Replies to final comments on **"A paradigm of extreme rainfall pluvial floods in complex urban areas: the flood event of 15 July 2020 in Palermo (Italy)."**

Antonio Francipane, Dario Pumo, Marco Sinagra, Goffredo La Loggia, Leonardo V. Noto

Dear Antonio Francipane,

We are pleased to inform you that the Editor report for the following NHESS manuscript is now available:

Title: A paradigm of extreme rainfall pluvial floods in complex urban areas: the flood event of 15 July 2020 in Palermo (Italy)
Author(s): Antonio Francipane et al.
MS No.: nhess-2021-61
MS type: Research article
Iteration: Minor Revision
Special Issue: Future risk and adaptation in coastal cities

The Editor has decided that minor revisions are necessary before the manuscript can be accepted. Please log in using your Copernicus Office user ID 210012 to find the Editor report at: https://editor.copernicus.org/NHESS/ms_records/nhess-2021-61

We kindly ask you to revise your manuscript accordingly and to upload the revised files, a point-by-point reply to the comments, and a marked-up manuscript version showing the changes made no later than 19 Jul 2021 at: https://editor.copernicus.org/NHESS/review-file-upload/nhess-2021-61

Please find all information on manuscript submission at: https://www.natural-hazards-and-earth-system-sciences.net/for_authors/submit_your_manuscript.html

Your revised manuscript will be reviewed again and you will be informed about the outcome by separate email.

Besides adjustments requested by the Editor or Referees, please check your manuscript carefully for typos, missing co-authors and their affiliations, terminology, updates of data in tables, or updates of variables in equations. All these have to be clarified with the Editor and therefore have to be included before you submit your revised manuscript. Should your manuscript be finally accepted it will not be possible to include such rather substantial changes anymore when your manuscript is in final production (proofreading).

Please note that all Referee and editor reports, the author's response, as well as the different manuscript versions of the peer-review completion (post-discussion review of revised submission) will be published if your paper will be accepted for final publication in NHESS.

You are invited to monitor the processing of your manuscript via your MS overview at: https://editor.copernicus.org/NHESS/my_manuscript_overview

In case any questions arise, please do not hesitate to contact me. Thank you very much for your cooperation.

Kind regards,

The editorial support team
Copernicus Publications
editorial@copernicus.org

Dear Editor,

Thank you for your efforts in handling our manuscript. We thank the Referees, as well, for their new constructive comments and observations that have contributed to improve our manuscript.

We provide our detailed replies to the Referees' comments and changes made in the manuscript below.

You will find responses keyed to Referees' comments with a black italic text style, while a grey oblique text style has been used for the Referees' comment.

Sincerely,
Antonio Francipane, Dario Pumo, Marco Sinagra, Goffredo La Loggia, and Leonardo V. Noto.

COMMENTS TO THE AUTHORS FROM THE EDITOR

Responses to Editor:

General Comments

Dear authors,

only a few minor issues remain to be fixed at this stage. From my side also a suggestion to improve a little the discussion/conclusion better mentioning "risk assessment and adaptation" in order to make stronger the link with the goals of the special issue https://nhess.copernicus.org/articles/special_issue1141.html (with key-word search it is not possible to find the word "adaptation", and just one-time "assessment")

I will provide a final quick check then before the publication.

Best regards
Paolo Tarolli

Response: Dear Prof. Paolo Tarolli, we thank you again for handling our manuscript and for your suggestions as well. On the base of this, we slightly modified the discussion and conclusions sections to make the link between our paper and the goals of the special issue more evident.

COMMENTS TO THE AUTHORS FROM THE REFEREES

Responses to Referee #1:

General Comments

Referee: *I am glad that authors carefully addressed all major remarks that were shared in the first round of review. A modified structured and content, especially regarding the introduction, was proposed addressing the first two general comments I raised in the first round. The discussion was also improved with a more strict and logical link between the manuscript title, the introduction and the final discussion/conclusions.*
As a result, it is now clear that the proposed "paradigm" of the presented Palermo case study is referring the use of a detailed hydrological and 2D hydraulic modelling cascade that was demonstrated to be supportive of novel knowledge and geospatial mapping of flood hazard characterizing the city of Palermo. The use of crowdsourced data (considering missing distribution hydrological monitoring network) was also demonstrated to be very helpful in the understanding and replication (modelling) of a recent very sever pluvial flood event.
The city of Palermo and the actual flood hazard zoning (that is to date missing to delineate the real and residual flood risk affecting the city) may definitely benefit from the proposed research that has both a value of providing novel knowledge and insights as well as descriving a modelling paradigm that can be replicated in other similar complex urban domains.
The final discussion and conclusion, linking the floodability concept in the framework of green economy oriented NBS, is also worth consideration. Several mediterrenean cities may benefit by means of shared knowledge by scientific efforts like this one, sharing pros and cons of similar challenges and related solutions. The discussion on the issues linked to flood warning systems is also very important considering meteo forcing may provide 12-24 hours forecasting but not easy and straightforward how to forecast impacts on ground of such flood events. The use of green spaces (or other solutions linked to the NBS-based floodability concept) and the integration of citizens (not only crowdsourced data but also integration of citizen science) as actors of the flood risk mitigation are definitely concept worth exploring.
As a result, I suggest the manuscript can be published almost as it is, after having addressed some minor comments I inserted in the commented PDF that is attached to this review.

We thank the Referee for his/her positive feedback and the new comments. Please find below our responses to the comments.

Referee: *I'd also suggest to extend the discussion to share authors' view on the role of cities in the proposed paradigm. I'd be glad if authors may integrate "Section4.3 Future directions in urban stormwater management" sharing their view on citizen engagement on monitoring and adapting to climate-induced floods. I think this is also relevant, within the floodability concept, without forcing the reader to check the 2020 La Loggia paper.*

Response: We are glad that Referee is interested in a deeper view of the concept of floodability and the role that people may play within it. It is for this reason that in the new version of the manuscript

we added more details about this aspect, despite we have tried to also follow the suggestion of the Referee #2 to reduce the length of this section.

The Referee can read the new part in the following:

A floodable system is a well-informed aggregation of resistant, resilient, and floodable subsystems in which people are the key actors. In such a system, people are instructed and trained to prepare themselves and adapt their properties and activities to the possibility of flood events and then to "live with floods". A learning-by-doing process is adopted to make the population able to adapt its strategies to the evolution of events and then to face also unexpectedly severe events. Moreover, the involvement of other actors, such as public bodies, citizen organizations, professional associations, commercial and industrial corporations, and technical experts, support the integration of structural mitigation measures with individual and coordinated actions that results into a reduction of cities' vulnerability and an improvement of the society's adaptivity.

Referee: *Please be very carefull with the language. I still find the manuscript that has some uncertainties in the language and, being a non mother tongue researcher, I'd suggest authors to make a final mother tongue review and proof editing before publication.*

Response: We deeply checked and revised the entire manuscript, also modifying the structure of some sentences.

Specific Comments

The Referee can find in the following the corrections that we made in the new version of the manuscript.

Referee: *lines 8-9. Urban drainage is not a defense, suggest rephrasing.*

Response: We have modified the sentence as in the following:

In such a context, the urban drainage systems may not be sufficient to convey the rainwater, thus increasing the risk deriving from the occurrence of such events.

Referee: *lines 10-11. Better mentioning the phenomenon, is not an example. Suggest rephrasing.*

Response: We have modified the sentence as in the following:

...; it represents a typical pluvial flood due to extreme rainfalls on a complex urban area that many cities have experienced in recent years, especially in the Mediterranean region.

Referee: *line 34. Not needed.*

Response: We have deleted it.

Referee: *line 35. Check english and check redundancies...."recent times... last years... used too many times".*

Response: We thank the Referee for pointing this out. We have double-checked and reduced the redundant use of terms highlighted by the Referee.

Referee: *lines 35-47. Adding pictures of impacts of flooding in Catania, Licata and Palermo would help (also with insets showing where cities are). These new figure(s) can be also inserted in the supplementary.*

Response: Following the suggestion of the Referee, we added the following new Figure S1 in the Supplementary Material.
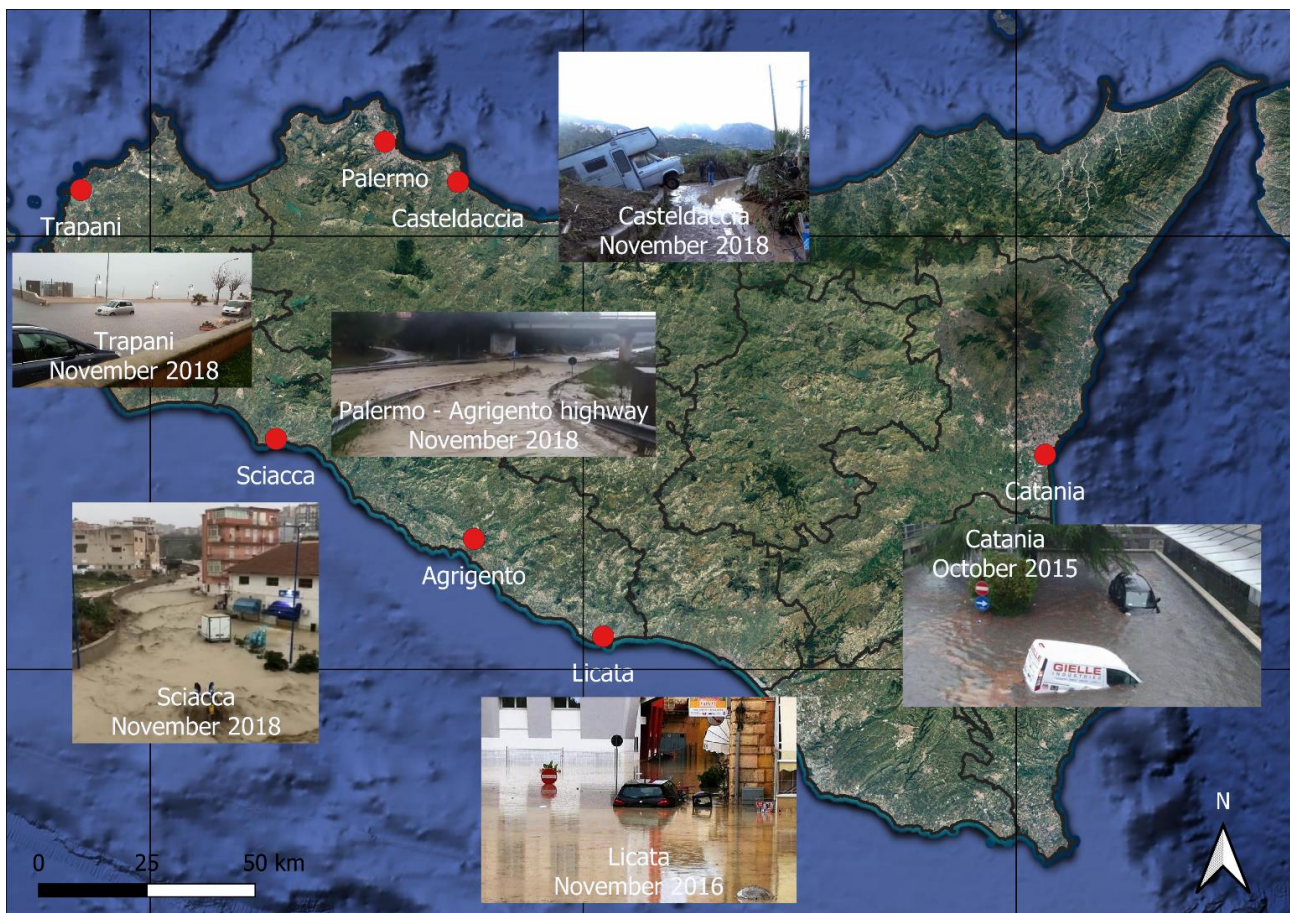
Figure S1 – Impacts of some floods that affected Sicily in the last years. Source aerial: © Google Maps Satellite basemap available within the QuickMapServices plugin of Quantum GIS.

Referee: *line 49. Not sure pluvial and surface water floods can be mentioned this way. Pluvial is rainfall-induced surface waters while surface water may be also not pluvial. Clarifying may help or adding a reference*

Response: The Referee is right, and we thank him/her for pointing this inconsistency out. In the new version of the manuscript, we have deleted the term in parenthesis.

Referee: *line 65. Fluvial and river or riverine are synonymous... no need to add term in parenthesis, to my view*

Response: Based on Referee's observation, in the new version of the manuscript we have deleted the term in parenthesis.

Referee: *line 93. I'd be more precise. Return time of this event? Suggest rephrasing*

Response: We had already reported the information about the return period in Section 2.2 (The precipitation event of July 15, 2020) and deliberately not reported this information in the Introduction section. However, we slightly modified this sentence as requested by the Referee.

Referee: *lines 127-128. Check redundancies in the text, this was said earlier*

Response: We thank the Referee for pointing this out. We have deleted the redundancy and double-checked through the manuscript to find out any other repeated concept.

Referee: *lines 153-158. I wonder... and probably reader will wonder if the city flood hazard plan is now updated considering flooding of recent events. A sentence to share this information would be suggested.*

Response: To our knowledge, also in light of the recent events, the Municipality of Palermo is working to update the flood hazard plan for the most vulnerable areas of the city. Unfortunately, the updated plan is still not available.
However, since we do not have any certain information about this, we would prefer not to add any information in the manuscript that might be incorrect.

Referee: *line 190. Check all verb tenses and by consistent.*

Response: We have double-checked the paragraph for inconsistent verb tenses and corrected them.

Referee: *line 241. Modelling for replicating the event? suggest rephrasing.*

Response: Following the suggestion of the Referee, we have modified the sentence as in the following:

This section presents hydrological and hydraulic models that were used for simulating the event that affected the district Uditore – Passo di Rigano.

Referee: *line 314. How net rainfall is estimated? is there any infiltration model or constant threshold or how?*

Response: The WEC-FLOOD model can apply one among the Horton, Green-Ampt, and constant threshold model. However, since we had the raster of the Curve Number (CN) for the study area, we externally calculated the net rainfall outside the model by means of the CN method and then provided it to the WEC-FLOOD model.

Referee: *line 317. Delete text.*

Response: Done.

Responses to Referee #2:

Referee: *This revised version of the manuscript has addressed all of my comments on the initial submission.*

I only provide two general comments to the Authors:

We thank the Referee for his/her positive feedback and the new comments. Please find below our responses to the comments.

Referee: *A- I remain unconvinced about the length of the Results and Discussion section. Section 4.3 should condense the findings more effectively.*

Response: We have tried to reduce the length of some sentences in order make this section shorter, despite the Referee #1 asked us for extending the same section with some more concepts on floodability.

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Referee: *B- I recommend further strengthening the grammar of the manuscript to improve content readability, quality, and effective communication of scientific ideas.*

Response: We deeply checked and revised the text by trying to improve the grammar and the sentences structures throughout the entire manuscript.

- -

Specific Comments

The Referee can find in the following the corrections that we made in the new version of the manuscript.

- -

Referee: *line 16. Change "for the modelling of extreme rainfall pluvial floods" to "for modelling extreme rainfall...."*

Response: Reading this sentence in the light of the Referee's comment, we decided to change the sentence "*...can be assumed as a paradigm for the modelling of extreme rainfall pluvial floods in complex urban areas under extreme rainfall conditions*" to "*...can be assumed as a paradigm for **modelling pluvial floods** in complex urban areas under extreme rainfall conditions*", since the dependence from extreme rainfall was already expressed in the final part of the sentence itself.

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Referee: *line 23. Delete "the".*

Response: Done.

- -

Referee: *line 23. Not sure this level of detail is needed.*

Response: We deleted this part.

Referee: *line 25. Paragraph should be improved.*

Referee: *lines 25-34. Sentence can be improved from 25-34.*

Response: We have modified the sentence as in the following:

Sicily is the largest island of the Mediterranean Sea and is characterized by a very complex morphology. The combination of its geographic position, morphology, and climate can lead to the generation of severe rainfall events, especially in between the end of the summer and the fall. In that period, indeed, the warmer air masses that move over the hot water of the Mediterranean Sea increase their atmospheric moisture-holding capacity (Drobinski et al., 2018;Pumo et al., 2019;Pumo and Noto, 2021) and, interacting with the steep orography on the coasts, can generate local convection processes that cause very heavy rainfalls (Dayan et al., 2015;Sheffield and Wood, 2008;Tramblay and Somot, 2018). In the last years, these rainfall events have become increasingly frequent and severe over the Mediterranean area (Arnone et al., 2013;Cipolla et al., 2020;IPCC, 2019), especially at the sub-hourly scale (Treppiedi et al., 2021), with a rainfall-runoff response often exacerbated by the ever-growing urbanization (Arnone et al., 2018;Easterling et al., 2000;Pumo et al., 2017).

Referee: *lines 35-36. Sentence can be improved.*

Response: We have modified the sentence as in the following:

Consequentially, in recent times, some intense rainfall events have caused urban floods and flash floods in many cities of the island, with consequent economic damages and, sometimes, human lives losses.

Referee: *line 81. Change "a correct modelling of pluvial flooding events" to "a correct pluvial flood model".*

Response: Done.

Referee: *lines 96-109. Sentence can be shortened and improved from 96-109.*

Response: Following the suggestion of the Referee, in order to shorten and improve the paragraph, we modified it and the previous one. In the following, the Referee can read the new version of the paragraph, where the bold text is that coming from the paragraph from line 96 through 109:

*In this perspective, **this study addresses questions regarding the way to deal with the flood risk in urban settlements where the economic, social, and cultural conditions do not allow either to build new drainage systems or to renew the existing ones**. To do this, the study focuses on a particularly intense urban flood that occurred within the Uditore - Passo di Rigano district in Palermo on July 15, 2020, which represents a typical extreme rainfall pluvial flood over a complex urban area that many cities, especially in the Mediterranean region, have experienced in recent years. On that occasion, a precipitation lasted about two hours, with a cumulative rainfall of 134 mm and an intensity peak of 168 mm/h in five minutes, caused the flooding of the ring road of Palermo and its underpasses with several damage to cars and inconveniences to people. In that case, as well as the*

precipitation, a significant impact on the flooding dynamic is surely attributable to the substantial alterations in the land use and land cover occurred over last decades, especially in the areas most affected by the event.

We capitalize on this event to create a modelling framework that can be assumed as a "paradigm" for those cases in which: i) complex hydrologic domains are linked to complex systems of natural channels integrated within an urban settlement; ii) the domain is forced with extreme precipitation; iii) there is a lack of observed data but a plenty of crowdsourced data that can be used qualitatively to verify the reliability of results returned by the modelling chain..

Referee: *lines 153-158. The idea is good but the paragraph could be improved.*

Response: In the new version of the manuscript, we improved this paragraph, as the Referee can read in the following:

The hydraulic hazard and risk maps for the study area are reported in the Hydrogeological Setting Plan (Piano stralcio per l'Assetto Idrogeologico - PAI) for Sicily, which is a regional plan that maps the hydraulic and geomorphological hazard and risk for the Sicilian territory. The PAI 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.

Referee: *line 345. Method?*

Response: We accepted the suggestion of the Referee.

Referee: *line 654. Grammar.*

Response: We modified the entire caption of the Figure as in the following:

Figure 1. Aerial view of the city of Palermo (Sicily, Italy) overlaid to its Digital Elevation Model (DEM). Red line and red point indicate the Uditore - Passo di Rigano district and the Uditore rain gauge station of the SIAS rain gauges' network, respectively. The yellow star in the inset indicates the location of Palermo. Source aerial: © Google Maps Satellite basemap available within the QuickMapServices plugin of Quantum GIS.