Land Use Change Analysis Using Remote Sensing and GIS: A Case Study of Kathmandu Metropolitan, Nepal

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(1) Introduction: The urban environment represents one of the most challenging areas for remote sensing analysis due to high spatial and spectral diversity of surface materials. However, multi-temporal Landsat and IRS satellites imageries are found useful to detect the major land use changes thematically in the Kathmandu valley.

(2) Objective: As a result of business opportunities and security risk created by active Maoist insurgents after restoration of democracy in 1990, the people movement to the valley from other areas in Nepal increased significantly. The population density in the Kathmandu metropolitan city was increased from 8370 persons/km^2 in 1990 to 13235 persons/km^2 in 2001. High population influx may cause a significant pressure to the limited resources in the valley. The main objective of this paper is to identify the spatial changes of major urban land uses in the valley using multi-temporal satellite images.

(3) Database and Methodology: Kathmandu valley is selected as a study area. Two images of Landsat satellite acquired in 31st October, 1989 and 04th November, 1999 and an image of IRS LISS III acquired in 18th December 2005 were processed using ERDAS Imagine 9.0 software. The images were subset to 10x10 km covering the Kathmandu metropolitan city. All the images are cloud free and have no seasonal variances. Road map as a GIS layer was used for correcting the geometric distortions in the images. The LISS III image was spatially enhanced from 24-meter to 30-meter to synchronize the resolution with Landsat images. Supervise classification technique using maximum likelihood classifier was applied while preparing thematic urban land use map for 1989, 1999 and 2005. More than 40 training samples for each image were prepared for the classification. Hundred random spatial points were generated for each thematic map for accuracy assessment.

(4) Results: The Fig.1, Fig.2 and Fig.3 represent the land use patterns in 1989, 1999 and 2005 respectively. Five land use classes namely Urban Builtup Area, Cultivated Land, Orchard, Water and Natural Vegetation are identified. The accuracy of classification results are 91% (K=0.87), 92% (K=0.88) and 91% (K= 0.86) for the year 1989, 1999 and 2005, respectively. The quantitative result (Fig.4) shows very low existence of water and natural vegetation. The degradation of these properties also seems to be very low as compared to agriculture area. The spatial extent of orchard is significantly decreased until 1999 but the urban builtup area is increased almost in same extent reversely. In this study, the land used by orchard indicates gardening near by the urban houses, horticulture, parks and bare land. However, the activities on orchard are being expanded in the later years. After 1999 the cultivated land is abruptly decreased which may be replaced by the urban builtup area as well as orchard activities. The urban built up area was accounted for 23% of the total land in 1989 which was increased by 17% until 2005 whereas the cultivated land was decreased from 36% to 22% in the same period. The overall result shows rapid expansion of urban builtup area and shrinkage of the cultivated land.

(5) Conclusion: The composition of urban environment is very complex where the Landsat and LISS III images are not enough to delineate detail urban information but good enough to extract thematic information. As concerned to the detail urban mapping, very high spatial resolution satellite images such as IKONOS and QuickBird are available in recent years. In this paper, we wanted to observe the urban spatial expansion in Kathmandu metropolitan after restoration of democracy. This paper is able to identify the urban expansion thematically and accurately. Land use conversion matrix should be prepared for analyzing urban land use change in detail.

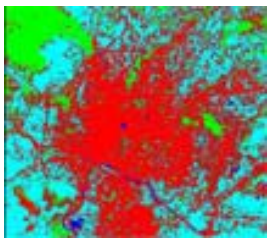

Figure 1: Land use 1989

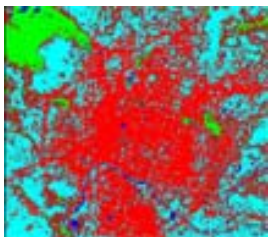

Figure 2: Land use 1999

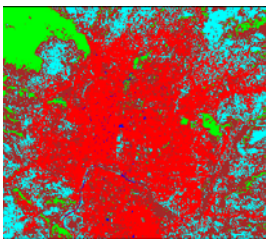

Figure 3: Land use 2005

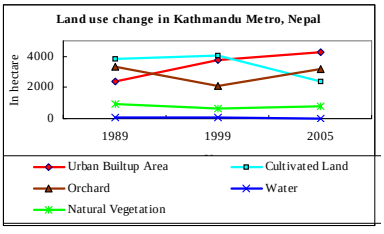

Figure 4: Land use change

Builtup Area | Cultivated Land | Orchard | Water | Natural Vegetation