Prof. Jim Freer
Editor
Hydrology and Earth System Sciences

June 05th, 2015

Dear Prof. Freer,

We would like to acknowledge the revision of our work entitled "**Propagation of hydro-meteorological uncertainty in a model cascade framework to inundation prediction**".

Following your comment concerning the identified need to highlight the limitations of the uncertainty evaluation within the model chain, we have added these in the methodology and discussion and conclusion sections as requested. Particular attention has been given to build a clear recognition of what was and was not done in the work.

We hope that this new version of our manuscript proves to be worth of publication and thank the reviewers and yourself for your effort and time in this revision. In the following lines, we point out the parts of the sections that incorporate these changes and explain how (i.e. by writing our reply in red) and where (i.e. by giving line numbers) this has been addressed

Very best wishes,

Dr. Adrián Pedrozo-Acuña on behalf of all authors

**Editor Decision: Manuscript accepted with corrections**

R1: In the methodology section a better description of what was done/not done has been incorporated. As requested we have included an explanation of the lack of uncertainty evaluation at the hydrodynamic level of the model chain. This is found at Page 7 Line 3 to Line 14 and reads as follows:

“It should be noted that the model cascade contains several sources of uncertainty at every level of the numerical framework (meteorological, hydrological and hydrodynamic). However, the uncertainty evaluation is only carried out at the meteorological and hydrological levels of the model chain. This enables the investigation of how errors originated in the rainfall prediction interact at a catchment level, and propagate to determine a given inundation area and depth. Therefore, the aim is not to reproduce an observed extreme event, but to use a state of the art numerical framework to examine how errors aggregate in a hindcast scenario.

An uncertainty assessment is not carried out at the hydrodynamic level of the model cascade. Instead, the 2D hydrodynamic model is setup following recommendations of published guidelines for the best possible representation of the case study, more specifically with regards to the selected spatial resolution, boundary conditions and roughness values (see Asselman et al. 2008).”

R2: On the other hand, in order to provide a clearer specification of the contribution of our work, we have modified the discussion and conclusions section to highlight its overall purpose, as well as to be clear to the reader in terms of what we have and have not done.
We have acknowledged this fact in the following manner,

1. Firstly, at Page 18 Line 6 to Page 18 Line 30, and reads as follows:

“The utilised methodology was comprised of a Numerical Weather Prediction Model (NWP), a distributed rainfall-runoff model and a 2D hydrodynamic model. Thus, the numerical framework contains several sources of uncertainty at every level of the model cascade (meteorological, hydrological and hydrodynamic). The quantification of uncertainty was only carried out at the meteorological and hydrological levels of the model chain; from which non-behavioural ensemble members were removed based on the fit with observed data. In contrast, at the hydrodynamic level, the numerical model was setup in a deterministic way, following recommendations of published guidelines for a good representation of the case study, more specifically with regards to the selected spatial resolution, boundary conditions and roughness values (see Asselman et al. 2008). This was done as uncertainties at this level have been mainly ascribed to issues with model implementations and definition of free parameters (Beven et al. 2011). This enabled the assessment of uncertainty and its propagation, from a modelled rainfall event to a predicted flooded area and depth.

At the meteorological level, a multi-physics ensemble technique was utilised to evaluate the generation of epistemic uncertainties (designed to represent our limited knowledge of the processes generating precipitation in the lower troposphere). While in the hydrological model a multi-response validation was implemented by means of the definition of six sets of plausible parameters from past flood events. This was done in order to reduce the dimensionality of the parameter calibration problem (see Gupta et al., 2009). This procedure was preferred over a GLUE analysis (e.g. Pedrozo-Acuña et al., 2015), as the investigation was aimed to understand the propagation of uncertainty along the model chain.

It should be borne in mind that it is not easy to disaggregate the many sources of uncertainty within the model cascade. Thus, it is necessary to make assumptions about how to represent uncertainty.

Therefore, the assessment of hydro-meteorological model performance at the three levels is carried out through the estimation of skill scores."

2. Secondly, at Page 20 Line 7 to Line 18, and reads as follows:

"It should be pointed out that this methodology contains more uncertainties that were not considered or quantified in the generation of flood extent maps for this event. Results showed that a large amount of uncertainty exists in the NWP model, and such uncertainty can propagated and aggregated at the catchment level. Members of the ensemble were shown to differ significantly in terms of their cumulative precipitation, spatial distribution, river discharge, inundation depths and areas. The evolution of skill within the model cascade shows a complex aggregation of errors between models, suggesting that in valley-filling events hydro-meteorological uncertainty has a larger effect on inundation depths than that observed in estimated flood inundation extents.

It is advised that in the future, attention should be given to the assessment of hydro-meteorological uncertainty in a similar numerical framework applied to catchments with different morphological setting."

R3: In addition, along the same lines of this correction, we have also modified the abstract of the manuscript and now it reads as follows:

"This investigation aims to study the propagation of meteorological uncertainty within a cascade modelling approach to flood prediction. The methodology was comprised of a Numerical Weather Prediction Model (NWP), a distributed rainfall-runoff model and a 2D hydrodynamic model. The uncertainty evaluation was carried out at the meteorological and hydrological levels of the model chain, which enabled the investigation of how errors originated in the rainfall prediction, interact at a catchment level and propagate to an estimated inundation area and depth. For this, a hindcast scenario is utilised removing non-behavioural ensemble members at each stage, based on the fit with observed data. At the hydrodynamic level, an uncertainty assessment was not incorporated; instead, the model was setup following guidelines for the best possible representation of the case study. The selected extreme event corresponds to a flood that took place in the Southeast of Mexico during November 2009, for which field data (e.g. rain gauges; discharge) and satellite imagery were available. Uncertainty in the meteorological model was estimated by means of a multi-physics ensemble technique, which is designed to represent errors from our limited knowledge of the processes generating precipitation. In the hydrological model, a multi-response validation was implemented through the definition of six sets of plausible parameters from past flood events. Precipitation fields from the meteorological model were employed as input in a distributed hydrological model, and resulting flood hydrographs were used as forcing conditions in the 2D hydrodynamic model. The evolution of skill within the model cascade shows a complex aggregation of errors between models, suggesting that in valley-filling events hydro-meteorological uncertainty has a larger effect on inundation depths than that observed in estimated flood inundation extents."