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Hydrology and Earth System Sciences Discussions

Interactive comment on "Use of ENVISAT ASAR Global Monitoring Mode to complement optical data in the mapping of rapid broad-scale flooding in Pakistan" *by* D. O'Grady et al.

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General comments

The manuscript of O'Grady et al. deals with the 2010 large-scale flooding in Pakistan. The event was covered by a large sample of ENVISAT ASAR GM images. The authors apply a customized region growing technique from the GRASS GIS package on all images in order to extract time series of flooded areas. For some days they compare the SAR-based flood inundation maps with those obtained from simultaneously acquired AQUA/TERRA MODIS imagery. One of the most interesting results here is that the

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change detection technique apparently allows eliminating from the flood maps those regions that exhibit a permanent flood-like radar response (especially from alluvial dry sand deposits). This result indicates that over-detection of flooded areas could be significantly reduced by considering pre-flood baseline backscatter values (in addition to the data acquired during the flood). Another interesting aspect covered by this study relates to the analysis of sampling rates of GM imagery and their variability in time and space.

I enjoyed reading the paper submitted by O'Grady at al. The paper is well written, the study is nicely introduced and the results of the study are presented in a clear, comprehensive way. The problem I have with this paper is that in its current form the scientific merit remains rather obscure. It is not clear to what extent the paper's primary focus is a case study of the extraordinary flooding in Pakistan or the presentation of a new flood extraction algorithm. While the presentation of the Pakistan case study is well done and certainly worth being published given the magnitude of the event that is certainly of interest for a broad community, I am far less convinced by the development and testing of the new flood mapping technique. The authors state to have developed a new ASAR GM mapping technique (p.5784 l. 19). However, the method is only presented rather shortly (p.5777 l.10-19) and is largely based on an existing algorithm implemented in the GRASS GIS package. Also there is no comparison with other state-of-the-art methods (see, e.g., a recent paper from our group introducing a similar method based on thresholding,region growing and change detection; Matgen et al., 2011). Therefore it is difficult for the readership to evaluate the advantages and limitations of this method with respect to other methods.

I have the feeling that the main interest for the community could be the study of the added value of pre-flood baseline backscatter values for flood detection. For this, it would be interesting to carry out the same flood extraction method, but to replace the change detection images with the calibrated flood images in the region growing process. Is there any significant gain in performance to be obtained by using the reference

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image? Or would you get similar or better results with the “flood” image?

In my opinion, another debatable point is the definition of the 2 dB tolerance criterion of the region growing. It is not clear from the manuscript how this parameter was fixed and how it influences the results of the case study. Is it obtained through an optimization with respect to the MODIS flood extent? The choice of this parameter, which arguably has a very significant impact on the results of this study, needs to be better justified. Ideally a sensitivity analysis should be added to the paper.

So I think that there is some good work here. However, I suggest a moderate revision before it is acceptable for publication.

Specific comments

Introduction: While I like the introduction to this study, I think that more attention should be given to high resolution SAR imagery. In fact, I believe that the combination of coarse resolution and high resolution SARs provides significant advantages (arguably even more so than the combination of coarse resolution microwave and optical imagery), but this is hardly mentioned here. Also I feel that many relevant papers on SAR-based flood mapping are missing (see, e.g., Schumann et al., 2009 for an extensive review of existing techniques, and Horritt et al., 1999, Mason et al., 2007, 2010; Martinis et al., 2009; Matgen et al., 2011 for some existing techniques that come to my mind)

p.5770, l. 24: it would be better to give the value of specific discharge (this value does not say much if the catchment size is not provided)

p.5771, l.24: it is not only the operation mode that helps increasing the repeat coverage. You could also mention multi-satellite constellations such as COSMO SkyMed or the combination of SAR data from different missions.

p.5773 l.14 Please explain why you created this buffer.

p. 5776 l.14 How did you make sure that it was a “dry” image? Does this choice have

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a significant impact on the results or would any image acquired from the same orbital track provide similar results?

p. 5776 l.17 Table 2 is mentioned before Table 1

p. 5777 23 Please add the Kappa statistics equation somewhere

p. 5777 l.10 Is it really necessary that the flood pixels are adjacent to the main river channel? During the receding limb of the hydrograph I assume that there could be a disconnection. Also there could be some flooding because of the outcropping of the groundwater table and/or the accumulation of rainfall in depressions. I think that these potential limitations of the method should be indicated somewhere.

p. 5778 l.23 please briefly introduce the MODIS-based flood classification of Brakenridge (2011)

p.5779 l.24 you refer to Fig. 8 before referring to Fig. 7

p. 5780 If I understood correctly all permanent and semi-permanent water bodies are removed from the SAR-based flood extent, while the MODIS data set includes all water bodies. Does this not impact the results of the analysis? Is there no way to exclude these areas from the analysis to make it more coherent?

p.5782 l.6 I would replace “rate of advance of the flooding” by “propagation speed of flood waves”

p.5782 l.27 delete 1x “to”

p.5783 l.10-23

Section 5.1 appears a bit disconnected from the rest of the paper. The paragraph over-simplifies the issue of integrating remote sensing data with hydrologic-hydraulic modelling tools. I can’t see any added value of this paragraph unless the issue is addressed in a much more exhaustive way Moreover, there seems to be some confusion between hydrological models and hydraulic models (the latter being used for simulating

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the propagation of flood waves and flood extent).

p.5786 l.2 If I remember correctly the planned launching date of SWOT is much later (please check)

p.5786 To be more exhaustive it would be necessary to also mention the upcoming ESA Sentinel-1 mission here.

Conclusion: The problem of mixed responses from flooded vegetation and open water could also be partly addressed with higher resolution SAR data.

Cross-polarized data as well as global DEM data might be used as well to at least partially address the problem of under-detection related to the Bragg resonance.

As mentioned earlier, I would suggest adding a comment on the possibility of combining GM modes with higher resolution products in areas affected by flooding.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 5769, 2011.