AUTHOR'S RESPONSES TO GUIDO FELDER

These are the Authors' replies to comments from Guido Felder, received and published on 27th June, 2018. We use blue color for our replies and black color for the comments.

RESPONSES:

Firstly, we want to sincerely thank Guido Felder for the remarks and recommendations which will undoubtedly improve the quality and scope of the paper.

1) Isn't there a mismatch between the target audience ("dam owners and dam safety practitioners") and the presented approaches? If the article aims to provide information for the mentioned target audience, I doubt that a methodology as proposed in Figure 4 is very useful for them. There are probably not many dam owners or dam safety practitioners who are capable to conduct GCM runs and statistical or dynamical downscaling procedures. Moreover, many dams are built within a complex topography, where results from global analyses are less reliable, and a proper downscaling of extreme events is even more challenging. Maybe this is a bit beyond the scope, but the question arises who should provide such locally representative scenarios. Science, governmental agencies, dam owners or someone else? On the other hand, if the article aims to contribute to the scientific discussion, I would suggest to elaborate a bit more on the literature review, particularly regarding GCM downscaling procedures for extreme events and regarding the stationarity assumption in FFE.

Dam Risk Analysis is a useful tool that must interpellate owners, administrations, regulators, consultants, users, civil protection services and all type of related entities and agents in dam management (SPANCOLD, 2012). The approach presented in the paper summarizes the state of the art of techniques and methodologies available to perform required studies and, although not all dam owners or dam safety practitioners may be capable to conduct some of the proposed studies, other techniques are based on easily applicable works and can be conducted without much effort. The authors would like to avoid pre-established restrictions on what techniques can be applied and who can apply them. In this regard, the authors have participated in more than 40 dam safety analyses in the last 15 years (Escuder-Bueno et al., 2016; Morales-Torres et al., 2016; Serrano-Lombillo et al., 2017; Setrakian-Melgonian et al., 2017) where not only technicians were involved but also dam owners and managers.

On the other hand, the authors agree that a more detailed review on GCM downscaling procedures for extreme events and regarding the stationarity assumption in FFE can improve the scope of the paper and thus new references will be added to the final version of the paper.

2) From a system load perspective, figure 4 implies that a downscaling of extreme GCM scenarios (or even long term runs) is the only way to assess climate change impact on dam safety risk. What about other (less costly) approaches like non-stationary FFE, or the use of adapted stochastic weather generators?

The objective of presenting the approach of Figure 4 was not to state that this was the only way of assessing the effects of climate change on the analysis of floods, but more of an example proposition. Other methods like non-stationary FFE, or the use of adapted stochastic weather generators will also be included in the next version of the paper to widen the scope of the work.

The legend of the figure that appears in the manuscript is not accurate and should be changed to "Example of methodology for the frequency analysis of floods under climate scenarios."

3) The probability of dam failure from a hydro-meteorological point of view is not primarily a question of the peak inflow, it's more dependent on the total inflowing volume over a given amount of time. I would therefore suggest to mention the ongoing discussion on bivariate FFE methods as well.

The relative influence of both factors (peak inflow and total inflowing volume) and/or their combination on failure probability cannot be generalized as it will depend on each case. In this context, a broader assertion could be stated: the probability of dam failure is not **only** a question of the peak inflow **and** the total inflowing volume, but **also** depends on the dam-reservoir system's capacity to absorb such hydrological loads.

If we consider the overtopping failure mode, for instance, its probability of occurrence mainly depends on two connected dam-reservoir characteristics: insufficient flood storage capacity and inadequate spillway capacity (Lee and You, 2013; USBR, 2014). On this matter, a soon to be published work of the authors reveals the relative importance of both the peak discharge and the flood volume when assessing the overtopping probability.

However, the authors consider that the comment is very pertinent in the context of hydrological risk evaluation and thus a special mention of the bivariate flood frequency methodologies will be included in the text.

4) I'm not sure whether the climate change impact on land use change and surface roughness is relevant for this topic. First, most of the hydrodynamic models for flood mapping are calibrated using the roughness parameter. A change of such a calibrated parameter could cause non-linear changes in the simulated runoff, and might lead to wrong conclusions. Second, I would consider slight changes in roughness as negligible, considering the huge uncertainties that come along with FFE (not shown in Figures 2a and 2b) and other parts of the system load component. More generally spoken: can you say something about the sensitivity of the single components in Figure 1?

The authors consider that climatic and non-climatic drivers can have an influence in land use and, at a certain point, in roughness changes. In turn, these factors can affect the evolution of inundation floods downstream the dam (Bornschein and Pohl, 2018; De Roo et al., 2001).

Although we cannot a priori state that the influence of a specific factor of the risk model will or will not be negligible for the final risk assessment, what we can say is that it is not always advisable to perform a risk analysis with a maximum level of detail. In some cases, it is convenient to include only those that will induce a significant effect on the risk, which would help avoiding unnecessary work or

Indeed, sensitivity studies must be carried out to understand the influence of the components in the risk model approach, as mentioned in your comment. Regarding this, some works have been published (Chauhan and Bowles, 2018; Escuder-Bueno et al., 2017) although in general further advances in this field can still be done, in particular when considering the additional uncertainties introduced by climate change.

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