Comment on nhess-2022-175

Dear Editor and Reviewers,

we thank the guest editor Francesco Marra for handling our manuscript and the referees for their insightful comments, which will surely help us in improving our work. In the following we reply to point-to-point to anonymous Referee #1.

Author's response to anonymous Referee #1

General Comments:

Referee #1: This is a mostly well-written preprint that I feel only needs minor revisions. The use of PCA to reduce the dimensionality of the hydrometeorological space is novel, and the thresholds produced are an improvement over other method. There are some missing details regarding the landslide inventory selection process, described below. These missing details constitute the bulk of my concerns and if addressed, I feel that the paper will tell a more complete story of the authors' methodology.

Author's Response: We acknowledge Referee#1 for globally appreciating our work, recognizing its novelty aspects. We will revise the manuscript adding more details about the landslide inventory, in order to make clearer the description of the work done.

Specific Comments:

Referee #1: Regarding the landslide selection process described near the end of section 2.1.
The selection of ground truth is a critical decision for this type of analysis, especially if that ground truth is partially derived from other algorithms or datasets, such as what you are doing with CTRL-T. I believe this section needs two additions to help convince readers that what you're doing is scientifically sound.

Firstly, for the "adjustable parameters" of CTRL-T, I would like to see some description of how and why you chose the final parameter values. I believe you briefly mention the separating length of time for rainfall events in wet and dry periods later on in the paper. There is also this sentence in line 135: "Rainfall event parameters were calibrated adopting the monthly soil water balance model and evapotranspiration analysis." But I'm unclear on if this calibration process was done automatically by the program or manually by the authors. A final list of adjustable parameter values, with some brief defense of their selection, would help readers understand what parts of CTRL-T are automated and which are tuned by hand.

Author's Response: We thank the reviewer for pointing out that more details should be provided regarding these aspects. For the computation of the regional parameters required by CTRL-T, we referred to a previous application of the algorithm to the Sicily Island (Melillo et al., 2015). As explained by the authors, the heuristic approach proposed by Brunetti et al. (2010), and updated by Peruccacci et al. (2012), has been adopted to separate two rainfall events. Specifically, according to this approach, the dry period (no rain) has been set equal to 48 hours ($P_{4,\ warm}$) between April and October (warm season, C_w), while it has been set equal to 96 hours ($P_{4,\ cold}$) from November to March (cold season, C_c). Indeed, in line with Köppen (1931) and Trewartha (1968), it is reasonable to assume that in Sicily, due to the Mediterranean climate, the warm period is longer than the cold one. At lines 135 and 136 we referred to the parameters representative of the time periods used to remove irrelevant amount of rain and to reconstruct rainfall events (P_1, P_2, P_4) and to the irrelevant rainfall sub-events that had to be excluded in the calculation of the final events (P_3). In more detail:

i. P_1 represents the dry interval separating isolated rainfall measurements and it has been set equal to 3 hours for the C_w period, and to 6 hours for C_c period;
ii. P_2 represents the dry interval separating the rainfall sub-event, namely the period of continuous rainfall separated from the immediately preceding and the immediately following sub-events by dry periods with no rain. It has been set equal to 6 hours in the C_w period and equal to 12 hours in the C_c period;
iii. P_3 represents the threshold to exclude the sub-events whose contribution can be considered irrelevant for the reconstruction of the rainfall events for the possible initiation of the landslide and, it has been reasonably set equal to 1 mm for the Mediterranean climate;
iv. P_4 represents the minimum dry period separating two rainfall events, where a rainfall event is a period of continuous rainfall resulting from the aggregation of single or multiple sub-events in order to obtain single rainfall events. P_4 has been set equal to 48 hours for the C_w period and equal to 96 hours for the C_c period.

Additional parameter needed to be set for the reconstruction of the rainfall events are: G_S, representing the instrumental sensitivity of the rain gauge; E_R, representing the instrumental sensitivity of the rain gauge and the minimum value exceeding which the isolated hourly measurements are considered relevant; and R_B, representing radius of the buffer to assign each landslide to the closest rain gauge.

A final table of the adjustable parameter values, as reported in the follow, will be certainly added within the manuscript in order to better explain their meaning and their role with respect to the algorithm.

Parameter name	Parameter value	
	C_w	C_c
G_S [mm]	0.2	0.2
E_R [mm]	0.2	0.2
R_B [km]	10	10
P_1 [h]	3	6
P_2 [h]	6	12
P_3 [h]	1	1
P_4 [h]	48	96

Regarding the monthly soil water balance model and evapotranspiration analysis, the calibration process was done automatically by the program, setting the related benchmarks. It was assumed that the evapotranspiration is inversely proportional to the time necessary to dry the soil, and, specifically, a factor of 2 between all relevant parameters in the C_w and C_c periods has been adopted ($ETR(C_w) \cong 2 \cdot ETR(C_c)$), as revealed by the analysis of the mean annual evapotranspiration in Italy (Melillo, 2009) using the Thornthwaite–Mather method (Thornthwaite and Mather, 1957) and as adopted by Melillo et al. (2015) for a previous application of the algorithm to the Sicily Island.

Referee #1: Secondly, I would describe briefly in greater detail how you decided that landslides did not have identifiable or uncertain rainfall conditions. I presume some threshold on the weights was used. If so, what were those thresholds values and how did you decide them? Or if some other metric was used to quantify the landslide cause as being uncertain, briefly provide and defend those decisions.

Author's Response: We thank Referee#1 for allowing us to clarify this aspect. The selection of the rainfall events responsible for landslides is performed within the algorithm in two steps. The first step involves the assignment of a record of rainfall measurements, given by a single rain gauge, to each landslide checking the match between the start and end dates of the rainfall events and the day and time of the landslide occurrence. This approach makes it possible to associate each landslide to a single rainfall event, discarding the landslides for which the time match does not fit. If multiple rainfall conditions that are mostly likely responsible for the triggering are found, the weighting procedure explained at lines 140-147 of the manuscript is adopted.

Technical Comments and Optional Suggestions:

Referee #1: See attached PDF for grammar corrections and other suggestions for additional figures or figure revisions that I do not feel are mandatory.

Author's Response: We also appreciate the additional grammar corrections and the other suggestions for figure revisions that will be certainly introduced within the manuscript, as well as all the additional information and insights reported in the above specific comments.

In particular we will apply all technical corrections. For the more specific comments in the annotated manuscript, we will modify the manuscript as follows:

i. insertion of a more specific overview regarding some statistics related to the cost, damages, and number of casualties due to landslides on worldwide scale;
ii. insertion of a grouped bar plot, as a subplot to Figure 4, graphing Eqs. 13, 14, 15, and 16.