

Comment on “Assessing Water Footprint at River Basin Level: a Case Study for the Heihe River Basin in Northwest China”

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Zeng et al. (HESSD 9, 5779–5808, 2012) introduced a study of assessing the basin-level water footprint (WF) of the Heihe River in Northwest China. They calculated the water footprint of crop and livestock productions using the index of virtual water content (VWC) for each crop or animal species. According to this study, among the calculated annual water footprint of 1768 million m³ in 2004-2006, 54% is green, and 46% is blue. For water consumption, crop takes 92% of WF, livestock takes 4%, industry takes 2%, and the domestic sector takes the other 2%. Compared with the water withdrawal value of 2625 million m³ in 1999, the WF value is believed more rational than the traditional withdrawal index in assessing sustainability, because the withdrawal value normally includes a large amount of return flow that can be further utilized within the basin. While there are many other researches focusing on water resources in the Heihe River (e.g., Cheng 2002, Feng et al. 2002, Wang et al. 2010), few studies have been conducted to trace the water footprint of this basin. This paper quantifies the WF values that are helpful for understanding how the water resources are directly and indirectly consumed by different social and environmental sectors, and for improving the basin-level water management. The authors have listed five aspects of shortcomings, which indicate that they have a good awareness of the constraints existing in this study. In addition to these, it is worthy of extra efforts to collect more detailed information for enhancing the accuracy of the research outputs.

The WF values in the paper are calculated from the statistical data of local crop and livestock productions, but it does not show a comprehensive footprint chains of the overall water cycling based on the land use of the basin. The exchange values between local and external water footprints are not well considered in their calculation either. Mapping the space-time changes of water footprints within the basin can increase our understanding of the entire processes of virtual water movement, and facilitate risk analysis of water use within the basin. A practical approach is to use models. While the paper mentioned that the annual and monthly blue water resources were derived from the SWAT modeling results, from the description in the paper, it seems that the research only used the output data of the modeling, rather than applying the WF approach to trace and measure the water cycling processes in the distributed hydrological modeling. The import and export goods attached with virtual water are also an important part of the WF, but are missing in the paper. Measuring the inter-basin exchange of WF still remains challenging because of the diversity of the goods and the scarcity of data.

Validation is essential in evaluating the WF results, but is not well addressed in the paper. Although the paper compared the WF values with the results from other studies, it is not a correctness proof of the conclusions. The indices of virtual water contents (VWC) are fundamental in WF calculation, but it is not well explained how such indices are derived, or if the numbers of these indices are feasible to the Heihe River Basin in terms of the local species, climate, soil, and management. Validation of the WF calculation is still a difficult task, but the conclusions can be much stronger if there are some supporting evidences from scientific experimental data, such as local farming practice, soil moisture changes, biomass, and irrigation experiments. Some other technologies, such as stable isotope analysis, can also be helpful to trace the water cycling processes and provide solid evidences to prove the results.

Sustainable water use is an ultimate objective of conducting such type researches, and it is addressed in this paper. However how to measure sustainability is still questionable in this paper. The authors used the value of EFR (environmental flow requirements) as an index for WF sustainability assessment, according to the suggestion in Hoekstra et al. (2011, 2012). In this paper, the EFR value being used is 80% of the total blue water resources of the basin, but what Hoekstra et al. suggested was 80% of the total natural runoff. It is necessary to discuss why the total blue water resources, instead of the total natural runoff, are applied. The number of 80% is a generic value, but is it feasible for the Heihe River Basin at all? Answering this question needs to setup a baseline of a “normal” water status, and then evaluate the actual water requirements, especially from the local ecological systems. The indices of blue water scarcity values are also a rather arbitrary standard, which is worthy of a further study to evaluate if it is suitable for this particular basin.

Overall, this paper demonstrates a good example of calculating WF values at a basin level. It is obviously more advantageous than using the traditional withdrawal index, because the WF approaches take more water cycling processes into account. Accurate assessment of WF values, however, is still challenging because of complexity of the water processes. Beyond the research presented in this paper, there needs a lot of extra efforts, including developing new methodologies, standards, and technologies to improve the WF approaches.

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