Response to reviewer: JL Zezere

Response to Specific Comments:

1 – We agree that there is a tremendous limitation to using a landslide database compiled from media reports due to both spatial and temporal uncertainty in many cases as well as regional biases. This uncertainty can clearly impact the quality of the hazard predictions in terms of accurately capturing the validation metrics. We attempt to capture the uncertainty in these metrics to some extent in Table 2, where we highlight the spatial buffer distance as well as 3 different temporal windows to highlight the potential predictive capability when different tolerances are defined. We agree with the authors that having a very accurate time series of landslide events would indeed improve both the calibration and validation of this system and may even allow us to develop a more detailed model. However, to our knowledge, such a database across multiple countries is very rare and does not exist within the study region. We are working to test this model over other regions but we are still impacted by the same limitations in regional (multi-national) databases. One option is to test the model over a small sub-national region with a dense landslide inventory. However, we have not yet done this as no data of this nature is available over our study area. We agree that this is an area of future study and we have stated this with new text in the discussion section:

Future work could include calibrating the LHASA model in an area with an extensive and accurate landslide inventory to fully assess the performance of this system. To our knowledge, no landslide inventories of this type exist over the current study region. Therefore, it would be necessary to parameterize the model over a new domain. This is outside the scope of the existing work but may be feasible as we continue to test this system in other regions.

2- We have added more descriptive text to outline the landslide inventories that have been considered to evaluate the landslide susceptibility map as well as used as input to testing the LHASA model (Section 2.2).

There are several different landslide inventories available within Central America that have varying geographic extents, compilation methodologies, temporal information and accuracies. We used four landslide inventories to develop and test the regional landslide susceptibility map, which are outlined in (Kirschbaum et al., 2015a). These inventories include: 1) landslides triggered by Hurricane Mitch in 1998, compiled by USGS and others (Bucknam et al., 2001; Cannon et al., 2001; Crone et al., 2001; Harp et al., 2004); 2) a historical Nicaragua database compiled by (Devoli et al., 2006, 2007); 3) a historical landslide database from El Salvador (Gerencia de Geología, 2012); and 4) the Global Landslide Catalog. While each of these inventories were useful in various ways to compute the regional static susceptibility map, the GLC had the most relevant spatial and temporal information for calibrating and evaluating the LHASA model. As a result, a record of historical landslides was selected from the GLC (Kirschbaum et al., 2010). We also selected 24 landslides from the El Salvador inventory compiled by the Ministry of the Environment and Natural Resources (MARN) (Gerencia de Geología, 2012). No times of occurrence were available for these points, nor were spatial accuracies defined. The combined landslide data covered the years 2007-2013.

With respect to the 50 landslides available in 2014, we describe this database in the following paragraph (from pre-edited text) and we also plot the 2014 landslides in Figure 1. If this description is not clear we are happy to amend it but we are unsure what additional information would be needed:

In 2014, 877 new landslides were added to the GLC. These were not available during the development of the dynamic landslide model and represent an independent dataset of the same type as the 2007-2013 catalog. 79 landslides were located within the study areas described above, accounting for 49 deaths and 30 injuries. Of these, 56 were known to be triggered by rain and had a spatial accuracy better than 25 kilometres. Due to the submission of a single detailed report, the exact location of 14 landslides was known. However, these points represent a single cluster of landslides occurring on June 23rd, 2014 near El Ayote, Nicaragua (INETER, 2014). In order to reduce the weight placed on this cluster, 6 closely spaced landslides were pruned from the GLC. The resulting 2014 catalog used in the analysis includes 42 landslides that occurred in Central America, 1 in Jamaica, and 7 that occurred in the Hispaniola study area.

We have also provided a brief discussion of the landslide typologies and size in Section 2.2:

Another uncertainty stems from the landslide types presented in this catalog. The GLC includes mass movements that are reported to have been triggered directly by rainfall (including debris flows, mudslides, rock falls, etc.), all of which we herein refer to as landslides. While it is often impossible to differentiate between landslide types from a media report unless detailed descriptions or a photo is included, we believe that the majority of landslides that are used to calibrate and evaluate the LHASA model are rapid, shallow movements of soil, rock, and other debris. The size of each landslide is often even more difficult to determine in most cases, but the reported landslides often occur above roads and tend to be narrow, long runout debris flows. These assertions are based on review of GLC event entries as well as previous work in this region (Bucknam et al., 2001; Cepeda et al., 2010a; Devoli et al., 2006, 2008).

3- We have edited the description of the modified sensitivity analysis we conducted at the beginning of Section 2.3:

Several other surface variables, such as land cover type, percent forest cover, and geology, were also tested within the susceptibility model framework, but did not enhance predictions. In some cases, variables that were largely redundant (e.g. cation exchange capacity) were eliminated, despite good validation results.

4- We have added a short paragraph explaining the fuzzy overlay model for computing the regional susceptibility map in Section 2.3:

These 4 layers were overlaid in ArcGIS through the use of fuzzy operators. First, each variable was transformed into a “possibility” between 0 (representing low landslide hazard) and 1 (representing high hazard) through the use of a fuzzy membership function. Next, the non-topographic variables were combined with a fuzzy gamma function, in which gamma was set to 0.4. Finally, the output was overlaid *with the transformed slope values with a "fuzzy product" operator, a simple function chosen to prevent the identification of flat ground as hazardous.*

5 –While it might be argued that the use of a binary node at the 1st level of the decision tree (Fig 6) is results in a loss of detail present in the susceptibility map, the same could be said of a 5-way decision node that used all the susceptibility classes. The use of a binary decision greatly simplifies the subsequent calibration of the rainfall thresholds (3 rather than 12 thresholds to calibrate) and it allows a larger portion of the landslide catalog to determine each threshold. Figure 2 shows an obvious difference between "very low" susceptibility and the other four categories. The caption describes the rationale for this choice:

The LHASA model used a threshold of "low" susceptibility or greater (SI ≥ 2) with rainfall and antecedent rainfall thresholds within the decision tree framework (Figure 6). SI ≥ 2 (low) was chosen to exclude a large portion of Central America without losing the ability to predict most landslide events.

6- Table 3 has been added to show FPR and r_j metrics for each catalog. In our opinion, it is not very useful to determine the FPR of only those dates and locations within the spatial and temporal windows around known landslides. Therefore, those metrics are not shown, resulting in a smaller table than table 2. We have also added an additional figure to further illustrate the TPR and FPR results for r_j using different daily and antecedent threshold values (

7 – We have added a brief description of this in the text:

In some regions, temperature has been shown to drive landslide triggering during freeze/thaw episodes or spring snowmelt (Chleborad, 1997; Li et al., 2013; Tatard et al., 2010); however, in the Central America region this triggering variable is less relevant given the predominant tropical or subtropical temperatures.

8 – Scales have been added to figures 1, 3, 8 and 9.

Comments to Technical Corrections:

References: All references have been corrected. With respect to the in-text citation style, we are using the Reference Copernicus Publication template for Mendeley Citation software which automatically defaults to a specific way of in-text citations. We reviewed the requirement and at: http://www.natural-hazards-and-earth-system-sciences.net/for_authors/manuscript_preparation.html it says "In terms of in-text citations, the order can be based on relevance, as well as chronological or alphabetical listing, depending on the author's preference." Since we are using the reference citation style provided by Copernicus, we are unable to change this the in-text citation from alphabetical to publication year. Also, the final comment of Chleborad et al. is actually correct, as we are referencing the paper:

Chleborad, A. F., Baum, R. L. and Godt, J. W.: Rainfall Thresholds for Forecasting Landslides in the Seattle, Washington, Area—Exceedance and Probability, U.S. Geol. Surv. Open-File Rep., 2006-1064, 2006.

If there is another paper by Chleborad and Phillips that is relevant to this manuscript that you feel we should include please let us know.

We have corrected all other minor corrections specified in the review.