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Hydrology and Earth System Sciences Discussions

Interactive comment on "Surface and subsurface flow effect on permanent gully formation and upland erosion near Lake Tana in the Northern Highlands of Ethiopia" *by* T. Y. Tebebu et al.

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General comments

This paper reports the findings of a study of erosion processes in the Ethiopian Highlands. The paper is well written and provides valuable insights into the relative impact of gully and rill erosion. A few points:

- The estimated gully erosion rates in 2008 are acknowledged to be very high in comparison to rates measured elsewhere in the World but no explanation is given as to why this might be the case, nor indeed why the rates in this year appear to be much

higher than the historical average in the same catchment. There is no discussion of possible errors/accuracy in the measurements made. This is really needed to provide confidence that the very high rates presented are indeed credible.

- The mechanism of erosion through sub-surface flow seems plausible and probable and is supported by the evidence presented. However, it is still a supposition and so should be presented in this manner rather than as an absolute fact.

- The paper would benefit from being re-structured slightly with some of the information presented in the results section moved into the methods section.

Specific comments

Introduction

Page 5237 – I would debate the assertion (lines 13-14) that little has been done to promote soil conservation. Since 1985 the government of Ethiopia has run an ambitious soil and water conservation (SWC) program supported by donors and NGOs and backed by the largest food-for-work program in Africa (Hoben 1996). Today the Productive Safety Net Program continues to implement many SWC measures in places where food security is an issue. The results may be mixed but things are being attempted.

Material and methods

Page 5240 – It would be useful to include a slightly more detailed description of the general catchment including more detail of the land–cover and farming systems (e.g. what are typical slopes in the catchment?; what crops are grown, and at what time of year?; what is the land preparation and when does this occur?; what is the role of livestock in the catchment?; have there been any SWC measures (e.g. terracing) attempted in the past?)

Page 5241 (line 17) – what is the floodplain zone?

Page 5242 (line 24) – would be useful to include a comment on the accuracy of the

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GPS – a 2m positioning accuracy does not seem very great when trying to measure changes in a gully. It is not clear if the GPS was also used to measure differences in elevation, but GPS vertical accuracy is often a lot less than in the horizontal directions so may well have been less than the 2m indicated.

Page 5242 (line25-27) – it is not clear how the measurements of width, depth and length were made. Was this done with a tape measure and pegs? Were identical locations visited on the latter date? How many locations and how were they selected? This needs to be made clear.

Page 5243 (line 14) – would be useful to know when the rainy season commenced and how rainfall was determined. Were rain gauges installed in the catchment? More generally it would be good to know if rainfall in 2008 season was above or below average.

Page 5244 (line 3-7) – again would be useful to have a little more information on exactly how the measurements were made and how volumes and rates of erosion etc. were calculated.

Results

Page 5244 (line 14) – why did people move to this location in 1980? Why was it not occupied before this date? What was the indigenous vegetation? This information would be more usefully included in the site description rather than the results section.

Page 5244 (line 18) - were the springs perennial or ephemeral?

Page 5244 (line 24) – Fall of the Derg regime will not be understood by those readers who do not know Ethiopian history

Page 5244 (line 26) – it is not clear why people were “returning” from Debre –Mawi town. Again maybe this should be included in the site description rather than results.

Page 5245 (line 10) – what is the reason for the very abrupt rise in water level in P13 on approximately 30th August? It seems that on this date flow commenced in this arm of

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the southern branch. Is that correct? What about the spring (3) had this been flowing prior to this date?

Page 5245 (line 15-24) – as well as indicating the change in the width of the gully (bottom and top) it would also be useful to know the absolute values prior to and after the rainy season. Figure 5 shows the average water table depth at different locations. However, this is a bit confusing because 5a appears to show depth to the water table from the ground surface while b shows water table above the gulley bottom. Is this correct? If so it needs a bit better explanation. There are two P17s and two P24s shown in 5a.

Page 5245 (line 25) – this is a supposition? While seemingly plausible and reasonable is it possible to say this definitively without some sort of strength test? Maybe this should be put in the discussion.

Page 5246 (line 4) – the results shown in Figure 5 would suggest that it is not quite stable at P17 – there is some erosion although at a lot slower rate than lower down in the gully.

Page 5246 (line 8) – why is the gully depth in October 2008 not shown in figure 7a?

Page 5246 (line 20) – why is the gully depth in October 2008 not shown in figure 8a?

Page 5246 (line 26) What is not clear is why if the saprolite dams the water so lowering water table at 115 m, why this isn't also the case 263 m which is also down slope of the saprolite, but where there is significant erosion.

Page 5247 (line 6) – this is again a supposition? It might be best to put this in the discussion.

Page 5247 (lines 15-25) – this description of estimating eroded volume should really be in the methods section of the paper.

Page 5247 (line 21) – need to explain what is meant by representative cross sectional

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area.

Page 5248 (line 5-6) – it is not entirely clear how the erosion was estimated for the period 1981 to 2007. Presumably this is a combination of estimates based on what local informants have described and the 2005 Quick Bird image. Is the assumption simply that there was no gully before 1980? How was gully depth estimated from the QuickBird image? This needs to be explained in more detail.

Page 5248 (line 6) Table 1 – needs to be consistent with the main text. I presume the "Branches" are A and B and the Main stem (C)? It is not clear why results from A and B are not disaggregated?

Page 5248 (line 13) – It is not clear how the 27t ha-1 has been computed. This needs a better explanation in the methods section.

Page 5248 (line 23) – is the lower crop cover of tef early in the wet season a function of farming practice (i.e. the tef is planted slightly later than the other crops).

Page 5248 (line 25) - what is meant by rills "degrade"?

Discussion

Page 5249 (lines 4 – 14) – the estimated gully erosion for 2008 seems very high compared to estimates elsewhere in the World. Is there a plausible explanation as to why this might be so? Is it possible to make some estimate of error bars on the estimates to provide some indication of the confidence that can be placed in the values derived?

Page 5250 (line 4) – this is the first mention of livestock. It would be useful to give some indication of livestock numbers in the catchment and the possible role that they might play in erosion processes.

Page 5250 (line 22) – it would be interesting to learn if local people are concerned about the erosion and what if anything they are doing to try and reduce it.

Technical corrections

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Page 5239 (line 5) – replace “intervals” with “periods”

Page 5239 (line 8 and 9) – for highlands be consistent in use of upper case or lower case H.

Page 5240 (lines 12 and 13) – should be written in the past tense – explored and compared

Page 5242 (line 17) – delete during

Page 5244 (line 18) – add full stop after long

Page 5244 (line 21) – replace “most bottom” with “lowest”

Page 5245 (line 16) – replace “are” with “were”

Page 5246 (line 23) – remove the “n” from dam

Page 5249 (line 8) – spelling of Lesotho

Page 5250 (line 10) – add “ed” to the end of report

Page 5250 (line 24) – delete “to”

Page 5250 (line 26 – add “than” after greater

References

Hoben, A. 1996. The cultural construction of environmental policy: paradigms and policies in Ethiopia. In: The lie of the land: challenging received wisdom on the African environment ed. Leach, M.: London, Mearnsm R. The International African Institute 187-208.

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