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Interactive comment on "Dynamics of green and blue water flows and their controlling factors in Heihe River basin of northwestern China" *by* Kaisheng Luo and Fulu Tao

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Dear Sir: We are very grateful for your insightful comments and suggestions, which have improved our manuscript. We have revised the manuscript based on your comments. We hope that it would be accepted for publication in HESS. Our responses are in blue. Thank you once again. Yours truly, Fulu Tao

1 Comment: Basically, the authors ground their analyses on the use of the Soil and Water Assessment Tool (SWAT) and employ diverse metrics (which are not 5 statistical approaches, as claimed by the authors) to assess the goodness of their results. Response: Yes, we applied 5 statistical approaches, including the Mann–Kendall (MK) trend test, the sequential Mann–Kendall (SMK), Theil–Sen method (TS), Determination

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coefficient of linear regression (DC) and Hurst index (H) to validated the use of SWAT model for the basin. 2 Comment: The level of scientific originality of the study, in terms of theoretical developments and conceptual advancement, is rather limited. Response: Traditional studies on the water resources pay little attention to the ecology water use, so Falkenmark (1995) first introduced the notions of blue water and green water and this scope became the research hot spot. Many scholars have undertaken related studies since the appearance of this notion and this scope has made great progress. However, county-level studies of green and blue water flow were rare. County-level blue and green analysis is quite important and informative for water managers to formulate specific and suitable strategies. The regional/basin studies can give us a big picture, and develop adaptive strategies for addressing the possible risks does need the local studies because all these strategies/schemes need to be implemented at level of county. In practice, there is an urgent need for decision makers to understand the green and blue water flow in each county. However, little previous researches focused on this scale and there is lack of a method and framework for the assessment of green and blue water flow at county-level. In this study, we specially focused on the county scale and develop a framework for the assessment of water resources including blue and green water and the total flow, combing SWAT hydrological model and statistical methods. Based on this framework, we mainly analyzed the dynamics of above-mentioned water variables for eleven counties in the Heihe River Basin of China during 1980-2009 and further identified their controlling factors in each county. There is little knowledge of county-level green and blue water flow, especially the controlling factors. Our study found that the dynamic and controlling factors vary considerably over counties, which are different from the region-level and basin-level findings. Meanwhile, this study provides the reference for further studies on the county scale in other regions and basins. Therefore, this paper is supposed to contribute greatly to theoretical developments and conceptual advancement. 3 Comment: Additionally, the relevance of the diverse quantities which are considered as potential controlling factors is tested with methods which do not assess the contribution of each of these

factors to the variability of the target state variable. Response: A large number of publications in the literature deal with the influence factors of water resources, e.g., green flow and blue flow on global or regional scales. However, there is currently only limited knowledge which factor control the green and blue water flow on county scale. Specially, the county-level assessment of blue and green water flows was lack of a standardized evaluation method and cannot obtain much reference from previous literature. But there are many questions needed for satisfactory answers. Whether the dynamics of green and blue water are inconsistent with the basin and region? What spatial variations are there in the dynamics of county-level green and blue water flow? What future trends in these dynamics? Which is the controlling factor for each county within basin? What is the pattern of controlling factors within a basin? In this paper, we have tried our best to overcome these difficulties and answer the above mentioned concerns in study area yet. Here, our work is supposed to much contribute to study on the assessment method and contents of county-level water resources. Therefore, our study can be perceived to be fully innovational and insightful. Most of time, it is enough to know the controlling factor of county-level water resources for policy makers and water resource managers. It would be interesting to quantify the contribution of the influence factors of county-level green and blue water flows in further study in future, which calls for more experiments and new method to make it. However, it is beyond the topic in this paper. 4 Comment: As such, it provides at best an incomplete picture and does allow to draw general conclusions nor to obtain a robust and quantifiable uncertainty assessment. It is also not clear how the authors include quantitatively issues such as measurement uncertainty in their analyses. Response: I would like to say that it is impossible to build a complete picture though a study only, because any progress in science is attributed to many experiments from so many researches over long time. The aim of our work is to address some problems and make some progresses in this scientific scope and hope this study served as a wake-up call to the scientific community and more scholars alike to focus on the study of county-level water resources. Our conclusions obtained from experiment are new and interesting,

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rather than general conclusions. Those conclusions were displayed in the Conclusions Department of manuscript. Such as the abrupt changes in the three water flows were mainly affected by the China's water transport project "Heihe River basin allocation project" respectively initiated in 1992, 1997 and 2000. For instance, at Qilian and Shandan counties, rainfall was the controlling factor of the blue water flow, green water flow, total flow. Please see the Conclusions Department in manuscript. As for the measurement uncertainty, in fact, we do many works during experiments which include yearly and monthly calibration and validation of hydrological model and comparing the simulated evapotranspiration (green water) with measured evapotranspiration by remote sensing technology. Given the length limit of manuscript, the state is not enough detail in 3.1 department of manuscript. In this paper, the Nash-Sutcliffe efficiency coefficient (NS), coefficient, percent bias (PBIAS) and RMSE-observation standard deviation ratio (RSR) (Awan and Ismaeel, 2014; Krause et al., 2005; Moriasi et al., 2007; Troin and Caya, 2014) were used to assess the reliability and accuracy of the model simulation. Meanwhile, as discussed by Moriasi and Arnold (2007), on the monthly scale, a model simulation is rated as good if $0.65 < NS < 0.75$, $0.50 < RSR < 0.60$ and $\pm 10\% < PBIAS < \pm 15\%$. A model simulation is judged as satisfactory if $0.50 < NS < 0.65$, $0.60 < RSR < 0.70$ and $\pm 15\% < PBIAS < \pm 25\%$ (Moriasi et al., 2007). Base on this, we did not present the results of uncertainty analysis on year scale. As a matter of fact, the hydrological performance is better and the uncertainty is smaller on the year scale than that on the month scale. In the revised version, we added the content in yearly uncertainty estimate and in more details and stated uncertainty analyses in 3.1 section. 5 Comment: Given the above issues, and considering the significantly application-oriented nature of the work, I would recommend it to be released from HESS. Response: Response: In this paper, the aim is to propose a new method and develop a new framework for the assessment of green and blue water at the county level, combing SWAT hydrological model and statistical methods. The application in Heihe River Basin of China is to carry out and verify the new method and framework. Our work also conforms to the aim and scope of HESS

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(http://www.hydrology-and-earth-system-sciences.net/about/aims_and_scope.html). Therefore, this paper is suitable for publication in the Hess. We have revised the manuscript based on the comments. We hope this paper can be accepted for publication in the HESS. Reference: Awan, U. K. and Ismaeel, A.: A new technique to map groundwater recharge in irrigated areas using a SWAT model under changing climate, Journal of Hydrology, 519, 1368-1382, 2014. Falkemnark, M.: Coping with Water Scarcity under Rapid Population Growth: paper for the conference of SADC water ministries. Pretoria, 1995. Moriasi, D. N., Arnold, J. G., Van Liew, M. W., Bingner, R. L., Harmel, R. D., and Veith, T. L.: Model evaluation guidelines for systematic quantification of accuracy in watershed simulations, T Asabe, 50, 885-900, 2007. Troin, M. and Caya, D.: Evaluating the SWAT's snow hydrology over a Northern Quebec watershed, Hydrol Process, 28, 1858-1873, 2014.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/hess-2016-241/hess-2016-241-AC1-supplement.zip

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