ABSTRACT

The United Nation Framework Convention on Climate Change (UNFCCC) stated that countries have to report the status of their forest resources regularly to get an understanding about the carbon stocks available in the countries. As a developing country, Sri Lanka needs to develop an accurate biomass estimation method to assess the carbon stock, spatially and temporally to fulfill the reporting requirements and to explore a possible mechanism for carbon trading.

Among the methods available for estimation of Above Ground Biomass (AGB), the traditional field sampling has been identified as the most accurate. However, this method consisted with numerous disadvantages such as, time consuming and labor intensive nature, and difficult to implement in remote areas. The remotely sensed data based approaches may offer better alternatives to overcome these limitations by contributing positively to reduce time, money and accessibility issues.

This research was focused to develop an acceptable methodology to estimate AGB for major vegetation types of Sri Lanka using multi sensor satellite data (optical, infrared and RADAR) coupling with field sampling and inventory data.

Accordingly, AGB was estimated for lowland rainforest, sub montane and montane forest, dry and moist monsoon forest, grassland, scrubland, chena, home gardens, mangroves, *Prosopis juliflora* associated vegetation, forest plantations of *Tectona grandis*, *Pinus caribaea* and *Eucalyptus grandis*.

Three approaches were used to estimate AGB namly; use of different allometric models with field sampled data such as Diameter of Breast Height (DBH) and height of trees; combination of estimated AGB with satellite driven vegetation models; and direct use of previously developed satellite based AGB models.

As the first method, the field sampled forest stand data were coupled with 16 biomass expression equations to investigate the best fitted models to estimate AGB of natural forests as well as forest plantations.

Secondly, Landsat ETM +, IRS LISS III, Landsat 8 TIRS and ALOS PALSAR images were utilized to develop vegetation indices, land surface temperature and backscatter coefficient to identify relationships with the field estimated AGB. Seven indices derived from optical imageries were used to estimate AGB of natural forests and forest plantations. Among the indices, Normalized Difference Vegetation Index (NDVI), Transformed TVI and Ratio VI were significantly correlated with AGB with an acceptable accuracy (60 – 72%). The backscatter coefficient of ALOS PALSAR images observed a negative correlation with estimated AGB while land surface temperature of Landsat TIRS showed a positive correlation. Accordingly, the average biomass investigated for lowland rain forest was 245 t/ ha, sub montane forests was 219 t/ha and montane forest was 41.76 t/ha. AGB of forest plantations of *P. caribaea* (33 - 46 t/ha), *E. grandis* (277.6 t/ ha) and *T. grandis* (55.3 t/ha) were also estimated.

The third approach was the estimation of AGB of selected vegetation types of Sri Lanka using direct application of remote sensing techniques without conducting extensive field work. Accordingly, AGB of major land use land cover types of the country were directly estimated through previously derived satellite based biomass models.

Accordingly, AGB was estimated for lowland rainforest (680 t/ha), sub montane forest (413 t/ha), montane forest (39 t/ha), moist monsoon forest (115 t/ha) , dry monsoon forest (108 t/ha) and other land cover types as scrubland with chena lands (in dry zone 36.4 t/ha, intermediate zone 80 t/ha, wet zone 128 t/ha), home gardens (in dry zone 48 t/ha, intermediate zone 83.5 t/ha, wet zone 148 t/ha) and grasslands (18.5 t/ha). Furthermore, AGB was observed in mangroves using field sampling (65 t/ha) and remote sensing (90.5 t/ha).

The temporal changes of estimated AGB of *Prosophis juliflora* associated vegetation in Puttalam to Mannar using multi temporal satellite imageries (AVNIR and Landsat ETM +) was also calculated and found a significant increment of estimated AGB during 2005 -2010 period.

Finally, IRS LISS III (2007 -2008) images which cover the whole country were used to develop National Biomass Map as new thematic layer for biomass quantification. This map will enable to assess the relative levels of biomass present in various vegetation types or ecosystems present in the country and can be used as a tool for analysis of temporal changes in biomass.

The study identified that NDVI is the most suitable vegetation index for most of the vegetation types in estimating biomass. However, the relationships derived between vegetation indices and AGB were not very strong in many occasions indicating the need for further investigations. The combination of three main approaches identified the possibilities and drawbacks associated with each method. However, the possibility of spatial mapping of AGB distribution using satellite derived vegetation models was highlighted in this study. The national biomass distribution map can be considered as a foundation for further exploration of assessment of AGB in different land use/ cover types in the future at spatial and temporal context with an improved level of accuracy.