

Interactive comment on “Hydroclimatological influences at multi-spatial scales on recently increased droughts in China’s largest freshwater lake” by Y. Liu and G. Wu

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General comments

The manuscript illustrates a multi-scale drought analysis aiming at investigating the causes of the recent increase in the frequency of severe droughts in the Poyang Lake (China). In particular, drought identification and characterization is carried out through the Standardized Lake stage Index (SLI), which is computed similarly as the Standardized Precipitation Index (SPI) (McKee et al., 1993) by using monthly lake stage series instead of precipitation series. Also, the authors apply a simple water budget equation to investigate the influence exerted by changes in both climatic and hydrologic variables in the observed drought events.

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Although the paper presents an interesting topic, it does not add any contribution to the current knowledge on drought analysis, both from a methodological and practical point of view. Indeed, the methodology does not show any novelty with respect to consolidated techniques; moreover, the case study is not original as well, as the Poyang Lake has been the subject of many studies investigating the effect of the modifications of the Three Gorges Dam on the Yangtze River and on the hydrological regime of the lake (e.g. Zhang et al., 2012 and 2014).

In addition, the proposed methodology, apart from being not novel, is, in my opinion, objectionable in several aspects, which may seriously compromise the foundation of the derived results.

Finally, from a stylistic standpoint, the paper requires an in-depth revision of the language.

Overall, I think that the paper should undergo major revisions.

Specific comments follow.

Major comments

A first criticism concerns the data set used for computing the drought monitoring index (i.e. SLI), namely monthly lake stage data at the Hukou outlet (see p. 5641, lines 7–8). Since the Poyang Lake is rather big, with a maximum area of 3860 km², I believe that the lake stage data observed at the outlet are unlikely to be representative of the variation in the water level of the whole lake. Is Hukou the only water level gauge station within the lake? If other stations are available, it would be better to determine an average water level by spatially interpolating contemporary local values. As an alternative, for the considered case study, the lake volume or the lake surface area should be considered as the reference variables in order to achieve a reliable drought analysis. Of course derivation of such variables implies the availability of bathymetric or satellite maps of the lake. As a matter of fact satellite images of the Poyang Lake

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are available from various space missions, and several studies have already applied these images to investigate the spatio-temporal change of the Poyang Lake. Maybe the authors should take into consideration the possibility to capitalize on the results of these studies to make their analysis more grounded.

Another critical point is related to the adopted time scale for computing SLI, i.e. one month (see p. 5638, line 22). In the original paper by McKee et al. (1993), monthly precipitation are aggregated on a period of k months, where k is 3, 6, 12, 24, or 48 months, representing “arbitrary but typical time scales for precipitation deficits to affect the five types of usable water sources” (e.g. soil moisture, ground water, snowpack, streamflow and reservoir storage). Although the authors consider lake stage instead of precipitation series, I think that, given the considerable size of the lake, one month time scale may be inadequate to account for drought effects on the lake storage mechanism. Besides, as for the SPI, 1-month SLI may be misinterpreted unless the seasonal variation of the lake stage are properly taken into account. In fact during the dry months where water level is normally low, large negative or positive SLIs may result even though the departure from the mean is relatively small. Perhaps a 3-month SLI would be a better choice. In any case, a sort of sensitive analysis should be carried out to select the appropriate aggregation time scale, also involving comparison with other drought indices, such as 24, 36 or 48-month SPI series.

Precipitation data from 13 weather stations within the Poyang Lake Basin (with an area of 162,225 km²) are grouped and averaged for Poyang Lake region, five sub-basins and the whole basin (see p. 5640, lines 15-19). I have two criticisms on this point. First, 13 stations are not enough to properly describe the spatial variability of precipitation over such a large region. Besides, since the areal precipitation is computed as an average, the orographic effect of mountains is totally disregarded. There are several interpolation techniques which enable to compute areal precipitation by also considering the orography of the investigated area.

With reference to the water balance, apparently all the components (i.e. precipitation, C2167

evapotranspiration, inflow and outflow) are referred to the same time period. Once again, given the large extent of the region under study, a proper lag time should be considered both between the climatic variables and the inflow (to account for the delay in the response of the major five river basins supplying the lake), and between the inflow and the outflow (to account for the storage process within the lake). In my opinion, the authors should examine this aspect in depth and check whether considering a lag time could substantially change the results reported in Tables 2 and 3.

Minor comments

The definition of drought magnitude applied in the present study should be clarified in the methodology, as in literature it can assume different meanings (see Keyantash and Dracup, 2002). In this study, drought magnitude is defined as the lower negative value in a sequence of consecutive negative SLI values preceded and followed by positive SLI values (see p. 5641, lines 10-13), which identifies a drought event. In other studies, drought magnitude is defined in terms of drought intensity, namely as drought severity divided by drought duration.

In Section 4.1, classification of identified drought events is made according to the magnitude, thus, for instance, a drought event is classified as “extreme” if there is at least one month within a drought period with $SLI < -2$. This approach sounds misleading with respect to the one commonly applied where dry and wet conditions are classified month by month, according to the values of the considered drought monitoring index. In particular, the proposed approach makes the comparison between drought events less straightforward. For instance at p. 5642, lines 21-25, the authors state: “Among the five droughts in the “moderate drought” category, the longest occurred from October 2003 to August 2004, lasting 10 months. Although it was classified as a moderate drought by magnitude, its drought severity was comparable to the second most severe one ...”.

Technical comments

p. 5634, lines 6-7: "This study proposes to use a multi-scale hydroclimatic analysis for the determination, taking Poyang Lake as an example.". Determination of what?

p. 5634, lines 11-12: "At the lake region, water deficiency severed as the hydroclimatic foundation for the worsening droughts". Awkward! Please rephrase the sentence.

p. 5635, lines 17-18: "both inflow and outflow may alter with anthropogenic influences". Awkward! Please rephrase the sentence.

p. 5636, lines 15-17: "If the River's blocking effect weakens, more lake water will flow out into the river (Shankman et al., 2006; Hu et al., 2007; Guo et al., 2012), thus making it more complicated to determine the controlling causes of the increased lake droughts." The possible causes of the weakening of the river's blocking effect should be mentioned here.

p. 5636-5637, lines 29: "This study proposes ...". Again, determination of what?

p. 5637, line 4: change "hydrocliamtic" into "hydroclimatic"

p. 5637, line 19: delete "normalized" before "monthly precipitation" as it is repeated right after.

p. 5638, line 22: "... as did in Keyantash and Dracup (2002)". I do not think that reference to the work by Keyantash and Dracup (2002) is appropriate here. Please check wheter Keyantash and Dracup used 1-month SPI in their study!

p. 5641, line 26-27: "Because both the lake precipitation and evaporation occupy less than 2

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