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ASSESSMENT OF CARBON STOCK IN GOKARNA FOREST, KATHMANDU, NEPAL

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Abstract

Assessment of carbon stock in urban forest is essential to obtain the carbon sequestration rate and has important role in urban environment with play vital role to conserve biodiversity. This study was conducted in Gokarna protected forest, Kathmandu, to explore the forest carbon stock. A total of 60 circular plots of random sample with size of 250 m^2 were sampled for study. The biomass of standing trees was estimated by using allometric equation of trees, measuring their diameter & height. A total of 844 trees were measured belonging to 52 species. The total tree biomass was found to be 548.92t/ha. The aboveground tree carbon and belowground tree carbon were found 214.99 (t/ha) and 42.99 (t/ha) respectively. On the basis of IVI value, the dominant tree in the forest was Neolitsea cuipala followed by Sapium insigne and other associated trees were Walsura trijuga, Celtis australis, Alnus nepalensis etc. The forest is well stocked with total trees carbon stock of 256.98t/ha. The protection of urban forest has positive impact on forest structure and biodiversity conservation.

Introduction

Forests play an important role in local, regional and global carbon cycle and they store large quantities of carbon in vegetation and soil, exchange carbon with the atmosphere through photosynthesis and respiration, are sources of atmospheric carbon (Brown & Pearce, 1994; Sharma & Pukkala, 1990). The carbon reservoir in the terrestrial vegetation and soil represent important sources and sinks of atmospheric carbon (Shrestha et al., 2010)

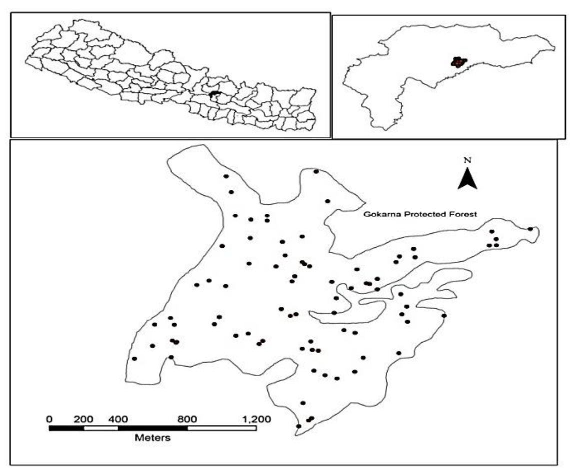
with land use change accounting for 24% of net annual anthropogenic emission of GHGs to the atmosphere (Prentice et al., 2001).

Forests can act both as sinks and sources of carbon, depending on the management activities. It is believed that the goal of reducing carbon sources and increasing the carbon sink can be achieved efficiently by protecting and conserving the carbon pools in existing forest (Brown & Schroeder, 1996). Protected sites are designated with the objectives of conserving biodiversity, but also fulfil an important role in maintaining terrestrial carbon stock, especially where there is little remaining natural vegetation cover. Soil carbon is an important part of terrestrial carbon pool and soils of the world are potentially viable sinks for atmospheric carbon (Bajracharya et al., 1998).

Materials and Methods

Study area

The research was carried out on Gokarna forest, is sub tropical type of forest with dense and bushy vegetation Nepal with altitude 1315 to 1381m. The average precipitation pattern between of 1999-2013 was 1700 mm which shows the forest type fall under the category of moist forest.



Map of study area showing sample points

Quantitative analysis of trees

Quantitative parameters such as basal area and density were determined. Tree cut stumps were also noted and identified wherever possible. Above ground biomass of trees was computed by using the Allometric equation developed by Chave et al., (2005) for moist forest stand.

Calculation of carbon

According to the guidelines the given equation was used to calculate tree biomass and carbon which is appropriate for the moist forest stand (Subedi et. al., 2010) that is the annual rainfall occurs with amount of 1500-4000 mm. This method was also recommended by Ministry of Forests and Soil Conservation, Nepal (2009) for the moist forest.

The allometric equations (models) is
$AGTB = 0.0509 * \partial * D^2H$
AGTC = 0.47 x AGTB (Where, 0.47=Conversion factor or default carbon fraction).

To calculate below-ground biomass, it is recommended that (MacDicken, 1997) root-to-shoot ratio value of 1:5 was used; that is, to estimate belowground biomass as 20% of aboveground tree biomass.

The belowground tree biomass carbon stock was calculated by using the given formula. BGTC = 0.47 x BGTB (Where, 0.47=Conversion factor or default carbon fraction)

The carbon stock was calculated by summing the carbon stock of the individual carbon pools of each plot using the following formula.
C = C (AGTB) +C (BGTB)

Data analysis

Parameters such as standard deviation and standard error were calculated using the respective formula. Qualitative form of data and information were also coded and then entered for analysis. The different statistics such as percentage, frequency, bar diagram and table were interpreted by using both qualitative and quantitative data.

Results and Discussion

Altogether 844 trees of the 52 different species in 60 plots were recorded from Gokarna forest. The high species number in forest may be due to the protection from grazing by livestock, not disturbance so may increase species richness (Connel, 1978). *Neolitsea cuipala* was found dominant species with 451 trees (>53%). *Schima wallichii* had the highest DBH (110 cm) and height 31m other larger trees were *Ficus benghalensis, Acer oblongum.* The average height of trees was 14.68 m and average DBH was 13.48 cm. The highest density was found of *Neolitsea cuipala* (330.67 trees/ha) followed by *Sapium insigne* (72.67trees/ha). The species such as *Ficus subincisa, Eurya acuminata, Dodecadenia grandiflora* were rare with density 0.667 trees/ha. Their density might be low because they are less dominant species with only occasional occurrences in the forest. The population densities of fourteen tree species were lower, so they are rare species of the forest. The forest is dense within the ranged values 390-1460 trees/ha reported by Khadka & Schmidt-Vogt (2008) in forests of Godawari hills, Kathmandu. Pandey et al., (2004) reported the values of density ranging from 140 to 750 trees/ha in Pindari forest Kathmandu. The variation of tree density within the forest could be due to different extent of disturbances exert by cutting as well as plantation management and protection. However, size class distribution of trees shows that although total density is higher, most of the trees constitute smaller girth.

The basal area is an important criterion for evaluating the timber production in forest ecosystem (Agrawal, 1992), an indication of the natural fertility of the site and maturity/age group of the forests. Similarly, the total basal area was $52.38 m^2/ha$. The basal area variation among plots were significantly different ($p<0.05$). Basal area of trees have been reported as between 0.80 to $76.15 m^2/ha$ in Sikre VDC adjoining Shivapuri National park, Kathmandu (Pandey & Bajracharya, 2010), 7.25 to $48.65 m^2/ha$ in Nagarjun hill forest (Yadav & Shah, 1998).

Aboveground and belowground trees biomass and carbon stock

Forest can capture and retain a large volume of carbon for a long period of time. The total carbon sink and storage in the forest are important factor to mitigate climate change. The total biomass of Gokarna forest was 548.92 t/ha. Biomass estimation of any forest depends on forest structure i.e. density of trees, diameter, basal area, tree height, age of trees etc. The above ground biomass of tree species in our study site was 457.44t/ha. Similarly, the total estimated carbon stock of the Gokarna forest was found to be 256.98 t/ha which was more comparable to values recorded by Thapa & Bhuju, 2011 in

Dhading district of Nepal (128 t/ha) more than the value estimated in Gadhanta- Bardibash CFM (208.363 t/ha). This value was higher than Singh (2002), who estimated the total carbon sequestration potential of Kusunde community forest, was 57.90 t/ha

A higher value of 86.02 tons/ha biomass was recorded by (Baral et al., 2009) in degraded Chirpine forest at Lalitpur district. Simillarly, Shrestha, (2009) estimated above ground tree biomass of *Pinus roxburghii* forest and mixed broad leaf forest of Palpa district to be 269.205 t/ha and 76.65 t/ha respectively. Gokarna forest showed higher above ground tree biomass than the findings in other forest. The higher percentage of above ground biomass in the present study is indication of good protection of the forest. The above ground biomass also depends on trees size and canopy opening.

The productivity was also high of old trees that contributed high value of above ground biomass. The biomass of trees varied according to species composition, aspect and density.

The more competitive and strong species uses all the nutrients available and increases its biomass. The species having DBH (10-20) cm and height 4-13) m had high frequency of occurrence in the sampling plots because there was less dominance of old trees in the areas where they were sampled.

While comparing with international values, mean total carbon stock of present study was higher than the total carbon stocks findings of FAO (2010) who reported a value of 161.8t/ha in the world's forests and (126 t/ha) in sub tropical pine *Pinus roxburghii* forests of Pakistan (Negi et al., 2003) but lower than accounted values (303 t/ha) in tropical seasonal forest of Southwestern China (Li et al., 2010) and 283.80 t/ha in natural forest of Bangladesh (Dixon, 1994). This dissimilarity in carbon stock might be expected as dense forest as well as trees with higher density, species composition and DBH of tree.

Conclusion

Gokarna forest consists of mixed broad leaved forest. The forest is well preserved with high density and basal area of trees. It showed that Gokarna forest, as urban forest patch act as a good sink of atmospheric carbondioxide. It is important to identify the factors affecting forest resources in future and its relation with diversity for better management of the forest ecosystem.

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