Responses letter

We are very grateful to the reviewers for his/her constructive suggestions for this manuscript, which is a great help and guidance for this study and our future research. Here are our responses to the comments from two reviewers and the details of how we made the changes in our manuscript.

Responses to the comments from the anonymous referee #1

1. "The matrix in Line 237 must be reformatted (see attached file)".

   Thanks to the reviewer for pointing out the wrong expression of formula. We have reformatted the matrix in the Manuscript as follows.

$$P_{con} = \begin{array}{c} \\ June \\ July \\ August \\ September \\ October \end{array} \begin{array}{c} \begin{array}{cccc} I & II & III & IV \end{array} \\ \begin{pmatrix} 0.398 & 0.311 & 0.049 & 0.243 \\ 0.393 & 0.268 & 0.266 & 0.073 \\ 0.218 & 0.402 & 0.312 & 0.0689 \\ 0.080 & 0.370 & 0.373 & 0.177 \\ 0.012 & 0.539 & 0.437 & 0.012 \end{pmatrix} \end{array}$$

$$R_f = \begin{array}{c} \\ t=164 \\ \\ \\ \\ t=194 \\ \\ \\ \\ \vdots \\ \\ \\ \\ t=284 \\ \\ \\ \end{array} \begin{array}{c} \begin{array}{cccccccc} l=0.1 & 0.4 & 0.7 & 1.0 & l=1.3 & 1.6 & 1.9 & 2.2 \end{array} \\ \begin{bmatrix} 0.80 & 0.43 & 0.01 & 0.00 & 0.00 & 0.00 & 0.00 & 0.00 \\ 0.15 & 0.42 & 0.57 & 0.15 & 0.00 & 0.00 & 0.00 & 0.00 \\ 0.00 & 0.05 & 0.13 & 0.04 & 0.00 & 0.00 & 0.00 & 0.00 \\ 0.00 & 0.00 & 0.00 & 0.00 & 0.00 & 0.08 & 1.00 & 1.00 \end{bmatrix} \begin{array}{l} d=1.8 \\ d=2.4 \\ d=3.0 \\ d=3.6 \end{array} \\ \begin{bmatrix} 1.00 & 0.49 & 0.01 & 0.00 & 0.00 & 0.00 & 0.00 & 0.00 \\ 0.45 & 0.82 & 0.10 & 0.01 & 0.01 & 0.00 & 0.00 & 0.00 \\ 0.00 & 0.04 & 0.22 & 0.28 & 1.00 & 0.94 & 0.02 & 0.00 \\ 0.00 & 0.00 & 0.00 & 0.00 & 0.01 & 0.00 & 0.13 & 0.43 \end{bmatrix} \begin{array}{l} d=1.8 \\ d=2.4 \\ d=3.0 \\ d=3.6 \end{array} \\ \\ \begin{bmatrix} 0.02 & 0.03 & 0.00 & 0.00 & 0.00 & 0.00 & 0.00 & 0.00 \\ 0.35 & 1.00 & 0.61 & 0.08 & 0.00 & 0.00 & 0.00 & 0.00 \\ 0.02 & 0.15 & 0.56 & 1.00 & 0.19 & 0.03 & 0.00 & 0.00 \\ 0.00 & 0.00 & 0.01 & 0.03 & 0.01 & 0.00 & 0.00 & 0.00 \end{bmatrix} \begin{array}{l} d=1.8 \\ d=2.4 \\ d=3.0 \\ d=3.6 \end{array} \end{array}$$

2. "The grammar in the article needs to be improved. For example, Line 30: There are many works discussing the multi-hazard risk assessment and Choi et al. (2021) had reviewed the relevant literature. ==> There are many works discussing the multi-hazard risk assessment which have been reviewed by Choi et al. (2021)".

   Thanks to the reviewer for the careful grammar checking on this manuscript. We have improved the grammar writing and the detailed can be seen in our Manuscript.

30 There are many works discussing the multi-hazard risk assessment ~~and Choi et al. (2021) had~~ which have been reviewed the relevant literature Choi et al. (2021). Furthermore, Wang et al. (2020) clarified the relationship between hazards in multi-

Responses to the comments from the anonymous referee #2

1. "Lines 74-81, if I understand it correctly based on the description, the main contribution of the paper is reflected in the first point, and the others are the improvement and verification of this method. Therefore, integrating this part with the last paragraph of introduction is recommended. At the end of the introduction, it is recommended to clearly point out the innovations of the paper and the main contributions of the authors. Technological innovation?"

   Thanks for your constructive suggestions for this manuscript. We did not clearly point out the innovations of the paper and the main contributions of the authors. As the reviewer said, some technological innovation and the application of proposed model have been concluded at the end of the introduction.

   The main contributions of this paper are summarized as ~~follows~~following two-folds.

   - 1) ~~We consider the uncertainties in compound hazards level evaluation and incomplete information in historical data sets, and~~ For technological innovation, we propose a hybrid model, named as Variable Fuzzy Set and Information Diffusion Method (VFS-IEM-IDM), to ~~deal with~~ assess compound hazards risk ~~assessment dynamically.~~
   - ~~2) To~~ dynamically. Furthermore, we simplify the calculation procedures of relative membership degree to improve the efficiency and accuracy of compound hazards level evaluation~~, the calculation procedures of relative membership degree have been categorized into three types.~~
   - ~~3)~~ 2) To examine the efficacy of the proposed model VFS-IEM-IDM, a case study of the Typhoon-Rainstorm hazards that occurred in Shenzhen, China is presented.

2. "Table 1. Classification standards of Typhoon-Rainstorm hazards. What is the reference for this standard? The precipitation in this table is the daily maximum precipitation or total precipitation? The strong wind here represents the maximum wind speed or extreme wind speed? Please define and explain them in detail."

   Thanks to the reviewer for pointing out the lack of explanation of the Classification standards of Typhoon-Rainstorm hazards in the original manuscript. We have look through some documents given by Shenzhen Climate Bulletin and tried our best to define and explain the classification criteria in detail.

   Since the Typhoon-Rainstorm compound hazards are characteried by three indicators ~~,~~ (Maximum Daily Precipitation, Extreme Wind Intensity, Transformed Location Number), the variable fuzzy set dimension reduction model can be used to get more precise comprehensive hazard level. ~~According to the Classification Standards of Rainstorm and Typhoon, this paper outlines~~ This paper has outlined the index classification criteria (shown in Table 1~~, Guided by TYPHOON ONLINE and the explanation is shown in the Table A1)and the four types of~~), which is guided by Shenzhen Climate Bulletin (http://weather.sz.gov.cn/qixiangfuwu/qihoufuwu/). We also classify the Typhoon-Rainstorm ~~hazard level~~compound hazard level into four types, and which is related to our final results.

3. "The monthly differences of different types of disasters may be closely related to the frequency of typhoons and the intensity of typhoons. What are the considerations in this paper?"

   Thanks to the reviewer for the question on the key process of dynamic risk assessment. As the reviewer said the monthly differences of different types of disasters may be closely related to the frequency of typhoons and the intensity of typhoons, we have taken the time dimension into consideration to deal with the time attribute so as to assess the risk dynamically.

4. "The data in the "Table A1"is the precipitation and strong wind data during the period affected by the typhoon rainstorms in Shenzhen, China. The source is the website of Shenzhen Meteorological Bureau. But there are big problems with the data in the table."

Thanks to the reviewer for the careful review of this manuscript. We have checked the data source more carefully in the Supporting Information and we have solved the data is inconsistent. The detail can be seen the Manuscript.

as Direct Economic ~~. The~~ Loss, and the Transformed Location Number (TLN) ~~is also denoted as the landing location by~~ denotes as the Typhoon Landing Location which is determined by radio distance transform using expertise knowledge.

Table A1: Data sets of Typhoon-Rainstorm hazards in Shenzhen.

Hazards Number	Impact Time	~~MP~~ MDP (mm)	~~SWI~~ EWI (m/s)	Landing Location	~~Transformed Location~~ TLN	DEL
~~20090627~~ 0904	0627	67.3	16.8	Huizhou	8.5	0
0906	0719	80	27.3	Shenzhen	10	1
0915	0912	127.9	28	Taibei	6	1
~~20100724~~ 1003	0724	31.3	16.2	Zhanjiang	6.5	0
~~20180606~~ 1804	0606	97.2	~~10.8~~ 8.8	Xuwen	8.5	0.9
1809	0718	50.7	11.1	Wanning	1.5	0.0
1816	0811	45.3	10.8	Yangjiang	7	0.5
1822	0916	173.5	30	Taishan	7.5	2.1
~~20190703~~ 1904	0703	48.8	11	Wanning	1.5	0.0
1907	0811	~~178.5~~ 99.1	14.1	Wenchang	5.5	0.9
1911	0824	~~97.6~~ 49.4	12.7	Zhangzhou	6	0.5
1914	0902	~~86.9~~ 52.2	11.3	Wanning	1	0.0

5. "Line 101, please provide references as evidence. Line 194, please provide references or related websites."

Thanks for your suggestions. The references have been added in the Manuscript as follows.

Though these four types of risks have been investigated by many researchers, there is little research on dynamic compound hazards risk (Huang et al. (2018)). In this paper, we give a definition of dynamic compound hazards risk and illustrate how to assess this kind of risks.

Since the Typhoon-Rainstorm compound hazards are characteried by three indicators ~~,~~ (Maximum Daily Precipitation, Extreme Wind Intensity, Transformed Location Number), the variable fuzzy set dimension reduction model can be used to get more precise comprehensive hazard level. ~~According to the Classification Standards of Rainstorm and Typhoon, this paper outlines~~ This paper has outlined the index classification criteria (shown in Table 1~~, Guided by TYPHOON ONLINE and the explanation is shown in the Table A1)and the four types of~~), which is guided by Shenzhen Climate Bulletin (http://weather.sz.gov.cn/qixiangfuwu/qihoufuwu/). We also classify the Typhoon-Rainstorm ~~hazard level~~compound hazard level into four types, and which is related to our final results.

6. "The limitations of this study and future plans are suggested to be added in the conclusion. " Thanks for your suggestions on conclusion. We have added the limitations of this study and future work in the conclusion part.

guide the emergency management in Shenzhen ~~, which also shows the potential of VFS-IEM-IDM being applied to~~ Dynamic risk assessment is a relatively new topic and we have proposed a hybrid model to assess the compound hazards. risk, but there are somewhere need to be improved. On one hand, the weight calculation of different types of hazards indicators is subjective and the results of vulnerability curve have not taken the changes in the internal attributes of the affected area into consideration. On the other hand, there are also some subjective issues regarding how to process the data sets, so maybe we can consider adopting a more scientific method to process the original data to obtain more scientific conclusions.