

Review of

A New Method for Calculating Highway Blocking due to High Impact Weather Conditions

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General comments

This manuscript evaluated the characteristics of the highway-blocking event data in terms of meteorological conditions and spatiotemporal distribution. A 5-level classification of highway blocking was proposed. Finally, the authors developed a highway load index as a weighted average of a set of selected parameters to represent the loss due to highway blocking. The general methodology was promising but certain clarification is needed. The discussion was detailed while some rationale of critical decisions needs to be further elaborated. The conclusions were valid and provided insights for transport management authorities. Some editing for the English language is required throughout the manuscript.

The manuscript presents a study on a topic within the scope of the Natural Hazards and Earth System Sciences (NHES). I would recommend this manuscript for publication after addressing the following comments with critical discussions and clarifications.

Specific comments

1. The highway-blocking features in Figure 2
 - The inner circle was not explained in the manuscript. Was there any causal relationship between the features of inner and outer circles?
 - Four main weather factors (i.e., fog, rainfall, snow, ice) were used in Table 1. However, ice was not shown in Figure 2, although it is mentioned in Line 170: “The highway blocking caused by snowfall (snow cover) and icing also accounts for 17% and 2%, respectively.”
 - It is recommended to improve the pie chart by enlarging the circle and adding the indication line.
 - The discussion was around the four main weather factors. Please confirm that event caused by other weather factors were removed from the database.
2. The cluster analysis
 - It is recommended to elaborate on how the method was used in this study after the mathematical equations. For example, it is inferred from section 3.3 that the number of clusters were decided to be five, corresponding to the five levels? It is unclear what the input vectors were, were they 2-dimensional (i.e., blocking mileage and blocking time) or only the meteorological factors?

- What are the uncertainties of the clustering centers in Table 2? What is the sensitivity of the clustering centers with respect to the meteorological factors?
- Related to the previous point, as shown in Figure 6, the distribution of the 5-level highway blocking is dominated by Level 1 and Level 3, while Levels 4 are limited. Are these caused by the thresholds?
- Notation is unclear for x_i and $C(i)=k$
- Equation 2 “armin” should be “argmin”

3. The highway load index

- The construction of highway load index was a weighted average of a set of selected indicators. This approach was similar to the widely used index construction using the principle component analysis (PCA). PCA takes advantage of multicollinearity and combines the highly correlated variables into a set of uncorrelated variables. In this study, the selected parameters were correlated, such as ΔTF_{load} the load capacity of freight transport for per kilometer and TF_{load} the total freight transport, ΔP_{load} the number of people for per kilometer and P_{load} the number of people. Please elaborate on why those parameters are selected and how the multicollinearity issue is addressed.
- What were the impacts of highway blocking levels and high-impact weather conditions on the highway load index? If possible, please discussion on the disaggregation of the highway load index to highway blocking levels and high impact weather conditions.
- Were the results aggregated across all the weather conditions? Some results for fog conditions are shown in Figure 8. What were the patterns for the other three weather conditions?
- In Figure 8, given fog conditions, Jiangsu, Hebei, Henan and Sichuan show high levels of damage in terms of four economic indicators. Since most of the highway blocks were due to fog weather, it is expected in Figure 7 that these provinces would have a high level of highway load. However, the highest highway load occurred in Guangdong and Jiangsu only. Line 308-309: “No highway-blocking events caused by dense fog occur in Guangdong Province”. What is the driving indicator behind the high level of highway load in Guangdong?

4. It is understood from Line 68-69: “Taiwan, Hong Kong and Macao are not included in this study due to the lack of data”, which is also reflected in Table 1, 5 and 7 and Figure 3. However, for Figures 7 and 8, there were results for Tibet and Taiwan (coloured map). Please clarify how the results for Tibet and Taiwan are computed given that no data was available.

5. The CRITIC weigh method

- The methodology was introduced in Section 2.3.2 and equation 3-4 explained the computation of some key parameters. It is unclear which correlation coefficient r^{ij} is used, Pearson correlation coefficient?
- The result in Table 6 showed extra parameters however they are not discussed or explained in the main text. What was the importance of these parameters? What were the implications on the weights?
- Line 131-135: “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.” Suggested large standard deviation S leads to larger weights. However, this trend was not reflected in Table 6.

6. What is the time span of the data introduced in Section 2.2 Data source? What is the time resolution of the data, which is related 10-day window and hourly distribution in Figure 5?
7. Terminology and notations are not consistent.
 - Level 4 is referred to as the severe level between Line 245 and Line 265, where it is labelled as serious in Table 2
 - Please add notations TF_{load} , GDP_{trans} , P_{load} and EP in the caption of Figure 8
 - “ice” vs “icing”
 - Equation 6 “ GDP_{trans} the added value of the GDP generated by transportation” vs Table 5 “ GDP_{trans} ” unit “100 million yuan/km” which is normalised by length vs Table 7 “ GDP_{trans} ” unit “Ten thousand”
8. The English language needs to be improved. Some editing for the English language is required throughout the manuscript due to too many mistranslations or mistakes. The authors must seek the help of a native English-speaking person.
 - Line 55-56: “The ability to estimate highway traffic demand caused by the highway blocking during adverse weather events; therefore, it is critically needed.” needs to be rephrased.
 - Table 2 five levels are recommended to be labelled as “slight-mild-moderate-severe-extreme”.
 - Line 188-190: “There are large seasonal differences in highway blocking in various regions of China due to differences in geographical environment and climatic characteristics (Fig. 4a), and high-impact weather types (Fig. 4b), such as dense fog, snowfall (snow cover), rainfall (road slippery) and icing, **are also various.**”
 - Line 232-235: “This study only considers the evaluation of road traffic by the blockage itself, and does not consider the basic resources of the road network and the impact of secondary disasters. If the road network resources are large, then the blocking may have little impact on the local road network, which is not considered in the blocking degree.” What do the road network resources refer to?
9. Clarification is generally needed to better explain the motivation of critical decisions in this study.
 - Line 23-24: “Results suggested that the highway losses caused by dense fog was the main contributor for highway blocking conditions and occur at about 43%.” 43% of what, the loss or the occurrence rate?
 - Line 81-82: “...follow the criteria of the Highway Traffic Blocking Information Submitting System of the Ministry of Transport of the People's Republic of China (2018, No. 451).” What are the criteria?
 - Line 89-90: “Therefore, all data were corrected in advance for spatio-temporal sequences, and the quality control was then carried out according to blocking causes and site descriptions, etc. 95% of the valid data is filtered out”. Please elaborate on what are the correction procedure and quality control as large amounts of data are filtered out.

- Line 165: “ α , β , γ , δ , ε , ϵ , θ , ϑ and μ are the corresponding coefficient values of each parameter.” It is recommended to clarify that they were weights computed from the CRITIC method and referred to Table 6 as well.
- Line 231-232: “we select the blocking mileage (the distance of the highways blocking), blocking time and response time as the most crucial reference indicators.” Why choose these three parameters? It is not clear where the response time is used in this study. What are the sensitivities of the results if more or less indicators were used?
- Line 236-238: “Firstly, the blocking mileage is used as the initial judgment condition of severity. Then, the blocking events caused by different meteorological factors are clustered. Finally, the severity of the blocking events is determined according to the size of the clustering centers.” It is very unclear what is the procedure here and how the clustering was actually carried out.
- It is stated in Lines 280-290 that the normalised economic indicators were used in Equation 8. Thus, the notation in Equation 6 and 8 should be unified. For example, H_d is the highway density, but it should be normalised highway density. Please confirm.
- Table 3 and 4, what does “/” indicate? No data or no obvious factors?

Minor comments

10. Please provide the link or reference to the data sources in Section 2.2.
11. Table 2 “type” is not sorted from A to E. Is there any specific reason or is it the cluster type that is not associated with the level?
12. Provinces in China are mentioned throughout the manuscript to discuss the highway blocking distribution due to high-impact weather conditions. Therefore, a map of provinces with labels is needed to facilitate the discussion.
13. Please add the subplot labels (e.g., (a) and (b)) to the figure, or use *Left* and *Right* in the caption
14. Line 54 please introduce HIW acronym before using it in the text. The first time you use the term, put the acronym in parentheses after the full term.
15. Figure 5 Left subplot a: results for Anhui was missing while results for Anhui was available in subplot b