arid and semi arid areas like Tunisia, synthesizing data by modeling is essential.

It is tempting to use the L-moment ratios in the judgement of hydrological similarity. However, a catchment may appear discordant to others in the 'pooling group' (Reed et al. 1999) because its record includes an exceptionally large event, a so-called 'outlier', rather than because the catchment is intrinsically different. It is important to scrutinize a catchment with unusual L-moment ratios for possible data error. However, where the data are valid, any decision to exclude a catchment from the pooling group must be based on hydrological properties, not on statistical properties of the sample.

A total of 49 annual flood series, representing natural hydrologic regimes, were used in this study. As suggested by the reviewer the level of significance was lowered to 1

The group size is strictly connected to the recurrence interval of the extreme flow estimation. The target pooling group size can be determined according to the 5T guideline (Jakob et al., 1999), which suggests that a pooling group should contain at least 5T station-years of data so as to obtain reasonably accurate estimates of the T-year flow quantile avoiding undue extrapolations. In this study, a total of 1134 site-years of data were used, which allows the estimation of a 0.5 annual return probability (200-year) flood, according to the aforementioned criterion. It is important to note at this stage, the 1

As recommended, the distribution of the observation periods of the different gauging stations are now included (Table 2). In general, different meteorological event types cause great floods in streams of different catchment areas. However, the study area (Tunisia) is composed of arid and semi-arid regions, which are particularly affected by flash floods induced mainly by convective storms. Furthermore, drainage area is

HESSD

4, S458–S462, 2007

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considered in the statistical analysis since it was used to compute weighted average L-moment ratios.

As a summary, even though physical processes of flood flows were not included (beyond the scope of this study), catchment physical characteristics as well as precipitation properties were directly incorporated as they affect peak floods, considered to be the hydrological response of a catchment induced by a rainfall input. Furthermore, the delineation exercise was first based on the three physiographic zones of the country, characterized by different relief, topography, vegetation cover and rainfall intensities. Drainage areas were also incorporated in the analysis since they were considered in the estimation of the weighted average linear moments. The rejected hydrometric stations, which did not pass the discordancy test, were found to be randomly spread all over the study area and the remaining preserved stations present well the different zones. The preserved data exceed 1100 site-years, allowing thereby the estimation of the 200 yr flood. All of theses explanations are now included in an unambiguous manner in the revised manuscript.

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HESSD

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Interactive Comment

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