Response letter

Dear Editor in Chief,

Thank you very much and the anonymous reviewer for the valuable comments on our work again. We have followed the words, and that makes our manuscript clear. We hope this improved manuscript will satisfy you.

Thank you very much for your further attention and consideration. We are looking forward to hearing from you soon.

Best Regards

Yours Sincerely,

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Comments Response to reviewer 1

General comment:

The quality of the manuscript has been significantly improved after the previous round of revision. The text description in the literature review has been modified and becomes more accurate. The methodology part can be understood easier with the new figure. The special fluctuation in the diversification trend has been explained. On the other hand, there are still some minor issues that need to be addressed. Therefore, a minor revision is recommended.

Response: Thank you for your help and recognition of our revision work!

Comment list:

(1) P8-9: Figure 3 and Figure 4: The gap between 1985 and 2000 in Figures 4B and 4C (uniqueness and competitiveness) may correspond to the complexity gap between YRB and national in Figure 3A during the same period. However, the higher peak after 2000 in Figure 3A is not reflected in the uniqueness and competitiveness trend in Figures 4B and 4C. It is recommended to explain this in the article if there is a special reason for this result.

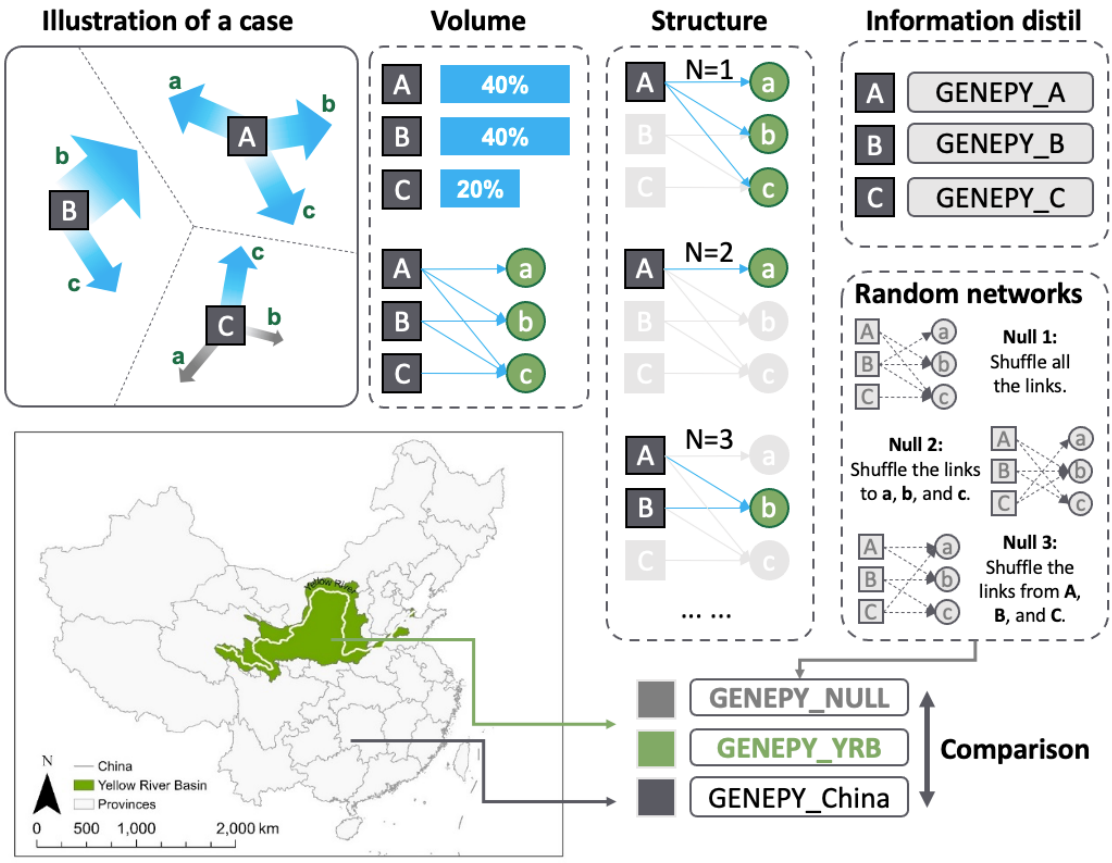
Response: Thank you for pointing out such an interesting but previously overlooked point. As you remarked, we agree that adding some description would help the reader understand.

> ***[P7, L150-L154]*** Firstly, an indication of crop diversification ($N = 1$, Figure~A) was that almost every region was transferring virtual water through 7-8 dominant crops on average. The peak of diversification occurred before about 2000 when the major crop species supporting virtual water transfer were most abundant. Still, there is no significant difference between the YRB, China, and the random network (null models).

(2) P6: Section 2.5 The introduction on 'Null models and sensitivity tests' is still not clear enough, especially the last sentence 'They were consistent with …' on P6. Also, the 'Random network' part of Figure 1. should be linked to Table 2. instead of simply using grey color.

Response: Thank you for the valuable comment. Now, we polished figure 1 and linked it to Table 2, with some modifications in text for a better explanation:

> ***[P6, L132-L137]*** We randomly created provincial-crop bipartite networks for a sensitivity test. We calculated the same metrics as a comparable reference value to decide whether the influence of networks structure was trivial (Figure 1). The idea behind the randomization procedure is that we can create a null model starting from the data but shuffling the links of the network while conserving some of its statistical properties. We randomly generated (executed by Python 3.9 and Numpy 1.2) three scenarios where the bipartite networks have the same (1) number of edges, (2) edge sequences on provinces, and (3) edge sequences on crops, with the original dataset, respectively (Table 2 and Figure 1).



Rectified Figure 1. Virtual water transfers between regions through multiple dominant crops. When the proportion of VWF from a region is large enough when considering a specific crop, we establish a connection between the region and the crop. In that way, we abstract region-crop bipartite networks for analysis. Here, we give a more straightforward illustration of our method: (1) Illustrating a nation comprised of three regions (A, B, and C) where three types of crops (a, b, and c) can be the productions for supporting virtual water flows (VWF). Region B doesn't produce crop a, and region C produce a negligible crop a and b. (2) When considering VWF volume, it is hard to compare regions A and B, as they support 40% national total VWF. (3) However, when the structure is involved, their position in region-crop bipartite networks are different, typically in their differences of diversification (N = 1), uniqueness (N = 2) and competitiveness (N = 3) (the parameter N refers to levels of decomposition, detailed interpretation in section 2.4). (4) Therefore, considering both volume (by ignoring eligible VWF crops) and structure, the GENEPY index is a method for distilling information (see section 2.3). Our main results derive from comparisons between indexes of YRB, China, and random networks (as a benchmark). We generated three different null models by shuffling links in different ways and Table 2 gives them mathematical descriptions.