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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: However, I regret to say that neither the proposed methodology Response: Most of the previous studies have focused on the streamflow and groundwater that can be directly used for human activities. Since the concept of green and blue water was introduced by Falkenmark (1995), green/blue water research has become more and more diversified, especially after Falkenmark and Rockstrom (2006)

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conceptualized a wider green-blue flows approach for water-resource planning and management. Many novel research methods have appeared as well. Recent studies have focused mainly on developing a concept or theoretical, developing simulation models and estimating quantities. However, County-level studies were rare. There are several studies about green and blue water at world, country, and basin scale. These studies were limited to regional scale and thus common results may not be derived for county-level assessment. County-level blue and green analysis is quite important and informative for water managers to formulate specific and suitable strategies. We admit that regional/basin studies can give us a big picture, but developing 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 especially 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, which was a priority focus of the research and a problem that needed an urgent attention for water management.Chinese government also provided many fund for addressing this problem. In this study, we proposed a framework and method for the assessment of green and blue water at the county level, combing SWAT hydrological model and statistical methods. Based on this method and framework, we assessed the green and blue water in the Heihe River Basin of China during 1980-2009. This study provides the reference for further studies on the county scale in similar regions and basin. Therefore, this paper is supposed to contribute greatly to the methodology that can assesse the county-level green and blue water in arid and semiarid basins. 2 Comment: The author present mainly an application of SWAT in combination with different standard statistical methods to assess trends in simulated green and blue water components. Response: In this study, we proposed a framework and method for the assessment of water resources including blue water, green water and total water. The Heihe River Basin is just the experimental site used to verify our methodology, where the county-level assessment of water resources due to climate and land use change

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needs urgent analysis for the water planning and management. Our work is also not just a case study, but provides reference for further studies to estimate the water resources at county level. Therefore, this paper mainly proposed a new framework and method for the assessment of water resources at county level and then turn out the feasibility of this method by experiment. 3 Comment: The presentation of the model results is very brief (0.75 pages), the author mainly declare that their model is suited for the objective of their study and start straight away discussing the trends in simulated flows. Response: In the beginning, in view of the limitation of paper lenghth, the model results did not be presented and discussed in details. We have done 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. Based on this suggestion, in the revised version, we have stated the model results in 3.1 section in details. 4 Comment: Contrary to the author's statement, I found their results are not so convincing. For instance the authors evaluate their model on a monthly basis, regardless of the fact that river discharge reveals a strong seasonal pattern. In such a case, and as discussed by Schaefli and Gupta (2007), the null model is not the overall mean of the discharge, but the mean annual cycle of daily discharges. A proper evaluation implied either to benchmark the model against predicted deviations from the annual cycle, or to work at the daily scale. Response: Although Schaefli and Gupta (2007) discussed the Nash–Sutcliffe efficiency measure when reporting the results of a catchment modeling study, these conclusions from this paper can not be used to judge our model. Because this paper discussed the defect of Nash–Sutcliffe efficiency measure when we only use the NS to estimate the model. If we only used the NS to estimate model results, we will ignore the seasonal pattern of river discharge. In our work, we have considered the influence from seasonal pattern, because we used four indexes including the Nash-Sutcliffe efficiency coefficient (NS), coefficient, percent bias (PBIAS) and RMSE-observation standard deviation ratio (RSR) (Awan and Ismaeel, 2014; Moriasi et al., 2007; Troin and Caya, 2014) to estimate the model results. Moriasi and Arnold

(2007) developed comprehensive Standardization guidelines for model evaluation. According to this literature wrote, on the monthly scale, a model simulation is rated as good if 0.65 < NS < 0.75, 0.50 < RSR < 0.60 and ±10% < PBIAS < ±15%. A model simulation is judged as satisfactory if 0.50 < NS < 0.65, 0.60 < RSR < 0.70 and ±15% < PBIAS < ±25% (Moriasi et al., 2007). The simulation effect is by Moriasi and Arnold (2007) when RSR belongs to 0.60-0.70 and NS belongs to 0.50-0.65. Base on this, we did not present the results of uncertainty analysis on year scale. Base on this, we did not present the model evaluation results on the year scale. As a matter of fact, we evaluated the model on both of monthly and yearly basis during processes of experiment. And our model evaluation show that the hydrological performance is better on the year scale than that on the month scale. However, we added the content in estimate of yearly model results and stated in 3.1 section based on the suggestion. Meanwhile, in order to ensure convincing, we further assessed the accuracy of simulated actual evatranspiration by observed actual evapotranspiration from remote sensing observed for 2000, 2005, 2006, 2008 and 2009 year. We used relative error to estimate the results of simulated actual evapotranspiration. The comparison showed the SWAT model performance was good, with relative small error. The content was presented in 3.1 section. Therefore, the results are convincing. 5 Comment: Secondly, the authors compare simulated and annual ET totals to underpin that their model is well suited to discriminate green and blue water flows. Firstly, I wonder how the authors estimated ET annual totals, unfortunately the manuscript does not provide any information on the data sources which are used to drive and test the model. If their ET estimation is based on the long term water balance (P-Q), this cannot be regarded as independent assessment. Response: The actual evapotranspiration (ET) used to validation is observed actual evapotranspiration from remote sensing , rather than water balance (P-Q) . These data get Chinese official recognition and can be downloaded from West Data Center of China (WDCC, http://westdc.westgis.ac.cn/) . To ensure accuracy, we further assessed the accuracy of simulated actual evaportranspiration by observed actual evapotranspiration from remote sensing observed during 2000-2010

in the revised manuscript. 6 Comment: Secondly, one cannot conclude to have a model which reproduces green water flow dynamics well, without comparing the model against dynamic data. Response: Model calibration is the process of estimating model parameters by comparing model predictions (out-put) for a given set of assumed conditions with observed data for the same conditions. Model validation involves running a model using input parameters measured or determined during the calibration process. According to Refsgaard (1997), model validation is the process of demonstrating that a given site-specific model is capable of making "sufficiently accurate" simulations, although "sufficiently accurate" can vary based on project goals. If the performance of hydrological model we build is acceptable using the meansured data during calibration and validation periods, the model we build can be used to carry out the special goals. Our estimation results indicate the performance of model we build is good, so the build model can be applied into our study. Therefore, we have changed this sentence. Please see the 3.1 section in the revised manuscript. 7 Comment: The authors might consider either to largely enhance the scientific depth of their study or to submit their work to a more applied journal. Response: We have largely enhanced the scientific depth of our study based on your 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. Falkenmark, M. and Rockstrom, J.: The new blue and green water paradigm: Breaking new ground for water resources planning and management, J Water Res Pl-Asce, 132, 129-132, 2006. 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. 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

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Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/hess-2016-241/hess-2016-241-AC2-supplement.zip

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