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Reply on RC1

Antonio Francipane et al.

Author comment on "A paradigm of extreme rainfall pluvial floods in complex urban areas: the flood event of 15 July 2020 in Palermo (Italy)" by Antonio Francipane et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2021-61-AC1, 2021

Responses to Referee #1

Referee: The authors apply a hydrological and hydraulic model for calibration and validation of an extreme pluvial event that occurred in Palermo last year. I consider the research valuable and useful in the practice of urban flood risk management. Therefore, to my view, the paper could be acceptable for publication in NHESS if some modifications are made.

I recommend further strengthening the introduction and discussion sections and correct minor grammar issues to improve the manuscript.

Authors: We thank the Referee for the efforts in doing a so in-depth analysis of this work, which has surely improved the quality of our manuscript, and the positive feedback. Please find below our responses to the comments.

Referee: 1- Although the authors provide clear evidence of previous flooding events in the area, the manuscript does not mention the existence of local flood mapping products. Some clues for the reader to lead them to a better understanding of the background on flood risks mapping and/or metrics in the study area would be useful.

Response: We understand the Referee's point and thank him/her for pointing this out. Actually, there is a Hydrogeological Setting Plan (*Piano stralcio per l'Assetto Idrogeologico* - PAI) for Sicily, which reports the maps for the hydraulic and geomorphological hazard and risk for the Sicilian territory. In the case of the Uditore - Passo di Rigano district, the PAI shows a hydraulic hazard only for the upper part of the domain of study. Despite this part of the domain has been affected by the event of 15 July 2020, it is undoubtedly the least interesting area in terms of pluvial flood effects and does not add any important information to the study. Moreover, the approach used for the determination of the PAI hydraulic hazard map was very simple and just based on the position of the morphological depressions within the study area without modelling any flooding dynamics. These are mainly the couple of reasons why we did not add this information in the manuscript. However, following the Referee's suggestion, in the new version of the manuscript, we have added a new paragraph to the section of Case of Study to explain what above said. The Referee can read the new part in the following:

Despite this area is often interested by flooding events, the Hydrogeological Setting Plan (Piano stralcio per l'Assetto Idrogeologico - PAI) for Sicily, which is a regional plan that reports the maps for the hydraulic and geomorphological hazard and risk for the Sicilian territory, shows the presence of a hydraulic hazard only for two little areas in the upper and central parts of the domain of study, which were scarcely affected by the flood here studied. In this case, the hazard map of the study, which dates to the early 2000s, was made by using a very simplistic approach just based on the position of the morphological depressions and without modelling any flooding dynamics in the study area.

For the Referee's convenience and information, we have reported in the section *Supplementary Material* of the attached file entitled *Replies to specific comments* the map of the PAI (Figure R1), where the P1, P2, and P3 indicate increasing values of hydraulic hazard, respectively, while the red line shows the domain of study.

In addition, following the indication of the Referee, in which he/she suggests strengthening the Introduction, and some indications by the Referee #2 as well, in the new version of the manuscript we have modified the Introduction by making some references to the use of the crowdsourcing data in hydraulic modelling of pluvial floods and stressing better the aims of our work.

Referee: 2- The discussion section is very long and should be greatly shortened. The introduction could also be shortened and should justify why it is important to use crowdsourcing data in pluvial flood risk studies. See Annis et al. 2019 and See 2019.
Annis, Antonio & Nardi, Fernando. (2019). Integrating VGI and 2D hydraulic models into a data assimilation framework for real time flood forecasting and mapping. Geo-spatial Information Science. 22. 1-14. 10.1080/10095020.2019.1626135.
See, Linda (2019). A review of citizen science and crowdsourcing in applications of pluvial flooding. URL=https://www.frontiersin.org/article/10.3389/feart.2019.00044.

Response: Despite we believe that a detailed discussion is essential to clearly communicate to the reader the main future solutions/interventions to face the effects of pluvial floods, especially in a paper in which we propose to give to the people a "paradigm" to face similar future events, we understand the Referee's concerns. For this reason, in the new version of the manuscript, we have shortened the old Discussion joining it to the Results section thus making a unique section entitled Results and Discussion.
About the opportunity to add some justifications on the importance of the crowdsourcing data in pluvial flood risk studies, we totally agree with the Referee. For this reason, in the new version of the manuscript, we have added a new paragraph in the Introduction, as already stated in our previous response, about the use of crowdsourcing data in pluvial flood risk studies. The Referee can read the new part in the following:

Modelling such a type of floods is never easy, especially when these affect very complex urban areas. Bulti and Abebe (2020) provided a review of the main flood modelling methods adopted for the study of pluvial floods highlighting the benefits and drawbacks of each approach. Some approaches, such as the rapid flood spreading (Lhomme et al, 2009; Wallingford, 2006), are easy to apply but return only the final state of inundation. Other approaches, such as the 1D, are recommended for studies that do not require high precision in describing the surface runoff routing, while still others, such as the 2D approach, seem to be more suitable for applications in urban areas where there is no stormwater drainage or the influence of stormwater drainage is considered insignificant on the flood phenomenon under the study. Coupled models (i.e., 1D-2D) can provide accurate information but being computationally expensive both in terms of run-time and data requirements. In all cases, however, reliable modelling of the phenomenon always

requires many kinds of information and level of accuracy, which are not always available or easy to obtain.
In this perspective, one of the main issues to deal with is the lack of observed data to be used as a reference for the calibration and validation of models (See, 2019). Indeed, differently than the case of fluvial (or river) floods in gauged systems, where the monitoring of the rivers makes available measures (i.e., water level, discharge, etc.) in different points of the domain, in urban areas there are no gauged sites that provide water level observations. Nowadays, one of the possibilities to deal with such a problem is represented by remote sensing data, which can provide the opportunity to overview flooded areas quickly and precisely (Di Baldassarre et al., 2009; Bates, 2012; Grimaldi et al., 2016). However, remote sensing data may not be always adequate to describe the evolution and the effects of a pluvial flood either because they are often not timely available for the satellite orbit revisit time (Annis and Nardi, 2019), especially when floods have rapid temporal evolution and limited flood area extent (Notti et al., 2018), or because the substantial areas of urban ground surface may not be visible due to the shadow caused by buildings (Dengsheng et al., 2010; Mason et al., 2014; Notti et al., 2018; Mason et al., 2021). In addition to remote sensing data, in recent times, data gathered by citizens (i.e., crowdsourced data) are becoming increasingly important, even because of the spreading of smartphones and social media users (Hilbert, 2016). The growing availability of crowdsourced data, especially in urban areas, such as pictures and videos acquired by mobile devices (e.g., smartphones, tablets, digital cameras, etc.) and content sharing on social media platforms (e.g., YouTube, Facebook, Instagram, etc.), offers the possibility to gather precious information about the temporal and spatial evolution of flooding events to be used for the calibration of hydraulic models. Many studies have used crowdsourced data to investigate flood events in the last years (Annis and Nardi, 2019; Mazzoleni et al., 2015; Mazzoleni et al., 2018; Smith et al., 2017; Yu et al., 2016).

Moreover, as already stated in our previous response, in the new version of the manuscript we have modified the Introduction by adding new required parts by the Referees. Despite these additional parts, we tried to make the Introduction no longer than the old version.

Referee: Please see the attached review for specific comments.

Response: We really thank the Referee for his/her effort in such a deep analysis and for his/her useful indications that have surely improved the quality of our manuscript. The Referee can find our corrections in the attached file entitled *Replies to specific comments*.

Please also note the supplement to this comment:
https://nhess.copernicus.org/preprints/nhess-2021-61/nhess-2021-61-AC1-supplement.pdf