Replies to the Interactive Discussion 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

RC1: 'Comment on nhess-2021-61', Anonymous Referee #1, 14 Apr 2021

Dear Antonio Francipane,

We are pleased to inform you that Anonymous Referee #1 posted a new Referee comment in the interactive discussion of the following NHESS manuscript:

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
Special Issue: Future risk and adaptation in coastal cities

Kind regards,

The editorial support team
Copernicus Publications
editorial@copernicus.org

Supplementary Material

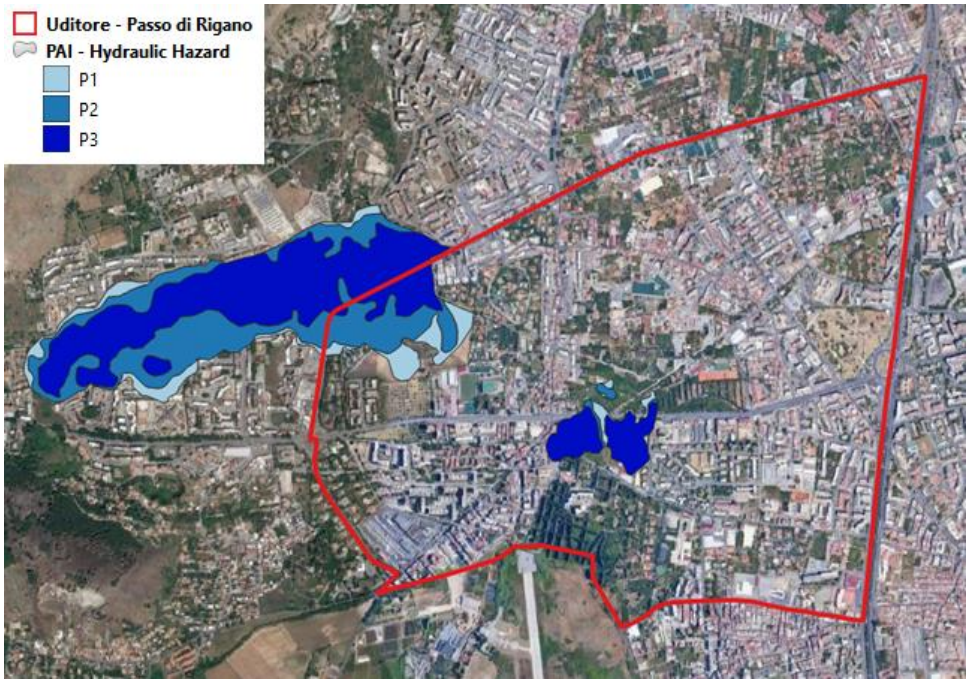

Figure R1 – Hydraulic hazard map for the domain of study (information gathered from the PAI of Sicilian Region)

Replies to specific comments.

Referee: *line 6. have witnessed.*

Response: Done.

Referee: *lines 7-8. need some editing to make the language more precise.*

Response: We deleted this part since by "ground effects" we meant the "response to… extreme rainfall events" already stated in the first part of the sentence. By the way, following the Referee's warning we changed "ground effects" with "rainfall-runoff response" in the rest of the manuscript.

Referee: *lines 8-10. This is a pretty long sentence. Try shortening it.*

Response: We changed this sentence as follows: "*In such a context, the traditional defense of urban areas based on urban drainage systems may not be sufficient to deal with the risk deriving from the occurrence of such events*".

Referee: *lines 12-13. mostly restates the first line.*

Referee: *lines 12-13. Rewrite as "have been experiencing, especially in the Mediterranean region."*

Response: We rewrite this part as follows "*it represents a perfect example of pluvial floods due to extreme rainfalls on a complex urban area that many cities have experienced in recent years, especially in the Mediterranean region*.

Referee: *line 30. Change "has been observed also" with "has also been observed".*

Referee: *line 33. Change "increasing" with "increase".*

Referee: *line 35. Stick with one style throughout the document.*

Referee: *line 36. See previous comment.*

Referee: *line 39. Delete "more and".*

Referee: *line 39. "the ground effects" - as mentioned, need some editing to make the language more precise.*

Referee: *line 56. Change "and humid thus generating" with "and humid. In turn, generating".*

Referee: *line 91. Delete "an".*

Response: Since we have deeply modified the Introduction to address some requests of both the Referees, the sentences with the highlighted parts have been rewritten or deleted. For this reason, the Referee will not find the sentences containing the highlighted parts. However, we would like to point out that we have considered the Referee's indications so as not to repeat the same mistakes.

With reference to the line 39 Referee's observation of the above block, please have a look to our second response to the specific comments.

Referee: *lines 40-41. Change "are further exacerbated, in many areas of the region, by the ever growing urbanization" with "are further exacerbated by the ever-growing urbanization"*

Response: Done.

Referee: *lines 53-54. "one-third"*

Response: Done.

Referee: *line 54. Change "aforementioned" with "previously mentioned".*

Response: Following the Referee #2 request, the part "*As it is possible to notice from the few aforementioned examples,*" has been deleted in the new version of the manuscript.

Referee: *line 60. this part can be put in parentheses.*

Response: We put the word "hillsides" in parentheses.

Referee: *line 60. Change "floods, usually," with "floods usually".*

Response: Done.

Referee: *line 61. Change "exceed" with "exceeds".*

Response: Done.

Referee: *line 62. Change "cause immediate" with "cause an immediate".*

Response: Done.

Referee: *line 67. Do you mean flooding?.*

Response: We meant the drainage of runoff. We now changed this part as well as follows: "*Moreover, pluvial flood modelling can be useful to demonstrate how in some cases a traditional defense of urban settlements based on urban drainage systems may not be efficient.*"

Referee: *line 70. Change "are likely to become always" with "are likely to always become".*

Response: Done.

Referee: *line 71. Change "necessary a new" with "necessary for".*

Response: Done.

Referee: *line 72. The idea is good as you are trying to connect new flood strategies with the 'floodability' concept, but a more concise paragraph (lines 67-72) would be more objective.*

Response: As already said, in the new version of the manuscript we have deeply modified the Introduction. In the new version we mainly moved to the Discussion and Conclusion sections the explanation of floodability concept.

Referee: *line 79. Change "urban flood occurred" with "urban flood that occurred".*

Response: Done.

Referee: *line 72. Change "on surface" with "on the surface".*

Response: Done.

Referee: *line 143. 15. Stick with one style.*

Response: Done.

Referee: *line 144. Change "events occurred" with "events that occurred".*

Response: Done.

Referee: *line 163. Delete "certainly".*

Response: Done.

Referee: *line 164. Change "on" with "in".*

Response: Done.

Referee: *lines 168-173. I suggest to rewrite this idea.*

Referee: *line 170. Change "developing" with "development".*

Response: We have rewritten the sentence as follows: "*This generated an intense updraft that favoured the rapid cooling of the humid air coming from the sea. Moreover, the presence of hills and mountains close to the sea favoured the downdraft of cold and dry air down to the sea, where the presence of warmer and humid air created the conditions for a new updraft that fed continuously the supercell*".

Referee: *line 182. Style should be consistent throughout the document. (check line 304). This also applies to other references.*

Response: We thank the Referee for pointing this out. We have now modified the style in old line 304 to make it consistent throughout the manuscript.

Referee: *line 189-191. Editing needed.*

Response: We have rewritten the sentence as follows: "*The presence of a strong subtropical jet stream (around the 300hPa), cold and dry air (above the 600hPa), and very warm and humid air in lower layers are confirmed by the data recorded at the Radiosonde Data Station Trapani-Birgi (see Figure S2 in the supplementary material)".*

Referee: *line 208. Change "(Forestieri et al. 2018)" with "Forestieri et al. (2018)".*

Response: Done.

Referee: *lines 230-231. Change "will be used for the determination (i.e., hydrographs) of the hydraulic forcing" with "were used to determine the hydraulic forcing".*

Response: Done.

Referee: *line 236. there seems to be a missing word(s)... not clear.*

Response: We have rewritten the sentence as follows: "*The model belongs to the family of the Probability Distributed Models - PDMs (Moore, 1985), which represent the basin as a series of storages of capacity c variable within it*".

Referee: *lines 251-252. 'Due' has been used as adjective/adverb repetitively in the manuscript. Best to use synonyms or rewrite ideas.*

Response: We changed "*is due to*" with "*comes from*".

Referee: *line 254. it is not entirely clear what do you mean by "the slow response of the basin".*

Response: We mean the baseflow. To clarify this concept, we modified the sentence as follows: "*generates the slow response (i.e., baseflow) of the basin*".

Referee: *line 273. Change "runoff surface" with "surface runoff".*

Response: Done.

Referee: *lines 275-276. this sentence could be improved to make it clearer.*

Response: We have rewritten the initial part of this section to make it clearer. The Referee can read the new version of this part in the following: "*The WEC-FLOOD (Filianoti et al., 2020; Sinagra et al., 2020) is a two-dimensional (2D) hydraulic model that solves the Saint Venant equations to study the flood propagation within a 2D domain. The model is suitable for the study in urban areas, where the high complexity in the modelling of the surface runoff prompts for the adoption of 2D models for a better simulation of the flooded areas (Abderrezzak et al., 2009; Dottori and Todini, 2013; Lamb et al., 2009; Mignot et al., 2006). The use of the diffusive form, instead of the fully dynamic one, is mainly motivated by the smaller sensitivity of the computed water depth with respect to the topographic error (Aricò et al., 2011)*".

Referee: *line 284. make problem? this sentence could be improved to make it clearer.*

Response: We have rewritten the sentence as follows: "*To make the model work properly, it is necessary to define the initial and boundary conditions for the domain (Eq. 4)*".

Referee: *line 299. typo.*

Response: We have corrected it.

Referee: *line 303. "and" seems out of place in this transition. Needs a better linking word.*

Response: We have rewritten the sentence as follows: "*In particular, the hydraulic forcing to be propagated within the study area consists of the hydrographs simulated at the outlets of the four contributing catchments (yellow circles in Figure 3) with the TOPDM*".

Referee: *lines 304-306. this sentence could be improved to make it clearer.*

Referee: *line 304. ?*

Response: We have rewritten the sentence as follows: "*The hydrographs were propagated within the study area with the WEC-FLOOD to obtain the flood map for the case study*".

Referee: *line 304. Style should be consistent throughout the document. (check line 153).*

Response: Please look at our previous response to comment on line 182.

Referee: *line 308. "Starting from the" is not needed.*

Response: We deleted this part.

Referee: *lines 311-312. "Consider breaking of ideas into two sentences.*

Response: We have rewritten the sentence as follows: "*The spatial distribution of the topographic index λ was derived from the 2 meters resolution Digital Elevation Model (DEM) data of the study area (Figure 3) with the Single-Flow Direction algorithm (SFD; O'Callaghan and Mark (1984)). The DEM is available at the SITR (Sistema Informativo Territoriale Regionale della Sicilia – Geographical Information System of Sicily). λ was used to derive the specific contributing area and the slope of each catchment with the W-M method (Wolock and McCabe Jr., 1995)".*

Referee: *line 318. this sentence could be improved to make it clearer (lines 317-319).*

Response: We have rewritten the sentence as follows: "*Rainfall data collected at the rain gauges Uditore, Zootecnico, UIR, Bellolampo, and OTT (see Figure 3) were interpolated with the Inverse Distance Weighted (IDW) interpolation to provide the spatial rainfall field over the study area; the distributed rainfall was then used to obtain the rainfall forcing, at the catchments scale, of the hydrological model*".

Referee: *lines 320-322. This sentence could be improved (e.g. The information provided by the MoP was used to.....)*

Response: Following the suggestion of the Referee, we have rewritten the sentence as follows: "*The information provided by the Municipality of Palermo was used to set the maximum discharge (i.e., channel capacity) for the Borsellino, Celona, Luparello, and Mortillaro channels equal to 40, 14, 25, and 11 m^3/s, respectively*".

Referee: *line 332. Change "area" with "environment".*

Response: "Done".

Referee: *line 341. Delete "previously obtained".*

Response: Done.

Referee: *lines 342-343. not clear if this values were adopted in the model. Recommend to be more specific.*

Response: To make it clearer, we have rewritten the sentence as follows: "*Particular attention has been paid to the choice of the roughness coefficient to be used for the simulations; two different Manning coefficient values have been adopted for urbanized and natural areas (Chow, 1959), with values equal to 0.03 $s/m^{1/3}$ and 0.05 $s/m^{1/3}$, respectively*".

Referee: *line 344. The organization and description of results needs some more work.*

Response: We thank the Referee for pointing this out. To address this criticism and some requests of the second Referee as well, we have rearranged the final part of our manuscript (i.e., results, discussion, and conclusions sections). In the new version of the manuscript, we have shortened the old Discussion and joined it to the Result section.

Referee: *line 345. Change "these regard urban floods" with "it comes to flooding in urban areas".*

Referee: *line 346. Change "values of water depth to" with "water depth values to".*

Referee: *line 347. Delete "common".*

Referee: *line 348. Change "shared in social media" with "and content sharing in social media platforms".*

Referee: *lines 350-352. sentence can be improved.*

Referee: *lines 354-355. be more specific...something like goodness-of-fit criteria for assessing the accuracy of simulations.*

Referee: *line 405. Delete "also".*

Referee: *line 405. Change "non-extraordinary storms" with "storms as well".*

Referee: *line 435. ?*

Referee: *lines 435-436. rephrase.*

Referee: *line 441. Change "to force" with "forcing".*

Referee: *line 445. Change "It is therefore" with "Therefore".*

Response: As above said the results and discussion section of the new manuscript version have been modified. In the new version of the manuscript the parts highlighted by the Referee have been changed or moved. However, we would like to point out that we have considered the Referee's indications so as not to repeat the same mistakes.

Referee: *lines 356-357. Sentence can be improve. rewrite sentence.*

Response: We tried to make the sentence clearer as follows: "*Figure 11 shows the map of the flooded areas returned by the simulations in WEC-FLOOD*". In the new version of the manuscript, the old Figure 12 has become the Figure 11 since we have moved the old Figure 6 to the Supplementary material.

Referee: *lines 365-372. grammar.*

Response: We have rewritten this part as follows: "*Figures 12 and 13 show the results of simulations in WEC-FLOOD for the underpasses Da Vinci and Michelangelo, respectively. In that occasion, the two underpasses worked as two big reservoirs where the water depth reached values higher than 4 m. Also in this case, it is possible to notice a good qualitative match with the historical pictures taken from the people in the underpasses Da Vinci (Figure 12) and Michelangelo (Figure 13). The simulation returned a value of about 3.2 and 5.0 m of water depth in points 1 and 2 of Figure12, respectively, which are totally compatible with values reported by the Fire Department (i.e., between 4.5 and 5.0 m in the deeper point of the underpass Da Vinci). With reference to the underpass Michelangelo, instead, the model returned a water depth of about 1.5 m in points 1 and 2 and about 2.3 m in point 3 of Figure 13, which are compatible with the water levels showed by the pictures.*".

In the new version of the manuscript, the old Figures 13 and 14 have become the Figures 12 and 13, respectively, since we have moved the old Figure 6 to the Supplementary material.

Referee: *line 378. it would be great to improve the quality of Figure S2.*

Response: We completely understand the Referee's point. Unfortunately, the resolution of the image is the best available from the website containing the products of Copernicus Sentinel-2 mission.

Referee: *line 381. The discussion session is really long and should be greatly shortened.*

Response: As already said, to address to this criticism and some requests of the second Referee as well, we have rearranged the final part of our manuscript (i.e., results, discussion, and conclusions sections). In the new version of the manuscript, we have shortened the old Discussion and joined it to the Result section.

Referee: *line 382. Change "An effective" with "Effective".*

Response: Done.

Referee: *line 412. Delete "the".*

Response: Done.

Referee: *line 416. Change "real time" with "real-time".*

Response: Done.

Referee: *line 426. Change "cope the combined" with "cope with the combined".*

Response: Done.

Referee: *line 426. Change "With this regard" with "In this regard".*

Response: Done.

Referee: *line 429. Change "green roofs and" with "green roofs, and".*

Response: Done.

Referee: *line 433. Delete "the".*

Response: Done.

Referee: *line 449. Change “of” with “for”.*

Response: Done.

Referee: *line 451. Change “for” with “to”.*

Response: Done.

Referee: *lines 454-455. Rephrase: "For extraordinary rainfall events, such as the one that has originated the event of Palermo investigated here, the only solution that could contribute to reducing damages and risks are probably those oriented to the concept of floodability.".*

Response: Done. We really thank the Referee for the suggestion.

Referee: *line 451. Change “fulfil” with “fulfill”.*

Response: Done.

Referee: *line 459. Delete “an”.*

Response: Done.

Referee: *line 459. Change “architectural” with “architecture”.*

Response: Done.

Referee: *line 467. Change “less and less rare” with “a new normal”.*

Response: Done.

Referee: *line 468. Change “increasing” with “increased occurrence”.*

Response: Done.

Referee: *line 479. Change “in urban” with “in an urban”.*

Response: Done.

Referee: *linse 480-481. again.*

Response: Done.

Referee: *line 482. Delete "the".*

Response: Done.

Referee: *line 625. Whats the resolution?*

Response: To specify the resolution of the DEM we slightly changed the caption of the Figure 1 as follows: "*Figure 1.* ***20 meters resolution Digital Elevation Model*** *of Palermo (Sicily, Italy) with location of the Uditore - Passo di Rigano district (red line) and the Uditore rain gauge station (red point) of the SIAS rain gauges' network. 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*".

Referee: *line 636. Main contributing catchments for the study area: Borsellino.....*

Response: Done. We thank the Referee for the suggestion.

Referee: *line 671. This figure would be clearer with more explanations.*

Response: The Referee is completely. In the new version of our manuscript, we modified the caption of the Figure 8 (Figure 9 in the old version of the manuscript) as follows: "*Figure 8. Computational mesh of WEC-FLOOD model. The vertices of each cell (black dots) are the computational centers of the cells (i.e., the point where the water surface is computed for the cell) and are obtained as the circumcenters of the generalized Delaunay triangulation*".

Referee: *Figure 10. lines in legend are blurry.*

Response: We thank the Referee for pointing this out. We have corrected the legend of the Figure 9 (Figure 10 in the old version of the manuscript). For the Referee's convenience and information, we have reported here the new Figure 9.

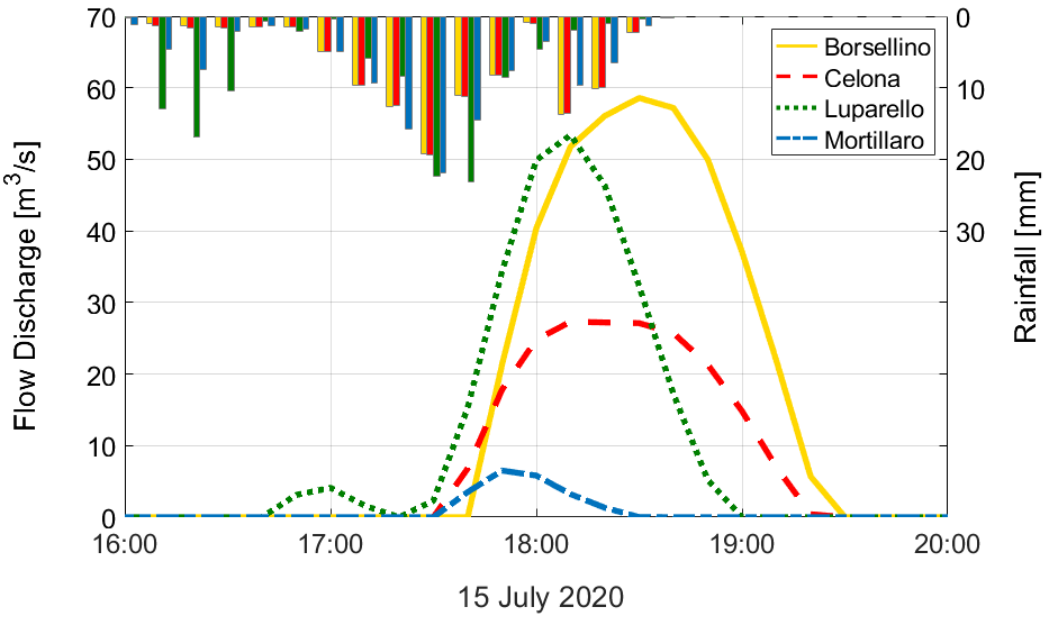

Figure 9. Rainfall Discharge obtained from the hydrological simulations in TOPDM. The bars in the upper part of the figure indicate the IDW interpolated precipitation over the four basins.