

SUPPLEMENATRY MATERIAL

Detailed responses the comments of reviewer 1 and 2:

Below the comment is cited in bold and the response is given below in normal text. The changes are indicated in red

DETAILED RESPONSES REVIEWER 1

P9013 L12–17 For example, runoff coefficients () increase during ...sediment concentrations fall as the rainy season progresses, in..

Sentence was edited to read:

“For example, runoff coefficients (i.e., the portion of rainfall that becomes runoff) **increase** during the rainy season (Liu et al., 2008), while mean sediment concentration **fall** as the rainy season progress, in both the semi–arid and humid parts of the highlands of Ethiopia as well as in other countries with monsoonal climates (Vanmaercke et al., 20120; Mulugeta, 1988; Lootens and Lumbu, 1986; Sharma et al., 1984).”

P9013 L28 ...monthly trends that are well under...

Sentence was changed to make the sentence more clearly explain how monthly trends are the main time scale under which one can achieve predictable trends when using said models in the Ethiopian context:

“Models developed in temperate climates such as the Agricultural Non–Point Source (AGNPS) pollution model (Haregeweyn and Yohannes, 2003; Mohammed et al., 2004), the Soil and Water Assessment Tool (SWAT) (Setegn et al., 2008, 2011), and Water Erosion Prediction Project (WEPP; Zeleke, 2000) **can** only **predict** monthly trends well under Ethiopian conditions.

P9014 L13 ... quantify sediment concentration changes...

Sentence was edited to read:

“Our objective is to quantify sediment **concentration** changes in the Ethiopia Highlands by investigating the relationship between sediment concentration and discharge in three watersheds.”

P9014 L16 The three study watersheds...

Sentence was amended to include the word “study”:

“The three **study** watersheds are located in high rainfall areas in the Ethiopian highlands with elevation generally above 1500 m. (Hurni et al., 2005) where agriculture is dominant (Table 1).”

P9015 L5&L11 Anjeni catchment is 90%, or 80% cultivated? Later in the text 80% is used, suggest changing L5.

The Anjeni catchment is 70 % cultivated in the early 1980s and increases to 90% cultivated later in the 1990s. Thus, the catchment was on average 80% cultivated during the years and this is the value that was used later in the text. We will be more careful introducing these quantities in the text.

P9017 L6 ... sediment concentration samples...

...during the event...

Sentence was changed to include suggested changes:

“First, in a few instances, storms would occur and sediment concentration **samples** were not captured as frequently during the **events** as discharge measurements (Fig. A1).”

P9018 L2 Reference is Vanmaecke et al. (2010)

Sentence has been changed to include the correct spelling of the reference:

“Asselman (2000) indicates that the physical interpretation for these coefficients has varied from author to author, some attributing the *b*-coefficient to be indicative of the erosive power of the stream, while others, such as

Vanmaercke et al. (2010), attribute the b -coefficient as a measure of the extent to which new sediment sources become available.”

P9018 L15&L18–19 Information is repeated from L7–8. Remove the parenthetical definitions.

The parenthetical definitions were originally placed to reemphasize the definition of effective precipitation, but can be removed, below is the edited version of the passages as suggested:

“...whereby “if the number of days with positive **effective precipitation** within the last 30 days was greater than or equal to ten and the 30-day sum was positive, then the ‘rain season’ was initiated.” The rain season was considered to have stopped if the previous 14 days resulted in no days with positive **effective precipitation.**”

P9019 L5 ...helped group storms...

Sentenced was adjusted to include the suggested change:
“This demarcation **helped group** storms based on when they occur in terms of the progression of the rainy season (and perhaps tillage operations) rather than where they fall in the calendar year.”

P9019 L7 In addition, sediment concentrations were averaged over...

Sentence was adjusted to include the suggested changes:
“In addition, **sediment concentrations were averaged over** all storms occurring in a 14 day period to filter out the effect of extreme events and very small storms.”

P9019 L22 Remove “the” after “sediment load is”

The extra word “the” was removed after “sediment load is”:
“The **sediment load is** greatest for the watersheds in either July or August, although sediment concentrations are decreasing, showing that the increase in load is offset by greater increases in discharge (Fig. 2). “

P9020 L15 Change “if” to “whether”

Sentence was changed to include “whether” to replace “if”:
“Thus, at the same discharge we can have many concentrations values depending on **whether** the storm occurs at the beginning or the end of the rainy season.”

P9020 L20 Change “gave” to “give”

Sentence edited to include “give” instead of “gave”:
“These same factors **give** rise to low coefficients of determination in the biweekly timescale as well when plotting all data points together (Table 2; $R^2=0.14, 0.23, 0.02$ for Anjeni, Maybar, and Andit Tid respectively in column named “Group” for “ALL” points).”

P9025 Eq. 6 (P-E) was defined earlier as P_e (P9018 L7–8) Why not use that information here? AND, since $C_w = C_c$ from Eq. 4., why not make this variable C_{wc} ?

P9025 Eq. 7 C_w was defined previously in Eq.4, why not rename this variable C_{wo} ?

We changed the text as indicated in the introduction to this response.

Page 9023 starting at line 19–25 the text should have been: The authors argue that the value $b=0.4$ can be derived by assuming that the velocity and the concentration are linearly related in the stream power equation. Then by applying Manning’s equation and assuming that the width of the rill is larger than the depth of flow, the velocity, V , is related to the runoff depth per unit area as:

$$V = kR_d^{0.4} \quad (5)$$

where k is a constant. Thus, the sediment concentration, C_w , is related to the discharge per unit area to the 0.4 power.

Then on page 9025 line 11 to 20 should be replaced by: Thus the concentration per unit crop land C_c (averaged over a 14-day period) is

$$C_c = a_c^{P_{ce}} R_d^{0.4} \quad (6)$$

where $a_c^{P_{ce}}$ a function of the cumulative effective precipitation P_{ce} since the beginning of the rainy phase of the monsoon and R_d is the 14-day average storm runoff. Assuming that the remaining of the watershed is well protected and does not contribute significantly to the sediment load, the concentration at the watershed outlet, C_w , can then be written by combining Equation 4 and 6 relates to the C_c as

$$C_w = A_c a_c^{P_{ce}} R_d^{0.4} \quad (7)$$

where A_c is the fractional crop land area in the watershed. This fraction.....

P9025 L27 Previous reference was to Liu et al. 2008, you could include that here as well.

Sentence was adjusted to include additional reference:

“The Maybar site has the least average rainfall and an intermediate amount of land that is cultivated (60 %) compared to the other sites ($A_c=0.60$; Table 1; Hurni et al., 2005; [Liu et al., 2008](#)).”

P9026 L3 ...to Eq. (7) (Fig. 5).

Sentence was edited according to suggestion:

“To test if the fraction of cropland can normalize the data, we re-plotted the 14-day average storm sediment concentration data of Fig. 4 adjusted according to the fractional cropland area according to Eq. (7) ([Fig. 5](#)).”

P9026 L12 Remove “to” after “contribute”

Sentence was edited according to suggestion:

“The exponent for the early part was adjusted to 0.45, rising just above 0.4, which according to Ciesiolka et al., (1995), Paningbatan et al., (1995) and Sombatpanit et al., (1995) occurs when processes other than flow-driven erosion **contribute** significantly to the sediment supply, i.e. gully formation, tillage, rain-drop impact erosion, etc.”

P9026 L22 Remove “these” at beginning of line

Sentence was edited according to suggestion:

“For the early period ($P_{ce} < 150$), concentration values for discharge were limited to discharges below 0.45 mm day⁻¹ as **flows** above this were more indicative of the transition between the early and mid-rainfall period.”

P9026 L25–26 also, high variability is to be expected with...

Sentence was edited according to suggestion:

“Also, **high variability is to be expected** with the many years of changing land use in these watersheds.”

P9026 L28 Consequently, basing the exponent on physically...

Sentence was adjusted by removing extra words before “basing”:

“Consequently, **basing** the exponent on physically based derivations of Ciesiolka et al., (1995) and Yu et al., (1997) and normalizing by the fractional cropland has improved the fit and R² of the rating curves.”

P9027 L1 Remove “the” at beginning of the line

Sentence was adjusted by removing extra words before “fractional”:

“Consequently, basing the exponent on the physically based derivations of Ciesiolka et al., (1995) and Yu et al., (1997) and normalizing by **fractional** cropland has improved the fit and R² of the rating curves.”

P9027 L3 ...especially when compared to initial ...

Sentence was edited according to suggestion:

“The sediment concentration–discharge points become now quite tight around the theoretical rating curve line especially **when compared to** initial sediment concentration data plotted as a function of runoff amounts in Fig. 2.”

P9027 L4 ...amounts (Fig.2).

Sentence was edited according to suggestion:

“The sediment concentration–discharge points become now quite tight around the theoretical rating curve line especially when compared to initial sediment concentration data plotted as a function of runoff amounts **(Fig. 2).**”

P9028 L7 ...the high and low concentration values.

Sentence was adjusted by removing extra word:

“However, the high variability in concentration led to analysis on longer time scales and stratification of data in order to attempt to describe the **high and low concentration** values.”

P9028 L10 ...the high concentration low flow events occurred for rating curves calculated for the...

Sentence was adjusted according to the suggestion:

“. Also, it was shown that the **high concentration low flow events** occurred for the rating curves **calculated** for the beginning of the rainy season ($P_{ce} < 100\text{mm}$) whereas the low concentration high flow events occurred for the rating curves calculated for the end of the rainy season ($P_{ce} > 700\text{ mm}$).”

P9028 L12 Remove both “the” in the line

Sentence was adjusted according to the suggestion:

“ Also, it was shown that the high concentration low flow events occurred for the rating curves calculated for the beginning of the rainy season ($P_{ce} < 100\text{mm}$)

whereas low concentration high flow events occurred for rating curves calculated for the end of the rainy season ($P_{ce} > 700$ mm).”

P9028 L14–15 ...watersheds, possible explanations arise for decreasing concentrations throughout...

Sentence was reworded according to suggestion:

“Thus by grouping sediment concentrations into periods of different moisture regimes for the watersheds, possible explanations arise for decreasing concentrations throughout the main rainy monsoon phase.”

P9028 L18 Change “and” to “which”

Sentence was adjusted by replacing “and” with “which”:

“Based on these similarities and to account for the decrease, theoretical rating curves based on normalization of fractional cropland for each part of the rainy season (early, middle, late) were calculated which led to one set of parameters that could be used for the three watersheds.”

References not in text

We apologize for the oversight in the extra references in the reference list. After we removed parts of the paper to make it more readable we forgot to check the references again. We will add the references to the text if appropriate or remove them.

The citation for Tebebu et al., 2010 is

Tebebu, T.Y. Abiy, A.Z., Zegeye, A.D., Dahlke, H.E., Easton, Z.M, Tilahun S.A., Collick, A.S., Kidnau, S. Moges, S., Dadgari F. and Steenhuis T.S.: Surface and subsurface flow effect on permanent gully formation and upland erosion near Lake Tana in the northern highlands of Ethiopia. Hydrology and Earth Systems Science, 14 , 2207–2217, 2010.