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Socio-economic and environmental benefits of *Barrringtonia acutangula*: a multipurpose floodplain tree species

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Abstract

Tree species of floodplain areas have various adaptation and life history strategies which allow them to cope with periods of water logging or even submergence. Floodplain tree species are strongly influenced by flood frequency, duration, timing and intensity. *Barrringtonia acutangula, a* naturally growing tree species grows on the bank of the fresh water river uniquely adapted to the aquatic conditions of Chatla Floodplains. A study was undertaken to explore the socio-economic and environmental benefits of *Barringtonia acutangula* in the flood plains of Cachar district of Barak Valley, Assam. Fishermen community of the floodplain region '*Kaivartas*' manages this species to fulfill diverse set of socio-economic and environmental benefits. A unique management system of *Barringtonia* forest for fish farming was observed during the study.

Barringtonia forests are managed for sprout production (diameter>20cm and length>150cm) used in fishery management. Sprouts are also managed for selling to other floodplain areas where the species is sparse. *Barringtonia acutangula* forest stocked with total above ground biomass of 314.71 Mg ha^{-1} estimated through dimension analysis method. Stand density of 3170 trees ha^{-1} was observed. Of the total biomass, leaf contributed 12.58Mg ha^{-1} (4%), secondary branch 18.88 Mg ha^{-1} (6%), primary branch 34.61Mg ha^{-1}(11%), sprout 96.23Mg ha^{-1}(22%) and bole 179.38 Mg ha^{-1} (57%) respectively. Vegetation carbon stock of the stand was estimated to be 157.355 Mg ha^{-1} of which bole contributed the highest amount (89.69 Mg ha^{-1}) followed by sprout (34.61Mg ha^{-1}). The quantity of biomass and the carbon stock of vegetation cover of *Barringtonia* forest suggest its direct influence on local, regional and even global climate. We suggest the promotion of management of *Barringtonia* forest for enhancing the socio-economic and environmental sustainability of such floodplain ecosystems.

Key words: Floodplain , biomass , traditional management , Assam.

Introduction

Floodplain areas are the unique part of the world. Floodplains are flat lands adjacent to streams or rivers, subjected to periodic flooding (Finlayson and Moser, 1991). Floodplains are highly diverse and productive systems of great social, ecological and economical values. The river floodplain interaction is mainly governed by the seasonal pulsing of flood water from the river onto the floodplain and its subsequent recession back into the river. The pulsing of the river discharge, the flood pulse, is the major force of controlling biota in the river floodplains. Primary and secondary production in the river-floodplain system is the sum of production during terrestrial and aquatic phases, the basic fertility of the floodplain depends on the nutrient status of the water and sediments deriving from the river. This fertility may be modified by tributaries and by runoff from the local catchment area of the floodplain (Jung, 1989). These areas are well known for their important roles in sustaining regional biodiversity and water quality, and for their capacity to produce trees and fish (Tockner et al. 2008). In many respects, floodplains are analogous to coral reefs and tropical forests in harboring regional diversity and sequestering carbon and nutrients (Naiman et al. 2005). The concentration of biodiversity, the levels of carbon and nutrient sequestration, the spatial and temporal variability in moisture and sediment characteristics, and the social values they support make floodplains disproportionately important relative to other portions of river catchments. Nevertheless, floodplains are being transformed worldwide through land conversion, flow regulation, and flood abatement actions (Tockner et al. 2008).

The quantity of biomass in a forest determines the potential amount of C (carbon) that can be added to atmosphere or sequestered on the land when forests are managed for meeting emission targets (Brown et al. 1999). With the intense focus on the increasing levels of atmospheric CO2 and the potential for global climate change, there is an urgent need to assess the feasibility of managing ecosystem to sequester and store C (Johnson and Kern 2002). If the existing C pools in different forest types can be estimated, it can be used to in making decisions about C management within forests (Sharma et al. 2010).

Methodology

Study area

Present study was carried out in Chatla floodplain in Cachar district of Barak Valley, Assam. Chatla is the catchment of river Ghagra the tributaries of river Barak. The topography of the area is low lying with numerous small hillocks in between that are inhabited by the villagers .Chatla has an area of around 10 km^2.The major ethnic group in the Chatla are the Kaivartas, a fisher community. When it is covered by water in the monsoon, it is treated as "Common property Regime"(CPR) with community fishing rights. However after the water recedes the land reverts to a "Private Property Regime" with restoration of individual property rights. In both season the fisher community used to capture and tread of fishes. The flood plains originally had rich vegetation with *Barringtonia acutangula* as the dominant tree species. This tree can withstand prolonged water logging and is common swamp forest species of this region. Large scale removal of this species was initiated in the 1960-70s at the time of settlement of the fisher community and now a few patches remain (Gupta, 2003).

Methods of study

Quantification of stand density and population structure:

A total of 20 plots (10m x 10m) were randomly selected. In each plot all *Barringtonia acutangula* tree were numbered with durable red paint and the DBH (1.3m above the ground level) was prominently marked around each trunk with the same paint. The DBH of all the trees within each plot were measured with the measuring tape.

To study the population structure all seedlings (height <50 cm) and saplings (height ≥50 cm to dbh<10 cm) and trees (dbh<10 cm) were measured and monitored in the study area.

Criteria for selection and harvesting of trees for allometric model development

A total of 200 trees were randomly selected and measured for DBH and classified into four (4) girth classes. For harvesting, 12trees were selected from those four convenient size classes with progressively larger diameter such as 10-30, 30-50, 50-70, 70-90 cm. Three trees were selected from each girth class.

Harvested trees were dissected into their component parts e.g. leaves, sprouts, boles and branches. Each tree was cut at the ground level with saw. At the time of cutting bole length, bole diameter, sprout length, sprout diameter, branch length and branch diameter as well as the fresh weight of all components were taken by spring balance.250gm of sub samples were taken from every component of each tree for oven drying. Samples were dried in an oven at 70^0C until a constant weight was attained. For each tree fresh weight values of the tree component (leaves, sprouts, boles and branches) were multiplied by their respective dry weight and fresh weight ratio to obtain component dry biomass. By summing the biomass components, the total above ground biomass of each tree were obtained.

Allometric model development for biomass estimation

Linear equation was developed between tree size and dry weight of trees (leaf, branch, sprout, bole) to estimate the biomass stock. The equation was of the form

$$Y = a + b X$$

where Y is the component dry weight (g), X is the diameter at breast height (cm), and a and b are the regression coefficients.

Result and Discussion

Traditional management system of *Barringtonia acutangula*

Barrringtonia acutangula are naturally growing tree, that grows on the bank of the fresh water river/pond and uniquely adapted to the aquatic conditions. In Chatla Floodplain of Barak Valley, the species is highly significant not only because it is adapted to seasonal inundation, but also because of the important role it plays in the benefits of rural livelihood. The species provides different types of subsistence and commercial goods including fuel wood, building materials, fodder etc. Dried leaves are collected by women and used as fuel for cooking purposes. Fish farming through the fishery management is an important source of livelihood to fishermen community in both rainy and winter season. The branches/sprouts are used in the management of fishery. The people usually cut the branches/sprouts of *Barringtonia acutangula* during June/July in every three years. The cut branch measures diameter >20 cm and the length >150 cm. Branch cutting allow the tree to produce more sprouts, that in turn enhance the commercial utility of the tree. Branches are cut just above the region of the bole where from it develops. Traditional utilization of sprouts involve, cutting of the sprouts and allow for sundry for 15-20 days. After sun drying and shedding of leaves, branches are kept in the water body. The compact/complicated branches protects fishes from the predator and provides suitable micro habitat (Nath et al. 2010). The rough surface of the branches helps the growth of algae on it and subsequently acts as an important fish food. During the dry season (December-February) fishermen collect the branches from the water body and again allow for sundry to use as fuel wood.

Tree density and population structure:

Tree density was dominated by 20--30 and 30--40 girth sizes i.e. the younger trees were dominant in the studied stand. Higher girth size trees were very less or absent in the study area. Stand density of the area was 3290 trees ha^{-1} (Figure 1). Dominance of younger trees represents the growing stage of the *Barringtonia* forest. Occurrence of very young tree population is attributed to grazing pressure and human disturbance prevailing in the area. Less number of larger trees are due to removal/felling by past human disturbances in 1970's when the people settled here migrating from other places.

Study revealed 40% of the total population is represented by seedlings, 3% by saplings and 57% by trees (Figure 2). Even though, a larger proportion of the population is represented by seedlings, due to intense grazing pressure mortality rate of seedlings are very high. This is also evident from the contribution of the saplings to the total population.

Biomass allocation and Biomass Carbon stock

The contribution of leaf, primary and secondary branch biomass exhibited an increasing trend with increase in girth sizes (Figure 3). The contribution of sprout biomass to the total biomass was also consistent with increase in girth size while the contribution of bole to the total biomass decreased with increase in girth size. At higher girth sizes (70-80 cm, 80-90cm) the contribution of bole and sprout to the total biomass was almost same. The contribution of different biomass component to the total biomass was in the order bole>sprout >primary branch >secondary branch>leaf.

Barringtonia forest was stocked with total above ground biomass of 314.71 Mg ha^{-1}. Of the total biomass, leaf contributed 12.58Mg ha^{-1} (4%), secondary branch 18.88 Mg ha^{-1} (6%), primary branch 34.61Mg ha^{-1}(11%), sprout 96.23Mg ha^{-1}(22%) and bole 179.38 Mg ha^{-1} (57%) respectively (Figure 4). Baishya et al.(2009) reported biomass in natural and plantation forests of humid tropics in northeast India as 323.9 Mg ha^{-1} and 406.4 Mg ha^{-1} respectively. Brown & Lugo (1982) reported that above ground biomass of the tropical rain forests in Malaysia (225-446 Mg ha^{-1}) and Cameroon (238-341 Mg ha^{-1}). *Barringtonia* forest exhibited biomass values quite comparable to the other tropical forest. Moreover, biomass stock of *Barringtonia* forest was higher than the above ground biomass for different forest types of Barak Valley that ranged from 32.47 Mg ha^{-1} to 261.64 Mg ha^{-1} (Borah et al. 2013).

Vegetation carbon stock of the stand was estimated to be 157.35 Mg ha^{-1} of which bole contributed the highest amount (89.69 Mg ha^{-1}) followed by sprout (34.61Mg ha^{-1}). Carbon stock in vegetation for different forest types in Barak Valley was reported between 16.24 Mg ha^{-1} to 130.82 Mg ha^{-1}(Borah et al. 2013).The aboveground carbon stored by natural and plantation forests of humid tropics in northeast India was 161.97 and 203.18 Mg C ha^{-1},respectively (Baishya et al. 2009).

Conclusion:

Population structure of the *Barringtonia* stand revealed the need of protection of seedlings from grazing and other anthropogenic stress for enhancing the expansion of distribution of the species. Biomass carbon stock in *Barringtonia* forest suggest the potentiality of the species for consideration under climate change mitigation programmes. Cutting of sprout can lead to increased above ground carbon stock of *Barringtonia acutangula*. Proper utilization and traditional management can provide benefits on a local, national and global level through livelihood, economy and environmental security for the inhabitants of the floodplain area.

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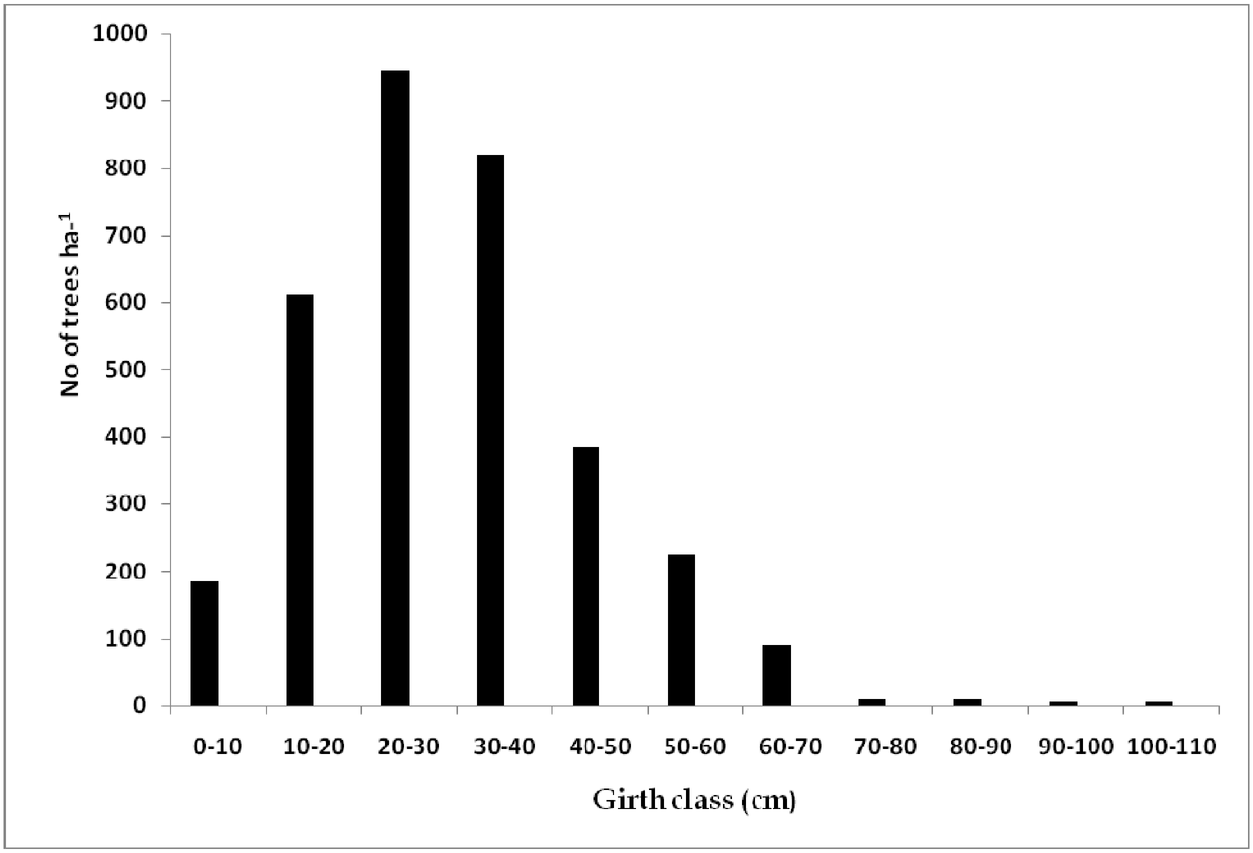

Figure 1. Density of trees with respect to girth sizes in *Barringtonia acutangula*

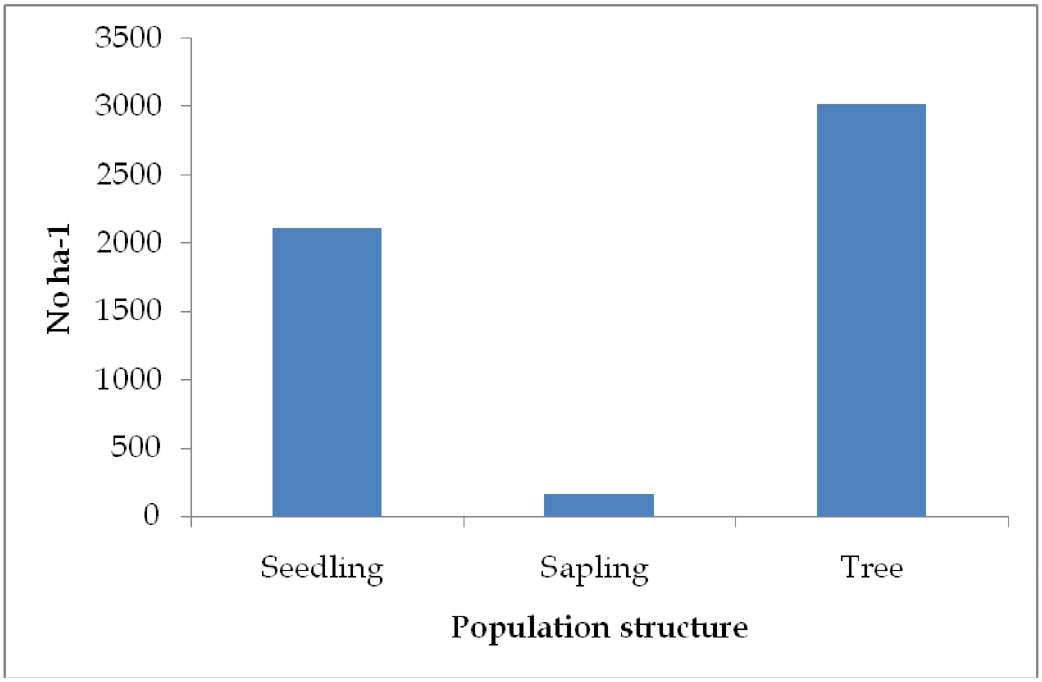

Figure 2. Population structure of seedling, sapling and trees in *Barringtonia acutangula*

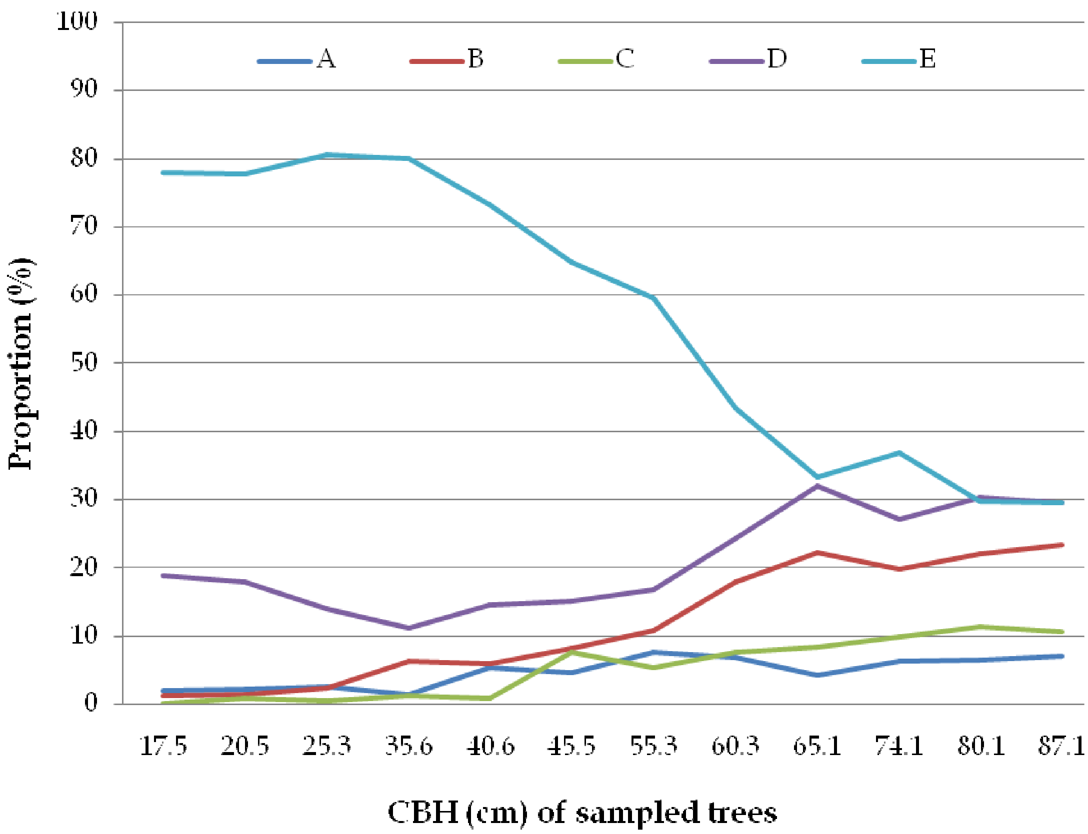

Figure 3. Contribution of different biomass compartment to the total biomass (A=Leaf, B= Primary Branches, C= Secondary Branches, D=Sprout, E=Bole)

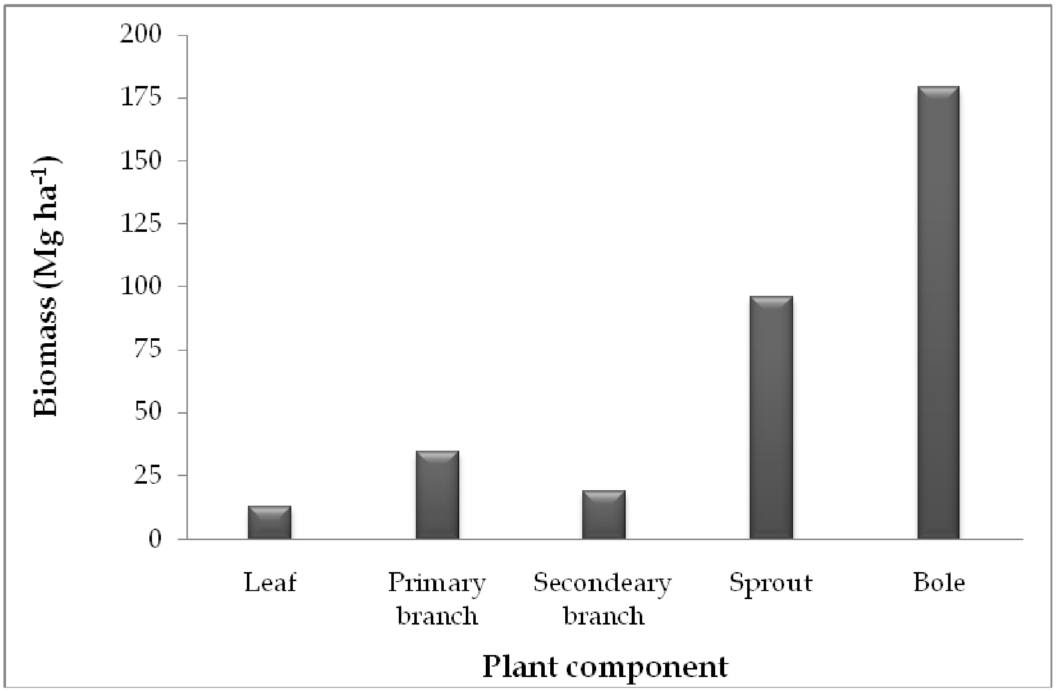

Figure 4. Different plant component contributing to total biomass in *Barringtonia acutangula*