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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Socio-hydrologic drivers of the Pendulum Swing between agriculture development and environmental health: a case study from Murrumbidgee River Basin, Australia" *by* J. Kandasamy et al.

Anonymous Referee #1

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General Comments

In this manuscript, the authors seek to show that policy changes within the Murrumbidgee basin are the result of a "pendulum swing" from an agriculturally-dominated system to basin in which water is shared more equally between human and environmental systems. The methods used to investigate the pendulum swing theory are fairly simple- quantitative information on various system parameters is collected. Trends in the data are used to support the idea that four distinct "eras" of management have

emerged over the last century through iterations of infrastructural, technological, economic and policy development. By simultaneously tracing both the hydrologic and human history of the Murrumbidgee basin, the authors seek to put forth a clearer view of how water resources are manipulated to reflect the demands and priorities of the community, and how management evolves over time. The authors use evidence from this case study to propose a new "socio-hydrologic" framework for studying human-hydrologic systems.

The manuscript could benefit from professional editing for both grammar and clarity. At the very least there is a need to revisit the definitions listed, both to reduce repetition and to increase comprehensiveness (examples of which are given in the "Technical Comments" section). However, the concepts developed and discussed in this manuscript are very interesting - I am happy to see issues related to water resources management being addressed in the context of greater complexity. This manuscript is likely to trigger a much-needed discussion on how to study coupled systems, but the authors could strengthen the arguments presented in this paper by addressing the following specific comments below.

Specific Comments

This work is of strong interest to those studying water management. However, the Introduction lacks references or acknowledgements of other works that also seek to understand human-hydrologic systems more holistically (for example, see references listed below). While these others studies were not conducted on the Murrumbidgee basin itself, appropriate referencing would not only lend support to those working on similar issues, but would also provide references to additional reading material for those interested in learning more about the broader issues being addressed by this paper.

Scholz, J.T. and B. Stiftel, 2005. Adaptive Governance and Water Conflict: New Institutions for Collaborative Planning. Resources for the Future.

Richter, B.D. et. al, 2013. Tapped out: how can cities secure their water future? Water

Policy. 15(3):335-363.

Much emphasis is placed on the differences in the system state over the last century (p.7204-7205, lines 20-4) with a schematic of the basin's current complexity displayed in Fig 2. However, without presenting a simple system for comparison, the "enormous" complexity (p.7204, line 23) is not apparent. The authors might consider modifying Fig 2 to include a schematic of a simple system (e.g., an overview of what the system looked like 100 years ago) to better illustrate their point.

The authors' use of the term "pendulum swing" implies that the system might once again fall (swing back) to management schemes which are detrimental to overall ecosystem health. The implications of the "swing" are relevant to the model proposed at the end of this work and therefore warrant some discussion.

Fig. 3 seems to be a visual representation of the hypothesis rather than a "result" , particularly since none of the supporting data has been discussed at the point where it is first referenced (p.7205, lines 8-10).

One of the primary goals of this paper is to use quantitative data to establish where and why different "eras" of management occurred. The authors could better achieve this goal by grouping the data in Fig 4 to highlight certain system drivers and responses for emphasis. For example, if the data were grouped by system type (agricultural vs. environmental), the reader would find it easier to see the important correlations between trends in analogous system variables at given times (e.g. as the volume of stored water for agriculture increases (Fig 4a), the downstream flows to important environmental systems decreases (Fig 4f)).

While the text-based narrative provides much evidence in support of the hypothesis proposed, it is not clear how some of the data in Fig 4 relate to these ideas. Fig 4a, 4b and 4h seem to be excellent examples of data that support the evolution of different "eras", showing distinct trends during different time periods. Other examples, however, seem less convincing. While the agricultural share of GDP (Fig 4g) helps paint the

broader picture, this lends little direct support to the emergence of Era 4 (p. 7213, lines 15-18), since there seems to be little if any difference between the share in Era 3 vs. Era 4. Quantitative information on specific examples of problems (e.g. soil salinity, environmental flows) and responses (e.g . Salt Interception Schemes, numbers of participants in the green lobby) plainly identified within the text would provide more substantial support to the analysis. The authors might consider either providing clearer explanations for inclusion of the current data, or incorporate new data that directly supports the key points of the narrative, especially if additional data could show analogous changes in the two systems.

This analysis heavily emphasizes the large cost (p. 7216, lines 23-24, p. 7217, lines 15-17) of the "pendulum swing". Yet, quantitative evidence for these costs is not obvious in this analysis. For instance, it would be very interesting to see the estimated amount of government expenditures on agricultural modifications vs. environmental rehabilitation over time. While all necessary data may not be available, inclusion of some quantitative information on the dollar amount spent over time on, for example, built irrigation infrastructure, water license purchases, environmental mitigation (wastewater treatment plants, salt interception schemes, fishways), etc. would lend more weight to the idea that these transformations were, indeed, costly. Similarly, the lack of quantitative evidence for changes to the environmental system also weakens the arguments made by the authors. Given that two of the biggest environmental problems faced within the basin were soil salinity (p. 7209 lines 14-23) and salt water intrusion (p. 7209, lines 8-13) efforts to include quantitative evidence of these "environmental costs" would significantly benefit this work.

It would also be useful to the reader to see a simple timeline of when major policies implemented in relation to the quantitative data presented in Fig 4.

The proposed framework for socio-hydrologic modeling is an exciting one. That systems may face great costs when they "swing" from state to state is relevant not only to taxpayers and politicians, but to those interested in protecting the overall productivity

and health of the system. Given the interest of the authors in incorporating both quantitative (e.g. hydrologic) and qualitative (e.g. cultural norms) within the socio-hydrologic framework, it would be interesting to include a deeper discussion on how to measure the qualitative "costs". In this case, there seems to be merit to weighing not only the ecological destruction over time, but also the loss of livelihood that farmers now face as the health of ecological systems take precedence and the pendulum swings out of the farmer's favor. If it is to be a truly socio-hydrologic model, there should be some way in which the damages to the agricultural community (possible displacement, reduced income, anger/mistrust) should be incorporated, as they are equally real as the damages to the environment. More insight on how the proposed model would capture this type of system complexity would be very insightful.

Technical Comments

Examples are first given for the term "infrastructure" on p7203 line 16, therefore there is no need to repeatedly include the same example (e.g. dams and weirs) every time the term is used again. (Further instances on p.7203, line 17; p.7206, line 17; p.7208, line 7; p.7210, lines 25-26; p. 7218, line 8).

p. 7202, line 5: Write out the full term prior to using its abbreviation (i.e. New South Wales (NSW))

p. 7202, line 18: Missing word- "to"

p. 7204, line 2: "these" dynamics- repeated throughout

p. 7206, lines 5-8: "pendulum swing", although defined here, is later re-defined several times. (p. 7216, line 18 and 20-21).

p. 7209, Title 3.2.2: Note that "Band-Aid" is a registered brand name for adhesive bandages

Fig 2: The colors used in the figure and those included in the key do not match

Fig 3: It would be helpful to see how the authors envision the pendulum swinging here (analogous to the visual used in Fig 5 or 6).

Fig 3: What exactly does "Emphasis Level" mean?

Fig 6 and 7: The photos used need citations.

Fig 6 and 7: There seems to be much repetition between Fig 6 and 7. Could these be combined somehow?

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 7197, 2013.