Chapter 46
Land Use – Terrain Correlations in the Piedmont Tract of Eastern India: A Case Study of the Dulung River Basin

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ABSTRACT

The Dulung River flows across West Bengal and Jharkhand in India. The geographical variables present within the basin area are categorised into groups like Physiographic, Morphometric and Land Use-Land Cover (LULC) attributes. These facets are mapped and overlain in a GIS environment and correlations drawn between them. Factor Scores obtained through Principal Component Analysis are further compared and correlated. The different variables are fused to obtain a comprehensive grouping of the above three facets that is reflective of the overall terrain attributes and its overlying LULC classes. Through this, within the Dulung River Basin, three broad Physiographic-Soil-Land Use Units (PSLUs) are identified, which comprise of the structural ridges and residual hills, piedmont plains and floodplains. For further insight into existing LULC-landform relations, select villages across the basin landscape are examined in detail. The relations derived help in suggesting possible land management practices in this region.

INTRODUCTION

Land use is a dynamic phenomenon and needs continuous monitoring (Bhattacharya, 1983). Though it is mainly controlled by climatic, pedological, socioeconomic and political conditions yet geology and geomorphology too play important roles since a physical landscape is inherently constituted by its underlying lithology and structure. Depending on their occurrence in a particular climatic region, individual landforms give rise to particular soil types and certain landform-soil associations are often more suitable

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for specific land uses. The terrain configuration, affecting the soil and surface drainage, is borne of the sub-surface geology, surficial landforms and their slopes. Morphometric parameters, after enumeration, could be thus used in many watershed and LULC planning applications. As such, studies which integrate landform analysis with soil, hydrology and land use and land cover (LULC) facets, should ideally form the basis of the land resource evaluation of a region (Subramanyan, 1978, 1981).

LULC study of an area provides information about its present land use status and helps form a baseline study for sustainable development of that locale (Krishna, Westinga, & Huizing, 1999). This requires current and archival LULC data of the area to track temporal change patterns (Chaurasia et. al., 1996), specifically information on existing land use and the distribution of settlements, forests, agricultural and barren lands (Christian & Stewart, 1953; Natarajan, Gajbe, & Manchanda, 1986; Shankarnarayan & Sen, 1977). LULC changes are linked to the intersection of natural and human influences on environmental regimes. Biosphere changes and biogeochemical cycle alterations are triggered by heterogeneous changes in land use and manifested further through their perpetuation (Turner, 1995).

Drainage basins have always had a special relevance in geomorphology (Doornkamp & King, 1971; Strahler, 1957) and watersheds are widely adopted in most countries as natural units of ecosystem planning and development (FAO, 1977, 1987; Honore, 1999; Moore, Grayson, & Ladson, 1977). The watershed is a geo-hydrological unit of area drained to a common point and considered as an ideal unit for analysis and management of natural resources and environmental planning in any ridge-to-valley treatment, with its appropriateness in regional planning quite evident (Easter, Stow, & Jenson, 1986; Gregory & Walling, 1978; Saha & Barrow, 1981). In India too, many developmental programmes are based on watershed management (Dhruvanarayana, Sastry, & Patnaik, 1990). Furthermore, India's agrarian-cum-rural economy (on which depend over two hundred million farmers) is extremely sensitive to land and water management and even if the country's irrigation potential is maximised, about 50% of the net cultivated area will continue to depend on rainfall (ISRO/RRSSC, 2009). Much focus thus needs to be given to how the land and water management influences local vegetation and land use - land cover (LULC) (Pant & Roy, 1990).

BACKGROUND

Geographic Information Systems (GIS) technologies for data management, manipulation, analysis and integration have arguably had the greatest impact on the spatial information environment and management of land (Dunkerley, 1988; Kasturirangan, 1994). Remote sensing (RS) and GIS are effective tools for not only mapping and detecting changes in LULC conditions (Anderson, Hardy, Roach, & Wilmer, 1976; Roy et. al., 1991; Skidmore et. al., 1997), but for also predicting future trends. This technique provides much information on LULC parameters by considering tonal variations in the images (Congalton et. al., 1993; Roy et. al., 1985; Schardt, Schurek, & Winter, 1990). Sensors measure the nature and strength of multispectral solar energy reflected from each pixel in the scene in multi wavelengths, the objective being to associate LULC categories with each of these reflected energies (Shetty, Lakshman, Thockchom, & Rajesh, 2005). This characteristic spectral response of objects to radiation in different bands of the electromagnetic spectrum has been advantageously exploited for the identification of objects of interest (Ayyangar, Krishna Rao, & Rao, 1980). Synoptic viewing, continuous monitoring and change detection in the LULC classes are major advantages from such mapping (Jenson, 1986; Kachhwaha, 1985; Luong,