J. Himalayan Ecol. Sustian. Dev. Vol 4. (2009) ISSN 0973-7502

ALTERATIONS IN NUTRIENT STORAGE IN THE FOREST FLOORS AT VARIABLE ALTITUDES IN KASHMIR

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ABSTRACT

Changes in carbon storage in soils have received recent attention owing to their impact on global carbon budget. The slightest changes in nutrient storage in soils under forest cover due to the deforestation though at slower rate may approach a new equilibrium. Total organic C storage integrated on the basis of soil having bulk density 1.2Mg is calculated as 55440 kg ha^{-1} in the soils under forests The storage of organic carbon in Kashmir in different forest floors has decreased in the range 22% to 48% in the forest floor because of deforestation. The reduction in the organic N storage has been estimated from 0.35% to 1.86% in deforested soils at different altitude.

Key words: Forest, Kashmir, Soils, Carbon, Storage

INTRODUCTION

Nutrient transfer processes which are mediated by organic matter and biomass in a forest ecosystem involving the production and decomposition of Litter, accumulation by vegetation and removal of biomass. The key processes of nutrient cycling in a forest ecosystem are the movement of nutrients from reserves to uptake, to input, and then back to reserves. A major portion of the nutrients taken up annually into the aboveground components of the trees is returned to the soil through Litter fall. In many forest soils, the thick forest floor is a major storehouse for nutrients (Bonan and Shugart 1989; Nilsson *et al.*, 1995). Carbon occurs in forests in living vegetation, in the forest floor and within the mineral soil. On an average deciduous and evergreen temperate forest vegetations contain 135 and 160Mg C ha^{1} (Houghton 1995). The loss and gain of organic C in soils depend on soil type, soil depth, soil temperature, soil erosion, vegetation type and management The sizes of the C pools are related to forest type, stand age, soil moisture and soil clay content (Grigal and Ohmann 1992). Estimates of the total organic C stored in the forest floors of the world have been reviewed by numerous researchers (Zinke *et al.*, 1986; Eswaran *et al.*, 1995). However, estimates of total organic C pools on land are highly variable because of incomplete quantitative measurements of soil carbon and plant biomass (Smil, 1985), organic C in soils is underestimated or ignored in most global estimates (Eswaran *et al.*, 1995). The availability of N limits the product-ivity of most agricultural and natural terrestrial ecosystems (Vitousek and Howanh 199 l). Natural inputs of N to forest soils occur as proteinaceous residues of plant or animal origin, which undergo further transformation into organic or inorganic forms mainly via microbial and faunal activities. Organic forms of N usually constitute more than 95% of the total N in organic-rich horizons. (Khanna and Ulrich 1984).

Our knowledge about temperate soils under forests is poor in comparison to Tropical soils and this has necessitated to take up the present investigation in the forest floors of Kashmir otherwise the lack of information about sites history may be an important source of error in the present context carbon trading.

MATERIALS AD METHODS

Forest floor and deforested soils area from each pre surveyed locations: namely Shankeracharya forest floor-T1, Shankeracharya deforest floor-T2 (Silty loam); Dachigam forest floor-T3 , Dachigam deforest forest-T4 (Fine loam); Ganderbal forest floor-T5, Ganderbal deforest floor-T6, (Silty loam) ; Kangan deforest floor- T7, Kangan deforest floor -T8 ,(Silty loam); Handwara forest floor -T9 , Handwara deforest floor –T10 (loamy), and Tangmarg forest floor –T11, Tangmarg deforest floor-T12 (Silty loam) were selected for soil sampling. Detailed physico chemical properties and site information was already described by Bhat and Thakur (2006). The samples from the humus layer through a depth of 30 cm at 20 cm intervals at 100 m^2 quadrate were taken. Soil samples were pooled for each quadrat and material was homogenized and stored (without sieving) before analysis. Soil water content was determined gravimetrically after drying sub samples at 105^0C for 12 h. Total N and Total P determined by digesting the sample with H_2SO_4 and peroxide (Thomas *et al*, 1967). Mineral N was determined by 2M KCL. (Bremner 1965). Organic P and Inorganic P was measured by bicarbonate (5M $NaHCO_3$ pH 8.5) extraction method and P in extractant were determined by ascorbic acid method (Murphey and Riley, 1962) Four fractions of organic carbon with different degrees of liability were calculated from three analysis: Fraction 1 is that part oxidized by 33mM $KMnO_4$,FractionII is excess carbon oxidized by 167 Mm $KMnO_4$,Fraction III the extra carbon oxidized by 333 mM $KMnO_4$ and Fraction IV is unoxidised carbon by 333 mM $KMnO_4$. (Blair *et al.*, 1995). Sustainability index was followed that developed by Blair *et al.*, (1995). Results were reported on oven dry basis and are presented in figures as arithmetic mean of at least 3 determinations. Significance of differences tested with analysis of variance (ANOVA) (Gomez and Gomez, 1984)

RESULTS AND DISCUSSION

Organic Carbon

The contribution of the forest floor to total organic carbon in soils is underestimated. There is a little data available on the storage of carbon in the forest floors of Kashmir region of J&K state. Such information is important from the carbon sequestration point of view to offset excess global carbon. In the present study concentration of carbon in the forest soils of Kashmir varied between 18 g kg^{-1} soil in Shankaracharya forest floors to 35 g kg^{-1} in Dachigam forest floors. Similarly total carbon also varied between 19.5g kg^{1} to 37.2 g kg^{-1}. The organic carbon of soil of these sites was more than 90% of total carbon. The storage of organic carbon decreased in the range 22% to 48% in the forest floor because of deforestation (Fig 1). If the estimate of organic C storage is integrated on the basis of soil having bulk density 1.2 Mg times forest area (Annonymous, 2001), the carbon storage in the soil under forest of Kashmir is calculated as 55440 kg ha^{-1} area in the soils under forests and the soils where deforestation has taken place, carbon storage has dwindled to 12196.8 kg ha^{-1}that indicates decrease in carbon storage by 22% Estimates in the soils of world have been reviewed by many researchers (Zinke *et a.l,* 1986; Eswarn *et. al.,* 1995.) However Carbon storage in the present study is higher than that derived by them. This is because natural deposition of plant residues that reach the forest floor in the form of litter fall & organic debris has still not reached to the disequilibrium proportion besides; Vancleve *et. al.,* 1990 explained more organic accumulation may be because of low temperatures. Similarly total carbon has shown a significant decrease ($P < 0.01$). Release of inorganic C which is mineralization of organic carbon is more in the deforested forest floor that has varied between 2.8 to 4.6g kg^{-1} soil (Fig 1) which is contrast to release of inorganic Carbon in the soils under forest. Perhaps removal of forest cover leads to certain environmental changes like more impingement of solar radiation, leading to the raise in soil temperature and consequently the release of more Inorganic – C. Effect of Temperature on the Carbon Transformation has already been explained by research workers (Vanclive and Yarie 1986, Bhat and Beri , 2002.) Release of Inorganic Carbon is negatively correlated with Organic Carbon storage ($r = 0.2999$) with respect to locations in term of altitude although the level of significance is very low.

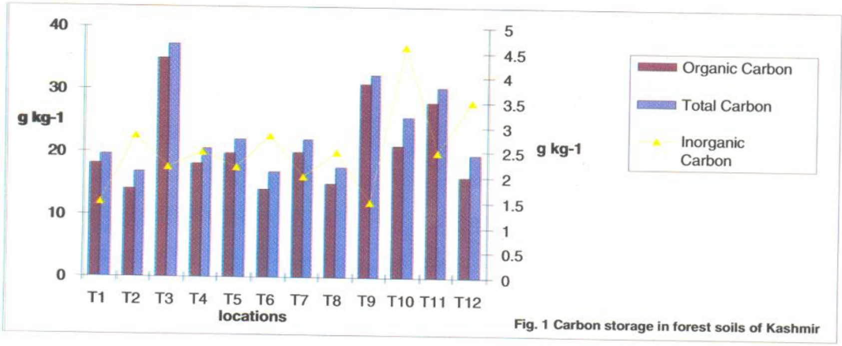

Fig. 1 Carbon storage in forest soils of Kashmir

A method based on the supposition that the oxidation action of potassium permanganate under neutral conditions is comparable to those enzymes from micro organism and other enzymes present in the soil. According to this method changes were observed in the different fractions of carbon (fig 3) in the different forest floor to assess the impact of forest clearing. Fig. 4 illustrate that how these pools are indicators of the slightest changes in the forest floor and is function of total carbon(r=0.973) Based on these indicators carbon pool size index (CPI) was calculated as ratio of total carbon in the deforested soils to reference (total carbon in the soils under forests) (Fig 4). This CPI was observed in the range of 0.55 to 0.79 in different forest floors deprived of forest cover. The loss of carbon from soil with a large carbon pool is of less consequence than the further loss of the same amount of carbon from a soil already depleted of C. Similarly more a soil has depleted of C, the more difficult is to rehabilitate the soil (Bhat, 2007) This carbon pool index as derived from the total soil C pool and C lability and is useful to evaluate the capacity of management systems to promote soil quality as evidence by its close correlation (r= 0.88X) with soil physical attributes.

Nitrogen

Besides understanding C dynamics, information on the storage of Nitrogen in the soil is equally important. The N pools in the world soils has been approximated to 7037 kgha^{-1} (Venclive *et al.*, 1990) but no computation has been made in the soils of the forest floors of Kashmir region of J&K state. In this study, the storage of N in the forest floor of Shankarcharya (T_1) Dochigam(T_3), Ganderbal (T_5), Kangan (T_7), Handwara(T_9) and Tangmarg (T_{11}) through 0-30cm depth is assessed as 543 mg kg^{-1},784 mg kg^{-1},737 mgk g^{-1}, 1400 mg kg^{-}

^{1}, 1374 mg kg^{-1} and 1478 mg kg^{-1} soils. But the reduction in the organic N storage has been estimated and has been brought to the extent 0.35% to 1.86 in deforested soils of these very sites (Fig 2).

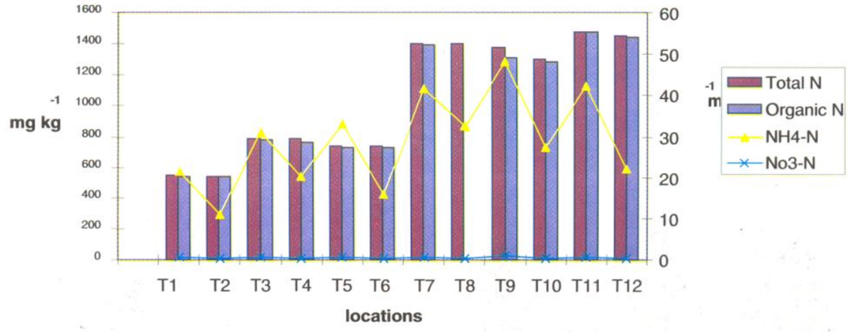

Fig. 2 Changes in nitrogen storage

Inorganic-N (KCl extractable NH_4-N & NO_3) comprised only a small fraction (less than 1%) of the total N in soils (Fig 2).The amount of inorganic N storage in the forest floor through 30 cm depth was 22.02 to 49.08 kg in soils under forest whereas it is 11.21-33.12 in deforested soils .On an average 3.6% of inorganic N mineralized from Organic Nitrogen storage in soil was in NH_4^+ form in the soils under forest cover. Whereas 2.1% of NH_4-N mineralized from organic Nitrogen in deforested soils which is contrast to mineralization of carbon in present studies. The lesser release of mineral N seems to be due to sluggish metabolism of Nitrosomonas. Similar observation was made by Alexander (1977). Nitrate concentration varied between 0.47 to 0.72 g kg^{-1} whereas in deforested Soils variation was in the range of 0.24 to 0.47 mg kg^{-1} soils. It has been observed storage of Organic N and total N has least correlated with thickness of humus layer of different site (r= 0.067) whereas release of NH_4-N is significantly correlated with storage of organic N(r=0.667). However the NO_3-N synthesis is well correlated with the synthesis of NH_4-N in all the sites (r= 0.779). NO_3 concentration is low perhaps it has been observed that soil nitrate concentration is function of changes in external environment (Stevenson, 1957). Other observation to support low NO_3 concentration in forest soils can be owing to the effect of low pH on the metabolic activity of the nitrifying bacteria (Sahrawat, 1982). However (Bhat and Thakur, 2006) the pH value in this study were too low to effect metabolic activity of nitrifiers but perhaps some

ISSN 0973-7502

inhibition must have existed in soil which inhibited nitrification. (Robertson 1980).

The information about the dwindling Carbon and Nitrogen storage in the deforested soils and the enhanced mineralization rate in deforested soil as compared to the soils under forest shall serve as an important basis for computing storage of C involving J&K in the carbon trading.

However further research is needed to explore the storage using more depth of soils under forest which shall lay a sound basis for future a forestation of the degraded land.

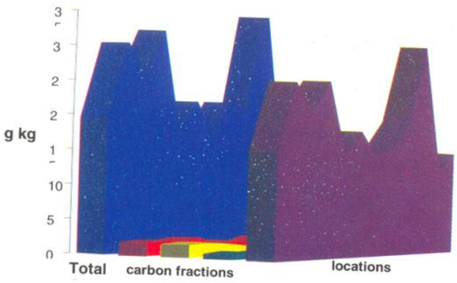

Fig. 3 Changes in different fractions of carbon

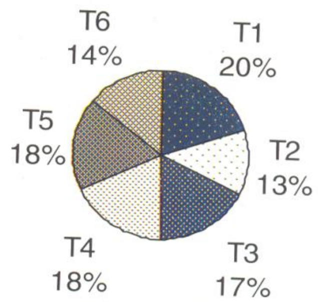

fig4 CPI index for different floors

ACKNOWLEDGEMENTS

Author is thankful to Prof. M.A. Khan HOD, Division of Environmental Science for his encouragement to execute this RCM sponsored project

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