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Hydrology and Earth System Sciences Discussions

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Interactive Comment

Interactive comment on "Assessing the potential hydrological impact of the Gibe III Dam on Lake Turkana water level using multi-source satellite data" *by* N. M. Velpuri and G. B. Senay

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Author's Response to Referee's Comments by Nigel Wright

We would like to thank Dr. Wright for his constructive comments. The following response aims to address the comments provided.

Comment #1: Page 2992, line 9: the statement "any other lake of natural origin" seems very absolute. How can the authors be so sure?

Author's response: Agree. This sentence has been changed in the revised manuscript as: “Generally, the lake level fluctuates annually with amplitude of about 1–1.5 m, but it also undergoes considerable long-term variations when compared to other rift valley lakes in Africa.”

Comment #2: Choose whether to use "modeling" or "modelling" consistently throughout the paper.

Author’s response: Agree. Changes have been done. All words - ‘modeling’ will be replaced as ‘modelling’ in the revised manuscript.

Comment #3: At the end of section 2, I would expect more discussion on the uncertainty in each data source.

Author’s response: Certainly. A new section on uncertainty will be added in the revised manuscript.

Comment #4: ‘A multi-sensor approach’ - explain what these sensors are. Are they physical instruments?

Author’s response: In this study, we used data from multiple satellites and sensors and from multiple sources. Hence we used the term multi-sensor approach. The satellite data and sensors used in this study are listed in Table 1 in the manuscript. To make this clear, we will modify the sentence in the revised manuscript as ‘multi-satellite multi-source approach’

Comment #5: Page 2999, paragraph 1: this seems to be a large assumption and it should be discussed further here and in the conclusions.

Author’s response: We agree with the reviewer’s comment and we will elaborate on the assumption in section 3.4 and also in the conclusions as suggested. We assume that rainfall in the Lake Turkana basin is stationary and the long-term mean rainfall in the basin has not changed (no significant impact of climate change on rainfall). This assumption holds good as trends in annual and seasonal rainfall fall has not undergone any significant change in Ethiopia (Seleshi and Zanke, 2004; Cheung, et al., 2008).

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Hence we use historical data from 1961-2001 to calibrate the model runoff data (1998-2009) such that, simulated runoff using nonparametric bootstrap resampling approach would approximate the distribution (trend and magnitude) of the observed historical data (1964-2001). Furthermore, rainfall variability observed over the 12 year period (1998–2009) could represent much of the seasonal and annual rainfall-runoff distribution of the basin.

Comment #6: section 3.7: why was NBR chosen? Why not Monte Carlo or Latin Hypercube?

Author's response: NBR is one of the many approaches available for stochastic generation of hydrologic variables (Lall and Sharma, 1996; Hardle and Mammen, 2003). We used nonparametric bootstrap resample technique as this approach does not require a preselected statistical distribution. The NBR technique was first introduced by Efron et al. (1993) and has been widely used for the simulation of rainfall or inflows using historical data (Rajagopalan et al., 1997; Lall and Sharma, 1996; Srikanthan and McMahon, 2001).

In this study, we used a simple NBR method where the time series data of future scenarios are drawn at random from the data numerous times using the Monte Carlo approach. The NBR approach was used to resample values from the existing satellite data and Monte Carlo approach ensured that the generated variables captured the variability in the input/existing data.

Comment #7: Section 3.7: I would appreciate a broad-brush initial description before the full technical details. This would help those not already familiar with NBR.

Author's response: Certainly. A general introductory description on the nonparametric bootstrap resampling technique will be added to the revised manuscript.

Comment #8: Section 3.7.1, last sentence: where is this presented?

Author's response: The correlation between the predicted and altimetry data is presented in Figure 5. We will make changes in the revised manuscript to convey this message.

Comment #9: where is the comparison of the three approaches presented?

Author's response: We will present a new section where the results from the three approaches will be compared.

Comment #10: Page 3005: underestimation of 49% seems high to me and warrants more discussion.

Author's response: All satellite based rainfall estimates have uncertainty or bias in their estimates. This bias in satellite rainfall can be location specific (with respect elevation) or specific to the rain rate. It has been thoroughly studied that satellite based rainfall products such as PERSIANN underestimates by 50% (Bitew and Gebremicheal, 2009; Romilly and Gebremicheal, 2011), RFE underestimates by 50% (Dinku et al.,2008), while CMORPH tends to underestimate up to 32% (Bitew and Gebremicheal, 2009) and TMPA 3B42 underestimates by 16% (Dinku et al., 2010).

While there is different degree of bias in different satellite based rainfall estimates, the use satellite based rainfall estimates can be reliably used for hydrological studies especially to understand the anomalies in rainfall.

However, while using satellite based rainfall estimates for volumetric hydrologic studies (such as this study), it is very critical that the rainfall or runoff estimates are calibrated with the in situ observations. Such calibration procedure would ensure the bias in rainfall/runoff estimates are taken into account.

In this study, we used un-calibrated RFE data to model Lake Turkana inflows. Hence the bias in rainfall estimates is transferred to inflow estimates. Hence, the modelled un-calibrated inflows showed up to 46% of under-estimation. However, we addressed the under-estimation problem by calibrating the modelled estimates with in situ data (Figure 2 in manuscript).

Comment #11: Page 3006, line 5: this sentence needs clarifying. Is the figure of 400-500 m3/s referring to "dam moderated inflows" or "peak flows and...base flows"?

Author's response: Yes. The number represents dam moderated inflows. We understand that the sentence is not clear in the published manuscript and is leading to confusion. We will modify the sentence as follows:

"The model results show that because of the dam, the peak flows into the lake are reduced and dry season flow is increased with an average dam moderated flow rate of 400-500 m3/s (Fig. 3a)."

Comment # 12: The acronyms "BN", "AN" etc. are clearly familiar to the authors, but the paper would be more readable for others if these were replaced by the full description.

Author's response: Agree. Acronyms have been replaced by the full description in the revised manuscript.

Comment # 13: Section 4.5: the value of 0.76 seems low? Why is there the variation between R2 greater than 0.5 and those less than 0.5: more discussion of this would be interesting.

Author's response: In the manuscript, we presented cross-validation results in section 4.5. First, lake levels are predicted for each year using data from other years. Then modelled lake levels are compared with satellite altimetry based lake levels. Results showed combined R2 value of 0.76 for all the years. We believe that a R2 value of 0.76 is not low but reasonable particularly because lake levels for a year are simulated using data from the other years. This demonstrates the predictive capacity of the model.

In the published manuscript, we used a threshold of R2 = 0.5 only to classify performance of individual years. We want to make a case that the years that tend to be different from the median distribution would show low correlation than the year that tend to follow the median distribution or the long-term distribution.

We will make necessary changes in the revised manuscript to convey the message clearly.

Other minor comments: We will also address other minor comments (mostly typos) highlighted by the reviewer in the revised manuscript.

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