Referee #2

Summary: This paper presents a study that evaluates the spatial accessibility of emergency medical services during inclement weather, including rain and snow, and measures the impact of precipitation on traffic speeds. It compares the accessibility of emergency services during inclement weather to a baseline value calculated two weeks before the event and two weeks after the event. The results highlight four days when emergency medical service accessibility particularly decreased. The study also shows that snow has a particularly large impact on emergency service accessibility. The study has the potential to provide a scientific basis for discussions with transportation and urban planners to improve access to emergency medical services, particularly in rural areas or areas with unequal conditions.

General comments:

1. The study includes examples of natural hazards and the difficulty of reaching emergency services in a timely manner (L. 55- 63). Can you provide the references for these examples?

Response: We thank for reviewer's comment. We have added the references for the news.

Beijing Evening. (2012). Beijing rainstorm, 120 calls increased by 1/3, trauma and car accident injury increased significantly. Available at: http://news.sohu.com/20120722/n348746024.shtml (accessed 30 August 2021).
Jimu News. (2021). Ambulance was blocked when the rainstorm hit the city in Qujing, Yunnan Province, firefighters transferred the injured boy in a canoe. Available at: https://new.qq.com/rain/a/20210624A0AFSB00 (accessed 30 August 2021).
Shaanxi News. (2019). Ambulance stalled on a rainstorm night, firefighters helped them get to hospital in time. Available at: http://news.cnwest.com/bwyc/a/2019/08/01/17913208.html (accessed 30 August 2021).

2. The study presents several case studies that use different models (L. 70 -104). Could you please summarize the research gaps in this area?

Response: We thank for reviewer's comment. We recomposed the whole part of review in Lines 100-105, Page 5.

Most of these studies assume that roads are impassable or traffic speed has a certain degree of reduction when the flooded water depth reaches a specific depth, and further evaluate the impact of rainstorm on EMSs accessibility. Due to insufficient recorded traffic data, relatively few studies have been performed to analyze the impact of road access capacity on EMSs accessibility according to actual traffic speed variation.

3. The text gives a good description of the resolution of the data used. In line 157, please define "inclement" and "normal" weather in the datasets. Is a little rain already considered bad weather?

Response: We thank for reviewer's comment. In this study, we set a rule that if the precipitation of more than 10 grids in Beijing is greater than 1.5 mm, it is considered an inclement weather scenario. And yes, we include the small rain in the scope of inclement weather, because the overall rainfall intensity was not high in the year of 2019. To make it clear, we have defined it in Lines 155-161, Pages 7-8:

According to the China Meteorological Administration, the moderate rain is defined as the rainfall is 5.0~14.9 mm within 12 hours. We chose intermediate value of interval and average it to each hour. In this study, we set a rule that if the precipitation of more than 10 grids (over 5% area of the city) in Beijing is greater than 1.5 mm in 2 hours, it is considered a precipitation event.

4. Some sentences are very long sentences and compromise readability:

- o L. 22 – 25 ("and" is used twice in short succession)
- o L. 50 – 55
- o L. 74 – 79
- o L. 91 – 95
- o L. 117- 123
- o L. 141 – 145
- o L. 366 – 373

Response: Thank you for pointing this out. We have rephrased the long sentences to several short ones.

5. L. 77: Please refer to the correct citation style and do not capitalize references: "Jones and Bentham…".

Response: We thank for reviewer's comment. We have corrected the citations.

6. L. 100: Could you please write out the abbreviation "PF-prone" when it is first mentioned?

Response: We thank for reviewer's comment. PF refers to pluvial flooding, and we have revised it.

7. L. 132: Instead of referencing the link in brackets, please refer to the correct citation style.

Response: We thank for reviewer's comment. We have corrected the citations.

8. L. 145: "Beijing was attacked by a rainstorm…". Could you please paraphrase this sentence?

Response: We thank for reviewer's comment. We have revised the sentence by changing the verb from "attack" to "hit". (Line 56, page 3)

9. L. 162: Section 2 has a wrong numbering of the subsections. Should this be 2.2.1. instead of 2.1, 2.2.2. instead of 2.2?

Response: We thank for reviewer's comment. We did make a mistake in the section labels, and it was corrected in revision.

10. L. 171: Instead of referencing the link in brackets, please use the correct citation style.

Response: We thank for reviewer's comment. We corrected the citations.

11. L. 183: "third-level grade-A hospitals." Could you please provide a brief explanation of hospital classifications that might help readers if they are not familiar with it?

Response: We thank for reviewer's comment. We added the explanation of "third-level grade-A hospitals." in Lines 169-172, Page 8:

The hospital point data were extracted from the online map point of interest (POI) data of Beijing in 2019. After coordinate correction and deduplication, it contains a total of 630 general hospitals, 76 of which are third-level grade-A hospitals (the highest level in the evaluation system of hospitals in mainland China).

12. L. 255: Could you please write out the abbreviation of "OD", when it is first mentioned?

Response: We thank for reviewer's comment. "OD" refers to origin-destination, and we have added it in the revision in Line 251, Page 12.

13. L. 465: Could you rephrase the phrase "we could guess"?

Response: We thank for reviewer's comment. We rephrased it in lines 497-499, page 25:

Under such precipitation conditions, the EMSs accessibility has been affected to a certain extent, and it would be much more difficult to get timely EMSs under even more extreme inclement weather condition.

- **Figures:**

1. Could you please specify which software tools you used to create the figures?

Response: We thank for reviewer's comment. Figure 1, Figure 4, Figure 6, Figure 8 and Figure 10 were created in ArcGIS 10.8 and composed in CoreDrawX7. Figure 2 was created in CoreDrawX7. Figure 3, Figure 5 Figure 7 and Figure 9 were created in Excel 2019. We add the explanation in the Method section in lines 185-186, Page 17:

Both service area analysis and OD Cost Matrix analysis are GIS-based, and was done in ArcGIS 10.8.

2. L. 305: Figure 4 is difficult to read. Is it possible to highlight some particular days with observations?

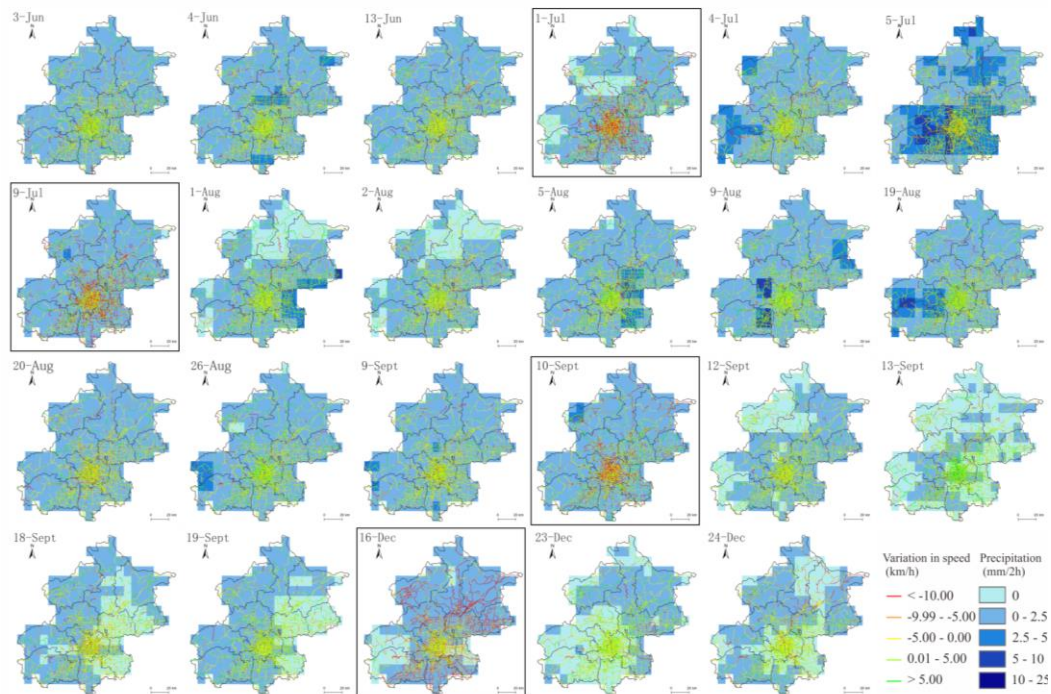**Response**: We thank for reviewer's comment. We added black borders to highlight the 4 special days.

Figure 4. *Variation in drive speed and distribution of precipitation on selected precipitation days*

(the 4 subfigures with black borders shows the 4 most affected scenarios)

• **Discussion:**

1. L. 435: In the discussion, it would be good to refer to the previously mentioned studies in the introduction and draw a link: How does this work build on the previously published literature body? Where do the results align, where do they differ?

Response: We thank for reviewer's comment. We have added discussions on this in Lines 474-480,

Pages 24-25:

In previous literature, simulation methods were widely used on the research on EMSs accessibility or traffic capacity under inclement weather. The ground-truth traffic data that covers every road in the whole city for a whole year in a row, was hardly used in the previous studies of the impact of weather on traffic and accessibility. And our study could be a good empirical verification in this field of study. The reduction extent of EMSs accessibility was close to previous studies. And we also found that snowfall may have a greater impact, which is hard to find out using flood simulation methods.

2 L. 467: As next steps, you mention that future studies should consider data on "extreme precipitation" events. Are there other data analyses that can be done with the available data?

Response: We thank for reviewer's comment. The lack of traffic data limits the sample size we could analyze. We are trying to obtain a longer time series traffic data, and its corresponding precipitation data. If we could get more samples with bigger precipitation magnitude, we could analyze more extreme scenarios. And we add some discussion about this in Lines 494-496, Page 25:

If with longer time series precipitation and traffic data, we could analyze the impact of precipitation magnitude to the traffic and accessibility, instead of simply dividing the days in a binary manner into inclement and non-inclement weather days.

Specific comments:

1. L. 24: Although it is mentioned in the Abstract, "inclement weather" is quite general. Later, in the introduction, the study refers to "rain or snow" (line 51). How much rain or snow is considered inclement weather, or is a little rain already inclement weather?

Response: We thank for reviewer's comment. We have mentioned it in Lines 155-161, Pages 7-8 in the revision：

According to the China Meteorological Administration, the moderate rain is defined as the rainfall is 5.0~14.9 mm within 12 hours. We chose intermediate value of interval and average it to each hour. In this study, we set a rule that if the precipitation of more than 10 grids (over 5% area of the city) in Beijing is greater than 1.5 mm in 2 hours, it is considered a precipitation event.

2. L. 63 - 65: Since this is a very general context, could you please provide some more references?

Response: We thank for reviewer's comment. Thank you for this comment. We have added the reference to this sentence:
Huber, D. G., and Gulledge, J.: Extreme weather and climate change: understanding the link, managing the risk, Pew Center on Global Climate Change Arlington, 2011.

Stott, P.: How climate change affects extreme weather events, SCIENCE, 352, 1517-1518,2016.
Stott, P. A., Christidis, N., Otto, F. E., Sun, Y., Vanderlinden, J. P., van Oldenborgh, G. J., Vautard, R., von Storch, H., Walton, P., and Yiou, P.: Attribution of extreme weather and climate-related events, Wiley Interdisciplinary Reviews: Climate Change, 7, 23-41,2016.

3. L. 78: Could you please name some references that use the 2SFCA method?

Response: We thank for reviewer's comment. We have added the reference to 2SFCA methods:

Chen, X., and Jia, P.: A comparative analysis of accessibility measures by the two-step floating catchment area (2sfca) method, INT J GEOGR INF SCI, 33, 1739-1758,2019.
Kanuganti, S., Sarkar, A. K., and Singh, A. P.: Quantifying accessibility to health care using two-step floating catchment area method (2sfca): a case study in rajasthan, Transportation Research Procedia, 17, 391-399,2016.
Li, M., Kwan, M., Chen, J., Wang, J., Yin, J., and Yu, D.: Measuring emergency medical service (ems) accessibility with the effect of city dynamics in a 100-year pluvial flood scenario, CITIES, 117, http://doi.org/10.1016/j.cities.2021.103314, 2021b.

4. L. 112 - 113: Could you please state the contribution of the study more clearly?

Response: We thank for reviewer's comment. We have elaborated the contribution of our study in Lines 110-113, Page 5 and in Lines 480-486 Page 25:

Our study provides an approach for evaluating the effectiveness and fairness of EMSs based on ground-truth traffic data, and the results can not only provide reference for the optimization of EMSs in Beijing, but also provide reference cases for other cities, which has a great practical significance. The results from this study provide a scientific reference for city planning departments in Beijing to optimize the site selection of emergency service facilities and get prepared for traffic dispersion on inclement weather. The relevant methods mentioned in this paper can also be popularized and easily applied to other cities once traffic data or empirical formulas regarding the impact of inclement weather on road traffic can be obtained.

5. L. 157: Can you give a brief description of the road network topology?

Response: We thank for reviewer's comment. We have added the description of the road network topology in Lines 135-139, Page 7:

Based on traffic data and meteorological data, we could build a topology road network (using node and edge primitives to describe interconnected linear features (roads) and points (roads junctions) on a map) with transfer time as impendence under inclement weather conditions and corresponding normal weather conditions.

6. L. 203: How many days with precipitation were included in the sample?

Response：We thank for reviewer's comment. There are 19 working days of rainfall and 3 working days of snowfall were selected. To make it clear, we have added the following description in Lines 159-160, Page 8:

The average precipitation of the whole city on each date is averaged by the precipitation of all grids. In 2019, 19 working days of rainfall and 3 working days of snowfall were selected.

7. L. 298: The analysis focuses on specific holidays (July 1st, September 10th). How transferable are the results of your study to other days?

Response：We thank for reviewer's comment. Our study provides a general method to evaluate the EMSs accessibility, it's suitable in both holidays and workdays. These specific days like July 1st or September 10th may affect the traffic flow, which has an amplification effect on the traffic congestion caused by inclement weather. And there could be more days that would change the normal traffic flow, and when they encounter the inclement weather, there are potential risks of decrease of traffic efficiency and EMSs accessibility, which should be given sufficient attention. We have added this in discuss section in lines 467-470, page 24:

Some specific days may affect the traffic flow, which has an amplification effect on the traffic congestion caused by inclement weather. When they encounter the inclement weather, there are potential risks of decrease of traffic efficiency and EMSs accessibility, which should be given sufficient attention.

8. L. 254: "population medical accessibility index". The term can be a little difficult to understand. Can you briefly explain the term in more detail?

Response：We thank for reviewer's comment. We changed it into "total transfer time", which describe the total time would need if every person in this grid did once transfer process.

Technical corrections:

- L. 31: "towns with lower baseline EMS accessibility **are** more vulnerable to inclement weather. Furthermore,".

- L. 53: For quotations in continuous text, please insert a space in between the text and the reference: "The efficiency of emergency services is highly vulnerable to inclement weather conditions[...], and sometimes block roads complete**ly (A**garwal et al., 2006;…"

- L. 152: For quotations in continuous text, please insert a space in between: "Andersson and Stålhult (2014) used network analysis"

- L. 188: How about phrasing the sentence: "The data records present the population size" or "The data records depict the population size…"?

- L. 192: How about phrasing the sentence: "Figure 2 presents" or "Figure 2 illustrates"?

- L. 315: Is it "In which the 15-min EMS coverage rate **reduced** by …"?

- L. 319: "…which **led** to a significant reduction in overall EMS coverage…"

- L. 418: Here, should it be "within the **Sixth** Ring Road extent"? Later, in line 363 and in line 365, the text refers to "within the Sixth Ring road".

- L. 428: "…were almost no regions where the population medical accessibility index **decreased**."

Response：　We thank for reviewer's comment. They all have been revised.