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Effect of Human Settlement and Altitude on Rangeland Herbaceous Species Biodiversity and Productivity in Kafta-Humera Woreda, Tigray, Ethiopia

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Abstract
This research was conducted in Kafta-Humera districts of the Northern Ethiopia with the objective to determine the effect of human settlement on rangeland productivity and biodiversity under three altitudinal ranges (600-1000, >1000-1400 and >1400-1800 m.a.s.l.) and along three distance intervals near (0-2 km), middle (2-4 km) and far (4-6 km) from settlement. Vegetation and soil data was analyzed by Statistical Package for Social Sciences. In the study districts, a total of 39, 30 and 15 species of grasses, forbs and herbaceous legumes species were identified, respectively. Species diversity and species richness in higher altitude were significantly higher than middle and lower altitudes. Species diversity and species richness were lower near to settlement than far distance from settlement. Grass biomass of near, middle and far distance from settlement were 113.59, 622 and 1102.56 kg ha^{-1} respectively. Similarly, grass biomasses of the low, middle and upper altitude were 349.8, 542.7 and 945.7 kg ha^{-1}, respectively. Far distance from settlement had significantly higher in organic matter, available phosphorus and available potassium than middle and near distance from settlement. The upper altitude had significantly higher in organic matter, available phosphorus and available potassium than the lower and middle altitude. Generally, the study area was highly dominated by the annual herbaceous species. This implies that there is undergoing reduction in soil quality, biodiversity and productivity degradation. Therefore, appropriate plan of soil and biodiversity conservation such as establishing, designing and implementations of watershed management for physical and biological conservation should be planned to minimize loss of biodiversity.
Keywords: Settlement, plant Species composition, plant species abundance, plant Species diversity, biomass production, basal cover, soil properties

1. Introduction

Settlement is defined as the integrator of human and environmental interactions in pastoral systems (Coppolillo, 2000; 2001). Settlement is done through government policies or natural calamities such as drought and natural disasters or due to increasing grazing land as the resulted in to concentration of livestock around the settlement area and water points and ending up with highly plant biodiversity degradation, soil degradation and over grazing (Jeffrey, 2007).

Settlement in Ethiopia was started during the Haile Selassie regime in the year 1966 (Desalegn, 2003). During the Military regime, resettlement was strengthened and by the current Ethiopian government has been considered as a principal strategy (FDRE, 2006).

Kafta-Humera rangeland is one of the vast rangelands in the north western lowland boundary of the country with area of 160,650 hectares and which has been subjected to varying degrees of disturbance like to vegetation and soil degradation (Hailesilassie, 1998; Gebrehaweria, 2011). It is important to have basic information on the effect human migrations from highland to lowland areas on rangeland biomass dynamics, biodiversity, soil characteristics in particular and rangeland degradation as these facilitate the efficient and effective use of rangeland resources. Accordingly, for successful livestock production, sustainable resource utilization and conservation of rangeland biodiversity, knowledge of productivity and biodiversity of the rangeland is important.

Therefore this study was conducted with the follow specific objectives:

- To determine the effect of human settlement on herbaceous species composition, plant abundance and species diversity under three altitudinal range sand distance away from human settlement in Kafta-Humera district of northern Ethiopia; and
- To investigate the effect of human settlement on rangeland biomass production and soil characteristics, as well as percentage of basal cover and bare ground under three altitudinal ranges and distance away from human settlement in Kafta-Humera district of northern Ethiopia;

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted in Kafta-Humera District of Tigray National Regional State in north-western Ethiopia

(Figure 1).

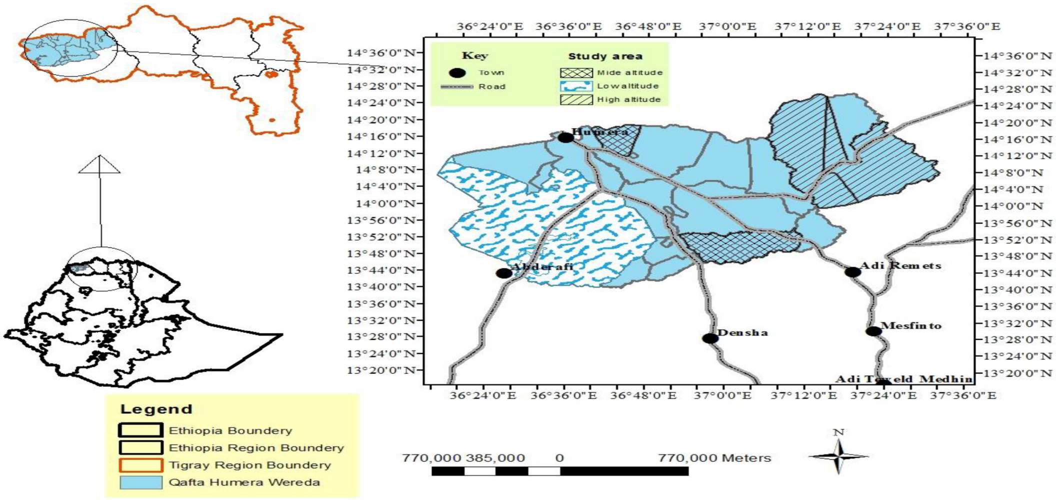

Figure 1: Location of Kafta-Humera, the study area

Kafta-Humera district is situated in the North West corner of Tigray regional state which is located 954 km north of Addis Ababa. The District is located between 13^{0}40'and 14^{0}27'N, and 36^{0}27'and 37^{0}32'E. It covers an area of 160650 ha and its altitude ranges from 560 to 1849 m.a.s.l. The mean maximum temperature varied from 41.7^{0}C - 33^{0}C while the mean minimum temperature varied from 22.2^{0}C - 17.5^{0}C. The rainfall ranges from 448.8 - 1102.5 mm (Hailesilassie, 1998; EARO, 2002).

2.2. Methods of Data Collection

Herbaceous species composition, plant abundance, species richness, aboveground biomass, the percentage of basal and bare ground covers was quantified in 1 m^2 quadrat. Five 1m by 1m quadrats were taken randomly locations per plots and sixty 1 m^2 quadrats per distance interval from settlements, a total of 540 numbers of observations (3 attitudes x 3 distance interval x 60 quadrats) in the study areas. Percentage of basal cover and bare ground were recorded using visual estimation. Dry matter yield was calculated according to ILCA (1990). The species diversity, as Shannon diversity and species evenness was calculated according to Shannon - Wiener diversity index (Magurran, 2004). Species composition similarity among distance interval was estimated by the model Jaccard coefficient of similarity using the present or absent of species according to Krebs (1998). Three composite soil samples in each distance interval under each altitudinal ranges were pooled and yielding a total of 27 soil samples.

2.3. Statistical Analysis

Ordination of sampling sites under the three altitude and three distance intervals from settlements was done by multivariate techniques, using Conoco (Ter Braak, 1997). Ordination species was done by a Principal Component Analysis (PCA). In addition, the correlations of soil parameters with the herbaceous species were done using a Redundancy Analysis (RDA).

The diversity indices for herbaceous vegetation, plant abundance of each species and species evenness data were estimated using PAST software (Koleff *et al*., 2003).

To test differences in species diversity, plant abundance, basal and bare ground covers, soil characteristics and biomass production, a General Linear Model (GLM) was applied using SPSS software (version.16) with altitude, distance from settlement and their interaction as independent factors. Moreover, Jaccard coefficient of similarity (Magurran, 2004) was used to test the differences on similarities in species compositions along altitudinal ranges and distance from settlement. Tukey multiple comparison was used to test significant differences among the means.

3. Results and Discussion

3.1. Herbaceous species

3.1.1. Herbaceous species composition and functional groups

A total of 84 herbaceous species were identified in the study area. The number of grass, herbaceous legumes and forbs were 39 (46%), 15 (18%) and 30 (36%), respectively (Table 1). Out of these 39 grass species 25 (64%) were identified as annual species whereas 14 (35.6%) were perennial grass species. The ordination result showed a clear separation of the 9 sampling sites for the herbaceous species, as the three altitudinal ranges are separately clustered from each other in Kafta-Humera rangelands (Figure 2a), indicating each altitudinal range was different in terms of herbaceous species composition. The first and the second ordination axis explained cumulatively 64% of the total variance extracted by the Principal Component Analysis (PCA). Moreover, the result of the 9 sampling sites x soil parameter using Redundancy Analysis (RDA) showed higher relationships with herbaceous species on the first and second ordination axes with a correlation coefficient of 0.991 and 0.989, respectively. The first and second ordination axis explained 53.1 and 75.6% of the total variance extracted by the RDA, respectively (Figure 2b).

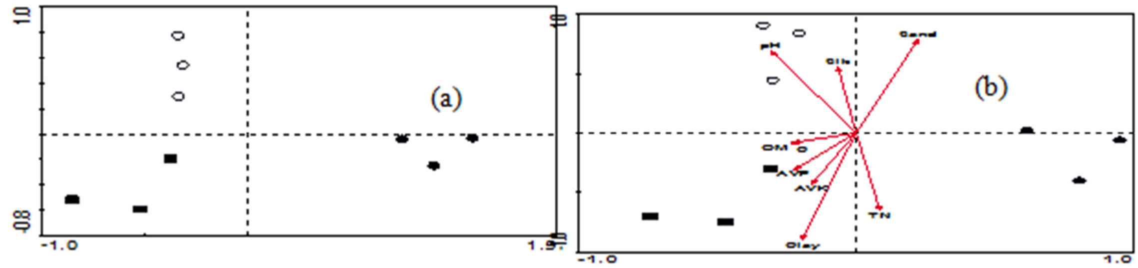

Figure 2: Ordination diagram of the nine sample sites for herbaceous species (a) and sampling sites x soil parameters for herbaceous (b) under three altitudinal ranges(open circles = low altitude; filled circles = mid altitude and filled squares = high altitude)

Table 1: List of herbaceous species with their relative abundance (nm^{-2}), life forms (LF) and functional group (FG) under three altitudinal rages (m.a.s.l.) three distances (km) away from human settlement in Kafta-Humera rangelands, northern Ethiopia

	Altitudinal Ranges										
	(600-1000)			(>1000-1400)			(>1400-1800)			LF	FG
Herbaceous species	0-2	2-4	4-6	0-2	2-4	2-6	0-2	2-4	4-6		
Acanthospermum hispidum	8.5	0	0	39.4	14.7	0	28.3	0	0	F	A
Albuca abyssinica	2	0	0	0	0	0	0	0	0	F	P
Alysicarpus quartinianus	8.5	0	0	0	8.67	4.5	0	20.5	12	L	A
Alysicarpus rugosus	0	0	0	0	0	0	9	15	13.4	L	A
Alysicarpus zeyheri	9	7.13	10	5	0	4.8	0	0	0	L	P
Andropogon chrysostachyus	11.3	29.1	35.5	12.1	23.4	25	0	39	0	G	P
Aristida adoensis	27.2	57.8	80.1	21.6	37.7	87.3	43	119	136.1	G	A
Aristida mutabilis	0	6.4	19	0	12.7	13	0	37.6	33	G	A
Aritsida adscensionis	15	0	0	0	0	0	0	0	0	G	A
Biden spilosa	4.3	11.2	9.1	18.4	9.5	10.9	10.5	15.5	7	F	A
Bidens setigera	0	0	0	0	0	0	29.5	6	0	F	P
Brachiaria lata	3.8	11.5	5.14	4	5.3	20	5	5	19.3	G	P
Brachiariara mosa	1	3.17	6	0	3.5	0	0	0	0	G	P
Brassica rapa	7.3	6.5	0	6	8.5	0	0	0	0	F	P
Cenchrus ciliaris	0	0	2	0	0	0	0	0	0	G	P
Chamaecrista mimosoides	0	0	0	0	0	0	42.4	21	0	L	A
Chloris gayana	0	17	0	0	0	0	0	0	0	G	P
Citrullus colocynthis	2.6	0	1	0	0	0	0	0	0	F	P
Commelina subula	0	0	0	3	0	0	38.4	12.8	2	F	A
Commicarpus granddflora	5	0	2	4.3	0	0	0	22	0	F	A
Corchorus olitorius	0	0	5	0	0	0	0	0	0	F	A
Corchorus trilocularis	41.7	23.9	8.6	24.7	14.2	5.33	0	0	0	F	A
Cyanotis barbata	0	0	0	1.5	4	0	0	0	0	L	A
Cynodon dayctlon	0	0	7.5	0	18	0	80.7	21.8	0	G	P
Cyperus rotundus	4	6.18	9.44	11	11.5	12.5	3	11	7.3	F	P
Dactyloctenium aegyptium	0	24.2	51.1	0	37.6	29	24	43.8	55.5	G	A
Digitaria ternata	12	21	27.6	13.8	19	15.4	16.1	2.7	32.8	G	A
Digitaria velutina	0	9.8	0	0	0	0	0	0	0	G	A
Dinebra retroflexa	15.8	15.8	13	24.6	14.2	9.33	10.5	7	18	G	A
Discopodium penninervium	2	2.14	1.33	2	0	1	0	0	0	F	A
Eleusine floccifolia	0	0	0	0	0	0	33.6	12	0	G	A
Eragrostis abyssinica	10.9	7.2	2	0	0	0	0	0	0	G	A
Eragrostis cilianensis	10	13.7	27	0	28.6	26	17.2	28	54.7	G	A
Eragrostis schweinfurthii	0	0	0	0	0	0	14	42.3	41.7	G	A
Euphorbia hirta	7	5	2.25	0	0	3.5	27.7	0	5.3	F	A

Euphorbia indica	0	0	0	17.1	15	9.5	40	17	13	F	A
Eurochloa fatamensis	0	0	0	0	0	0	24.5	0	0	G	A
Flaveria trinervia	14.3	23.2	18.3	19.3	19	16.5	14	24	20.2	F	A
Guizotia scabra	0	0	0	0	0	0	3.5	0	0	F	A
Hibiscus articulatus	0	0	12.7	0	10.5	6.5	0	0	0	F	A
Hibiscus camabinus	9	10.5	8.33	0	0	0	0	0	0	F	A
Hygrophilla schulli	0	0	0	0	0	0	48.4	15	7	F	P
Hyparrhenia rufa	0	0	20.1	0	42	9.7	11.5	11.3	6	G	P
Hypoestes forskalei	0	0	0	3	0	13.5	20	0	15	F	A
Hypoestes triflora	0	0	0	4.43	6.3	4.3	0	0	0	F	A
Indigofera amorphoides	0	0	0	0	0	0	44	0	0	L	P
Indigofera spicata	0	0	0	0	0	0	0	6	14	L	P
Indigofera viciodes	6	0	0	0	0	0	0	0	0	L	P
Ipomoea purprea	0	14	9.6	0	0	0	0	0	0	F	A
Kedrostis foetidissima	0	0	0	51	0	0	0	0	0	F	P
Legenaria siceraria	0	0	0	6	0	0	0	0	0	F	P
Leucas martinicensis	10.9	9.5	3.91	9	6.43	4	23	0	0	F	A
Medicago polymorpha	8.8	4.3	3.2	3.5	4	5.5	2.33	5	4.4	L	A
Melanocenchris abyssinica	0	0	0	0	3.2	7.3	0	6.5	19.3	G	A
Nicandra physaliades	9	0	0	0	0	0	0	0	9.8	F	A
Panicum atrosanguinium	0	15.4	24	0	14.5	37.1	0	33.3	43.9	G	A
Panicum coloratum	0	0	8	0	0	17	0	76.3	83.5	G	P
Panicum maximum	0	0	11	0	22.7	2.5	0	60.8	73.6	G	P
Panicum subalbidum	6	0	0	3	15.2	10.7	14.6	46	35.3	G	A
Pennisetum glabrum	2	0	0	0	7.3	6.9	12	34.6	54.1	G	P
Pennisetum sphacelatum	6	16	19.3	10.8	25.4	48.3	25.4	71.7	104.8	G	P
Polystachya bennettiana	7	4.7	17	11	0	16	0	8	0	F	A
Rhamphicarpa fistulosa	0	0	16.8	17	8	0	0	0	0	G	P
Rhaynochosia minima	23	14.7	6	37.8	2.7	3	0	0	0	F	P
Rottboelia cochinchinensis	0	14	13.3	0	0	0	0	0	0	G	A
Schoenefeldia gracilis	7	0	17	0	0	0	0	0	21.5	G	A
Senna obtusifolia	77.3	5	0	21.3	0	0	0	0	0	L	A
Senna occidentalis	0	0	0	0	21.6	5	0	0	0	L	A
Setaria pallid-fusca	6.2	22.5	22.3	8.9	13.5	30.5	17.5	34.8	49	G	A
Setaria pumila	0	0	8	7	0	10.5	5.4	9	11	G	A
Sorghum arundinaceum	0	0	13.4	0	0	6	0	0	0	G	A
Spermacoce sphaerostima	0	0	0	0	0	0	12	32.5	0	G	A
Tephrosia interrupta	7	10.3	8.7	11	9.1	12.8	58.8	11	0	L	P
Tetrapogon tenellus	0	0	5.56	8	10.7	4	24	16.3	13	G	P
Themeda triandria	0	0	18.8	0	26	24	20.2	24.3	14.2	G	P
Tiragia cinerea	0	0	14.5	0	12.8	0	0	0	0	L	A
Tragus racemosus	0	13	0	0	0	0	0	0	0	G	A
Tribulus ternatus	0	9	0	0	0	140	0	0	0	F	A
Trifolium mattirolianum	0	5.71	0	41.4	0	.7	0	14	0	L	A
Urochloa bracyra	0	0	0	0	0	0	0	22.5	9	G	A
Urochloa fatamensis	0	0	14.2	17.8	5	39	23	15.1	22.3	G	A
Urochloa panicoides	0	0	0	18	1	0	0	0	0	G	A
Xanthium abyssinicum	43	7	2.5	18.2	12.4	2.5	0	0	0	F	A
Zennia elegans	0	0	0	0	0	0	34.7	9.6	24.5	L	A
Number of species											
Grasses species	14	17	26	13	23	22	20	26	22	-	-
Perennial grasses	5	6	12	5	11	9	7	9	7	-	-
Annual grasses	9	11	14	8	12	13	13	17	15	-	-
Legumes	6	5	4	6	6	8	6	8	5	-	-
Forbs	17	14	16	18	11	14	11	9	10	-	-
Total number of species	37	36	46	37	40	44	37	43	37	-	-
Percentage of species											
Grasses species	37.8	47.2	56.5	35.1	57.5	50	54.1	60.5	59.5	-	-
Perennial grasses	13.5	16.7	26.1	13.5	27.5	20.5	19	20.9	18.9	-	-

Annual grasses	24.3	30.5	30.4	21.6	30	29.5	35.1	39.5	40.5	-	-
Legumes	16.2	13.9	8.7	16.2	15	18.2	16.2	18.6	13.5	-	-
Forbs	46	38.9	34.8	48.7	27.5	31.8	29.7	20.9	27	-	-
Total percentage species	100	100	100	100	100	100	100	100	100	-	-

A = annual; P = perennial; F = forbs; G = grass; L = legumes; LF = life form; FG = functional group

3.1.2. Herbaceous species diversity and plant abundance

3.1.2.1. The effect of distance on herbaceous species diversity and plant abundance at different altitudinal ranges

In the lower altitude, herbaceous species evenness, relative plant abundance and richness were significantly lower near to settlement than the other two distance intervals. This could be related to the presence of heavy grazing pressures on grass species and replaced by non-grass. Hence, heavy grazing pressure tends to cause grass species to decline and subsequently replaced by other herbaceous plant (Haan *et al.,* 1997). In the mid altitude, far distance interval from settlement area had significantly lower in species diversity and evenness but significantly higher in plant abundance than the other two distance intervals (Table 2). This was in relation to the *A. adoensis* grass species which were highly dominated species in far distance from settlement. In the upper altitude, herbaceous species abundance had significantly increased with distance increased from settlement area (Table 1).

3.1.2.2. Effect of altitude on herbaceous species diversity and plant abundance

Herbaceous species abundance in the upper altitude was significantly higher than lower and middle altitudes (Table 2; F2, 531= 109.89, $P < 0.000$). But species diversity and richness were significantly lower than middle and lower altitudes (Table 2). This is related to the fact that the species abundance is increasing with altitude increasing (Admasu *et al.,* 2010).

3.1.2.3. Effect of distance on herbaceous species diversity and plant abundance

Species diversity and species richness were significantly lower near to settlement than far from settlement. This is related to the fact that plant damage is high around settlement areas due to heavy animal grazing and human activities (Brinkmann, 2009) and (Jeffrey, 2007) also reported that continuous grazing around permanent settlement areas causes to lowers plant diversity and favors the spread of unpalatable herbs and shrubs.

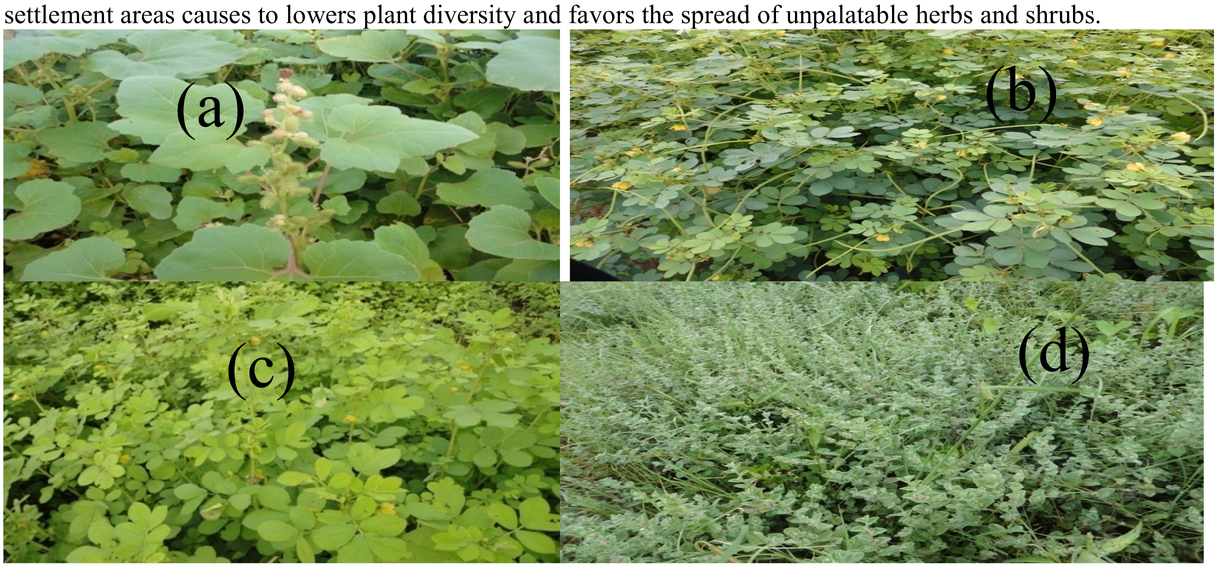

Figure 3: Invasive forbs herbaceous species *Senna obtusifoli (*a*)* in the lower altitude near to the settlement and *Corchorus trilocularis (*b*), Xanthium abyssinicum (*c*)* and *Rhaynochosia minima (*d*)* in the lower and middle altitudes near to the settlement in Kafta-Humera, northern Ethiopia.

Table 2: Effect of altitudinal ranges (Low altitude: 600-1000, mid altitude: >1000-1400 and high altitude: >1400-1800 m.a.s.l.) and distances interval away from human settlement (km) on herbaceous species diversity, species evenness, total plant abundance (nm^{-2}) and species richness under three altitudinal ranges and three distance intervals away from settlement in Kafta-Humera, northern Ethiopia.

	Shannon diversity	Evenness	Plant abundance	Species richness
Altitudinal ranges				
600-1000				
0-2	1.137^{c}	0.63^{b}	109.583^{b}	5.333^{b}
2-4	1.322^{b}	$0.67b^{a}$	136.367^{a}	5.933^{a}
4-6	1.473^{a}	0.735^{a}	146.367^{a}	6.2^{a}
>1000-1400				
0-2	1.25^{a}	0.8^{a}	118.67^{b}	5.467^{a}
2-4	1.515^{a}	0.78^{a}	117.25^{b}	5.967^{a}
4-6	1.242^{b}	0.678^{b}	$152.0.67^{a}$	5.50^{a}
>1400-1800				
0-2	1.183^{a}	0.756^{a}	165.1^{c}	4.6^{a}
2-4	1.197^{a}	0.728^{a}	195.95^{b}	4.67^{a}
4-6	1.117^{a}	0.718^{a}	239.133^{a}	4.52^{a}
Altitude (A)				
F (df = 2,531)	25.42	13.18	109.89	45.88
P	0.000	0.000	0.000	0.000
Distance (D)				
F (df = 2,531)	4.28	1.01	41.54	4.15
P	0.014	0.36	0.000	0.016
(A) * (D)				
F (df = 4,531)	13.18	11.70	3.27	2.08
P	0.000	0.000	0.012	0.025
Adjusted R^2	0.162	0.111	0.364	0.161

Df = degree of freedom, F-ratio = F test value, P = probability value**,** A = Altitude, D = Distance. Means with the same letter in columns are not significantly different at $P \leq 0.05$

3.1.3. Effect of altitude and distance on biomass of herbaceous species.

In all altitude ranges grass biomass had significantly increasing with distance from settlement increasing (Fig. 4a; $F_{2,531} = 552.04$, P< .000), Whereas, non-grass biomass had significantly decreasing with distance from settlement increasing (Fig. 4b; $F_{2,531} = 399.18$, $P < 0.000$). This result could be related to the decreasing of animal grazing pressures and human activities on plant damaged with increased distance from settlements. This finding conforms to the reports of (Brinkmann 2009). Grass standing biomass had highly significant increasing with altitude increasing (from low to high altitudes) (Fig. 4a; $F_{2,531} = 208.63$, P< 0.000), whereas non grass standing biomass had highly significantly decreasing with altitude increasing (Fig. 4b; $F_{2,531} = 22.24$, $P < 0.000$). This result was supported by (Amsalu 2002; Gemedo 2005).

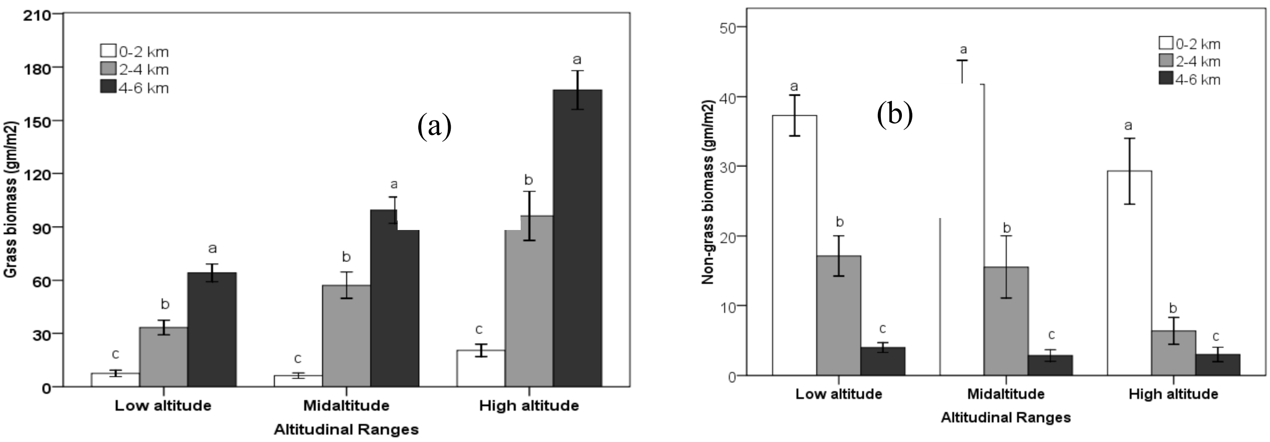

Figure 4: Effect of altitude (Low altitude: 600-1000, mid altitude: (>1000-1400 and high altitude: >1400-1800 m.a.s.l) and distances from human settlement on grass biomass (a) and non-grass biomass (b) in Kafta-Humera, northern Ethiopia

3.1.4. Effect of altitude and distance on percentages of basal cover and bare ground

Altitude and distance from settlement had highly significant effect on the percentages of basal cover and bare ground for herbaceous species. In all altitude ranges percentages of basal cover had significantly increasing with increasing distance from settlement (Fig. 5a; $F_{2,531}$ = 306.84, P < 0.000). Whereas bare ground had significantly decreasing with increasing distance from settlement (Figure 5b; $F_{2,531}$ = 296.79, P < 0.000). Basal cover had highly significantly increasing with altitude increasing (from low to high altitudes) (Figure 5a; $F_{2,531}$= 111.33, P<0.000), whereas bare ground cover had significantly decreasing with altitude range increasing (Fig. 5b; $F_{2,531}$ = 103.75, P < 0.000).

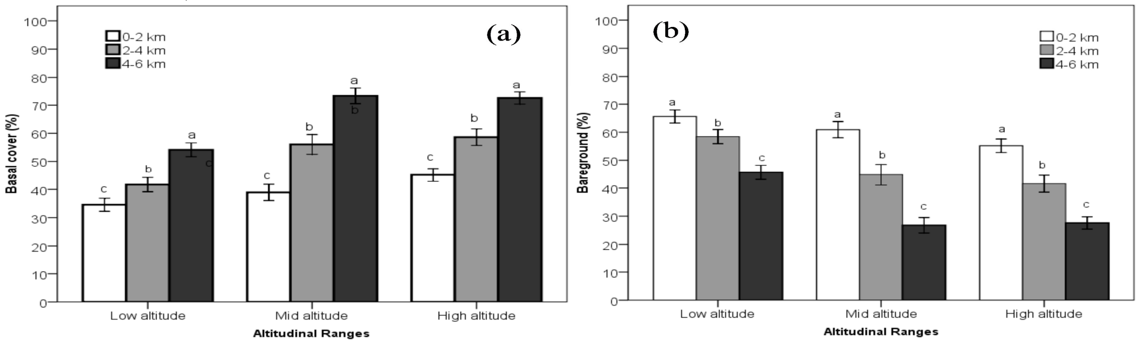

Figure 5: Effect of altitudinal ranges and distances interval away from human settlement on percentage of basal cover (a) and bare ground (b) in Kafta-Humera rangelands, northern Ethiopia

3.1.5: Herbaceous species similarity

The highest two Jaccard coefficient similarity index (0.70 and 0.66) for herbaceous species composition was recorded between far distance and middle distance in the upper altitude. And far distance interval and middle distance interval in the middle altitude respectively. The lowest two Jaccard coefficient of similarity index (0.25 and 0.27) was obtained between near distance from settlement in the upper altitude and middle distance interval in the lower altitude (Table 4). This result indicated that community species similarity was high between far and middle distance from settlement within the same altitude.

Table 4: Jaccard coefficient of similarity for herbaceous species under three altitude and three distances from human settlement in the rangelands of Kafta-Humera, northern Ethiopia

	Altitudinal ranges								
	600-1000			>1000-1400			>1400-1800		
	0-2	2-4	4-6	0-2	2-4	4-6	0-2	2-4	4-6
600-1000									
0-2	-								
2-4	0.56	-							
4-6	0.48	0.55	-						
>1000-1400									
0-2	0.50	0.45	0.41	-					
2-4	0.42	0.43	0.54	0.49	-				
4-6	0.43	0.48	0.61	0.52	0.66	-			
>1400-1800									
0-2	0.27	0.25	0.32	0.35	0.39	0.41	-		
2-4	0.29	0.32	0.33	0.36	0.45	0.56	0.60	-	
4-6	0.30	0.26	0.33	0.30	0.44	0.55	0.55	0.70	-

3.2. Soil Parameters

3.2.1. The effect of altitudinal and distance on soil Parameters

3.2.1.1. The effect of distance on soil **Parameters** at different altitudinal ranges.

In the low altitude, far distance was significantly higher in organic matter as well as available phosphorus and sand soil than near distance to settlement. In the middle altitude, organic matter of soil was significantly lower in near distance than far distance from settlement. In the upper altitude, organic matter, available of phosphorus and available potassium of soil contents were recorded significantly higher in the far distance from settlement than near and middle distance from settlement.

3.2.1.2. The effect of altitude on soil Parameters

Sand soil had showed significant decreased with altitude increasing (Table 5; $F_{2,18}$ = 33. 07, P < 0.000). Whereas, clay soil content was increased with altitude increasing (Table 5; $F_{2,18}$ = 52.33, P < 0.000). In the lower altitude, pH value was recorded significantly higher than upper and lower altitudes (Table 5; $F_{2,18}$ = 6.16, P < 0.009). This is related to the fact that the pH value and sand soil increase with altitude decreases but clay soil content increase with altitude increase Abreha *et al.*, (2012). In the upper altitude, organic matter, available phosphorus and available potassium had significant higher as compared to other two altitude ranges. This is supported by the finding of Getachew *et al.*, (2007) in Borana rangelands, Ethiopia.

3.2.1.3. The effect of distance on soil Parameters

In near distance interval to settlement, sand soil content had showed significantly higher than far distance interval from settlement (Table 5; $F_{2,18}$ = 3.65, P < 0.047). This result may be related to the high degree of soil erosion, high grazing pressures and human activities near distance interval to settlement than far distance interval from settlement. Organic matter and organic carbon had significant increased with distance interval increased from settlement. In far distance interval from settlement, available phosphorus and potassium were recorded significantly higher than that of the near and middle distance intervals from settlement. The total nitrogen percentage near to settlement has not shown significant difference from the other two distance intervals but it was significant difference between middle and far distances intervals away from settlement area (Table 5). Percentage of nitrogen had significantly higher in far distance interval from settlement than middle distances interval from settlement (Table 5; $F_{2,18}$ = 4.97, P < 0.019).

Table 5: Effect of altitudinal ranges and distance interval away from settlements (km) on physical and chemical soil Parameters in Kafta-Humera rangelands, northern Ethiopia

		pH	OC (%)	OM (%)	AVP.ppm	AVK.ppm	TN (%)	Sand (%)	Silt (%)	Clay (%)
	Mean									
Altitude (m.a.s.l)										
600-1000										
	0-2	7.45^{a}	1.06^{b}	1.83^{b}	0.61^{b}	1.42^{a}	0.09^{a}	53.33^{a}	16.33^{b}	30.33^{a}
	2-4	7.22^{a}	1.50^{ba}	2.58^{ba}	0.99^{ba}	1.43^{a}	0.08^{a}	48.67^{ba}	26.67^{a}	24.67^{a}
	4-6	7.09^{a}	2.10^{a}	3.62^{a}	1.28^{a}	1.96^{a}	0.10^{a}	42.00^{b}	27.00^{a}	31.00^{a}
>1000-1400										
	0-2	6.86^{a}	0.95^{b}	1.64^{b}	0.92^{a}	1.57^{a}	0.163^{a}	45.67^{a}	22.33^{a}	32.00^{a}
	2-4	6.73^{a}	1.34^{ba}	2.32^{ba}	0.95^{a}	1.78^{a}	0.129^{a}	36.33^{a}	16.33^{a}	47.33^{a}
	4-6	6.60^{a}	2.03^{a}	3.51^{a}	1.22^{a}	2.34^{a}	0.269^{a}	28.67^{a}	23.33^{a}	48.00^{a}
>1400-1800										
	0-2	6.87^{a}	1.59^{b}	2.75^{b}	1.44^{b}	1.87^{b}	0.210^{a}	17.67^{a}	21.33^{a}	61.00^{a}
	2-4	6.71^{a}	1.77^{b}	3.06^{b}	1.09^{b}	2.41^{b}	0.206^{a}	20.67^{a}	18.33^{a}	61.00^{a}
	4-6	6.53^{a}	2.57^{a}	4.44^{a}	2.10^{a}	3.39^{a}	0.311^{a}	16.33^{a}	23.00^{a}	60.67^{a}
Altitude (A)										
	F (df =2,18)	6.16	10.43	10.52	19.07	25.95	14.32	33.07	1.47	52.33
	p	0.009	0.001	0.001	0.000	0.000	0.000	0.000	0.255	0.000
Distance (D)										
	F (df =2,18),	1.66	35.97	36.21	18.17	25.98	4.97	3.65	4.03	1.50
	p	0.219	0.000	0.000	0.000	0.000	0.019	0.047	0.036	0.25
(A) * (D)										
	F (df =4,18),	0.02	0.22	0.23	3.75	2.44	0.99	0.85	4.35	2.38
	p	0.999	0.922	0.92	0.022	0.084	0.441	0.513	0.012	0.09
	Adjusted R^2	0.23	0.767	0.769	0.758	0.802	0.57	0.726	0.44	0.807

OC = Organic carbon; OM = Organic matter; AVP = Available phosphorus; AVK = Available potassium; TN = Total nitrogen.
Means with the same letters in columns are not significantly different at P ≤ 0.05

5. Conclusion

We concluded that a reduction in soil quality parameters was observed as a direct effect of distance from settlement and altitudes in the rangelands of Kafta-Humera, northern Ethiopia and this consequently affected the growth, diversity, abundance, aboveground standing biomass and basal cover of herbaceous species. Annual herbaceous species were higher than perennials. Relative abundance of grass species were increased with increasing distance from settlement whereas, forbs were decreased with distance increased from settlements. Vegetation resources which recorded near to settlement and middle distance from settlement had been degraded as a result of decrease in grass cover through replacing of non grasses species. Areas which were found near to settlement exposed to soil erosion and have increased due to grass cover removal. In general, declining grass cover and its substitution with annual type of vegetation was the outcomes of the recent settlements. Therefore, under the present soil status, biodiversity and productivity circumstances of the areas near to settlement and middle distance intervals from settlement, preservation or return of habitats should be of greater concern because the best way to minimize biodiversity loss is to maintain the integrity of ecosystem function.

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