Hydrol. Earth Syst. Sci. Discuss.,
doi:10.5194/hess-2016-184-AC2, 2016

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Changing patterns of extreme water levels in urbanizing plain river network region of Taihu Basin, China: characteristics and causes" *by* Y. Wang et al.

Y. Wang et al.

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Received and published: 4 August 2016

This paper presents an analysis of daily rainfall and water level data for the period 1960 to 2012 for the Taihu basin, in the delta region of the Yangtze river in China. The aim is to detect changes in annual minimum and maximum water levels over the study period and to see whether changes can be attributed to changes in precipitation patterns and/or to anthropogenic impacts. While the dataset is rich in that it includes data for 24 rain gauges and 8 water level gauges, most of the analyses seem to be based on single water level and rainfall time series, representing either a single gauge or an average over all gauges (this is not clear from the text). Basic statistical tests are performed for trend analysis and detection of change points in the time series of

annual maxima and minima. Then, an attempt is made to attribute detected changes to precipitation and anthropogenic influence. The latter is based on small datasets (the original dataset is split into two), which provides a weak and, in my view insufficient, basis to support conclusions drawn from this analysis.

Author answer: We really appreciate this Reviewer's valuable and constructive advice on our manuscript. It will greatly help us to improve the quality of our manuscript. In original manuscript, the analysis is mainly based on the regional average water level. After considering the Reviewer's suggestion, we found it was not appropriate to study extreme water level like that. We will reanalyze extreme water level through single water level series in our revised manuscript. What's more, in Section 4.2, we will divide the whole time series according to decade scale (i.e. 1960-1969, 1970-1979, 1980-1989, 1990-1999, 2000-2012) and relevant paragraphs also will be rewritten.

The paper would greatly benefit from more extensive analysis of the available datasets, including an explicit analysis of data from the individual gauges and looking more deeply into relationships between rainfall and water levels across the basin. One of the key aspects of this study is analysis of anthropogenic impacts on the hydrological system, which are associated with rapid urbanisation over the past decades. This relationship is studied in a rather indirect way (based on the annual data series) and has a spatial aspect that is not touched upon in the paper. With the available data, there seems to be room for analysis of spatially varied urbanisation impacts across the basin (since it is likely that urbanisation is no-homogeneously distributed across the basin, one would expect different impacts on water levels at different gauges over time).

Author answer: Thanks for the constructive comments. As we all know, urbanization area is not homogeneously distributed across this region. Considering the Reviewer's advice, we will try to explore what relationship it is between urbanization distribution and the alteration of water level in our revised manuscript.

Comments per section:

1. Introduction: - In their discussion of references, the authors refer to water level as one of the relevant hydrological parameters. The reason why they do so, is because they will be analysing water levels, not flows, in their study. This is however not explicitly mentioned, which makes the description in the first 2 paragraphs somewhat confusing. I would suggest to first present relevant literature, then explain specifics of water level instead of flow as a relevant parameter for delta regions, where storage (water level variation) dominates over flow.

Author answer: Thanks, this valuable comment will make the introduction more logical. We will reconstruct this section according to the Reviewer's suggestion.

2. - P2, line 23: what do the authors mean by "criss-cross river network with a density of 3.2 km/km2", is this a river network density? In general, this paragraph (lines 23-35) needs to be restructured in a more logical way.

Author answer: Thanks for this comment. It is the unit of river density. River density is the total length (km) of river networks in unit basin area (km2), which was firstly introduced by Horton (1945). We also will rewrite this paragraph in a more logical way when we revise it.

3. Study area and data source: - P3, lines 20-21: please report period for which the percentages are reported.

Author answer: We will rewrite this sentence in revised manuscript according to the Reviewer's suggestion.

4. - P3, line 30: it is stated that Thiessen polygons were used to calculate regional extreme water level series. First, this does not seem to be an appropriate method for interpolation of water levels and second, it is not clear why this interpolation was done, since later analyses seem to be based on single data series?

Author answer: Thanks for this valuable advice. In original manuscript, the analysis is mainly based on the regional extreme water level series, and some trend analysis was

also detected for single series. After considering the Reviewer's suggestion, we found it was not appropriate to study extreme water level like that. We will reanalyze extreme water level through single water level series in our revised manuscript. Moreover, some relevant paragraphs also will be rewritten.

5. - P3, lines 27 and 32: please report type of gauges for rainfall and water levels, data resolution and data gaps, if any.

Author answer: In this study, the water level and rainfall are both daily scale data. Both of them are with no data gap. Water level is collected from eight national hydrologic station and rainfall data is collected from national precipitation station. In addition, we also will add some sentences to make data sources clear.

6. - P4, lin1: please specify "some other data" – what land use data, river network data and how these were used in the analysis Methodology.

Author answer: Thanks for this comment. In this study, land use and river network data are mainly used to reflect changes in human activities. Due to the rapid urbanization, landscape and river system have been changed dramatically in this region. Land use data and the area of each type were extracted from three periods of TM images in 1991, 2001 and 2010 provided by the US Geological Survey. River networks were extracted using three periods of topographic maps (1:50000) in the 1960s, 1980s and 2010s. These human activities have an important effect on hydrological factors, such as water level. Therefore, we conduct a comprehensive analysis on these data in discussion section. What's more, some specifications on these data will be added when we revise it.

7. - In section 3.2, the dataset is split into 2 separate periods to study water level changes. The resulting sub-datasets are very small in size, thus insufficient to support statistical analysis. Also, the assumed relationships between precipitation and water level are far too simplistic to draw valid conclusions from the results.

Author answer: Thanks for this valuable suggestion. Considering the Reviewer's suggestion, we will divide the entire period according to decade scale (i.e. 1960-1969, 1970-1979, 1980-1989, 1990-1999, 2000-2012). According to the Reviewer's advice, it is not appropriate that we just used annual precipitation to estimate extreme water level. So we will select the precipitation and evaporation to build the relationship between extreme water level and climate factors, and the relationship equations also will be built according to dry and wet seasons respectively, which means that the climate factors of wet season are used to estimate maximum water level and the climate factors of dry season are used to estimate the minimum water level. In addition, relevant paragraphs also will be rewritten in our revised manuscript.

8. Results and discussion: - At several points in the discussion, authors draw conclusions on the impact of climate change and human activity on water levels which are not well justified by the results.

Author answer: Thanks for the comment. In Section 4.3, we have made a comprehensive discussion about climate change and human activity on water level changes in this region. According to the Reviewer's suggestion, we will reconsider some expression of conclusion and reconstruct the paragraphs according to reanalysis results. Meanwhile, some necessary references also will be cited to make the manuscript more logically and clearly.

9. A more critical analysis and discussion of results is required (for instance on page 6, lines 25-26; page 7, lines 10-11 and lines 26-27)

Author answer: Thanks for the comment. We will rewrite these sentences and add more critical analysis in our revised manuscript.

10. - Section 4.2: as mentioned earlier, the number of data points seems to be too small to draw these conclusions.

Author answer: Thanks for this comment. Considering the Reviewer's suggestion,

we will divide the period according to decade scale. Some details can be referred to Comment 7.

11. - Section 4.3: lines 27: please check numbers for urbanisation, they do not match and seem to be rather low compared to the size of the basin (7929 km2).

Author answer: Thanks for this comment. We have made a mistake about it. The urban land area should be 2481 km2. We have corrected it in our revised manuscript.

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