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Hydrology and Earth System Sciences Discussions

Interactive comment on "Changes in land cover and stream flows in Gilgel Abbay catchment, Upper Blue Nile basin – Ethiopia" *by* T. H. M. Rientjes et al.

T. H. M. Rientjes et al.

t.h.m.rientjes@utwente.nl

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Dear Editor,

Please find below and attached our reply to the comments of reviewer 1.

Kind regards

Tom

General comments - It is an interesting paper utilizing (i) RS data to detect land use change over 30 year period, (ii) statistical analysis to assess trends of runoff in the

same catchment. The interesting part of the paper is not clearly reflected, i.e., how results from (ii) supports or reject results from (i). It also lacks the discussion on physical processes that might happen because of land use change. Reply; we thank the reviewer for this observation and we have more extensively addressed the issue in the discussion and conclusion section.

A possibility to discuss physical processes is by a rainfall-runoff model, but could be a lot of work for this paper. Reply: Indeed applying a model requires quite some extra effort and possibly causes that the focus of this paper becomes weaker specifically when issues of model calibration (and uncertainty) have to be discussed.

- It does not add much to the research question(s) by extending part of the analysis (river flow trends) to neighboring catchments. Either make similar analysis to all catchments (land use change detection plus trend analysis), or give complete analysis to one catchment. Reply: We thank the reviewer for this comment. We agree to the suggestion and only focus on the Gilgel Abay for river flow trends since only for this catchment the remote sensing based land cover change assessment has been performed.

-Though the structure of the paper is good, the text doesn't follow a clear story line that links research question(s), material, methodology to results and discussion. Reply: We revised the manuscript and made the necessary improvements.

Specific comments - P9569, L3, give reasoning or justification that impact of land cover change decreases with catchment size increase. Reply: This statement reflects on scale issues in hydrology. From a scaling point of view, any change at a small scale (in space or time) will become less pronounced (or will even diminish) when effects are assessed at (much) larger scales. Changing land cover at a single plot is unlikely to be observable when assessment is at a catchment of regional (10 - 1000 km2) or fluvial scale (10.000 - 100.00 km2). We modified the text to better explain on the issue of scale.

- P9569, L6 to 16, is it wise to derive a generic conclusion on impact of land cover

change on runoff, if the process itself is physically controlled by the local context as stated in L 14-15. Re-phrase this paragraph, e.g., "different results" could be more meaningful than "inconsistent results" Reply: We appreciate the comment and have made the necessary modifications. In fact the entire paragraph has been rewritten.

- P9570, L5, see Tesemma et al.,2010, 0.1002/hyp.7893 in hydrological processes, is a relevant study in the same basin. Reply: We revisited the paper as suggested by the reviewer but we note that the paper by Tessema et al., (2010) has much wider and somewhat different scope than our paper although part of the work focuses on trend analyses of rainfall and runoff time series. In one part of the paper runoff time series are for Lake Tana outflow (Abay river). In the same article it is suggested that the Chara Chara weir affected flows from 1996 onwards thus constraining analysis if changes in land use may have impacted the hydrologic behavior of Lake Tana basin at large. We note that we have used similar techniques for trend analysis of rainfall and runoff time series.

- P9570, L8, update Gragne et al, 2008 to correct year. Reply; we thank the reviewer for this comment since, after reviewing the reference, we realized that a wrong manuscript title was mentioned. We made the necessary modification.

- P9571, L28, give more in depth discussion about the quality of the discharge series at Gilgel Abay, which actually derived from rating curve equations, in particular at high flood, and at low flow. How much is the uncertainty involved, and how this affects the answer of the core question - impact of land use change on runoff? Reply: We thank the reviewer for this important remark. We more extensively discuss results of time series correction and have added graphical results. We also discuss how errors may have affected results of land use change impacts. Since we only used corrected steam flow time series for further analysis this suggest that uncertainty by erroneous data only is small.

- P9573, L19, why not using a more recent image than 2001 if ground truthing is done

in 2008? Reply : After an extensive search of the Global Land Cover Facility it proved that no image was acquired during the dry season (Jan/Febr) that covered the entire Gilgel Abay area.

- P9576, L21, Q5, Q95, low index, high index, check definition. Reply:To our knowledge the definition is not wrong. Q5 indicates a 5% probability that this Q is exceeded during an observation while Q95 indicates the probability that Q is exceeded 95% for any time of observation. Therefore Q5 relates to high flows and Q95 relates to low flows.

- P9576, L21, could be more robust to use seasonal means (high or flood season or low or dry season) instead of single values for Q5, Q95. Reply : We calculated Q5 and Q95 to assess changes in high and low flows at daily time scales which is required in many applications such as flood studies. For analysis over larger time scales, we aggregated rainfall and stream flow at monthly time scales (which allow assessing intra-annual changes including dry and wet season changes) and presented results of MK-test and change detection.

- P9589, Table 2, WM appears two times, why? Reply: We corrected the table and WM is replaced by SL (shrub land))

- P9578, L20, discuss this results in relation to results given in literature for the same basin if not for the same catchment, see Bewket and Sterk 2005, Musefa (ITC thesis 2007), among others, ... Why results are different? Reply: The works mentioned by the reviewer do not focus on the Gilgel Abbay catchment. As such we hesitate to make a comparison. We now discuss results from Bewket and Sterk 2005 in our review section. The work by Musefa (ITC thesis 2007) was supervised by the first two authors but has some constrains by poor data availability.

- P9578, L23, why stream record not up to date? Reply: we only used data till 2005 since the gauged location in the Gilgel Abay was changed in that year. To the knowledge of the authors a rating curve has not been established for the new location and thus stream flow data is not reliable.

- P9593, Table 6, what is the reason of including Megech and Gumera? they are different catchments, and given information doesn't add much Reply: We have removed Megech and Gumera following the suggestion by the reviewer.

- P9579. Top paragraph. How these results influenced by quality of discharge data, in particular at high/low month, e.g., June? The results could well be attributed to inaccuracies of the rating curve. Please discuss critically. Reply: The reviewer addresses the issue of quality of discharge data for the second time. We refer to our comment made above. A description and a new figure on stream flow correction have been added.

- P9579. Top paragraph, perhaps interesting to compute and discuss results per season, e.g., low season, high season. Reply: We aggregated rainfall and stream flow at monthly time scales and presented results of MK-test and change detection. These results show changes in dry and wet seasons.

- P9579, L4 to L19, the sample size of 3 catchments is too small to derive generic results Reply: Following earlier suggestions, we have removed the descriptions of Gumera and Megech

- P9582. It is important to single out or assess the effect of rainfall to be able to infer impact of other parameters (e.g., land cover change) on catchment runoff. Reply : To reinforce results of our analysis, we included MK test for rainfall records on annual and monthly bases and linked observed trends in rainfall to that of streamflow.

- P9583, L25. The literature (e.g., on South-African catchments) shows that forest ET is higher compared to other vegetations, implies higher runoff for deforested catchments. Could you verify your conclusion against this? - Conclusion is a bit long, and not evidently strong Reply: We completely revised the conclusions section and have more extensively addressed aspects of hydrology and the water balance.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/7/C5361/2011/hessd-7-C5361-2011-

supplement.pdf

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 9567, 2010.