General comments

The study assessed the potential to optimise water supply allocation during extreme drought years in the Yellow River Basin. Specifically, three water supply scenarios were created to optimise different management measures in order to minimise water shortages. The water supply scenarios aimed to explore the potential for rainwater harvesting, water storage and groundwater abstraction (i.e. “unconventional” sources) to supplement surface water abstraction (i.e. “conventional” sources) during an extreme drought year (2010). The authors provided interesting insights into the measures to mitigate drought impacts and maximise water supply security, including considering sustainable and equitable water use across sectors.

However, whilst the topic is relevant to NEHSS and the wider implications of the main results could be an important contribution to improving water resources management, the paper requires a clearer structure, a more comprehensive description of the methods and a more critical discussion of the results. I would therefore recommend major revisions before this paper can be reconsidered for publication. To improve the paper, I would suggest including distinct methods and results sections to make clear which sections of the paper are results generated by the authors and which sections are information taken from secondary sources. Additionally, it is unclear from the paper how the water supply scenarios were modelled, how the water resources allocation model is parameterised and how the scenarios are applied. A number of major and additional comments (denoted by line numbers) are further presented below. I hope my comments will help the authors improve their paper.

- **Methods：** There should be a Methods section clearly detailing the definition of each scenario and exactly how these scenarios are defined within the water resource allocation model. It is hard to decipher how the various equations presented fit together-perhaps a flow chart could help here to illustrate the various inputs, outputs, model parameters and what, if any, algorithms were used to solve for the optimal water resources allocation. There is mention of the genetic algorithm used to optimise the model solution in the Discussion section but that information should ideally be placed in a methods section and explained more fully. The authors could also consider providing details on whether the model has been tested or validated in the methods section. I would also appreciate more information on how the water supply scenarios were modelled (e.g. were the model coefficients presented varied in some ways to represent the specifications of each scenario?).

Reply: First, about the definition of the situation, before the repair, in the “2.2 potential scenario setting” part has been described, the specific definition is as follows: according to the strength of water-richness, different scenarios are tapped. From scenario 1 to scenario 3, the supply potential increases in turn, and different supply increase scenarios correspond to different supply increase measures.

Secondly, about the embodiment of water supply scenario in the model, the formula and constraint conditions of water supply in the model have been described. Thirdly, about the algorithm of multi-water source allocation, the “3.4 model solution” part is added, and the process and parameters of the solution are introduced. The specific new contents are as follows:

Genetic algorithm is a kind of intergenerational evolution, survival of the fittest, from low to high level algorithm. This algorithm takes the optimization of the global as the goal, carries out random search in the feasible solution space, realizes the group replacement and iterative optimization through cross compilation, and makes each individual gradually reach the optimal until the evolution of each generation. The genetic algorithm has strong adaptability, can independently optimize and search the solvable space, has fast convergence speed and does not depend on the decoding process, and the large search space greatly improves the calculation accuracy.

(1)The calculation steps of multi-water allocation algorithm are as follows:

The first step: Let the random scale value A, the initial population B_0, and B_0 as the parent population;

The second step: calculate the crowding distance and the order of the parent population, and optimize the selection, crossover and mutation to obtain the offspring population B_t;

The third step: merge B_0 and B_t to obtain a scale of $2A$, and the resulting offspring population is C_t.After sorting, the individual crowding degree is calculated, and the previous A individuals are selected to form the parent population B_{t+1};

Step 4: judge whether the result meets the conditions, if not, go back to the second step, and output the result if it meets.

(2)The decision variables are written as follows:

This paper considers five water sources (surface water, elastic groundwater exploitation, flood resources, unconventional water) and three water supply scenarios (Scenario 1, Scenario 2, Scenario 3), four water sectors (domestic, industrial, agricultural, and ecological water). According to the constraints of the multi-water allocation model, the decision variables are numbered as follows (Table 7), $x_{i,j}$ represents the water supply of different water supply sources to different water use sectors. Among them, i represents the type of water supply source, (i =1,2,3,4,5), j represents different water use sectors, (j =1,2,3,4), p represents different water supply scenarios, (p = 1,2,3).

Table 7 Numbering of decision variables

Water use Department	Life	Industry	Agriculture	Zoology
Surface water	$x_{11,\ p}$	$x_{12,\ p}$	$x_{13,\ p}$	$x_{14,\ p}$
Unconventional water	$x_{21,\ p}$	$x_{22,\ p}$	$x_{23,\ p}$	$x_{24,\ p}$
Groundwater	$x_{31,\ p}$	$x_{32,\ p}$	$x_{33,\ p}$	$x_{34,\ p}$
Flood resource utilization	$x_{41,\ p}$	$x_{42,\ p}$	$x_{43,\ p}$	$x_{44,\ p}$

(3) Function call and optimal solution selection:

The gamultiobj function needs to be called during the operation of the genetic algorithm. The function expression to be called is [x, fval] = gamultiobj (fitnessfcn, nvars, A, b, Aeq, beq, lb, ub, options), x is the pareto solution set obtained by the gamultiobj function, fval is the objective function, nvars is the total amount of variables, options is the genetic parameter, fitnessfcn is set as the handle of the objective function, which is regarded as the fitness function. A, Aeq, b and beq are the constraint conditions of the function, and ub and lb are the upper and lower limits of the constraint values. The genetic parameters of the genetic algorithm are set as follows : the individual coefficient is 0.3, the highest evolution generation is 3000, the end generation is 3000, and the fitness function error value is 0.0001.

The optimal solution is distributed in the pareto solution set, and the minimum water shortage of domestic water demand, industrial water demand, agricultural water demand and ecological water demand is comprehensively considered. Finally, the optimal solution is selected. Under the condition of satisfying the available water supply and related constraints, the priority of domestic water supply is considered, then the industrial water supply is considered, then the agricultural water supply is considered, and finally the ecological water supply is considered.

Results: The results from this paper seems to be Table 7, which shows the water availability for each sector and each scenario after solving the water resources allocation model. However, this section is very short with limited description of the main results. Table 8 compares the scenario results with actual water resources availability during 2010 but this is just a repetition of what is already shown in Table 7. Instead of a large table like Table 7, perhaps some figures summarising the results visually would be helpful and could replace repeated information in Table 8. The inclusion of water demand satisfaction estimation in Table 10 is interesting and seems novel but it is not explained in the paper how water demand satisfaction is estimated, how water demand is considered in each of the scenarios and how they are included in the water resources allocation model.

Reply: Table 7 gives a detailed summary of the water supply in the living, industrial, agricultural and ecological sectors of each sub-region based on the three water supply scenarios. Therefore, a lot of space is saved, and only the water supply and water shortage under different scenarios are expressed. Table 8 analyzes the changes of water supply before and after tapping the potential from the perspective of different water supply departments, and it is also a more detailed interpretation of table 7. The water demand satisfaction in Table 10 refers to the degree of satisfaction of water demand (the proportion of water supply in each water department to the water demand of each department). The water demand satisfaction is calculated based on the results of multi-water source allocation, and does not need to be included in the multi-water source allocation model.

Discussion: This section is very short and there is very limited discussion of how the results fit with the wider literature on drought mitigation measures (such as relevant studies in nature-based solutions for drought mitigation) in the wider region and/or globally. While I appreciate that findings often differ between studies due to different methods and spatial scales, there should be much more critical discussion of how your results relate to the wider scientific literature in drought management. Additionally, there is no discussion of possible sources of uncertainties associated with the water resources allocation model. For example, the authors could consider providing some discussion of the assumptions of the model and how that may influence the reliability of the results.

Reply: First, in the discussion, a comparative discussion between the results of this study and the national scientific literature was added. The specific new contents are as follows :Firstly, Compared with the research results of other scholars (Wang, 2024), the literature (Wang, 2024) takes the Yellow River Basin as the research object, the spatial scale of the research is relatively large, and the water resources allocation scheme obtained is not specific enough. This paper takes the Henan water supply area of the Yellow River as the research object. The multi-water source water supply scheme is specific to the district and county levels, which improves the accuracy of multi-resource allocation, and more scientifically reveals the drought and supply and demand conditions at a smaller spatial scale. The multi-water source tapping potential based on multiple scenarios has greatly alleviated the drought status of the Henan

Yellow River water supply area, reduced the water supply pressure and water use restrictions of conventional water sources, and improved the support capacity and guarantee capacity of water resources. In the future, it is necessary to further optimize the research methods and improve the accuracy of data to enhance the rationality and scientificity of multi-water source allocation schemes.

Secondly, about the uncertainty problem related to the configuration model, some problems of the model algorithm are added in the ' 4.3 discussion ' section. The specific contents are as follows: Due to the randomness of crossover and mutation operations, the algorithm may fall into the local optimal solution in the search process, and the global optimal solution cannot be found, which may affect the accuracy and reliability of the solution. At the same time, the parameter settings in the genetic algorithm, such as crossover rate and mutation rate, have an important impact on the solution results. However, the setting of these parameters often needs to be adjusted according to specific problems, and there is no unified setting method at present. Different parameter settings may lead to the instability of the solution results. In the future, the algorithm needs to be further optimized.

Additional comments:

L38–please explain what you mean by “uneven water cycle”. This does not seem to be consistent with the language used by the IPCC.

Reply: The “uneven water cycle” here has been changed into the contradiction between supply and demand of water resources. The contradiction between supply and demand of water resources refers to the imbalance between supply and demand of water resources. This contradiction is usually manifested in the supply of water resources can not meet the needs of human life and economic development, or in some areas, the development and utilization of water resources more than the carrying capacity of the local environment, resulting in the shortage of water resources or excessive consumption.

L49–this is the first time “unconventional water resources” are used in the text. “Conventional” and “unconventional” should be introduced, perhaps with examples, from the start. For example, the section from L172-182 explaining rainwater harvesting, reclaimed water, water storage capacity and groundwater abstraction should be placed much earlier.

Reply: The concept of conventional water and unconventional water has been added in the “Introduction” section. The new content is as follows: conventional water resources (which are widely used in daily life, easy to obtain, and can be directly used for human activities after appropriate treatment, such as surface water, groundwater, tap water); unconventional water (which refers to water resources other than conventional water resources such as surface water and groundwater in the traditional sense, such as reclaimed water, rainwater, seawater, mine water, brackish water, etc.)

L56-91–instead of listing out studies one after the other, it would be more insightful if you identified common themes, methods and findings from previous studies which motivated the study aims.

Reply: We are willing to accept the proposal. In the future research, we will improve the insight of academic research, find problems such as themes and methods from the research, and carry out targeted and insightful research.

L129–“drought change of the PDSI annual sequence”–do you mean drought occurrence?

Reply: “drought change of the PDSI annual sequence” is based on the PDSI value to determine whether the drought exists and the degree of drought, according to the size of the PDSI value to divide the drought level (as shown in table 2).

Table 2 PDSI drought classification standard table

PDSI	Drought level	PDSI	Drought level
（-1，1）	Normal	（-4，-3]	Serious drought
（-2，-1]	Light drought	（-∞，-4]	Extreme drought
（-3，-2]	Moderate drought		

L138–“every 10 or so”–is this referring to years?

Reply: “every 10 or so” refers to the probability of severe drought (on average, one severe drought every 10 years).

L140–drought severity rather than “grade” might be clearer.

Reply: The drought severity is expressed according to the drought level. The drought level can be divided into no drought, light drought, moderate drought, severe drought and extreme drought. Therefore, the drought level is used to describe the severity of drought.

L144-145–repetition of L139

Reply: “the drought degree of the Yellow River Water Supply Area in Henan reached the level of extreme drought in 2010.” has been deleted from the original text.

L183–What do you mean by “water richness” and how is it quantified?

Reply: “water richness” refers to the water yield capacity of aquifer, which is a sign to measure the water yield of aquifer during groundwater exploitation. In this paper, the water-rich grade of groundwater in each zone is judged according to the unit water output of the water source well and the spring water flow. The specific quantitative division standard is referred to Table 4.

Table 4 Division table of groundwater water abundance in the Yellow River Water Supply Area in Henan

Regionalization basis	Partition			
	Weak water-rich area	Medium water-rich area	Strong water-rich area	Extremely strong water-rich area
Unit output of water source well(m^3/h·m)	$q<1$	$1\leq q<5$	$5\leq q<10$	$q>10$
Flow capacity of spring (L/s)	$Q<1$	$1\leq Q<10$	$10\leq Q<5$	$Q<50$

L183–As noted in general comments, it is not clear from the text what “tapping” means–do you mean the different scenarios are tested adopted depending on groundwater abundance of the region? Both “tapping” and “digging” potential are used throughout the text but neither terms are properly defined–are they different concepts or do they refer to the same thing?

Reply: "tapping" means that under extreme drought conditions, different degrees of potential tapping are carried out according to different supply increase measures (see Table 5). From water supply scenario 1 to water supply scenario 3, the degree of potential tapping gradually increases. "tapping" and "digging" express the same thing, that is, the meaning of digging, and "digging" has been completely changed to "tapping".

Table 5 Measures for increasing supply of different potential water sources under different supply scenarios

Additional supply scenario	Unconventional Water Tapping	Flood resource utilization	Elastic groundwater exploitation
Scenario 1	Increase the scale of rainwater harvesting facilities by 5%	Increase the scale of water storage project by 5%	Mining 15% of water source in strong water-rich area and extremely strong water-rich area
Scenario 2	Expand the scale of 5% rainwater harvesting facilities; reclaimed water and sewage utilization efficiency increased by 10%	Increase the scale of water storage project by 5%; reasonable setting to speed up the recovery scheduling rules	Mining 15% of the water source in the strong and extremely rich water area; mining and excavating 10% of the water source in the medium water-rich area
Scenario 3	Expand the scale of rainwater harvesting facilities by 5%;the utilization efficiency of reclaimed water and sewage is increased by 10%;increase the utilization ratio of mine water by 20%	Increase the scale of water storage project by 5%; reasonably set up the scheduling rules for accelerating the recovery of savings; dynamic adjustment of reservoir flood control level	Mining 15% of the water source in the strong and extremely rich water area; mining and excavating 10% of the water source in the medium-rich water area; mining 5% water source in weak water-rich area

Table 4–What does q and Q stand for in the table? The relevance of this table is not clear and it is unclear how it relates to the water supply scenarios listed in Table 5.

Reply: In Table 4, q and Q represent the unit water yield of water source wells and spring water flow respectively. According to these two indicators, they are only used to judge the water abundance of groundwater in each partition and carry out the elastic tapping of groundwater. Table 5 is from the perspective of percentage, based on unconventional water, flood resources, groundwater potential water, to tap the potential of different scenarios.

Table 6–Does this table report results obtained from the study or are they values taken from secondary sources.

Reply: The unconventional water, flood resource utilization and groundwater volume in Table 6 are calculated according to the potential water volume. The potential water volume has been explained in the part of “3.1 Water Source Analysis of Multi-Scenario Potential Exploitation” (i.e. the potential water volume of unconventional water in Henan Yellow River Water Supply Area in 2020 is 50.45 billion m3, the potential water volume of flood resource utilization is 10.223 billion m3, and the potential water volume of groundwater elastic exploitation is 9.660 billion m3). At the same time, the potential water volume of different scenarios is calculated according to the percentage and the potential water volume of various water sources. The percentage is based on the comprehensive setting of the supply capacity and scale of rainwater harvesting facilities, water storage projects, etc.

Section 3.2–Did the authors come up with the water demand hierarchy themselves? If not, there should be appropriate reference to previous studies which have applied similar concepts.

Reply: In the original text, the “3.2 Water demand level division and configuration principle” section has put forward the level of water demand, which divides the water demand process of life, industry, agriculture and ecology into three levels, namely rigid demand, rigid elastic demand and elastic demand. Rigid water demand is in the first priority in the water distribution, and once it is destroyed, it will be difficult to recover the loss; rigid elastic water demand is the second priority in the distribution water, and the loss caused by water shortage is recoverable; elastic water demand is the last consideration in water resources allocation.

L264–what does “enemy” mean?

Reply: Has been corrected to “Where Z_p is the total water shortage of scenario p”

Open research section: are these meant to be hyperlinks to the data source? If so, the links don’t seem to be working.

Reply: The data in this paper are derived from the paper-based statistical yearbook of Henan Province over the years, and cannot generate hyperlinks. At the same time, these data are confidential and are not provided, please understand. However, in the “1.2 Basic Information” section, references to data sources have been added. The new literature is as follows:

[27] Kang J F, Zhang Y N, Liu C, et al. Human Economic Data Set of the Yellow River Basin from 2015 to 2019, China Scientific Data, 7(04): 118-132, 2022.

[28] Li J, Nie H M, Xu G Z. Characteristics Analysis on Carbon Reduction of Crop Production in Henan Province Based on the Statistical Yearbook Data, Chinese Journal of Agrometeorology, 44(09): 759-768, 2023.

[29] Zheng Z. Regional Water Consumption Characteristics and Trend Forecast under the Most Stringent Water Resources Management System, North China University of Water Resources and Electric Power, 2018.