# Reviewer 2

This manuscript presents a new approach for modeling water-energy-food nexus by incorporating social feedback loops driven by environmental awareness and a water resources allocation model into the system. It's a interesting topic for researchers in the related areas, and the proposed approach has potential application value in other basins. The manuscript is clearly organized and the study background is described comprehensively in the Introduction. However, the method is not clearly explained in some places, and there are some detailed errors in words. Below are some detailed comments:

Thank you very much for your positive remarks on our paper. We will thoroughly revise the paper based on your comments. We believe the current comment can greatly help improve the quality of the paper. Here are the responses to your comments:

1. The impact of water supply on energy consumption is related to industrial water, not ecological water or domestic water. Please clearly distinguish the impacts of different types of water supply on energy and food.

1 Response:

Thank for your supportive suggestion. We will give more details to distinguish the impacts of different types of water supply on energy and food in Section 2 as follow: The water supply for socioeconomic water use sectors outputted from water system module is taken as the input of energy system module to determine energy consumption. And the agriculture water shortage rates is taken as the input of food system module to estimate the food production.

2. In Figure 1, is the output of the water resources allocation model a total water supply or water supply of different sectors for every operational zone?

2 Response:

Thanks for your supportive suggestion. The outputs from water resources allocation model are the water supplies for different water use sectors in each operational zone. We will add more details to describe the water supply in Section 2.

3. In the energy system module, water supply not only affects energy consumption, but also energy supply, such as in thermal power, hydro-power and some other sectors. It is need to consider the impact of water supply on planning energy production.

3 Response:

Thanks for your supportive suggestion. We quite agree with your opinion that water supply also plays an important role in energy production. The energy structure in the study area involves thermal power, hydro power, wind power, solar power and biomass power, which brings a great challenge to the data collection and further the energy production simulation. Therefore, as the paper focuses on assessing the impacts of environmental awareness and water resources allocation on WEFS nexus, we simplified the energy production as the boundary conditions of the model (i.e., planning energy production).

4. Please explain why GDP will affect the change of water quota in detail and provide some references for it.

4 Response:

Thanks for your supportive suggestion. We are going to add the references indicating that community wealth, which can be indicated by GDP, is considered as the vital driving factor to promote water-saving technology in Section 2.1.1. Water use quotas are assumed to decrease with the technology advancing due to expansion economy (Blanke et al., 2007; Hsiao et al., 2007). As the difficulty of saving water by the advances in technology is increasing, the changing rate of water use quota is decreasing in equation (6) (Feng et al., 2019).

5. Line 197-202: There are several variables in the equation (6) that are not explained.

5 Response:

Thanks for your supportive suggestion. We will correct equations for water shortage determination in IRAS water resources allocation model. The detailed description for the shortage determination will also be added. Water shortage at demand node should be firstly determined on basis of its water demand and total water supply. The total water supply consists of natural water inflow (i.e., local water availability) and water supply from reservoir. In each sub-time-step (except the first), the average natural water inflow in previous *sts*-1 sub-time-step is estimated as the extrapolated natural water inflow in rest sub-time-steps by equation (7). The water shortage can then be determined by deducting the demand reduction, the total real-time water inflow and the extrapolated natural water inflow from water demand through equation (8). The total water shortage rate can then be determined by equation (9).

$$WE_{i,j}^{sts} = (\sum_{1}^{sts-1} WTSup_{i,j}^{sts} - \sum_{1}^{sts-1} WRSup_{i,j}^{sts}) * \frac{(Tsts - sts + 1)}{(sts - 1)} \quad (7)$$

$$WS_{i,j}^{sts} = \frac{WD_{i,j}^{ts}(1 - f_{red}) - \sum_{1}^{sts} WTSup_{in}^{sts} - WE_{i,j}^{sts}}{Tsts - sts + 1} \quad (8)$$

$$WSR_{i,j}^{t} = \frac{\sum_{ts}\sum_{sts} WS_{i,j}^{sts}}{\sum_{ts} WD_{i,j}^{ts}} \quad (9)$$

where *ts* is the current time step; *Tsts* is the total number of the sub-time-step; *sts* is the current sub-time-step; $WE_{i,j}^{sts}$ is the extrapolated natural water inflow for *j*th water use sector in *i*th operational zone; $WTSup_{i,j}^{sts}$ is the total water supply; $WRSup_{i,j}^{sts}$ is the water supply from reservoir; $WD_{i,j}^{ts}$ is the water demand; $f_{red}$ is the demand reduction factor; $WS_{i,j}^{st}$ is the water shortage; $WSR_{i,j}^{t}$ is the water shortage rate in *t*th year.

6. For equation (9), why does the energy use quota of an optional zone multiplied by the water use quota of an optional zone equal total energy consumption? What is the definition of energy use quota in the paper? Please explain it.

6 Response:

Thanks for your supportive suggestion. We have carefully read your constructive comments. And we found that water supply plays a more important role in energy production, rather than consumption. Therefore, we will take this valuable suggestion. We are going to re-build the WEFS nexus model by re-defining the energy consumption in Section 2.2 and the results will be updated.

We will focus on the energy consumption during water supply process to further help investigate the energy co-benefits of water resources allocation schemes (Zhao et al., 2020; Smith et al., 2016). The energy consumption for water heating and water end use will not be included in revised manuscript. Energy consumption is determined by energy use quota and the amount of water supply for water use sectors (Smith et al., 2016), the energy use quota of which indicates the amount of energy consumption when per unit of water is supplied. Despite the amount of energy consumption from water supply process is much smaller than the total amount of energy consumption in the study area, it's still an interesting topic to quantitatively assess the trade-offs between water supply and energy consumption under different water resources allocation schemes.

7. Line 238: the calculation formula of WSR isn't presented in the paper, please add it.

7 Response:

Thanks for your supportive suggestion. We will add the equation for water shortage rate estimation in Section 2.1.2 as is discussed in "5 Response".

8. Line 328-331: Please add references to illustrate the contradictions between the increasing demands and limited resource supply will be aggravated in the study area

8 Response:

Thanks for your supportive suggestion. We will add corresponding references to illustrate that the contradiction between demands and limited resources will be intensified in study area with the impacts of climate change and the fast socioeconomic expansion in Section 3.1. Due to population expansion, fast urbanization and rapid economic development, the local demands for water, energy and food are going to increase enormously (Zeng et al., 2021). The contradictions between the increasing demands and limited resources will be intensified. Improving use efficiencies for water, energy and food in mid-lower reaches of Hanjiang river basin is needed urgently (Zhang et al., 2018; Liu et al., 2019).

9. Are the impact of policy on water supply taken into account in the water allocation model, such as total quantity control of water consumed in the region?

9 Response:

Thanks for your supportive suggestion. Yes, we have indeed taken the "total quantity control of water consumed" policy into account in our study. As the total water demand increase over a give threshold (i.e., 20 billion $m^3$ in study area), the reduction factor (i.e., 0.95) is used to reduce industrial and agricultural water demand. We will add the description for resources-saving policies in the study area in Section 3.1.

10. Line 358: How long is the data used for parameter calibration? Please add it.

10 Response:

Thanks for your supportive suggestion. The observed data of annual water demand, energy consumption, food production, population, GDP and crop area from 2010 to 2019 are used to calibrate the model. We will add more details for parameter calibration in Section 4.1.

11. The conclusion section is too long now, please make it conciser and highlight the key conclusions.

11 Response:

Thanks for your supportive suggestion. We will carefully improve the conclusion part to make it conciser as follow.

The proposed approach provides a valid analytical tool for exploring the long-term co-evolution of the nexus across water, energy, food and society systems. Environmental awareness in society system can effectively capture the human sensitivity to shortages from water, energy and food systems. The feedback driven by environmental awareness can regulate the socioeconomic expansion to keep the integrated system from constant resources shortage, which contributes to the sustainability of WEFS nexus co-evolution. The co-evolution of water demand, energy consumption and food production can be divided into expansion (accelerating and natural expansions for food production), contraction, recession and recovery phases based on environmental awareness. The co-evolution mode of WEFS nexus functioning strongly depends on the selection of certain parameter values. Rational parameter setting of boundary conditions and critical values is important for managers to keep the socioeconomic sectors from violent expansion and deterioration, especially in contraction and recession phases. Water shortage can be effectively relieved by the increased water supply through reservoirs operation. The high-level environmental awareness lead by water shortage is thus remarkably alleviated. As the negative feedback driven by environmental awareness is weakened, socioeconomic sectors develop rapidly. Water is thus no long the vital factor constraining the concordant development of WEFS nexus in expansion phase. Therefore, water resources allocation is of great significance for the sustainable development of WEFS nexus.

**technical comments:**

1. Line 124-125: There is no need to use the serial numbers "(1), (2)..." here, please getting rid of them.

12 Response:

Thanks for your supportive suggestion. We will delete the serial numbers.

2. Line 174: The sentence "...are the of population..."is lack of some words.

13 Response:

Thanks for your supportive suggestion. We will check and correct the sentence.

3. Figure 1: "Municipal water demand" projected by population is lack of rule water demand, which needs to be added.

14 Response:

Thanks for your supportive suggestion. We will add "Rural water demand" in Figure 1.

4. The font size of Equation (3)is not consistent with other equation

15 Response:

Thanks for your supportive suggestion. We will correct the front size of the equation to keep it consistent with others.

5. Figure 4(i) : The text after "phase 1: "is blank.

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16 Response:

Thanks for your supportive suggestion. We will add it in Figure 4 (i).

6. Line 404: The word "phase"doesn't need an s.

17 Response:

Thanks for your supportive suggestion. We will delete the "s".

# References

Blanke, A., Rozelle, S., Lohmar, B., Wang, J., and Huang, J.: Water saving technology and saving water in China, Agric. Water Manag., 87, 139-150, 10.1016/j.agwat.2006.06.025, 2007.

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