Urban land use/cover mapping using ALOS imagery: a case study of Tsukuba City

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The urban environment represents one of the most challenging areas for remote sensing analysis due to high spatial and spectral diversity of surface materials. Despite advances in satellite imaging technology in recent years, computer-assisted methods of image classification are still unable to produce land use/cover maps and statistics with a high enough accuracy. Considering the complexity of urban landscape and the importance of spectral and radiometric resolution to land use/cover classification accuracy, advantages of four different image classification approaches: unsupervised; supervised; fuzzy supervised and hybrid; are presented in this paper. The paper aims to present an application of ALOS image in urban remote sensing and compare the accuracy of thematic maps generated from the approaches.

ALOS (Advanced Land Observing Satellite also known as 'Daichi', a new high resolution satellite) imagery was selected for the study. An AVNIR-2 sensor image of the satellite covering Tsukuba city acquired on August 4, 2006 was used for the study. The image consists of three visible bands and a near infrared band at 10-meter spatial resolution. The image was geometrically corrected using 1:25000 digital road data. The unsupervised ISODATA clustering method was initially used to segment the image into a large number of clusters of pixels. With reference to field survey data, color aerial photographs and QuickBird satellite image, homogeneous clusters were carefully interpreted and labeled into seven categories of urban land use/cover type. The land use/cover categories selected in this study were Urban Forest, Lawn/Grass, Paddy Field, Dry Farmland, Business/Industry, Residence/Parking/Road and Water. Training samples of 900 pixels for each land use/cover type was prepared to train the supervised and fuzzy supervised approaches. A hybrid method was proposed that incorporates the advantages of unsupervised, supervised and fuzzy supervised classification approaches. Four separate land use/cover maps were generated using these approaches. A total of 300 geographic reference (ground truth) points for each map were prepared to assess the accuracy of the maps. Stratified random sampling approach was used while preparing the geographic reference points. Error matrix and Kappa index were computed to quantify the map accuracy.

The hybrid approach significantly improved the classification accuracy as compared to the results of other approaches (i.e., unsupervised, supervised and fuzzy supervised). The highest overall accuracy (89.33%) was obtained with hybrid approach. The fuzzy supervised approach yielded also quite better accuracy (87.67%) which was higher than the conventional supervised and unsupervised approaches. It may be due to mixed pixels dealing capacity of the fuzzy approach. The hybrid approach mapped the urban woodland and water most accurately. The hybrid approach purposed in this paper is simple and can be applied in any standard GIS software package to produce better land use/cover maps from satellite images even in a complex urban environment. However, the paper explored the strength of the four different classification approaches to extract thematic information from the ALOS 10-meter spatial resolution imagery which may significantly help to understand and interpret the complex urban characteristics using newly born high resolution Japanese satellite sensor.