Hydrol. Earth Syst. Sci. Discuss.,
doi:10.5194/hess-2016-524-AC2, 2016

Hydrology and Earth System Sciences
Open Access
Discussions

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

Amin Elshorbagy et al.

amin.elshorbagy@usask.ca

Received and published: 1 December 2016

The authors would like to thank the anonymous referee for providing a review. We are providing here below our detailed response to each remark. Some of our remarks are copied from our response to the first referee wherever the referee's comment is similar to one made by the first referee

1. I miss a clear statement of the research problem and what is novel with the purposed study. The structure of section one and two could be improved by avoiding jumping back and forth between topics.

R1. The paragraph on Page 2, Lines 15-23 and Page 4, Lines 7-12 state clearly the problem and the aim of our work. We would like to emphasize that our approach here proposes for the first time the integration of detailed topographic information, in the

form of distance and elevation from streams, with hydrologic and human settlements information to assess flood risk. We cannot see eye to eye with the referee the issue of jumping between topics, however, we will review this carefully with the aim to sort out this issue in the revised manuscript.

2. [Page 8-9] To create the EAND and DFND classes, a drainage network was created using ArcGIS hydrology tool on a coarse resolution DEM. This can produce many errors - why not use an already existing drainage network, or at least verify against one?

R2. In the revised manuscript, we will present everything using the finest scale-resolution DEM available for Canada (20 m). Even the river network made available through Environment and Climate Change Canada (ECCC) is generated using DEMs of a coarser resolution. We used Google Earth to compare the river network we generated against actual rivers, and the comparison, which validates the use of the 20m DEM, will be presented in our Response letter.

3. [Page 9, Lines 12-13] The classification process for the different maps produced is not clear. For example, the hazard class intervals were selected somewhat arbitrarily. I would like to see more thought behind this, e.g., do they represent floodplains, and why five classes?

R3. The five hazard classes selected can represent different hazard levels across the country as the topography is different across the country. However, as we explained on Page 18, this can be adapted locally to different types of representation; e.g. flood frequency. As the reviewer pointed out, the intervals for DFND and EAND were decided taking into consideration that flooding extent in floodplains would be much larger than in hilly areas. In hilly areas, EAND governs the hazard mapping, thus reducing the extent of hazard. For the study over the entire country, the 5 classes considered were deemed adequate.

4. [Page 12, Lines 6-8] The exposure map based on nightlight data indicate that 98%

of Canada's area has absent or low human activity. This leads to the following question –is a national flood risk assessment useful?

R4. Yes, very useful. Majority of population are in southern areas, however, hundreds of thousands of Canadians are spread across the Canadian landscape. Some of the northern population groups can be even more socially vulnerable than others, and floods in their regions are critical. In addition, major infrastructures, including roads which are important element for mobilizing rescue efforts are spread across what seems to be areas with low nightlight luminosity. This work aims to highlight these issues. Because of the large area of Canada (almost equivalent to the area of Europe), visually, it looks like most of the country is dark at night, but zooming in can reveal more details. The availability of our product in a digital form with 20 m resolution allows for investigating issues at finer scales.

5. [Page 12, Table 2 and 3; Page 31, Figure 7; Page 32, Figure 8] The land-use classes and the nightlight classification used for the exposure map give northern communities very low or low exposure level by default, resulting in very low or low flood exposure, and very low flood risk in areas above 60o N. Is this national flood risk map useful for residents above 60o N? I am missing a discussion around how the classification process affects the end product.

R5. The first part of the question was addressed by our response to the previous comment. The classification process and selection of number of classes are usually arbitrary and subject to the judgement of the analysts. However, it is more convenient to fix the number of classes of the various maps. Increasing the number of classes would not be of much help as decision makers would eventually prefer to lump a few intermediate classes for easier interpretation. Five land-use classes are sufficient as one can even associate an average dollar value to each class.

6. [Page 14-15, Lines 14-21, 1-5] A coarser DEM is chosen for the study to keep computational costs low, but results show that a finer resolution DEM (20 m in this case)

gives better results and a more reliable flood hazard assessment. Floods are usually analyzed and managed at the provincial level in Canada where local information is important, why is a national flood risk assessment needed?

R6. The idea is a way to address flood risk at large scale, and we addressed the importance of this earlier. Even at the provincial level where one province in Canada (e.g., Quebec is more than twice the area of France) is too large for detailed flood mapping based on hydraulic modeling. Our approach is useful even at the provincial level, especially in light of the fact that we are reproducing the maps using 20 m resolution.

7. [Page 15, Lines 16-20] It is suggested that hazard levels can be reclassified locally to match floods with different return periods in areas where flood inundation using hydraulic modeling is available. But, how useful are local topography-based flood hazard maps where flood inundation maps based on hydraulic modeling already exist? Also, topography-based flood hazard maps does not account for backwater and other hydraulic effects on areas upstream of flood protection. One related question is also how useful flood hazard maps with different return periods are if many floods are caused by ice-jams [Page 7, Lines 7-8; Page 18, Lines 11-14]?

R7. We meant that areas where hydraulic modeling was done can be used as key locations to identify the water stage that corresponds to certain flood frequencies, which can be also simply approximated using rating curves). When flood stages of different flood frequencies are estimated, they can replace our hazard classes. The issue of backwater curve not captured by our approach is certainly acknowledged in our manuscript (Page 16, lines 8-11). Ice jams do cause floods. However, this is not a universal phenomenon. At locations where information on ice-jams are available, floods can still be translated to flooding depths and the same map can be used to determine the associated hazard upstream of it, independent of return-periods.

8. [Page 16-17, Lines 23-24, 1-3] The authors bring up the issue with overglow effect when analyzing nightlight data. Have potential overglow effects been analyzed for the

2013 nightlight data used in this study, e.g., in comparison with previous years?

R8. Overglow effect is inherent with nightlight images for all years. We did not carry out any comparison study on overglow variations in nightlight images as the decision was to use the latest nightlight imagery for the study. The classification of DN into different classes alleviates the overflow effect to some extent.

9. [Page 17, Lines 10-19] There is a discussion that population data should be used together with nightlight data to separate social and economic impact, as airports and industrial areas show high luminous values but low population density. I will argue that although these built-up areas have low population density, they have high social impact, e.g., airports.

R9. We agree with the reviewer. The purpose here was to show that using only census data might not be enough to determine social impacts as zero population according to census do not mean no human presence. There is still capital investment and human lives are disturbed at different levels when homes, workplace, or transportation are impacted. A statement about this in the revised manuscript will be provided to address the issue.

10. [Page 19, Lines 12-16] There are many uncertainty aspects with the classes identified and some of the methods used – is the final product really useful and practical [Page 20, Lines 6-7] - also when considering the shortcomings the authors have presented?

R10. The classes identified and methods used do have a degree of uncertainty with them and we have identified and provided discussion on them in the manuscript. The final product is still useful and practical as it is easy to obtain these maps for any part of the country. The shortcomings do not affect the methodology as much as it affects the end product. With the provided approach, the product can always be subject to improvements when finer/accurate data become available.

11. The article has 10 figures, are all of them needed? For example, Figure 1 – a and b should be combined if to be included at all. Also, is both a and b in Figure 2 needed, they show the same information. Figure 5 – exclude enlarged figures, and visually improve the main figure.

R11. Yes, we agree regarding combining Figure 1 a and b in one piece. Figure 2 is important to show, at least visually, the effect of classification of nightlights. As for Figure 5, we will consider this, especially after presenting the validation of the hazard mapping quantitatively.

12. Minor issues: [Page 1, Line 13] The authors state that the study uses datasets at reasonably fine resolutions to create flood risk maps – what is considered reasonable?

R12. This statement will be irrelevant after re-doing the analysis using 20 m resolution.

13. [Page 9, Line 4] What do you mean by horizontal distance?

R13. We are referring to a buffer like distance while describing DFND. However, in GIS, the term “buffer” is usually applied to concentric distances to a feature (line, point or polygon) in vector format. For the present study, the stream network was retained in raster format to maintain consistency in all subsequent calculations. Horizontal distance refers to the Euclidean distance between the drainage cells and adjoining cells that are estimated using the “Euclidean distance” tool in ArcGIS, followed by reclassification using the limits mentioned in Table 1. Hence, the word “buffer” was avoided and “horizontal distance” was used instead.

14. [Page 9, Line7] EAND instead of EFND

R14. Thanks, we will correct it.

15. [Page 11, Lines 19-22] It is stated that the average values of all nightlight satellites were used in this study, but there is only one available for 2013.

R15. As the reviewer pointed out, data for 2013 is only from a single satellite. It will be mentioned in the revised manuscript. The availability of data from more than one satellite is true for some years for which data are available and we were referring to that. The sentences will be rephrased to mention this in the revised manuscript.

16. [Page 17, Line 17] What is the “average” effect?

R16. Simply what we meant is that integrating two aspects in one can mask the individual effects.

17. [Page 21, Line 31] De Moel should be de Moel.

R17. It will be corrected in the revised manuscript.

18. [Page 23, Line 25] The reference Schanze is not found in the text.

R18. It will be removed from the reference list in the revised manuscript.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., doi:10.5194/hess-2016-524, 2016.