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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Debris flow susceptibility mapping using a qualitative heuristic method and Flow-R along the Yukon Alaska Highway Corridor, Canada" *by* A. Blais-Stevens and P. Behnia

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Interactive comment on "Debris flow susceptibility mapping using a qualitative heuristic method and Flow-R along the Yukon Alaska Highway Corridor, Canada" by A. Blais-Stevens and P. Behnia Anonymous Referee #2 Received and published: 24 August 2015 Dear Editor, Please find here below my review of the paper nhessd-3-3509-2015: Debris flow susceptibility mapping using a qualitative heuristic method and Flow-R along the Yukon Alaska Highway Corridor, Canada By A. Blais-Stevens and P. Behnia

This paper presents a susceptibility mapping based on heuristic model and a simple

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Interactive Discussion

Discussion Paper

numerical model for debris-flow sources and propagation. The application is performed are compared. It presents the pros and cons.

General comments This paper addresses an interesting problem which is the debris-flow hazard assessment at regional scale in areas where data are lacking. This problem is of great importance in terms of management poorly studied regions and for remote areas. This problem is still not solved scientifically. It is well written and clear, but some clarifications are needed. It needs a few additional points. In my opinion instead of using the terms: "Quantitative susceptibility mapping", I would prefer systematic or regional numerical approach. We agree to some extent except that in the heuristic, we also use a somewhat regional numerical approach because we add an equation adding up all of potential landslide triggering parameters into one SI index per pixel. It can become confusing, so we decided to keep the term quantitative susceptibility mapping.

First, the approach of the susceptibility mapping can be a bit more detailed, the equation can be clearly described: is it only dedicated to the source areas? Yes, it is and we have explained in more detail in the text

It seems that the propagation is linked to an inventory. Then please detailed the way it is mapped (by one or two sentences), because the reader must know if the map includes the entire fan deposits or not. We have mentioned that the inventory (compiled with air-photos and satellite imagery) includes only the debris flow deposits, not the source, so yes, the result of propagation.

As a consequence, the difference between true debris-flows and bed load has been made or maybe not. This questions are important because they provide arguments for the discussion. In other words, a model like Flow-R will depends on the present state of the topography (in addition to artefacts of the such DEM), as a consequence, the comparison with a map that take into account all past event will be different (Normally this software cannot provide event oriented simulations like other software like Flow-2D,

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but Flow-R has limitations). Then the hidden question is: in such map do we consider only the possibility given by a numerical model, which will give results for short term maps or non-extreme events, or shall we extend to the whole fan area. A discussion about this question and the dispersion of Flow-R can be also added. We have added more detail in the in the discussion of Flow-R.

I am not sure that the full equations for flow-R are necessary as it is already published in NHESS, but some aspects have to be presented (see below in specific comments) We have shortened the text by excluding a lot of the equations and have referred to Horton et al's 2013 paper as also suggested by other reviewer.

The DEM type must be described, how it has been created, and what we can expect from its accuracy. In the introduction, the authors must insist about the challenge to create such map at regional scale based on documents that are not precise enough to provide really accurate results. This must be discussed as well in the discussion section based on the questions addressed above. We have addressed this in the text at the introduction and in the evaluation.

Scientific Significance: The challenge addressed by this paper is significant as explained above, trying to solve the problem of regional hazard assessment for debris-flow, as such type of susceptibility mapping is not yet solved. The intent of this paper is to demonstrate and outline areas that are susceptible to debris flow activity. In addition, we have tested two different methods and have validated with what we consider a good level of success (validation curve for the heuristic method) and map of the deposits overlain on the colour coded susceptibility maps. We are aware that some of the mapped deposits (that occurred in the past) may or may not reflect present-day conditions. However, we expected that some of the calculated propagation (ie, susceptibility) for most of the deposits would cover at least a portion of the mapped deposits, which is what we observe. What we also observed were areas that had no deposit, but still showed potential propagation, therefore, susceptibility to produce a debris flow that could affect the Alaska Highway.

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Scientific Quality: The proposed methodologies are appropriate, but some clarification are necessary in order to highlight the inputs and the remaining issues (see above). References are consistent with the paper content. We have clarified our methodologies in the introduction and the methods

Presentation Quality: The overall quality of the paper is good, but some aspect have to be clarified. Figures are fine, but maybe some supplemental material with larger maps will be nice. If these problems are addressed the paper can be considered again for publication. We will ask to have full extent of figures

Specific comments Page 3512, line 6: explain why here the DEM has a resolution of 10 x 10 m, while in the rest of the text it is 5 x 5 m. The resolution of DEM is 5 * 5 m. The full resolution in the heuristic method but because in the Flow_R method, higher resolutions may result in channelization (Horton et al. 2013), we decided to resample the resolution to 10 m to account for more spreading in the fans. This is explained in the text.

Page 3512, lines 6 and 13: see comment above about “quantitative method” (replace). We chose to keep the term “quantitative method” because we have used a numeric method in the qualitative heuristic approach.

Page 3512, line 20: Is Denali fault linked earthquake. Yes, there has been historical evidence of seismicity along the fault but mostly in Alaska.

Page 3513, line 13: which type of temperature is it: daily, monthly??? It’s daily. We added it in the text.

Page 3514, lines 21-22: please add more detail and clarify about the relationships between DEM and heuristic model with respect to the type of maps produced. Done Lines 21-22 in page 3514 explain why we selected the Kluane Lake area for detailed study using Flow-R method. In previous articles, we had used a heuristic method using coarser DEM (30*30 m), which is explained in section 4.1.

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Page 3516, line 23-24: Please add a reference for the equation 1. We specified at the beginning of the section 4.1 that the method (and the equation) is modified from 3 references, i.e., Soeters and van Westen (1996); Riopel et al. (2006); Blais-Stevens et al. (2012).

Page 3518: in the steps you have to introduce what has been used in this study and not the general scheme. We used the general scheme, but we did test through trial and error several combinations of algorithms and threshold values of the required parameters. The extent of the calculated propagation relative to past events (mapped deposits) led us to make a decision on the appropriate algorithm and threshold value.

Page 3521 lines 11-15: this can be partly moved to the previous sub-section. In my opinion it would be better to merge section 4.2 and 4.2.1, it will avoid duplication of the Horton's paper, in order to be more specific to this study. We decided to keep the sections as they are. However from both reviewers' comments, we eliminated details of the theory relating to Horton et al's Flow-R method.

Page 3524 line 25: This point about spreading is important, it has to be discussed as already mentioned above. Section evaluation: the discussion about what is an event and what is a susceptibility map must be added. Does an event affects the whole fan? But a map must include the whole fan? The Evaluation section was revised accordingly.

Section conclusion: Includes some aspects about the above points, and add what are the remaining problem to solve about such regional "hazard" mapping. We revised the conclusion accordingly.

Figure 8: the black lines are map of past events or heuristic susceptibility, clarify if the deposit are clearly showing debris-flow morphology. The black lines represent the past events (mapped debris flow deposits in the legend). The mapped deposits were compiled using air-photos and high resolution satellite imagery (and field verification) as outlined in section "Previous work". Most of the deposits show the debris flow morphology.

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Figure 9: draw contours of the past events and/or of the susceptibility map. Figure 9 is not a georeferenced photo and it's not possible to overlay the susceptibility polygon on it precisely. However Figure 8b displays the susceptibility for that channel (point F) and it is mentioned in the caption.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 3, 3509, 2015.