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Interactive comment on "Topography- and nightlight-based national flood risk assessment in Canada" *by* Amin Elshorbagy et al.

Anonymous Referee #1

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This article provides a series of spatially distributed products for Canada that include a flood hazard map, a flood exposure map and a flood risk map. The indices for each are essentially derived from topography and an indication of population through satellite maps of night lights. The product is assessed by comparison to a 100 year flood plain map of a small region of southern Alberta and to a region around the City of Winnipeg, Manitoba in an effort to relate the product to flood protection infrastructure. The document is well written with few typographical errors so it is easy to follow. There are some good qualities to this paper but I feel there are a few issues that warrant further discussion; in particular the lack of detail in various sections, the lack of discussion and the lack of rigorous validation. Thus, my discussion is more philosophical and about the approach used. My comments are not in any particular order but all speak to these issues to some degree.

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1. The authors have used what they consider to be a static entity like topography through two quantities “elevation above nearest drainage” and “distance from nearest drainage” to create a flood hazard level for each grid cell. The floods in the Bow and Elbow Rivers in Calgary, Alberta in 2007 for example, (one of the locations the authors use to verify one of the maps) significantly affected drainage to the point that it changed the rivers’ locations, meander and moved a significant amount of sediment. While this would not likely affect a product that is based on a resolution of over 300 metres (at best) because these rivers may not change bank locations by more than 100 metres in one flood, it does beg the question of how often should this product be updated, maintained, etc. Products like this should be given technical support but there is no suggestion of technical support. This is fine because I don’t think the development of a product is something that is suitable for publication in HESS and perhaps the authors are more interested in providing an approach leading to a potential product. Well in that case, a much more rigorous evaluation of that approach is required and that is lacking here. What is currently presented is really nothing more than a simple GIS exercise, which I might suggest is not suitable for HESS and thus, the work needs greater discussion, validation and verification if the ultimate objective is indeed to suggest an approach.

2. Page 7 lines 12-19 – The authors need to state in greater detail what they are doing with the comparison around the City of Calgary. Is this a validation or verification? It seems like none of these, than what is this comparison for? If you want to make a comparison, it should be quantitative, instead it is entirely qualitative.

3. Page 8 – The Canada DEM resolution is reported as 326 metres. This is the spatial resolution – what is the elevation resolution and accuracy – 1 metre? 50 cm? What are the implications of this error on flood risk or hazard? The authors combine two topographic indices to create a skewed topographic index and call this flood hazard. I don’t necessarily agree that this is flood hazard – what it definitely is, is a new topographic index related to position from a “drainage point”. If the authors want to suggest

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a surrogate for flood hazard that is easy to create, then they would have to verify that surrogate but that has not been conducted here. At this point, the authors should be true to what they have presented and not label that products as flood hazard but simply the product of two topographically related indices.

4. Page 9 – the authors state “horizontal distance” from nearest drainage network. What is this exactly? Are the authors referring to a buffer like distance? If so, why not just create a buffer? A “horizontal distance” makes no sense in a GIS context, the authors must be careful with their terminology and provide greater detail. For example, in the definition of EAND, the authors intention I suspect is the nearest drainage cell, or point on the drainage network defined by the ArcGIS. But if a point is equally distant from two drainage points, how is the choice made? Details like this should be noted as well as metadata information, errors in the data, etc.

5. Page 9 – line 2 – the authors state that they developed a drainage network as the river network from the ARCGIS tools. Even with a filled DEM, etc, as the authors report, it is well known that a river network derived from a topographic map can often deviate from the actual river network because of errors in the DEM. Given the scale of the DEM used and the size of many of the rivers in Canada, it is possible for drainage points on the DEM derived drainage network not to coincide with actual river locations. Surely this is a problem so why wouldn’t the authors use the actual river network for Canada or at least correct their product for actual rivers?

6. One of the reasons why the authors went with such a resolution was because they felt that it made the problem tractable but with “reasonable” detail. But because of the large expanse of this country with little population, there are large areas of the maps with no interest because there are no urban areas. Page 12 refers to Table 2, which shows that the percentage of Canada covered with land use 4 and 5 is less than 6%. The nightlights confirm the enormous area with little population and therefore, with little interest in products like this. It makes me wonder why the authors would create a product that covers all of Canada. Why not create a higher resolution produce that

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just focuses on urban areas and simply cut out all the rest? The authors state how problematic political borders are to watershed management. Well then why not create products in only the most hazardous areas? Why not eliminate all the region that is of no interest and not display them? Instead we get maps of the entire extent which has a lot of information that does not have to be displayed or provided. Because the authors rely on visual representation of their work, these visual representations are all that can be critiqued.

7. In Table 3, the percentage of areas covered by high and very high luminosity is tiny in comparison to the rest of the country. The nightlight DN value between 0 and 63 with resolution of one is now descritized into five classes each separated with the same value – one. The authors lump DN values from 11 to 63 for medium to very high luminosity in three out of five classes. Why not instead descretize those regions of interest (medium to very high) into five classes because ultimately you create a skewed product (when you multiply this five level classification with another five level classification scheme) that ignores the detailed information (nightlight, population, land use) and distribution that resides within the two most important classes. In doing this, the authors relegate two whole classes out of five for the bulk of the country that is of no interest. It would make more sense for the authors to focus in on the regions of interest and have five maybe 10 levels of classification within areas of interest. Why did the authors choose five levels of classification and not two, or four or 10?

8. The risk product combines a 326 metre resolution DEM with a 30 arc second DEM. At the Canadian-US border this resolution is probably around 600 metres. So what merging algorithm did the authors use when combining two grids of differing resolutions? What is the ultimate resolution of their product?

9. Page 13 lines 14 - 15, the authors state that “airports and industrial and commercial areas are highly luminous but the census data show low or no population”. Floods create numerous environmental hazards that are equally as lethal as is the potential for floods to drown people. If that is what the flood exposure map is about – human harm,

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then I would argue, it is incorrect to negate the potential human health risk associated with flood waters having moved through an industrial site simply because no one is living there at night. Flood waters in urban areas are more polluted than sewage and carry harmful hazardous waste that can be extremely harmful if people are exposed. The authors ignore this and simply acknowledge residential areas. This is the general problem I have with this approach.

10. There are too many figures and few that are actually useful. Figure 1 really is not very useful. If you really want to use up valuable journal paper space then why not superimpose (a) and (b)? I would just remove (a).

11. I would appreciate better attention to semantics. For example, on line 13 page 6. How is sufficient defined here by Apel or the authors?

12. Page 14 refers to Figure 2. Again (a) and (b) are both not necessary – just have (b). Figure 3's caption should be revised to read "resulting from EAND X DFND" because this is not a flood hazard map but a map of that index. The topographic index defined by the authors contributes to one kind of flooding but there are others that are equally as hazardous that are not well represented. British Columbia suffers from severe flash flooding that moves enormous amounts of debris yet there seem to be few hazards associated with this type of flooding that is mostly in mountanous regimes showing up in the map because of the way the authors have chosen their index. Can the authors comment on the universality of their choice in Canada? The authors clearly state early in their paper that extreme flooding in Canada is the result of many factors like ice jams, etc. This is very true and thus, the index defined by the authors cannot in fact be toted as a flood hazard by virtue of the fact that what leads to sudden high streamflow – the really danger - is not simply a flat area close to a stream bank. But if that's what the authors want to create, that's okay but then it requires a good discussion of why the approach is novel for defining a flood plain and what the benefits are (like computational ease), then they need to report the computational cost of creating these maps and report a quantitative comparison with things like the 1/100 year flood plain

map in Calgary. Figure 5 refereed to on page 15 shows areas of overlap between the product and the flood plain map. This is again qualitative. A more quantitative comparison is required with even something simply like number of grid cells overlapped versus not overlapped to start with.

13. This brings me to my next point. Large municipal urban centres already have information on high flood risk regions. What information does this product bring them that they don't already have at a better resolution? Risk of fire is largely a problem when it starts encroaching on an urban area and not generally at the same time as a flood risk so how can this low resolution product be helpful to Calgary?

14. The discussion is lacking in many regards in this paper particularly where figures are produced. Page 16 for example refers to figure 6 but honestly, there is nothing really discussed or noted of significance here. Figure 7 is too coarse a resolution to be useful. Figure 8 is an "enlarged" version of an area for better visual interpretation but if they don't provide the exact area in space (not just with hatchmarks but perhaps with an areal photo showing the flood plain in the area) it is not a useful figure. This figure also has little discussion.

15. The authors don't provide a rigorous enough evaluation of their product at this stage. In Figure 10, the authors refer to reduced levels of social risk for commercial regions. Again I disagree with this but perhaps this is due to a lack of rigerous definitions on the part of the authors as to what is "social" – human residential impairment? The authors should revise all their captions to state what is truly shown. Also, there were numerous areal photos of flooded regions within Calgary during the 2013 floods. Why not use this valuable information to compare to their product? That would be a much better evaluation and would demonstrate the deficiencies and limitations of the product in an actual flood that was not 1 in 100 but with an extent that was outside the 1/100 year flood plain.

16. Page 17: line 17, the authors refer to the "average" effect. Why would they be

integrated in the first place? Why is “average” in quotes? My point is that this work is really a GIS exercise and the GIS community understands the issues and limitations with combining data of different resolutions, etc., yet I’m concerned with the lack of attention to terminology or basic GIS concepts used in the discussion. A more formal language is preferred along with greater detail on what was actually created and how.

17. I really do think products like these are good ideas but it’s not just what is novel that must be shown but how it is useful and why it is needed. Unfortunately, I do not feel that the reader is given a full understanding of how this approach or product is useful. There is some attempt but more depth is needed. For example, on page 18, line 15, the authors state: “In other regions, and depending on the topography, the 100 year flood might cover two or three of the flood hazard classes.” I don’t mean to sound curt but so what? How is this useful to a planner that is required by most by-laws to deal with the 100 year flood or design with the 5, 10 or 30 year flood in Canada?

Typographical errors: Line 13, Page 6 – insert “data” after “remotely sensed” Page 8 – insert “an” or “the” before “eight” Page 11 – line 9 replace “from” with “for” Page 32: Spelling eerror in the caption of Figure 8 (should be severe not sever)

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