INTERNATIONAL JOURNAL OF ENVIRONMENT
Volume-5, Issue-3, June-Aug 2016 ISSN 2091-2854
Received:12 April *Revised:3 May* *Accepted:31 August*

VARIATION IN SOIL ORGANIC CARBON WITHIN HIGHLAND GRASSLANDS OF LANGTANG NATIONAL PARK, NEPAL

Keshab Shrestha
College of Applied Sciences- Nepal, Tribhuvan University, Nepal
Corresponding author: keshabs534@gmail.com

Abstract

Grassland also plays important role in food security. The estimated grassland area in Nepal is about 1.75 million ha. Most of the grassland in Nepal is located in higher elevation above, 2000 meter. The aim of this research is to observe difference in SOC of grassland in different altitude. Soil samples were collected from grasslands of altitude: 1500- 2000m, 2001-2500m, 2501-3000m, 3001- 3500m and 3501- 4000m. The soil samples were collected at successive depths in each grassland i.e. 0 – 10 cm, 10 – 20 cm and 20 – 30 cm. The maximum SOC was found in grassland at altitude 3001 m- 3500m. The lowest was SOC was found in grassland at altitude 3051m – 4000m. Correlation analysis between altitude and SOC shows that SOC is positively correlated with altitude with correlation coefficient 0.850 (significant at $P<0.05$ level). But SOC decreases sharply in treeline with negative correlation (Significant at $P<0.05$).

Keywords: Soil organic carbon (SOC), Grassland, Altitude

Introduction

Grassland is the open land where the dominant vegetation is grasses rather than trees and shrubs. Grassland supports indigenous or introduced vegetation and it is important natural resource that can be grazed by domestic and wild animals. Grassland also has valuable regulation service in soil erosion control, water purification and biodiversity protection. From the beginning of human civilization grassland ecosystem is valued as important resources of forage for the livestock. It is called with different name in different part of the world, 'Prairies' in North America, 'Pampas' in South America, 'Rangelands' in Australia. 'Steppes' in Asia It is estimated that grasslands occupy approximately 51% of terrestrial surface of the earth (Prentice *et al*., 1992). Grasslands are the important storage of atmospheric carbon dioxide (CO_2). During photosynthesis ($6CO_2 + H_2O \xrightarrow{\text{Sunlight}} C_6H_{12}O_6 + 6O_2 + 6H_2O$) the vegetation in grassland assimilate atmosphere carbon into its tissues and part of it is added to soil as soil organic carbon (SOC). Soil is considered as the largest pool of terrestrial organic carbon in the biosphere, storing more Carbon than in plants and the atmosphere combined (Schlesinger, 1997). Any changes in SOC can largely affect the global carbon cycle and carbon budget (Bellamy *et al*., 2005). High SOC in soil indicates soil productivity, soil water retention capacity and soil fertility (Murrage *et al.,* 2000; Bationo *et al*., 2009).

Though grasslands are considered as potential and useful carbon sink, sometime degradation of this resource can show negative effect by emission of carbon back to the atmosphere through reducing aboveground biomass and soil carbon (Lipper *et al*., 2010). So, sustainable use of grassland is essential. Overgrazing and conversion of natural grassland into agricultural land causes the degradation of grassland. Conversion of grasslands to agricultural land can lead to loss of 95% of the aboveground carbon, and up to 50% of the belowground carbon (Reid *et al*., 2004).

Total land area of Nepal is 147,181 $km^{2.}$ Of total area, grassland is estimated to cover about 1.75 million ha or nearly 12% of Nepal total land area (TLDP 2002, Parajuli *et al.,* 2013). Nepal's largest grassland lies in high mountains, about 50.6% of total grassland area (TLDP

2002, Parajuli *et al.,* 2013). Because of overgrazing and trampling, grasslands of this region is degrading and converting into barren land. This research will find the difference in stored soil organic carbon (SOC) of grasslands in different altitude in Langtang National Park (LNP).

Materials and Method

The grassland in different altitude was identified with the help of GPS and topographical map. The soil sampling sites at altitude 1500- 2000m, 2001- 2500m, 2501-3000m, 3001-3500m and 3501- 4000m was determined.

Soil samples were collected opening a soil profile of 30 cm in depths by the means of metal core of known volume. The soil samples were collected in successive soil depths i.e. 0 – 10 cm, 10 – 20 cm and 20 – 30 cm and placed in the labeled sample bag. The collected soil samples were brought to laboratory to determine the density and carbon content. Carbon content in soil was determined through modified Walkey- Black method.

The carbon stock density of soil organic carbon was calculated as given by (Pearson *et al.,* 2007).

$SOC = p * d * \% C$

Where,

SOC = soil organic carbon stock per unit area (t ha^{-1})

p = soil bulk density (gm cm^{-3})

d = total depth at which the sample was taken (cm)

% C = carbon concentration

$$\% \text{ Organic Carbon: } \frac{\text{Soil organic matter}}{1.724}$$

Soil bulk density (gm cm^{-3}) = (oven dry weight of soil) / (volume of soil in the core)

Study Area

Langtang National Park (LNP) is situated in the north- central region of high Himalaya region with an area of 1710 km^2 extending from 27°57'36" to 28°22'48" and 85°12'36" to 85°52'48". The park was established in 1976 by Government of Nepal to preserve the diversity of habitat for plant and wildlife. The elevation of park ranges from 792 meter above sea level to 7245 meter. The average annual precipitation of LNP is 674.64 mm with almost 75% of precipitation in the monsoon period. The minimum temperature remains above 0°c for six months (May- October) and for remaining six months (November - April) it goes below 0°c. The maximum and minimum temperature for the hottest month (July) are 11.7°c and 7.3°c and coldest month (January) are 3.2°c and -6.6°c respectively (Aryal, 2009).

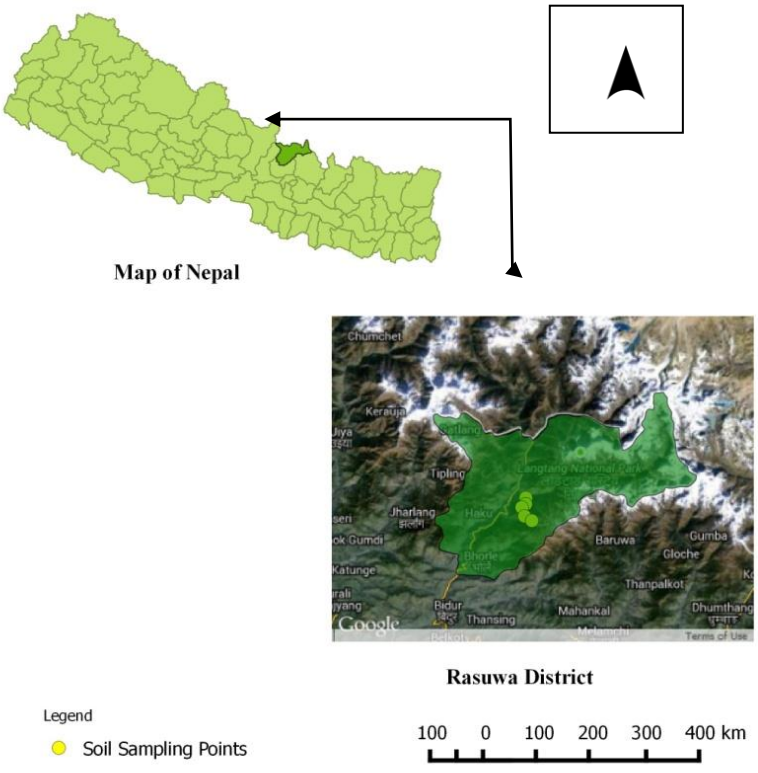

Figure 1 Study area

Result and Discussion

SOC of grassland at different altitude is presented in the table (Table 1). The highest SOC, 84.90 t ha^{-1} was observed in grassland at altitude 3001- 3500 meter. The lowest SOC, 54.24 t $ha^{-1}$was observed in grassland of altitude 3051m – 4000 meter. The result in Table 1 shows that SOC increase with increasing altitude but decrease sharply in tree line (Figure 2). This is due to increasing precipitation and decreasing temperature at high altitude. This condition results in production of greater amount of plant biomass in higher elevation (Smith *et. al* 2002). The decomposition of biomass increase SOC. Treeline is the edge line, beyond treeline tree cannot survive due to harsh climatic condition. The sharp decrease in the SOC in tree line is due to the presence of rocky surface and fewer ground vegetation (Smith *et. al*. 2002). The treeline in study area begins from an altitude, 3500 meter.

The concentrations of SOC were found highest in top layer (0- 10 cm) in all grassland and decreased gradually in down layers (Table 1). Higher amount of humus present in the top layer of soil increase the carbon content in soil. Another factor that affects SOC in the soil is the soil profile. The soil texture and clay size fraction largely affect the carbon content in soil (Trujilo *et al*., 1997). Vegetation covering the soil layer also affects in vertical distribution of carbon. Research suggests that in average 42% of SOC is accumulated in the top layer (Jobbacy *et al.,* 2000).

Table 1: SOC at different altitude and soil depth

Altitude (m)	Soil Depth (SOC t ha^{-1})			Total (SOC t ha^{-1})	S.D	S.E
	0- 10 cm	10- 20 cm	20- 30 cm			
1500- 2000	31.17	23.19	17.61	71.97	±2.02	0.82
2001- 2500	33.00	26.72	25.13	84.85	±1.48	0.60
2501- 3000	28.90	28.01	27.91	84.82	±1.34	0.54
3001- 3500	32.97	29.68	22.25	84.90	±3.03	1.23
3501- 4000	20.51	17.10	16.63	54.24	±1.99	0.99

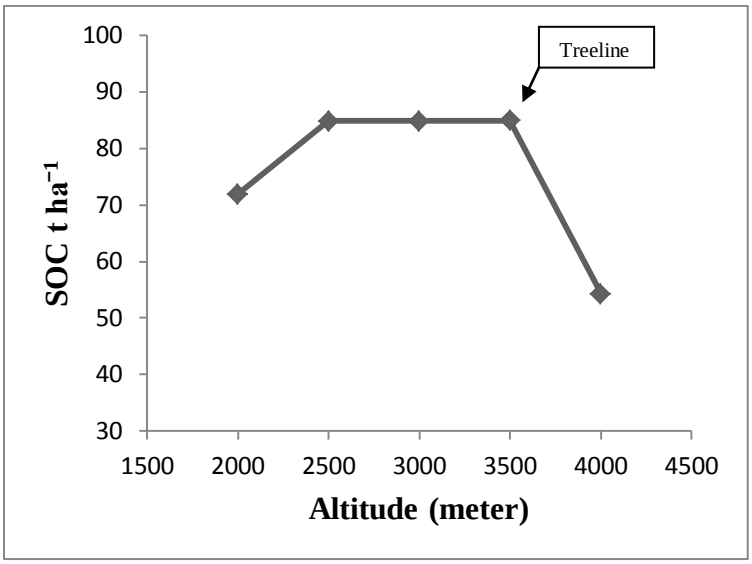

Figure 2. Relation between SOC and altitude

Correlation analysis between altitude and SOC in grassland shows that SOC is positively correlated with altitude with correlation coefficient 0.8502 (significant at $P<0.05$ level) (Figure 3). But SOC decrease sharply in treeline (3500 meter). (Figure 4) and is negatively correlated (Significant at $P<0.05$). It indicates that SOC is lower in treeline than low altitude grasslands.

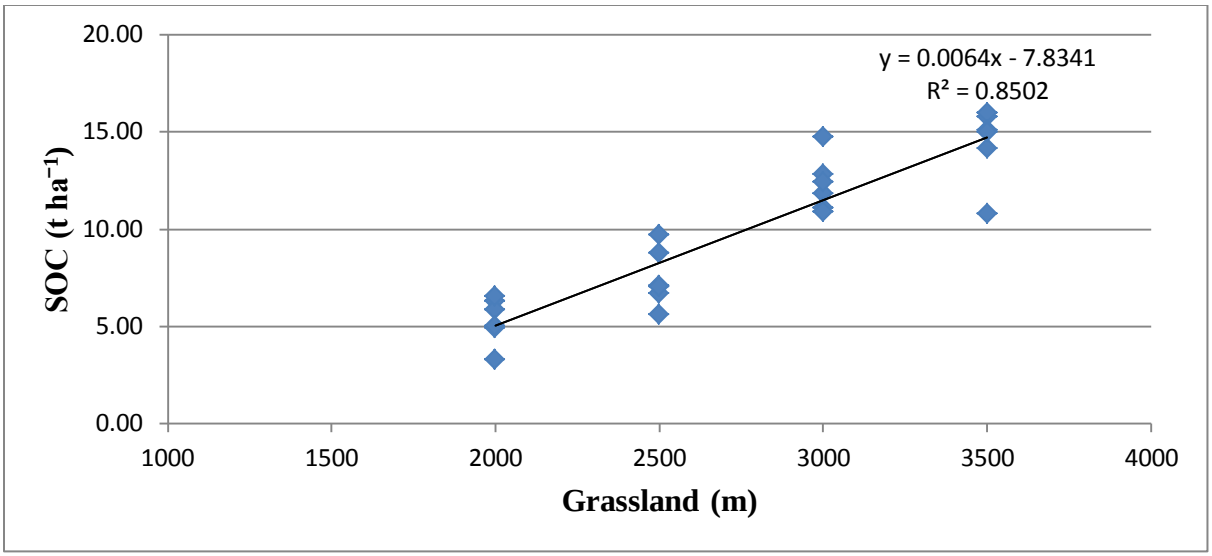

Figure 3: Relation between SOC and Grassland (up to altitude 3500 meter)

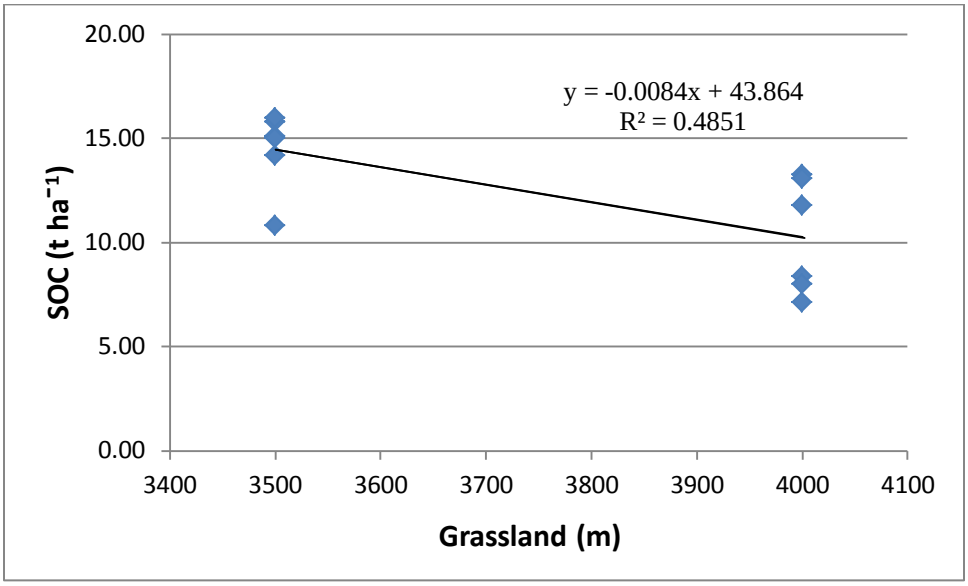

Figure 4: Relation between SOC and Grassland (after treeline, 3500 meter)

Conclusion

The result shows that Soil organic carbon in grasslands of Langtang National Park increase with increasing altitude until treeline. Soil organic carbon of successive grassland has increased nearly by 4.31% in average with increasing altitude but after treeline the carbon content in soil decreases sharply by 36 %. The vegetation cover in grassland plays important role in soil carbon storage. Land covered with vegetation has high potential of soil carbon storage than without vegetation. Though low land grasslands are important source of atmospheric carbon storage but unsustainable utilization of this resource may lead to decrease in soil carbon storage potential. Generally grasslands are treated as the common pool resource and are grazed unsustainably in Nepal.

Carbon storage of soil is high in top layer (0 – 10 cm) and carbon content decrease gradually with increasing soil depth. In an average the soil organic carbon has decreased by 14.86% from top 10 cm to 20 cm soil depth. Similarly the soil organic carbon has decreased by 11.63 % from soil depth 20 cm to 30 cm.

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