1. General Comments

Evaluating the overall quality of the discussion paper:

1.1 GENERAL OVERVIEW OF PAPER. This paper presents an interesting and novel methodology for assessing risk to natural hazards on mountain roads. It proposes that instead of using average values of number of vehicles on a stretch of road in rockfall hazard models, we should take into account that vehicles potentially will spend longer on hazardous stretches of road due to more difficult driving conditions. The recommendations section of the manuscript (Section 5.3) is strong, clearly demonstrating how this approach could potentially improve estimations of and efforts to reduce risk on mountainous stretches of road. I believe that with appropriate medium and minor revisions, this paper will be an excellent addition to the literature, establishing a basis for further research and model development in the field of dynamic traffic simulators for natural hazards.

1.2 STANDARD OF ENGLISH. The standard of English is generally excellent, although as a native English speaker, I have suggested some very minor corrections to make the language more "natural" (listed in Technical corrections).

2. Medium-Level Comments, in no particular order of importance

2.1 LITERATURE USED. I feel the paper would benefit from making stronger links and greater reference to the existing body of research within the transportation literature. Indeed, dynamic modelling of traffic flow is not a new idea in itself. Moreover, dynamic traffic simulators have been used for other natural hazards such as hurricanes and earthquakes. By discussing and explaining what has already been done, this creates a stronger case for what you are doing (as there is relatively little literature looking at the interactions of mass movements and transport networks). From a quick search (certainly not exhaustive), some highly cited papers on the topic include:

Miller, A.: A Queuing Model for Road Traffic Flow, Journal of The Royal Statistical Society, Series B, 23(1), 64 – 90, 1960.

Cameron, G. D. B., Duncan, D. I.D.: PARAMICS – Parallel Microscopic Simulation of Road Traffic, The Journal of Supercomputing, 10, 25-53, 1996.

Rajat, J., MacGregor-Smith, J., Modeling Vehicular Traffic Flow using M/G/C/C State Dependent Queueing Models, Transportation Science, 31(4), 324-336, 1997.

Nicholson, A., Du, Z. P., Degradable transportation systems: an Integrated Equilibrium Model, Transportation Research B, 31(3), 209-223, 1997.

Chiu, Y. C., Zheng, H., Villalobos, J. A., Peacock, Henk, R., Evaluating Regional Control-Flow and Phased Evacuation Strategies for Texas Using a Large-Scale Dynamic Traffic simulation and Assignment Approach, Journal of Homeland Security and Emergency Management, 5(1), 2008. **DOI:** 10.2202/1547-7355.1409

Note, I realise that on page 1289, lines 6 – 11 you explain that you do not use existing dynamic traffic simulators because they are not designed to simulate accidents, but without giving more background on dynamic traffic simulation, I do not think this is very clearly justified.

2.2 PARAMETERS USED. (i) It would be difficult to replicate the experiment with the information supplied in the paper. It would be useful to have a table of the speed, visibility and kinematics parameter values (visible in box 2 of Figure 2), along with sources of information. (ii) This also makes it difficult to judge how easy it would be to apply the model to different locations without detailed traffic surveys. What I would really like to know is if generally applicable parameters could be derived based on road geometry features (for example, road x is this sinuous, so decision sight distance will be y etc., thus dynamic risk on this section will be z). (iii) I would have thought some of these parameters could be generalized from the transportation literature. I think this would make this research very useful for practitioners to incorporate into existing models.

2.3 TITLE. The title is somewhat ambiguous as it does not mention what kind of risk along roads. The fact that this is risk of rockfalls and/or landslides needs to be mentioned here. I would suggest something like "Dynamic traffic simulation to assess rockfall risk along mountain roads".

2.4 TECHNICAL TERM DEFINITIONS. The introduction has some technical terms which could do with further explanation to ensure good understanding for readers from both the hazards and transportation research fields. Particularly paragraph 1 of the introduction.

2.5 INTRODUCTION. (i) Throughout the introduction, the focus of application seems to be on rockfall modelling, but throughout the methodology and results, the authors more generally refer to "hazards" rather than specifically mass movements. I would recommend either talking more generally about mountain hazards in the introduction or giving more detail on rockfall modelling throughout the methodology, and ensuring there is consistency and linkages between

sections. (ii) The introduction quickly jumps to talking about various scales of rockfall hazard modelling – I am not totally clear on the relevance of this. (iii) The first two sentences of section 2.2 (lines 20 to 23, page 1290) are strong, and I would encourage the authors to use this in the introduction to make it really clear from the outset why this work is important. (iv) It would also be good to devote a couple of sentences to the basics of how rockfall models work. (v) Make clear how rockfall and landslide are being defined (there are various definitions).

2.6 DYNAMIC vs. STATIC RISK. On page 1292, lines 22 to 24, it is implied that the most dangerous portions of the road co-occur in the most sinuous sections of road. Potentially, there could be a straight (ergo, fast) section of road that is also high risk, but drivers spend less time in due to higher speeds. For this reason, it would be interesting to see how the dynamic risk compares to static risk when looking over a wider road section (e.g., with different sections of sinuous road, straight road etc.). I wonder if over a larger region, the values average out to the static risk. Please put something acknowledging this variability in the paper.

2.7 ABSTRACT. Please put more quantitative information in the abstract, for data/model used and for the results.

2.8 Might it be appropriate to add in supplementary material (e.g., more extensive model results)?

3. Minor Corrections

3.1 The authors may want to consider using the term "vehicle tailbacks" or "traffic tailbacks" rather than "vehicle columns". This is more commonly used in the literature and intuitive for non-experts.

3.2 There are a number of cases where the authors use the plural "vehicles" when "vehicle" would be more appropriate (and vice versa). For instance, p.1286 line 7, p.1288 line 12.

3.3 It would be useful to introduce Table 1 (listing parameters) before the equations are introduced, for example at p.1287 line 23. Please ensure that 'all' variables in the paper are in the table of variables used (such as H, Exp_i, V, W, X and D_k).

3.4 I am not exactly clear on why the conversion factor f is used to convert [km m^{-1}] to [m day^{-1}]. I cannot see any other variables with the units [m day^{-1}].

3.5 On page 1288, line 16, should Exp_i[full stop] be Exp_i [multiplication symbol]? If not, perhaps Exp_i should go in brackets so this is clear (i.e., "N_v represents the sum of exposures (Exp_i).").

3.6 Please try to avoid one sentence paragraphs (e.g., p. 1290).

3.7 In equation 7, I am unclear on what σ represents.

3.8 Please ensure consistency in equations. Equation 7 has multiplication symbols [·] between all variables apart from σβ.

3.9 Please ensure consistency in units. For example, year is referred to as year and yr (page 1287, line 26). Also "per" is sometimes /year, other times yr^{-1}.

3.10 In section 3.3, line 24, further clarification of what the Vaud Canton (referenced as Canton Vaud) and FEDRO actually are is required.

3.11 In section 5.1, there are two sentences that could do with clarification. These are page 1295, line 24 to 26 and page 1296 line 19 to 20.

3.12 In Table 1, the word "appellation" is used in the table header. This does not really translate. Perhaps "Description" would be better.

3.13 In Figures 5 and 6, the small rectangle (which I assume is a rockfall) needs to be added to the legends.

3.14 In Figure 7, the y axis should be labelled as "Percentage" (not pourcentage).

3.15 The full URL for websites should be given. For example, references #2 and #3 in the reference list are reports accessible at http://www.planat.ch/ which is the landing page – for the reader, it would be useful to know which section of the website these reports are located at.