Variability of Sediment-fixed Nutrient Export from a Micro-Watershed in Northern Ethiopia

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The downslope sediment-fixed nutrients flow causes *in-situ* soil nutrient depletion. We assessed nutrient movement through water erosion from different land use types and landscape positions. Using a nested hierarchical approach, runoff samples were collected from first-order stream outlets of an 18 km^2 micro-watershed (Maileba, Figure 1) in northern Ethiopia. Micro-watershed here refers to a watershed with an area covering less than 25 km^2 and whose rivers or streams are draining towards one outlet. The analytical results indicated that the micro-watershed had a total soil loss rate of about 3820 t yr^{-1} of which about 1299 t yr^{-1} was estimated to be a sediment export rate out of the watershed, the remaining 2521 t yr^{-1} estimated to be deposition (Table 1).

Table 1. Sheet, rill and gully erosion, sediment deposition and export rates (t yr^{-1}) from the land uses of the Maileba micro-watershed (18 km^2).

Process	Landscape position	Cropland	Rangeland	Exclosure	Gully erosion	Specific rate (t $ha^{-1}yr^{-1}$)	Total rate (t yr^{-1})
	Lower	701	391	19	454	14.6	1564
	Middle	558	427	11	359	15.5	1355
Erosion	Upper	350	283	19	249	14.8	901
	Lower	425	294	133	305	9.6	1156
	Middle	338	165	105	242	9.8	851
Deposition	Upper	212	301	73	167	13.3	753
	Lower	276	-	-	321	6.2	596
	Middle	220	-	-	254	5.7	505
Export	Upper	138	-	-	176	3.0	198

The sediment-fixed nutrient export was estimated at 28.3 kg nitrogen (N) $ha^{-1}yr^{-1}$ from the cropland (Table 2) and 17.9 kg N $ha^{-1}yr^{-1}$ from the rangeland. The available phosphorus (P) export was about 0.6 kg P $ha^{-1}yr^{-1}$ from both the crop and range lands. The estimated exchangeable potassium (K) export was 8.5 kg K $ha^{-1}yr^{-1}$ from the cropland and 5.4 kg K $ha^{-1}yr^{-1}$ from the rangeland.

Table 2. Sediment-fixed nutrient export (kg $ha^{-1}yr^{-1}$) from major land uses of the study watershed catchment.

Landscape position	N_{tot}*		P_{av}		K_{exch}	
	Cropland	Rangeland	Cropland	Rangeland	Cropland	Rangeland
Lower	11.7	7.4	0.2	0.3	3.5	2.2
Middle	10.9	6.9	0.2	0.2	3.3	2.1
Upper	5.7	3.6	0.1	0.1	1.7	1.1
Total	28.3	17.9	0.6	0.6	8.5	5.4

* N_{tot}, total nitrogen; P_{av}, available phosphorus; K_{exch}, exchangeable potassium.

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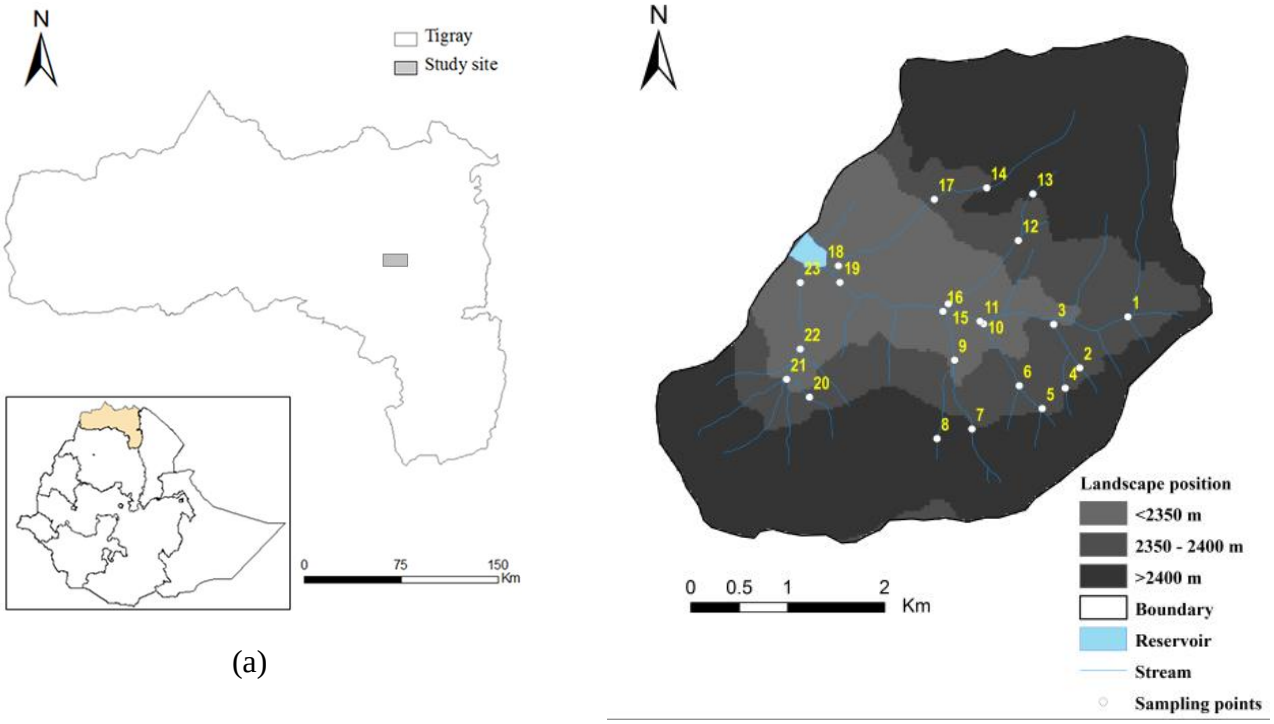

Figure 1. Location of the study area: (a) Study site in Tigray region of northern Ethiopia (inset), (b) Study landscape positions and runoff sampling points at Maileba micro-watershed in Tigray region.

The runoff, once entering the gullies, practically bypasses the middle and lower landscape positions and exports the sediments out of the watershed. An understanding of the variability of soil erosion and deposition rates among sub-watersheds is important. The middle landscape position acts as a runoff transfer zone from the upper to the lower landscape position and this could be a potential position to start diverting runoff to enhance sediment deposition at selected land use types where appropriate. However, there is little experience and research information on channeling of the runoff from gullies to other land use types.

This situation calls for more research on runoff nutrient monitoring and on fine-tuning of action plans with a focus on runoff channeling and sediment harvesting schemes into farm lands, in order to curb the problem of nutrient loss and depletion in the northern Ethiopian highlands.