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Estimation of Biomass using Remote Sensing: A Study of Bhadra Wild Life Sanctuary

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Biomass is an organic matter, both plant and animal that can be used for fuel source for energy. Biomass refers to any biological material derived from living or recently living organisms, including plants, animals and microorganisms. Biomass is a renewable energy source, it can be replenished relatively quickly through natural process as plant growth. Estimation of this biomass is a process of determining the total mass of living organisms in give particular given area including forestry, ecology and agriculture. That can effectively done with the help of remote sensing data and machine learning language. The objective is to estimate biomass for study area have been carried out for the Bhadra Wildlife Sanctuary. Above and below ground biomass have been calculated using random forest algorithm and the results were discussed.

Above Ground Biomass:

Random forest algorithms

Random forest is a commonly-used machine learning algorithm, trademarked by Leo Breiman and Adele Cutler that combines the output of multiple decision trees to reach a single result. Its ease of use and flexibility have fueled its adoption, as it handles both classification and regression problems

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Random forest algorithms have three main hyperparameters, which need to be set before training. These include node size, the number of trees, and the number of features sampled. From there, the random forest classifier can be used to solve for regression or classification problems.

The random forest algorithm is made up of a collection of decision trees, and each tree in the ensemble is comprised of a data sample drawn from a training set with replacement, called the bootstrap sample of that training sample, one-third of it is set aside as test data, known as the out-of-bag (oob) sample. Another instance of randomness is then injected through feature bagging, adding more diversity to the dataset and reducing the correlation among decision trees. Depending on the type of problem, the determination of the prediction will vary. For a regression task, the individual decision trees will be averaged, and for a classification task, a majority vote—i.e. the most frequent categorical variable—will yield the predicted class. Finally, the oob sample is then used for cross-validation, finalizing that prediction.

Below Ground Biomass

Below Ground Biomass means all living biomass of live roots. Fine roots of less than 2mm diameter are sometimes excluded because these often cannot be distinguished empirically from soil organic matter or litter.

Below Ground Biomass (BGB) in Kg/hectare = 0.15 * AGB

Total Accumulated Biomass (TAB)

Total Accumulated Biomass means sum of above and Below Ground Biomass TAB in

(Kg/hectare) = AGB + BGB

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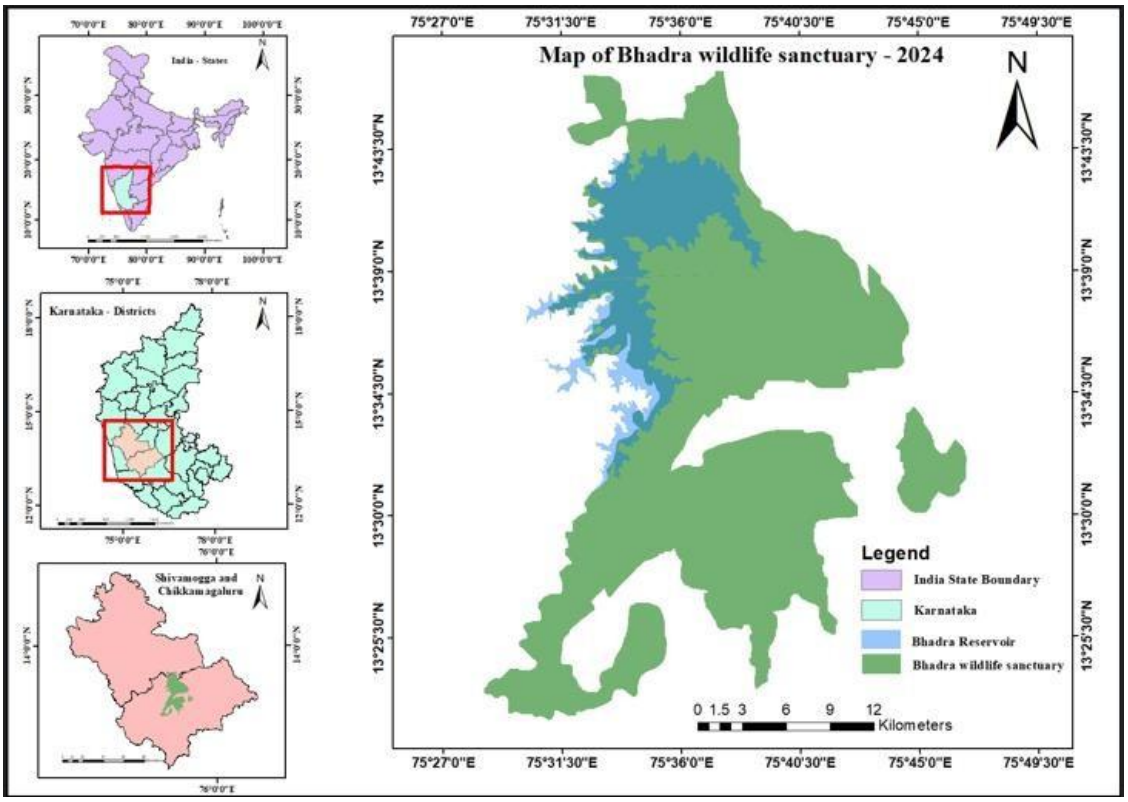
Location of Bhadra Wildlife Sanctuary

Bhadra Wildlife Sanctuary is located in Karnataka State, India, between N 13°25' and 13°50' latitude to E 75°15' and 75°50' longitude and covers an area of 492.46 km2. This is a hot spot of biological diversity in the Western Ghats. The sanctuary is surrounded by the Bababudan Hills, Bhadra reservoir and teak forest patches adjoining plantations opening a corridor into Kudremukh National Park. Bhadra Wildlife Sanctuary includes four forest types, dry and moist deciduous, semi-evergreen, and evergreen forests (Champion and Seth 1968).



Above Ground Biomass (AGB):

Above-ground biomass (AGB) refers to the total mass of living plant material, including trees, shrubs, and herbaceous vegetation, found above the soil surface. In forest ecosystems, AGB is crucial for estimating carbon storage, understanding forest productivity, and assessing the impacts of land-use changes.

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Components of Above-Ground Biomass:

Tree Biomass: The most significant component, including the trunk, branches, and leaves.

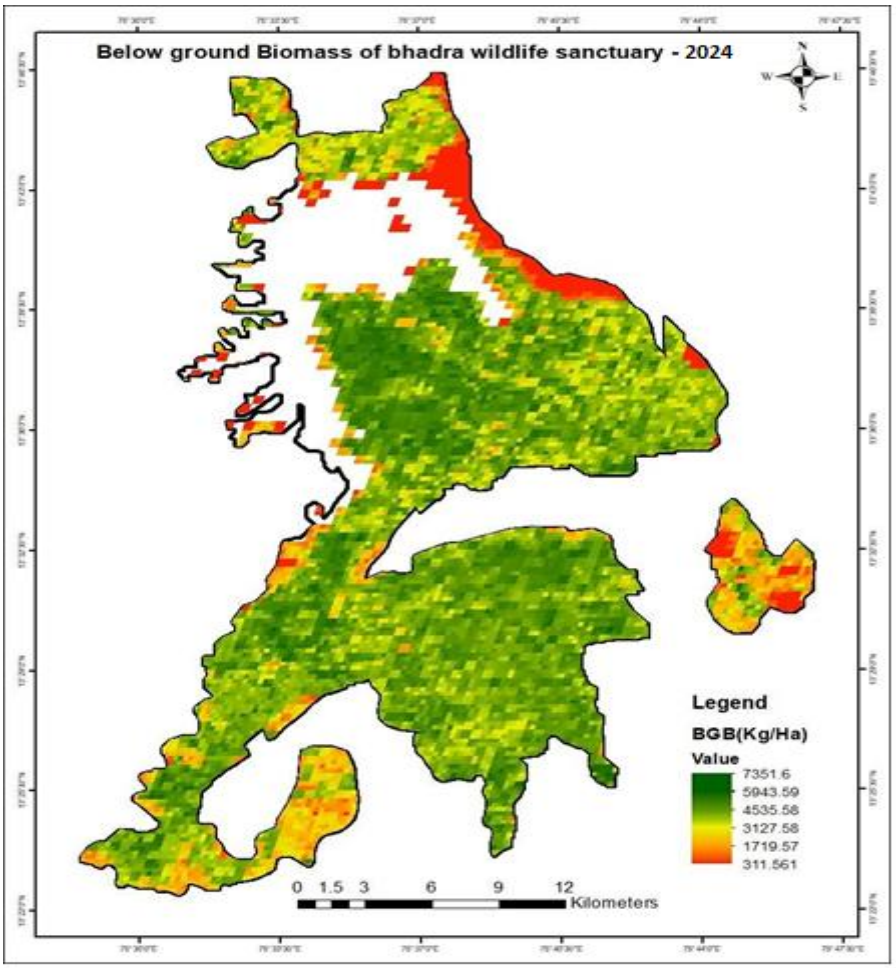
Shrub and Understory Biomass: Vegetation below the tree canopy, including shrubs, saplings, and herbs.

Dead Wood: Standing dead trees (snags) and fallen logs.

Here the AGB is calculated using Random forest algorithms.

The total above ground biomass (AGB) = 4,30,261 Kg

= 430.26 ton



AGB map of Bhadra Wildlife Sanctuary

The Above ground biomass of year 2024 is calculated using machine learning algorithm Regression model.

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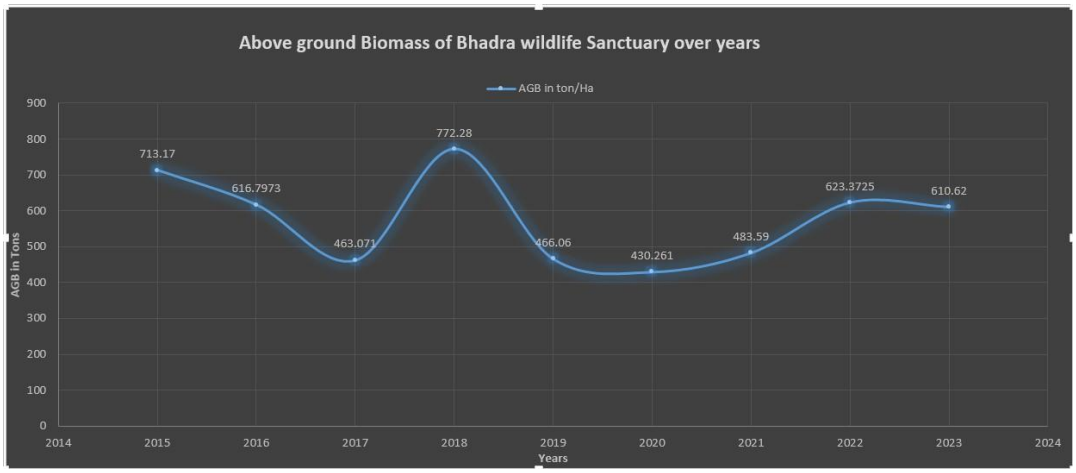

AGB of Bhadra Wildlife Sanctuary over series of years

Below Ground Biomass

Below Ground Biomass means all living biomass of live roots. Fine roots of less than 2mm diameter are sometimes excluded because these often cannot be distinguished empirically from soil organic matter or litter. Below-ground biomass accumulation is linked to the dynamics of above-ground biomass. The greatest proportion of root biomass occurs in the top 30 cm of the soil surface (Bohm 1979; Jackson et al. 1996). Revegetation of degraded land leads to continual accumulation of below-ground biomass whereas any disturbance to topsoil leads to loss of below-ground biomass.

Since below-ground biomass could account for 20– 26% of the total biomass, it is important to estimate this pool for most carbon mitigation as well as other landbased projects. Estimation of stock changes in below-ground biomass is also necessary for greenhouse gas inventory at national level for different land- use categories such as forest lands, cropland and grassland. This chapter presents

Methods of estimating and monitoring below-ground biomass. **Below Ground Biomass (BGB) in**

Kg/hectare = 0.15 * AGB Below Ground Biomass (BGB) = 64,539.15 Kg

=64.539 Ton

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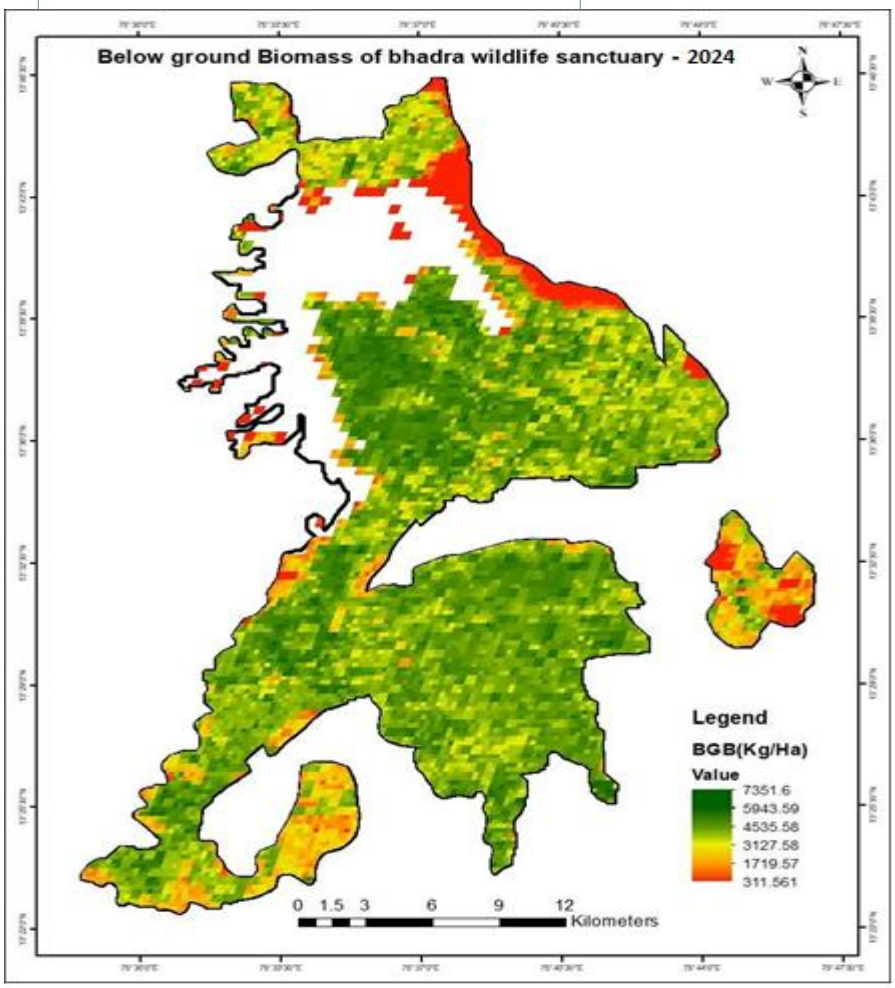

BGB of Bhadra Wildlife Sanctuary

AGB and BGB comparison in Bhadra Wildlife Sanctuary

AGB and BGB comparison in Bhadra Wildlife Sanctuary

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Total Accumulated Biomass (TAB)

Total accumulated biomass is the net change in standing biomass over time. It can be calculated by adding up the dry weight biomass of all individuals in a given area after removing water from the plant material in a drying oven.

Here are some examples of total accumulated biomass:

Global live biomass

As of May 2024, the total global live biomass was estimated to be 550 billion tonnes of carbon, with most of it in forests. Wetlands, estuaries, and coral reefs can also be productive, generating similar amounts of new biomass each year as forests.

Clonal teak

In one study, total biomass increased from 5.8 Mg ha−1 at one year to 115.0 Mg ha−1 at 14 years. Over 80% of the biomass and carbon stock was accumulated above ground, with leaf biomass and carbon stock decreasing as the trees aged. **Red leaf lettuce**

In a plant factory with electric lighting, a study aimed to establish a light recipe for mass producing red leaf lettuce by measuring the total biomass accumulated over time.

Factors that can influence biomass accumulation include:

Light availability: Low light levels can reduce photosynthesis, but high light intensity can damage the photosynthetic apparatus.

Temperature: Very high temperatures can disrupt enzymatic reactions.

Soil water: Low water levels can cause the stomata to close, reducing the availability of CO2 for photosynthesis

Total Accumulated Biomass means sum of above and below Ground Biomass

TAB in (Kg/hectare) = AGB + BGB

Total Accumulated Biomass = 4, 94,800.15 Kg

= 494.80015 Ton

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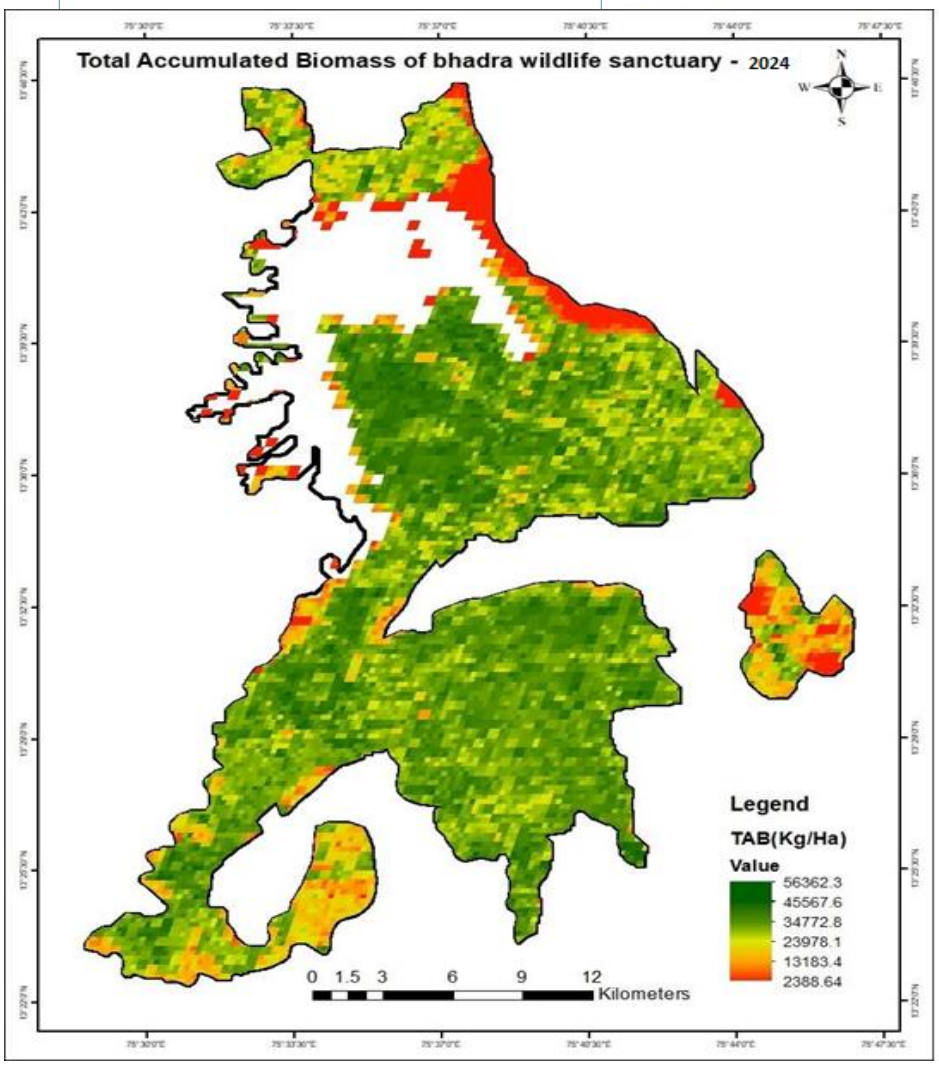

Total accumulated Biomass map of Bhadra Wildlife Sanctuary

SI. No.	Feature	Total (Kg/Hectare)	High (Kg/Hectare)	Low (Kg/Hectare)
1	Above Ground Biomass (ABG)	4,30,261 Kg	49010.7	2077.08
2	Below Ground Biomass (BGB)	64,539.15	7351.6	311.56
3	Total Accumulated Biomass (TAB)	4, 94,800.15	56362	2388.64

Result of Biomass Calculation

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Conclusion

The study has been concluded that in 2024 Above Ground Biomass (ABG) is 49010.7 Kg/ha is the highest and the lowest is 277.08 Kg/ha, Below Ground Biomass (BGB) 64539.15 Kg/ha is the highest and lowest is 311.56 Kg/ha and Estimated Total Accumulated Biomass (TAB) is 494800.15 Kg/ha is high and the lowest is 2388.64. using remote sensing data and Machine Learning language biomass can be estimated with more accurately without physical investigation

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