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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Landslides triggered by the 12 January 2010 Mw 7.0 Port-au-Prince, Haiti, earthquake: visual interpretation, inventory compiling and spatial distribution statistical analysis" *by* C. Xu et al.

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We deeply appreciate the comments and suggestions of Referee 2 that significantly improved our manuscript. We have revised and modified the manuscript following this comments and suggestions. We will reply to the comments and questions below:

1. Type, resolution, date and coverage of each satellite image should be listed on a table for clear reading and information of data quality. Reply: Our work is based primarily on the images provided in the Google Earth platform. The images are mixed

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and do not have detailed information. However, we provide the time information of our accessed time-period (last accessed September 2011), so that the readers may be able to obtain the image information by searching on the Google Earth platform.

2. Infrared band which is the most sensitive one to recognition of landslides among all satellite bands was commonly used in recognition of landslides. Is infrared band used in the present study or not? This must be explained. Reply: We agree with the referee that infrared images are very sensitive for recognizing landslides. Ideally, images of different wave bands, such as infrared band or near-infrared bands, can be analyzed separately to obtain the best results of landslide identification. Due to the accessibility of images in the study area, however, we chose to use the images freely accessible from the Google Earth platform, and our results suggest that the true color images (RGB combination) can also provide satisfactory results. We have added several sentences in the text to discuss this.

3. Landslide interpretation by an expert and field check are always necessary and related to quality of inventory. So, these must be assessed and discussed. Reply: We agree with the referee that field check is very important in landslide inventory. Unfortunately, due to the accessibility of the study area, this is difficult to accomplish in this study. However, by using very high resolution images, we can show that the results obtained in this study are comparable to results obtained by field investigations. We have added a paragraph in the text to discuss this.

4. In the statistical analysis, some efforts have mentioned by previous researchers to make the results unbiased.

These include: (1) different types of landslides are analyzed separately, Reply: As pointed out by the referee, if different types of landslides are analyzed separately, we may be able to obtain a better result. However, since many co-seismic landslides show characteristics of two or more classifications, it would be difficult to perform such analysis with objective decision of landslide types for individual landslide.

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(2) Landslide deposition area must be recognized and not included in the analysis, Reply: We agree with the referee that the landslide deposition areas may need to separate from the analysis. However, in performing the analysis we encountered the issue that the upper part of landslide deposition areas are generally overlapping with the lower part of the landslide areas. That is, the lower boundary of a landslide is generally covered by landslide materials and is difficult to delineate. Moreover, it is perhaps a transition zone rather than an exact line. In order to solve this issue and to prevent the influence of landslide deposition areas, we also analyzed the landslides using the landslide scarp as a point for the calculation. This is also discussed in the text.

(3) Flat region must be separated from the study area and not included in the analysis, and (4) landslide ratio (probability of landslide failure) instead of landslide number or landslide area is used in the analysis (e.g. Lee, 2013). For example, in the vicinity of Port-au-Prince and in that of Leogane, there are wide flat region. If these flat regions are included in the statistical analysis, then the result becomes unclear and obscure. A pdf file of "Lee, C.T. (2013) Re-evaluation of Factors Controlling Landslides Triggered by the 1999 Chi-Chi Earthquake. In: Earthquake-Induced Landslides, Ugai, K., Yagi, H., Wakai, A. (eds.), Springer, 213-224" can be found in Google Scholar. Reply: We deeply appreciate the referee's comment and suggestions. We have researched many previous studies, and both excluding the plat regions and keeping the integrity of the study area have been proposed. In general, most studies did not exclude area of slope angle lower than a threshold, because this manipulation will affect the integrity of the earthquake affect area, and such flat areas (e.g., slope angle < 5°) will not affect the statistical result. Such areas will be classified into one class (slope angle lower than 5°, or Quaternary in Lithology), and such class is little affected by co-seismic landslides, and the other classes will not be affected by this flat area. Therefore, we decided not to exclude the flat area, but instead added a section in the text to discuss this.

5. The definition or mathematic expression of "slope curvature" must be described in

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the text. Reply: We have added this in the text.

6. P17, Line 20-22: “The 453 landslides triggered by the Haiti earthquake contain various landslide types and experienced relatively gentle ground motion comparing with the Wenchuan event, thus have relatively short runout distances.” This is questionable, because the apparent friction is commonly controlled by landslide volume, not the ground-motion intensity. Reply: In the Wenchuan event, the landslides were larger rock avalanches, which may have longer runout distance purely due to their size. In addition, co-seismic landsides may have longer runout distance under stronger ground shaking since materials may be thrown farther by the greater ground shaking. We have modified the text in this section, and added one reference to discuss this.

7. P18, Line 4-7: “This perhaps because the coherent deep-seated landslides of large areas mostly have higher angle of reach due to their smaller horizontal runout distance, whereas shallow-disrupted landslides of small areas have lower angle of reach due to their larger horizontal runout distance.“ This is questionable, because the coherent deep-seated landslides commonly have large volume and smaller apparent friction, whereas the shallow-disrupted landslides commonly have small volume and smaller apparent friction. Reply: According to the Table 1 of Keefer (2002), we found that coherent deep-seated landslides generally have short runout distance. This will result in higher angle of reach. We believe this also indicates that such landslides have larger apparent friction. We have modified the text of this section, and added this reference.

8. P4, Line 4; P19, Line 10, 14, 17, 18; P20, Line 1, 8; P22, Line 13; P25, Line 15, 18: “LPND” should be typing error of “LTND”. Reply: We have changed this typing error.

9. Fig.13: What density means must be demonstrated in the figure caption and must be discussed in the text. Reply: We have added the meaning of this in the text and in the figure caption.

10. P30, Line 16-17: “The correlations of the maximum values and distribution area (or number of 1 km $\times$ 1 km grids) were shown” should be “The correlations of the

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maximum values and distribution area (or number) of 1 km × 1 km grids were shown". Reply: We have rewritten the sentence.

11. P30, Line 20-21: "Fig. 30 indicates the completeness of the inventory of landslides triggered by the Haiti earthquake". This is questionable and better reserved. Completeness of a landslide inventory is commonly evaluated from the plot of a frequency-size relationship. Reply: We agree with the referee and have rewritten the sentence to "The very few abnormalities in figure 30 indicate rather even spatial distribution of the co-seismic landslides in different scales."

12. One anonymous author comment indicates "I wonder if some of those that don't show anything remarkable could be dropped and their relationships just mentioned." I agree this comment and suggest authors of present manuscript can redo statistical analysis of the landslide controlling factors according above-mentioned unbiased approach, and emphasize only some significant factors. Reply: We agree with the referees and have modified the figures following the suggestion of the referee.

13. To improve the readability of this manuscript, I recommend the manuscript should be proofread by native English speaker. Reply: We have revised the text of the manuscript and have asked a native English speaker to read through the text of this manuscript.

References: Lee, C.-T., Re-evaluation of factors controlling landslides triggered by the 1999 Chi–Chi earthquake, in K. Ugai et al. (eds.), Earthquake-Induced Landslides. 2013, Springer-Verlag Berlin Heidelberg. p. 213-224.

Keefer, D.K. Investigating landslides caused by earthquakes - a historical review. Surveys in Geophysics, 2002, 23(6): 473-510.

With best regards, Chong Xu and other authors

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 2, 1259, 2014.