

## ***Interactive comment on “Hydrological characterization of watersheds in the Blue Nile Basin” by S. G. Gebrehiwot et al.***

**S. G. Gebrehiwot et al.**

solomon.gebreyohannis@vatten.slu.se

Received and published: 15 October 2010

Dear Editor, We are grateful to the reviewers for their suggestions about how to improve our paper. Based on their comments, we have made corrections to the paper with a focus on clarifying the methodology and the main points of the paper. We have also redone the statistics with a transformation of the categorical variables for use in multivariate analyses along with continuous variables. The details of our responses to reviewer 1 are presented below.

Comments from Reviewer 1.

C2995

General comment:

The paper seems to present statistical analysis of effects of watershed physical properties on hydrological responses of the Blue Nile using historical average values. Even though the study appears to be important, the manuscript has got major problems both in terms of articulating the objectives and research questions and choice of analysis methodology. I found the idea of characterizing the 32 sub-watersheds in a way that helps to understand which watershed variable significantly affects which hydrological responses to be very interesting. But, the idea of using regression analysis among categorical variables and continuous data based hydrological variables does not make sense. The results were not presented in a convincing way. Moreover, the manuscript is full of short unclear and incorrect sentences. To me the main message could be, despite lack of clarity in the manuscript, the need to classifying the 32 watersheds based on watershed properties (variables) that influence their hydrologic responses the most. Thereby one can understand the hydrology of the watersheds (Blue Nile Basin) and that the results can be used for land and water management planning purposes which could be significant contribution for the country under consideration. But because of these major flaws the authors may need to formulate their research questions and plan for adequate analysis tool.

With regards to the clarity of the message, we accept that there were problems of articulation in the original paper. We have tried to address these problems in the extensively revised version that lifts up the importance of characterizing differences in hydrological regime that relate to catchment topography, geology, land use and local climate. We hope that the amended paper has now achieved a standard of clarity and focus that is suitable for publication. As for the statistical methodology, we realized that the simple correlation analysis we presented as background to the multivariate analysis was inappropriate. To even start with simple regression analyses of categorical and continuous data in the same table was neither correct nor helpful, so we have removed that correlation analysis. We had specifically chosen multivariate analysis, because, as

C2996

we state page 7 line 20-28, and page 8 line 1-5 "...Multivariate analysis is capable of handling both categorical and continuous types of data in the same analysis (Eriksson et al., 2001; Gärdenas, 1998; and Eriksson et al., 1995)". In the process of double checking the literature on mixing categorical and continuous data in multivariate analyses, we discovered we had not recognized the need to make a suitable transformation of the categorical data due to the fact that the values for each categorical data type summed to 1. So we redid the multivariate analyses from the beginning as detailed on page 7 line 21-28, page 8 line 1-5 "...The first step was transforming the categorical data, which sums to one with a special log- transformation recommended by Wang et al. (2010), called log-ratio transformation. The log-ratio transformation is indicated in the figure attached. This transformation linearized the data and resolves the problem of proportions adding to unit one. The second step was centering and scaling of the variances to control variability caused by the different data types with different units. Centering and scaling is used to generate unit variance and control the differences in scales (Eriksson et al., 2001) given to each variable in the geology, soil and land use groups..."

Specific comment:

It was mentioned that the research is based on information from 1953-1964 (we think it is to say 1959-1963); which definitely have changed through the last half century. This brings that the strength of the study to be the methodology used in the study than the findings. The presentation of the results can be equally important but simply in order to show the soundness of the methodology.

Yes, the study is based on data recorded from 1959-1963. We appreciate that the reviewer recognizes the methods for characterization employed here are of interest in their own right for those who want to make hydrological characterizations in other places and time periods. We now emphasize this in the conclusion (page 12, line 16-18). We have also done more to document the methods used at that time. We appreciate that the referee pointed this out and we have given more space to describing

C2997

the methodology used for water level gauging, establishment of rating curves (page: 5, line 24-28) and meteorological data (page: 6, line 5-8).

Literature review part was not done to put the research under question in perspective, requiring more literature review and elaboration in support of the significance of your study.

We have tried to strengthen the use of the existing literature to define the significance of this study's findings. Some 6 more references are now cited, but the key is not so much the number as trying to use them effectively to support the message about the value of classifying the hydrological response of catchments.

In terms of writing, most of the paragraphs require rewritings (clarity of the message and logical flow of the sentences need to be given more attention). It is also very important to follow proper formatting of the paper for quality presentation. Some of the sub-topics create more confusion than enhancing the clarity of the research: like the sub topic "The USBR study and selection of watersheds" under Data and Methodology (read as Materials and Method).

We have rewritten the manuscript extensively to address the problem of clarity. We have redone the subheading structure to make it better support the development of ideas in the manuscript. This included removing the misleading subtopics in the methodology section (page 5-7). Data from 1959-1963 is valid for determining the hydrological response to different natural land use types, such as forest and grassland cover, that are now uncommon. We appreciate the concern that changes in climate, agricultural technologies, and progressive soil degradation may all be influencing the hydrological response of the catchment. Nonetheless we still feel that it is justified to carefully examine the USBR dataset due to its uniquely comprehensive spatial coverage of the region using consistent methodologies within a single project, so long as we are clear about the possibility that land use, soils and climate may have changed. We have presented this argument page 12 line 5-7. While natural forest and

C2998

grassland cover is currently less extensive than it was in 1960, it is still of relevance for management purposes to know what a greater extent of these natural land cover types could mean for dry season flows. If in the future, comparably comprehensive spatial data become available for present conditions, the manuscript we present here will facilitate comparison to the earlier situation.

Please also note the supplement to this comment:

<http://www.hydrol-earth-syst-sci-discuss.net/7/C2995/2010/hessd-7-C2995-2010-supplement.pdf>

---

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 4089, 2010.

C2999

$$t = \log \frac{x_i}{\sqrt{\prod_j x_j}} \quad (\text{Wang et al., 2010}).$$

**Fig. 1.** transformation equation

C3000