Amendments to Proof (Reviewer #1) Date: 2016/08/24

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Paper Title: Evaluation of Environmental Factors in Landslide Prone Areas of Central Taiwan using Spatial Analysis of Landslide Inventory Maps

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1	37-54	-	-	Number of figures: 23 figures are too many for a single paper. The number of figures could be reduced, for example, summarizing figures from 1 to 3 into a single figure; the same applies to other cases.	Thanks for the comments. To avoid excessive figures and reduce unnecessary information, the authors will try the best to combine those similar GIS-data layers, or statistical results of identical regions into single figures within reason as to not diminish the quality of the study and then polish the revised paper to make it more readable, the data more clear.
2	3	-	-	The Introduction section is rather general and not focused on the purpose of the work. Many introductive information are found in other paragraphs such as "Spatial data and methodology" or in the firsts parts of other subparagraphs (see specific comments)	Thanks for the comments. Under your direct indications, the Introduction section of the manuscripts will be rewritten substantially and introductory information found in other sections will be moved to this section. After revision, the full paper will be expected to be well-structured, more concise and highlighted the research results and data value.
3	4-6	-	-	Hazard history of the study area. This Section is too long and not useful to make the point of the manuscript (see specific comments).	Thanks for the comments. Shenmu area has been affected by serious sediment-related disasters and the hazard history information is used to point out and classify the landslide areas of differing proneness. The section aims to deliver hazard history of over 20 years and the effects of heavy rainfall and typhoon events highlighting and strengthening the legitimacy of the research and the context which it represents. Without the hazard history, the validity of the report becomes more questionable and is seemingly incomplete. The inclusion of hazard history information in landslide research is seen as industry-standard as can be seen by many different researches. Nonetheless, the authors will

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					simplify the whole section content and reduce the length of each paragraph by removing irrelevant or information not useful for revealing or improving upon the above points.
4	**6-8** **16-23**		**-**	**The whole manuscript can be made clearer; for example the** **"Methods and spatial data" should present strictly the data and methods used for the analysis;** **the Results section should present strictly the results of this study(see specific comments)**	**Thanks for the comments.** **The two sections described above "Methods and spatial data" and "Results" will be reconstructed and rephrased to reflect data and methods and results of this study.**
5				**In this Discussion section, the Authors should discuss all the obtained results point by point, which is not the case in the present version of the Manuscript. The discussion of the Earth amplification Effects is not clear to me and poorly described. Moreover the subsection 5.2 and 5.3 "Combination of Causative factors" and "Landslide potential maps" should be moved in the Method and Result section, respectively.**	**Thanks for the comments.** **The obtained results have been described point by point in the Results section. Earthquake Amplification Effect is not the main contribution of this paper and has been discussed by previous researchers mentioned in references, therefore it is unnecessary for a lengthy discussion on this topic. The authors will only keep "Combination of Causative Factors" and "Landslide Potential" to the sections suggested enhancing the value and readability of the study. The observation related to Earthquake Amplification Effect are shortly concluded and removed into the Conclusion Section.**
6	**P3**	**6-11**	**-**	**what do you mean by "primary contributors" and "secondary contributors"? River undercutting is a borderline factor (trigger or causative)**	**Thanks for the comments.** **In this study, we refer to some researcher papers which discuss landslide occurrence and utilize some key terms associated with landslide occurrence. One such term is the triggering factor and another is causative factor. The triggering factor of landslides occurrence is associated with dynamic characteristics which means landslides occur when unstable rock and soil masses on slopes are disturbed by agents of natural or human activities such as heavy rainfall, typhoons, earthquakes, river undercutting or road construction. The causative factor of landslides occurrence is associated with**

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					static characteristics with spatial characteristics with a given environmental that inherit itself the potential causes of vulnerability such as topography, geology, land use. **To avoid misunderstandings, the authors will remove the words above "primary contributors" and "secondary contributors". The original paragraphs will be amended in detail and also add some reference to support the above description.**
7	**P5**	**6**		**Page 5, line6: the analysis consider the influence of Nanchuang and Heshe formations. Please describe the two formations in detail, highlighting the existing differences and providing information about the percentage content of each formation in the two watersheds, Aiyuzih and Chushui.** **Moreover, the two watersheds should be described in terms of factors considered for the analysis (elevation, slope, aspect, lithology, human activities ecc.), and other irrelevant information should be removed (for example, the historical information from page 5, line 14 to page 6, line 16) or substantially reduced.**	**Thanks for the comments.** **The Shenmu area is crossed by three primary geologic structures: the northeast-southwest Heshe Anticline and Tungfu Syncline and the Chen-yo-lan River Fault. These mountain slopes are covered with dense forests and were built up by the Nanchuang and Heshe formation. These formations consists mainly of hard, dark grey argillite and grey slate with thinly bedded muddy sandstone, which are prone to severe weathering and become weak layers in the rock strata (see the Figure). Its percentage content of each formation in the Aiyuzih (45.36% of Heshe formation and 54.64% of Nanchuang formation) and Chushui watersheds (0.61% of Heshe formation and 99.39% of Nanchuang formation) will be provided into revised paper. In addition, environmental factors affecting landslide occurrence considered for the analysis (elevation, slope, aspect, lithology, human activities ecc.) will first be substantially reduced and then introduced in the heading of manuscript.**

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					 **Figure. Photos of dark grey argillite and grey slate**
8	**P6**	**17-19**	**-**	**Page 6, line 17-19: irrelevant here; please remove.** **From page 6, line 21 to page 9: there are many portions of text which belong to the Introduction. In this Section, only the spatial data used in the analysis should appear.**	**Thanks for the comments.** **Irrelevant information in Page 6, line 17-19: would be reduced or deleted. And, introductory information found in page 6, line 21 to page 9 would be removed to the Introduction**
9	**P10**	**30**	**-**	**Page 10, line 30: "If NDVI value is less than 0.05, there is a high probability that the detected land cover/objects are landslides (see Fig.5)". This fact cannot be seen from figure 5. Moreover, the statement about the numerical value should be justified or a reference should be provided.**	**Thanks for the comments.** **The original sentence has not described NDVI method or value precisely so this causes misunderstandings.** **In a single, identical area, satellite imagery acquirement may be affected by seasonal changes, the angle of incidence of the Sun, atmospheric radiation and capture angles, which results in inconsistence of NDVI range for each difference period images.** **Therefore, this paper chose some of samples plot on the single**

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					image to define NDVI threshold to separate vegetation and non-vegetation areas with reference GIS-layers such as roads and land use maps to identify whether it belongs to landslide area. **The revised manuscript will, for example, take given satellite images and utilize NDVI results to illustrate vegetation change and the original sentence will also be amended according to the above mentioned. Additionally to increase clarity, some references to NDVI method of land cover detection will be added.**

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					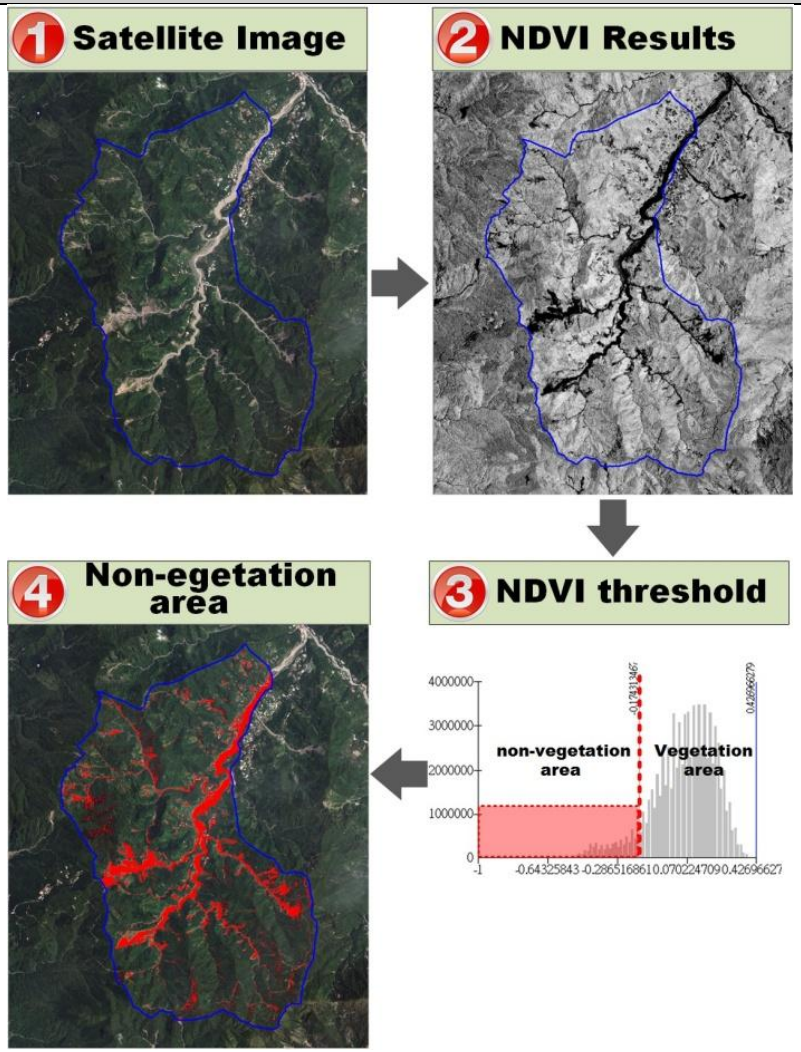

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10		-	-	From page 11, line 10 to page 12, line 10: please try to illustrate the artificial image identification in a clearer and synthetic way.	Thanks for the comments. The authors will add the graph to clearly demonstrate artificial image identification.
11	12-13			Section 3.3: the whole section provides a lot of irrelevant information and, in my opinion, it should be substantially reduced.	Thanks for the comments. The authors will follow your suggestion to reduce some information to highlight the standpoint of Section 3.3.
12	13	21		Page 13, line 21: "landslide area" should be "watershed area", according to Eq. (2).	Thanks for the comments. The paragraph is amend as below, *Similarly, the new landslide ratio as the ratio of new landslide area to the watershed area.*
13				Page 15, lines from 2 to 10: these introduction is irrelevant to the Section, and should be removed. In the following, the Authors use the Uchihugi formula to calculate the new landslide ratio from the magnitude of the rainfall events. They modify the original formula adding a parameter, C. How do they obtain the value of C parameter quoted in figure 17? What do they mean by "initial increment landslide ratio"? Which is the physical meaning of the constant they introduce? Page 15, line 15: "However, when the rainfall parameters of Uchihugi empirical model reach the critical rainfall, the new landslide in the watershed becomes zero." This sentence is not clear to me! It seems that when the value of cumulated rainfall is larger than the value of critical rainfall the new landslide becomes zero. I checked in the article "S.-J. Chiou, et al.: Evaluating Landslides and Sediment Yields Induced by the Chi-Chi Earthquake and Heavy Rainfalls" (the suggested reference is actually only	Thanks for the comments. In some parts of the paper Uchiogi is mispelled as Uchiughi, these errors will be corrected in the revised paper. According to Uchiogi formula, one can assume that for a given watershed, triggered landslide emperica equation for a rainfall event under 200mm of critical rainfall can be stated as follows: $NLR(\%) = \frac{ILA}{WSA} \approx K \times 10^{-6} (R_A - 200)^2 \;\; R_A \geq 200$ One can find that if the accumulated rainfall is up to 200mm and is inputted into this formula, the estimate of the new landslide ratio by this event can be calculated as follows: $NLR(\%) = \frac{ILA}{WSA} \approx K \times 10^{-6} (200 - 200)^2 = 0$ The calculated result shows that the new landslide ratio is zero which means no landslides or slope failures occurred during

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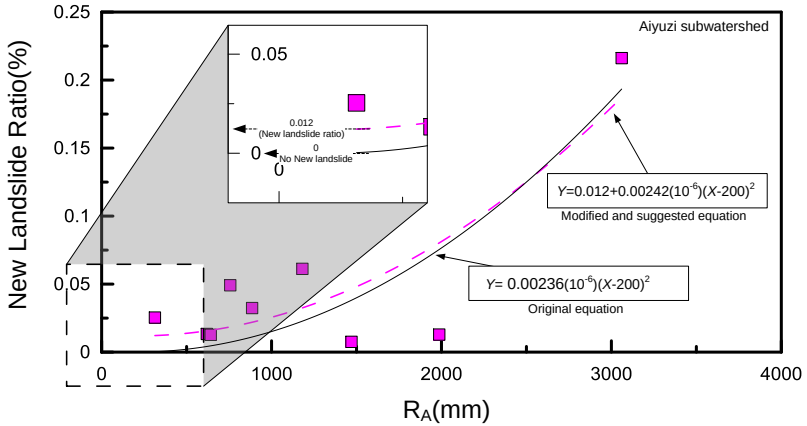
				available in Japanese, which is not acceptable), <u>in which the same formula is used and the value zero is obtained for cumulated rainfall smaller than critical rainfall, as it should be.</u>	**this event which does not match with physical phenomena of the exceedance of critical rainfall for slope failure.** **To modify the imperfection of the original formula, the authors suggest the addition of one constant(C) to the original formula. C aims to represent that when the accumulated rainfall equals or exceeds the critical rainfall a certain amount of new landslide occurs in a watershed. The correction will make the original formula more reasonable and enhances its applicability. The modified formula is as follows:** $$NLR(\%) = \frac{ILA}{WSA} \approx C + K \times 10^{-6}(R_A - 200)^2 \quad R_A \geq 200$$ **In terms of obtaining the value of C parameter, the data for each rainfall-induced landlide event and its corresponding accumulated rainfall will be compiled for statistical regression based analysis on the suggesting governing formula (see the figure). The figure shows that the C parameter is a constant and seems like a truncated value of the y-axis(new landslide ratio).**  **From the perspective of physical significance, it implies when a rainfall event reaches its critical rainfall, this parameter(C**

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					constant) represents the minimum amount of new landslide area in a watershed. **In view of these points, the authors will arrange the above mentioned descriptions and revise the original sentence to make the manuscript more readable and clear.**
14	**16**	**6**		**From page 16, line 6 to page 17, line 3: the description of the temporal and spatial analysis could be used to introduce briefly paragraph 4.1 and 4.2. Please remove, or move this part to the suggested location.**	**Thanks for the comments.** **The authors will remove those sentence such in from page 16, line 6 to page 17, line 3 to the heading of Subsection 4.1 and 4.2 respectively under your suggestions.**
15	**20**	**2-8**		**Page 20, lines from 2 to 8: this part fits better in the Discussion section than in the Results one; many sentences are very general ones and can be safely removed.**	**Thanks for the comments.** **The authors will follow your suggestion to remove sentences in Page 20, lines from 2 to 8 into the Discussion section. And, if the sentences are very general ones, they would be safely removed.**
16				**In conclusion, I believe that, in general, the manuscript should be substantially reduced in length by removing irrelevant information.** **The Discussion and Conclusions sections should be rewritten from scratch, using the results actually obtained in this work and avoiding generic comments and lengthy introductory text.** **Moreover, I suggest that the Authors analyze how the landslide potential map change using the combination of causative factor for the three temporal periods pre-1999 Chi-Chi earthquake, from 1999 Chi-Chi earthquake to pre- and post- typhoon Morakot. A validation of the map itself could be performed by discussing the landslide potential map obtained from each period against the observation of the next one.**	**Thanks for the comments.** **The author will follow your suggestion to remove relevant information and reconstruct the Discussion and Conclusions sections based on main obtained results. In addition, landslide potential map of the three temporal periods pre-1999 Chi-Chi earthquake, from 1999 Chi-Chi earthquake to pre- and post-typhoon Morakot would be also discussed and validated in the revised manuscript.**