Natural Hazards and Earth System Sciences Discussions

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Comment on nhess-2022-63

Anonymous Referee #1

Referee comment on "Effectiveness of Sentinel-1 and Sentinel-2 for flood detection assessment in Europe" by Angelica Tarpanelli et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2022-63-RC1, 2022

The authors attempt to assess which percentage of flood events can theoretically be observed by the satellites Sentinel-1 and -2. They do so by a rather coarse synthetic study, with several optimistic assumptions, but I very much appreciate the research question and the clarity with which the authors approach the topic. The paper is very well written, key messages are listed in the conclusions, figures are good quality. The authors discuss most of their assumptions, there are just a few points on which I request further clarification:

- A lot of SAR data is unfortunately commercial, Sentinel-1 being a notable exception
- It is absolutely fine as a "working framework" to assume that it is always possible to map inundated areas from satellite images, however to state that this assumption is "quite confirmed by several examples in literature" is misleading. There are still big issues with satellite-based flood mapping! A general discussion on the limitations can for example be found in Schumann 2021: https://doi.org/10.1016/B978-0-12-819412-6.00014-6 and a more specific evaluation on a well-documented flood, mapped by the Copernicus EMS and other scientific products with a good ground-truth reference, revealed that rapid mapping products can be of very poor quality (Table 3): https://doi.org/10.3390/rs13112042 This is not only a problem of the classification algorithms, but indeed also of the image quality / observability. In sensor design there is a trade-off between image quality and coverage, so when investigating the potential coverage of specific satellites, we have to deal with the true quality of the sensor. Another key difference between optical and SAR data is the viewing geometry. Operational SAR sensors are side-looking, which causes additional issues in urban areas, radar shadows, layover effects etc. Therefore it is in theory able to detect water below vegetation, however that depends on wavelength and is usually not part of operational flood detection algorithms. Ignoring flooded vegetation can obscure the true land-water boundary, and most impacts occur in urban areas. Products like EMSR detect almost exclusively open water, and even that is not always convincing! There should be a paragraph in the paper on these limitations, to avoid the impression that the 58% potentially observable flood events by Sentinel-1 actually translate to 58% of flood events being mapped in sufficient quality, I assume it is only a small fraction of that.

- The authors made an assumption on cloud coverage based on a dataset by Wilson and Jetz 2016. They do not take into account that flood events are typically triggered by rain, which requires clouds, and therefore should expect a correlation between the presence of clouds and a flood event. The assumption of the authors is therefore optimistic, which is ok as long as it is clearly stated. I would find it interesting to actually check how often and how long floods are accompanied by clouds, depending on the geolocation/climate, but I understand that this was not aim of the study to do so. My feeling is that there could be quite significant spatial differences on the percentage of floods that optical sensors may detect (while for SAR it should be the same percentage in all places). Detectability on SAR images probably depends more on topography or built-up density. As the two percentages are your primary results, please briefly discuss this point and whether you think it is useful/possible to put a number on that spatial variability.
- Another debatable assumption (which the authors do mention) is the definition of a flood event by placing a percentile threshold on a 10-year discharge (!) observation time series. Whether a flood occurs or not is of course dependent on the protective measures, which drastically vary in their design level, up to > 1/10000 years in the Netherlands https://www.deltares.nl/app/uploads/2014/12/kind2014_JFRM1.pdf In rural areas, if there is nothing except agricultural crops to protect, actual flood defense might be much lower, but this will probably not be at the location of the measurement station? There are footprints of real flood events, e.g. from the Dartmouth flood observatory that could potentially be used for such a purpose. See Figure 6 in Lüdtke et al. 2019: https://doi.org/10.1029/2019WR026213 I am not entirely sure why the authors have not used validated flood locations, but I do find the synthetic approach also very interesting. Maybe you can make this more clear?

I am happy to recommend the article for publication, if the abovementioned discussion points are addressed.