

Spatial heterogeneity in mangroves assessed by GeoEye-1 satellite data: a case-study in Zhanjiang Mangrove National Nature Reserve (ZMNNR), P.R. China

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Abstract

Mangrove forests, which are declining across the globe essentially because of human intervention, require an evaluation of their past and present status (e.g. areal extent, species-level distribution, etc.) to implement better conservation/management strategies. In this paper, the mangrove cover changes at Gaoqiao (under the jurisdiction of Zhanjiang Mangrove National Nature Reserve - ZMNNR, P.R. China) were assessed through time using 1967 (Corona KH-4B), 2000 (Landsat ETM+), and 2009 (GeoEye-1) satellite imagery. The results indicate an important decline in mangrove cover (434 ha) between 1967 and 2009 due to agriculture (paddy) and aquaculture practices. Moreover, the mangroves delimited by dike construction were prevented from expanding landward. However, between 2000 and 2009, the seaward mangroves increased from 583 to 775 ha because expansion of aquaculture took place at the expense of agricultural areas located landward of the dike. In the land-use/cover map based on ground-truth data (5 m × 5 m plot-based tree measurements) (August-September, 2009) and spectral reflectance values (obtained from pansharpened GeoEye-1), both *Bruguiera gymnorhiza* and small *Aegiceras corniculatum* are distinguishable at 73-100% accuracy, whereas tall *A. corniculatum* is at only 53% due to its mixed vegetation stands close to *B. gymnorhiza* (classification accuracy: 85%). Among others, clay, sand and organic matter in the sediment showed significant differences (Kruskal-Wallis/ANOVA, $P < 0.05$) between the three mangrove classes. Distribution of tall *A. corniculatum* on the convex side of creeks (with rich clay and organic matter) and small *A. corniculatum* on the concave side (with sand) are apparent. Overall, the advantage of very high resolution satellite images like GeoEye-1 for mangrove spatial heterogeneity assessment and/or species-level discrimination is well demonstrated, along with its difficulty to provide a precise classification for non-dominant species (e.g. *Sonneratia apetala*) at Gaoqiao. Despite the limitations such as geometric distortion and single band information, the 42-year old Corona declassified images are invaluable for land-use/cover change detections against recent satellite data sets.

Keywords

change detection, declassified imagery, remote sensing, Gaoqiao, China