Dear Editor and Reviewer,
Thank you very much for the constructive suggestions on our paper entitled "A New Method for Calculating Highway Blocking due to High Impact Weather Conditions". They are very helpful for improving the manuscript. We have revised the manuscript accordingly. We sincerely hope that you will find this version acceptable to be published in Natural Hazards and Earth System Sciences.

Best regards.

Yours sincerely,
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Manuscript Title: A New Method for Calculating Highway Blocking due to High Impact Weather Conditions

Responses to Reviewer #3

General comments

In this study, the authors present a methodology to evaluate the effects of different weather-related events on the Chinese highway network. While the statistical and geographical description of weather events and its effect on road impact is very interesting and well presented, several concepts that seem fundamental to understand the results, such as highway load and losses, are not clear and can be misleading. Better care should be given to clearly explain these concepts and separate them from their usual denominations for traffic demands and direct economic impacts.
Overall, the value proposition (why this study and its results are important) is not clear. The study should be reevaluated to clearly provide a valuable discussion of its results, considering the strengths and limitations of the methodology. Large revisioning for the English language and grammar is required throughout the manuscript, which is beyond the scope of the present review.
RESPONSE: Thank you for your suggestions. The English language and grammar is required throughout the manuscript.

Specific comments

Abstract

The text in the abstract needs revision, I recommend to reorganize it considering a "why, how and what" storyline. "Why" focuses on the problem, "How" on the methodology and how it can help the problem, "What" focuses on the work done and the results. Currently, the Why is presented in a trivial way, the How is barely present and the What is too focused on the methods and not enough on the results and what they mean (the reference of 43% is not clear).
RESPONSE: Revised.
Abstract: Fog, rain, snow, and icing are considered to be the high-impact weather events often lead to the highway blockings, which in turn causes serious economic and human losses. At present, there is no clear calculation method for the severity of highway blocking which is related to highway load degree and economic losses. Therefore, there is an urgent need to propose a method for assessing the economic losses caused by high-impact weather events that lead to highway blockages, in order to facilitate the management and control of highways and the evaluation of economic losses. The goal of this work is to develop a method to be used to assess the high impact weather (HIW) effects on the highway blocking. Based on the K-means cluster analysis and the CRITIC (Criteria Importance through Intercriteria Correlation) weight assignment method, we analyze the highway blocking events occurred in Chinese provinces in 2020. Through cluster analysis, a new method of severity levels of highway blocking is developed to distinguish the severity into five levels. The severity levels of highway blocking due to high-impact weather are evaluated for all weather types. As a part of calculating the degree of highway blocking, a new method is proposed for China, and the highway load in each province is evaluated. The economic losses resulting from highway-blocking events caused by dense fog are specifically assessed, the highway losses caused by dense fog are mainly concentrated in Northern China, Eastern China and Southwestern China.

Introduction

*The use of "high-impact weather conditions" is not ideal, it makes reference to impact and it is not clearly defined. I recommend focusing on the event and not the impact, adopting something similar to "adverse weather conditions". Also, it is best to not say "**the** high-impact weather conditions", just "high-impact weather conditions".*

RESPONSE: Thank you for your suggestions. The World Meteorological Organization (WMO) defines high-impact weather as severe weather events that have significant adverse impacts on society, infrastructure, and the environment. These events can cause widespread damage, disruption, and loss of life (Marsigli, 2021).

High-impact weather refers to severe weather events that have a significant impact on human activities, infrastructure, and the environment. These events can cause widespread damage, disruption, and loss of life. In this study, we discuss the high impact weather that has an impact on highway operation.

Line 37

*I recommend the following change: "Therefore, driving in foggy weather is a potentially dangerous activity **for users, which increases the potential for** road blocks ~~ing conditions~~ (Yan et al. 2014)."*

RESPONSE: Revised.

Line 54

the term HIW is used before it is described in line 57. Also, the study is not improving the effects on road blocking, but helping to better characterize and predict the impact. Please change the text to reflect that.

RESPONSE: Revised. In this respect, the current work will further help to improve HIW events prediction and the effects on road blocking.

Line 55

Statistics of China's road length and ranking needs a reference

RESPONSE: Revised.Liu, Dan, Liugang Sheng, and Miaojie Yu. 2023. "Highways and Firms' Exports: Evidence from China." Review of International Economics 31: 413-43.

Line 56

"The ability to estimate highway traffic demand caused by the highway blocking during adverse weather events; therefore, it is critically needed." needs to be rewritten to clarify. I recommend: "Therefore, there is a critical need to improve the ability to estimate highway traffic impact, caused by highway blocking during adverse weather events"

RESPONSE: Revised.Therefore, there is a critical need to improve the ability to estimate highway traffic, caused by the highway blocking during adverse weather events.

Line 57

Replace "factors" with "components" or "contributors"

RESPONSE: Revised.

Line 58

Replace "affected" with "caused"

RESPONSE: Revised.

Data and methods

● *Please include a reference on where the authors are obtaining the data about the geometry and characteristics of the highway network.*

Response: Revised. Highway blockage data comes from Highway Monitoring & Emergency Response Center, and the data recording process and specifications are in accordance with the "Information Reporting System for Highway Traffic Blockage of the Ministry of Transportation and Communications of the People's Republic of China" issued by the Ministry of Transportation and Communications of the People's Republic of China.

● *In Section 2.3.3, it is unclear to me how the K-means algorithm is applied to the methodology proposed.*

Response: Revised.

The correlations between data items are higher because some of the data items are obtained by performing calculations from other data items.Specifically, data normalization is firstly performed for all traffic indicators, where Z is the normalized data, calculated by $Z = \frac{Z_i - Z_{min}}{Z_{max} - Z_{min}}$ **, and then the weights are assigned to each normalized data by using the CRITIC weight method to obtain the weight value of each indicator. So we develop an equation (Eq. (6)) to calculate the degree of highway load.**

● *Please provide some lines into what is the physical meaning of the CRITIC weights in this context. This will help clarify the percentages reported in the results section.*

RESPONSE: Equation3-4 and the key parameters are Revised.

Contrast intensity, expressed as a standard deviation, indicates the dispersion degree of an indicator. The larger the standard deviation is, the greater the dispersion degree is, the larger the differences between samples are, and the larger the assigned corresponding weights are. The standard deviation *S* can be expressed in Eq. (3).

$$S_j = \sqrt{\frac{\sum_{i=1}^{p}\left(x_{ij} - \frac{1}{n}\sum_{i=1}^{n} x_{ij}\right)^2}{n-1}} \quad \textbf{(3),}$$

where x_{ij} denotes the data processed by standard deviation, S_j the standard deviation of the *j*th indicator, *n* the total number of samples, and *p* the total number of indicators.

Correlation is expressed as the correlation coefficient between indicators. The stronger the correlation between indicators is, the higher the repetition rate of information expression. Therefore, the corresponding weights of the indicators can be reduced to a certain extent. The correlation coefficient *R* can be expressed in Eq. (4).

$$R_j = \sum_{i=1}^{p}(1 - r_{ij}) \quad \textbf{(4),}$$

where, R_j indicates the correlation coefficients of the *j*th indicator with the other indicators, and r_{ij} denotes the correlation coefficient of the *i*th indicator with the *j*th indicator.

Results

● The bar plots in Figure 3.b need to be clarified to give a reference of what does the height of the bars represent.

RESPONSE: Revised. Figure 3 High impact weather types leading to highway blocking in different provinces of China (a: proportion, b: the height of the bars represent number:)

● *Given the type of events considered (fog, rain, snow and ice) it is not clear to me why so many instances of road blocking are happening in the summer. Please include some lines to acknowledge and clarify this.*

RESPONSE: Revised. Summer rainfall in mountainous areas is heavy, often accompanied by thunderstorms and short-term heavy precipitation events. Mountain terrain is special, the speed of rainwater runoff is fast, easy to form flash floods or debris flow, these natural disasters are the main reasons for blocking the highway.

● *The way that the severity of the blocking is defined needs to be further clarified. It is not clear to me what "blocking mileage" (L) is. Maybe including a couple of illustrative examples would help.*

RESPONSE: Revised.

Highway blocked miles are the total length of a highway that cannot be used normally during a given event or condition. For example, due to flash floods caused by precipitation in mountainous areas, there are 100 kilometers of highway can not be used normally, we believe that the blocked mileage caused by heavy rain is 100 kilometers.

Discussions

● *The way that the concept of "highway load" is being treated in this section is not clear to me, or how it relates to losses. While the idea of using a "highway load" as a proxy for economic impact potential is clear, it is misleading to say they directly relate to economic losses. There are many other factors that come into play when evaluating economic losses. It is advised to clarify this concept, to assure the reader what the methodology is actually capturing and what the results mean potentially.*

RESPONSE: Revised. We carry out the assessment of the carrying pressure per unit length of road in different areas by calculating the highway loading index, and when it carries more transportation tasks, more losses will be incurred in the event of a blockage.

● *The results presented in Figure 8 should be first presented in the Results section, clearly explaining how they were derived and only then can they be discussed in this section. In the current format it is not clear where these values are coming from.*

RESPONSE: Revised.

By carrying out this new calculation method proposed, we have analyzed and calculated all four types of catastrophic weather, and because the results are too lengthy, we have selected the fog weather blocking loss distribution, which has the highest percentage, for a demonstration. If needed, we can analyze the damage caused by the remaining three hazardous weather types of weather in a presentation and discussion.

In results part, the methods is

● *Overall, this section lacks transparency about the strengths and limitations of the methodology.*

RESPONSE: Revised. Overall, this method can effectively calculate and evaluate the economic losses caused by highway congestion caused by high impact weather events, so as to facilitate highway management and control and economic loss assessment.

However, The limitation of this approach is that the completeness of economic data in different regions can lead to bias in the evaluation results, and the evaluation model needs to be updated regularly to adapt to changing environmental and social needs.

Conclusions

● *The final parts of this section makes reference to natural disasters, which have not been clearly discussed previously. I suggest this is removed to avoid misleading the readers into thinking that these events were accounted for in this study.*
RESPONSE: Revised.

● *There is a mention to direct and indirect losses, though their difference has not been discussed or defined in the paper, I suggest to remove it.*
RESPONSE: Revised. The highway-blocking data used in this study is only for the year 2020 as a test year, and additional time series of observations are needed to validate the results. The assessment of losses is only judged by the degree of highway load. In the subsequent work, economic models can be employed to continue refining the research.
