Response to the comments on Paper hessd-11-3911-2014 by Referee #1

Title: A coupled modeling framework of the co-evolution of humans and water: case study of Tarim River Basin, western China
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First of all, we greatly appreciate the valuable and constructive comments from the Referee #1. The following lists our point-to-point replies to the comments.

General comment: This study presents a novel socio-hydrologic model from co-evolution perspective. The results are interesting, and the mathematical framework and insights generated are valuable contribution to the hydrology community. I would recommend acceptance contingent on satisfactorily addressing the following comments, mainly on the presentation side.
Response: Thanks for the positive comments.

1. Line 8-9, it'd better to provide more solid reason other than "for a start". Actually the authors did so at L18-20, P3919;
Response: Thanks for the suggestion. Now the sentence reads as "other industries will be ignored here because almost no other major industry exists in the Tarim River Basin apart from agriculture".

2. L8, P3919, "mainly comes from" ->"is mainly satisfied by";
Response: Done.

3. L22, P3919, "water storage" is used a representative variable, which is slightly inconsistent with previously usage of "stream discharge" (e.g., L16, P3912).
Response: Thanks for the reminding. The term "water storage" is the state variable (in m^3) of the hydrological sub-system and "stream discharge" is the flux variable (in 10^9 m^3 $year^{-1}$). Usually the stream discharge is the variable of interest in the hydrological research. But in the ordinary differential equation, a state variable is needed to describe the system. Therefore, "water storage" is adopted as the state variable of the hydrological sub-system in the modeling framework and the stream discharge is simulated at the same time in the model. The term "stream discharge" is replaced by "water storage" for clarity on Line 16 P3912, Line 21 P3912, Line 22 P3912, Line 7 P3920, Line 21 P3936 and Line 23 P3936.

4. Line 12-13. The logic is not clear. Is it simply an assumption that evolution of irrigated crop are can be described with a logistic type equation (to be consistent with that of natural vegetation and of population)?

Response (Line 12-13 P3924): Originally, the logistic type equation is introduced to simulate the growth of biological systems. Subsequently there have been a lot of applications of the logistic model outside the field of Biology also. As summarized by Tsoularis and Wallace (2002), the logistic type equation has been used to describe the market penetration of many new products and technologies, world energy usage and source substitution, an evolutionary process of the industrial revolution. For our case, the evolution of the irrigated crop area is driven by wasteland cultivation and farmland abandonment, which is corresponding to the colonization and mortality of the biomass, and can be roughly described by the logistic type equation. This is currently consistent with that of natural vegetation and of population, but is not necessary and can be modified according to further research. More description is added and the logic is smoothed in the revised manuscript.

Tsoularis, A. and Wallace, J.: Analysis of logistic growth models, Math. Biosci., 179, 21–55, 25 2002.

5. L16-17. Contradictory with earlier L6-7. Please rephrase.

Response: Does the comment refer to P3931? If so, our explanation is as follows:

The catchment area of the main stream of Tarim River is 4.6×10^4 km^2 and the mainstream is the typical inland river, where no runoff can be generated along the main stream and all water comes from the headwaters. Along the mainstream of the Tarim River, the runoff is consumed by the agricultural irrigation. So there is more water in the upper reach than in the lower reach in Tarim River.

6. L24, P3932. Don't understand the terminology "runoff frequency". Please define or rephrase.

Response: Thanks for the reminding. We replace "runoff frequency" by "recurrence interval". In Line 24, the sentence now reads as "if the recurrence interval of the annual runoff at Aral in 2020 is 2 years".

7. L 25-28, P3932. I don't feel a smooth transition between the baseline and revised model results. Here it might be a good place to provide adequate transition.

Response: Thanks for the suggestion. The following sentence is added in Line 28 P3932 to make the transition smooth:

"But in the current model, the negative feedback, "VCL–WU–WL–VCL", is not in effect. The model should be revised to activate the restorative force to analyze the long-term evolution dynamics. "

8. L2-3, P3933. “are repeated 4 times” ->“are repeated another 4 times after 1951-2010”. Again, I don’t feel a clear and smooth transition between the baseline and revised models. The major difference is whether the environment protection policy is explicitly accounted for or not. This environment protection policy is somewhat mentioned a few times earlier already, e.g., L2-4, P3926. It is not until later stage of this story (Section 5) this distinction has been brought up. Maybe stating this upfront would make it easier for the readers to follow.

Response: L2-3, “are repeated 4 times” is replaced by “are repeated another 4 times after 1951-2010”.

The reason to introduce the revised model is to activate the restorative force, "VCL–WU–WL–VCL" so that the environment protection policy can be explicitly accounted for. It has been already explained in Line 5-6 of P3929 and Line 15-19 of P3933 in the original manuscript. The environment protection policy in Line 2-4 of P3926 is the fourth negative feedback loop, RIU–WU–WL–VCL–RIU, and it is mentioned in Line 14-16 of P3929.

About the transition from baseline to revised model, the distinction will be mentioned in the section of “3.5 Feedback loops in the socio-hydrological system” in Line 6 of P3929 in the revised manuscript. Thanks for the suggestion.

9. L15, P3935. “irrigation coefficient will decrease” ->“will increase”.

Response: The “irrigation coefficient” is kc in Equation (2) and it is “crop coefficient of evapotranspiration”. It is replaced by “crop coefficient of evapotranspiration” in Line 15 and Line 26 on P3935.