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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Analysis of causes of decreasing inflow to the Lake Chad due to climate variability and human activities" *by* Rashid Mahmood and Shaofeng Jia

Anonymous Referee #2

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In this manuscript the authors investigate the climatic variability and quantify the separate and combined impacts of human activities and climate change on the streamflow of Lake Chad basin from the period 1951-2015. They applied statistical trend tests and hydrological modeling. The results showed increasing trend in mean temperature, and decreasing signals in precipitation, with a decreasing trend of streamflow to Lake Chad. Furthermore, the impacts of human activities for the reduction of streamflow is more substantial than the impacts of climate variability. In general, the topic is scientifically challenging and is relevant for proper water resource management.

The differentiation between climate impact and human impact on the river discharge

into Lake Chad is performed in a rather simple way. A baseline period ("normal" climate before the detected breakpoint in 1971) is defined and the hydrological model is calibrated and validated for this period. For the remaining period up to present conditions the model is rum with the calibrated parameters. The deviation between the measured and the simulated hydrographs after the breakpoint is associated to human impact. This approach is intriguing, but has to be proved in a more rigorous way. Missing points are (see also my comments in the paper (pdf)): 1. Estimation of the uncertainty of the hydrological model (sensitivity of the parameters), 2. Interpolation and associated uncertainty of the meteorological input variables, 3. Cross checking of the results by incorporating the irrigation areas into the hydrological model.

The conclusion that water transfer from the Congo River is the best solution is not scientifically proven. There are many other options in the framework of Integrated Water Resources Management. The authors should skip this conclusion (It is not part of the paper) and write a second paper about it.

Further comments, which are not included directly into the pdf:

1. On page 5, L11-L12: monthly data of 11 meteorological (six for the period of 1950–2013 and other for 1985–2013) stations and 7 hydrometric stations (four for 1997–2007, two for 1951–2007, and one for 1951–2013) were collected from the Lake Chad Basin Commission (LCBC). However, on page 14, L6-L7, only the three stations of TM and PP were compared with CRU data for validation using statistical indicators. As the study area is very large, spatial variability is expected, and hence, validation of CRU data at three stations is not enough to capture the spatial variability.

2. On page L26-L28, the surface area of LC is decreased from 25, 0000 km 2 to 300 km2 in the 1980s. Moreover, the lake was divided into two parts in 1975 because of devastating drought over the African Sahal belt. This showed that climatic variability has a great impact on the hydrology of the Lake Chad. However, the findings of this paper is different (i.e. on the whole, an average decrease of 40% was estimated due

to climate variability and human activities for the period of 1972–2013, of which 66% of total decline was due to human activities and 34% due to climate). It is hardly possible to find a justification that can prove your model result. How do you explain this contradiction?

3. The potential impacts of irrigation projects are usually carried out during feasibility studies and detailed design of the irrigation fields. Please cite the outcome of these (governmental) studies and explain why the impact of the irrigation on discharge is higher than estimated.

4. Deficit and constant loss method that you used for your HEC-HMS model is referred to as event model in the HEC-HMS technical reference manual on page 40. This event model simulates behavior of the hydrologic system during a precipitation event while soil moisture accounting loss model is a continuous model that simulates both wet and dry weather behavior. So, base flow simulation during the dry weather might be questionable in your model?

5. HEC-HMS model is a lumped model in which spatial variations are averaged or ignored. Hence, the application of HEC-HMS for such large area (967,000 km2) considering the same landcover, soil type and other catchment characteristics might have an effect on the result.

6. Why human impact becoming dominant for the decreasing of the streamflow? How much water is extracted for irrigation will help to understand the implication of separate human activities as recommended by this manuscript. The role of evapotranspiration combination of both human and climate variability is also missing.

Minor comments a.. Description of study area is too much and there is a redundancy in different section of the manuscript which sometimes confused to understand. b. On page 2, L21....only in the last century (906-2015)... what is 906?? c. On page 2, L30... 1973-105... "105" may be error d. In the manuscript the word "streamflow"; " flow" and "runoff" used interchangeably. So, better to used one word consistently e. time

period for analysis is not consistent for instance, 1951-2015, 1951-2016, 1951-2013.... f. On page 6, L16 911000 km2 is mentioned which is different from 967000km2 g. On page 6, L26-L27, for each subbasin, meteorological variables were obtained by taking the average of all CRU grids covering that basin. How do you deal about the spatial variability of the climate? why not used some interpolation techniques? h. Figure 3 is not clear, needs improvement

Please also note the supplement to this comment:
https://www.hydrol-earth-syst-sci-discuss.net/hess-2018-139/hess-2018-139-RC2-supplement.pdf

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