The authors would like to thank our reviewer, M. Herrnegger, for his critical evaluation and comments concerning our manuscript titled: *Hydro-climatic modelling of an ungauged basin in Kumasi, Ghana*.

The comments are in normal text and the responses are in bold italic.

General Comments

1. The authors state that the Owabi watershed has an area of 13 km². This number also corresponds to the map shown in Figure 2, when taking the scale bar into consideration (Side note: Legend and scale bar in Figure 1 are too small and not readable). However, Akoto and Abankwa (2014) and Ghana Hydro-Database (2017a) give an area of 60 and 69 km² for the Owabi reservoir catchment, which is about 5 times larger than the value used in the manuscript. Figure 1 shows the Owabi and Barakese reservoirs around Kumasi. The river network is provided by Ghana Hydro-Database (2017b). Unfortunately, catchment polygons are not available and a catchment delineation was not done for this review. As a size comparison the map includes two circles of 13 km² and 65 km². These circles do unfortunately not really shed light on the real catchment area, and from the map it remains unclear if the catchment area used in the manuscript is correct. There are however indications that the catchment area of 13 km² is not correct, at least if the aim is the modelling of the reservoir catchment: A long-term mean annual streamflow value of 0.073 m³/s is given by the authors (P14L15). This corresponds to a daily water yield of 6 300 m³. This number seems unrealistically too low for two reasons: (i) According to Ghana HydroDatabase (2017a) the reservoir has a storage volume of 2 600 000 m³. With the streamflow given by the authors, it would take over 400 days to fill the reservoir. A reservoir is normally not designed and dimensioned in this way. (ii) According to Erni (2007) the Owabi reservoir provides about 13 500 m³/d for drinking water. This number is over two times larger, compared to the water yield given by the authors. The streamflow in the manuscript would therefore not cover the water demand currently used for the water supply. These considerations ignore issues of residual or environmental flow, which would enhance the quantity of water needed to fill the reservoir or provide water for the water supply. In summary, a wrong catchment area implies that the results are to be reviewed in a critical way and are likely not showing what they should – the hydrological conditions of the Owabi catchment.

Response: The Owabi catchment indeed extends to about 69 km^2 area. The aim of the study was to model the hydrology of the 13 km^2 forest sub-catchment only. But after careful consideration of your comment, we have decided to incorporate the actual catchment area into the modelling. Hence the entire catchment covering 69 km^2 is now used. We have also re-run the SWAT ver2012 model and obtained an improved results consistent with values obtained by Erni (2007).

2. It is clear that data availability is a challenging aspect when modelling areas not only, but also in SSA. In the manuscript, missing discharge data is substituted by, very crudely, multiplying the daily rainfall data with a factor of 0.15, assuming a time

constant runoff ratio of 15 %. (Eq. (2) should be something like $Q_{e,t} = P_t * c * w$, with $Q_{e,t}$[m³/s] - estimated discharge of day t, P_t[mm/d] - rainfall of day t, c - runoff coefficient (0.15) and w - a factor to convert mm/d to m³/s, including catchment area). The estimated discharge is then used to tune or calibrate the model parameters. This procedure is not legit for several reasons. (i) It completely ignores that runoff ratios change with time (e.g at the beginning of the rainy season, depending on antecedent soil moisture conditions, rainfall intensities or vegetation cover etc., different runoff ratios will be found compared to the end of the rainy season; etc. - reasons why runoff ratios change with time are numerous). (ii) Discharge time series normally show recession curves or falling limbs after peaks that frequently have the orm of an exponential function. They are also continuous in time. Rainfall time series are in contrast discrete. Simply multiplying the rainfall data with a constant factor, especially with daily data, is not an appropriate method to generate an "estimated discharge", since the time series characteristics will be completely different. (iii) The estimated discharge (which is based on the rainfall) is used as comparison to tune model parameters of a model driven by the same input on which the “observed” discharge is based on. This is something like a circular reference and is problematic, to put it kindly. The authors do not, in any way, critically reflect their procedure.

Response: The observed streamflow generation method has been removed, as measured streamflow data from a the nearest gauge station (River Offin) is being used. This so as we employ the spatial proximity setting approach aimed at obtaining a more realistic streamflow data for our analysis.

3. In total, 36 years of historical meteorological data is available, of which 31 years are used for calibration and validation of the simulations (5 years are used as spin-up time). However, the data used is not consistent. About 1/3 of the time series of temperature and rainfall is based on reanalysis data. Judging from Figure 9, the “estimated discharge” seems to be systematically lower in the periods, in which reanalysis data is used (1985-1997/98) compared to periods in which station data is available. This can be a coincidence, but lastly cannot be verified, since the “observed” discharge data is intrinsically based on the (biased?) rainfall. Additional meteorological parameters (e.g. solar radiation or humidity) are taken completely from reanalysis data. The authors do also not critically discuss this. The additional meteorological data is probably used for estimating potential evapotranspiration (ETp). Why did the authors not use the simpler Hargreaves method also available in SWAT, in which "only" minimum and maximum daily temperature is needed, especially when having the climate projection simulations in mind?

Response: Previously, the Penman-Monteith method was used, which was based on rainfall, temperature, solar radiation and wind. However, the Hargreaves method is currently being used which requires only daily rainfall and temperature (maximum and minimum) for the new model run in both baseline and future projections. Observed climatological rainfall data developed by the Meteorology and Climate Science Unit of KNUST and reported in Aryee et al., (2017) is being used for the model. Although comparison of daily minimum and maximum temperatures (2000 – 2004) from the Owabi station and ECMWF data showed a

consistent agreement (R = 0.6), currently, we have used the nearest weather station data from Kumasi Airport to fill in the missing temperature gaps.

4. Uncertainties in the simulations are significant. Not necessarily evident in the objective criteria (e.g. Table 6, numbers in Fig. 6) but based on the fact that the discharge estimates used for calibration are not legit (see (2)). The trustworthiness of the model is low. With this model, the future runoff conditions are simulated based on a single climate model projection. Uncertainties in climate projections are, especially concerning precipitation, extremely large. Therefore more than one climate projection should be used as input, simply to get an idea about uncertainties concerning future changes. I also missed a critical discussion by the authors on this topic.

Response: The high pace of urbanisation and deforestation at the catchment led to the choice of the RCP8.5 as the projection scenario. Notwithstanding, we are also including trends in RCPs 2.6 and 4.5 in the revised manuscript. Uncertainties associated with the simulations will be reviewed and appropriately updated in the revised manuscript.

5. In this context, Table 7 shows the differences between historic and future simulations. Although there is some change in seasonality in rainfall, the annual sums do not differ significantly (1266 mm/a vs. 1234 mm/a). However, actual evapotranspiration (ETa) is reduced by over 62 %, from 671 mm/a to 366 mm/a! This seems unrealistic and the change is theoretically not reproducible. Since temperatures are expected to increase (e.g. Issahaku et al. 2016), it is likely that the potential ET will be of the same magnitude or, more probable, higher compared to current levels. So the energy available for evapotranspiration will likely increase. It could be that, compared to the past, more months show lower precipitation input, which could lead to lower ETa, since the system becomes water limited. However, this does not seem to be the case, since all months systematically show lower ETa values, independent of the precipitation sums (Table 7). The reason for the lower ETa is insufficiently analysed. The authors state that Penman - Monteith (check spelling in manuscript) was used to estimate ETp. This method is very data intensive and it is unclear, what data (e.g solar radiation, wind speed or humidity) was used for the future simulations.

Response: The spelling of Penman-Monteith has been modified in the manuscript. Due to the absence of solar radiation, wind and humidity data at the catchment, 10 meter wind (u) and net solar radiation data were obtained from ECMWF ERA-Interim. This led to the choice of the historic evapotranspiration estimation method to be the Penman-Monteith. For the future projections, only daily rainfall and maximum and minimum temperatures were used. However, in the modified script, the Hargreaves method is being used to ensure that both baseline and projection data are of the same type.

6. The Owabi catchment is located near the strongly growing Kumasi metropolis and is therefore exposed to significant human pressures. Changes in the land use and land cover in the catchment is an issue, as stated by the authors but also by Ameyaw and Dapaah (2017) or Forkuo and Frimpong (2012). The latter for example show for the Owabi catchment that the class “Built-up” increased by 26 % and 11 % in the periods 1986-2002 and 2002-2007. At the same time, the class “High Density Forest” was reduced by -23 % and -12 %. These changes took place in the period, for which the simulations were performed. These changes in LULC should be considered, not only for the past, but also for the future projections. (Side note: Why is there no land-use class “water” in Figure 2?)

Response: Different landuse scenarios will be developed for the future projections at the watershed. A new landuse data from the European Space Agency, which characterises the landuse change between 1992 to 2015 at 300 m spatial resolution, has been found be more suitable for the work. This is currently being employed in the study. Landuse category “water” is also presented in the modified manuscript.

REFERENCES

Aryee, J.N.A., Amekudzi, L.K., Quansah, E., Klutse, N.A.B., Atiah, W.A. and Yorke, C., 2017. Development of high spatial resolution rainfall data for Ghana. *International Journal of Climatology*.