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Interactive comment on "Modeling the integrated framework of complex water resources system considering economic development, ecological protection, and food production: A practical tool for water management" *by* Yaogeng Tan et al.

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Dear referee #1: Thank you very much for giving a decent suggestion of this paper and the opportunity of revising this paper. The suggestions are very useful for me to improve the quality of the paper, and I also quite agree with your comments, in other words, the relationship between SD and optimal model should be clarified. Here are some comments:

1. The concern of SD and optimal model

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The overall framework is how to address and quantify the interaction and coevolution of the complex water resources system under the changing external drivers. Therefore, system dynamic model is used to reflect its dynamic status. However, to achieve sustainable development goals, systematic optimization is an indispensable approach because the water usage for socioeconomic development, ecological protection, and food safety conflicts with each other. The two approaches in the current version are indeed not so clear and, so in the revised version, we have to make it clear. Here is the new framework of coupling these two models and will consider it in the revised version of the paper:

As noted in the text, the external drivers of a water resources system can be outlined by the "pendulum model" that can substantially be regarded as the connection of different time steps. Precisely, the "time" variable is inherently the component of SD model and, therefore, it can reveal the dynamic status of a certain system. The external drivers, based on the pendulum model, can be quantified by both the increasing rate of population & GDP size and ecological awareness. They are in conflict with each other and we can regard it as the "pendulum swings" vividly. In the scope of water resources, it can be reflected by the changing water demands. That is, the changing rate of population and GDP size can be revealed by the changing rate of domestic and industrial water demands. The changing water demands will result in the changing water supplies, further changing carrying capacity, food production, etc. It is clear that the external changing condition will inevitably influence the operating state of a system, which can be quantified by SD model that can reveal such relationships and their dependent changes of those variables. Additionally, according to CAS theory, the external changes can also stimulate both the entire system and each agent to readjust themselves and attain the adaptive status, which can be quantified by systematic optimization. However, there's no optimal function within SD model and therefore, the system dynamics of a water system are not optimal and cannot ensure the sustainable development goal. Therefore, it should be coupled with the optimal model.

To couple both models, the initial scheme of water supply should be generated by SD model. We define each time step of external drivers as τ. For each τ, both water supply and demand can be calculated by SD model (For calculation of SD model, the equation of each variable can be seen in Supplementary data of the paper). The water supply scheme generated by SD is the initial solution of the optimal model (Li et al., 2018). The optimal solution (optimal water supply scheme) is generated by the iteration of the optimal model until the adjacent iteration result is less than a specific error. Then, the optimized water supply will transfer back to SD to update the system status of the current time step, and prepare for the next τ and repeat the whole process. We define T as the total number of τ. If τ<T, repeat the whole process; If τ=T, end the process. The flowchart of the whole process is in the supplement of this reply. (See Fig.1)

2. Calibration and validation of the model

The calibration and validation process is indeed needed as the reviewer mentioned, and we will surely add this part. We have also discussed with each other about this issue (what the result of 2016-2020 represents), and we decided to use these five years for model calibration and validation. The status of 2016-2020 already happens and it is of no significance to simulate this period. 2021∼2030 and 2031-2040 can act as different future scenarios (with the different increasing rates of socio-economy) and SD is inherently used to simulate future scenarios. In the revised paper, we will delete the simulation result of 2016-2020, and give new scenarios starting with 2021.

3. Other concerns:

L26: In what way does the paper "highlight the importance of water resources management"? Please explain.

The current water resources system considers multiple water use agents that is conflict with each other. Therefore, in this study, we have generated multiple scenarios based on different weighting factors. Water allocation is not for only one water department but for multiple water use departments, which is an important issue for water resources allocation for multiple water users. Giving different water resources allocation schemes for different policy-makers from different departments can help them choose the best scheme from portfolios based on their own benefits.

L85: are usually manifested.

Writing mistake. I will make changes in the revised paper.

L113: The framework is not yet raised to theoretical altitude. It is a little bit exaggerating. The word, such as "overall", "general" may be better.

I will make changes in the revised paper. It indeed does not raise to theoretical altitude.

L139-147: Why single out "CAS theory" here? Please explain the usage in this text and the relationship of subsequent sections (or add some relative statements).

CAS theory reveals the system and its components, as well as their relationship. CAS is addressed based on the fact that a system is easy to be influenced by external drivers. There's no doubt that external dynamic changes will influence the status of a system and stimulate the system to make corresponding responses. The response is to make each component and the entire system attain the most suitable status. In the water resources system, the components are multiple water users, i.e., different agents in the scope of systematics. The optimal process is the most effective approach to allocate the water for different water users, making all the agents to their best status, which is the direct manifestation of CAS theory.

L150-158: As noted before, SD and optimal model should be reconsidered. Therefore, this part should be thoroughly edited to reveal the correct logical relationship.

Yes, this relationship should be thoroughly rewritten. The relationship and logic have outlined in my first response to your comments.

L656-657: Please explain why uncertainty analysis "gives a strong reference for decision-making process".

The uncertainty analysis contains scenario analysis based on multiple tradeoffs of water users. Each scenario contains one or two of each water user that share a relatively larger proportion (e.g., A1$\sim$A3 focuses more on ecological streamflow, A4$\sim$A7 focuses more on food safety). By analyzing each water allocation scheme of each scenario, the results can give a strong reference for stakeholders on (1) how to make changes based on the policymakers. If the local policy inclines to ecological protection, then A1$\sim$A3 will be the possible water allocation scheme; (2) how can each stakeholder itself make tradeoffs based on different scenarios. For example, the results show that the equal consideration of each water user can best attain sustainable development, and each stakeholder will make tradeoffs to get a win-win status. It also helps policymakers on how other stakeholder acts if one of the stakeholders is emphasized (with higher weighting factor) of neglected (with lower weighting factor).

L720-721: The general brief sentence should be added to explain how the research framework "becomes a practical tool". The following two paragraphs are used to disclose the general brief sentence. Also, check if the abstract has mentioned this. The title includes "practical tool" and all the text should be surrounded this issue.

Yes, this comment is very important to improve the quality of the paper and help make the logic easy to understand. Actually, the research "becomes a practical tool" can be reflected as I mentioned in the previous reply (L656-657). I will compress those expressions in the corresponding location of the current paper.

Also, I found the overall terminology of the entire framework is a little questionable. The framework of "Economy-ecology-food" (EEF) in which "economy" has already contained "agricultural economy" that corresponds to the "food" module. It has a repetitive concept. I want to rename the framework of "Socioeconomy-ecology-food" (SEF) because the prefix "socio" emphasizes more on "human", and therefore, "socioeconomy" will emphasize more on population, industry, and tertiary industry compared with primary industry.

References:

Li Z, Li C, Wang X, et al. A hybrid system dynamics and optimization approach for supporting sustainable water resources planning in Zhengzhou City, China[J]. Journal of Hydrology, 2018, 556: 50-60.

Please also note the supplement to this comment:
https://hess.copernicus.org/preprints/hess-2020-461/hess-2020-461-AC1-supplement.pdf

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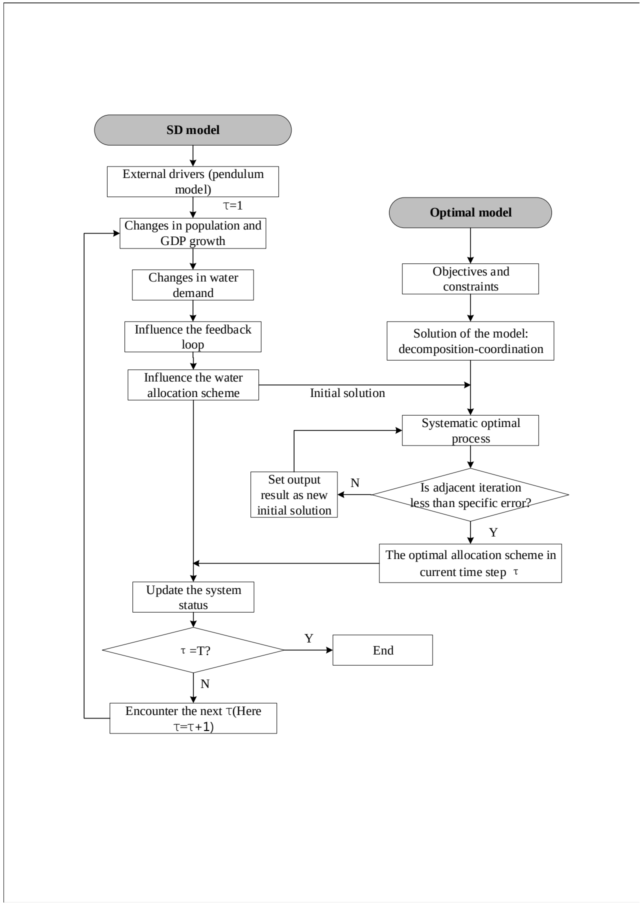

Fig. 1.

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