Academic View

Comparative Study of Soil Organic Carbon in Forest of National Park and Sacred Grove in Kathmandu Valley

Prakash Chandra Wagle
Department of Environmental Science, Tri-Chandra Multiple Campus, TU, Kathmandu, Nepal
E-mail: *prakashwagle54@yahoo.com*

Abstract

Soil organic carbon (SOC) represents a significant fraction of the global carbon pool and is vital for understanding the ecosystem functions that occur in soils. Forest types and management can have a significant impact on soil organic matter and, as a result, soil organic carbon. However, comparative studies of SOC with respect to forest management have been carried out to a limited extent. Thus, the study was carried out in the Shivapuri-Nagarjun forest and the pine forest of Gokarneshwor with the aim of comparing the SOC of the Shivapuri forest of Shivapuri Nagarjun National Park and the pine forest of Gokarneshwor. Soil samples were collected by the stratified random sampling method. The composite samples from the depths of 0–10 cm and 10–15 cm were taken, mixed properly, air dried, and tested in the laboratory. Soil organic carbon was measured using the modified Walkley and Black methods. The soil organic carbon of the Shivapuri-Nagarjun forest was found to be 91.11 tons/ha, and the pine forest was found to be 34.77 tons/ha on average. Further analysis interlinking plant residue and microbial activities and their implications for soil organic carbon could be beneficial in forest management decisions.

Keywords: *Land Use, Management Practices, Shivapuri Nagarjun forest, Soil Organic Carbon*

Introduction

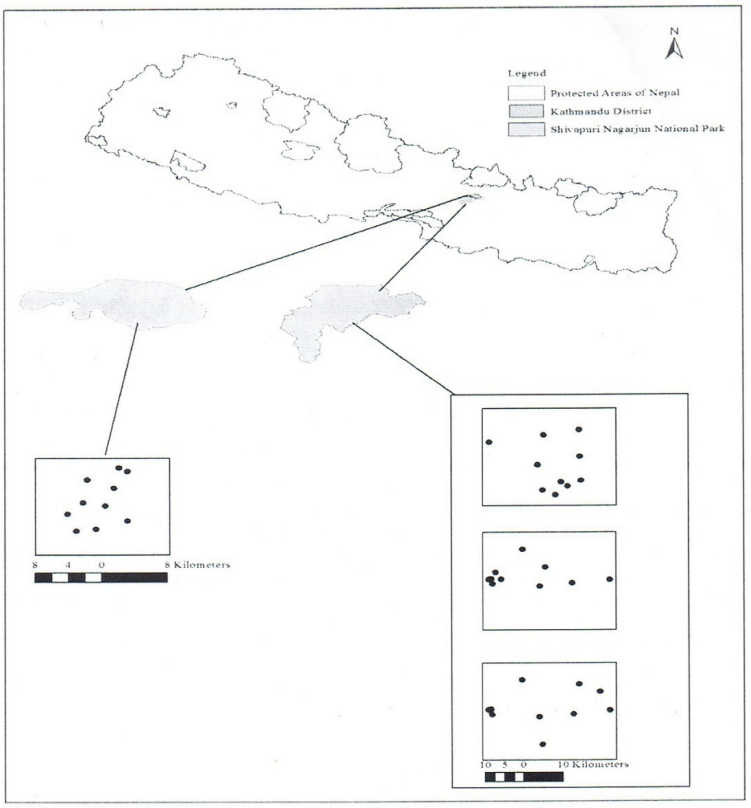
Soil is a dynamic natural body on the surface of the earth in which plants grow and is composed of minerals, organic materials, and living forms (Brady, 2020). Soil provides ecosystem services like habitat for plant growth, animals, bacteria, fungi, temperature regulation, water cycling and regulation, waste decomposition, carbon and nutrient cycling, and natural purification. Soil organic carbon is a measurable component of soil organic matter; it makes up just 2-10% of most soil masses and plays an important role in the physical, chemical, and biological functions of agricultural soils. Soil organic carbon is an important factor affecting soil quality and soil health (Nsabimana et al., 2004), and it has a key role in nutrient cycling and can help improve the soil structure. Soil acts as the major carbon sink in the world, constituting more than 3000 pg (1 pg = 1 billion tons), among which 70% exist as organic carbon in the top 1 m of the soil (Jansson et. al., 2010).

Sequestering carbon in soil organic carbon is seen as one way to mitigate climate change by reducing atmospheric carbon dioxide. Small increases in soil organic carbon in very large areas will significantly reduce net carbon dioxide emissions from agriculture. Soil carbon sequestration is the process of converting atmospheric carbon into soil organic carbon, mainly through the medium of organic matter. Carbon sequestration focuses to recognize the importance of soil carbon and quantitative changes affected by different land use patterns and management of vegetation covers. In Nepal, soil is deteriorating at an alarming rate due to changes in land use (Intergovernmental Panel on Climate Change, 2000), lowering carbon sequestration. Native ecosystems are slowly being converted into cultivated ecosystems, which cause significant losses of soil carbon worldwide.

Climate change is one of the most pressing issues in the world, and the major causes are attributed to the emission of greenhouse gases through anthropogenic activities like deforestation, urbanization, burning, and agricultural expansion. Forest land contains a large amount of organic matter and is a major sink for Earth's carbon sequestration as soil organic carbon. Rather than being just source and sink for plant nutrients, soil organic carbon has an essential function in the carbon cycle, as a major terrestrial pool of carbon. So, the aim of this article is to compare the soil organic carbon of protected areas, i.e., the forest of Shivapuri Nagarjun National Park and the pine forest of Gokarneshwor, which is a sacred grove.

Materials and Methods

Study Area- The study was carried out in the northern part of Kathmandu valley (Figure 1) comprising of Sundarijal to Chisapani route of Shivapuri - Nagarjun National park, Gokarneshwor community forest and Tarkeshwor Municipality Ward No 5 and ward no.9 which lies between latitude of 27°44'9" North to 27° 72' 26"North and longitude between. 85° 18′ 13" East to 85" 49' 43". E. The study area lies in between the altitude of 1340m to 2100m above the mean sea level and occupies two municipalities and one National park.



Methods:

To determine the soil organic carbon of soil, composite samples were taken at the depth of 0-5 cm and 10-15 cm. A total of 20 soil samples were collected for soil organic carbon estimation with 10 sample from each forest. The soil sample from a single plot was then mixed properly after drying. The air dried and mixed soil samples were sieved by using 0.5 mm sieve and laboratory analysis was carried out. The soil organic carbon was determined by Modified Walkley and Black Method (1934).

Formula: %So C or % C = 3.951/g [1- T/S]

Where, g =weight of sample taken T = ml of Ferrous solution with sample titration, S = ml of Ferrous solution with blank titration.

The total organic carbon was determined by using the methods used by Batijes (1997) and Chhabra, et al, (2003) as follows:

SOC (t/ha) = % Cx px d

C=Carbon Concentration

p = soil bulk density (gm/cm3)

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

Bulk density was determined through corer sampling method.

Bulk density=*weight of dried soil sample / volume of corer samples*(Baatuuwie, 2011)

Results

Soil Organic Carbon (SOC) was recorded higher in Shivapuri Nagarjung Forest than Pine Forest of Gokarneshwor (Figure 2). SOC was found in the range of 25.45t/ha to 130.24 t/ha in Shivapuri Nagarjung Forest with an average of 91.11 t/ha. Similarly, SOC in Pine forest of Gokarneshworwas found ranging from 15.6 t/ha to 62.94 t/ha with an average of 34.77 t/ha.

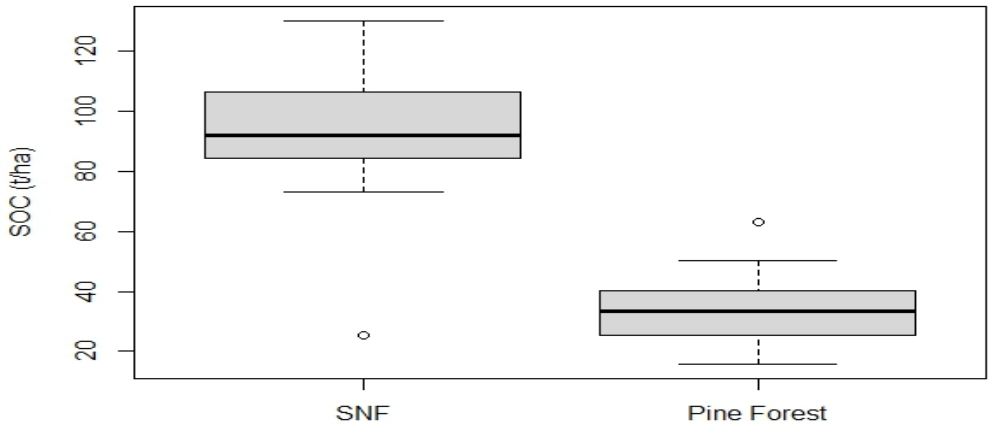


Figure 2

Comparative representation of Soil organic carbon between Shivapuri Nagarjung forest and Pine forest of Gokarneshwor.

Discussion

In Shivapuri-Nagarjun forest soil, organic carbon has been found to be higher, i.e., 91.11 tons/ha, than in the pine forest of Gokarneshwor. In Shivapuri forest, organic carbon was found to be highest, which might be due to the presence of dense tree cover and the highest amount of plant reduction associated with microbial activities, which displays the interlinkage of the forest ecosystem and organic carbon sequestrationin soil compared to other land uses. Thus, more litter production and faster decomposition rate of soil organic matter in mixed vegetation have a better soil carbon storage(Sariyildiz and Anderson, 2003).

The organic carbon content depends on various biotic and abiotic factors, such as vegetation, the environment, and human disturbances. Topography, altitude, and climatic conditions like temperature and rainfall have a large effect on soil carbon levels. At higher temperatures, the rate of soil carbon oxidation increases, resulting in greater release of CO2 into the atmosphere (Batijes and Som Brock, 1997).

Whereas in pine forest, the soil organic carbon is found to be less than in Shivapuri forest, i.e., 34.71 tons/ha. It might be due to the relatively low ground vegetation cover in pine forests. The community forest user groups utilize the fodder, litter, and dead wood for domestic purposes, which reduces the chances of organic matter decomposing in the soil.

Conclusion

This study concludes that Shivapuri Nagarjun forest has higher soil organic carbon than the pine forest of Gokarneshwor. These results have shown that the soil organic carbon depends upon the vegetation status, number of species, and type of particular species climatic conditions. The soil organic carbon is lower in pine forests because of the amount of litter accumulation, vegetation cover, and soil microbial activity in forests. But the organic carbon in the soil decreases with elevation. This study will serve as a baseline to formulate measures to combat the problems of carbon storage, greenhouse gas emissions, and soil fertility status. Taking into account the capacity of different land uses and land coversfor carbon storage will help to understand the prospective role played by soils in carbon sequestration and carbonstorage.

References

Baatuuwie, B. N., Ochire-Boadu, K., Abdul-Ganiyu, S., & Asante, W. J. (2011). Assessment of soil and water conservation measures practiced by farmers: A case study in the Tolon-Kumbungu district of northern Ghana. *Journal of Soil Science and Environmental Management*, 2(4), 103-109.

Batjes, N. H., & Sombroek, W. G. (1997). Possibilities for carbon sequestration in tropical and subtropical soils. *Global change biology*, 3(2), 161-173.

Brady, N. C. (2020). Making agriculture a sustainable industry. In Sustainable agricultural systems (pp. 20-32). CRC Press.

Chhabra, A., Palria, S., & Dadhwal, V. K. (2003). Soil organic carbon pool in Indian forests. *Forest Ecology and Management*, 173(1-3), 187-199.

Intergovernmental Panel on Climate Change. (2000). Land Use, Land-Use Change, and Forestry: A Special Report of the Intergovernmental Panel on Climate Change. Intergovernmental Panel on Climate Change,Cambridge university press, Cambridge,U.K.

Jansson, C., Wullschleger, S. D., Kalluri, U. C., & Tuskan, G. A. (2010). Phytosequestration: carbon biosequestration by plants and the prospects of genetic engineering. *Bioscience*, 60(9), 685-696.

Nsabimana, D., Haynes, R. J., & Wallis, F. M. (2004). Size, activity and catabolic diversity of the soil microbial biomass as affected by land use. *Applied Soil Ecology*, 26(2), 81-92.

Sariyildiz, T., & Anderson, J. M. (2003). Interactions between litter quality, decomposition and soil fertility: a laboratory study. *Soil Biology and Biochemistry*, 35(3), 391-399.

Walkley, A., & Black, I. A. (1934). An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil science*, 37(1), 29-38.