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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "A coupling of hydrologic and hydraulic models appropriate for the fast floods of the Gardon river basin (France): results and comparisons with others modelling options" *by* O. Laganier et al.

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Response to Anonymous Referee #1

First of all, we thank the referee for its relevant remarks, which will significantly contribute to the improvement of our manuscript. In the following, we respond point by point to the comments. The response is based on a new version of the manuscript (in supplement).

In the first paragraph of its comments, the referee reminds the object of the manuscript, and the analyses carried out. It seems, according to comments, that the main objective is not rather clear in the manuscript: it is not just a comparison of 1D Saint-Venant modellings with those of a Lag&Route model; the purpose is to evaluate the results of a coupling of hydrologic and hydraulic models, and then, secondly, to analyze these results compared with those of other modellings options. The Lag&Route model is one of these options. Probably, we did not specify properly in the manuscript the desired end of the coupling (this point is also underlined by the second referee). We wish to build a tool adapted to the modelling and to the forecast of discharges and flooded areas of the Gardon river: the coupling has to have limited calculation time, to be able to supply information of water levels and discharges in every point of the stream, but also information relative to the flooded zones. For this purpose, a coupling of models seems adapted. It shall contain a hydraulic model based on the Saint-Venant equations or on simplifications of these (kinematic wave or diffusive wave); Muskingum or Lag&Route approaches does not allow to estimate the flooded zones, and thus do not suit; a 2D hydraulic model seems to have too important calculation times. So, we use a 1D Saint-Venant hydraulic model. These choices are described more precisely in the new version of the manuscript, at Sections 3.1 and 3.2. So, the presented results correspond to a first level of analysis of the suitability of the coupling of models: the suitability of the coupling for the reproduction of hydrographs observed during past events, at the Ners, Russan and Remoulins stations. Then, these results are compared with those of other modelling options. It is the heart of the manuscript. 2nd and 3rd levels of analysis concern (2) the suitability of the coupling to model flooded areas, and (3) the suitability of the coupling for flood and inundation forecasting. The results of these last two points are not presented in the manuscript, but are discussed (see Section 5.2). The comparison with the results of other modelling options has for objective to bring elements of responses to the following questionings: 1) Is a simplified propagation model also relevant as a hydraulic model based on the full Saint-Venant equations, for modelling the discharges at the Ners, Russan and Remoulins stations

(coupling vs Lag&Route option)? 2) Is adding lateral inflows justified for all the events? In other words, is the choice of a coupling appropriate, or is a simple hydraulic model, without lateral inflows, could suit (coupling vs SVMOD option)? 3) What is the impact of the quality of modellings injected at Anduze and Alès on the results of the coupling in the downstream part (coupling vs COUPLOBS option)? In the new version of the manuscript, these questionings are clearly detailed in the introduction, and reminded at the beginning of Section 4.2.

In the second paragraph, the referee indicates that the K0 parameter should be calibrated in the downstream part of the Gardon river, for an appropriate COUPLMOD vs Lag&Route comparison. In the new version of the manuscript, we calibrated the V0 and K0 parameters of the LR routing model according to the discharges data of the Ners, Russan and Remoulins stations, for each event. The results of the LR option are effectively improved; it appears that there are little differences with the coupling results; in other words, the Lag&Route model is also relevant for the discharges modelling. These new results replace the former, and are detailed at Section 4.2.1.

Additional comment #1: in the new version, we clearly indicate that the LR model is based on a cascade of linear reservoirs (p. 9). Concerning the Muskingum model: as already noted, this type of model is not adapted for the modelling of the flooded areas ; thus, it is not adapted for the coupling. On the other hand, it can be completely relevant for the discharges modelling; in this sense, we share the views of the referee.

Additional comment #2: the referee indicates that the V0 parameter has to remain constant for each event. Effectively, it seems more realistic. In fact, we reproduced the calibration strategy described by Tramblay et al. (2011): these authors calibrates S and V0, independently for each event, and observes satisfactory results. Since, we tested an additional option: a calibration of S for each event, with a V0 value fixed for all the events to 2.5. This value corresponds to the average value of the V0 parameters calibrated for about twenty events at the Anduze station. The gaps between both calibration strategies are on average moderated at Anduze (average Nash of 0.74 when

only S is calibrated, vs 0.84 when S and V0 are calibrated), but sometimes the differences can be important. For example, in the case of event n°1, the Nash value is of 0.44 when only S is calibrated (with V0=2.5), against 0.72 when both parameters are calibrated (Tab. 4, p. 39). So, because of these important degradations in some cases, we prefer to maintain our results, obtained by calibrating both parameters. We suggest rewriting the part describing the calibration method, by summarising these remarks (see Section 3.6).

Additional comment 3: the referee wishes a clearer separation between calibration and validation data. The number of modelled events is rather low (7), which prevents from defining two sets sufficiently robust. In fact, very few events were recorded at the downstream stations. Some of these stations were installed since only a few years (Russan: since 2003; Alès: rating curve valid since 2006). We tried to improve the writing of this part of the manuscript.

Additional comment 4: the referee advises to take into account the event of September 2002. This extreme event was strongly overflowing. Its modelling with a 1D model seems simplistic; it is necessary to complete the hydraulic model with storage areas, as Bonnifait et al. (2009) did it, or even to choose a 2D model. We think that it would degrade the clarity and the object of the manuscript. Furthermore, the analysis of the coupling results would be different from this event, with regard to the other events (the observed data are not the same).

Concerning the quality of the English: we tried to refine the translation.

Concerning the modifications of the outline: - The summary, the introduction and the conclusion were largely rewritten. - Sections 3.1 and 3.2 were added, and should allow the reader to better understand the choices of modelling made. - The description of the application of the coupling to the Gardon river (former Section 3.1) was completed, and moved after the description of both models (new Sections 3.4 and 3.5). - Part 4.2 was completely rewritten: it contains now 4 sub-sections, instead of 3 in the former

version of the manuscript. - The discussion (Section 5) was also modified: the former sub-section 5.1 was deleted; the former section 5.2 becomes the section 5.1 of the new version. Finally, the new Section 5.2 discusses the usefulness of the coupling for forecasting purposes, and for the flooded areas modelling.

Concerning figures and tables: Four tables were added (n°7,8,9,10), and are described at new Section 4.2. The figure 4 was improved. The former figures 5, 6, 7 were deleted, and are replaced by figures 5, 6, 7 and 8 in the new version.

References: Bonnifait, L., Delrieu, G., Le Lay, M., and Boudevillain, B., Masson, A., Belleudy, P., Gaume, E., Saulnier, G.M.: Distributed hydrologic and hydraulic modelling with radar rainfall input: reconstruction of the 8-9 September 2002 catastrophic flood event in the Gard region, France, Adv. Water Res., 32, 1077-1089, doi:10.1016/j.advwatres.2009.03.007, 2009. Tramblay, Y., Bouvier, C., Ayral, P.A., and Marchandise, A.: Impact of rainfall spatial distribution on rainfall-runoff modeling efficiency and initial soil moisture conditions estimation, Nat. Hazard. Earth Sys., 11, 157-170, doi:10.5194/nhess-11-157-2011, 2011.

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/1/C2899/2014/nhessd-1-C2899-2014-supplement.pdf

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