This is the Authors' reply to comments from Reviewer nº1. We will use blue colour for our reply and black colour for Reviewer nº1 comments.

First of all, the Authors want to thank the Reviewer for the work and comments which without doubt will help to improve the paper.

It should be noted that the comments of the Reviewer nº1 make reference to pages and lines of the production paper. We will use the same criteria in this reply.

Manuscript Number: HESS-2012-17
Journal: HESS
Title: Assessing the impact of uncertainty on flood risk estimates with reliability analysis using 1-D
and 2-D hydraulic models
Author(s): L. Altarejos-García, M.L. Martínez-Chenoll, I. Escuder-Bueno, and A. Serrano-Lombillo

The paper is interesting since it deals with practical application of numerical models for flood risk estimates. It describes the PEM method comparing it with the Montecarlo approach. It refers to a 1D and a 2D commercial models.

First of all I set forth some general remarks.

The structure of the paper is correct.

Figures are not very intelligible, mainly those showing water heights over flooded areas. Adding contour lines shall improve their readability. The legend as well as the axis title should always be displayed.

Some more references should be added in the text.

We thank the Reviewer for the general remarks. Comments regarding figures and references are addressed in the reply to the detailed remarks that follows.

More in detail I make the following remarks.

Pag 4 line 29- The authors have cited only one reference ( Cobby et al 2001) on the use of DEM models for floodplain delimitation. In the scientific literature there is plenty of more recent models that use DEMs, that should be added in the text.

[1] Cook A., Merwade V.,(2009) Effect of topographic data, geometric configurations and modeling approach on flood inundation mapping, Journal of hydrology, Vol. 377, pp 131-142

[2] Gregory M., Walker B., Yi S., Cunningham B., Kjelds J. (2007) Case studies in automated floodplain mapping, proceedings of Flood management Asce conference,

[3] Sanders B.F. (2007) Evaluation of on line DEMs for flood inundation modeling, Advances in Water resources, Vol.20, pp 1831-1843

[4] Shatnawu F.M., Goodall J.L.,(2010) Comparison of flood top width predictions using surveyed and lidar derived channel geometries. Journal of Hydrologic Engineering, Vol. 15, 2, pp 97-106

These references will be added in the final version of the paper.

Page 4 line 32, some more references for the uncertainty related to the manning roughness coefficient, see e.g.

Pappenberger, F,Beven, K,Horritt, M, Blazkova, S (2005) Uncertainty in the calibration of effective roughness parameters in HEC-RAS using inundation and downstream level observations, Journal of Hidrology 2005, 302, pp 46-69

These references should added in the text

This reference is cited elsewhere in the paper (Page 5 line 29) but it will be cited as well in Page 4 line 32 as suggested.

Pag 5 line 5 The authors talk about 1d and 2D models, without adding proper references, see e.g.

He, H., Yu, Q., Zhou, J., Tian, Y.Q. & Chen, R.F. 2008 Modeling complex flood flow evolution in the middle yellow river basin, china. Journal of Hydrology, 353, 76-92.

Helmio, T. 2005 Unsteady 1D flow model of a river with partially vegetated floodplains application to the Rhine river. Environmental Modeling & Software, 20, 361-375.

Horrit M.S., Bates P.D., 2002. Evaluation of 1D and 2D numerical models for predicting river flood inundation, Journal of Hydrology, Vol. 268, pp 87-99

Yoshida, H. & Dittrich, A. 2002 1D unsteady state flow simulation of a section of the upper Rhine. Journal of Hydrology, 269, 79-88.

Remo J.W.F., Pinter N., Heine R. (2009) The use of retro and scenario modeling to assess effects of 100 + years river of engineering and land cover change on middle and lower Mississipi flood stages, Journal of Hydrology, Vol. 376, pp 403-416

Wright, N.G., Villanueva, I., Bates, P.D., Mason, D.C., Wilson, M.D., Pender, G. & Neelz, S. 2008. Case study of the use of remotely sensed data for modeling flood inundation on the river Severn, U.K. Journal of Hydraulic Engineering, 134 (5), 533-540.

These references should added in the text

These references will be added in the final version of the paper.

Some coupled 1d-2d model should at least be cited, see e.g.

S. N. Kuiry; D. Sen; and P.D. Bates (2010).Coupled 1D–Quasi-2D Flood Inundation Model with Unstructured Grids, Journal of Hydraulic Engineering, Vol. 136, No. 8, pp 493-506

Kun-Yeun Han, Jong-Tae Lee & Jae-Hong Park (1998): Flood inundation analysis resulting from Levee-break, Journal of Hydraulic Research, 36:5, 747-759

Finaud-Guyot, P.; Delenne, C. Guinot, V.; Llovel, C. (2011), 1D-2D coupling for river flow modelling,Comptes Rendus Mécanique, vol. 339 (4), pp. 226-234

LaTorre B., Burgete J., Murillo J., Brufau P., garcia navarro P., Petaccia G., Calvo B., Savi F, (2009). Flood wave simulation with 1d-2d coupled models., Proceedings of CCWI 2009, Taylor and Francis. London. CCWI.

These references will be added in the final version of the paper.

Page 5, line 28 the authors refer to a 1D and a 2D commercial code, that will be used in the paper.

The authors should cite more 1D and 2D academic research code, see e.g. MIKE 11, MIKE 21, BASEMENT (see references) and tell the reason of their choice.

BASEMENT- Basic Simulation Environment for computation of Environmental flow and natural hazard simulation. Version 2.2,ETH Zurich, Faeh R., Mueller R., Rousselot P., Vetsch D., Volz C., Vonwiller L., Veprek R., Farshi D., 2006-2011

More codes will be cited in the final version of the paper, with their references, such as ISIS and INFOWORKS RS (Wallingford), HAESTAD (Bentley), GISPLANA and IBER (Cedex), LISFLOOD (Joint Research Center of European Commission).

Among the reasons for selecting GUAD 2D it can be mentioned that it is a commercial code frequently used by consultant companies in flood risk assessments in our environment; we have already used the code on both research and professional applications.

Page 6- line 17- the authors refer to three models, two of them are 1d and one is 2d. How were the simulation performed with HEC-RAS? Using the unsteady or the steady module? The authors should distinguish between the geometry ( simplified 1d with only one cross section, 1D with 12 cross sections and 2D with how many computational cells?) and the mathematical model used (uniform flow/steady flow/ unsteady Flow)

In this research we were interested in the comparison of flood extent and characteristics for a given constant flow value. Accordingly, the simulation with HEC-RAS was performed with the steady state module.

We will reflect more clearly in the paper the distinction between the geometry used and the mathematical models employed.

The geometry used in the three models comes from the same DEM. The simplified 1D model uses only one, simplified, cross section. The 1D HEC RAS model uses 12 cross sections taken from the DEM model. The 2D model develops over the DEM with a grid of 1140 rows and 1541 cols, rendering 1.756.740 cells of 1x1 m.

The mathematical models are uniform flow for the simplified 1D model, steady flow for the 1D HEC RAS model and unsteady flow for the 2D model.

Page 12, line 20- again the authors should specify which are the upstream boundary conditions, why are different by the 2d model boundary conditions? The downstream boundary condition in the 1D model is uniform flow while in the 2D model is a stage discharge relation. Is there a reason for this difference? The authors should explain it in the text.

The downstream boundary condition in the 1D HEC RAS model is uniform flow, according to the downstream river reach characteristics. This kind of boundary condition is typical in HEC RAS. On the other hand, the GUAD 2D allows five different downstream boundary conditions: 1) hydrograph Q(t); 2) water level as a function of time, y(t); 3) stage discharge relation, Q(y); 4) critical flow; and 5) flow over a spillway. Of these, we have used a stage discharge relation, which was obtained using HEC RAS.

The boundary conditions will be specified more clearly in the text in the final version of the paper.

Page 13- line 2 why is the turbulent viscosity taken into account? Which was the $\nu_t$ value for the simulations? How were the source terms treated? How many elements has the computational grid? Which was the CFL used for the simulations?

Equations (23) and (24) reflect a general form of the SWE equations. In our model the turbulent viscosity was not taken into account, so in the final version of the paper these equations will be modified, eliminating the turbulent viscosity term in order to reflect with precision the model used.

The 2D model develops over the DEM with a grid of 1140 rows and 1541 cols, rendering 1.756.740 cells of 1x1 m.

In the numerical model the source terms are projected on the basis of the eigenvectors and they are added to the discretization. The CFL used is a fixed value of 0.8, and some explanation on this will be included in the final version of the paper.

Two new references will be included in the paper:

J. Murillo; P. García-Navarro; J. Burguete; and P. Brufau (2007). The influence of source terms on stability, accuracy and conservation in two-dimensional shallow flow simulation using triangular finite volumes, Int. J. Numer. Meth. Fluids, **54**:543-590

J. Murillo; P. García-Navarro; and J. Burguete (2008).Analysis of a second-order upwind method for the simulation of solute transport in 2D shallow water flow, Int. J. Numer. Meth. Fluids, **56**:661-686

Page 14 line 3-the authors compare the uniform flow with the 1d HEC_RAS model, but the type of flow is not specified ( uniform/steady?)

The mathematical models are uniform flow for the simplified 1D model and steady flow for the 1D HEC RAS model.

Page 14-line21- Figure 3 should be improved, the title axis should be added, together with the legend and the title for each set ( uniform, triangular, normal)

Figure 3 will be improved taking into consideration the comments of the reviewer.

Page 15 line 29- the convergence in figure 5 is not clear, the authors should say which is the error between the asymptotic value and the value after 1000 simulations, did the authors try with a larger number of simulations?

The asymptotic value is not known. We did not try with a larger number of simulations. The mean value of water depth after 1000 simulations is 4.27 m and the mean value of velocity after 1000 simulations is 1.81 m/s. What can be said is that the 95% confidence interval for the mean value of water depth after 1000 simulations is [4.24; 4.30] and that the 95% confidence interval for the mean value of velocity after 1000 simulations is [1.77; 1.85]. Taking into account the short amplitude of these intervals for practical purposes the authors decided not to try with more simulations.

Page 17-line 5- Figure 7 should be improved, the scales of the right figures should be reduced to better view the variations, the axis should be labelled in all 4 the figures.

Figure 7 will be improved taking into consideration the comments of the reviewer.

Page 17 line 25-figure 11 is not clear, the differences between the two models are not easy to understand. The authors should add a table with the mean error or unify the two figures in one in order to show the differences.

Figure 11 will be improved taking into consideration the comments of the reviewer.

Figure 12-13-14-15-16-17 are not clear, adding contour lines shall improve their readability, adding some more intervals in the legends should also improve. How were the 1D And 2D flooded map taken? Using the same GIS interface or using different tools? In figures 12 and 13 the 1D cross sections should be added.

The flooded maps were taken with the same GIS interface. Figures 12-13-14-15-16-17 will be improved taking into consideration the comments of the reviewer.

Page 18 line 10, which was the duration of the constant discharge step?.

The duration of each constant discharge step was 30 minutes.

Page 19 line 9-the authors refer to the dragging coefficient which was not introduced elsewhere in the text.

The dragging parameter was defined in page 4 line 14.

Why the severity analysis was not performed for the 1D models?

The velocity distribution along each cross section of the 1D model was considered to be too rough to allow a meaningful comparison with the 2D model in terms of severity. This comparison, though interesting, is out of the scope of the paper.

Figure 19 should be more commented by the authors. Why does the higher discharge, for a given severity level, give sometimes lower inundated area? Explain the data for a severity level of 1 and 2.

The reason for the fact that the higher discharge for a given severity level may give sometimes lower inundated area lies in the geometry of the riverbed and floodplains. The total flooded area (the sum of the areas for each severity level) is always higher for higher discharges. This effect will be commented in the final version of the paper, with emphasis on severity levels 1 and 2.