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Characteristics and Onsite Financial Cost of Erosion in Abay Basin: *The Case study from Meja Watershed*

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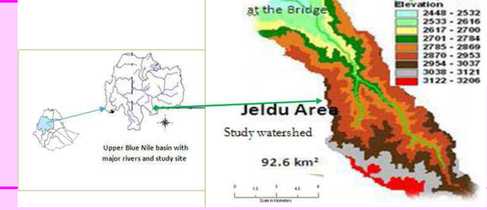

The Study watershed

Abstract

- Most erosion studies in the highlands are focused on quantification of sediment and lack specific information on its associated plant nutrients loss
- This study was quantified and characterized runoff along with estimated the onsite financial cost of erosion
- Daily runoff samples was collected at three monitoring stations during the rainy season
- Results indicate that both nutrient and sediment concentration vary with space and time
- Both sediment and nutrient loss was very hotspot at the beginning of rainy season
- The depletion of plant nutrients have profound economic implications in the survival of the poor of Meja watershed

1. Introduction

- In Meja watershed erosion by water resulting in significant loss of top fertile soil and plant nutrients during the flood period.
- This poses threat to the development of sustainable agriculture and crop water productivity of the area.
- Consequently a considerable area of cropland is currently unable to provide reasonable crop yield
- Though there are efforts but most of the researches in the highlands are focused on quantification of soil loss with little attention to the nutrients loss despite its importance
- This study was, therefore conducted with the objectives of (1) Quantifying suspended sediment concentration loss with runoff (2) Characterizing of sediment and runoff water samples for selected physical and chemical parameters (3) Estimating the onsite financial effect of due to the loss of major plant nutrients

Photo was taken during the cropping season but still almost bare since farmers lost hope to undertake farming activity because the land is severely degraded

Dam constructed on Meja River a year ago now crammed with sediment

2. Methods and Materials

Monitoring Stations Selection,

☞For monitoring runoff, sediment and nutrient losses; three monitoring stations were selected based on the availability of discharge measurement gages and the LULC of the upper contributing micro watersheds

Data Collection

The rivers discharge was measured directly by **Area - velocity** method and then **Q-d** rating curves were developed for each station.

- Depth-integrated runoff sampling was carried out every day on a kind of flow-proportional base starting from the beginning of July up to the offset of September
- To minimize cost and to get sufficient sediment sample, the 10 consecutive days samples were bulked as a representative sample.

Laboratory Analysis Analyzed Parameters

- Physical
  - SSC and TSY
  - sediment texture
- Chemical
  - SOM, Plant nutrients (TN, NH_4-N, NO_3-N and Pav,
  - Runoff water (dissolved NO_3, NH_3 and PO_4)

General procedures followed for financial lost calculation of erosion

Total amount of N and P fertilizer lost with sediment and runoff was determined

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The major crop that assumed to be grown in the upper catchment was identified

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Yield response calibrated curve was developed for those crops

⇩

Computing the Optimum grain and tuber yield with these amount of nutrient loss

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Converted these yield in to monetary values with existing market prices

So that the financial benefits that the farmers lost due to erosion can be calculated as:

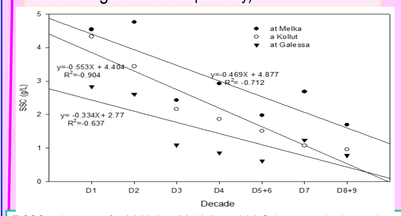
Lost benefit (ETB*) = Grain cost (ETB*/kg) X Estimated optimum total grain yield (Kg)/ lost nutrient

Here the cost of grain and tuber yield was from the existing market price rates and the yields were based on the yield response calibrated curves for each crop types in each station.

3. Result and Discussion

Temporal variability of SSC

The regression analysis between SC and sampling time indicated that it was strong relation in each station with (R^2=-0.71, -0.90 and -0.64 at Melka, Kollu and Galessa monitoring stations respectively)

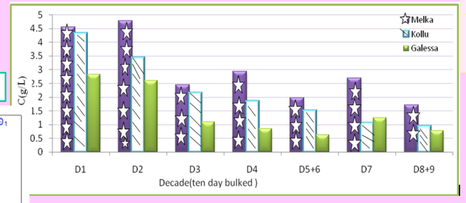


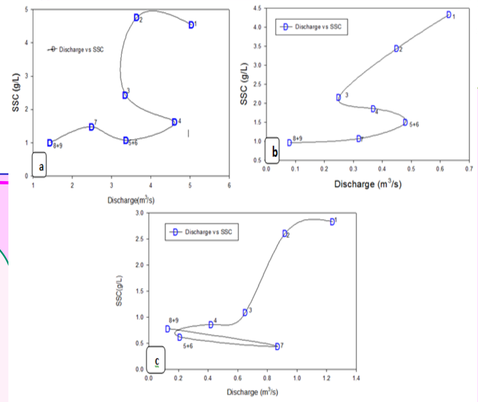
T-SSC rating curve for (a) Melka, (b) Kollu and (c) Galessa monitoring stations

Spatial variability of Sediment concentration among stations

Sampling station	Average SSC (gm/L)	Average discharge (m^3/s)	Total suspended sediment load loss (kg)(10^3)	SSC SD among stations	SSC CV(%) among stations
Melka	3	3.5	24611	1.2	120
kollu	2.2	0.3	2753	1.3	90
Galessa	1.4	0.6	683	0.9	80

Parametric test between SSC and monitoring station shows that there was statistically significant at p<=0.05 among the three stations





Q-SSC rating curve (a) for Melka, (b) for Kollu and (c) Galessa monitoring stations

- The above graph also shows that the relationship between sediment concentration and water discharge were scattered correlation (r^2=0.335, 0.559 and 0.533 for Melka, Kollu and Galessa stations respectively).
- Which typical of due to 'supply- limited' periods of the year when sediment may be more readily available than at other times

Deeply incised valley with intensive agriculture

Plant Nutrient Loss by Erosion from Meja Watershed

- Analysis of sediment and runoff samples from the three monitoring sites indicated that there was a significant amount of plant nutrients mainly TN, NH_4-N, NO_3-N, Available phosphorus (Pav) and organic matter was lost associated with the sediment and runoff water.

Station		Total lost during the study period from in the watershed							
		In Sediment (g/kg)					Dissolved in runoff water (g/L)		
		TN	NH_4-N		$P\text{-}P_2O_5$	SOC	NH_3-N	NO_3-N	$P\text{-}PO_4$
Melak	**Total**	**14.80**	**3.46**	**1.35**	**2.08**	**810.23**	**1.20**	**4.53**	**2.37**
	Mean	2.11±1.51	0.49±0.31	0.19±0.02	0.30±0.16	31.88±21.9	0.17±0.14	0.65±0.51	0.34±0.24
Kollu	**Total**	**10.08**	**1.32**	**0.42**	**1.44**	**14.18**	**1.12**	**2.92**	**0.82**
	Mean	1.44±1.53	0.27±0.19	0.27±0.16	0.21±0.12	2.3±2.0	0.16±0.06	0.46±0.25	0.22±0.14
Galesa	**Total**	**18.54**	**1.48**	**0.20**	**0.73**	**76.78**	**1.32**	**6.12**	**1.37**
	Mean	2.65±2.57	0.21± 0.2	0.03±0.02	0.10±0.09	10.97±8.45	0.19±0.13	0.87±0.56	0.20±0.17

Spatial and Temporal Variability of Nutrients Loss

- The statistical significance difference test in nutrient concentration among stations at 0.05 level of significant showed that there is significant difference for NO_3, NH_4, TN and OC among stations.
- This variation may come due to the LULC of the upper contributing areas of the stations
- For example the higher OC and TN at Galessa is due to is the addition of manure from livestock that visit the upper contributing catchment area where as the NO3, NH3 and PO4 is high at Melka station may because of the intensive crop production in the Ridge of Meja River
- While the mean statistical test at 0.01 level of significant showed that there is significant difference for NO_3 and NH_4 in each stations from the onset of July (D1) to the mid of August (D4) sampling period.
- But the general trend shows that highest concentration was observed at the start of the rainy season both in the sediment and runoff water

Onsite financial loss by erosion

Monitoring station	Total lost fertilizers (Kg/ha)		Estimated optimum total grain and/or tuber yield (Kg)/ha with lost		Assumed grown crop	Seed and/or tuber cost (ETB*/ Kg)	Subtotal lost benefit (ETB*)/ha	
	N	P	N	P			N	P
Melka	9	6	32	47	Barley	7.50	240	356
Kollu	17	5	25	43	Barley	7.50	187	323
Galessa	3	3	210	340	Potato	4.50	945	1530

- Then based on cropping pattern data; Potato was the major crop type grown at Galessa and barley for Melka and Kollu station of upper catchment areas.
- The table shows that there was the loss of 9,17 and 3 of N and 6,5 and 3 Kg/ha of P fertilizer from Melka, Kollu and Galessa micro watersheds.
- So that it answers the economic benefits lost to the local people if they were applied this lost amount of N and P nutrients for the production of these crops in their farmlands
- Hence when we scale up this catastrophe in to the watershed scale; this has been noted to reduce income of farmer's by 595 birr/ha, 510 and 2475 birr because of only N and P nutrient losses from Meja , Kollu and Galesssa sub catchments respectively in the watershed as a result of erosion only in one particular rainy season.

4. Conclusion and Recommendation

- Analysis of runoff samples indicated that the loss of sediment and plant nutrients associated with runoff was one of the challenges for sustainable crop-water productivity for Meja watershed.
- From the general observation; both SSC and nutrient concentration were highly variable both in time and location situations.
- High erosion hazards were observed at the beginning of rainy season and
- The lower and middle part of the watershed was relatively severed or hotspot areas than the upper sub catchments of Galessa .
- Therefore any interventions better to give priority to those erosion prone indentified areas and when erosion is more hazardous
- Runoff water harvesting should be an opportunity cost to maximize production and simultaneously to minimize erosion risks

Acknowledgement

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