Anonymous Referee #2

The authors present a study on thresholds for debris flows. The topic is certainly suitable for the audience of Natural Hazards and Earth System Sciences. However, I think the paper needs major revision before publication. I hope that the following comments would give some indication to the authors on how improve the paper.

Broad comments

1. In my opinion references are too scarce and do not represent well the state of the art of the subject you are discussing. I would also have expected a broader introduction on rainfall threshold for debris flows.

   Thank you for your reminding. We have added references as the following list.

   Lin C.W., Shieh C.-L., Yuan B.D., Shieh Y.C., Liu S.H., Lee S.Y.: Impact of Chi-Chi earthquake on the occurrence of landslides and debris flows: example from the Chenyulan River watershed, Nantou, Taiwan, Engineering Geology, 71, 1–2, 49-61, 2004.

   Liu S.H., Lin C.W., Tseng C.M.: A statistical model for the impact of the 1999 Chi-Chi earthquake on the subsequent rainfall-induced landslides, Engineering Geology, 156, 11-19, 2013.

   Huang R., Li W.: Post-earthquake landsliding and long-term impacts in the Wenchuan earthquake area, China, Engineering Geology, 182, 111-120, 2014.

   Lin C.W., Liu S.H., Lee S.Y., Liu C.C.: Impacts of the Chi-Chi earthquake on subsequent rainfall-induced landslides in central Taiwan, Engineering Geology, 86, 2–3, 87-101, 2006.

   Chiou, S. J., Cheng, C. T., Hsu, S. M., Lin, Y. H., & Chi, S. Y.: Evaluating landslides and sediment yields induced by the Chi-Chi Earthquake and followed heavy rainfalls along the Ta-Chia River, Journal of GeoEngineering, 2, 2, 73-82, 2007.

   Lin M.L., Tung C.C.: A GIS-based potential analysis of the landslides induced by the Chi-Chi earthquake, Engineering Geology, 71, 1–2, 63-77, 2004

   Zhuang J.Q., Cui P., Wang G.H., Chen X.Q., Iqbal J., Guo X.J.: Rainfall thresholds for the occurrence of debris flows in the Jiangjia Gully, Yunnan Province, China, Engineering Geology, 195, 335-346, 2015.

   Wan S., Lei T.C.: A knowledge-based decision support system to analyze the debris-flow problems at Chen-Yu-Lan River, Taiwan, Knowledge-Based Systems, 22, 8, 580-588, 2009.

   Yuan L.F., Zhang Q.F., Li W.W., Zou L.J.: Debris Flow Hazard Assessment Based on Support Vector Machine, Geoscience and Remote Sensing Symposium, 2006. IGARSS 2006. IEEE International Conference, 4221-4224, 2006.

   Bui D.T., Pradhan B., Lofman O., Revhang I.: Landslide Susceptibility Assessment in Vietnam Using Support Vector Machines, Decision Tree, and Naïve Bayes Models,

Mathematical Problems in Engineering, 2012, 1-26.

2. The language needs some revision.

   Thank you for your reminding. We have modified the grammar mistakes based on your kind advice.

3. The procedure you propose follows a consistent logic. However, it is not clear how you want to use these thresholds in the territory.

   Because lots of critical rainfall thresholds have been changed caused by amount of landslides after 1999 921 earthquake in Taiwan. This study collects the first four years after 921 earthquake to analyze the critical rainfall threshold of debris flow streams, however, there is not enough occurrence data for analyzing critical rainfall thresholds. Therefore, this study combines debris flow streams into one group with same patterns through FCGA. At last, critical rainfall threshold of each group has been defined by support vector machine which represents the changes of post-earthquake.

Specific comments

5958 – 4: discard disaster of debris flow (in all text), use damage or other synonymous

Thank you for your reminding. We have modified all “disaster” as “damage”.

5958 – 19/21: *lead to the amount* reformulate the sentence as it is not clear, also avoid adjectives like tremendous

Thank you for your reminding. We have modified as “*These **serious** landslides often brought sediment material into the streambed, in the initiation area of debris flow*” in PAGE 2 LINE 5-6.

5958 – 23/25: explain why you hypothesize the upward trend, maybe using references and moving the explanatory sentences that now are in the first lines of page 5959 upwards

Thank you for your reminding. We have added following references to depict this hypothesis which describe that landslide and debris flow damage might be more seriously caused by large earthquake influence.

5958 – 25/26: I think that in this sentence, but maybe in the whole paragraph, there is a problem with verb tenses

Thank you for your reminding. We have modified *as* “*This means that the debris flow damages have been more unpredictable and destructive with the amount of sediment material (Lin and Tung, 2004)”* in PAGE 2 Line 10-12.

5959 – 5: Figure 1 is not necessary

Thank you for your reminding. We have removed in this version.

5959 – 9/10: are considered

Thank you for your reminding. We have modified as "*are considered*" in PAGE 2 LINE 21.

5959 – 11/12: I think it is good practice to be a little more illustrative in the introductions. If you introduce the concepts of genetic algorithm or SVM in the introduction of a paper citations and a sentence explaining briefly what they are must follow.

Thank you for your reminding. We have added three reference about this problem. The additional description is already added in PAGE 5 LINE 14-31.

Wan S., Lei T.C.: A knowledge-based decision support system to analyze the debris-flow problems at Chen-Yu-Lan River, Taiwan, Knowledge-Based Systems, 22, 8, 580-588, 2009.

Yuan L.F., Zhang Q.F., Li W.W., Zou L.J.: Debris Flow Hazard Assessment Based on Support Vector Machine, Geoscience and Remote Sensing Symposium, 2006. IGARSS 2006. IEEE International Conference, 4221-4224, 2006.

Bui D.T., Pradhan B., Lofman O., Revhang I.: Landslide Susceptibility Assessment in Vietnam Using Support Vector Machines, Decision Tree, and Naïve Bayes Models, Mathematical Problems in Engineering, 1-26, 2012.

5959 – 16/17: the sentence is not clear, maybe a verb is missing. Moreover: what do you mean with blocks?

Thank you for your reminding. We have rewrite this sentence as "*The Chi-Chi earthquake occurred in 1999 in Taiwan and caused numerous landslides, the locations of these landslides were up to 2365 and the total area were approximate 14347 hectares, represented as Fig. 1(a).*" in PAGE 2 LINE 29-31.

5959 – 20/21: check grammar

Thank you for your reminding. We have rewrite this sentence "The debris flow streams triggered by the landslides which affected seriously by the Chi-Chi earthquake were studied in the experiments." as "*The debris flow streams are triggered by the landslides affected seriously by the Chi-Chi earthquake in the experiments of previous study.*" in PAGE 2 LINE 32 and PAGE 3 LINE1.

5959 – 24: Figure 2b streams with or without disaster in the legend have the same color

Thank you for your reminding. We have redrawn Figure 1b with different legend color in PAGE 16.

5959 – 25 and following: since the paper you cite is not easily available online and the definition of effective watershed area A15 as the area with slope greater of 15° is not so broadly known, in order to help your readers in the comprehension of the paper please place also a small definition.

Thank you for your reminding. We have added a short description in table in PAGE 13. While the slope value of riverbed or watershed area is greater than

15°, then this area has a potential of debris flow damages. That is the reason why this study defines the slope value of effective watershed area is greater than 15°.

5960 – 3: Table 1 for me needs some explications and corrections. First of all unit measures are to be indicated with [] brackets. In the specific not (degrees) but [°]. Moreover, if Ss is the mean surface slope of A15 how comes that the values, in degrees, are lower than 15°?

Thank you for your reminding. We have replaced “degree” as “º” in PAGE 13 . For the value of 15°, this threshold is widely used in many research. Because the mean surface slope need to be greater 15° and this is one of the initial condition of debris flow damages

5960 – 5: discard statistical

Thank you for your reminding. We have deleted the word “statistical”.

5960 – 7: discard statistical

Thank you for your reminding. We have deleted the word “statistical”.

5960 – Data processing paragraph: I think that your notation is not clear and do not help the comprehension of these equations. You use j both to differentiate vector Fi and Fj and as an alternative counter for M. It allows confusion in my opinion. Moreover, as best practice, you have to explain each equation. I know that they are pretty standard but if you write them you have to devote two lines in explaining them.

Thank you for your reminding. Among these paragraph, we did not describe about the Eq.3 and Eq.4, as the result, we add a short sentence about them as “*where* $\bar{X}_i$ *and* σ_{X_i} *are refered to Eq.3 and Eq.4.*” in PAGE 3 LINE 29-30.

5961 – Clustering analysis paragraph: In this paragraph it should be clearly stated why you apply this procedure. The algorithm separates groups of similar processes but it seems to me that this is independent from the location of the stream so it seems that your output would provide thresholds for each stream not on regional basis, which could be precise and useful but should be explicitly stated.

Thank you for your reminding. About the output of cluster, we have added description about this in PAGE 5 LINE 3 “*The experimental results revealed that the FCGA is a promising method for constructing the optimal tree of streams. Fig. 3 presents the seven groups of 377 debris-flow streams on the basis of their patterns among 8 factors mentioned them in previous section.*”.

5963 – 8/12: I would advise you to discard Fig.4 and Fig.5a since they represent a well-known problem in scientific literature, use references. In order to explain better SVM and why you pass in a higher dimensional space, you can modify

figure 5b using data as fields and explicit better in the texts that this helps you with overlapping.

Thank you for your reminding. About literature part, we have already added four references about support vector machine.

Vapnik V.:Nature of Statistical Learning Theory, John Wiley and Sons, Inc., New York, 1995.

Tax D., Duin E.:Uniform object generation for optimizing one-class classifiers, Journal of Machine Learning Research, 2, 155-173, 2002.

Ballabio C., Sterlacchini S.: Support Vector Machines for Landslide Susceptibility Mapping: The Staffora River Basin Case Study, Italy, Mathematical Geosciences, 44, 1, 47-70, 2012.

Vapnik, V.: Statistical learning theory*. New York: John Wiley & Sons, 1998.*

5963 – 14/15: A *that* is missing

Thank you for your reminding. We have added the word “that”.

5963 – 20/21: A verb is missing

Thank you for your reminding. We have added the verb “is”.

5964 – 2: in Figure 7 the blue dots are very difficult to detect, try to switch to yellow or other brighter colors

Thank you for your reminding. We have redrawn Figure 7 with different symbol color.

5964 – 9: I would not use *likely*

Thank you for your reminding. We have changed the word “likely” as “possible”.

5964 – 18: *for* debris flow (in all text)

Thank you for your reminding. We have changed the word “for” in all text.