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Interactive comment on “Reproducing an extreme flood with uncertain post-event information” *by* Diana Fuentes-Andino et al.

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We thank Referee # 1 for her/his interesting observations that will help us to improve our manuscript. In general we agree with the reviewer and we will developed more in the discussion sections on the implication of the results from the data, hydrological and hydraulic perspectives. More specifically, we addressed each of the reviewer points as follows:

1) We agree that uncertainties in discharge estimates will directly affect estimates of roughness coefficients and vice versa (Aronica et al., 1998; Warmink and Booij, 2015; Wohl, 1998), therefore a localized setting for the roughness coefficient can improve model fit (e.g. Romanowicz and Beven, 2003). With the data availability in our study, we could estimate the localized roughness coefficient for the most downstream reach,

using points 3, 6 and 7 in Fig. 1 and 2, however this will prevent us from using point 7 for validation. In addition, except for the most downstream reach, for the other four reaches we only have observed high water marks to calibrate against. Thus, a localized roughness-coefficient will lead to an increased number of parameters in the hydraulic model when we do not have enough information at each reach to constrain the local roughness. We will include in the manuscript a discussion on the interrelationship of roughness coefficient with discharge and about the improvements that can be done in this work if more data was available. Thus, we will also suggest strategies for improvements on the post-event data collection campaigns.

2) We will add and explain better this part of the procedure in the manuscript based on the following comment. Regarding time of the peak, all observations have the same source i.e. witnesses account. Regarding the peak discharge, points 1, 2, 3 and 5 at fig. 1 and table 1 were used for the calibration. The uncertainty at 1 and 2 were chosen considering, and assumed larger, than the values suggested at Benson and Dalrymple (1967) and Cook (1987). The discharge at point 5, although it was estimated by running a RRM by JICA (2002), was used for calibration here since its magnitude was similar to the maximum peak outflow measured at Los Laureles dam which is located in the same river and with nearly same contributing upstream areas than point 5 in Fig. 1. The uncertainty given to points 1 and 2 was considered large enough and was also chosen as the uncertainty at point 5 because there was no better source of information to constrain it. Thus, the peak discharge at Los Laureles reservoir was used to support our decision to use the discharge produced by JICA (2002) at point 5 to constrain maximum peak discharge at that point. The hydrograph at the Concepción reservoir was routed using the TOPMODEL and the Muskingum–Cunge–Todini routing approach.

3) We checked for consistency of the data prior to the calibration procedure. We will incorporate that into the manuscript, including a discussion on the implications of the quality and the quantity of the data.

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From the analysis we did prior to the calibration procedure we found that maximum peak discharge and time of the peak information was consistent. Consistency in the high water marks was also checked, and we did notice that the profiles for the observed high water marks were not smooth (some sudden jumps without any obvious physical explanation) but this is expected given the origin of those observations (witness accounts). Thus we did not eliminate any of the observations but instead assigned a reasonable uncertainty range to each of them for the calibration procedure. Because of the quantity of high water mark observations (available on average every 200 meters, location in Fig. 2) it was not convenient to assign numbers for each of the observations.

4) We agree with the reviewer comment, the global calibration procedure is flexible p. 14 Lines 10-12: “The weights could be changed according to the purpose of the study which might also result in different ensembles being behavioural for different purposes (Pappenberger et al., 2007)”. Thus, results from a sensitivity analysis will be bound to the weighting scheme chosen. We did not look into differences arising from different schemes as we wanted to have a restricted focus within this work.

5) To parameterize the TOPMODEL and the Muskingum–Cunge–Todini routing in our work, we included the often considered parameters within these modelling concepts and the parameters that we thought would be important in driving the hydrograph in our catchments. We avoided to constrain our model from the start by simplifying it. Instead, to consider a possible over-parametrization, we check for stability in the produced cumulative distribution of the output predicted variables (i.e. peak discharge and time of the peak) and made as many simulations until the distributions stabilized (the distributions did not changed after adding more realisations (p 8 Lines 19 to 25). Thus even if the RRM model was over-parametrized, the stability of the obtained cumulative distribution indicated that the parameter space was explored sufficiently. Within the LISFLOOD hydraulic model, besides the roughness coefficients, we added a slope for the downstream boundary condition as it is known to affect the predicted water level at the downstream end (Pappenberger et al., 2006) especially because we made a simple

normal flow assumption at that boundary. Prior to the setting of the hydraulic model, we explored its sensitivity to the channel depth and channel width values (through a multiplying factor), which lead to treating the channel width as an uncertain parameter in the analysis. Thus we finally considered a total of four parameter for the hydraulic modelling which we think is a reasonable number. The ranges chosen to sample the model parameters were set wide enough to consider uncertainty in parameter values especially when they represent spatially-aggregated effective values. Using a range to represent the uncertainties each parameter is associated to, can lead to a large variation in the resulting range of figures 5-7. We tested if the available data can help to constrain and decrease those ranges. We will add value to the manuscript by incorporating a framework for the GLUE within as an uncertainty analysis technique and explain the reason why we chose GLUE methodology.

6) We considered a rainfall multiplier to represent uncertainty in the spatial average estimation of rainfall as it has shown to improve model prediction (Fuentes Andino et al., 2016), this uncertainty is important to consider when few rain gauges exist as in this study. As the multiplier is considered as an extra parameter, it interacts with all the model parameters, as the reviewer suggests. Note that in the face of such epistemic uncertainties, the GLUE formulation used allows for complex interactions between parameters (not just variance/covariance forms) in that it is the parameter SET that is evaluated as behavioural or not. Thus the complex interactions are contained implicitly in the resulting ensemble of behavioural simulations. As the reviewer pointed out, the limitations due to the use of few rainfall gauges, was evident specially for predicting the time of the peak. We will further highlight this limitations and discuss the importance of a denser rain-gauge network.

7) a) We think to improve the work by extending on the discussion section about the inconsistency between model and observations at some specific locations. b) It was not possible to identify inconsistency in the post-event estimated peak discharge, but we noticed after the simulations: “as in comparison to the Grande and Guacerique

sub–catchments, most of the hydrograph simulations for Chiquito River sub–catchment were rejected because the simulated peaks were larger than the observations (even considering the uncertainty) (Fig. 5)" (P 14 L33 to P15 L 1-3) this was only possible to see after the simulations. All major revision we consider to make in the manuscript are summarized in the Major revisions document uploaded as supplement.

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