

Chapter 52

Spatial and Temporal Patterns of Wetland Cover Changes in East Kolkata Wetlands, India From 1972 to 2011

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ABSTRACT

Land use and land cover change has a slow but prolonged impact on various aspects of environment on local, regional and global scales. In developing countries especially population pressure and food demand have compelled conversion of wetlands to built-up and agricultural lands. One such unique example is the East Kolkata Wetlands (EKWs) located on the eastern fringes of Kolkata City in India where such land cover change is very intense and rapid. In this study, wetland conversions in EKWs from 1972 to 2011 were analyzed with four Landsat images using the Geographic Object-Based Image Analysis (GeOBIA) and a post-classification comparison. Results suggested that wetland areas decreased by 17.9 percent during the study period. The western part of the wetlands saw the maximum conversion of wetlands to built-up areas with time, whereas the east and south experienced more of wetlands to agricultural and other land conversions

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INTRODUCTION

Land use and land cover (LULC) change substantially alters the structure and functioning of wetland ecosystems which affects plant communities and microclimate thereby changing fluxes in water, nutrients, and energy across the land-atmosphere interface. By definition, wetland ecosystems are transitional regions between terrestrial and aquatic ecosystems with unique soil conditions, plants, and animals, and are essential components of terrestrial carbon and nutrient cycles (Mitsch & Gosselink, 2007; Cui *et al.*, 2009; Li *et al.*, 2012). Initially, conversion of wetland areas to agricultural lands was a main reason for wetland loss. Large area wetlands were converted to cropland to sustain food production for the ever-increasing population (Rijsberman & De Silva, 2003). In recent time population growth and urbanization have further undermined wetland areas and gradually converted them to built-up areas and agricultural lands (Bolca *et al.*, 2007; Cui *et al.*, 2010; Parihar *et al.*, 2013). Drainage ditches for cropland have significantly lowered the water table depth of wetlands and reduced water-storage capacity and changed local hydrological cycling such as precipitation and runoff (Bartzen *et al.*, 2010). Wetland conversion to built-up area results in an increase in impervious surfaces which may cause increases in evapotranspiration and runoff (Carlson & Arthur, 2000). These changes may also increase temperature due to rising greenhouse gas emissions from human-related sources and reduced vegetation covers (Chen *et al.*, 2006; Balçık, 2014). Therefore, a thorough investigation of LULC dynamics on wetland ecosystems is the key to understandings of LULC change-induced hydrological, ecological and climatic processes.

Various methods have been developed in LULC dynamic studies using satellite data and can be generally referred to classification and post-classification comparison (Zhou *et al.*, 2008). The classification method refers to techniques that use various classification algorithms to directly obtain land cover maps (Yuan *et al.*, 2005). It mainly includes two techniques - Pixel based and objected based classifications (Dronova *et al.*, 2011; Whiteside *et al.*, 2011). Recently, Geographic Object Based Image Analysis (GeOBIA) has been widely used for image classification. Compared with the pixel-based methods, the GeOBIA not only considers spectral and textural information that are main factors influencing pixel-based classifiers, but also includes shape characteristics and context in adjacent pixels (Myint *et al.*, 2011). A number of geographical/geometric feature attributes (e.g. shape, adjacency, and topological entities) are included in objects, which provide useful information that cannot be obtained from single pixels and can be easily processed by setting a series of classification rules (Whiteside *et al.*, 2011). Therefore, the performance of GeOBIA is usually more efficient than the pixel-based classifier in processing data with relatively high spatial resolutions (Gao & Mas, 2008; Kindu *et al.*, 2013). Besides the high efficiency, the object-based analysis can eliminate the salt and pepper effect that is caused by closely located pixels classified into different land cover types, which usually occurs in pixel-based classification. In addition, the GeOBIA has fewer errors in identifying distinct edges of different land cover types and performs better in temporal analysis of LULC change than the pixel-based methods (Dingle Robertson & King, 2011). For wetland classification, since high spectral and spatial heterogeneities exist due to differences in water depths and vegetation, the process is highly context-dependent (Wright & Gallant, 2007; Cui *et al.*, 2010). The features of object-based analysis make GeOBIA a very useful method in investigating wetland changes over long periods (Dingle Robertson & King, 2011; Dronova *et al.*, 2011; Moffett & Gorelick, 2013).

Identifying related indices is the key for LULC detection during the classification process. Water body is a commonly used index to identify wetlands in satellite images (Mitsch & Gosselink, 2007). Surface water shows relatively higher reflectance in the visible wavelengths and lower reflectance in

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