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Discussions

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

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Comments: General: This paper does not follow a socio-hydrology analysis as there are not feed- back loops. The analysis comprises of a regression of the data. Importantly there is no interaction between principal parameters ie no co-evolution.

We agree with the reviewer that the feedback loops provide a research pattern for socio-hydrology. Our manuscript aimed to recast catchment water balance for allocating water between human society and catchment ecological systems that indeed reflected feedback between human and water use, both on a yearly basis and for over a hundred year period.

Comments: Detail: This paper explored the societal and ecological water use by re-

casting evapotranspiration. It is interesting to see how evapotranspiration is modified by humans. As whole the analysis depends on land use data with temporal resolution 10 years (11 points describing the period 1900-2005). All results and explanation hinge on this data.

We agree with the reviewer that the land use data are very important for the analysis. Our study period was from 1900 to 2010. It was based on annual water balance and the temporal resolution was yearly. However, we could not find yearly land use datasets from 1900 to 2010, and the HYDE 3.1 spatially-explicit database of land-use change with a temporal resolution 10 years provided the best available datasets, and which have been widely used. As annual land use change was normally small, annual land use data were obtained through linear interpolation, and this is reasonable for the purposes of this study.

Comments: The authors explained 4 periods based on the results, how are these periods identified? This is questionable as societal land use increase even after 1985. According to ABS, 84% of the land in the MDB is owned by businesses engaged in Agriculture. Modelling by the Bureau of Rural Sciences (BRS) has identified that 67% of the land is used for growing crops and pasture in 2001-2005. This is higher value than the presented in the paper and land use change continues to âĹij2000 as explained in Kandasamy et. Al (2014) for Murrumbidgee River. Actual rebalancing of water between ecology and human use started in 1997 as shown in figure 5 or figure 3(d).

The basis for division of the MDB land and water management into 4 periods was to reflect the evolution of human and water relationship with the change of the relative percentage of water use between societal systems and ecological system, land use change and water diversion change, which are three key interacting factors for integrated catchment management. Specifically, Period 1 (1900–1956) corresponded with expansion of water and land use by the societal system, and at the end of this period the water used for societal system increased up to the amount used for the ecological systems. Period 2 (1956–1985) was a time of maximization of water and land use by the societal system, and Period 3 (1985–2002) was maximization of water diversion for the societal system, and Period 4 (2002–present) was when there was a rebalancing of water and land use between the societal and ecological systems.

The land use data were obtained from HYDE 3.1, which provided long-term estimates of croplands and grasslands. The uncertainty was roughly estimated as 5% in AD 2000 and 10% in AD 1900 (Klein et al., 2011). According to HYDE 3.1, the sum of croplands and grasslands was about 61% in the early 21st century, and this ratio was close to the modelled data of the BRS. However, we fully agree with the reviewer. We will check these data with the ABS data as far as possible. We will also discuss the uncertainty in the datasets we used including the water balance data, land use data and the MODIS data when we revise our manuscript.

Klein Goldewijk, K., Beusen, A., Van Drecht, G., and De Vos, M.: The HYDE 3.1 spatially explicit database of human-induced global land-use change over the past 12,000 years, Global Ecol. Biogeogr., 20, 73–86, doi:10.1111/j.1466-8238.2010.00587.x, 2011.

Comments: there are is no observed validation for runoff/discharge. Is there any better estimation of runoff due to the inclusion of human dynamics compared to AWAP method? There are is no observed validation for runoff/discharge. Is there any better estimation of runoff due to the inclusion of human dynamics compared to AWAP method?

The AWAP data included a long-term historical monthly water balance (1900 to 2010) which were developed with model-data fusion methods in combination with measurements and are the most robust datasets for the MDB. They have been widely used for research and management practices. The impact of human dynamics has been included in the catchment water balance model through inclusion of diversion and changes of ET and runoff.

Comments: When the land transformed from native to crop or grass, it changes the crop factors. How do crop factors come in to the analysis? According to this paper, ET is portioned based on the crop area ratio in each grid only. In figure 3 (a,b) native vegetation area remains the same from 1970, but why does ET ratio shows increasing trend later part of 2000. Any explanation? Even after reduced water allocation to irrigation, crop cultivation show increasing trend. How is that?

We did not consider crop factors changes in the manuscript because this research was based on modelled data rather than field investigations. As ET and GPP data for the three vegetation types over this period were not available, we used the land use datasets HYDE 3.1 to estimate ET and GPP for each vegetation type by assuming that the three vegetation types shared the ET and GPP by area ratio in each grid. We will discuss the limitations of this method when we revise our manuscript.

As we have shown in Section 2.2, ecological system evapotranspiration (ETe) includes evapotranspiration from precipitation, surface runoff, and groundwater in native vegetation areas, and societal system evapotranspiration (ETs) comprises evapotranspiration in croplands and grasslands originating from precipitation and irrigation, and water consumed by society. The ET of the societal system from surface water diversion reached a maximum in 2002 and declined after that (Fig. 3d), and more runoff was left for native vegetation, which contributed to the increasing trend of ET ratio for native vegetation.

Comments: This modelling does not have any feedback loops. It cannot show how population changes with trends in water use. Many not parameters are not considered ii the analysis eg technology development.

As we stated previously, we disagreed with this comment. Our study aimed to recast catchment water balance for allocating water between human society and catchment ecological systems. It described the feedback between human and water both on a yearly basis, and for over a hundred year period.

We agreed that population increase and technology development are two major drivers for the transition of societal systems, which have been widely used in social sciences. We will increase the population trend in Figure 5 in our revised manuscript to show how population co-evolved with human water use in a clearer way.

The impact of technology development on water use was reflected in the increase of water storage capacity, water diversion and increased GPP from societal systems in Figure 5. We will add explanations and discussions in our revised manuscript on how technology development influenced human water use in a clearer way.

Comments: Reference: http://www.abs.gov.au/ausstats/abs@.nsf/mf/4610.0.55.007 Kandasamy, J. et al., 2014. Socio-hydrologic drivers of the pendulum swing between agricultural development and environmental health: a case study from Murrumbidgee River basin, Australia. Hydrology and Earth System Sciences, 18(3), pp.1027–1041.

Thanks. We have referred this paper in our manuscript.

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