ABSTRACT

Mapping and quantitative assessment of above ground biomass (AGB) of mangroves may be possible using multiple remote sensing datasets such as optical, RADAR and LiDAR supported by fieldwork. This study assessed South Australian (SA) mangroves (*Avicennia marina*) in the St Kilda area near Salisbury. Literature asserts that mangroves absorb four times more carbon than normal forest; thus estimation of AGB is important for planning and decision making in coastal zones. The main objective of this research was to assess the capacity of satellite data to study mangrove extent and AGB in St Kilda and to build a technical framework to integrate multiple remote sensing datasets. A specific research question was what are the optimum methods to study AGB using optical, RADAR and LiDAR? Additionally, does a data fusion approach assist quantise AGB? This comprehensive study of mangroves was undertaken using optical satellites (Pléiades Neo, and Sentinel-2) and RADAR (ALOS-1 PALSAR, ALOS-2 PALSAR, and Sentinel-1) and demonstrated that AGB estimation is possible by identifying correlation between remote sensing variables and biomass determined from field observations using statistical regression. Linear regression for $LiDAR_{CHM-mean}$ and mean heights from field work, showed a high correlation between these two variables with a R^2 value of 0.87. The average value for AGB estimation from field data was 59.7 tons h^{-1}. An optimum regression model from $LiDAR_{CHM}$, with a R^2 value of 0.74, yielded a total biomass of 96,149 tons. Regression models from optical satellite data, Pléiades Neo, provided the R^2 value of 0.48 using NDVI and 0.27 using principal component analysis (PC-2). In contrast, Sentinel-2 gave R^2 value of 0.40 using red-edge NDVI (NDVIre) and 0.48 using the mangrove vegetation index (MVI). The final AGB estimation from optical imagery yielded a value of 69,024 tons with an optimum model. In assessing mangrove extent, two classification approaches were used for Pléiades Neo; random tree (RT) and ISO cluster. RT, a variant of Random Forests, application resulted in the extent of mangroves (13.09 km^2 & 15.78 km^2) for pan-sharpened and multispectral respectively and similarly, ISO cluster computed (14.35 km^2 & 14.99 km^2) for both sets of imagery. The RT model achieved a user accuracy of 0.98 with Kappa value of 0.86 for Pléiades Neo, using a combination of six spectral bands, vegetation index (NDVI) and a CHM. Three RADAR datasets were used to calculate AGB estimation using backscatter coefficients, RADAR indices, GLCM matrix, PCA techniques and $field_{mean}$ biomass by applying statistical regression. The regression results showed R^2 values for $field_{mean}$ biomass against backscatter (HV=0.18, VH=0.14, VH=0.12), PCA (0.27, 0.09, 0.16), GLCM (0.23, 0.15, 0.17) and RVI (0.29, 0.09, 0.12) for ALOS-1 PALSAR, ALOS-2 PALSAR, and Sentinel-1 satellites respectively. Additionally, a pixel based fusion approach for ALOS-2 PALSAR and Sentinel-1 resulted in R^2 between PC-2 and $field_{mean}$ biomass values of 0.27 at 4m. The satellite remote sensing approach made this study non-intrusive, potentially repeatable and regular, and showed excellent capability to map mangrove extent, especially when multiple datasets were used.