Response to the reviewer's comments - hess-2019-618

The authors would like to thank the reviewers for their constructive comments that helped to improve the quality of the manuscript. Our point-by-point responses for the reviewers' valuable comments are listed below.

Reviewer 2:

The manuscript is about using Budyko method and HBV model to investigate mean annual streamflow changes, due to climate variation and human influence, in the important Karkheh River Basin in western Iran. Although this manuscript is an interesting study but this study doesn't identify any major contributions in terms of process understanding or developing new methods. However as stated in the manuscript, authors claim that their approach combining HBV and Budyko is novel and for the first time used in Iran. However, the knowledge gap/novelty and the importance of this work is still missing throughout the whole manuscript and it needs to be clearly stated.

Thank you for the detailed review and pinpointing shortcoming of the manuscript.
Although, we admit that all the methods including the Budyko, HBV, DBEST, and satellite image processing used in this study are separately developed in previous studies, our manuscript introduces a novel combination of these methods such that a new, more robust framework of separating human vs climate variation effects on streamflow of large river basins in the data-scarce area is presented.
As mentioned, this is the first time that Budyko analysis is implemented in the Iranian catchment. The case study is one of the most important catchments in the country and ironically there is the lack of studies investigating separate impacts of human activities and climate change in the area. In any case, the study offers a new approach for data scarce areas to quantify effects of climate change versus anthropogenic influence. This involves a technique to validate the Budyko method with remote sensing analyses. None of the previous studies mentioned by the reviewer has applied satellite remote sensing techniques to quantify land use changes over a long period of time for verification of the Budyko and HBV modelling results. We firmly believe that this is one of the major contributions of this study to the methodological approaches in the field of hydrology.
Also, as a novel approach, we used the newly developed DBEST algorithm for detecting breakpoints. DBEST uses a (novel) segmentation algorithm for detecting and characterizing significant breakpoints, and has a general designation making it suitable for different time series data inputs. It has been applied successfully in several other studies and this paper shows its suitability for streamflow change detection. Not mentioning that the introduction of the DBEST method here is important because it is new in

hydrological studies and specifically relevant in Budyko applications for a more reasonable, systematic selection of time periods to be compared.

The method section is too long with elaborated with details. In other hand, the discussion (section is too short and general repeating the same message said earlier rather than putting the results from this study in a broader context of studies in similar regions and worldwide.

The methodology and introduction sections have been revised and presents more precisely now. The discussion part was extended by adding more detailed discussion as suggested.

In the conclusion, authors claim that "The outcome of this study can be used to assist policymakers and water professionals in proposing a proper water management plan to prevent the further reduction of streamflow and groundwater storage". How the results of this study would help policy makers to prevent reduction of streamflow and groundwater storage? When the results show that we have a combined effect of both human (increased irrigated area and reduction of forests), and climate (decreasing annual precipitation) on streamflow reduction almost all over the basins.

Although it might be difficult to manage the impact of climate variation at the local scale, with a better understanding of the human activities' impact on water quantity, it is possible to introduce better management plans, such as improved agricultural management methods and urbanization control to limit the inverse impacts. These discussions are added to the revised manuscript.

Authors need to work properly with all figures for instance order of figures should be improved, authors refer to figure 2 and then figure 9 and then back to figure 3. Figure 11 can be removed from the discussion part and Figure 12 is not necessary.

Thank you for the suggestion. Your comment has been implemented in the revised version of the manuscript.

This a big assumption in this work that streamflow has not been influenced by human activities before the breakpoint. Please clarify!

As mentioned earlier, the applied procedure is a common method which has been employed by other researchers such as (Hu, Liu et al. 2012; Sun, Tian et al. 2014; Chang, Zhang et al. 2016). However, your valuable point has now been discussed in the limitation sub-section on page14- line415, in the revised manuscript.

Additional References (added to the revised manuscript):

Chang, J., H. Zhang, Y. Wang and Y. Zhu (2016). "Assessing the impact of climate variability and human activities on streamflow variation." Hydrology and Earth System Sciences **20**(4): 1547-1560.
Hu, S., C. Liu, H. Zheng, Z. Wang and J. Yu (2012). "Assessing the impacts of climate variability and human activities on streamflow in the water source area of Baiyangdian Lake." Journal of Geographical Sciences **22**(5): 895-905.
Sun, Y., F. Tian, L. Yang and H. Hu (2014). "Exploring the spatial variability of contributions from climate variation and change in catchment properties to streamflow decrease in a mesoscale basin by three different methods." Journal of Hydrology **508**: 170-180.
Wu, J., C. Miao, X. Zhang, T. Yang and Q. Duan (2017). "Detecting the quantitative hydrological response to changes in climate and human activities." Science of the Total Environment **586**: 328-337.
Zeng, S., J. Xia and H. Du (2014). "Separating the effects of climate change and human activities on runoff over different time scales in the Zhang River basin." Stochastic environmental research and risk assessment **28**(2): 401-413.
Zhang, Q., J. Liu, V. P. Singh, X. Gu and X. Chen (2016). "Evaluation of impacts of climate change and human activities on streamflow in the Poyang Lake basin, China." Hydrological Processes **30**(14): 2562-2576.