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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Analysis of the combined and single effects of LULC and climate change on the streamflow of the Upper Blue Nile River Basin (UBNRB): Using statistical trend tests, remote sensing landcover maps and the SWAT model" *by* Dagnenet F. Mekonnen et al.

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Comments on "Analysis of the combined and single effects of L ULC and climate change on the streamflow of the Upper Blue Nile River Basin (UBNRB): Using statistical trend tests, remote sensing landcover maps and the SWAT model."

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Page 1 lines 18 to 19. "The LULC change detection findings indicate the conversion of forest land to cultivated land during the period 1973-2010". Comment Analysis of systematic transitions in Jedeb (Teferi et al. 2013), and Tana & Beles (Woldesenbet et al. 2017a) indicated that cultivation land is gained mainly from open grazing land though natural forest coverages is decreased over times.

Page 1 line 19. "Natural forest decreased from 17.4% to 14.4%, 12.2% and 15.6%" Comment What does 'Natural forest' here means, only natural or does it include plantations? There is a significant area that has undergone eucalyptus plantation, especially at upstream sub-catchments.

Page 1 lines 23 to 25. "The single effect of LULC change on streamflow analysis suggested that LULC change significantly affects surface run-off and base flow. This could be attributed to the 5.1 % reduction in forest coverage and 4.6% increase in cultivated land." Comment Woldesenbet et al. (2017a) indicated that cultivation land and woody shrubs at Tana and Beles watersheds are the main LULC classes which are significantly affecting surface runoff and groundwater components.

Page 2 lines 3 to 4. "The direct and indirect impacts brought by both LULC and climate change exacerbate the water scarcity of the Nile basin as they are the key factors that can modify the hydrology and water availability of the basin." Comment As your trend analysis for streamflow indicated significantly increasing trend during observed period, how come water is scarce due to LULC and climate change?

Page 2 31 to 34. "Although, substantial progress has been made in assessing the impacts of LULC and climate change on the hydrology of UBNRB, most studies focused on single aspects i.e., either analysing the statistical trend of precipitation and streamflow or analysing impacts of single factor LULC or climate change on the flow

(Gebremicael et al., 2013; Rientjes et al., 2011; Tekleab et al., 2014). Impacts by combined effects of LULC and climate changes are not well understood because their contributions are difficult to separate and vary regionally (Yin et al., 2017)." Comment A very recent study by Woldesenbet et al. (2017a) has assessed the impacts of individual LULC classes on water balance components for Tana and Beles sub-basins. This study is totally overlooked in the present discussion manuscript. Not only combined effect of historical LULC and climate changes, but also combined impacts of future LULC and climate change are not well reported in the upper Blue Nile Basin.

Page 4 lines 12 to 18. "The soil map developed by the Food and Agriculture Organization of the United Nations (FAO-UNESCO) at a scale of 1:5,000,000 downloaded from (http://www.fao.org/soils-portal/soil-survey/soil-maps-anddatabases/faounesco-soil-map-ofthe-world/en/) was used for SWAT model. The soil information such as soil textural and physiochemical properties needed for the SWAT model was extracted from Harmonized World Soil Database vl.2, a database that combines existing regional and national soil information (http://www.fao.org/soils-portal/soil-survey/soilmaps- and-databases/harmonized-world-soil-databasevl2/en/) in combination with.." Comment Worqlul et al. (2018) indicated that accurate spatial information of soil data is significant in hydrological modeling of LULC change. Federal Ministry of Water Irrigation and Electricity of Ethiopia has better soil map. Besides, the soil physical parameters could also be incorporated from many recent irrigation and hydropower design reports in the basin.

Page 4 lines 23 to 24. "Filling missed or gap records was the first task for any further meteorological data analysis. This task was performed using the inverse distance weighing (IDW) and regression methods, the best performed method was chosen .." Comment Poor station network and missing records of significant length are one of the problems of meteorological data in the study region. For this region, Woldesenbet et al. (2017b) suggested that the coefficient of correlation method is better than the inverse distance weighting method for filling in gaps in daily rainfall and temperatures. They

also indicated that the rainfall and temperature data are not satisfying the preconditions for using multiple linear regressions.

Page 8 lines 23 to 29. "Finally, after classifying the raw images of Landsat into different landcover classes, change detection which requires the comparison of independently produced classified images (Sing, 1989) was performed by the post-classification method. The post-classification change detection comparison was conducted to determine changes in LULC between two independently classified maps from images of two different dates." Comment Systematic transition from one LULC classes, net gain, losses and swap (Teferi et al. 2013) might help to understand the changes from one LULC classes to another rather than comparing percentage changes in individual LULC classes (which does not indicate spatial changes).

Page 13 lines 14 to 16. "The highest gain in bushes and shrubs was (0.3%) from 1973 to 1985, while the highest gain in forest coverage (3.4%) was recorded during the period 1995-2010. Water coverage remained unchanged from 1973 to 2010." Comment This might be due to eucalyptus plantation at homestead for fuel consumption or construction poles.

Page 13 lines 18 to 19 "The increased forest coverage and the reduction in cultivated land over the period 1995 to 2010 shows that the environment was recovering from the devastating drought and forest clearing for firewood and cultivation due to population growth." Comment Besides, farmers start converting cultivation land to eucalyptus plantation (See Teferi et al. 2013; Woldesenbet et al. 2017a).

Page 13 lines 21 to 25. "To summarize, during the period from 1973 to 2010, forest coverage declined by 1.8%, with both bushes and shrubs, as well as cultivated land increasing by 0.8% and 1 % respectively from the original 1973 level. This result agrees well with other local level studies (Gebrernicael et al., 2013; Rientjes et al., 2011; Teferi et al., 2013), which reported the dramatic changes in the natural vegetation cover resulting from the agricultural land." Comment Another recent study (Woldesenbet et al. 2017a) is overlooked.

Page 15 lines 11 to 13. "The highest Qs/Qt ratio (53.1 %) and the lowest Qb/Qt ratio (3.3%) was recorded with the LULC map of 1995. This could be attributed to the 5.1 % reduction in forest coverage and 4.6% increase in cultivated land with the 1995 LULC map as compared to the 1973 LULC map." Comment Woldesenbet et al. (2017a) identified that expansion of cultivation land and decline in woody shrubs are responsible for the increase in surface runoff and decrease in groundwater component at Tana and Beles watersheds.

Page 16 lines 28 to 30. "The combined results from three different approaches, namely statistical trend test, semi-distributed SWAT modelling and LULC change analysis, are consistent with the hypothesis that LULC change has modified the run-off generation process, which has caused the increase in streamflow of the UBNRB while the climate has remained unchanged." Comment In fact, the climate of Lake Tana and Beles watersheds have become wetter and warmer for the period 2010-2013 (Woldesenbet et al. 2017b).

Page 17 lines 2 to 5. The limitation of this study could be due to the uncertainty of the SWAT model, as the SWAT model does not adjust CN2 for slopes greater than 5%, which could be significant in areas where the majority of the area has a slope greater than 5%, such as UBNRB. Therefore, we suggest adjusting the CN2 values for slope > 5% outside of the SWAT model for further research. Comment The steeper the slope, the higher the CN2. On one hand, adjusting the CN2 values for slope greater than 5 % might increase the values of CN2. On the other hand, intensive terracing on the basin might counterbalance the increase in CN2 due to steeper slopes.

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