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Assessing Mangrove Forest Structure, Cover and Biomass in the Niger Delta, Nigeria.

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Mangrove forests degradation in the Niger Delta, as a result of local wood exploitation and urbanization, has led to the adverse effect on forest structure increasing vulnerability to nipa palm invasion. Here, we report the largest stem survey of mangrove forests and the first analysis of nipa palm cover in the region. We investigated the effects of local disturbance on the forest structure; estimated mangrove and nipa area, and generated a mangrove biomass map in the Niger Delta. We established twenty-five 0.25 ha plots and 200 observations points over the region. Aboveground biomass (AGB) was estimated from established allometric equations based on stem diameter at breast height (DBH) of mangrove trees $>$ 5cm and leaf area index (LAI) was recorded using hemispherical photos. Plots were divided into three disturbance regime and stem were divided into four size classes. We used radar and optical sensors to classify mangrove and nipa palm across the region. The relationship between field estimates of AGB to radar backscatter was also established in order to generate a biomass map of the region. A total of 6.25ha of mangrove area was sampled with mean AGB of 80 t ha^{-1} and mean LAI of 1.45. We discovered that LAI had a significant explanatory potential of 28% on AGB. We also observed that vegetative indices for the growing season also showed a positive correlation with in-situ LAI (R^2= 63%) and AGB (R^2= 80%). Undisturbed plots showed an even contribution ($\sim$20%) of stem size range to AGB. Land cover classification results showed Support Vector Machine (99.9 %) performed better than Maximum Likelihood Classifier across the Niger Delta (98.7%). Producers (PA) and Users accuracy (UA) for the best SVM classification were above 98 %, however these were lower for mangrove (PA- 91 %, UA- 38 %) and nipa palm (PA- 32 %, UA- 80 %). We estimated a current mangrove area of 794,561 ha and nipa extent of 11,419 ha. We also discovered a 14% decrease in mangrove area and over 100 % increase in nipa palm between 2007 and 2017. We estimated a significant 56% explanatory potential of ALOS PALSAR radar on AGB in the region. We estimated mean AGB over the Niger Delta as 83.4 t ha^{-1}. We conclude that forest degradation is removing larger stems preferentially from these mangroves and increasing the number of light gaps. This change in stem structure is also reducing the AGB potential of mangrove forests in the region and paving the way for the recruitment of an invasive species. Our research also identifies opportunities to use remote sensing to estimate biomass, based on LAI-AGB and radar backscatter-AGB relationship we found. Land cover change is drastically reducing mangrove forests over the Niger Delta region, majorly replaced by urban regions and with nipa invasion playing a subtle role. For the first time, we have georeferenced biomass data from a large number of sites within a globally significant area of the Niger Delta, to support better mapping and modelling activities into the future.