Response to Reviewer's Comments

Manuscript: Reducing the basin vulnerability by land management practices under past and future climate: a case study of the Nam Ou River Basin, Lao PDR
Authors: M. Maharjan, M. S. Babel, S. Maskey
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We are thankful to the Anonymous Reviewers for their valuable comments on, and suggestions for, our paper. Below we provide our responses and the revisions made in the manuscript to address these comments. The changes/improvements in the revised manuscript are shown in RED in this document to facilitate the reviewing process.

Comment 1:
First, let me point the main similarities between Shrestha et al. (2013) and the paper under review. This paper:
-uses exactly the same SWAT model setup as in Shrestha et al. (2013);
-uses the same model calibration and validation results for both discharge and sediment as in Shrestha et al. (2013);
-also discusses the topic of the impact of climate change on discharge and sediment yield quantified using the same SWAT model in both cases;

What is new in the current paper compared to Shrestha et al. (2013)?
-it uses different (presumably more advanced, but this is not discussed) approach for downscaling of GCM climate scenarios; however this does not bring any new insight since, as the authors mention on p. 9878, line 11 "The result of climate projection from this study is comparable with that from Shrestha et al. (2013)...". Both papers admit that the uncertainty of climate projections leads to very uncertain projections of future flows and sediment yields.

-it uses a classification of critical sub-basins based on some thresholds on sediment yields taken from literature; there is nothing exciting in it, especially given that that the model resolution is so coarse (only 19 sub-basins per 30 000 km2);
-it quantifies the efficiency of 5 different land management practices aiming at reduction of sediment yield under current and future climate; this is the only really novel part compared to Shrestha et al. (2013). There have been lots of papers though that evaluated sediment BMP efficiency though (but very few under future climate => the authors should have emphasized this aspect more). The problem is that in my opinion it is too little (of essentially novel aspects) for a paper to be published in HESS.

Otherwise, as a person having expertise in SWAT modelling, I agree with most of the critical comments of the Reviewer 1 concerning the "proper use of SWAT" and too modest Discussion.

My evaluation would have been different if I hadn't been aware of the Shrestha et al. (2013) paper. I would have said that the paper is novel, interesting and worth publishing after minor/major revision. But this is not the case.

References

Shrestha, B., Babel, M. S., Maskey, S., van Griensven, A., Uhlenbrook, S., Green, A., and Akkharath, I.: Impact of climate change on sediment yield in the Mekong River basin: a case study of the Nam Ou basin, Lao PDR, Hydrol. Earth Syst. Sci., 17, 1–20, doi:10.5194/hess-17-1-2013, 2013.

Response 1:
Thank you for your valuable comments. The similarities and new things that have been pointed out in the interactive comment on this paper are correct and we agree with the reviewer. As acknowledged by Shrestha et al. (2013), the research conducted in the Nam Ou River Basin was a part of the first phase of the Post-Graduate Research Programme on Adaptation to Climate Change (PRoACC) project in the Mekong River Basin. This research was funded by the Dutch government. This was taken as the starting point for the MSc research of Maharjan (2012), the chief author of this paper. Thereafter, the research was extended as a part of the second phase of PRoACC. Thus, we would like to make it clear that the main idea of this paper is to link between these two components of the research for the PRoACC project. We do agree that the current paper is an extension of the first work reported in Shrestha et al. (2013). Additionally, we are also working on the similar theme and objectives in the Chi River Basin of Thailand, another sub-basin of the Mekong River basin. One objective of our research is to compare the results of the similar aspects between two projects.

The main comment from the Reviewer 2 is with respect to "what is new" in this paper, as compared to Shrestha et al. (2013)'s work. Since this research is an extension of Shrestha et al. (2013)'s work in the same river basin, the same calibrated and validated SWAT model was used in this paper as was used in Shrestha et al.'s. Having said that, we still strongly believe that there are many new aspects in this study which warrant its publication in HESS. In fact, in the authors' view, HESS readers would find it interesting to read a series of papers on the themes of erosion, sediment transport, land management practices under future climate etc. The following are the main points that outline the novelty of this paper:

- Shrestha et al. (2013) used four GCMs and one RCM for climate downscaling based on the performance in the simulation of precipitation in the 20^{th} century. Whereas, in this paper, three GCMs were systematically chosen after considering the results of the 15 GCMs incorporated in LARS-WG (Maharjan, 2012). The three selected GCMs represent the spectrum of expected change in precipitation (maximum change, average change and minimum change) in future projections out of the 15 GCMs to cover the uncertainty range of the GCMs.

- The downscaling technique used in this study is different from Shrestha et al. (2013). The downscaling of precipitation and temperature data was carried out using the simple delta change approach by Shrestha et al. (2013). This method takes into account changes in mean, maxima and minima of climate variable only but ignores the change in variability (Diaz-Nieto and Wilby, 2005). Such an approach assumes that the spatial pattern of climate change will remain constant. Using the simple delta change method does not change the temporal sequence of wet days, while changes in wet and dry spell might be important aspect of climate change. To amend that, in our study, LARS-WG was used to downscale the climatic information at the basin level. Through this approach, we were able to assess the impact of future climatic conditions on flows and sediment yield and to evaluate different land management practices to reduce the basin's vulnerability to soil erosion or sediment yield under past and future climates. LARS-WG is a more advanced downscaling technique and has been tested in adverse climates in various sites. Good performance in reproducing various weather events statistics including extreme events has been reported and better simulation results in downscaling of precipitation compared to delta change method has been reported (Coles, 2008).

- The results of future climate projections in our study and Shrestha et al.'s (2013) using two different techniques are similar in general, with respect to the direction of change. But there are significant differences in the magnitude of the change of precipitation and temperature. A detailed analysis of changes in terms of seasonal or monthly variation in precipitation and temperature ascertained that the results from these two research are different, though, as said earlier, change in direction (positive or negative) is similar. Thus, the statement in the original manuscript that "the results from Shrestha et al., (2013) are comparable…" means only the general similarities. We appreciate your comment which has helped us to highlight the results of the current study, and how these are different from Shrestha et al.'s. Hence, we have changed our statement in the revised manuscript.

- Coincidently, the CGCM3 GCM used in Shrestha et al. (2013) is also incorporated in LARS-WG and was one of the three selected GCMs in our study. However, the projections arrived at using two different downscaling techniques have shown significantly diverse results. This also supports the idea that climate projections from two different downscaling methods do not necessarily match. We will emphasize these differences in the revised manuscript.

- The classification of the sub-basins into different critical or vulnerable basins based on soil erosion or sediment yield thresholds under both past and future climate is novel in this paper. The results provide an overview of different levels of vulnerability under the three GCMs (which cover the range of uncertainty) and the three future periods in the study basin. Taking into account Reviewer 1's comment about the necessity of peer-reviewed journal articles related to classification schemes of critical sub-basins to better support our classification, we have added the details of classification and citation in the revised manuscript.

- The evaluation of five land management practices for reducing the basin's vulnerability under past and future climatic conditions is also new in this paper. In fact, this evaluation is the main objective of this paper. This has also been acknowledged by the reviewer. Five land management practices have been evaluated in this study to reduce the basin's vulnerability due to high sediment yield based. The vulnerability is based on the thresholds defined in the paper under the past climate, as outlined in the paper. The results of the reduction of sediment yield give the reader an idea about the effectiveness of various land management practices in sub-basins with different levels of vulnerability. The same approach was also applied in the future climatic conditions, under which there are higher number of vulnerable sub-basins under different GCMs and GHG emission scenarios. The reduction in sediment yield under future climate by different land management practices are assessed and it is found that some severely vulnerable sub-basins could not be brought up to a moderate level of vulnerability due to high sediment yields in the future. This indicates that the land management practices evaluated in this paper solely may not be effective for some future climate periods and the application of combination of two or more management practices is to be assessed in those cases. This information will be useful to planners and policy makers to manage the basin's vulnerability. To address the comments from the reviewer, the manuscript has been revised and a more focused and precise discussion has been added.

In the revised version of the manuscript, the authors will reduce overlapping parts that are already discussed in Shrestha et al. (2013) and will give more room to detail discussion on new results and added values of this manuscript.

Revisions in the manuscript:

The additional discussion in Section 4.1 of the original manuscript, which deals with the differences in results of the climate change projections of this paper, as compared to Shrestha et al. (2013), reads as such now:

For this study basin, the climate projections reported in Shrestha et al. (2013) are generally similar to our results in terms of the direction of change but there are differences in the magnitude of change and in seasonal variations. In the case of precipitation, both studies showed that there is no unidirectional change in future precipitation; which means that both decrease and increase in precipitation are observed in future climate depending on the choice of GCMs, GHGES and future periods considered. Shrestha et al. (2013) showed a remarkable increase of about 36% in precipitation under CGCM3.1 in the period 2041-2070. In contrast, this study showed that the highest increase in precipitation is only 26 % in the period 2080-2099 under HADCM3, which projected the highest change in precipitation among the 15 GCMs in LARS-WG. It is to be noted that the CGCM3 GCM was also incorporated in the 15 GCMs when extreme changes in future projections were quantified for selecting three GCMs in Maharjan (2012). This indicates that the maximum change projected by HADCM3 is comparatively lower than that projected by CGCM3.1 under different scenarios by Shrestha et al. (2013). In addition, our study showed a decrease in precipitation in the dry season (November to April) and increase in the wet season (May to October) in the future periods, which was not the case in Shrestha et al. (2013). The shift observed in the peak monthly precipitation from July to August in the future climate found in Shrestha et al. (2013) is not so distinct in this study. Similarly, in case of temperature, Shrestha et al. (2013) demonstrated decreases in projected temperature in months January, February and November which are different than the results of the current study as shown in Figure 4.

The delta change method (as used in Shrestha et al., 2013) is one of the simple bias correction methods commonly used in climate downscaling. It has the advantage of being simple and efficient. Its main limitation is that it takes into an account the changes in mean, maxima and minima of climate variables only but ignores the change in variability (Diaz-Nieto and Wilby, 2005). It assumes that temporal structure of the future climate scenarios remains remain constant. In this method the temporal sequence of wet days is not changed, while changes in wet and dry spell might be important aspect of climate change. Diaz-Nieto and Wilby (2005) also found that the heat wave (condition when daily maximum temperature is greater than 30^{o}C for 2 days continuously) also did not vary much under this method. In contrast, simulation of extreme weather events at different sites by Semenov (2008) showed that LARS- WG reproduces means of yearly maxima for daily precipitation and 10-20 year return values as well as yearly maxima for length of heat waves and its 10-20 year of return values. Semenov and Stratonovitch (2010) stated that LARS-WG has been tested in diverse climatic conditions and it demonstrates good performance in reproducing various extreme weather events. It is therefore not surprising that the LARS-WG simulation performed better for the simulation of precipitation, as compared to the delta change method (Coles, 2001).

Added references in the revised manuscript:

Coles, S: An introduction to statistical modeling of extreme values, Springer, Berlin, ISBN 1-85233-459-2, 2001.

Diaz-Nieto, J., Wilby, R. L.: A comparison of statistical downscaling and climate change factor methods: impacts on low flows in the River Thames, United Kingdom, J. Climatic Change, 69 (2-3), 245-268, 2005.

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