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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Automated object-based classification of rain-induced landslides with VHR multispectral images in Madeira Island" *by* S. Heleno et al.

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Dear Reviewer,

We thank you for your helpfulp comments that we believe will improve our manuscript. Please find below our answers to your comments.

Sincerely, Sandra Heleno

[Q] The authors describe an object-based approach for detecting landslides and separating source from run-out areas based on a GeoEye-1 satellite image supported by a pre-event LiDAR DEM. They use a SVM classifier within the ENVI feature extrac-

tion module to perform segmentation and classification. The topic is very interesting. However, there are several issues that need to be clarified. A thorough revision is needed. General comments: Using the term "automated" for the presented approach is exaggerated. Semiautomated seems to be more realistic; also in the title. Please be consistent when using specific terms: Sometimes "semi-" is used, sometimes not. At one time the authors use "automated" and at another time they use "automatic".

[A] We agree with the criticism. We will use the term semi-automated consistently.

[Q] The Introduction section might be slightly improved/restructured to make it more readable. For example, why do the authors talk about change detection in one paragraph? Change detection is not done here and thus, not really relevant for this manuscript.

[A] Our reference to change detection techniques was an attempt to contextualize our motivation for developing classification procedures targeting post-event images solely. In other words, we intended to highlight the demands that CD techniques require during pre-processing, namely rigorous co-registration and radiometric correction, which showed especially difficult in our study area. We acknowledge that these reasons have not been made sufficiently clear in the text, and we will strive to improve it. In general, we will attempt to make similar improvements in the introduction.

[Q] The differentiation of source and run-out is a good idea, but I am not fully convinced about the way how this was done. A more detailed discussion is needed. It seems that the source areas (or what was treated as source areas) appear darker on the image. I am wondering why this is the case?

[A] The main reason for this darker appearance of the source areas is the fact that these correspond to freshly uncovered deep soil, contrasting with the disturbed and/or bended vegetation and superficial layers of soil in the run-out areas.

[Q] Was this spectral difference the primary driver for the differentiation? The process

should be described in a clearer and more structured way. Maybe I missed it, but which main features were the most relevant ones therefore?

[A] The set of (spectral, textural and geometric) features used to perform the source/non-source separation was the same employed in the landslide/non-landslide classification. However, we acknowledge that specific groups of features may have been more discriminant for one purpose or the other. From qualitative analysis of the feature maps produced for each of the (over 80) spectral, textural and geometric attributes, we observe that spectral measures were the primary discriminant between source and run-out areas, followed by geometric attributes (e.g. elongation), and texture. We acknowledge that a detailed discussion of these findings is useful and we intend to include it in an improved version of the text.

[Q] The authors also mention that they differentiate debris flows into source and run-out, which is questionable for me (for details see my comment below: ". . .run-out areas were mapped separately inside the disturbed region, both for the shallow translational type of slides and debris flows". Do you mean that also debris flows were separated into source and run-out? Shouldn't a debris flow rather correspond to run-out areas? Please explain and rephrase). But no information about that is given in the Methods or Results section. Neither debris flows are shown in the Figures. To address all yellow areas in Figure 7 as run-out is also questionable; at least this needs more discussion.

[A] Indeed we have separated debris flows into source and run-out areas. The simplest case in which we have done so is when the landslide is composed of a shallow translational slide that further develops into debris flows (as reported and illustrated for Madeira Island in Lira et al., 2013, fig. 2). But, even within the debris flow track, we have separated darker, fresher-looking areas that we interpreted as scoured areas acting as important sources of material. This is expected to occur in the steepest sectors of the drainage network (see for instance Schurch et al., 2011; Theule et al., 2014; Tiranti et al, 2015) which is the case of our study area. We acknowledge that this explanation is missing in the paper.

[Q] Furthermore, the authors also state that the source areas were divided into primary and secondary sources, but I do not fully understand how and why this was done.

[A] In fact this is not well explained in the text, and we will clarify it. Following the terminology above, primary areas correspond to shallow translational slides and secondary areas are scoured areas within debris flows tracks.

[Q] Specific comments: Page 5636, line 12: "Panchromatic" should be replaces with "multispectral" since you talk about Ikonos, QB, etc. and the "best" option for landslide mapping. Page 5636, line 12 and 13: it should be "QuickBird", GeoEye" and "WorldView". Please be consistent throughout the manuscript. Page 5636, line 17: No landslide events are mapped, only landslides are mapped. So, it should be changed to ". . . to map landslides on. . .". Page 5639, line 6 ff: What does "pixel-1" mean? Why not just writing "2m spatial resolution" instead of "2.0m pixel-1"? Page 5639, line 18: Change to "visual interpretation of orthophotos" (check in the whole manuscript). Page 6540, line 1 and 2: I don't understand the part: ". . .run-out areas were mapped separately inside the disturbed region, both for the shallow translational type of slides and debris flows". Do you mean that also debris flows were separated into source and run-out? Shouldn't a debris flow rather correspond to run-out areas? Please explain and rephrase. Page 5640, line 15 and 16: Was there a shift between panchromatic and multispectral images so that co-registration was necessary before pan-sharpening? Page 5642, line 2 and 3: Please mention how the comparison was done. I assume it was based on visual interpretation or did you apply any statistical calculations? Page 5647, line24 ff: Please go back to literature and check again. I believe there is the one or other paper where the differentiation of source and transportation area or landslides from debris flows/run-outs with OBIA is tackled at least to some degree. Technical corrections: English language needs to be carefully improved (including punctuation and minor errors). Please check the ordering of references when citing more than on reference in the text (alphabetically or by date, etc.). Figure 2: Why is the figure shown in greyscale? Figure 4: The caption should be revised. The segmentation parameters

are not shown, rather the resulting segments.

[A] We consider all the specific comments useful, and they will be taken in consideration in our revision.

Cited references:

P. Schürch, A. L. Densmore, N. J. Rosser, and B. W. McArdell, 2011. Dynamic controls on erosion and deposition on debris-flow fans. Geology, 39, 827-830.

J. Theule, F. Liébault, and D. Laigle, 2014. Spatial Variability of Channel Erosion by Debris-Flows (Field Observations in the French Alps). Engineering Geology for Society and Territory - Vol 3, 97-101, Springer.

D. Tiranti and C. Deangeli, 2015. Modeling of debris flow depositional patterns according to the catchment and sediment source area characteristics. Frontiers in Earth Science, 3, 1-14.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 3, 5633, 2015.