

## ***Interactive comment on “Socio-hydrologic perspectives of the co-evolution of humans and water in the Tarim River Basin, Western China: the Taiji–Tire Model” by Y. Liu et al.***

**Y. Liu et al.**

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Response to general comments:

1. This paper is a well-researched paper discussing the history of socio-hydrological evolution over the past 2000 years in the Tarim River Basin, located in northwest China. It concludes using a model called Taiji-Tire intended to frame the discussion. I needed to read the paper several times in order to take in its considerable content. I would suggest some significant reorganization and stream-lining to help future readers who may not read it multiple times, in order that they have an easier time the first.

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Answer: We thank the reviewer for the time and positive comment on the manuscript. We have made several important revision due to the reviewer's constructive advices. Please see following responses for details.

2. Most importantly, the Taiji-Tire model as currently presented comes across as an afterthought - it is mentioned late in both the abstract and main paper. If intended as a framing model meant to help the reader understand the content of the paper, it should be introduced much earlier and integrated with the rest of the text. As it presented now, the model does not add value to the paper in terms of presenting its arguments more thoroughly or holistically.

Answer: The Taiji-Tire model was summarized as a result of the efforts of searching for a framework to explain the whole stories we have discussed. In the earlier versions of this manuscript, we have tried putting the part of Taiji-Tire model earlier as an independent part, just as the reviewer recommended. Some invited readers liked this structure but some not. After severe discussion and consideration, we decided to follow the suggestion by the reviewer and to move the Taiji-Tire model part earlier as Sect. 3, after the introduction about the study area, with some necessary revision about the context. Thanks a lot.

3. Also, the paper could be revised for improved flow if it adhered more strictly to the organization of 3 times periods and 4 spatial SHS types as laid out in the abstract. As a major example, much of the historical overview of Section 2 should be instead incorporated into the subsequent sections that are devoted to specific time period, rather than going back and forth through time as the paper does now. The 4 spatial SHS types are more sporadically referenced, but consistent referencing of them within the different sections for time periods would also improve flow.

Answer: We thank the reviewer very much for this comment because it is also what we worried about when we are working on the manuscript. We have also considered how to address the TRB coupled human-water system with a logical sequence. If we just

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discuss the socio-hydrological process stage by stage, it may be difficult for readers to understand single event from a broader perspective without a general impression of the coupled human-water system as a whole. So we generalized the key facts and 2000-yr. history of TRB as an independent section as Sect. 2 to help the readers to be familiar with overall TRB quickly. The important events of human-water interactions, which could tell what was actually happening with human-water relationship, however, are then discussed carefully in following sections of specific time periods with considerable details. We believe this is a better way for readers who are curious but not familiar with TRB as well as the historical socio-hydrological perspective we've applied in the research. Nevertheless, we improve the flow by condensing the section. For instances, we have moved the paragraph about Silk Road to Sect. 4.2, as shown in revised manuscript p. 13 Line 375-385, and shorten the last two paragraphs, as shown in revised manuscript p. 7 Line 189-210. Thanks all the same.

4. Finally, I believe the conclusion section should be reworked to be specific to the TRB and future research directions for this and other contexts.

Answer: The comment is very important for us and we have revised the conclusion section by more closely linking the 4 types of SHSs to TRB, especially in section 7.4 (see response for p. 12777 Line 10), as well as adding more contents about the future research directions in revised manuscript p.26 Line 787-796, which was not explicitly reflected. Thanks.

Response to specific comments:

1. Abstract – p. 12754 Line 17: Awkward construction: how is an eco-hydrological system populated? Line 26: Introduce concept of Taiji-Tire Model sooner?

Answer: The TRB is populated with too much people that the vulnerable eco-hydrological system may reach to a critical point that it can no longer support the further societal development. We have moved the Taiji-Tire model part earlier in revised manuscript. See the answer to general comment #2 for detail. Thanks.

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2. Introduction – p. 12755 Line 22: Run-on sentence, consider shortening. 1. Introduction – p. 12756 Line 7: Seems unqualified to say that “water dominates the dynamics of the eco-environmental system” without being more specific. Lines 6 & 9: Basin is referred to as “arid” and “hyper-arid” in close proximity. Choose one? Line 13: Confused, what is “star-studded pattern of oases”? Line 22: Can you please be more specific with “advancement of social productive forces”? What are the “social productive forces”? This language comes up several times throughout paper. 1. Introduction – p. 12757 Line 11: After reading the full paper, I don't follow how the general framework proposed stems from the specific observations of this paper, as indicated by “On the basis of these observations...” Line 14: “Perspectives on possible future research” are not ultimately discussed.

Answer: p. 12755 Line 22: We have rewritten the sentence, as presented in revised manuscript p. 3 Line 73-78. Now it reads as: Historical analysis serves as one of the key methodologies of socio-hydrological study. Basically, it involves studying the past (i.e., immediate past or distant past) and reconstructing the associated co-evolutionary socio-hydrologic processes, through systematic analysis of the social and physical events and mechanisms and their interactions that together may have contributed to such history, and organizing them into distinct phases. Although accurate historical data...

p. 12756 Line 7: The assertion may be inexact and we have deleted it and rewrote the sentence in the revised manuscript p. 3-4 Line 83-88. Now it reads as: With a current population of over 10 million and a long and varied history of human settlement, the Tarim River Basin presents itself as a study area where the interactions and feedbacks between human and water systems are very pronounced, the understanding of which will be useful for addressing even contemporary water sustainability challenges. In this inland...

Lines 6 & 9: To avoid the misunderstanding, we revised the corresponding sentences. See response to p. 12756 Line 7.

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Line 13: That “star-studded pattern of oases” means the oases in TRB in history are not linked with each other, they are along rivers and lakes and basically isolated with each other. We add more descriptions in the revised manuscript p. 4 Line 92-93. Thanks.

Line 22: The “social productive forces” is a comprehensively applied concept in philosophy of Marxism to represent the ability of human society to exploit, utilize the resources (natural or social), to meet the societal need. More details could be referred to Wikipedia as item of “productive force”: [http://en.wikipedia.org/wiki/Productive\\_forces](http://en.wikipedia.org/wiki/Productive_forces). To facilitate the reading, we add more explanation and guideline for further information in the revised manuscript p. 4 Line 102-105. Thanks.

p. 12757 Line 11: In our manuscript, we have discussed many socio-hydrological processes and the impact of many recognized natural and social factors like climate change, river channel migration, social unrest, war and policy. After these observations, we realized that the socio-hydrological systems are driven by basically two sorts of factors as natural ones and social ones and the essence of human-water relationship is the water consumption at different spatial and temporal scales, whereas the influencing natural and social factors are functioning as enforcing or weakening the degree and scales of water consumptions. So we generate the framework of Taiji-Tire model to reflect our understanding. In the revised manuscript we have moved the Taiji-Tire model part earlier to help readers to understand the following discussion, just as the reviewer recommend. Also, in order that our readers could more easily understand the Taiji-Tire model, we have added more information in revised manuscript p. 8 Line 213-218, 224-225, etc. Thanks.

Line 14: We have added the discussion contents about the possible future research as presented in revised manuscript p.26 Line 787-796. Thanks.

3. Study Area – p. 12759 Line 20: Instead of “picking”, use “gathering”? Also occurs later in paper. Line 9: This paragraph and the following on the next page set-up the

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major structural features of the paper, their topics are referenced in the abstract, yet they are buried here. This content should come sooner.

Answer: p. 12759 Line 20: We have replaced “picking” by “gathering” throughout the manuscript. Thanks.

Line 9: We believe that by briefly introducing the basic information and co-evolutionary history of human-water system in TRB would be helpful for readers who first time learns about TRB and socio-hydrology. In order to make these paragraphs more easily to be understood, we have moved the paragraph of “A far-reaching event that occurred during...relationship in the ancient TRB” to Sect. 4.2, and condensed the paragraphs about the paper structural features, as presented in revised manuscript p. 7 Line 189-210.

4. Natural stage – p. 12761 Section 3.1 Why is this section titled “the mathematics of development”? Line 10: Why is “LI” in all-caps? Line 25: Why is “ZHANG” in all-caps? Also occurs later in paper. Section 3.2 – p. 12763 Line 24: awkward phrasing “mixed area”, instead something like “more diverse”? Section 3.3 – p.12766

Answer: p. 12761 Section 3.1: We have retitled Sect. 3.1(now Sect. 4.1) as “Climate migration and river course change”, as shown in the revised manuscript. Thanks.

Line 10: Unlike that in the English ones, the family name always comes before given name for Chinese names. So we spell all the Chinese names with family names in all-caps to avoid misunderstanding.

p. 12763 Line 24: We have revised the phrase as the reviewer advised, changing “mixed area” to “more diverse area”. Thanks.

5. Exploitation stage – Section 4.1 – p. 12769 Line 10: Who introduced innovative farming and engineering methods, was this part of tax reforms just mentioned? Line 29: Confused how this period (late 19th to mid-20th century) belongs in this section (titled “expansion of traditional agriculture...”) because it says here that “expansion of

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farmland ceased and some farmland retrogressed back to natural landscapes of grassland”. But later on next page we get into floating population, a reclamation campaign and expansion of farmland. The segue to floating population and nature of reclamation campaign (what was reclaimed, by whom, and why did this influence farmland) need to be clarified. Section 4.1-p. 12770 Line 12: “A remarkable feature of the SHS... enlarged” . This paragraph awkward as written. Main point seems to be buried in last sentence – that the formerly isolated SHS’s merged.

Answer: p. 12769 Line 10: The innovative farming and engineering methods are not part of the tax reforms. They are the consequence of the social development in technologies and scales. We have clarified this point in the revised manuscript p. 18 Line 555. Thanks.

Line 29: That “expansion of farmland ceased and some farmland retrogressed back to natural landscapes of grassland” could be regarded as a pulse of the whole exploitation period of traditional agriculture, which is also the social cause for a reclamation campaign that could resolve the problem of floating population. So it is a story about sequent events during the expansion of traditional agriculture: social unrest and war has stopped the procedure of farmland expansion, but the population was still increasing because the delay recognition of the lack of foods and jobs. The surplus of labor force due to too much population, which is what floating population mainly refers to, were a threat to social stability. A reclamation campaign was conducted by central and regional government of ROC to take those floating population in and raise them. Therefore, after a stop of farmland expansion, the traditional agriculture began increase again. The main important difference of this sub-period of development with the former one is that this increase of farmland is drove by government purposely with large-scale, which is a stimulated response to social problem, while the former one is a gradual procedure of coordinated social development. We have updated the paragraph to help the future readers for more easily understanding this point, as presented in revised manuscript p. 19 Line 580, 582 and 584-587.

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p. 12770 Line 12: The mentioned paragraph has been revised to highlight the main point according to the comment. See p. 20 Line 591-593 in the revised manuscript. Thanks.

6. Degradation... – p. 12773 Line 14: Specify what “special human intervention” means

Answer: p. 12773 Line 14: It refers to the emergency water transfers specifically in the manuscript. The sentence here appears to be unhelpful, so we have deleted this sentence to avoid confusion and misunderstanding. The sentence we deleted, in p.22 Line 685 is: However, ecological recovery was only realized under special human intervention, especially emergency water transfers.

7. Taiji-Tire - p. 12774 See general comments. This section is very general as written. It should come sooner, be written more concisely, and frame the remainder of the discussion. Specific references to components of the model should be embedded in the other sections.

Answer: We thank the reviewer very much for this comment and after seriously consideration, we have moved the Taiji-Tire part earlier and added more information in main context of the manuscript to link the discussion of 3 time stages to Taiji-Tire model more closely (see added information in Sect. 4.3, Sect. 5.3, Sect. 6 for examples).

8. Summary – p. 12777 Line 10: “Accordingly” misplaced. If the classification of SHS’s follows the model, then the model needs to come first in the text. Section 7.4 – p. 12779 The title of this section explicitly references the TRB, but its content is mainly about other places. Where are future directions discussed?

Answer: p. 12777 Line 10: We deleted the word “accordingly” and rewritten the last sentences of this paragraph, which could be seen in revised manuscript p.23-24 Line 709-713. Now it read as: Based on the historical analysis of co-evolution of the SHSs within TRB, we found that 4 types of SHS could be identified in terms of social economic formation, i.e., primitive agricultural SHS, traditional agricultural SHS, industri-

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alized agricultural SHS, and urbanized SHS. The spatial features and age differences between the 4 types of SHSs and the stages of co-evolutionary history of the SHSs within TRB are presented in Table 1. We have moved the model earlier as Sect. 3 and added Table 1.

p.12779: In section 7.4, we are trying to address the common sense of the impact of urbanization and resulting relevant factors on human-water relationship and explain what was happening in TRB. In order to more explicitly discuss the TRB case, we have updated the sub-section with more examples and details of urbanization within TRB, as shown in p. 25-26 Line 755-756, 761-762, 769-773, 775-778 in the revised manuscript. To be noted, we also added a reference of Li et al. (2010), as shown in p. 29 Line 863-864.

The future directions are added in our manuscript in p. 26 Line 787-796.

9. Figure 2: Please label inset maps clearly. Lower left is the Xinjiang province? Need to say so. Need basin boundaries on right panel. Figure 6. Y-axis mis-spelled. Should read "Population (x 10,000)" Figure 8. Include only left-most content (a). Side (b) and the symbol in the middle are unnecessary. Also (a) and (b) are not labeled in the caption. If you leave the content as is this should be addressed.

Answer: Figure 2: We have reworked on the map with more clear labels and other adjustments. To be noted, the Fig. 2 is originally adopted from Hao (2009).

Figure 6: The mistake of Y-axis has been corrected, many thanks to the reviewer's advice. Please note that we have moved the Fig. 8 earlier, so the former Fig. 6 is now Fig. 7.

Figure 8: Thanks to the reviewer's advice. After seriously consideration, we have deleted the Taiji symbol, but kept the Tire to help the readers to understand the Taiji-Tire model. Please also note that the previous Fig. 8 is now Fig. 3.

Reference:

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Li, C., Yang, D., Zhang, Y., Qiao, X., Liu, J.: Correlation between urbanization and water resources utilization in the Tarim River Basin, *J. Desert Res.*, 30, 730-736, 2010.

Hao, X., Chen, Y., Li, W.: Impact of anthropogenic activities on the hydrologic characters of the mainstream of the Tarim River in Xinjiang during the past 50 years, *Environ. Geol.*, 57, 435-445, 2009.

Please also note the supplement to this comment:

<http://www.hydrol-earth-syst-sci-discuss.net/10/C7414/2014/hessd-10-C7414-2014-supplement.pdf>

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Interactive comment on *Hydrol. Earth Syst. Sci. Discuss.*, 10, 12753, 2013.

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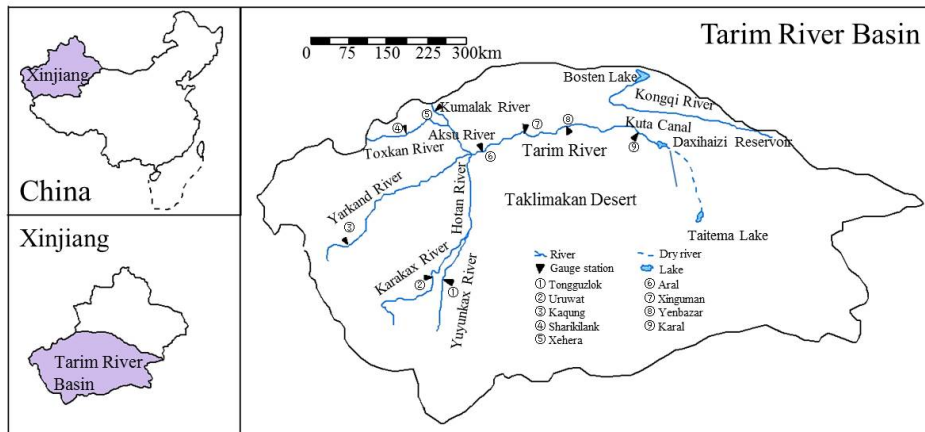


Fig. 1.

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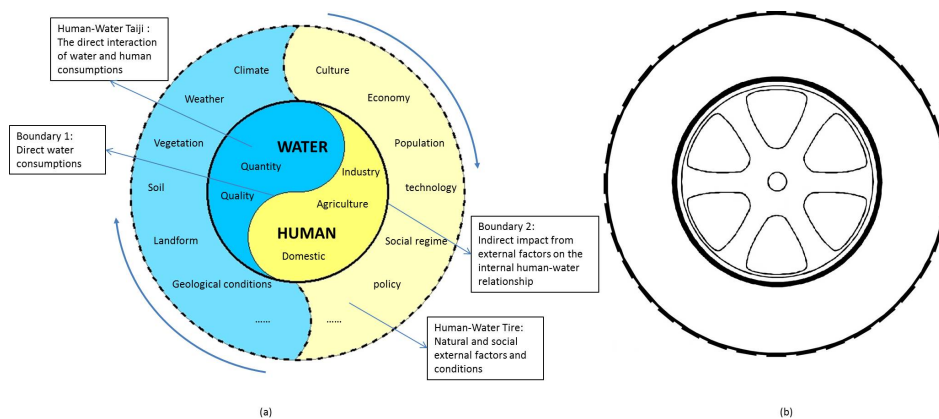


Fig. 2.

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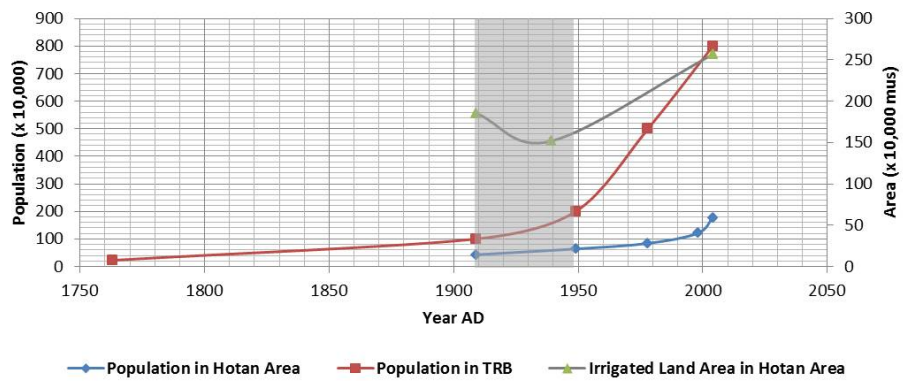


Fig. 3.