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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Socio-hydrologic modeling to understand and mediate the competition for water between agriculture development and environmental health: Murrumbidgee River Basin, Australia" *by* T. H. M. van Emmerik et al.

Anonymous Referee #3

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In this work, a framework bases on coupled differential equations is proposed to model a human-river system composed by five sub-systems: hydrology, population, ecology, irrigation and environmental awareness. The model is then calibrates using data from the Murrumbidgee River system.

Although the paper present interesting ideas and challenges for future research in hydrological science, I am afraid to say that it is a too ambitious work that eventually do

not lead to any significant contribution to the new born topic of socio-hydrology. I have also serious concerns regarding the methodology used in the paper.

In the following I will list my major concern.

The authors write differential equations for each one of the five state variables representing the sub-systems. However, in order to keep the equations as simple as possible, the dynamics of each subsystem is basically driven by a quite unrealistic deterministic equation where all the complexity is hidden in the parameters and the stochastic nature of the dynamics is neglected. Moreover, as the authors say, "the constitutive relationships that are used to link the governing equations are not prescribed; rather, both their functional forms and associated parameter values are obtained by calibration". Therefore I think that the work miss its more important aim that is to capture and better understand the complex relationship occurring between sub-systems. Moreover I think that there is the risk of an over-parametrization of the system and that the model proposed by the authors belong to the class of "sloppy model" [Gutenkunst, Ryan N., et al. "Extracting falsifiable predictions from sloppy models." Annals of the New York Academy of Sciences 1115.1 (2007): 203-211]. In short, a big ranges of parameters can be used to fit the same data, because sloppy combinations of parameters can vary over wide ranges without changing model behavior. Perhaps one is fitting the existing behavior, but for the wrong reason. There is no understanding of the process underlying the systems dynamics.

In my view, in order to face the ambitious authors goal, the effort should be put in properly linking with a general theoretical framework already existing and recognized models for the five subsystems, with physical meaningful parameters that can be evaluated independently by data on each subsystems.

I have also other minor concerns, regarding stability of the ODE system, effect of the initial conditions, sensitivity of the parameters and threshold choices. I also agree with reviewer #2 that the take home message of the work is unclear.