We deeply appreciate the detailed and constructive comments provided by the three anonymous reviewers. Following their suggestions and comments, we have extensively revised the manuscript and provided a point-to-point response to each comment. The original comments are in **bold** font, our response is in regular font, and the changes in the text are in blue.

Comment 2

The paper presents a novel and insightful approach to connect green water flows to their economic value across different provinces in China. The manuscript is well-structured and written. However, there are a few points that could be clarified and improved to enhance the overall impact and clarity of the study.

Response: Thank you for taking your time to review our study and provide feedback and comments. In the revision, we added more introductions about the connections between green water and socio-economic indices.

1 **The use of the UTrack dataset for processing and tracking the green water flow is commendable. But the uncertainties associated with the input precipitation data (P) in the forward-tracking process need further elaboration.**

  1.1 **It would be good to include the processing scripts for the UTrack dataset and a clearer explanation how you got from the dataset to the data that is used in the already included Python notebook.**

  1.2 **Additionally, this preprint (https://www.researchsquare.com/article/rs-4177311/v1) indicates that the water balance in the UTrack dataset does not appear to be closed, which leads to under- and overestimations of P and ET in either tracking direction. While this may be difficult to solve in the scope of this study, its implications should be discussed and made aware of. How could such uncertainties be addressed and how do they influence the results of this study?**

Response: Thank you for the comments.

1. Uncertainties associated with the input precipitation data (P) affect the precipitation contribution and precipitation recycling ratio.

The revised texts in section Discussion are shown below:

First, ET and precipitation datasets driving the UTrack model affect the tracked trajectories and magnitude of moisture flow. The resulting moisture trajectory is expressed as the fraction of ET to precipitation, and the amount of moisture is restored by the ET and precipitation dataset chosen by users. Different ET and precipitation datasets lead to different precipitation contribution and PRR (Li et al., 2023). We used the ERA5 dataset to keep consistent with the original UTrack model. It is noted that the non-closure of the moisture balance from ERA5 (Tuinenburg et al., 2020) results in more uncertainties in moisture tracking results (De Petrillo et al., 2024).

1.1 We will share all the processing scripts for the UTrack dataset and our analysis before publication of the paper.

1.2 The preprint by De Petrillo.et al indicates deviations between the tracked evaporation (ET) and precipitation (P) volumes at the country/ocean scale, because of the unclosed water balance by ERA5. The non-closure of water balance leads to more uncertainties in capturing moisture tracking. This preprint used the Iterative Proportional Fitting (IPF) procedure to adjust the tracked moisture flow matrices to ensure that the total evaporation and precipitation volumes match the reanalysis data at the country/ocean scale.

We estimated the ratio of P in sink province originating from ET of different source province, and then used the observed provincial P to estimate the P contribution from each province. This practice ensures that provincial P is 100% decomposed into different sources, avoiding the estimation bias of sink precipitation due to unclosed water balance by ET and P data.

2. While the paper shows a novel approach of linking green water flows to economic values, the connection between green water and socio-economic outcomes needs more clarity.

2.1 Green water appears to be treated similarly to blue water under the assumption that all green water flows can be used by humans and directly transferred into an economic value. But large parts of the flows probably remain inaccessible for direct human use and are rather important for indirect ecosystem services, and the stability of the carbon and hydrologic cycle.

2.2 More clarity is needed to understand how the link between the green

water flows and the socio-economic values are made. This is the novel part of this paper and would benefit from making this connection clearer. For instance, sections 3.1 and 3.2 present results which aren't really novel but rather an exploration under a different geographical lens. Section 3.3 presents the novel results of this study and hence, by streamlining 3.1 and 3.2 space could be made to focus and expand on the connection between green water and socio-economic values in China.

Response: Thank you for the comments.

2. We apologize for the confusion regarding the introduction about the connections between green water and socio-economic values.

The tele-connection of green water and socio-economic value is depicted as cascade: green water forms precipitation, then precipitation recharges water resource, which then sustains economic activities, human livelihood and crop growth. So we used the water resource volume, economic output (GDP), population and food production, the four variables, to estimate the green water contribution.

In the revision, we clarify these in section 2.2 and Figure 1. Please see the revised texts and figure below.

Green water from upwind source provinces flows and precipitates downwind to recharge water resources, and therefore sustains socio-economic activities in sink provinces (Fig. 1). Consequently, precipitation, water resources, and socio-economic factors such as economy activities, human livelihood, and crop growth in sink provinces rely on green water exported from source provinces. Changes in green water may affect water resource volume, and then impacts the water supply for economy activities, livelihood and irrigation of crop growth. We choose water resources volume, economy output (GDP), population and food production, the four socio-economic indictors that are tightly related to water resources (Li et al., 2018) to evaluate green water socio-economic contributions of the source province and capture the social dynamics of moisture recycling (Keys and Wang-Erlandsson, 2018).

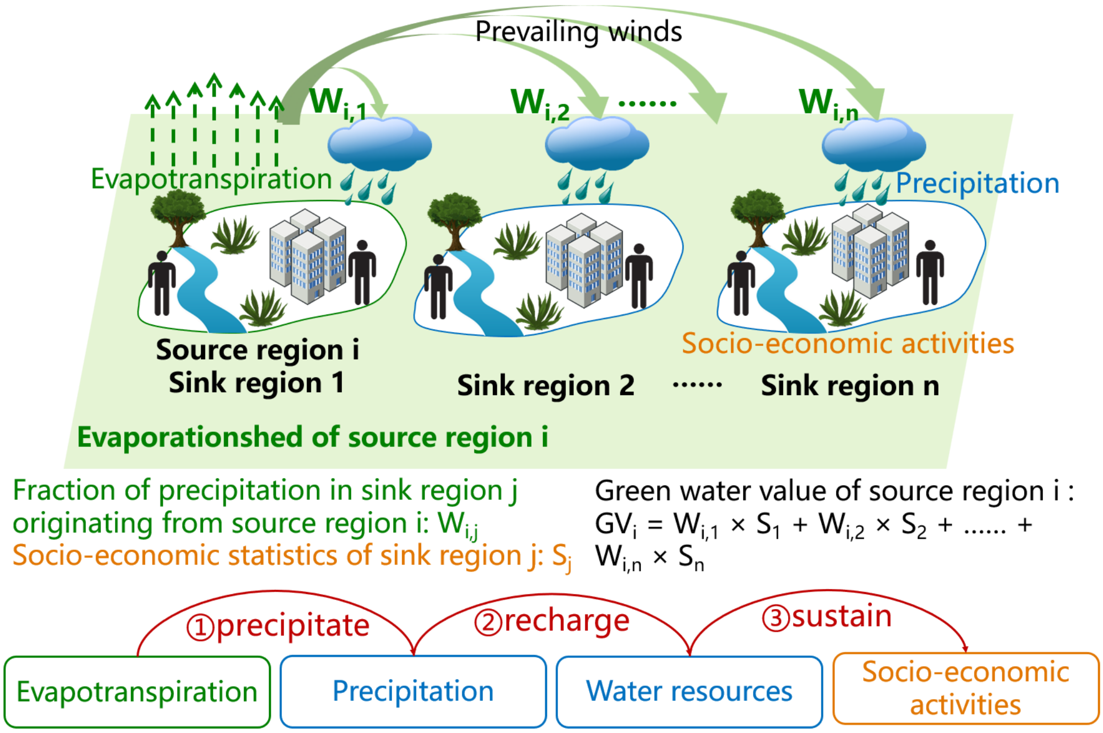

Figure 1. A conceptual diagram depicts the teleconnection of green water flows and their socioeconomic contributions in a cascade manner. Evapotranspiration (green dotted arrows) from source region i flows downwind with prevailing winds (green thick arrows) and precipitates in sink region n, which recharges water sources and sustains socioeconomic activities in sink regions.

2.1 We totally agree with that large parts of green water flows probably remain inaccessible for direct human use. Only the water resources generated from precipitation and consumed by human activities sustains the socio-economy. We used the ratio of water resources formed by precipitation (P) in the calculation of green water value. Since this ratio can be eliminated during the calculation process, Equation (1) is simplified and does not show the ratio involved in the calculation. The process of simplification is below. We take the GDP value of ET in one province as an example:

$$
\begin{aligned}
&\textit{water resouces value of green water} \\
&\quad = \frac{\textit{water resources}}{\cancel{P}} \times \cancel{P} \times \textit{green water forming P fraction} \\
&\quad = \textit{water resources} \times \textit{green water forming P fraction}
\end{aligned}
$$

$$GDP\ value\ of\ green\ water$$

$$= \frac{water\ resources\ value\ of\ green\ water}{water\ resources} \times GDP\ value$$

$$= \frac{\cancel{water\ resources} \times green\ water\ forming\ P\ fraction}{\cancel{water\ resources}}$$

$$\times GDP\ vlalue = green\ water\ forming\ P\ fraction\ \times GDP\ value$$

This research assume that all the used water resources are from precipitation generated by green water. This point was added in the Discussion and revised texts are shown below:

Secondly, the socio-economic value assessment of green water in this study only considers green water flows within China, excluding flows moving abroad and to the ocean that may embody socio-economic value beyond territory of mainland China. We mainly attribute socio-economic values to green water and generated precipitation, because precipitation is the ultimate water source to recharge surface and groundwater of a region. Strictly speaking, such attribution is not precise because socio-economy also utilizes streamflow from upstream areas which deserve separate attention. In addition, not all water resources replenished by green water-generated precipitation are accessible for human activities, part of them serve the nature ecosystem, such as sustaining forest function (Keys et al., 2019). Despite three socio-economic indices closely linked to water resources, the socio-economic contribution of green water flows can be manifested in other aspects such as livestock production, irrigated agriculture. In future study, green water's socio-economic contribution can be assessed annually by using moisture tracking dataset containing interannual variations and with or separation of water resources consumed by socio-economy (surface and ground water), which is more conducive to understand long-term changes and variations in the linkage between green water, water resources and economic development.

2.2 Sections 3.1 and 3.2 show the results of interprovincial green water transfer. Many studies have analyzed the pattern of moisture recycling in China from amphoteric and hydrological sciences, they identified moisture source and sinks at the grid (Zhang et al., 2023), basin (Wang et al., 2023) and ecological regional scale (Xie et al., 2024). These studies present a clear understanding of the large-scale spatial pattern of moisture circulation. Few studies focus on the moisture recycling analysis at the administrative district scale, which is important for the water management. Therefore, this study promotes the application of moisture recycling at the water resources management scale, which is also important for research outside the field of atmospheric science.

Sections 3.1 and 3.2 can help water resources managers understand the moisture recycling. The network of interprovincial moisture recycling is the basis of the socio-economic contribution of green water in each province.

In the revision, we will streamline 3.1 and 3.2.

Reference:

De Petrillo, E., Fahrländer, S., Tuninetti, M., Andersen, L. S., Monaco, L., Ridolfi, L., and Laio, F.: Reconciling tracked atmospheric water flows to close the global freshwater cycle, https://doi.org/10.21203/rs.3.rs-4177311/v1, 30 April 2024.

Keys, P. W. and Wang-Erlandsson, L.: On the social dynamics of moisture recycling, Earth System Dynamics, 9, 829–847, https://doi.org/10.5194/esd-9-829-2018, 2018.

Keys, P. W., Porkka, M., Wang-Erlandsson, L., Fetzer, I., Gleeson, T., and Gordon, L. J.: Invisible water security: Moisture recycling and water resilience, Water Security, 8, 100046, https://doi.org/10.1016/j.wasec.2019.100046, 2019.

Li, X., Zhang, Q., Liu, Y., Song, J., and Wu, F.: Modeling social–economic water cycling and the water–land nexus: A framework and an application, Ecological Modelling, 390, 40–50, https://doi.org/10.1016/j.ecolmodel.2018.10.016, 2018.

Li, Y., Xu, R., Yang, K., Liu, Y., Wang, S., Zhou, S., Yang, Z., Feng, X., He, C., Xu, Z., and Zhao, W.: Contribution of Tibetan Plateau ecosystems to local and remote precipitation through moisture recycling, Global Change Biology, 29, 702–718, https://doi.org/10.1111/gcb.16495, 2023.

Tuinenburg, O. A., Theeuwen, J. J. E., and Staal, A.: High-resolution global atmospheric moisture connections from evaporation to precipitation, Earth System Science Data, 12, 3177–3188, https://doi.org/10.5194/essd-12-3177-2020, 2020.

Wang, Y., Liu, X., Zhang, D., and Bai, P.: Tracking Moisture Sources of Precipitation Over China, Journal of Geophysical Research: Atmospheres, 128, e2023JD039106, https://doi.org/10.1029/2023JD039106, 2023.

Xie, D., Zhang, Y., Zhang, M., Tian, Y., Cao, Y., Mei, Y., Liu, S., and Zhong, D.: Hydrological impacts of vegetation cover change in China through terrestrial moisture recycling, Science of The Total Environment, 915, 170015, https://doi.org/10.1016/j.scitotenv.2024.170015, 2024.

Zhang, B., Gao, H., and Wei, J.: Identifying potential hotspots for atmospheric water resource management and source-sink analysis, CSB, 68, 2678–2689, https://doi.org/10.1360/TB-2022-1275, 2023.