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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Recasting catchment water balance for water allocation between human and environmental purposes" *by* S. Zhou et al.

S. Zhou et al.

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General Comments: Overall quality of the paper is moderate. The topic of water allocation for ecosystem services is highly relevant to the scope of HESS; the Murray-Darling basin an appropriate case study. The authors' technique in modifying a tested hydrologic tool and applying it to evaluate ecosystem water needs is original and thought provoking. However, the authors place unbalanced focus on terrestrial portions of the river basin, neglecting water needs of the rivers themselves. Structuring of the water balance retains a fundamental flaw in human thinking about ecosystem needs for water. In the authors' rendering of water accounting, all water needs are accounted for, leaving aquatic ecosystem requirements as a "whatever is left" term. This conceptual-

ization supports outdated and disregarded ideas that water flowing in the river to the sea is 'wasted' or that human uses of water may continue unabated until all flows appropriated. The authors thus demonstrate little understanding of ecosystem services provided by aquatic ecosystems and the role of flow regime in aquatic ecosystem function, both of which should ideally be addressed in their framework. The partitioning of ET into agriculture, pasture, and native vegetation is interesting, however it is unclear what the analysis of ecological vs. social ET/GPP provides that a land use analysis could not have provided. The key messages/contribution of the paper could be more effectively packaged by restructuring the paper slightly. The language and grammar are largely comprehensible, however, many errors in tense and syntax exist. Thorough copy-editing by a native speaker is necessary to eliminate all such errors.

We really appreciate this reviewer's very valuable and constructive advice on our manuscript. It will greatly help us to improve the quality of our manuscript. As these general comments are reflected in the following specific comments, we will address them as follows:

Comment 1: Abstract must clarify that the four time periods of the MDB case study are obtained through the recast water balance and are an analytical outcome of the paper. As it reads now, it is understood that the authors divided time according to basin management and analyzed each period.

We agree. We will revise this sentence in our revised paragraph according to the reviewer's advice.

Comment 2 : Description of results and significance is lacking in abstract. For example, "The recast water balance provided new understandings of the water and land dynamics between societal and ecological systems in the MDB, and it highlighted the experiences and lessons of catchment water management in the MDB over the last more than 100 years." Specifically, which new understandings came from the analysis? What experiences and lessons were elucidated?

We fully agree. We will add several sentences in the abstract to explain our new understanding of catchment water balance and the experiences and lessons for future catchment management that were obtained from our findings.

This study aimed to advance social-hydrology by developing social-hydrologic catchment water balance in which water use is partitioned into use for societal systems and use for ecological systems, instead of conventional catchment water balance in which precipitation is partitioned into runoff and ET. It can be used to understand the historical human-water relationships and to provide the basis for water allocation between societal systems and ecological systems. In practice, this analytical approach, which integrates the land and water analysis at river basin, can explain the interactive impact of land and water use which either land use analysis or the water balance approach could not provide.

Comment 3: Rather than repeatedly framing the technique as the “recast water balance”, it may be more effective to give the technique a more descriptive name. For instance the “socio- hydrology water balance” or the “human-ecosystems water balance”? Something that others could refer to in their future work. This new nomenclature should appear in the title.

Thanks for the reviewer’s very valuable idea on improving our manuscript. We will use “socio-hydrologic water balance” as a new nomenclature in our revised title.

Comment 4: Introduction needs more specific information about why the traditional water balance approach cannot support sharing of water between social and ecosystem needs. What specifically are the shortcomings?

We had a longer version of the introduction that included a detailed description on why the traditional water balance approach cannot support water allocation between societal and ecosystem needs. We will add them in our revised manuscript.

Comment 5: Needs mention of ecosystem services related to freshwater. How specifi-

cally is the traditional water-balance able/not able to support ecosystem services?

We agree. We will discuss ecosystem services in our revised manuscript, as addressed in more detail in Comment 11.

Comment 6: Discussion of IRBM needs updating. If there is a reason the authors choose to retain focus to IRBM it should be stated, with discussion of how IWRM and IRBM are compatible/different.

We agree. IRBM is IWRM at catchment (river basin) scale. We will update our discussion on IRBM based on our review on recent literature in integrated river basin management.

Comment 7: Objective statement (lines C25822-23, pg. 914), specifically how will this study advance socio-hydrology?

This study aimed to advance social-hydrology by developing a social-hydrologic catchment water balance in which water use is partitioned into use for societal systems and use for ecological systems, instead of conventional catchment water balance in which precipitation is partitioned into runoff and ET. It can be used to understand the historical human-water relation and provide the basis for water allocation between societal systems and ecological systems. We will expand on this in the Introduction when we revise our manuscript.

Comment 8: The paper could be more effective with a few simple restructures. I suggest describing theory first, followed by a case study example. First outline segregation of the water balance, moving description of the MDB to later in the paper.

We agree. We will restructure our manuscript as the reviewer suggested when we revise it.

Comment 9: The authors’ water balance does not account for reservoir storage. dS/dt is defined solely as soil water storage. This is valid in natural river basins, but as the authors’ proposal is of the most utility in regulated basins, they should perhaps

propose a term for surface storage, particularly to make their model more applicable to sub-annual analyses. Same comment could be made for storage in snowpack.

We agree. The surface (reservoir) storage was used for water diversion and was consumed as societal system evapotranspiration by croplands and grasslands in this paper. Thus, we neglected the change in reservoir storage. We will add this term in Eq. (2) to make our model more applicable in our revised manuscript.

Comment 10: Some terms in classified as ET in the proposed water balance are not intuitive and need further explanation, for instance ETH. Why is water used for households classified as ET?

We agree. We will replace these inappropriate terms with more intuitive ones in our revised manuscript and explain them in a more detailed way.

Comment 11: The authors claim their proposed water balance is an improved management tool to balance water needs of humans vs. ecosystem needs. However, their structuring of the water balance retains a fundamental flaw in human thinking about ecosystem needs for water. In the authors' rendering of water accounting, all water needs are accounted for, leaving aquatic ecosystem requirements as a "whatever is left" term. Page 917, line 11 " . . .the remaining surface runoff is retained for ecosystem purposes or flows into the sea." This conceptualization supports outdated and disregarded ideas that water flowing in the river to the sea is 'wasted' or that human uses of water may continue unabated until all flows are appropriated. The proposed places unbalanced emphasis on terrestrial water needs while ignoring aquatic needs. The authors thus demonstrate little understanding of ecosystem services provided by aquatic ecosystems and the role of flow regime in aquatic ecosystem function, both of which should ideally be addressed in their framework. To remedy, the authors could define Rout in Eq. 2 as river runoff. The Rout term can then be unpacked as follows: Rout = Re + Roth Where Re is a term for ecological river flows and Roth is what remains after ecosystem needs and human needs have been accounted for. Rather than

explaining Re as runoff to the sea, suggesting it holds little or no benefit to the river basin, the authors may state that this quantity must be maintained at specified values through the water year to support ecosystem services in quantities determined through environmental flows assessment in accordance with the natural flow regime of the river basin.

Thanks for this very valuable critique. We fully agree that the role of flow regime in aquatic ecosystem function should be addressed in the framework. In the recast water balance, ecological system evapotranspiration includes evapotranspiration from precipitation, surface runoff, and groundwater in native vegetation areas. Thus, water consumed in aquatic ecosystems to support ecosystem services was a part of the evapotranspiration from surface runoff. We will add the ecological river flows component in the recast catchment water balance and discuss the change of ecological river flows and associated ecosystem services during the study period in our revised manuscript.

Comment 12: Figures 3a and b are redundant.

We agree. We will delete Figures 3a and 3b in our revised manuscript.

Comment 13: Figure 3d- label reservoir storage to avoid confusion with soil storage. See comment 8 above.

Thanks for this comment. We will make the suggested change in our revised manuscript.

Comment 14: What does the analysis of ecological vs. social ET/GPP provide that a land use analysis could not have provided? What is the additional information provided in the water balance approach?

Thanks for these good questions that will help us to sharpen our discussion in our revised manuscript. The analysis of ecological vs. social ET/GPP which integrates the land and water analysis in the river basin can reveal the interactive impact of land and

water use which neither land use analysis or the water balance approach could provide. We will provide more detailed discussion on this issue in the revised manuscript.

Comment 15: The authors may strengthen their claim that the proposed water balance may be a tool for future sustainable water management in basins by suggesting how managers may approach determining acceptable thresholds/balance between ecological and social water needs. This may be sourced from prior ecological study indicating thresholds or tipping points in land conversion or water abstraction and ecosystem quality.

Thanks for this valuable advice. When we revise our manuscript we will strengthen our claim that the proposed water balance can be a tool for future sustainable water management in basins by linking our findings to the previous ecological study indicating thresholds or tipping points in land conversion or water abstraction and ecosystem quality.

Comment 16: There are many grammatical errors, in tense and syntax. Thorough copy-editing by a native speaker is necessary to eliminate all such errors.

We apologize for this. We will invite a land and water scientist who is a native English speaker to edit the revised manuscript.

Comment 17: Figure 2a and b: lines are difficult to distinguish, esp. Rout, G, and dS/dt. Moving the x-axis labels lower and using more distinct colors will help.

We agree. We will revise Figure 2 according to the reviewer's advice.

Comment 18: There is much redundant information in figures. Figure 5 summarizes much information from Figures 3 and 4.

We agree. We will only keep the information in Figures 3 and 4 that has not been included in Figure 5 in our revised manuscript.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 911, 2015.