Reply to Reviewer 2

We thank for the comments and feedback provided by Reviewer 2. The responses to all the comments/questions raised by the reviewer are included below in **bold**.

General Overview:

The manuscript "Quantifying the Impacts of Land Cover Changes on Hydrological Responses in India" predicts the future impacts of Land Use Land Cover (LULC) change on hydrological regime, with uncertainties, in Mahanadi River basin, India, using Variable Infiltration Capacity (VIC) model. The manuscript is well structured, and the performed modelling experiment is theoretically sound.

The key contribution of the study is in quantifying the parameter uncertainty in predicting the impacts of LULC change on hydrological components. The impact on streamflow is the key focus in the study. My comments and questions on the manuscript are given below.

We would like to thank the reviewer for this positive feedback

Specific comments:

I feel that inclusion of Basin name in the title would make it more appropriate.

Thanks! We will include the basin name in the tile: "Quantifying the impacts of Land Cover Change on Hydrological Responses in the Mahanadi River Basin in India"

Results of the study indicate the importance of parameter uncertainty in assessing the hydrologic impacts of LULC change. In most of the sub-catchments the uncertainty is considerably large, highlighting the importance of considering uncertainty in such assessments. With uncertainty bounds, the quantified impacts are more realistic and useful to decision makers. However, in such studies the input uncertainty, due to uncertain land cover maps, is also important which is not included in the assessment. Categorical and positional uncertainties in LULC maps could increase the total uncertainty, and in some cases, the total uncertainty could be even higher than the net impacts.

We agree that the uncertain land cover maps could contribute to the total uncertainty. We use future land cover maps from the Land Use Harmonisation 2 (LUH2) database (Hurtt et al., 2011) which consists of six future scenarios (See Table S2). However, we use the information from a single scenario (RCP3. SSP4) because the percentage of land cover change relative to the baseline from other scenarios is either negligible or are comparable to our chosen scenario. Our chosen scenario shows the maximum changes in land cover; hence it was selected as the 'worst case' scenario for our simulations and will likely produce the largest impact.

It is mentioned that the conversion from forest to agriculture reduces ET (line 26, and 462). However, there may not be very significant net change in ET due to forest-to agriculture conversion. The additional moisture available during non-monsoon seasons due to irrigation could compensate the decreased LAI (due to conversion from forest to agriculture). The impact of such conversion will be only significant during monsoon season, when effect of irrigation is minimum. Since the irrigation was not considered in this study, the impacts on ET due to forest-agriculture conversion may not be very useful. However, this may not affect the assessment of impacts on runoff.

We thank the reviewer for this comment. Yes, we did not consider irrigation in our study, and we will add a further discussion related to this point in our revised version of the manuscript.

Authors mentioned that the recurrent flood events in the basin might be due to LULC change (line 31, 579). In my view, the LULC change has a little role in affecting the peak runoffs. With increased precipitation intensity the effect of LULC reduces, therefore during the episode of high precipitation which causes flood may not be affected by small scale LULC changes. Also, the precipitation is much more sensitive to affect runoff as compared to LULC. I believe that if the model is re-run with varying precipitation, instead of keeping it constant (line 337), the impact of LULC change may not be visible.

We agree with the reviewer, but we believe the addition of experiments with varying precipitation would likely distract readers from the main point of the paper and it is in fact beyond the scope of our study. However, for completeness, we will highlight this point in our revised manuscript.

The LULC proportions (%) mentioned in Table 3 are not summing to 100% in most of the cases, particularly for 'Salebhata'.

We thank the reviewer for pointing this out. This is a typo, and we will correct this in our revised version of the manuscript.

If the uncertainty assessment is included, does the model calibration add any value to the performance? Generally, the model parameters are perturbed between the feasible lower upper bounds by taking some probability distribution. In such case, is there any use of calibrated parameters?

We believe it does. Model calibration is an important aspect particularly to remove unwanted biases coming from the model structural deficiencies. We believe the fact that we have kept the uncertainty ranges coming from the most influential parameters allows us to evaluate the spread of calibrated model.

Please expand 'USGC' at line 194.

Thanks! This will be corrected to "United States Geological Survey (USGS)" in the revised manuscript.

The line 303 is not clear to me – 'The land cover maps from LUH2 are processed and converted to a LULC map of Mahanadi basin extent showing a single vegetation coverage at each grid cell of 0.25 and further converted to VIC grid size of 0.05 deg'. Does that mean each grid contains only one vegetation?

Thanks for pointing this out. We believe that the confusion may have been caused by the lack of clarity in the manuscript.
No, each grid contains more than one vegetation type, as VIC model maintains heterogeneity within the vegetation types.
The LUH2 approach estimates the gridded land use fractions, annually at a resolution of 0.25◦. The land use fraction maps are available for each land use type at a resolution of 0.25◦. So, we have first obtained LUH fraction maps of different LULC types for Mahanadi basin extent at a resolution of 0.25◦ and further re-gridded to VIC grid size of 0.05◦. Next, to run the VIC model, we have prepared a vegetation parameter file where we included the

fractional coverage of all LULC types for each grid cell ensuring that each grid will contain more than one vegetation type.

Please note, that there is not a 'single' spatial map available from LUH2 comprising of all LULC classes, which is why we have included figure 3 that shows spatial maps of 'individual' classes.

What is 'behavioural model'? Please explain.

There may exist 'equally probable parameter set' or 'behavioural set' that can yield equally good or acceptable model performance known as behavioural models, due to the complex interactions among the model parameters to represent the complex hydrological processes. This is known as equifinality and is considered as one of the main sources of uncertainty in hydrological modelling. We will make it clearer in our revised manuscript.

Please correct line 462 'Removal of forests at the **expense** of cropland…..'.

Thanks for the suggestion. We will change this line to "Removal of forests decreases the LAI of the natural vegetation and hence decreases ET".