

Interactive comment on “Socio-hydrologic perspectives of the co-evolution of humans and ground water in Cangzhou, North China Plain” by Songjun Han et al.

Anonymous Referee #2

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The authors present an interesting case on groundwater use in Cangzhou, North China Plain. The area is highly agricultural and co-evolution of the area has been dominated by the desire to keep agricultural produce high and mitigate unintended consequences resulting from water resource use. The paper, however, still has loose ends that need to be solved. Also a better alignment of objectives, methods and analysis, would improve readability. I hope the authors find the comments below constructive.

General comments

1) It would be helpful for the reader if concepts were clearly defined from the start. Currently, the use of concepts is mixed and includes the use of Taiji Tire model, the concept of pendulum swing (Kandasamy et al. 2014) and the concept of community

C1

sensitivity (Elshafei et al., 2014). While the pendulum swing is not defined as such, the concept of community sensitivity is introduced in the discussion, but at the same time forms a major part of the discussion. If the authors wish to use more than one concept, the reader would benefit from a more comprehensive introduction of these concepts early in the paper, possibly including their purpose and/or limitations, and how these concepts are used for the current analysis of the Cangzhou case. The latter would give the reader a clearer indication of what it can and cannot expect from the current analysis. For example, the Taiji-Tire model is merely offered as an organizing framework to represent and explain the human-water relationships (Liu et al., 2014). The conceptualization of interactions serves as a first step to a quantitative (numerical) model that can be used to explain the past and develop predictive insights (Liu et al., 2014). The pendulum swing refers to “an exclusive focus on agricultural development and food production in the initial stages and its attendant socioeconomic benefits, followed by the gradual realization of the adverse environmental impacts, subsequent efforts to mitigate these with the use of remedial measures, and ultimately concerted efforts and externally imposed solutions to restore environmental health and ecosystem services” (Kandasamy et al., 2014).

2) The primary goal as defined by the authors is the interpretation of the case study using the Taiji Tire model. It remains however unclear which methods are used to relate the observed feedbacks in the case study to the more abstract concepts in the model: what is used to distinguish endogenous from exogenous variables? How are the major drivers of the system resolved? When is a feedback considered to be productive or restorative? Currently, this seems to be dependent on your system boundary? The environmental burden seems to be partly shifted from groundwater to the surface water systems that deliver the water transfers?

3) Environmental awareness/ community sensitivity/ natural restorative force is ultimately put forward as a driver of groundwater table restoration. It is however unclear at the moment how this is inferred from the case study. The description of the case study

C2

is detailed and shows the complexity of the system including groundwater changes in both the shallow and deep water aquifer, resulting in policy developments aimed at improved groundwater management and ultimately an increase in groundwater tables. At the same time, it is mentioned that pumping costs increase due to the deeper groundwater table, land subsides (up to almost a meter), salt intrudes and additional water is available due to water transfers. How does environmental awareness relate to economic incentives or the availability of an alternative water source? If the paper would include an interpretation (qualitative or quantitative) of the strength of the various feedbacks, it would make the current conceptualization much stronger.

4) The text would benefit from editing and proof reading to improve its readability.

Specific comments

Page 3, line 3. Please lengthen, since it is currently the core of the article. By which measure are feedbacks categorized? How exactly is a social productive force defined? How are main drivers distinguished among all plausible drives? Zhang et al. (2011), for example use five steps to deduct causal mechanisms in their research to link climate change and large-scale human crises.

Page 4, line 12 to 16, please check era titles with paragraph titles; not all of them match.

Page 4, paragraph 3.1, what are the sources used for this paragraph?

Page 4, paragraph 3.1, while the statements related to irrigated area argue in favor of natural variability dominating socio-hydrological change, the statements related to reservoirs, diversion projects and drainage-oriented policy currently imply that humans seems to have considerable impact already during this period. Adding a statement on the (limited?) effects of these policies on groundwater would strengthen the argument.

Page 5, figure 2, please check the figure references: subfigure d is referred to twice, resulting in a mismatch (e to i) from there on.

C3

Page 5, figure 2f (irrigated area), what is meant by irrigated area, is this total irrigated area or irrigated area using surface water?

Page 5, figure 2, having a figure here showing the incoming water from all or the most important diversions/transfers into the region would complete the story. I can imagine that the availability of an alternative water source plays a significant role in the restoration of groundwater levels.

Page 7, line 18, "Groundwater then became an important water resource for agricultural irrigation." Should this be "the most important water resource"? Given that well drilling for groundwater started a few years earlier?

Page 7 to 10, paragraphs 3.2, 3.3., 3.4, what are the sources used for these paragraphs?

Page 9, line 19. "the environment noticeably deteriorated". How was this the case?

Page 9 & 10, has the reduction of overexploitation become a goal in itself or are earlier mentioned problems such as subsidence or salt water intrusion still an issue in the region? Are there specific quotes from governmental documents you could use to strengthen your argument?

From Page 11 onwards, How, using what method/definitions, are the more abstract general concepts as mentioned in figure 3 related to the individual, observed feedbacks as mentioned in the text? How are productive, restorative and healthy status defined? Can anything be said about what triggered the restorative force (e.g. economic motives, a change of norms and values) and/or what is meant by the steady state of the system?

Page 12, figure 4a, how are the axis defined? Is a decrease in groundwater table indicated with a positive sign? Are values calculated with regard to the groundwater table of the previous year? Has a correction been applied for water inflow (e.g. precipitation)?

C4

Page 12, figure 4b, out of interest, how can it be that with a larger withdrawal the center of depression in 2013 is equal to 1984?

Page 12, figure 4c. The description of this figure is quite difficult to follow. Since two sets of data are presented in the figure, i.e. black (1976 - 2002) and blue (2003 – 2013) a discussion of these different trends would be appreciated. If individual data points are discussed as is the case now, maybe the individual years could be marked in the plot?

Page 12, line 14. "The interactions of inner Taiji ... of blind development." On which literature is this statement based? Elinor Ostrom has, among others, done a lot of research aimed at understanding the circumstances under which overexploitation takes place.

Page 13, line 13, it would be helpful to see the definition of the restorative and productive force earlier in the paper, for example when introducing the Taiji Tire model.

Page 14, line 6, "This is because at ... protections (Elshafei et al., 2014)." On what evidence is this statement based? How is community sensitivity defined? How is it measured in the case study?

Page 14, line 13. "The social productive ... extremely costly". On what are these statements based? Is there evidence that technology and management tools are developed solely for environmental protections? Costly in relation to what (alternative)?

Literature

Elshafei, Y., et al. "A prototype framework for models of socio-hydrology: identification of key feedback loops and parameterisation approach." *Hydrology and Earth System Sciences* 18.6 (2014): 2141-2166.

Kandasamy, J., et al. "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 (2014): 1027-1041.

C5

Liu, Ye, et al. "Socio-hydrologic perspectives of the co-evolution of humans and water in the Tarim River basin, Western China: the Taiji–Tire model." *Hydrology and Earth System Sciences* 18.4 (2014): 1289-1303.

Zhang, David D., et al. "The causality analysis of climate change and large-scale human crisis." *Proceedings of the National Academy of Sciences* 108.42 (2011): 17296-17301.

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C6