The Pharma Innovation Journal 2023; SP-12(11): 1061-1065

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(11): 1061-1065

www.thepharmajournal.com
Received: 03-09-2023
Accepted: 07-10-2023

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Assessment of biomass in different forest types of Yellapur forest division of Uttara Kannada district, Karnataka

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Abstract

Forest plays a vital role in mitigation and adaptation to ongoing climate change. A substantial portion of this carbon is sequestered in the above-ground biomass, underscoring their critical contribution to the global carbon cycle and their role in regulating the Earth's bio spheric climate. The forest biomass changes according to site factors human interference such as natural forest or plantation forests and open or closed forests. The effective method of biomass estimation at regional level has a significant importance to mitigate ongoing global warming and climate change. In this context the biomass was estimated in dry, moist deciduous and semi evergreen forests of Yellapur forest division by laying the permanent plots of size one ha (100 m×100 m). The biomass was estimated using non-destructive method. The above ground biomass of semi evergreen forest showed maximum above ground biomass (325.14 t ha^{-1}) which is statistically higher than dry deciduous forest type (180.67 t ha^{-1}). The semi-evergreen forest exhibited the highest below ground biomass with a value of 84.53 t ha^{-1}, statistically higher than the dry deciduous forest type. The total biomass distribution which is the addition of above ground biomass and below ground biomass across different forest types where the semi-evergreen forest type displayed the highest total biomass of 409.68 t ha^{-1}, the minimum total biomass in the dry deciduous forest. The highest total biomass accumulation in semi evergreen forest is due to availability of moisture and green leaf flush throughout the year. The larger and buttressed trees in the semi evergreen forest holds maximum biomass. The lesser biomass accumulation in dry deciduous forest is because of moisture stress in the tree and also tree remains leaf less for short period of time. It is evident from the results that the semi evergreen forest accumulates higher biomass therefore, conservation strategies need to be imposed on such forest in order to mitigate ongoing climate change.

Keywords: Biomass, climate change, forest types, permanent plots

Introduction

Climate change poses a serious threat to the ecosystem and quality of human life all across the world. Forest plays a vital role in mitigation and adaptation to ongoing climate change (Koppad and Tikhile, 2013) [7]. Forest can also act as a sink, reservoir and carbon source. Healthy forest vegetation stores greater amount of biomass than other terrestrial ecosystems. The forests in India represent some of the most abundant terrestrial ecosystems globally, containing roughly 50% of the world's living terrestrial carbon. A substantial portion of this carbon is sequestered in the above-ground biomass, underscoring their critical contribution to the global carbon cycle and their role in regulating the Earth's bio spheric climate (Shi and Singh, 2002) [10]. The existence of forest resources significantly contributes to the sustainability of life on Earth. Many ecosystem services that support human existence and quality of life are benefited from forests, which are the essential ecological units that regenerate on their own. These services include soil and water conservation, air and water purification, carbon sequestration, drought and flood mitigation, *etc*. Forests play a crucial role in maintaining the stability of the Earth's climate and regulating the global carbon cycle, as a substantial amount of carbon is stored in the form of above-ground biomass within these ecosystems (Shi and Singh, 2002) [10]. Growing stock represents the collective volume of all living trees within a forested region. Regularly assessing growing stock is crucial for shaping a nation's policies and strategies concerning the sustainable management of forests. It holds significance in the context of a country's overall wealth and serves as an indicator of the sustainability and productivity of its forests. Forest inventories have the objective of evaluating growing stock, along with various quantitative and qualitative parameters like biomass, carbon stock, regeneration status, population, and structure.

Traditionally, estimating growing stock has been instrumental in calculating the sustainable timber yield from these forests (Anon, 2019) [2]. The estimation of biomass is an important variable in different forest types which helps in understanding the carbon sequestration potential of forest types. The forest biomass changes according to site factors human interference such as natural forest or plantation forests and open or closed forests. Biomass plays a crucial role in assessing and characterizing forest ecosystems. The effectiveness of carbon storage in organic material is indicative of the environmental factors, quality, soil composition, and nutrient availability. An accurate understanding of biomass is essential for evaluating potential harvests in these ecosystems (Vanclay, 1995) [15]. About 60 per cent of the total above ground biomass was found in commercial bole, while only 3-5 per cent of biomass was found in leaves of fodder forms in closed forests (Brown, 1997) [3]. Therefore, carbon and biomass estimation serve as one of the effective metrics for evaluating changes in the structure of the forests. The data related to aboveground biomass (AGB) can also serve the purpose of comprehending alterations in forest composition brought about by succession or for distinguishing among various forest types (Cairns *et al*., 2003) [4]. The effective method of biomass estimation at regional level is precious to mitigate ongoing global warming and climate change. In this context the biomass was estimated in dry, moist deciduous and semi evergreen forests of Yellapur forest division by laying the permanent plots.

Material and Methods

The present study was conducted in different forest types of Yellapur forest division of Uttara Kannada district. The Yellapur forest division has dry deciduous forest in its eastern part, moist deciduous forest in the central part and semi evergreen forests in the western part. A reconnaissance survey was conducted within the study area to confirm the specific sample site locations intended to collect ground inventory data. The permanent plot of size, one ha (100 m×100 m) was laid out across the forest types of Yellapur forest division. The total of 9 permanent plots, three each in dry, moist deciduous and semi evergreen forests were laid. There were 9 sub plots each of size 33.33m ×33.33m were marked using nylon ropes. The total of 7 sub plots were selected from three permanents plots (one ha) laid randomly in different forest area for the enumeration. All the trees having girth at breast height ≥30 cm within the plots were given number and marked using permanent paint (Tamilselvan *et al*., 2021) [14]. Each tree within a sub plot were measured for its girth at breast height and at base and height. The study was structured using a Randomized Block Design (RBD) consisting of three treatments and seven replications. These treatments were based on three distinct forest types within the Yellapur forest division of Uttara Kannada district, with seven subplots selected from each forest type to serve as replications. The total tree height was measured using digital laser hypsometer, Girth at Breast height (GBH) and Girth at Base (GAB) was recorded using measuring tape.

Estimation of above ground biomass (AGB)

The data collected on various parameters such as GAB and GBH and tree height was used to calculate volume.

Volume of tree (m^3) = Basal area (m^2) × Height (m) × Form factor

Tree biomass was estimated by multiplying volume with wood specific gravity. The above ground biomass of tree (Chaturvedi and Khanna, 1984) [5] obtained from each quadrat is used to estimate total AGB (t ha^{-1}). It is calculated using the following formula,

Above Ground Biomass (t ha^{-1}) = Volume of tree × Wood specific gravity

Estimation of below ground biomass (BGB)

Anon (2007) [1] suggest that below ground biomass is close to 26% of the total above ground biomass and indicate that majority of the underground biomass of the forest is contained in the heavy roots generally defined as those exceeding 2mm in diameter.

In the present study BGB is obtained by multiplying AGB with factor of 0.26

Below ground biomass (t ha^{-1}) = AGB × 0.26

Estimation of total biomass (TB):

Total tree biomass density is the sum of the aboveground biomass and belowground biomass (Sharma *et al.*, 2010) [9].

Total biomass (t ha^{-1}) = AGB+ BGB

Results and Discussion

The distribution of above ground biomass in various forest type is presented in Table 1. The above ground biomass of semi evergreen forest showed maximum AGB (325.14 t ha^{-1}) which is statistically higher than dry deciduous forest type (180.67 t ha^{-1}). The maximum biomass accumulation in semi evergreen forest type is due to higher moisture content availability in the trees. The larger and buttressed trees contribute more to above ground biomass accumulation in semi evergreen forest type. The maximum biomass accumulation in semi evergreen forest depends on the species composition and its wood specific gravity. Wood specific gravity plays a pivotal role in the conversion of forest volume data into biomass The AGB of moist deciduous forest (269.58 t ha^{-1}) was on par with the AGB of semi evergreen vegetation type (Fig 1). The study also revealed that statistically difference between AGB of dry deciduous forest (180.67 t ha^{-1}) which recorded less among the various forest type. The leaf less period for short period of time and also moisture stress in the dry deciduous forest could be the reason for the less accumulation of AGB. The estimated values of AGB in present study was significantly higher than Khaple *et al.* (2016) [6]; but the similar trend was followed where Khaple *et al.* (2016) [6] reported maximum AGB (95.87 t ha^{-1}) in moist deciduous forest than in dry deciduous forest (43.86 tha^{-1}) because of the higher basal area and volume recorded in moist deciduous forest. However, it was found that AGB of different forest type showed significant variation. The AGB of moist deciduous forest type is on par with the dry deciduous forest. Swamy *et al.* (2010) [13] found that the AGB in tropical evergreen forests of the Western Ghats ranged between 416 to 552.9 t ha^{-1}, which aligns with the results of the present study. Moreover, Ramachandran *et al.* (2007) [8] conducted similar studies and reported AGB values of 307.30 t ha^{-1} in the evergreen forest and 251.65 t ha^{-1} in the deciduous forest of the Eastern Ghats. These findings also correlate the AGB estimates obtained in the present study.

The semi-evergreen forest exhibited the highest BGB with a value of 84.53 t ha^{-1}, statistically surpassing the BGB of the dry deciduous forest type. Remarkably, the BGB of moist deciduous forest (70.09 t ha^{-1}) was found to be on par to that of the semi-evergreen vegetation type. The BGB of moist deciduous has varied significantly with that of dry deciduous forest. On the other hand, the BGB of dry deciduous forest (46.97 t ha^{-1}) was significantly lower compared to the other forest types. (Table 1 and Fig 2)

The Total Biomass (TB) distribution which is the addition of AGB and BGB across different forest types is shown in Table 1. The semi-evergreen forest type displayed the highest TB of 409.68 t ha^{-1}, the minimum TB in the dry deciduous forest. Interestingly, the TB of the moist deciduous forest (339.67 t ha^{-1}) closely resembled that of the semi-evergreen vegetation type. The TB of moist deciduous forest has varied significantly with that of dry deciduous forest. Conversely, the TB recorded in the dry deciduous forest (227.64 t ha^{-1}) was notably lower compared to the other forest types (Fig 3).

The statistical analysis indicated that TB is significantly differing in all the three forest types. In all the forests, notable variations in total biomass were observed. It is significant to note that the statistical analysis used in the study supported the results indicating that the moist deciduous forest type and the semi-evergreen forest type have similarities in terms of TB.

In a comparable study conducted by Swamy *et al*. (2010) [13] in the Western Ghats of India, the total biomass for evergreen forests were reported to be within the range of 439 to 587 t ha^{-1} and 206.33 to 275.89 t ha^{-1}. These findings align with the results obtained in the present study. In their study, Shukla *et al*. (2014) [11] documented a total biomass of 1938.28 metric tons per hectare for teak plantations in the Terai zone of West Bengal which is higher than the estimated values of present study. Singh and Singh (1991) [12] reported a total biomass ranging from 53 to 94 metric tons per hectare in tropical dry deciduous forests of India, due to a greater number of stems and which is drastically lower compared to this study.

Table 1: Distribution of above ground biomass, below ground biomass and total biomass in different forest types of Yellapur forest division of Uttara Kannada district.

Forest type	AGB (t ha^{-1})	BGB (t ha^{-1})	TB (t ha^{-1})
Dry deciduous	180.67	46.97	227.64
Moist deciduous	269.58	70.09	339.67
Semi evergreen	325.14	84.53	409.68
SEm (±)	18.66	4.85	23.51
C.D@5%	58.14	15.11	73.25

*Figures in column are AGB- Above ground biomass, BGB-Below ground biomass, TB-Total biomass, NS = non-significant, CD = Critical difference, SEm- Standard error of mean

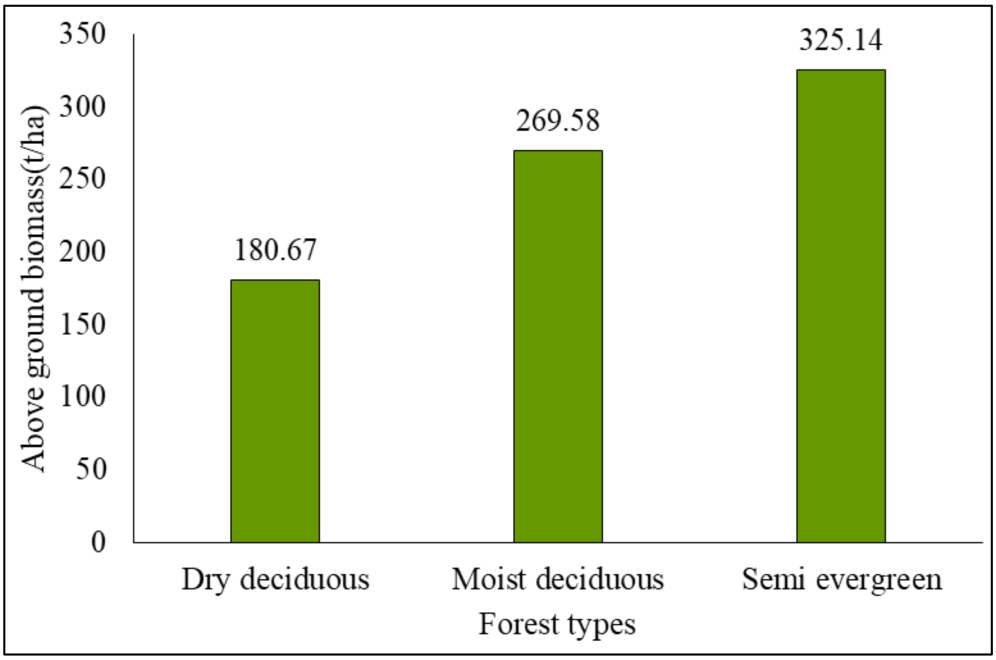

Fig 1: Distribution of above ground biomass across different forest types

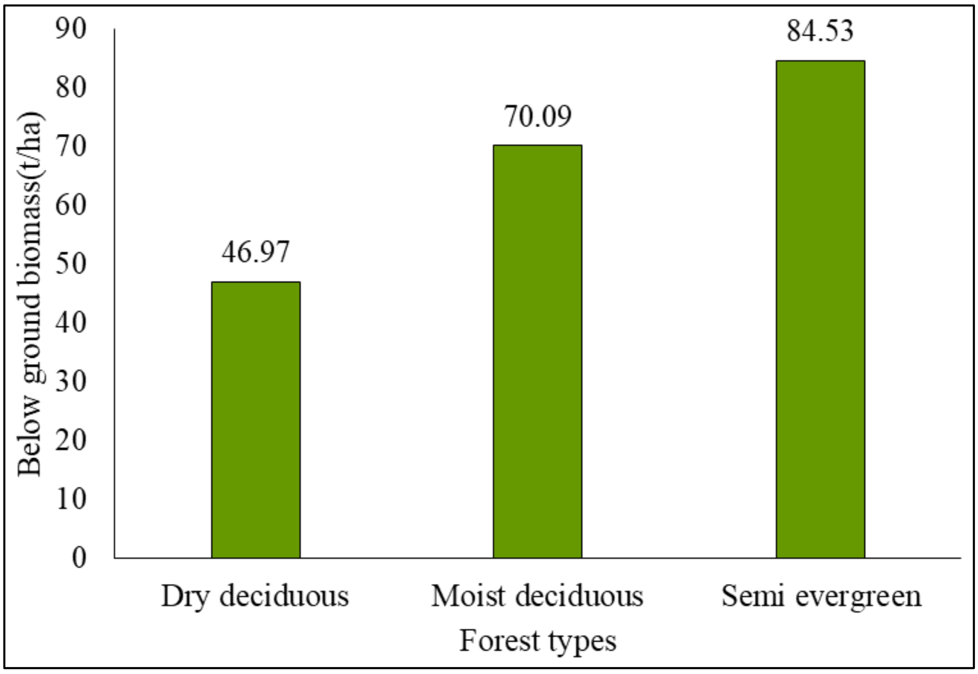

Fig 2: Distribution of below ground biomass across different forest types

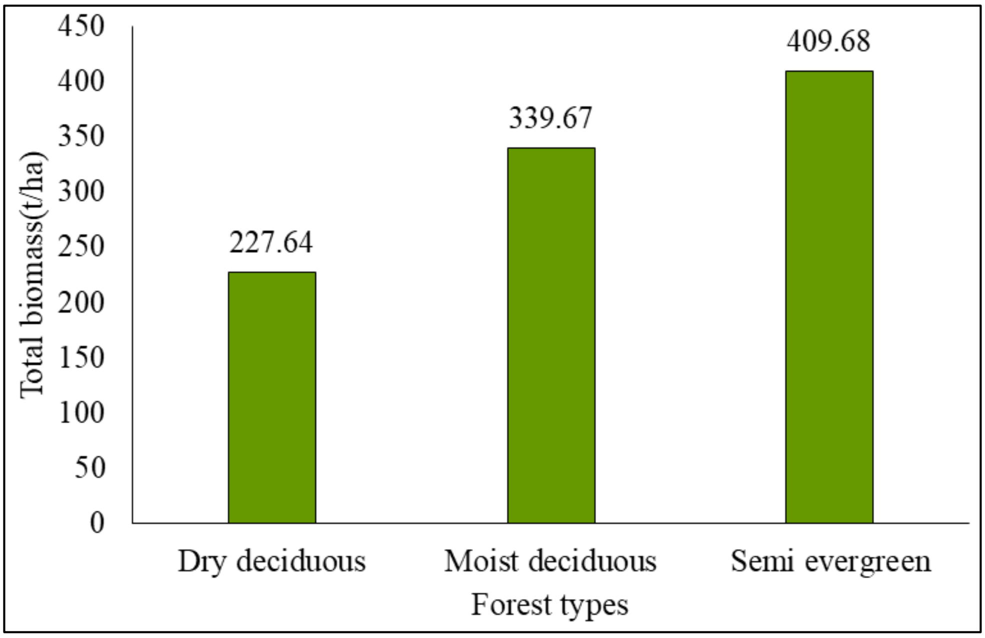

Fig 3: Distribution of total biomass across different forest types

Conclusion

The study was conducted in Yellapur forest division by laying permanent plot in dry, moist deciduous and semi evergreen forest types to understand the pattern of biomass distribution. Among all the vegetation type maximum above ground biomass (325.14 t ha^{-1}) was found in semi evergreen forest, and also the highest below ground biomass with a value of 84.53 t ha^{-1}. The semi-evergreen forest type also displayed the highest total biomass of 409.68t ha^{-1}. The higher AGB in semi evergreen forest could be due to larger trees and continuous availability of moisture. The AGB, BGB, TB were found to be less in dry deciduous forest due to less basal area and moisture stress in the trees. These results contribute to understanding the biomass accumulation and carbon sequestration potential across different forest types in the region. In this regard, study on biomass accumulation across forest types is essential for various ecological, environmental reasons from carbon storage and climate change mitigation to biodiversity conservation and sustainable resource management. It also helps to make informed decisions and policies to ensure the well-being of forests and planet.

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