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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Application of a hybrid model of neural networks and genetic algorithms to evaluate landslide susceptibility" *by* H. B. Wang et al.

Anonymous Referee #1

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NHESS-2013-37 REFEREE COMMENT

General comments The manuscript deals with landslide susceptibility evaluation by applying a combined neural network/genetic algorithm approach. Despite the topic, that is undoubtedly relevant (but not completely new), the overall quality of the manuscript is poor. In fact, authors fail in giving enough information on i) the environmental characteristics of the study area (lithology, attitudes and structures; types and extents of the slope movement), ii) the method (from the selection of model and GA parameters, to the definition of the classes of parameters, to the application of the GA for optimizing the neural network). Moreover, details on some relevant issues (e.g. the number

of landslides) appear to be always not consistent throughout the manuscript (cf. text and figures). The discussion of the results should be improved (n.2 of the considered parameters are not discussed), and more information given on the method adopted to evaluating susceptibility and accuracy predictions.

Specific comments Does the paper address relevant scientific and/or technical questions within the scope of NHESS? The considered topic falls well inside the scope of NHESS.

Does the paper present new data and/or novel concepts, ideas, tools, methods or results? The use of evolutionary algorithms to optimize neural networks is not novel, also for landslide susceptibility. The application of the method was performed to a study area located in China (I presume.. it is never explicitly stated in the ms!).

Are these up to international standards? The description of the study area should be improved, by also including geological references and a lithological map (possibly with structures and attitudes). All the mentioned toponyms (mountains, streams, villages, ..) should be evidenced in the figures. By the way, they should also be "immutable" in the text (e.g. Changshou or Changshougou?..). The adopted method is not explained in full detail. Hence, the reader cannot properly understand all the steps performed by the authors (from the selection of parameters to be considered, to their classification, to the optimization of the neural network through GA, to the evaluation of accuracy of the results). In particular, results are poorly commented (2 of them are not commented at all), and the advantage of the adopted method is poorly justified in the conclusions. More serious: the description concerning the data set (slope units vs. landslides, both in total and those used for training/validation) seems to be not consistent in the text (How many are the slope units? How many the landslides?). At this regard, cf. also discrepancies between text and figures 15-18. Geological conceptual issues should also be clarified (e.g. the lithologic description of the study area – by the way: do really authors consider loess as an example of fluvial deposit?).

Are the scientific methods and assumptions valid and outlined clearly? The scientific method, as far as it can be understood, sounds valid. Though, it should be better described.

Are the results sufficient to support the interpretations and the conclusions? As said, results are not thoroughly commented. Those related to a couple of model parameters are not commented at all.

Does the author reach substantial conclusions? This is not clear.

Is the description of the data used, the methods used, the experiments and calculations made, and the results obtained sufficiently complete and accurate to allow their reproduction by fellow scientists (traceability of results)? No.

Does the title clearly and unambiguously reflect the contents of the paper? Yes.

Does the abstract provide a concise, complete and unambiguous summary of the work done and the results obtained? (fairly) Yes.

Are the title and the abstract pertinent, and easy to understand to a wide and diversified audience? Yes.

Are mathematical formulae, symbols, abbreviations and units correctly defined and used? If the formulae, symbols or abbreviations are numerous, are there tables or appendixes listing them? Yes.

Is the size, quality and readability of each figure adequate to the type and quantity of data presented? No. In Fig.1, orientation and scale are missing. In the same figure, some details on elevations a.s.l. (at least at some point locations, or by adding major contour lines) would be useful. Fig.2 is not a “landslide inventory map”. Please, give basic information on mapped phenomena - i.e. landslide type and age/state of activity, following international standards (e.g. Cruden & Varnes, 1996). In addition, landslides (as well as slope units) used for training should be marked differently from those used for validation. In Fig.3, only the traces of the main rupture surfaces and the

main movement directions can be appreciated. Landslide boundaries are not shown. Figs. 5, 6, 7, 8: the adopted classes are not defined/described in the text. The legend is missing, and ranges look strange (in fig.5, also the accuracy of the values sounds strange). In Fig.9, change “algorithms” into “algorithm”. The number of landslides cited in figures 15-18 is not consistent with data description in the text. In Fig. 12 and 13, the blue line seems to be the best solution trend, while the red one the mean of the whole population. Please insert a legend or give the information in the caption. Fig.17: perhaps, it would be better to indicate aspects as cardinal points (e.g. bisectors of the ranges). Fig.19: it is not clear how susceptibility is shown in the map (I see neither relative classes nor values). Only the landslide potential on stable slopes is marked in yellow. Finally, an additional figure depicting the geological characteristics of the study area, plus those related to the 2 factors “distance to rivers” and “distance to human activities” should be added.

Does the author give proper credit to previous and/or related work, and does he/she indicate clearly his/her own contribution? (fairly) Yes. Some references for the geological description, and to studies adopting a similar approach should be added.

Are the number and quality of the references appropriate? (fairly) Yes.

Are the references accessible by fellow scientists? Yes.

Is the overall presentation well structured, clear and easy to understand by a wide and general audience? No.

Is the length of the paper adequate, too long or too short? Adequate.

Is there any part of the paper (title, abstract, main text, formulae, symbols, figures and their captions, tables, list of references, appendixes) that needs to be clarified, reduced, added, combined, or eliminated? The description of the adopted method should be extended and improved. E.g.: why authors decided to use those environmental parameters? how they decided the classes for each parameter? how they decided the

values of the GA parameters? More details on how the GA was combined to the neural network should also be given. How they compute the prediction accuracy?.. (see also the comments above). When describing the environmental factors, as well as in the discussion of the results/conclusions sections, it should be clarified that the cited characteristics of each slope unit are just “average” or “prevailing” conditions (as only one value is assigned to each parameter). Also in this respect, results are poorly discussed; a couple of parameters are not discussed at all. In section 2, the geological description must be improved (by the way, loess deposits seem to be described as fluvial..). Page 24, lines 294-299: consider to arrange GA parameters in a table. If possible, provide more information, e.g. the genotype encoding (if binary or real) and length. Page 30, lines 353-369: the period may be moved to Conclusions.

Is the technical language precise and understandable by fellow scientists? The description of landslide phenomena (as well as the related map) must be improved by giving – at least - essential information on their types and extent (a mere description of relative ages, and of their main scarps, is not enough).

Is the English language of good quality, fluent, simple and easy to read and understand by a wide and diversified audience? In the first part of the manuscript it is more accurate than in the second one. The English (also the use of the tenses) should be improved.

Is the amount and quality of supplementary material (if any) appropriate? n.a.

Technical corrections page 4, line 75: change “self-organized system” into “self-organized systems”. page 4, line 76: change “evaluation, and these variables” into “evaluation, which”. page 4, line 77: change “with the evaluation” into “with evaluation”. page 6, line 126: please, specify where the study area is located. page 6, line 127: change “The elevation is 600-700 m” into “The average elevation is 600-700 m a.s.l.”. page 6, lines 130-135: improve the description of geological units and of lithological characteristics, and add references. Loess deposits cannot be described as “fluvial”!

Moreover, more information on the structural setting would be useful (e.g. show the main faults / folds in the map; show the structure/attitudes of the strata; ..). pages 6-7, lines 135-137: improve the description of loess terrains (what is a “problem soil”?), and add references. page 7, lines 141-142: “..seasonal shifts in dominant winds”. Please improve the sentence. page 8, lines 148-150: landslides cannot be described merely in terms of relative ages. Please, improve this period by including more details (at least: landslide types, according to Cruden & Varnes, 1996 – or other international nomenclature). Moreover, improve the landslide map by distinguishing them based on type, age/state of activity, etc. page 8, lines 153-154: please, explain why slopes of 18° guarantee stability in the study area. page 9, lines 157-158: perhaps, it can be said that the largest phenomena are located by the stream junction. page 10, lines 159-170: what’s the base of the statement on the major factors that affect the triggering of slope movements and their type of movement? what’s for ancillary factors? are these general statements or based on local evidence? what’s the relation between structures and strata attitudes, on one side, and morphology? page 10, line 171: change “geological periods” into “relative age”. By the way, lines 171-172 report concepts already mentioned in the text. page 10, lines 176-177: “Steeper slopes .. terraces.” Please, improve this sentence (a figure would help). page 10, line 180: change “semi-circular failure plane” into “concave surface of rupture”. page 11, line 181: “fluvial” deposits? page 11, line 189: “presented”? page 13, line 210: change “such as, slope” into “such as slope”. page 14, line 211: change “and the shape” into “and shape”. page 14, line 212-213: change “distance to river and human activities” into “distance to rivers and to human activities”. page 14, line 213: at the end of the period, comment why those (and not other) parameters have been selected, and add references. page 14, line 215: at the beginning of the paragraph, the possible role of the considered parameter in conditioning slope stability (in this case, the average slope angle in the slope unit, but the same should be done for all the parameters) should be commented, and references given. page 12, line 217: please, justify the selected classes, and comment the different extent of the first and of the last ones. page 15, line 221: please, explain why

slope height (perhaps, better to say “relative height”) plays an important role in slope stability, especially in loess areas (and add references). page 16, line 222: change “Considering.. failures,” into “Other conditions being equal, ..”. page 16, line 223-224: please, explain why “higher slopes can increase stress values..”. page 16, line 224: please, justify the selected classes, and comment the different extent of the last one. page 16, line 226: please, specify whether that computation was made per each slope unit. page 18, lines 231-232: please, specify how aspect was calculated (give ranges of azimut per each class). By the way, in fig.7 not all the classes are listed in the legend (apart from the cited discrepancy, in figs. 5-8, between values of classes shown in legend and those described in the text). page 19, line 237: what is the evidence for sub-surface flow being the main hydrological triggering mechanism (n the study area?). how slope morphology classes are defined? (why?) – add references; moreover, how slope units were classified? page 19, lines 238-240: this period describes the results of the analysis in the study area. It should be moved into the Discussion of Results section (and commented). page 20, line 243: before the section on “Methods”, 2 more factors (among those considered by the authors) should be described, i.e. “distance to rivers” and “distance to human activities” (add also missing figures). “Methods” (pages 20-26): more details should be given on how the GA was combined to the neural network. Values of model parameters, as listed at page 24, should be justified (if suitable, by adding references). The training and validation sets should be better described (and shown in the landslide map), and details on the number of slope units and landslides made consistent throughout the manuscript. page 24, lines 300-303: please, improve this period. page 26, lines 312-313: improve the sentence (also including the 2 missing parameters). page 26, line 314: improve “..within the scope of GIS..”. page 26, lines 315-318: improve the period “..the geological condition.. Quaternary loess”. Add information on relationship between structures and attitudes with respect to local morphology. Improve the description of geological units and lithologic outcrops (cf. loess vs. fluvial..). page 26, lines 318-319: improve the period (why did you focus on those parameters? what about the missing 2?) page 26, lines 320-328: it is not clear how it can

be stated that “36% of landslides occurred on slopes with angles between 40 and 50.. almost 45% of the landslides occurred at elevations between 100 and 150 m [a.s.l.].. 38% and 56% of landslides were toward SE and SW, resp.”. As far as I’ve understood, the analysis was performed on the base of slope units, not landslides. Perhaps, results can properly be expressed in terms of “slope units affected by landslides”.. Moreover, the cited environmental characteristics do reflect average conditions of the slope units. Overall, authors should re-write discussion and conclusions by keeping in mind this point of view. page 27, lines 324-325: by considering the general shape of the study area, and therefore the expected aspects of most of the slopes, it sounds strange that so many “landslides” (slope units affected by landslides) face toward SE. This result should be better checked and, if confirmed, properly discussed. page 27, lines 325-326: which “other five variables made little contribution..”? and why? page 27, lines 326-328: please, improve the sentence “In addition, .. loess areas”. Furthermore, at the end of the period, the discussion of the results obtained for the “missing” 2 factors should be added. page 28, lines 339-340: how was susceptibility computed? (by slope units?) is it expressed in absolute or relative terms? how is susceptibility mapped (if it is..) in fig.19? page 28, lines 340-344: how was the comparison made? how was the accuracy of prediction of landslide occurrence evaluated? (again, the analysis was carried out for slope units..) page 29, line 348: do yellow zones mark today-stable slope units that resulted potentially unstable? or do they mark the only susceptible slope units? page 30, lines 349-352: it is not clear which “all of these slopes” are.. the yellow zones? By the way, improve the sentence: slopes (slope units) cannot face, at the same time, toward SE “and” SW (I guess this was authors’ idea.. in the text, SE is repeated twice..). The remaining characteristics do refer to averages values in the slope units (where the angle of 43° come from?). finally, no one slope unit falls on plane sectors? (when checking fig.18, this does not seems the case). page 30, lines 353-369: re-phrase/improve this period and move it to Conclusions. page 30, lines 370-399: improve the Conclusions by considering all the comments above. Note that, the Conclusions should not merely repeat part of the Discussion.. page 31, lines 321

and 376: Changshougou?.. page 31, lines 353-369: the statistics of landslides and slope units, even for training and validation, seem to be not consistent with those mentioned elsewhere in the text (e.g. 380-384). Please check and correct them. page 31, lines 373-374: “According to the mechanism analyses.. six environmental factors were selected..”. Please, improve. page 31, lines 388: again, SE and SE.. (perhaps, authors really wanted to write this way.. well, at least, it should be explained). page 32, lines 394-399: resulting strong and weak points of the adopted approach to the study area are not commented enough. Please, discuss them more in detail. page 32-37, References: please, add some examples of landslide susceptibility analyses performed by coupling neural networks and GA. e.g. Hongling Tian; Hongli Nan; Zongji Yang, "Select landslide susceptibility main affecting factors by multi-objective optimization algorithm," Natural Computation (ICNC), 2010 Sixth International Conference on , vol.4, no., pp.1830,1833, 10-12 Aug. 2010 doi: 10.1109/ICNC.2010.5584507

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