Responses to Reviewers

Reviewer #1:

The authors presented a study on flood relief logistics planning based on Geographic Information System (GIS) analysis and resource allocation optimization models in the Shanghai area. They explored the effectiveness and fairness of resource distribution in managing flood crises under 100-year and 1000-year flood scenarios. They found that the current capacities of emergency flood shelters (EFSs) and emergency reserve warehouses (ERWs) are adequate for a 100-year flood but insufficient for a 1000-year flood scenario, and highlighted the need for greater resource investments to address potential shortages. In general, this study is interesting and has practical significance. Most parts of the manuscript are well structured and expressed. This study would be helpful for the community of disaster management and urban planning. However, the current manuscript needs a major revision before it is published in this journal.

We greatly appreciate the invaluable and constructive feedback provided by Reviewer #1. Our responses are highlighted in blue italic. We have acted upon all the points raised. The comments were very useful in improving the overall quality and readability of the manuscript.

Comment 1: The paper presents a well-integrated framework for flood relief logistics that combines Geographic Information Systems (GIS) and optimization models. However, the validation of these models is primarily limited to a case study without comparisons to actual event data or established models. Comparing the proposed model outputs with historical flood events or the results from established models would significantly enhance the manuscript's robustness. I suggest the authors to add a discussion in the last part.

Thank you for your valuable feedback on our paper. The issue of model validation you pointed out is indeed important. We have added a discussion in the final section highlighting the need for such validation and indicating the direction for future work. Specifically, we have added the sentence as follows:

line 458-461: '3) Model validation: This study has not yet incorporated a formal validation of the proposed models. Comparing model outputs with historical flood event data or established decision models would provide a more comprehensive validation and enhance the robustness of the framework. Future work should prioritize these comparisons to improve the model.'

Comment 2: The manuscript briefly mentions specific details about the optimization methods used, such as the NSGA-II algorithm and parameter setting withoutin-depth explanations. Providing detailed descriptions of these methods would enhance the reproducibility of the paper and offer a clearer understanding for readers with specialized knowledge.

Thank you very much for the suggestion. We have added the sentence as follows:

Line 359-369: 'This bi-objective mathematical model is solved via the nondominated sorting genetic algorithm II (NSGA-II), which is used to obtain a Pareto optimal solution in multiobjective optimization problems (Deb et al., 2002). NSGA-II is an advanced multiobjective evolutionary algorithm that maintains population diversity across generations through nondominated sorting and promotes a uniform distribution of solutions along the Pareto front using a crowding distance measure. The NSGA-II algorithm is widely used in selected combinatorial optimization problems and has the advantages of fast convergence speed, low computational complexity, and high robustness (Ma et al., 2023; Verma et al., 2021). The corresponding algorithm settings for the solution in this study are shown in Table 4.'

Table 4. NSGA-II Parameters Table

Parameter	*Population Size*	*Maximum Number of Iterations*	*Pareto Fraction*	*Crossover Probability*
Value	*500*	*3,000*	*0.4*	*0.8*

Comment 3: More comprehensive details regarding the data sources used in this study would be beneficial. Clarifying the availability and accessibility of these data for other researchers or planners, as well as disclosing any proprietary or restricted data, would enhance the transparency and applicability of the research.

Thank you very much for your comment. Regarding the data sources used in this study, we have provided more comprehensive details. The emergency shelter data for Shanghai, which can be publicly accessed, was provided by the Shanghai Emergency Management Bureau and is available at https://gfdy.sh.gov.cn/yjbncs/. This information has been noted in line 292 of the revised manuscript.

Specifically, the remaining datasets include:

1) *The future flood inundation scenarios in Shanghai under the climate scenarios used in this study were previously established by the authors (Yin et al., 2020).*
2) *The community census data and road network data for Shanghai were provided by Shanghai Municipal Bureau of Statisticsa and Key Laboratory of the Ministry of Education at East China Normal University.*
3) *The data for the emergency warehouse locations were supplied by our collaborating*

institution, the Shanghai Emergency Management Bureau.

These datasets are not open-source. We have ensured that the necessary permissions have been obtained for their use in this study.

Comment 4: The manuscript mostly cited is relatively old. It is recommended to add more recent researches that would update and enhance its relevance to current disaster management and urban planning challenges.

Thank you very much for your comment. We added the references to include recent studies in the fields of disaster management and urban planning as follows:

Line 56-60: 'Moreover, the New Urban Agenda outlines actions to strengthen cities' capacities to reduce disaster risk and mitigate their impacts (Habitat III, 2017). The Making Cities Resilient 2030 (MCR2030) initiative advocates for incorporating climate risk projections into disaster risk reduction and resilience strategies (UNDRR, 2022). Yin et al. (2024) demonstrated the improved performance of risk-informed, strategic evacuation planning in advance of coastal flooding.'

Line 46-47: 'Disaster risk management systems face increasing challenges in adapting to evolving risk profiles (IPCC, 2023).'

We also added some references in revised manuscript as follows:

Lines 34-35： 'Over the past two decades, the number of major flood events has more than double, claiming approximately 1.2 million lives and impacting over 4.03 billion people. (Mizutori and Guha-Sapir, 2020).'

Comment 5: The language of this paper needs to be further refined since some language expressions are not accurate, and the expression in some places is too redundant.

Thank you very much for your suggestion. In the updated version, we refined the manuscript to correct redundant expressions and inaccuracies throughout the text.

Comment 6: The captions of figures and table can remove "the". Data sources and model parameter variables are best represented by tables.

Thank you very much for your comment. We appreciate your valuable suggestion. In the revised manuscript, we have removed "the" from all figure and table captions and added additional table as follows.

Table 1. Data Sources Information.

Data Type	*Source*	*Description*
Flood Inundation Maps	*Yin et al. (2020)*	*Simulated coastal flood inundation scenarios for 100-year and 1000-year return periods under the RCP 8.5 scenario.*
Road Network	*Key Laboratory of the Ministry of Education at East China Normal University.*	*Comprises approximately 243,000 road sections with attributes including name, type, function, direction, and length.*
Demographic	*Shanghai Municipal Bureau of Statistics*	*Detailed demographic information at the community level.*
Emergency Warehouse	*Shanghai Emergency Management Bureau*	*Includes information from 169 emergency warehouses.*
Emergency Shelter	*Shanghai Emergency Management Bureau*	*Includes 117 emergency shelters divided into three classes.*

Table 4. NSGA-II Parameters Table

Parameter	*Population Size*	*Maximum Number of Iterations*	*Pareto Fraction*	*Crossover Probability*
Value	*500*	*3,000*	*0.4*	*0.8*

Comment 7: The authors selected two scenarios of 100-year and 1000-year for comparison. Does it fully consider the differences in other scenarios ? For example, 500-year, will it affect the results ? It is suggested to add some discussion.

Thank you very much for your comment. We chose these two scenarios primarily because they represent situations where supply either exceeds or falls short of demand. In the case of a 1000-year flood scenario, where supply is insufficient, decision-makers may need to consider the fairness of resource allocation. Therefore, we proposed a bi-objective allocation model to address this issue and provide guidance for decision-makers.

A 500-year flood event would involve different population needs, leading to different allocation outcomes. However, given that the 100-year and 1000-year scenarios adequately represent the *supply-demand dynamics that decision-makers encounter in resource allocation, we focused on these two scenarios to demonstrate the application of our allocation model.*

While we did not explore the results for other scenarios in this paper, future research involving the optimization of emergency resource locations for multiple recurrence periods will consider more scenarios.

Responses to Reviewers

Reviewer #2:

This paper proposes a logistics planning framework for flood relief tailored to coastal cities, with Shanghai serving as a case study. The authors integrate GIS network analysis and resource allocation optimization models to investigate emergency management strategies under different flood scenarios. The framework offers valuable support for decision-making by incorporating geographic and resource allocation data to enhance flood relief efforts. However, the manuscript requires significant revisions. The main concerns are outlined below.

We greatly appreciate the invaluable and constructive feedback provided by Reviewer #2. Our responses are highlighted in blue italic. We have acted upon all the points raised. The comments were very useful in improving the overall quality and readability of the manuscript.

Comment 1: The paper does not include a description of the flood models used, referencing only Yin et al. (2020). The referenced study covers various flood scenarios across different years. Why does this paper focus solely on the 2030 scenarios with 100- and 1000-year return periods?

Thank you very much for your valuable comment. We provide a more detailed explanation of the flood models used and justify the selection of these specific scenarios in the revised manuscript.

We have added some sentences as follows:

Line 262-267: 'In addition, FloodMap-Inertial, developed from FloodMap (Yu and Lane, 2006), has been thoroughly tested and applied in Shanghai (Yin et al., 2016a, 2019), showing reliable performance in flood prediction. This model uses a computationally efficient inertial algorithm to solve the 2-D shallow water equations (Bates et al., 2010), using the Forward Courant-Friedrichs-Lewy (CFL) condition for the calculation of time steps. A complete description of the model structure and parameterization can be found in Yu and Lane (Yu and Lane, 2006).'

Line 267-270: ' In this study, we focused on the 2030 scenarios with 100- and 1000-year return periods under the RCP 8.5 scenario. The RCP 8.5 scenario represents high radiative forcing and worst-case climate impacts. Thus, these two future scenarios represent extreme flood inundation. The 2030 projections are the closest to the present, making them relevant for near-term planning.'

The flood inundation results used in this study are shown in the following figure.

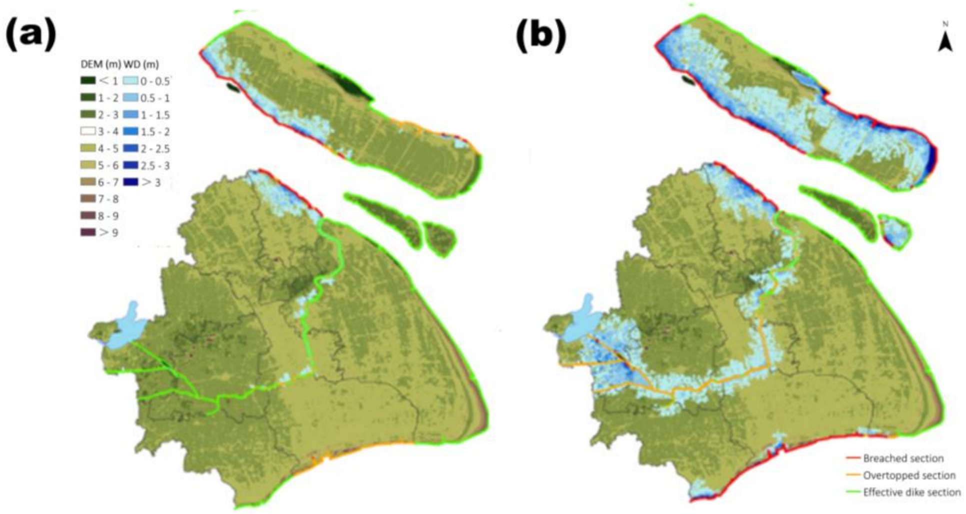

Figure. Projected flood inundation under future scenarios (RCP 8.5) in 2030. One hundred - year flood (a) and One thousand - year flood (b). (Yin et al. ,2020).

Comment 2: The population data utilized in the analysis is from 2010. Given the aging population trend between 2010 and 2030, how might this demographic shift affect the analysis results? Would it significantly impact the findings?

Thank you very much for your valuable comment. Considering the aging trend between 2010 and 2030, demographic shifts could affect the analysis results. In fact, we do not have specific projections data of the elderly population at the community level. We only can refer to the overall projections provided by the Shanghai Statistics Bureau. According to their reports, the projected elderly population in Shanghai for 2030 is expected to reach 4.8 million, an increase of approximately 106% compared to 2010.

Assuming the elderly population in affected communities grows at the same rate, under a 100-year flood event, the number of affected elderly individuals would be approximately 299,138 and under a 1000-year flood event, it would rise to around 1.1 million—more than double the number affected in 2010. When comparing these figures with the current capacity of emergency flood shelters (EFSs) and the supplies stored in emergency reserve warehouses (ERWs), we find that while the capacity of EFSs is adequate for a 100-year flood event, ERWs would not be sufficient. For a 1000-year flood event, neither EFSs nor ERWs would suffice to meet the needs of the elderly population.

While the simple analysis as mentioned suggests that an increase in the elderly population could affect the results, it assumes that the growth rate of the elderly population in affected communities is the same, which may not be the case in reality. Due to the lack of detailed spatiotemporal *projections of the elderly population in affected communities, we cannot draw definitive conclusions about the impact. Consequently, the final results can only suggest a high probability that the increase in the elderly population by 2030 will lead to greater shortages in shelter resources and supplies in two costal flood scenarios.*

As a result, in the revised manuscript, we have added a discussion section to address these limitations. Specifically, we propose that future research should focus on obtaining more detailed spatiotemporal data on the elderly population to better understand the spatial distribution and temporal changes in the affected elderly population. This would be beneficial to refine the social vulnerability component of the risk assessment and further optimize resource allocation strategies.

We have revised some sentences as follows:

Line 457-461: 'However, to arrive at more robust conclusions, future studies could be directed to the following aspects: 1) Demand Estimation: Given the aging issue in Shanghai, the elderly population is likely to increase significantly by 2030, leading to a high probability of greater scarcity in shelter resources and supplies. Therefore, future research should focus on obtaining more detailed data on the elderly population to better understand the spatial distribution and temporal changes in the affected elderly population.'

Comment 3: In Equation 1, the number of affected individuals is estimated based on the proportion of flooded areas. However, is there a valid linear relationship between the number of people affected and the flooded area? Further justification or discussion of this assumption is needed.

Thank you very much for your valuable comment. Currently, the available data is at the community level, and we do not have more detailed the elderly population data. Therefore, to estimate the number of affected elderly individuals within each community, this study assumes a uniform spatial distribution of the elderly population. The number of affected elderly individuals is calculated using Equation 1.

In the revised manuscript, we have further clarified this assumption as follows:

Line 152-155: 'Additionally, owing to the lack of more detailed spatial distribution data for the elderly population, this study assumes a uniform distribution within the community. The number of elderly individuals in each affected community can be calculated using Equation 1.'

Comment 4: Line 90 mentions that previous studies did not consider flood scenarios under climate change. Does the 2030 flood scenario used in this study genuinely reflect a climate change scenario, and if so, how?

We thank the reviewer for pointing out the need for clarity regarding the consideration of climate *change in the flood scenarios used in our study. The 2030 flood scenario employed in this study reflects a climate change scenario, as it incorporates projections of sea level rise under the RCP 8.5 scenario. Specifically, the flood inundation scenarios are derived from Yin et al. (2020), which included climatically driven absolute sea level rise projections provided by Kopp et al. (2014). These projections consider factors such as ice sheet melting, glacier and ice cap melting, and ocean thermal expansion.*

To further clarify this point, we have revised the manuscript to explicitly state that the flood scenarios considered in our study incorporate climate change impacts. We have revised some sentences as follows:

Line 259-262: 'Future flood inundation scenarios in Shanghai are derived from Yin et al (2020). In their previous work, coastal flood inundation caused by overtopping and dike breaching was simulated via a 2-D flood inundation model (FloodMap-Inertial) with a fine-resolution DEM for three representative return periods (10, 100, and 1000 years) under current and future climate scenarios (RCP 8.5). The study considered climatically driven absolute SLR by using probabilistic, localized SLR projections at the Lvsi gauge station located in the Yangtze River Delta, provided by Kopp et al. (2014). This projection accounts for climatic factors such as ice sheet melting, glacier and ice cap melting, and ocean thermal expansion.'

Comment 5: The application of the bi-objective model in multi-objective optimization is central to this paper. However, the background description of the model is insufficient, particularly regarding the implementation of the NSGA-II algorithm. It is recommended to provide more details on the algorithm's steps and discuss its advantages in practical applications.

Thank you very much for the suggestion. We agree that a more detailed explanation of the NSGA-II algorithm is necessary. We have added some sentence as follows:

Line 359-369: 'This bi-objective mathematical model is solved via the nondominated sorting genetic algorithm II (NSGA-II), which is used to obtain a Pareto optimal solution in multiobjective optimization problems (Deb et al., 2002). NSGA-II is an advanced multiobjective evolutionary algorithm that maintains population diversity across generations through nondominated sorting and promotes a uniform distribution of solutions along the Pareto front using a crowding distance measure. The NSGA-II algorithm is widely used in selected combinatorial optimization problems and has the advantages of fast convergence speed, low computational complexity, and high robustness (Ma et al., 2023; Verma et al., 2021). The corresponding algorithm settings for the solution in this study are shown in Table 4.'

Table 4. Optimization parameter settings for NSGA-II

Parameter	*Population Size*	*Maximum Number of Iterations*	*Pareto Fraction*	*Crossover Probability*
Value	*500*	*3,000*	*0.4*	*0.8*

Comment 6: For extreme flood scenarios, does the model account for time constraints associated with emergency response? How does the model ensure that supplies can be delivered to affected areas in a timely manner?

Thank you very much for your valuable comment. The model does not explicitly account for time constraint. According to the '14th Five-Year National Comprehensive Disaster Prevention and Mitigation Plan' in China, it is required that basic living needs of affected individuals be met within 12 hours after a disaster occurs. In this study, we primarily consider the city scale, assuming supplies can be delivered within 12 hours. Moreover, in Shanghai, supplies can be distributed within 3 hours. This timeframe is considered acceptable, so no specific time parameters were set. We have also clarified our assumptions in the paper:

Line 144-146: ‘A8: Any resource allocation within the city can be completed within 12 hours. Notably, the 14th Five-Year National Comprehensive Disaster Prevention and Mitigation Plan in China stipulates that the basic living needs of affected individuals will be met within 12 hours.’

Responses to Reviewers

Reviewer #3:

In the context of climate change, more and more extreme events are occurring in coastal cities, increasing disaster risk. Disaster emergency rescue needs are greater, and how to allocate the available rescue resources is an issue worthy of further study. The author combines resource status with allocation management, considering the efficiency of resource allocation and the equity between regions. The flood relief logistics planning framework can be used to guide the allocation of emergency relief materials. Shanghai is a high-risk area for flooding and needs emergency rescue. This paper presents a comprehensive framework for flood relief logistics planning using a combination of GIS network analysis and analysis. The resource allocation optimization model projects the 100-year and 1000-year emergency rescue logistic allocation scenarios in the study area Shanghai, which has important scientific and practical significance for the emergency rescue for Shanghai.

It is suggested accepted with minor revision.

Before the manuscript to be accepted for published, some points should be made clearer.

We greatly appreciate the invaluable and constructive feedback provided by Reviewer #3. Our responses are highlighted in blue italic. We have acted upon all the points raised. The comments were very useful in improving the overall quality and readability of the manuscript.

Comment 1: Line 80~84: Is the motivation for this study due to the lack of research, or the lack of consideration of future climate change scenarios and supplies shortages?

Thank you very much for your valuable comment. The motivation for this study stems from three key gaps in the literature. First, while disaster logistics has been widely studied, there is limited research specifically focused on flood scenarios. Second, these existing studies are based on historical flood scenarios, without considering the potential increased risks posed by extreme weather events under future climate scenarios. Last, these existing studies focus on optimizing efficiency in resource distribution, there is relatively little research on ensuring fairness in the allocation process.

We have revised some sentences as follows:

Line 89-91: 'Despite considerable research in the field of disaster relief logistics, only a few studies have examined the impact of floods on resource distribution logistics, particularly the disruptions caused by the inundation of emergency facilities and roads.'

Line 98-102: 'However, it is noteworthy that these existing studies were primarily based on historical flood scenarios and did not adequately consider the potential increased risks posed by *extreme flood events under future climate scenarios. Moreover, most of these studies focused on optimizing the efficiency of resource distribution, whereas relatively little research has focused on ensuring equity in the allocation process.'*

Comment 2: Line 16~18: "Considering the fairness of resource allocation, a biobjective allocation model that minimizes the total transportation cost and maximum unsatisfied rate is developed." Why maximum unsatisfied rate?

Thank you very much for your important question. In situations where resources are insufficient, some regions may inevitably receive less than the required amount, leading to an unmet demand rate for each area. The maximum unsatisfied rate refers to the highest unmet demand rate among these regions. By minimizing this rate, we aim to reduce disparities in unmet demand across regions, ensuring that no area experiences extreme shortages. This objective promotes fairness by preventing any region from bearing a disproportionately high burden of unmet needs.

We have included an explanation of this concept in the revised version as follows:

Line 218-220: 'The maximum unsatisfied rate refers to the highest unmet demand rate among these regions. By minimizing this rate, we aim to reduce disparities in unmet demand across regions, ensuring that no area experiences extreme shortages.'

Comment 3: Line 110~113: When supply exceeds demand, emergency managers tend to focus on maximizing efficiency to optimally allocate resources. Lack of supply should be considered more in efficiency. It should be said that when supply is plentiful, considering efficiency alone is enough. When supply is shortage, attention should be paid to both efficiency and equity. But is it a scientific and technical issue or a managing issue?

We agree with the comment. We have removed the statement in line 110-113 and added the sentence as follows:

Line 212-214: 'When supply is insufficient to meet demand, emergency managers should ensure that resources are distributed fairly across regions to avoid the humanitarian inequalities that result from unbalanced allocation.'

Regarding your question on whether this is a scientific and technical issue or a management issue, we believe that in practice, the decision to balance efficiency and fairness is largely a management decision. Emergency managers must weigh these objectives based on factors such as the severity of the disaster and the availability of resources. However, addressing this balance effectively often requires complex mathematical optimization, which depends on scientific and technical support.

Comment 4: Line 300 and 324: The cyan area in Figures 2 and 3 should be explained (legend).

Thank you very much for the suggestion. We have added an explanation of the cyan area in the legend in the data source section as follows:

line 285-289: 'Based on surveys and the Standard for the Construction of Relief Goods Reserve Warehouses (Ministry of Civil Affairs of the People's Republic of China, 2009), it was assumed that city-level (Level 1) warehouses can meet the basic needs of 200K affected people, district-level (Level 2) warehouses can meet the needs of 5K people, and township-level (Level 3) warehouses can meet the needs of 3K people.

Comment 5: Line 409~439: It is suggested that the conclusion condenses more definite points.

Thank you for your valuable feedback regarding the conclusion of our manuscript. We have revised the last two paragraphs of the conclusion section as follows:

Line 448-468: 'Our work can assist emergency managers in better understanding the inadequacies of existing emergency facilities and highlights the importance of incorporating climate risk information into exhaustive government flood relief logistics plans. The framework in this study can also be adopted for applications in other coastal cities worldwide. However, to arrive at more robust conclusions, future studies could focus on the following aspects: 1) Demand estimation: Given issue of ageing in Shanghai, the elderly population is likely to increase significantly by 2030, which is highly likely to lead to greater scarcity of shelter resources and supplies. Therefore, future research should focus on obtaining more detailed data on the elderly population to better understand the spatial distribution and temporal changes in the affected elderly population. 2) Traffic scenarios: Currently, the model assumes that roads are closed when the water level reaches 30 cm. Future work should incorporate more complex traffic scenarios, such as variable speeds at which vehicles can safely navigate flooded areas, to better simulate real-world conditions. 3) Model validation: This study has not yet incorporated a formal validation of the proposed models. Comparing model outputs with historical flood event data or established decision models would provide a more comprehensive validation and enhance the robustness of the framework. Future work should prioritize these comparisons to improve the model.

Furthermore, in this study, the disaster situation was explored in ArcGIS, and the resource allocation models was developed in MATLAB. Therefore, future efforts could focus on developing comprehensive decision-support systems and large models that integrate disaster assessment with relief resource allocation models. Such systems can offer predictive analytics and scenario-based simulations, enabling proactive decision-making. By filling these research gaps, researchers can contribute to optimizing effective flood relief logistics planning in the future, providing more resilient and adaptive emergency responses in coastal cities worldwide.'