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Dr. Kai Schröter
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Kalman-filter based stochastic-multiobjective network optimization and maximal-distance Latin hypercube sampling for uncertain inundation evacuation planning

Dear Kai Schröter,

Many thanks for your invitation to review the above paper. I have found this paper of interest and value, particularly given the growing interest in the study of crisis and risk management. The author report an interesting analysis with some novel perspectives. However, I suggest a major revision and I provide some suggestions in order to improve the manuscript. Below I have outlined overarching comments, and then listed smaller and more specific edits. Should you or the authors have any further comments or questions, I would be happy to address these, and also review any further revisions.

General comments

In my opinion, the evacuation model is decontextualised of what a real evacuation process means. The authors do not explain or describe the evacuation scenarios they want to simulate and how the multiple factors comprised by them are addressed by the evacuation model. It is very difficult to develop an evacuation model flexible enough to be used and adapted to whatever situation. The evacuation scenarios and behaviours that can be addressed/simulated by this model should be described in the methodology in order to understand the model's limitations and scopes.

In this work, different methods have been presented, however, the interaction between them and their specific characteristic are not very well explained. I think the authors should start explaining the type of evacuations process they want to simulate, according to the natural hazard and the characteristic of the threatened area. Then they should follow describing the flood model more deeply and how it interacts with the evacuation model. And finally the evacuation model. I think it is important to separate this approaches first and then highlight the interaction between them in order to understand much better the presented work.

It would be also useful the use acronyms when referring to the developed models or methods throughout the text.

Specific comments

Abstract

Line 8. *“The subject of this research is to develop...”* The subject of this research is to present the development (I understand the work have been done).

Introduction

Lines 25-32. I suggest to move this paragraph below and start the introduction in the current line 33.

Line 35. This is just an opinion. I think the evacuation plan mainly prevents the loss of life, but I am not sure about property damage (specially in an urban context), unless the evacuee carry with all his properties, which is not common. If people must be evacuated is because they live in a hazard area and very sure their houses will be left behind.

2. Methods

Before explaining how the evacuation model work, authors should explain or described what kind of evacuation scenarios they want to simulate and for what kind of evacuation scenarios is this evacuation model useful.

I think some of the following questions should be addressed, first as a general issue and then in the example: Is the evacuation process a self evacuation where people make the decision about where they want to go? Is an assisted evacuation, where authorities evacuate people using public transport or other approaches? Are people following a pre-established evacuation plan, where shelters locations and the evacuation routes are perfectly known by people? Or is it a random process? How is the shelter chosen by the evacuee (how this decision making is managed or represented by the model)? There should be a theoretical connection between these important questions and how they are solved or addressed by the model.

Have the evacuation time intervals been included or considered in this model? To assess the total evacuation time the model should manage many factors and time intervals (as has been described in the bibliography, see for example Urbanik et al. (1980); Lindell (2008); Opper (2003) and Frieser (2004), Marrero et al, (2013)) Has this evacuation model such ability? If so, it should be very well explained. Other way, the results may be underestimate. For example, how do people know that a shelter is full? I think they only know that when they reach the shelter. Then, they need an extra time to find out where they can go (next shelter), which it will be conditioned by how the shelters spread the information about their capacity status. Has this consideration been included in the model in order to assess the evacuation time? Adapting an evacuation model to an specific context is also important to get the best results.

Here I think the authors should differentiate the use of the model during a real crisis or in the context of a long-term designing process of an emergency planing. In the former, the capacity of a shelter or even the transportation network can not be expanded easily during the evacuation, even if it is necessary (the transportation network can be modified with a very well evacuation planing designed in advance, but more time is needed to improve the shelters). Related with the transportation network capacity, how the evacuees travel from their home to the shelters? do they travel by car, bus or they go by walk?. This considerations affects the transportation network capacity and the travel time and they have not been addressed throughout the text.

Given the importance of the weighting method in this work, I think It should be better explained. What does the weighting method mean in the context of a real evacuation? What specific part of the evacuation process have been simulated by this method? If I understood, the efficiency of the evacuation strategy depends on the tradeoff analysis, that is, the relation between the shelter expansion cost and the evacuation time. For such relationship, people should know the emergency plan in advance (evacuation routes and shelters location and capacity), but what they will not know is whether the shelter capacity has been increased or not, and the next shelter they can go if the one they found first is totally full. Probably I do not understand very well why this factor is so critical if people do not know the information in advance? If authors want to predict the decision behaviour of evacuees that should be better explained.

In order to understand the proposed method, it would be helpful to add a Figure where all important elements are present (nodes, arcs. Etc.) with their attributes and letters (i, j, k. etc.), not as a flow chart but as a schematic drawing.

Line 94. “...are conducted and displayed on the GIS...” has the software been developed in a GIS? If so, which programming language, which GIS platform? Is it available on web?

Line 101. What do the authors mean by “...The model also considers uncertain inundation scenarios”? Flooding scenarios/areas with a very low probability of occurrence. If I understood, the evacuation model does not define the flooding area, that process is conducted by the flood models. If so, the evacuation model should evacuate the affected areas or whatever zone given as an input data, no matter how uncertain it is. Please, make more clear this question because it is not clear if the authors are referring to the flooding scenario probabilities or the evacuation scenario probabilities.

Line 100. Why are the arcs bidirectional?

Line 103. “...decisions for shelter and transportation capacity...” Who make the decision to expand shelters and roads capacity?, and why?. This is an strategy and it should be linked with a more global emergency plan.

Line 105. “...Following the occurrence of uncertain flooding events” Does it mean that the methodology is only useful for such uncertain flooding events and it cannot be applied for the most common flooding events.

Line 109. “...optimal evacuation plan...” I would say evacuation strategy, and apparently for one threatened area. Are the best routes chosen or just the available routes?

Line 118. “...At the initial time...” What does initial time mean here? Did the authors consider the response time, the warning time, etc.? When the evacuation order was given? Or the evacuation process starts when everybody is ready. In such a case, the final result of the model should represent the travel time, not the evacuation time.

Line 120. “...demands that all evacuees must end up in a shelter...” Why must all evacuees end up in a shelter? In real evacuations it is very common that people evacuate with their relatives or in other places, outside the dangerous area, which means they could follow different routes. If all evacuees must reach a shelter, the authors should explain why (see comments above related with the description of the evacuation scenario).

3. Results and discussion

Line 168. “...is applied to simulate uncertain inundation scenarios...” Probably I do not understand well, but why are the results of the uncertain inundation scenarios compared to the normal behaviour of the river during a flood? Are they specific or common flooding scenarios? Were the flooding areas assessed using only flood models or they also include real scenarios based on past events?

Line 173. “...The transportation network system of Muzha is plotted...” Does the evacuation model address the total transportation network or just the main roads? That should be explained in the methodology and highlighted here.

Line 175. About shelters, are they known by people at risk? Have they been included in an evacuation plan? Do people know the shelter they should go or is it a free choice? Please, be more specific in the description of the evacuation model you are trying to simulate and how this kind of emergencies are managed in Muzha.

Line 178. “...Shelter locations and capacities...” Is the maximum capacity shown? Is the capacity

included in the management of the global emergency plan as a key factor?

Fig. 4. Please add an arrow to show the flow direction of the river.

Line 184. “...*Based on the HEC-RAS simulation of 425 times...*” Given the same water level and levee heights, how the HEC-RAS compute the variation in the results?

Line 186. Why are there shelters located in the evacuation area? Is there any problem with the local authorities in the design of the emergency strategies? Are this shelters considered by the evacuation model as sink nodes?

Lines 188. Why people living on higher floors do not need to be evacuated? Is it a question related with the capacity of the evacuation model or an evacuation plan design? Please, explain this important question, because people do not use to do what it is expected during an emergency situation (more people travelling could cause traffic jams) and an evacuation simulation never should be done for crisis management considering just part of the people living in a threatened area.

Line 193. “...*evacuation times of 55, 12, and 24 minutes??*”

Line 194. “... *Shihjian Activity Center is the only shelter that is required to be expanded...*” that assuming that no one living above the first floor will make the decision to evacuate.

Figs. 5-7. Some questions here: first, how do you represent such expansion on figures?, because I cannot see them easily (even comparing with figure 8-9). Is the minimum capacity of the shelters what it is showed on figures or is the maximum capacity they can reach? Authors do not highlight the total capacity of the shelter, I mean, the capacity in normal condition and the maximum capacity in extreme condition that shelters could reach. Second, it is seems the authors have separated the flooding scenarios as if they were isolated flooding areas instead of a global process. How is that possible? If there is a flooding, I suppose that all flooding areas should be affected more or less at the same time, if not, authors should explain why. I say that because evacuees are using roads that they should not be (for example, the road located in the south that cross the Hengkung Bridge flooding area to reach the shelter located at west, fig 7). Is that possible because the evacuation start before the flooding? Third, you should keep highlighted the flooding areas in order to see from where the evacuee are coming from in each scenario, when a security area is reached and if there are more hazard areas that should be avoided by the evacuees. Fourth, has the evacuation model the capacity to assess the time needed to evacuate the flooding hazard zone or just the time to complete the travel time.

Line 219. “...*further to shelters...*” here, do the authors mean that people have to travel far away to find shelters because the closer ones were not expanded and they are full?.

4. Conclusions

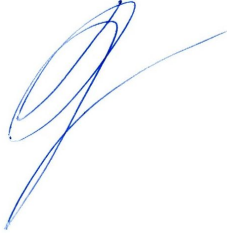
Line 239. “...*Evacuation planning is analyzed for various disasters...*” Analyzed or used?

Line 240. “... *inundation evacuation under uncertainty...*” Again, does it means the framework developed is not valid for more common scenarios whit less uncertainty.

Line 245. “...*and evacuation planning have been presented on the GIS platform...*”. If the presentation on the GIS is oriented to decision makers, all figures should keep the hazard areas (authors should not delete the hazard limits just to show the results of the evacuation model). Decision makers need to understand the global process and where are located the threatened areas (all of them).

Should you require any further information, please do not hesitate to contact me.

Yours Sincerely,

A handwritten signature in blue ink, consisting of a large, stylized 'J' followed by a long, sweeping horizontal line that extends to the right.

José M. Marrero