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Remote Sensing And GIS Application In Mapping And Estimation Of Bamboo Biomass In Kolasib District, Mizoram: First Step Towards Scientific Resource Management And Sustainable Development.

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Abstract:

Bamboo has got a prominent place in vegetative composition of the forests in the northeast Indian forests and intensely amalgamated with socio-economic and cultural matrix of this part of the country. Mizoram, in particular, is bestowed with a variety of bamboos, out of 58 species of bamboos found in the eastern states of India, Mizoram has twenty species. Bamboo is used for shelter, furniture, and handicraft; as food, energy source, medicine; in pulp and paper industries, and practically in every ethno religio-cultural purposes. Potential of bamboo as energy source is also marked, though not fully explored, by use of bamboo charcoal which could be a viable substitute for conventional charcoal from trees and thereby can help in checking deforestation and forest degradation. For all these, a precise mapping and near real estimation of bamboo resource is the prerequisite for proper management and utilization of this valuable resource which would help in sustainable development of the rural poor. It was found that miscellaneous forest, mixed bamboo, Pure Bamboo and non-forest area occupies an area of 646, 326, 200 and 210 km^2 *respectively. The total bamboo biomass (dry weight) was estimated to be 1961.8 thousand tonne in Kolasib district. In the present paper efforts were made to map and estimate bamboo biomass in Kolasib district, Mizoram using Remote Sensing and Geographical Information System in combination with conventional techniques, which can be considered as the first step towards scientific management of biomass for sustainable development.*

Keywords: *Bamboo Biomass, Sustainable development, Mizoram, Remote sensing, GIS*

Introduction

Biomass energy from various sources has been used in rural areas for sustainable development of the rural people. Bamboo has got a prominent place in vegetative composition of the forests in the northeast Indian forests and intensely amalgamated with rural socio-economic and cultural matrix of this part of the country. Bamboo is used for shelter, furniture, and handicraft; as food, energy source, medicine; in pulp and paper industries, and practically in every ethno religio-cultural purposes. Potential of bamboo as energy source is also marked, though not fully explored, by use of bamboo charcoal which could be a viable substitute for conventional charcoal from trees and thereby can help in checking deforestation and forest degradation.

India has rich bamboo resources; Mizoram, in particular, is bestowed with a variety of bamboos, out of 58 species of bamboos found in the eastern states of India, Mizoram has 20 species. Bamboo generates large-scale rural employment in the management of bamboo forests; harvesting, collection, transport, storage, processing and utilization of bamboo. For all these, a precise mapping and near real estimation of bamboo resource is necessary which is the prerequisite for proper management and utilization of this valuable resource. In the present paper efforts were made to map and estimate bamboo biomass in Kolasib district, Mizoram using Remote Sensing and Geographical Information System (GIS) in combination with conventional techniques, which can be considered as the first step towards scientific management of bamboo biomass for sustainable development.

Remote sensing, GIS and GPS technology (together known as 'Geoinformatics') has been proved to be quite successful in mapping bamboo resources. Nair and Menon (1998) estimated bamboo resources in Kerala by remote sensing technique. Goswami et. al. (2010) tried to develop algorithm to segregate reflectance of bamboo from other vegetation classes. FSI estimated that presently about 9245 km^2 area is under bamboo in Mizoram (FSI, 2011).

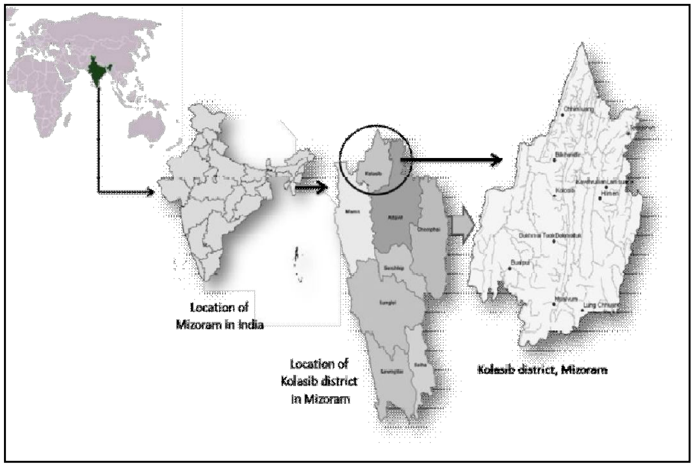

Figure 1 : Location of study area

Methodology

Study Site

Kolasib district of Mizoram, with a total area of 1,382 km^2 extends from 92° 30' 31" to 92° 54' 00" E and 23° 57' 34" to 24° 22' 21" N. The altitude ranges from 55 to 1,200 m. The average annual rainfall varies from 3,000 mm to 3,500 mm and temperature of the study area ranges from 5°C in winter and 35°C in summer. The forest types prevailing includes- Assam Valley Tropical Wet Evergreen Forest- Dipterocarpus (1B/C1), Cachar Tropical Evergreen Forest (1B/C3), Cachar Tropical Evergreen Forest (1B/C3), Cachar Tropical Semi-Evergreen Forest (2B/(2s2/C2), Moist Bamboo Brakes (2B/E3) and secondary Moist Bamboo Brakes (2B/E3) (Champion and Seth, 1968).

Data And Software

Data used include Landsat ETM+ for the year 2001, Survey of India topographic sheets, IRS ID Panchromatic image, forest cover map and vegetation thematic map. ArcGIS package and ERDAS IMAGINE was used for GIS database creation, analysis and Digital Image Processing respectively.

Methodology

The geometric and radiometric corrections of the raw satellite images were done followed by re-projection of the images using Universal transverse Mercator projection. Reconnaissance survey was undertaken for broad understanding of the study site and to get acquainted with the general patterns of vegetation, forest types and topography. The area was classified as: miscellaneous forest (forest dominated mainly by trees), mixed bamboo forest

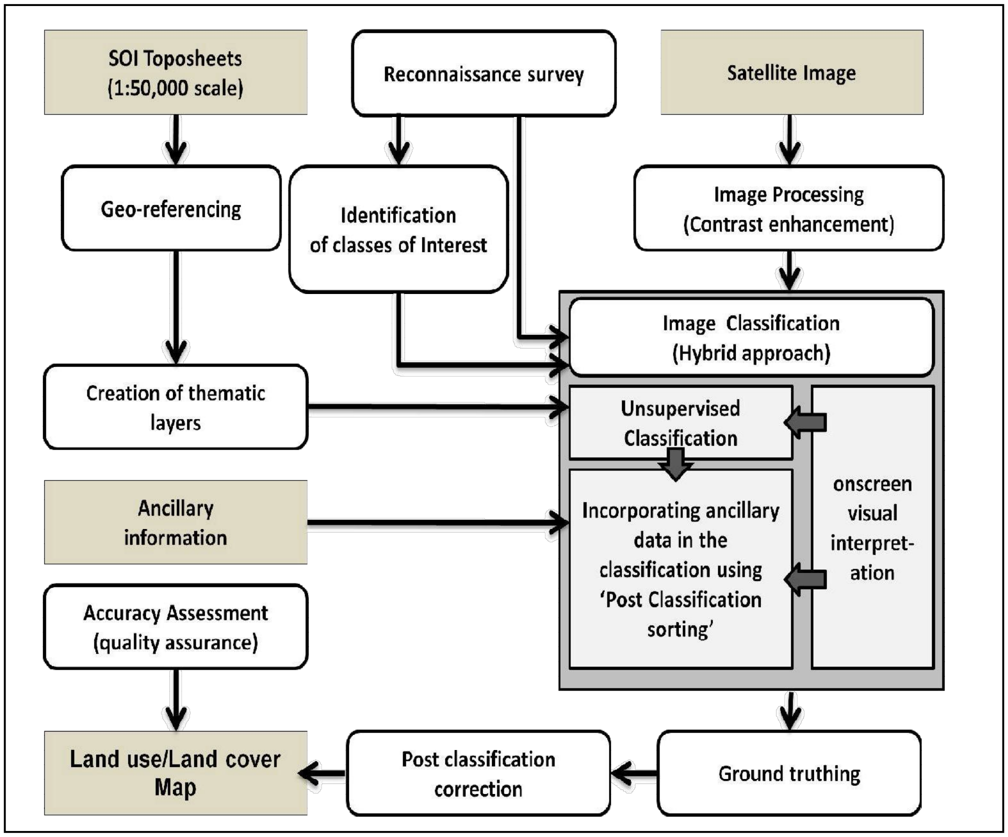

Figure 2: Flow chart of Methodology

(dominated by both tree as well as bamboo), pure Bamboo forest (dominated by Bamboos), and non forest area which include scrub, shifting cultivation, open/barren land, Settlement and water. A hybrid approach of classification was followed where classified map generated by unsupervised classification algorithm aided by onscreen visual interpretation is improved or streamlined incorporating ancillary data following a 'post classification sorting' method (fig.2). Interpretation key for vegetation classification was developed based on the intensive ground truth information. Ancillary data was incorporated using a method called '*Post Classification sorting'* where the application of very specific rules to initial remote sensing classification results and spatially distributed ancillary information are used (Jensen, 1996). Digital elevation model (DEM) was generated from the contour information (20 m interval).

Slope map and altitude map was then created from the DEM. Specific rules of '*if-then'* based on prior knowledge of the study area were applied to the slope map, altitude map and initial remote sensing classification to improve the classification accuracy. For example, it is well known that bamboos are generally found in comparatively lower elevation. Therefore, bamboo area, if found in higher elevation, were demarcated and more ground truth points were taken for the same. The map generated integrating PCA based and NDVI based (Goswami et. al. 2010) indices of bamboo also tested on the ground and incorporated wherever felt necessary.

The accuracy of the classification was assessed using ground information of sample points and satellite images with higher spatial resolution. The overall classification accuracy was estimated to be 87.1% where as K_{hat} (an estimate of KAPPPA) value implies that the classification process was avoiding 85.8% errors of a completely random classification. A probability proportionate stratified random sampling was adopted and a total of 145 sample plots with a size of 0.10 ha were selected on various classes for the present study. The sampling intensity achieved was 0.0125%. For biomass estimation of Bamboo, a regression equation (dbh vs. dry weight) generated was used (Das, 2012).

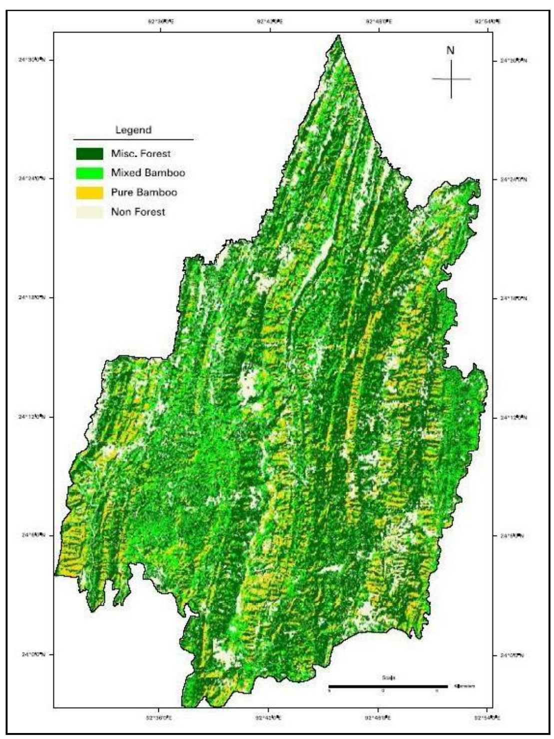

Figure 3: Vegetation map of Kolasib district

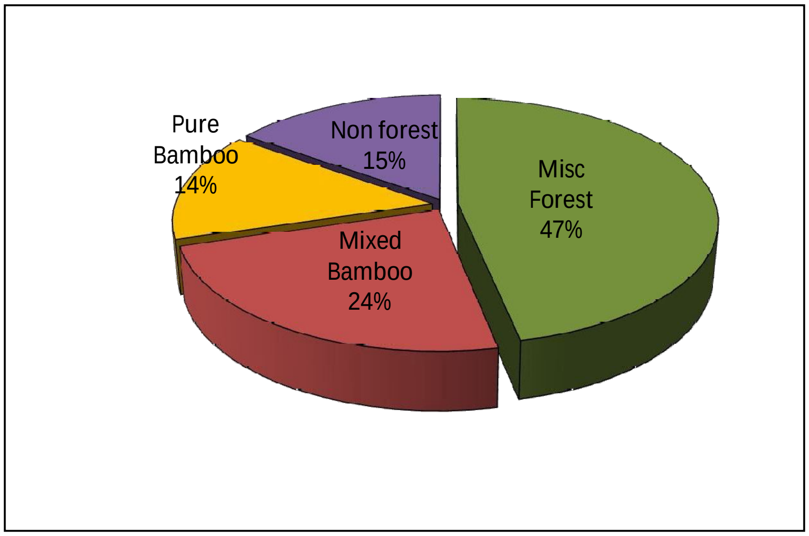

Figure 4: Area of vegetation classes

Result And Discussion

Area Of Vegetation Classes

Miscellaneous forest occupies an area of about 646 km^2 (46.8 % of the total geographical area) whereas mixed bamboo forest occupies an area of 326 km^2 (23.6 %). Pure Bamboo forest covers an area of 199.6 km^2 (14.4%). Pure Bamboo forests (bamboo brakes) are mainly dominated by non-clump forming bamboo *Melocanna baccifera* (Muli or Mautak). Other clump forming bamboo mainly includes *Dendrocalamus hamiltonii* (Phulrua), *D. Longispathus* (Rawnal or Khang), *Bambusa tulda* (Rawthing or Kaligada) and *D. strictus*. Rest of the area i.e. 210 km^2 come under non-forest category (fig. 4).

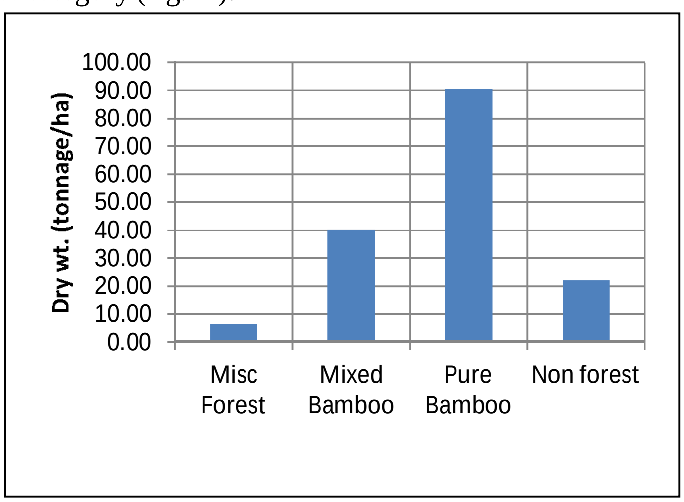

Figure5: Bamboo biomass per unit area

Bamboo Biomass

Bamboo biomass, in the present study include above ground part of the plant. Bamboo Biomass per unit area (tonne/ha) was found to be highest in Pure Bamboo forest (91 tonne/ha) followed by Mixed Bamboo (40 tonnage/ha) and Non forest (22 tonne/ha). The lowest Bamboo Biomass per unit area was found in Misc. Forest (7 tonne/ha) (fig. 5). The total bamboo biomass (dry weight) was estimated to be 1961.8 thousand tonne in Kolasib district. It was found that 97% of the bamboo biomass in Mizoram is contributed by Muli bamboo. Highest Bamboo Biomass was estimated in Pure Bamboo forest (880 thousand tonne) followed by Mixed Bamboo (726 thousand tonne) and Misc. Forest (186 thousand tonne). The lowest Bamboo Biomass was estimated in Non forest (880 thousand tonnas) (fig. 6).

Mizoram is very rich in bamboo resources. This is mainly due to large scale shifting cultivation practices in the state. Shifting cultivation is responsible for creation of gap in the forest landscape and allows bamboo to grow as secondary colonizer. Bamboo based industries need to be established in Kolasib for proper utilization of these huge bamboo biomass of about 1.96 million tonne. The surplus biomass may be transported to the nearby paper mills/other bamboo based industries.

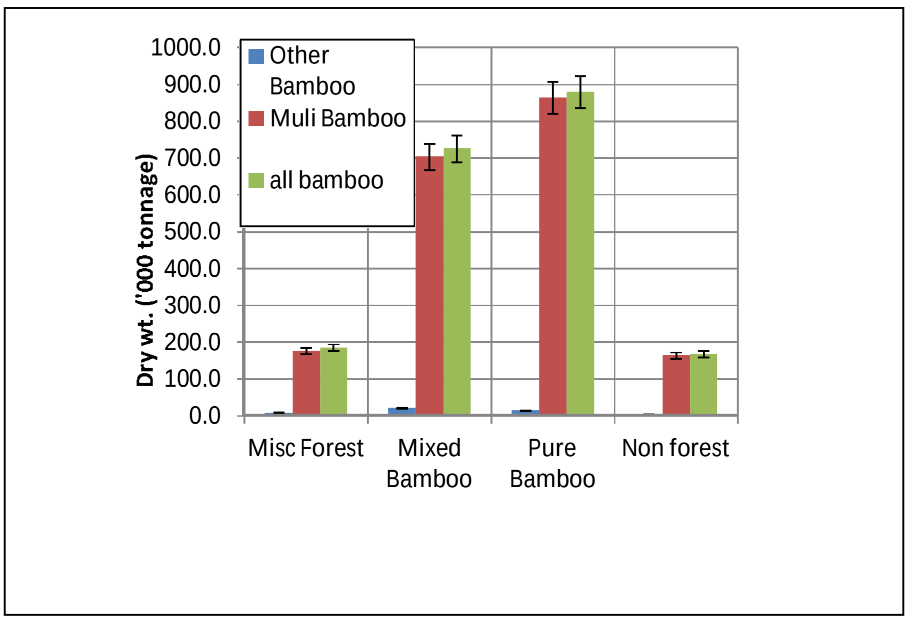

Figure 6: Total bamboo biomass

Conclusion

The paper presented area distribution of vegetation classes mainly based on 'presence of bamboo in percentage area.' The accuracy of the mapping exercise was found quite high in case of pure patches of bamboo (bamboo brakes) whereas accuracy falls when bamboo forms as under shrubs. However, the issue was addressed taking more and more ground truth points in the field. Remote sensing image interpretation, both visual and digital, along with GIS has been proved to be an extremely effective tool for mapping and bamboo biomass estimation.

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