Response to reviewer 2

We thank the reviewer for their feedback on the manuscript and constructive comments. The reviewer's main concern relates to the choice of the statistical model used as a baseline. In particular, they question the chosen model (Chalise 2003) as being too simplistic and non-representative of current state of the art statistical models.

We agree with the reviewer that there are a wide selection of statistical models for the flow duration curve available, and that there are statistical models of greater sophistication than the method of Chalise which could (and should) be compared to the performance of process-based models. We intend to provide this richer context in the introduction of the revised paper. For the present study, however, we consider that the Chalise model is appropriate for comparison with the process based approach, for the following reasons:

(i)   The purpose of the study was to assess the operational value of a process-based approach as a tool to predict streamflow in ungauged basins in Nepal, a globally representative region in terms of gauge density. The method described by Chalise 2003 is (to our knowledge) the most recent statistical method specifically developed for and validated in the region. It is thus representative of the statistical approaches most likely to be used in the region for practical hydrological engineering purposes (given the local data availability constraints). In this sense it is also directly comparable to the process-based model, which we previously developed for and tested within the Nepal region.

(ii)   Our results show that under current climate, the statistical method (slightly) outperforms the process-based method for streamflow prediction in Nepal. This conclusion is unlikely to be altered by using a more advanced statistical approach (if anything, it would substantiate that conclusion). Similarly, the fact that process-based models are more robust to changing rainfall will presumably also hold for more advanced statistical models. Thus, we do not consider the choice of the relatively simple Chalise statistical model to bias the outcome of the comparison between models.

To make these points more explicit, we will modify the introduction of the revised manuscript as follows:

-    In the **introduction (**p9770 l.14): We will provide a more extensive discussion of the selected statistical method (Chalise 2003) with respect to the other more advanced approaches as described in Castellarin 2013. We

will provide a more extensive overview of the range of currently available statistical approaches and justify our choice of the selected method, namely that the approach is, to our knowledge, the most recent statistical method specifically developed and validated in the study region. While it may not represent current the state of the art in statistical approaches, we believe that the method is representative of the statistical approaches likely to be implemented in the region for practical hydrological engineering purposes.

- In the **conclusion**, we will clarify the fact that, although we believe that the selected models are appropriate to compare process-based and statistical approaches for practical PUB application in Nepal, this study cannot be interpreted as a general benchmark to compare these approaches at a global level. Substantial research remains to be done to compare these approaches in other parts of the world, where locally appropriate methods should be carefully considered.

Response to specific comments

1. Thanks for your comment. We changed the title to:

   Comparing statistical and process-based flow duration curve models in ungauged basins and changing rain regimes"

2. Please see our above comments on the selection of the Chalise method as a baseline. Further, we would argue that the regression parameters of the statistical model (i.e. annual rainfall, gauge altitude and the catchment area ratios occupied by each of the eight considered geological classes) are independent model parameters. Therefore, the dimensions of the approaches are similar (10 vs. 7 parameters).

3. Thanks for your comment: this application will be added to the introduction in the revised manuscript.

4. Thanks, this will be corrected in the revised manuscript.

5. Thanks for your comment. Following our understanding of the typology provided in Castellarin 2013, we use the term "index flow method" to describe approaches that (i) use a scaling factor to rescale the flow duration curve and (ii) assume that normalized FDCs do not vary within homogenous regions, except for the said scaling factor. Our understanding is that the scaling factor (i.e. the flow index) can be either deterministic (as in Chalise 2003 and Ganora 2009) or stochastic (as in Castellarin 2004b).

6. Thanks for your comment. However, we would like to point out that the model used to generate synthetic streamflow is *not* identical to the model used to derive the process-based model. The rainfall generator assumes a Markov process with gamma-distributed depths, which we showed in Muller 2013 reproduces well the rainfall observed in Nepal (see p 9780 l. 1-10). In contrast the process-based model assumes a marked-Poisson rainfall process with exponentially distributed depths: crucially, rain events are assumed uncorrelated in time.

   We understand that the statement on p 978 l.11 is conductive to confusion and will modify it as follows:

   > *By explicitly representing runoff generation processes, the stochastic dynamic framework used in the process-based model is an ideal tool to explore the resilience of flow regimes in catchment that follow its basic underlying assumptions **on recession behavior**.*

7. Thanks for your comments. We will modify the revised manuscript as follows:

- The caption of table 3 will be modified to locate the dependent and independent variables and explain the symbology describing the significance of the regression estimates (stars).

- Fig 4d-f and 5a-c: captions will be modified to better describe (rather than interpret) the graphs.

- The reference on p9785 l.3 will be changed to 5d, for which the following caption will be added:

   (d) Error duration curve showing the prediction errors of the statistical methods when the parameters are estimated using observed streamflow, instead of linear regression. Comparison with Figure 2b shows that interpolation uncertainties on the model parameters are the main source of error of the statistical method.

   - Caption of Fig 4c will be changed to :

   *(c) **The linear regression of the statistical model** underestimates….*