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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "HazMapper: A global open-source natural hazard mapping application in Google Earth Engine" *by* Corey M. Scheip and Karl W. Wegmann

Anonymous Referee #2

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The authors present a simple interface to Google Earth Engine that allows the user to map the impact of natural disasters using changes in vegetation seen in satellite images. Specifically, the relative difference in Normalized Difference Vegetation Index (rdNDVI) of Ambrose et al (2019) is calculated from Sentinel and Landsat images acquired before and after the natural disaster, and the resulting map of rdNDVI is displayed in such a way to highlight the vegetation changes. The interface then provides a tool to digitize these changes and export the resulting shape, along with the original images, to various formats. The impact of opaque atmospheric clouds is mitigated by the use of greenest pixel composites, which mosaic images over a given time period, selecting for each pixel the greenest values from the images in that period. The utility of

this approach is shown with 5 case studies, two of which are validated using published data. I have been able to follow the procedure outlined in the flow chart in figure 2 and confirm that the functionality works as presented.

The novelty in this paper is the combination of the pre existing methods of rdNDVI and greenest pixel compositing, along with the Google Earth Engine service, to map hazard related vegetation changes, as well as a simplified user interface to make this accessible to the public. The authors are to be commended for trying to span the gap between the world of cloud computing and big data, which allow very large satellite datasets to be processed rapidly in response to a crisis, and government agencies and the general public, who could gainfully interact with the data, but may not have the expertise to engage with it through the Google Earth Engine directly. The web interface is streamlined and easy to use, and the rdNDVI technique appears to work well in the case studies, although it would be nice to see more ground truthing, or at least some kind of verification for the examples where there is none. I believe HazMapper has the potential to be very useful in the future and the authors have succeeded in producing a useful tool.

My main criticisms are as follows:

(1) The change detection method presented is entirely based on vegetation changes. This is not mentioned in the title and abstract, so the scope of the paper is really quite a bit smaller than a cursory glance would imply.

(2) I'm not sure the website succeeds in making natural hazard impact assessment completely open to non-experts. It seems you still need to know something about green-pixel compositing and why there might still be 'holes' in the images that will then propagate into strange features in the rdNDVI images, as well as what rdNDVI is measuring and how vegetation regrowth might affect it. I don't think rdNDVI can simply be used as a naive index of change that non expert use of the system implies. I do think this can be remedied by adding a tutorial mode that walks you through the case

studies, pointing out what it all means and where the method fails. There are many JavaScript libraries that make this painless to implement, such as driver.js.

(3) Apart from Figure 1, the figures that present the results of using HazMapper in various settings seem to have been made in ArcMap using data exported from HazMapper – this gives a somewhat misleading presentation of what the website actually does. In particular, it does not seem to be possible to reproduce the style of presentation in figure 3, which looks like thresholded rdNDVI over greenest pixels in HazMapper. I think either this thresholding ability needs to be added to HazMapper (which shouldn't be hard) or the figures need to be changed to screenshots from HazMapper to reflect the actual user experience.

(4) Stylistically, the paper can be quite "wordy" with redundant words within sentences and the same concept being explained repeatedly in successive sentences and in successive sections of the paper. I feel the whole paper could do with being edited for brevity – I've highlighted some examples in the detailed comments below.

(5) The paper is quite "jumbled up". Advantages of Google Earth Engine are mixed in with the advantages of HazMapper, proven applications in the case studies are mixed in with proposals for future work, sentences extolling the virtues of HazMapper that read a bit like ad copy are present, some parts seem more like a research proposal. It's not always clear what's novel, what's been done before, and what is being proposed for the future. All of these components have their place in a paper (except the ad copy!), but they need to be separated out. I understand presenting a new tool like this departs from the traditional structure of a research paper, but I think the solution is to treat the case studies more like a results section, and have a traditional discussion section that assesses the results, and an extended conclusion section in which all the consideration for future work can be placed.

(6) It seems to me that only making HazMapper available to the reviewers during submission to an open review journal is a missed opportunity to get feedback from a wider

base of potential users. If the purpose of the paper is partly to advertise for potential users and contributors (as the current abstract implies), having it open at the review stage would seem like a good idea.

(7) The source code should have been made available to the reviewers. The text also does not explicitly mention what licence the code will be released under – this should be included.

(8) The web interface could also be improved with an rdNDVI color bar and distance / area measurement tools, if possible.

(9) The website can be quite slow, and it is not always immediately obvious that the little bars in the layers button show the loading time. Also. sometimes the little loading bars indicate loading is complete, and yet downloads are not available. If there is extra "loading time" required in the background after the images are displayed but before they are available for download, this should be indicated to the user in some way.

Detailed Comments:

Line 1: "rapid repeat-cycles" here the words "repeat" and "cycle" are effectively saying the same thing, and don't tell you what is being repeated. I would change to "rapid image acquisition cycles".

Line 7: "HazMapper is openly available to the public" repeats the claim of line 4. It only needs to be said once in the abstract.

Line 9: "It is the intent of the authors ..." this reads like an advertisement or community announcement more suitable for a conference or email list than the abstract of a research paper. I would remove it. And if the intent is to advertise for users during an open review, the software probably ought to be open at the time of review. Limiting access to the web page until after the review is complete seems like a missed opportunity. Plus the source code itself really should be available to the reviewers.

Line 14: "developed . . . undeveloped" this distinction doesn't seem to be pertinent to

the following discussion, I would remove.

Line 20: Again, not sure how this sentence is pertinent to the following discussion – this seems to be a point about a spatial scale below which natural disasters don't leave a lasting mark in vegetated landscapes resulting in incomplete historical records, but this point doesn't seem to be pursued? The following sentence seems to be saying that organizations are looking for evidence of these events, despite them leaving "no readily observable field evidence" in most instances, which doesn't make a lot of sense. I would rephrase this.

Line 23: "field work is inefficient" compared to what? Maybe change to "inefficient compared to remote sensing methods" or something like this.

Line 23: "provides a single time-stamp" - perhaps change to "snapshot in time", or some other wording – I think one can say data is timestamped, but I'm not sure it makes sense to say that a timestamp is provided, unless you are referring to a digital (or physical) text string that gives the time and date that is then attached to a bit of data?

Line 25: "The advent of rapid-repeat cycle satellite datasets .... has revolutionized" → maybe change to just "revolutionized", or cut entirely. "has revolutionized" implies a recent or ongoing revolution, but as you point out in the next sentence the "revolution" is now almost 50 years old, and monitoring environmental change with high res satellites is now a pretty orthodox thing to do. However, we are in the middle of a micro satellite resolution, with one provider (Planet) aiming to cover the entire globe everyday, currently at a much higher frequency than Landsat/sentinel with a much higher spatial resolution and NDVI capability. This is not mentioned in this paper, and it is obviously commercial in nature, but it should be noted that this is a rival platform with similar ambitions and capability, that is set to grow in the future.

Line 28: "subsequent satellite networks (e.g. MODIS, Sentinel ..." - MODIS isn't a satellite, maybe change to "subsequent sensors aboard different satellite constellations" or

suchlike

line 38: "scientific curious public" → "scientifically curious"?

Line 41: "HazMapper is useful for monitoring landscape change that results in disruption of surface vegetation" this seems an important point, as it is the entire basis of how HazMapper currently works, and should probably be in the abstract, and maybe the title. The authors point out their intent to add other approaches, both by their own efforts and through growing an online base of contributing developers, but that is for the future and not a research result being presented here.

Line 42: "While the underlying mathematics are not entirely novel ..." my understanding is that the mathematics presented here is not novel, and the novelty comes from the combination of technologies and how they are made available? I would delete this line, unless I've missed some novel mathematics somewhere, in which case it should be made explicit what exactly that is.

Line 43: "HazMapper democratizes ..." I'm wondering if democratizing is the appropriate word here – doesn't that imply some kind of collective decision making? I imagine HazMapper could be used in such a way by a group of people, but it doesn't seem to provide anything explicit to facilitate "democratic" decision making. It seems to me to be more about accessibility than anything else.

Line 50: "Because HazMapper is intended to be an emergency management tool ... it is designed around user input variables" aren't all user interfaces formulated around user-input variables? I would skip this sentence.

Line 51: "Variables include ..." → something like: "The user is able to control the following variables ... and cloud cover" - make an exhaustive list.

Line 53: "Basemap options include ... " → "The basemap options are"

Line 54: Missing "The" at start of sentence.

Line 58: Sentence starting “Optical aerial...” duplicates point in next sentence and can be removed.

Line 65: I assume the greenest pixel technique is something that comes built in to Google Earth engine? If so, is there a reference for it?

Line 74: Might be an idea to explicitly state what “pixel fractionation” is

Line 87: “Available basemaps on the platform include” repeating information from line 53? If so, delete.

Line 89: Is “Heads-up” digitization different from regular digitization?

Line 96: “For this article and shared finds ...” Not obvious what “shared finds” are – please rephrase.

Lines 106 -126: Section 3 is titled “Earth Engine vs. Traditional GIS Environments”. However in this section it’s not entirely clear if the virtues being extolled are those of HazMapper or Earth Engine. E.g. , lines 122-126 – both of these sentences apply to Google Earth Engine alone if one is proficient with Javascript and the GEE API? Would be good to rewrite this and make more explicit what the advantages of GEE are, and what HazMapper builds on top of that.

Lines 107-112: This is quite a long winded way of saying that the main aim of HazMapper is to make satellite image analysis available to less wealthy areas. Consider condensing into a sentence or two, rather than a paragraph. Plus it occurs to me that Google Earth Engine has already solved the problem of making modern scientific analysis available - it seems to me anyone with the computational resources to use HazMapper can use Google Earth Engine as well. Isn’t HazMapper really about expertise, you’re trying to make it available to those who aren’t going to learn JavaScript and the GEE API for whatever reason?

Line 117: “timestamp” → “take a snapshot of”? The method uses greenest pixel composites, which seem fundamentally diachronous in nature, whereas “timestamp” to me

implies an instant in time.

Line 121: “HazMapper’s source code” - > “The source code for HazMapper...” or “The HazMapper source code...”. Plus the source code should really be available in an online repository and linked to from the paper. Also, what license will it be made available available under?

Line 129: “. . . difficult to overstate ...” I would rephrase to be less effusive. Also, reference seems to be for radar, which has different concerns to optical sensors, which are the subject matter here?

Line 138: “HazMapper is intended to facilitate future research...” This seems to be repeating the sentiment from the end of the introduction – I would expand that section rather than repeating here. Unless maybe you mean to say this future research will be added to the case studies, in which case I would say that explicitly here.

Line 143: “$” → “USD” or whatever the appropriate currency code is (assuming US Dollar is the currency).

Line 146: “Significant research” significant in what sense? Needs explanation.

Line 152: “...analysis by trained professionals with access to high-powered computers and large storage capacity...” this point has been made before, I would remove this sentence.

Line 152: “Whether to provide ... ” This reads a bit more like advertising copy than scientific journal text, would consider rephrasing. Plus I think this has been said before in the paper, just in a general natural hazards context, rather than in a specific context (mass wasting). Maybe best to remove.

Line 178: “Acquisition schedules ...” This seems like a general statement about potential use of HazMapper, rather than something that was a part of this particular case study and should be in the discussion or conclusions section as part of a “potential use” section. It seems to me that the case studies function as a kind of results section in

this paper, and should be limited to those results, rather than speculation on un-proven, future usage.

Line 185: “Fatalities ... from the earthquake itself (Budimir et al., 2014” → “Fatalities from co seismic mass wasting can be up to an order of magnitude greater than fatalities resulting from the earthquake itself (Budimir et al., 2014”

Line 188: “. . . are not well understood for this event that occurred ...” →”are not well understood on account of this event occurring in a rural and remote . . ..”

Line 201: “HazMapper provides . . ..evaluation of empirical relationships between parameters such as moment magnitude ...” Seems to me this is about future work and so is out of the scope of the case studies presented here which function as a kind of results section of the paper. Again move to a “potential future work” section in the discussions or conclusions.

Paragraph starting 205: again mixing up future work and case studies. This part feels a bit like a research proposal.

Line 224: Again, referencing future potential – these aren’t really results of the case studies and should be moved to the discussion.

Line 243: Future potential again.

Line 290: “advancement” → “advance”, “met with obscurity” → “hindered”

Line 306: “democratize” see previous comments.

Line 312: “...suggesting the extents...” this seems to be the core of what the approach presented here does, and it needs to be highlighted more.

Line 314. “. . . rapid response ...” it seems to me the appropriate timescale for something to be considered a “rapid response“ for a natural hazard, at least as far as non-academics are going to be concerned, is the timescale on which people’s lives are lost as a result of the event and its aftermath, and two weeks is actually quite a long time

in this context?

Line 316: verification of maps produced by HazMapper could form part of a discussion section?

Line 355: “See letter to the editors” - is this appropriate to have under “code and data availability”, and will the letter be available to readers when the manuscript is finally published? Should any important information in the letter be moved into this section?

Equations 1 and 2 – do equations in this journal have captions like figures? If not, I would replace the captions with text in the main article, something like “where x is the variable for blah, y is the rate of blablah, and z is the magnitude of blahblahblah”.

Figure 1. “Heads up digitize” - again, is this different from regular digitization?

Figure 3. “All maps have same orientation” - unnecessary, delete – add N arrows to figs b,c,d if worried about ambiguity.

I was unable to reproduce the maps in this figure in HazMapper– it seems as if perhaps the rdNDVI is being thresholded somehow and overlain on the greenest pixel images in ArcMap? If this is the case, it is a bit misleading to be presenting this as an example of the successful use of HazMapper. Presumably it would be possible to add such a facility to HazMapper with relatively little effort, otherwise the figures should really be replaced with screenshots from HazMapper, (or at the very least it needs to be made more explicit that this is a more “advanced” analysis performed for validation purposes only, and that the facility will not be available to non-expert users within the HazMapper interface itself).

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