

**Interactive comment on “Assessment of spatial and temporal patterns of green and blue water flows in inland river basins in Northwest China” by C. F. Zang et al.**

Anonymous Referee #2

Received and published: 8 June 2012

**General comments:**

The study applied the SWAT model for the simulation of green and blue water flows in the Heihe river basin in the arid region in China. The model was run for the ‘natural conditions’, i.e., without consideration of the human interventions, e.g. land use, irrigation, field management, etc. The authors stated that the ‘results are helpful for formulating reasonable water policies to improve water resources management in the river basin’. As the authors acknowledged at the end, however, the water resources distribution in time and space has been significantly altered by human activities in the basin. This has led to significant deviations of the green and blue water flows and transformations from the natural conditions in the basin. Hence the ‘natural status’ simulated by the model would not reflect the reality. Given this situation, solely providing a simulation with a straightforward application of a well-established and widely used hydrological model in the Heihe river basin may have limited scientific and practical value as it neither advances the understanding of the hydrological process on the river basin scale, nor helps formulate the ‘reality-based’ measures to improve the water management of the basin. Having said that, I do think that the paper has a good potential for improvement by taking into consideration the ‘reality’ in the assessment. For this reason, I strongly suggest the authors to use this current study as the base, and go further to incorporate the human activities, particularly land

use and irrigation, into the model simulation. By doing so, the extent of the impact of human activities on the hydrological cycle and the green and blue water flows can be quantitatively investigated on the spatial and temporal dimensions. The results would then have good policy relevance and are useful for the water planners to formulate the appropriate measures to meet the challenges.

**Authors' response:**

We thank the reviewer for the comments. We agree with the reviewer that the spatial and temporal distribution of water resources in the Heihe river basin has been significantly altered by human activities. This has led to large deviations of green and blue water flows and transformations from what can be expected under natural conditions. However, based on a literature review, we found that many studies have paid attention to the influence of human activities, but have often ignored research into ecosystem states under natural conditions. Using hydrological model simulations to characterize natural conditions is an overlooked area of research. The results of such simulations can be used as a reference to inform researchers and policy makers about the original state of a river basin and a baseline to study the extent to which human have modified the natural river ecosystems, especially in data-poor regions. The aim of our current research was to establish a benchmark for the natural flows of water in the basin and to 'study the temporal and spatial distribution of green and blue water under natural conditions'. Certainly, the effects of human activities are also of importance, and this will be the next step of our research.

To better reflect the main aim of the paper we have adapted the abstract as well as the objectives of the paper. (See page 5 line 14-25 and page 6 line 1-5 in the revised version)

**Specific comments:**

In the introduction, the authors need to state the major research gaps in the literature

relating to their study. This is important to warrant a need for conducting such a study. It is particularly important to address the scientific significance of the study as the paper is seeking for publication in the reputable international scientific journal. The objectives of the study relating to the research gaps need to be explicitly stated in the introduction.

**Authors' response:**

The major research gaps were summarized based on a literature review (See page 4 line 18-24 and page 5 line 14-25 in the revised version). Many previous studies have paid much attention to the influence of human activities, but have ignored research into ecosystem states under natural conditions. These results can be used as reference for follow up studies and inform researchers and policy makers about the original state of a river basin as an input into decision-making.

We have clarified our objectives in the introduction (See page 6 line 1-5 in the revised version). The overall aim of the paper is to quantify the spatial and temporal dynamics of green and blue water in the entire Heihe river basin under natural conditions. Specific objectives were (1) To calibrate and validate the SWAT model at two hydrological stations that account for 85% of the total discharge in the Heihe river basin but are not much affected by human intervention; (2) to quantify the spatial and temporal dynamics of green and blue water under natural conditions in the entire Heihe river basin and discuss implications for further research. (See page 6 line 1-5 in the revised version)

**Comments**

Page 3333, Figure 3. The maps in the first and second rows are both total water flows, only the units are different. The authors should clearly indicate the differences by providing a sub-heading in Figure 3. Besides, the geographical units of the maps needs to be indicated clearly in the text and maps. I presume that the maps in the first

row are HRU based and those in the second row are at the sub-basin level. If so, I think the legends should be better designed to reflect the contents. As it is, the meaning of the values in the legends is not clear. Furthermore, I assume that the values provided in the maps in the first and second rows are the annual average over the specified periods, and the maps in the third row are the changes between the starting and the end years. All these need to be clarified to allow the understanding of Figure 3.

**Authors' response:**

Agreed. We have modified Figure 3 as per the reviewer's suggestion. (See page 29 line 1 in the revised version)

**Comments**

Page 3323, lines 18-20. The authors pointed out the variations of green water flows in different sub-basins and gave reasons as that the upstream sub-basins have high precipitation and relatively low temperature and evapotranspiration, and the downstream sub-basins have the opposite features. However, I do not see much meaning to comment on the differences in the total quantity of the green water flows in the individual sub-basins from these aspects, when the sizes of the sub-basins vary largely which are the major reasons for the variations in the total quantity of green water flows across sub-basins.

**Authors' response:**

Agreed. The sizes of the sub-basins vary largely and this is the major reason for the variations in the total quantity of green water flows across sub-basins. We have deleted the related discussion and now compare the flows on a per area basis. (See page 16 line 13-15 in the revised version)

## **Comments**

Page 3321, lines 6-7. The authors stated ‘Interestingly, the agreement between simulation results and observations was even better for the validation period than the calibration period’. The authors should give explanation on this better agreement. Is it just a coincidence? If so, it is not really interesting.

### **Authors’ response:**

Agreed. We think this might be a coincidence. (See page 13 line 20 in the revised version)

## **Comments**

In a number of places, the authors referred to Monireh et al. (2009). But it should be Faramazi et al. (2009).

### **Authors’ response:**

Corrected. (See page 9 line 2 and so on in the revised version)

## **Comments**

The entire manuscript should be checked for grammatical clarity.

### **Authors’ response:**

Agreed and corrected.

The following references are used in the revised manuscript.

## References:

Li, Z.: Runoff simulation in the upper reaches of Heihe River Basin and uncertainty analysis in hydrological modeling Dissertation Submitted to Beijing Normal University in Partial Fulfillment of the Requirement for Degree of Doctor of Engineering 5-21, 2009.

Faramarzi, M., Abbaspour, K.C., Schulz, R., and Yang, H.: Modelling blue and green water resources availability in Iran, *Hydrological Processes*, 23, 486-501, 2009.

Schulz, R., Abbaspour, K. C., Yang, H., Srinivasan, R., and Zehnder, A. J. B.: Modeling blue and green water availability in Africa, *Water Resources Research*, 44, 10.1029/2007WR006609, 2008.

Neitsch, S. L., Arnold, J. G., Kiniry, and Williams, J. R.: Soil and Water Assessment Tool Input/Output File Documentation Version 2005, Grassland, Soil and water research laboratory, Agriculture research services & Black land research Center Texas Agricultural Experiment station, 2004.