Chapter 3
Geo-Informatics for Land Use and Biodiversity Studies

P. K. Joshi
TERI University, India

Neena Priyanka
TERI University, India

ABSTRACT

The dynamics of land use/land cover (LU/LC) is a manifestation of the cyclic correlation among the kind and magnitude of causes, impacts, responses and resulting ecological processes of the ecosystem. Thus, the holistic understanding of the complex mechanisms that control LU/LC requires synergetic adoption of measurement approaches, addressing issues, and identifying drivers of change and state of art technologies for mitigation measures. As the spatio-temporal heterogeneity of the LU/LC increases, its impact on biodiversity becomes even more difficult to anticipate. Thus, in order to understand the spatio-temporal dynamics of change in landscape and its relationship to biodiversity, it is necessary to reliably identify and quantify the indicators of change. In addition, it is also important to have better understanding of the technologies and techniques that serve as complimentary tool for land mitigation and conservation planning. Against this background, the chapter aims to synthesize LU/LC studies worldwide and their impacts on biodiversity. This chapter explores identification and analysis of key natural, socio-economic and regulatory drivers for LU/LC. Finally, it attempts to collate some LU/LC studies involving usage of geospatial tools, such as satellite remote sensing, Geographic Information System (GIS), Global Positioning System (GPS), and integrative tools, besides conventional approaches that could assist decision makers, land managers, stakeholders and researchers in better management and formulation of conservation strategies based on scientific grounds.

DOI: 10.4018/978-1-60960-619-0.ch003

1. INTRODUCTION

Land use (LU) term entails the manner in which human beings employ the land and its resources (Ramachandra & Kumar, 2004; GLP, 2005; Castella *et al.*, 2007; Encyclopedia of Earth, 2007) whereas Land cover (LC) implies the physical or natural state of the Earth's surface (GLP, 2005; Castella *et al.*, 2007; Encyclopedia of Earth, 2007). The change in both LU and LC is intertwined with multiple socio-economic issues such as loss of biodiversity (Murthy *et al.*, 2003), sustainability of agriculture (Gordon *et al.*, 2008), provision of maintaining water and soil quality (NRCS, 2007), climate change and carbon cycle (Turner, 2004). Hence, in order to use land optimally, it is not only necessary to have the information on existing LU/LC but also the capability to monitor the dynamics of LU resulting from both changing demands of increasing population and forces of nature acting to shape the landscape. Conventional ground methods based on sampling techniques of LU/LC mapping are labor intensive, time consuming and are done relatively infrequently and thus become outdated rather soon with the passage of time, particularly in a rapid changing environment. In fact monitoring changes and time series analysis is quite difficult with traditional methods of surveying. In recent years, technologies such as satellite remote sensing, Global Positioning System (GPS), and integrative tools, such as Geographical Information System (GIS) and information systems, together form the basis for Geo-informatics, facilitate the synoptic analyses and monitoring of such dynamic land system function, pattern, and change at local, regional and global scales over time (Lee *et al.*, 1999; Sedano *et al.*, 2005; Navalgund *et al.*, 2007; Roy & Giriraj, 2008). The data assembled using such techniques also provide an important link between intensive, localized ecological research and regional, national and international conservation and management of biological diversity (Roy & Tomar, 2000, Sharma *et al.,* 2008). In case of inaccessible regions, these techniques are perhaps the best methods for obtaining the required data in a cost effective and efficient way.

Information on LU/LC at various scales is found in a widely scattered literature, some of it refereed and some in other grey literature and others unpublished as yet. Although information is incomplete globally, several products are now available that depict LU/LC scenarios worldwide (Global Land Cover Network, 2000; GLP, 2005; IGBP, 2007). A similar condition holds true for regional analysis whereby snapshots of many important regions with substantial LU/LC have been developed, for example, in Russia, South America and Africa, parts of East Asia and Southeast Asia, and the continental US and Canada for future sustainable planning and management of their land (Corves & Place, 1994; Cohen *et al.,* 2003; FAO, 2004; GEO, 2005). There are numerous instances of studies and resultant databases of rapid LU/LC and ecosystem disturbances at local scales in many parts of the world: deforestation and fragmentation in the pan-tropical forest belt, fire frequency in parts of South America, Southern Africa, and parts of Russia, influence of urbanization in selected cities worldwide, biodiversity assessment in parts of India etc (Roy & Tomar, 2000; Roy & Giriraj, 2008; Sharma *et al.*, 2008). In addition, there have been regions with concomitant rapid expansion of the availability of data and information but there has not yet been a systematic assessment of the status and trends in LU/LC of terrestrial, coastal or other ecosystem processes (Townshend *et al.*, 1991; Lambin *et al.*, 2003; Lillesand *et al*., 2007). Henceforth, there is an apparent need to determine the inter-relationships between inventory data, geo-informatics and statistics and therefore synthesizing information about LU/LC augmented by indicators of condition, status, and trends of the change. In addition to the scientific needs for a systematic documentation of LU/LC from past to present for understanding the current state and potential future, there is a pressing need to understand these changes from the standpoint