

Interactive comment on “Water requirements of the oasis in the middle Heihe River Basin, China: Trends and causes” by Xingran Liu and Yanjun Shen

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Received and published: 13 October 2017

We appreciate your comments and the effort you made to review the manuscript very much. Here are the responses for the weak points:

1. I cannot see the points of comparing the simulation water requirement with the actual ET simulated by other models. Firstly, other models don't have the detailed data the authors have collected. Secondly, in an arid region, the actual ET is limited by the water available thus it can be largely different from the potential ET. Moreover, the reference data is too short to provide solid results, for example, in Figure 9, there are only three years and a few months samples.

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Response: Water requirement is defined as a theoretical value, and there are no available data to validate it directly. In most researches about water requirement, the validation part were omitted. But we wanted to validate it through an indirect way, so we used the actual ET data. Firstly, the spatial resolution of the actual ET data showed in Figure 8 is also 30 m as the resolution we used to calculate the water requirements. Secondly, the study area is dominated by the irrigated farmland which uses too much water from the Heihe River and causes serious ecological problems downstream. Though the irrigation cannot make the soil water conditions optimum all the time, the actual ET can also serve as a reference to some extent. Moreover, we used two kinds of reference data to validate the results. The data showed in Figure 9 is only one kind of the data, which can be taken as the supplementary data for the other kind data showed in Figure 8. We just want to use as much available ET data as possible.

2. A few questions on the water balance analysis. (1) In Table 3, what do you mean the “runoff for mainstream of the middle Heihe River”? Is it the river discharge flowing into the middle river basin (measured at Yingluo Gorge)? However, the value is not the same as you gave in the study area description. (2) In L106, you mentioned that there is more groundwater withdrawal in the basin recently. How much is the groundwater withdrawal compared to the surface water and to the water requirement? It will affect your water balance analysis in section 3.4 and Figure 10. (3) Is it possible to remove the water balance analysis since it is very close to the main topic.

Response: (1) The oasis is irrigated by the mainstream of Heihe River and some small tributaries like Liyuan River which have been separated from the mainstream. “The runoff for the mainstream of the middle Heihe River” means the river discharge of the mainstream of middle Heihe River flowing into the middle river basin. The middle Heihe River flows from Yingluo Gorge to Zhengyi Gorge, so the runoff for mainstream of the middle Heihe River is the difference of the river discharge between Yingluo Gorge and Zhengyi Gorge. We will make this part clear in the manuscript. (2) The mean annual groundwater withdrawal is about 0.33 billion m³. We will enrich the description

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of groundwater withdrawal in section 2.1. And also we will add the groundwater withdrawal data into Figure 10 and analyze the water requirement with the surface water and groundwater withdrawal in section 3.4. (3) Water balance analysis can help researchers make clear the status of water supply and demand. We think it's meaningful to analyze the water balance.

3. The study area is very small with a catchment area of 8600 km². It facilitates the water requirement calculation but it cannot reveal the general situation for large scales (i.e. basins, continents or globe), while it is the aim of journal ESD.

Response: Though the middle Heihe River Basin is not very large, but it's a very typical basin in arid regions, where river water originated from the high mountain area through snow/glacier melting and rainfall-runoff processes, consumed mainly by agriculture and human society in oases in middle reaches, and finally discharged and dispersed in the tail lake at the lower reach. All the rivers in arid region take the same hydrologic setting. Due to human over exploitation of water resources in the middle reach, i.e. oases, large amount of arid river basins are suffering severe ecological degradation in the world, such as Aral sea basin, Lake Chad basin, Tarim basin, etc. Because of the typicality and not too large to collect data, Heihe river basin was chosen as the target basin for a key national research programme on ecohydrology and integrated basin water management by the Natural Scientific Foundation of China in 2012. And the programme is still going on, this paper is totally supported by an key project of this national research programme. Even though Heihe river basin is not a large basin, but insight of the nexus relationship between agriculture, hydrology, and ecology is considered to be significant and able to reveal the general characteristics of the arid basins. As for the facts of Heihe River basin, it is the second largest inland river in China. More than 90 percent of the population and arable land in the Heihe River Basin were concentrated in the midstream, where the most water in the whole basin was consumed. Additionally, the middle river basin is the grain base for the Northwestern China. To restore the ecological environment and mediate the competition for water

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between agriculture development and environmental health, the Chinese government have invested 1.49 billion Yuan in the middle Heihe River Basin. The importance and typicality of the study region make the study valuable to the research for the arid regions in the world.

Interactive comment on Earth Syst. Dynam. Discuss., <https://doi.org/10.5194/esd-2017-75>, 2017.

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