Response to Reviewer 3's Comments

Dear reviewer,

Thank you very much for your comments and professional advice. These opinions help to improve academic rigor and quality of our article. We have taken your comments and suggestions into account and are dedicated to making substantial revisions to our work to address your concerns. We hope that our work can be improved again. Furthermore, we would like to show the details as follows:

Point 1: The novelty of this paper should be further clarified.

Response 1: Thank you for the suggestions of the reviewer. We have made revisions to the original text and further clarified the novelty of this paper in the introduction. The specific content is as follows:

Traditional maintenance methods for waterway improvement buildings have limitations, as they operate in a reactive and periodic manner which makes it difficult to efficiently utilize resources and improve operational efficiency. Current evaluation models are mainly focused on individual and passive assessments, evaluating only after issues have already occurred rather than proactively predicting future risks. This limits effective maintenance of waterway transportation infrastructure and hinders optimal allocation of limited maintenance funding. Although research has advanced our understanding of various aspects of improvement building evaluation, there remains a pressing need for a transition towards more comprehensive and forward-looking maintenance methods.（line89-95, page3）

In the field of transportation infrastructure, effective maintenance is crucial, as it not only relates to safety and reliability but also to the rational allocation of resources. Although effective maintenance decision models already exist in road transportation, research in this area is relatively scarce relative to waterway transportation. This has motivated our re-search to explore new methods for enhancing maintenance efficiency, optimizing resource allocation, and fostering the sustainable development of inland waterway transportation. This research aims to bridge existing research gaps and provide improved tools for management authorities to address maintenance challenges in inland waterway transporta-tion infrastructure.（line121-127, page3）

Maintenance decision optimization methods based on network-level assessment have long been used in the field of road transportation infrastructure, providing significant help to management authorities in saving maintenance costs. Therefore, the maintenance decision-making for the improvement buildings along the Yangtze River can also draw in-spiration from the principles of bridge system management and adopt network-level assessment.（line128-131, page4）

Point 2: The limitation of this paper should be figured out.

Response 2: This paper's proposed prediction method needs to consider the following limitations: (1) Dependency on sample size: The accuracy of the prediction method is related to the size of the time series samples. Smaller samples may result in less accurate predictions.

In practical applications, continually adding new evaluation data to the sample set helps optimize model parameters and improve prediction accuracy. (2) Assumption of relative stability: The reliability of this model is based on the assumption that the navigation conditions within the jurisdiction have been relatively stable over the past few years with minimal significant changes. It is suitable for predicting the future conditions of navigational improvement and maintenance for the upcoming year, but may not be applicable to longer time spans or situations where there are drastic changes in navigation conditions within the jurisdiction. (3) Limited prediction accuracy: Although the model provides useful predictions, it has inherent limitations and its prediction accuracy is limited. Therefore, it should be regarded as a reference tool for optimizing regional waterway infrastructure maintenance strategies rather than for individual structure maintenance assessments.

The content has been discussed in section 5.1"The advantages, disadvantages and applicability of the proposed technology", which is as follows:

The network-level assessment predictive model proposed in this paper is straightforward, easy to understand, and does not require a large sample. It has demonstrated sufficient reliability, making it highly suitable for wide application in practical engineering. The model is particularly well-suited for small sample predictions. However, the prediction ac-curacy is still related to the size of the time series sample. In real-world applications, new evaluation data can be con-tinuously added to the sample set, allowing for ongoing refinement of model parameters and improving prediction ac-curacy over time. (line405-410, page14)

The premise for applying this model is based on the assumption that the waterway conditions within the jurisdictional areas remain relatively stable with minimal changes over the preceding years. Therefore, this model is well-suited for predicting waterway improvement building maintenance status of the upcoming year and less suitable for scenarios with a significantly longer period. Similarly, the model does not apply to situations with a sudden and dramatic change in waterway conditions within the jurisdictional areas. Such changes may result from events like the construction of dams upstream, landslides affecting flow rates, flow velocities, water levels, riverbed alterations, or severe structural damage and deformations of buildings due to human activities. In such cases, a reevaluation of the structural stability of buildings, risk factors, and the extent of changes in waterway elements should be conducted through further simulation experiments or theoretical analyses.(line411-419, page14-15)

Additionally, it is essential to note that the predictive accuracy of the proposed model is limited. Therefore, it should be utilized as a reference for optimizing regional waterway infrastructure maintenance strategies but should not be applied for individual building maintenance assessments. In practical applications, a comprehensive maintenance deci-sion-making and assessment process should consider not only the model's predictive outcomes but also various other relevant factors.(line420-424, page15)

Point 3: What is the main question addressed by the research?

Response 3: The following introduction discusses the main problems to be solved in this article: Around the world, the economic resources allocated to transportation infrastructure maintenance are limited and often far from sufficient to fully maintain the required reliability and service levels throughout the life cycle. Therefore, the op-timal allocation of existing funds has become the most important goal [6]. With the rapid development of the Yangtze River

waterway construction, the comprehensive benefits of the improvement buildings are becoming increasingly prominent. This requires rational resource allocation and the unified coordination and operation of the waterway man-agement [7-9]. Assessing the technical condition and maintenance of these buildings is a challenging task. One of the key challenges faced is the limited efficiency of the current periodic operational model, which further faces constraints due to limited economic resources allocation. Consequently, innovative methods are required to simplify maintenance oper-ations and resource utilization. Additionally, current methods mainly focus on evaluating the current service status of individual building, often overlooking the critical aspect of future overall risks. Therefore, a paradigm shift is needed in the maintenance of harbor remediation buildings, moving from conventional maintenance practices to forward-looking and systematic approaches. Evaluation methods should not only be focused on current conditions but also on predict-ing future risks.（line46-58, page2）

The primary purpose of this study is to apply network-level assessment to waterborne transportation infrastructure, collect and organize historical inspection data of multiple waterway improvement buildings, propose a network-level assessment and maintenance prediction method for inland waterway improvement buildings from a system manage-ment perspective, and provide a new approach for optimizing the maintenance fund allocation and comprehensive navigational infrastructure management. The main research questions include: 1) How to adjust and apply net-work-level assessment methods to the maintenance of waterway transportation infrastructure? 2) Is it feasible to use historical inspection data to predict the future risk status of channel improvement buildings?（line31-38, page4）

Point 4: Can the method proposed in this paper be used in the field, or can it be used in other fields as well?

Response 4: The prediction method proposed in this paper is simple and easy to understand, making it well-suited for small sample size prediction and practical for on-site application. It is not only applicable to navigational improvement construction but can also be used in other fields. The generic network-level assessment framework and prediction model are applicable to similar infrastructure maintenance decision optimization problems. In the paper, we have also explored the research results in a broader context relevant to the field, discussing their impact and significance. The modifications are as follows:

Based on the final results presented in this paper, the JMA model demonstrates the best predictive performance. Conducting network-level assessments of improvement buildings on a jurisdictional basis is reasonable and aligns with practical management needs. The research results can provide a scientific basis for setting maintenance budgets for waterway improvement buildings and offer ideas for inland waterway management and maintenance. The proposed prediction method applies to not only the Yangtze River trunk waterway but also other inland waterways, which is of great practical significance.（line426-431, page15）

Point 5: The contribution should be further clarified.

Response 5: We accept the proposal. Therefore, we have added section 5.2 "Further discussionon the research results" to further clarify the contribution of this article, as follows:

The theoretical contribution of this study mainly revolves around the improvement of the network-level evaluation framework for optimizing maintenance decisions of inland waterway

infrastructure. This is an important extension and new application, as most previous research was limited to road traffic and other related fields. As a result, this study enriches the literature on predictive maintenance models for infrastructure and paves the way for future research, promoting a theoretical understanding of water transport infrastructure management. (line432-436, page15)

From a management perspective, this study provides insights into the optimal allocation of limited maintenance funds through predictive models. The proposed model provides a tool for a quick evaluation of overall risk, which may significantly improve management decision-making and infrastructure maintenance practices. By comparing different models, this study also offers clear guidelines on the choice of predictive models, where the Jurisdiction Moving Average (JMA) model was identified as the most ideal due to its larger confidence interval. (line437-441, page15)

At the policy level, this study provides important insights for the improvement, management, and budgetary decision-making of waterway infrastructure. By applying network-level evaluation, this study recommends a resource allocation approach that considers the condition of inland waterway construction technology. Decision-makers can use the insights from this study to develop sound and efficient infrastructure maintenance policies, optimize budget allocation, and ultimately promote the sustainable development of water transport industry. (line442-446, page15)

Point 6: The proposed prediction method in this paper should be futher validated.

Response 6: Thank you very much for your professional opinion.

We fully agree with your point that further validation can make the conclusions more reliable. However, we have already taken into consideration the available field measurements and the limitations of the literature research at the time when designing this study. Therefore, we not only conducted detailed error analysis and t-tests to evaluate and compare the performance and reliability of the three models, but also further validated them through the final results of the maintenance quantity for the upcoming year. The results showed that the JMA and LR models performed well overall and met the research needs. Especially the JMA model, with its confidence interval in the prediction results, increased the credibility of the predictions, making it the optimal choice. (See line 233-235, page 8; line 296-315, page 10; line 344-388, page 12-13)

At the same time, we are well aware of the importance of practical engineering experience in decision-making for waterway infrastructure maintenance. Therefore, we plan to apply the prediction method to practical engineering to further validate its reliability and feasibility. However, due to the limitations of field measurements and the time and resource investment required for experimental validation, this needs to be a dynamic process and will be part of our future research direction.

Thank you very much for your guidance and suggestions. We will actively adopt them to optimize and improve our research system and provide more reliable and accurate services for practical applications.

Point 7: The Jurisdiction moving average analysis is unclear. What's the moving window size?

Response 7: The Jurisdiction Moving Average (JMA) analysis is a simplification of the double-parameter moving average method, which includes a moving time window and a moving spatial window. The size of the time window is set to 10 years based on the condition of the waterway. The size of the spatial window is determined by the data characteristics and ranges from 25 to 50 building samples. However, due to the small sample size of the time series dataset in this study, with no more than 5 years of data, the time window does not need to move and the average is directly calculated. The spatial window moves on a jurisdictional basis, with each jurisdiction having 25 to 30 building samples (except for CQB).
In order to make the description clearer, modifications and supplements have been made at the respective positions in the text. (See line 237-242, page 8; line 264-265, page 9)

Point 8: Linear regression and Quadratic curve regression mean the data has linear and nonlinear relationship, respectively. The relationship between data needs to be illustrated through scatter plots firstly, and then the suitable model can be chosen.
Response 8: Thank you for your valuable input. Your analysis of the data relationships is very accurate. We agree that it is very important to first reveal the relationship between the data through scatter plots before selecting the most suitable model. In our paper, we first used several selected models for trial calculations, rather than directly selecting one from these two models. In fact, We have done preliminary data visualization and studied the data characteristics to decide to try these two models. In this paper, a total of three models including Jurisdictional Moving Average (JMA), Linear Regression (LR), and Quadratic Curve Regression (QCR) were selected to predict the maintenance conditions of inland waterway improvement structures. These models were chosen based on the characteristics of the data set and the needs of the waterway infrastructure network evaluation.
Based on this, we further conducted error analyses and example validations to compare the accuracy and reliability of these two models. Our goal is to find out which model can more accurately describe the characteristics of the data in specific contexts.
In order to highlight that our research is based on scientific methods and theoretical knowledge rather than random selection, we have modified the original description：
According to an in-depth analysis and complexity assessment of the problem, this study identifies three potential pre-diction models: moving average, linear regression, and quadratic regression. The next step involves testing the predic-tive performance of these three models based on actual data and determining which model to employ for practical fore-casting purposes.
（line247-250, page8）

Point 9: The sample data only covers 2017 to 2021. There are only five points. The small sample size will make the results unconvinced.
Response 9: Thank you very much for your meticulous review of my paper and your constructive comments. We understand your concern about the sample size. The data used in the calculations of the paper covers the sample data from 2017 to 2021, and the 2022 data used as the test set is the latest data obtained from the field. Ideally, of course, we would like to have more data points to increase the credibility of the research results. However, there are practical difficulties in collecting earlier data. The early data is not as comprehensive and systematic, mostly stored in paper format, making it difficult to access. Additionally, there are limitations

such as data availability and the improvements in some testing and measurement methods, which may prevent direct comparison between the early data and the recent data.
Although the sample size is relatively small, we have used appropriate statistical methods and models to minimize the impact of the small sample size. The paper clearly acknowledges the potential issues that may arise due to the small sample size and interprets the results cautiously. Despite these limitations, the findings of the article are still valuable to the readers. Therefore, we believe that these results still have some persuasiveness and can provide some deeper insights into the topic we are discussing.

Point 10: What does “Network-Level” mean? What’s the differences between network-level and non-network-level predictions?

Response 10: "Network-level" refers to a method of comprehensive assessment and prediction of the condition of multiple infrastructure buildings in a network or system. In the context of this research paper, network-level assessment refers to the application of this method to a maintenance prediction model for improving buildings in an inland waterway. The main difference between network-level and non-network-level prediction lies in the scope of assessment. Non-network-level prediction usually focuses on individual buildings or components within the system, while network-level prediction takes into account the overall condition and risk status of multiple buildings in the network. Network-level prediction provides a more comprehensive understanding of system performance and helps optimize the allocation of limited maintenance funds. The description of this has been provided in the introduction as follows:
While scholars have researched the temporal variations in the functional status of buildings, their focus was primarily on evaluating and predicting individual buildings in the lower reaches of the Yangtze River [14], neglecting the distribution of building clusters and the overall risk status.（line82-84, page2）
Research on road transportation infrastructure has divided the evaluation of bridge technical condition indicators into two categories: current assessment and condition development prediction. The former reflects the current structural conditions and mainly focuses on individual buildings, while the latter predicts future conditions (i.e., time-dependent conditions) and is mainly used for overall assessment and maintenance decision optimization of bridges at the network level [21], known as network-level assessment.（line96-100, page3）
Maintenance decision optimization methods based on network-level assessment have long been used in the field of road transportation infrastructure, providing significant help to management authorities in saving maintenance costs. Therefore, the maintenance decision-making for the improvement buildings along the Yangtze River can also draw inspiration from the principles of bridge system management and adopt network-level assessment.（line128-132, page3）

Point 11: It should be revised to no more than 7 keywords through deleting the unnecessary ones.

Response 11: Thank you for the reviewer's suggestion on the keywords. We have revised the keywords according to your advice and narrowed them down to the most important seven. The revised keywords are as follows:

inland waterway; improvement building; network-level assessment; prediction; moving average method; regression analysis; maintenance decision optimization

In addition, we removed 1 reference that were not very relevant to the research work and added 1 new reference on known existing technologies. We also carefully reviewed the language to ensure that there are no grammar errors.

Once again, we thank you for your time and effort in reviewing our work, and look forward to your reassessment and feedback.

Yours sincerely,
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