Analyzing Patterns of Land Cover Change in Ganges Delta Region in India from 1999 to 2010

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Among the fastest growing economies of the early 21st century world, India stands out as one of the instances where agriculture-based economy has been rapidly propelled into the center of the global economy. Built-up areas in these less-developed parts of the world outbid all other uses for land adjacent to it, including prime croplands. The divergent rates and patterns of land use and land cover change (LULCC) and the increase in poverty in this part of the world are key elements in rising vulnerability of land to the negative consequences of global environmental change. The present study focuses on the southern part of the low-lying Ganges delta region of India. A largely poor but fertile agricultural region, this region has experienced astonishing land changes due to a combination of rapid economic development, increased population, industrialization and urbanization. Yet little has been done to map and monitor LULCC of this region. The presently available land cover maps for this region are at course resolution, which lacks understanding the dynamics of LULCC at the regional scale. Thus the objectives of this study are: (i) to map land cover change of the southern part of Ganges delta region using multi-temporal Landsat images; (ii) to understand the relationship between land cover change and socio-demographic change. Characterization of past and present LULCC with socio- demographic variables helps to analyze the causes and the consequences of land change. The study uses 2 Landsat scenes from the same season for years 1999 (November) and 2010 (January). Images were atmospherically corrected followed by radiometric normalization considering 2010 as the base imagery. Reference data for training and accuracy assessment were collected carefully using quickbird high-resolution imagery in Google Earth. Final classification was performed using Random Forest Classification (Breiman, 2001) technique with feature space consisting of Landsat non-thermal bands, slope and aspect derived from ASTER DEM and normalized difference vegetation index (NDVI). The images were classified under 4 land cover classes such as built-up area, agricultural area,

natural forest, and water bodies. To better increase the accuracy of the classified images, the area was subdivided into 8 districts (5 whole, and 3 partial) and the classification was performed in each of them. Random forest is ensemble classifier, which uses multiple classification trees and creates the final classified map on the basis of majority voting. It also generates an unbiased estimate of generalization error called out-of-bag error (OOB) in order to provide confidence in the classified images. The oob error for the output images in this study varied from 0.12 – 1.57. For cross-validation, Kappa indices were used for an independent accuracy assessment. Post-classification accuracy analysis shows overall accuracy of 84.66% for the 2010 image and 79.58% for 1999 image. Kappa statistics varied from 0.83 to 0.77 for 2010 and 1999 respectively. Preliminary results of the study show that in last 10 years the rate of land cover change has increased which is directly correlated to overall increase in density of population in the region. There is an immense increase in built-up area for both urban and rural regions. The built-up area increased predominantly along the river and the edges of pre-existing built-up areas. Overall approximately 5100 sq.km out of 23100 sq.km of area under study, changed. So out of 22% of the changed land area, 11% is attributed to the increase in built-up area, 7% and 1% to the decrease in agricultural area and natural forest respectively. During this decade the spatial pattern of density of population remained unchanged, that means the dense areas become more dense. Compared to the rest of the districts, though Kolkata Metropolitan Area has the highest density of population but over the last decade its density has decreased unlike the others. Among land cover types in each district, the district of Bardhamaan experienced highest amount of overall change with largest decrease in agricultural land, whereas district of South 24 parganas which houses the sundarban mangrove forest area experienced highest amount of built-up increase with largest amount of decrease in natural forest area. Further analyses are in progress but from the present results it can be concluded that rapid land change and modification are threats to biodiversity and human habitability of built-up areas itself because the built-up areas itself gets affected by warmer temperature, sea-level rise, and changes in the monsoon regime. If global change is to be managed for mankind's benefit, then control and knowledge of land use and land cover will be paramount.

References

Breiman L (2001) Random Forests, Machine Learning archive, Volume 45 Issue 1, October 1 2001, Pages 5 – 32, Kluwer Academic Publishers Hingham, MA, USA