



Title	Hierarchical classification of land use types using multiple vegetation indices to measure the effects of urbanization
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1 **Hierarchical classification of land use types using multiple vegetation**
2 **indices to measure the effects of urbanization**

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4 Concise title: Hierarchical classification of land use types

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19 **Abstract**

20 Detecting fine-scale spatiotemporal land use changes is a prerequisite for understanding and
21 predicting the effects of urbanization and its related human impacts on the ecosystem. Land
22 use changes are frequently examined using vegetation indices (VIs), although the validation
23 of these indices has not been conducted at a high resolution. Therefore, a hierarchical
24 classification was constructed to obtain accurate land use types at a fine scale. The
25 characteristics of four popular VIs were investigated prior to examining the hierarchical
26 classification by using Purbachal New Town, Bangladesh, which exhibits ongoing
27 urbanization. These four VIs are the normalized difference VI (NDVI), green-red VI (GRVI),
28 enhanced VI (EVI), and two-band EVI (EVI2). The reflectance data were obtained by the
29 IKONOS (0.8-m resolution) and WorldView-2 sensor (0.5-m resolution) in 2001 and 2015
30 respectively. The hierarchical classification of land use types was constructed using a
31 decision tree (DT) utilizing all four of the examined VIs. The accuracy of the classification
32 was evaluated using ground truth data with multiple comparisons and *kappa* (κ) coefficients.
33 The DT showed overall accuracies of 96.1% and 97.8% in 2001 and 2015, respectively, while
34 the accuracies of the VIs were less than 91.2%. These results indicate that each VI exhibits
35 unique advantages. In addition, the DT was the best classifier of land use types, particularly
36 for native ecosystems represented by *Shorea* forests and homestead vegetation, at the fine
37 scale. Since the conservation of these native ecosystems is of prime importance, DTs based
38 on hierarchical classifications should be used more widely.

39 **Keywords**

40 Fine-scale data; hierarchical classification; decision tree; land use change; *Shorea* forest