Nat. Hazards Earth Syst. Sci. Discuss., 2, C3447–C3453, 2015
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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Amalgamation in landslide maps: effects and automatic detection" *by* O. Marc and N. Hovius

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Received and published: 18 February 2015

In addition to this reply we would like to give access to the Matlab script that we used for automatic detection of amalgamated landslide polygons. The script is attached as a zip-file and is properly commented and ready to use. We think it could benefit the community if it is directly in open access as a supplement of the final manuscript.

C.T. Lee

Comment: A good landslide inventory requires firstly a good remote sensing image for recognition of landslide, and secondarily an experienced person to recognize the landslide.

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Interactive Discussion

Discussion Paper

Comment: If a slope unit map is overlaid on the remote sensing image for manual recognition and digitizing of landslides, then amalgamation may be the least.

Reply: These comments are addressed later together with the general comment of the second referee.

Specific comments Comment: Figure 2b is a mistaken; this figure may have a problem of map projection, because our original data (Liao and Lee, 2000) has no this kind of ridge crossing. I suggest removing Figure 2b.

Reply: Figure 2B has been replaced with a figure showing ridge crossing and errors in the Northridge area.

Comment: Page 7655, line 21: “automated mapping procedure”. Actually, Liao and Lee (2000) landside inventory was done by manual mapping procedure.

Reply: Original text: A striking example of amalgamation due to automated mapping procedures can be found at the JouJou mountain... "due to automated mapping procedures" was removed.

Comment: 2.3 Page 7657, line 15: Please change “mapped automatically” to “manually mapped”.

Reply: Changed to manually mapped

Comment: 2.4 Page 7663, line 15-16: “we impose an arbitrary threshold size ratio of branches relative to the longest branch, RBc”. It may be RBc/Lmax.

Reply: RBc is the threshold. Therefore the maximal acceptable length for a secondary branch is Lmax / Rbc.

Anonymous referee 2:

Comment: Most of the approaches adopt equations for the computation of landslide volumes starting from landslide areas. These relationships are already based on rough volume estimates which can be affected by large errors and/or uncertainty. This paper demonstrates that the estimates can be or have been affected by relatively large errors. what is the acceptable level in common estimates? When thinking at landslide stabilization works, for example, a wrong volume estimate can be unacceptable even for relatively small values errors in volume estimate by a factor of three could seem enormous, the same change in power law exponent of 50%. so what can we really accept of the past analyses already published in the literature?

Reply: We cannot define an absolute level of "acceptable uncertainty", we can only provide information on the different sources and possible magnitude of errors. It is then up to the users and analysts to judge which level of errors is acceptable in relation to their aims. The same applies to already published studies, depending on the data and potential errors within them, their conclusions may or may not be likely erroneous.

Comment: the authors suggest the problem of the subdivision of the landslides in subareas/sectors: source, transportation and deposition. In many earthquake induced landslides the transportation zone can be extremely large. So the computation of the total area can introduce a major error in the computation.

Comment: The same can be said for coalescent landslides or those that are enlarged by erosion connected to successive rainfall events or for example other ground shakings. The experience of this reviewer suggests these can be extremely important. It would be interesting to add some more comments.

Comment: It is also frequent that for many automatically detected landslides the mapped phenomena are not landslides at all and this could be said.

Reply: In view of these 3 last comments about other source of errors, and the general comment from C.T. Lee, we have added this paragraph at the end of the discussion.

"In the end, we must recall that amalgamation even if it may be a major source of errors, such as in the Wenchuan example, it is not the only one. Firstly, anthropogenic clearance or other disturbance of the landscape may be mistaken for a landslide, especially by automatic algorithms. Secondly, when scar, transport and deposit areas cannot be differentiated the volume of landslides with long runout may be substantially over-estimated. Thirdly, when landslides are reactivated and previously stable parts of the landscape are not implied, then it may be hard for the mapper to delineate the area of the actual failure with accuracy and this new failure may also not yield a volume as large as expected from area-volume relationships. These issues may be difficult to deal with but their effects will be suppressed when high resolution imagery is used by an experienced mapper. Additionally, systematic ways of dealing with these issues, such as the flagging of reactivated landslides and the differentiation of the transport area of debris flow or long runout landslides should be practiced by mappers and also considered by users analysing old data."

Comment: what is the influence on the results of using different volume thresholds for different earthquake datasets?

Reply: It is not quite clear which threshold the referee has in mind. If it is the size threshold at which we stopped to split manually amalgams (for example 10,000m^2 and 100,000m^2 for the Northridge and Guatemala datasets), then we reported in the text that the polygons larger than this threshold were representing 56% and 73% of the total uncorrected volume, and when corrected resulted in a volume change of 16% and 35%, respectively. This quantification should give a good impression of the effect of cutoffs and enable users to make independent decisions about trade-off between work and level of correction. Because amalgamation enlarges polygons, smaller polygons are less likely to be amalgams, and because volume scales non linearly with area, it is clear that the volume change obtained by correcting smaller polygons would be less than that obtained by correcting larger polygons. Therefore, we can expect the polygons smaller than the correction threshold to represent a minor additional volume change.

We have added text to cover this point – p.10, line 5: "Because polygons smaller

NHESSD
2, C3447–C3453, 2015

Interactive Comment

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Discussion Paper

than the threshold represent only 44% and 27% of the total volume, respectively, and because they must be less amalgamated and have much smaller individual volumes, their correction would likely add only a minor contribution to the total volume change."

Comment: the algorithm for checking the elevation within each branch is unclear

Reply: See changes below for the comment about p14 line 2-4

Comment: Sc = 10, isn't this a low value? can just comment a little bit more about this threshold or the influence on your model of the use of diffferent threshold values?

Reply: The studies cited in the text have found the effects of landsliding to still be relatively common in slopes as gentle as 10-15°. This is related to the fact that mapped landslides incorporate steep scars and less steep deposits. Thus, the critical slope Sc must be low in order to limit the number of false positives. We actually ran the algorithm with Sc=12°. Imposing Sc = 15° may increase significantly the number of false positives but not necessarily the number of true positives as the most common type of amalgamation is related to multiple branches. We have added line 11 p 16 : "However, increasing Sc to 15° or more may increase significantly the number of false positives but not necessarily the number of true positives as the most common type of amalgamation is related to multiple branches."

Comment: please to make easier the reading give between brackets the false neg and false pos definition for your problem

Reply: complementing the information already in the manuscript we have added definitions at line 5 P 15: The algorithm missed 70 amalgams (3.6% of false negatives, that is undetected amalgams) and wrongly classified 76 single landslides as amalgams (3.9% of false positives, that is correct polygons classified as amalgams) and in the table caption: "Therefore, false positives are correctly mapped polygons erroneously identified as amalgams, whereas false negatives are amalgams that remain undetected by the algorithm."

NHESSD
2, C3447–C3453, 2015

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Comment: page 5: I do not think it is simply a problem o f bad and incorrect preparation of inventory maps before the use of landslide area-volume relationships. Many recent inventories are clearly affected by this error and many of these inventories and older ones have been used for computing and developing volume – area relationships

Reply: Original text : "when the primary goal of the mapper is not to map landslide extent precisely, but rather to rapidly evaluate the area affected by slope failure. This seems to be especially common for maps predating widespread use of landslide area-volume relationships." Changed to: "This seems common for maps predating widespread use of landslide area-volume relationships as well as for more recent inventories, underlining the current lack of care in avoiding or at least flagging amalgamation."

Comment: (end of) page 6: is it like saying that the geological features are not relevant at controlling landslide size, position and density?

Reply: The original text states: Large earthquakes can trigger many thousands of landslides in a limited area, reducing possible effects of geological heterogeneity on landslide populations and their statistics. This does not say what the referee implies.

Comment: page 9 line 20: amalgamation ;

Reply: Corrected.

Comment: page 10 line 1: 162, respectively 51? there is something wrong

Reply: Original text: "162, respectively 51 of these polygons were found to be amalgams of several landslides." This was referring to the polygons analyzed in the Northridge and Guatemala datasets. Replaced by: 162 out of 356 and 51 out of 90 of these polygons were found to be amalgams of several landslides

Comment: page 14 - lines 2-4: not fully clear and understandable

Reply: Original text : First, the algorithm checks that all elevations along the branch are within the elevation range bracketed by the branch endpoints. A violation of this condition typically signals that the branch traverses a ridge or valley floor ... Replaced with: First the algorithm checks that the highest and lowest elevations within the main branch coincide with the top and toe of the mapped landslide. A violation of this condition typically signals that the branch traverses a ridge or valley floor, ...

Comment: page 15 - lines 21 etc: pixels? better use cells

Reply: Pixels changed to cells in the discussion section.

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/2/C3447/2015/nhessd-2-C3447-2015-supplement.zip

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 2, 7651, 2014.

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