Title: Mangroves affected by shifted river mouth underscore the importance of sustainable conservation of Setiu Wetlands, Malaysia

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Abstract: Setiu Wetlands on the east coast of Peninsular Malaysia have been facing a significant impact of the changed hydrodynamics and sedimentation due to the shifted river mouth. In particular, sand accumulation over the mangrove areas is threatening vegetation, that warrants a careful assessment of the ecosystem. In this study, ground inventory data (collected between September 2023 and January 2024) (147 plots) and remote sensing (Sentinel-2) (November 2023) imagery were employed to identify the mangrove vegetation structure and to produce a land use land cover map. Results highlight the predominance of *Rhizophora apiculata* and *Nypa fruticans*, with clear zonal contrasts in the distribution of *Bruguiera* species and evidence of declining (mangrove) hybrid populations. Structural attributes decreased significantly towards the river mouth away from the core mangrove zone, reflecting spatial environmental gradients and localized human pressures inferred from land-use patterns. Ground and remote sensing results were complementary: the extensive cover of *R. apiculata* in the classified maps corresponded with its highest stem density and importance values in the field inventory. In the case of remote sensing, artificial neural network (ANN) consistently outperformed support vector machine (SVM) and random forest (RF) classifiers, achieving the highest accuracy (91.36 ± 7.61 %) for differentiating mangroves from non-mangrove vegetation and moderate accuracy (65.88 ± 10.67 %) for species-level mapping. Overall, the mangrove cover was found to be 436.89 ha, showing an expansion of 18.89 ha compared to earlier studies, largely due to planting efforts. This workflow provides a robust baseline for monitoring Setiu Wetlands, supporting conservation under the changed hydrological and land-use conditions.

Keywords: Vegetation structure Remote sensing Machine learning classifiers Species-level mapping Environmental changes

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