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Title: Title: Assessment of Integrated Watershed Health based on Natural Environment, Hydrology, Water Quality, and Aquatic Ecology
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Anonymous Referee #2

COMMENTS: This study assesses health condition of the Han River basin in South Korea based on monitoring data, water quantity and quality time series simulations of the SWAT model and an ensemble of indicators related to 6 components of the watershed landscape related to stream geomorphology, hydrology, water quality, aquatic habitat condition, and biological condition. The paper deals with an interesting topic which is watershed health condition. Indeed, there is a weak understanding of the complex processes and watershed components interactions that govern the healthy/unhealthy state of the watershed and such paper is needed to bridge the gap. This is a nice paper, well written and structured in a coherent way. But to my opinion, the approach needs to be improved by including an uncertainty assessment/analysis of the SWAT model.

Authors used SWAT model simulations for water quality and quantity time series reconstruction which in-turn were used for indicators and sub-index development, as stated in the first specific object of the paper. Rely on model simulation for developing these indicators may add uncertainty in the indicators and sub-indexes. In addition, the definition of the reference condition here is crucial and used as a kind of "threshold" to discriminate between healthy and unhealthy watershed condition. This choice is based on SWAT simulation without any uncertainty analysis. I would prefer to see an acceptable range of reference condition based on model uncertainty analysis rather a single value of reference indicator.

General

1. lines 314-316: Authors mentioned that surface water and lateral groundwater flow interactions were of major importance for the water balance in the Han River basin. In particular, infiltration, return flow, groundwater recharge were important factors for the whole hydrological cycle. These results were based on SWAT simulations. Again, in absence of model uncertainty analysis the contribution of these components to the total water balance may vary or change depending on the parameter of the model. Therefore, I don't think that metrics developed based on the above results can be used for establishing specific management objectives as stated by the authors in line 323.

   ● Response:
   (Lines 247-259) We added a new paragraph in 2.5.2 Calibration and validation of the model section as follows: "In this study, uncertainty analysis was performed for the hydrology using daily dam inflow using the SUFI-2 method. This method was chosen because of their applicability to both simple and complex hydrological models. SUFI-2 is convenient and easy to implement and widely used in hydrology (e.g., Freer et al., 1996; Cameron et al., 2000; Blazkova et al., 2002). In SUFI-2, parameter uncertainty accounts for all sources of uncertainty, e.g., input uncertainty, conceptual model uncertainty, and parameter uncertainty (Gupta et al., 2005). The degree to which uncertainties are accounted for is quantified by a measure referred to as the P factor, which is the percentage of measured data bracketed by the 95% prediction uncertainty (95PPU). Another measure quantifying the strength of a calibration or uncertainty analysis is the R factor which is the average thickness of the 95PPU band divided by the standard deviation of the measured data. The excellence of calibration and

prediction uncertainty is judged on the basis of the closeness of the P factor to 1 and the R factor to 0. For the uncertainty analysis, 20 parameters were selected by sensitivity analysis. In this study, three iterations were performed with 1,300 (100+200+1,000) model runs in each iteration. The coverages of measurements (P factor) and the average thickness (R factor) of the 95PPUs for model predictions were 0.79 and 0.32 for the dam inflow during calibration and validation periods."

(Lines 281-284) We added NSE with inverse discharge (1/Q) in Table 2. We added new sentences: "Additionally, model calibration and validation included the NSE with inverse discharge (1/Q) for low flow. The average NSE with inverse discharge (1/Q) during the calibration (2005–2009) and validation (2010–2014) periods was 0.35 at HSD, 0.53 at SYD, 0.30 at CJD, 0.54 at KCW, 0.47 at YJW, 0.69 at IPW, and 0.58 at PDD."

(Lines 607-612) We added new sentences about limitation of water quantity, quality data, and model input in Conclusion section as follows: "Finally, the limitations of this study include the simulation of the water quantity and quality data for a possible long term changes in the watershed model. Although the prediction of long-term water quantity and quality data using the modeling is essential to assess water resource systems, the hydrologic and water quality conditions cannot be projected perfectly due to uncertainties in the models, climate data and other inputs required for the simulations. However, the results of this study are useful in terms of identifying potential watershed health issues regarding ongoing watershed change."

We agree with your opinion. We know that the model is involved uncertainty, we tried to simulate spatial trends of water quantity and quality as successful as possible. The indicator score for the hydrology metric was re-scaled to normalize each sub-index score to a range from 0 to 1 using the percentile rank method. This index score shows the relative results for each standard watershed of the study area by calculating the various hydrologic components by the reference condition.