RESEARCH ARTICLE

European Journal of Environment and Earth Sciences
www.ej-geo.org

Using the Normalized Differential Vegetation Index (NDVI) to Detect Vegetative Change with Remote Sensing and GIS: A Study of the Kumbur River Basin in Kodaikanal Taluk, Dindigul District

Mahesh Ramanujam, Neelakantan Rangasamy, Anbalagan Rathinam, and Padmanaban Veeraiyan

ABSTRACT

Land use exercises also ultimately affect land cover spatially and in the short term. The primary consideration responsible for land cover adjustment is to meet the growing needs of an expanding population through the intensification of food crops and the clearing of conventional land cover as forests for food and business activities. Land cover modification also disturbs other characteristics of soil maturity, soil decay, environment, biodiversity, air quality and water systems of the disturbed area. Innovating remote sensing and GIS has been developed as a suitable instrument to examine the land use and land cover adjustment of the area at spatial and transient scale. In this survey, the NDVI-based team demonstrated a remarkable change in land cover from 2009 to 2016. A large change was observed in forest cover, where approximately (3.34%) of the forest was degraded between 2009 and 2016.

Keywords: Change Detection, NDVI, Remote Sensing, Resourcesat-2 LISS III Images, Vegetation Index.

Published Online: September 29, 2022

ISSN: 2684-446X

DOI :10.24018/ejgeo.2022.3.5.270

M. Ramanujam*
Department of Industries and Earth Sciences, Tamil University, Thanjavur, Tamil Nadu, India.
(e-mail: rsmahesh.r@gmail.com)
N. Rangasamy
Department of Industries and Earth Sciences, Tamil University, Thanjavur, Tamil Nadu, India.
(e-mail: neels2004@gmail.com)
A. Rathinam
Department of Earth Science, Indian Institute of Technology, Roorkee, India.
(e-mail: anbaiitr@gmail.com)
P. Veeraiyan
Departmentof Geography, Bharathidasan University,Tiruchirappalli, Tamil Nadu,India.
(e-mail: padmanabanveeraiyan@gmail.com)

****Corresponding Author***

I. Introduction

Land cover refers to the physical state of the land surface including cropland, forest, and wetland, etc. [7]. Whereas land use refers to biophysical assets used by human [4] and [5]. Land use/land cover analysis is important for agricultural planning, urbanization and environmental studies [8],[9],[11],[13],[21] and [22] and this detail helps to understand the relevance between cropland, forestland, settlement etc. In modern time, the urbanization and demographic development have increased the land use and thereby affecting the land cover [17]. The assessment of the global land use and land cover change and environmental monitoring can be derived using remote sensing data and GIS, because of its spatial and temporal coverage [2],[10],[16]. Normalized difference vegetation index (NDVI) can be used as an appropriate method to compare by using multi-date satellite data and the proposed methods for change detection in land use and land cover [18],[20],[24]. Geoinformatics allows us to detect and assess the land cover over the large area and over a longer course period. The change in land cover and land use (LULC) varying along different places, in rural areas because of agriculture expansion, deforestation and illegal tree cutting while in urban areas it is mainly due to urbanization and commercialization19.

The change in land use and land cover of an area is specifically related to other environmental indicators like groundwater quality of the area as well as fertility of the soil [21]. The NDVI is used for the mapping of the changes in the land cover [23],[12]. The assessment can be analyzed by evaluating the difference between images derived by transforming multi-temporal images to digital indicators of those changes [15]. In this study, investigation of land use/land cover spotlights going on subsequent perspectives finding of changes in land use & land cover over the period of 2009 and 2016 for the identification of the type of changes & evaluation of the change in trend.

The main objective of this study was to highlight the nature and extent of land cover changes in the study area over the

eight years and to distinguish the main factors that caused the changes.

II. Research Area and Geology

A. Study Area

The study area is one of the most popular hill stations in Tamil Nadu. This is a great ski resort at about 2560 m on the southernmost tip of the upper slopes of the Palani in Tamil Nadu in the Western Ghats. The study area is geologically located to the west of the Dindigul region, it lies between latitude 10º07'00"N to 10º16'00" N and longitude 77º16'00"E to 77º21'00"E, has an area of 104.77 km² (Figure 1). An immediate part of the Western Ghats. Curiously, the Western Ghats is considered the most rugged mountain trail on the planet, made of rock that is believed to be billions of years old. The study area is administratively located south from Bodinayakanur Taluk, west from Kerala state, east from Kodaikanal block and north from Udumalaippetai Taluk. The temperature of the study area is nearly temperate, with summer temperatures (April-May) reaching a high of 24 °C, and a low of 13 °C. Winter temperatures (December-January) fluctuate between a maximum of 16 °C and a minimum of 7 °C. Precipitation is continuously dispersed, with a normal rainfall of 1300 mm per year. The atmosphere of the study area is distinctive, with mild autumns, winters and springs, and mild summers. The study area also receives a lot of rainfall on a consistent basis, making it an ideal location for development. Therefore, many varieties of fruits and vegetables are grown in these areas, many of which are only grown here including hill banana, passion fruit, peaches, pears, grapes, plums, cauliflower, potatoes, carrots and also coffee. The plants that inhabit in this area includes pine, walnuts, blue gum and other fruit trees, which are cultivated. The total population of the study area is about 13933 persons according to the 2001 census.

B. Geological Parameters

The Palani Hills, which rise sharply above the plain, are part of the Western Ghats. The general trend of the hills is from northeast to southwest. The study area forms part of the northern slopes of the Palani Hills located in the South Granulite terrain of South India. The Kodaikanal region of the Madurai Block lies between the PalghatCauvery and Achankovil cuts. The study area is part of Dindigul district with the following rocks. It is granite gneiss, laterite and laterite. Rocks are exposed in the area with overly thick mantle ranging from thin to thick in some places.

TABLE I: Image Details Used in the Study

Image	Path/row	Acquisition Date	Spatial Resolution
NRSC Bhuvan Satellite Imagery Resourcesat-LISS III	103/67	16/02/2009	24 meter
NRSC Bhuvan Satellite Imagery Resourcesat-LISS III	103/67	21/03/2016	24 meter

Overburdened soils include humus, lithograph and slope wash material. Cool rock outcrops are visible on the cut slopes of roads and terraces as well as cliff faces visible in the hills. The Mannavanur, Pundi regional exhibitions are carefully observed. Species observed in the region are neutral to intermediate, characterized by gray, medium to coarse grain with feldspar crystals. The steep to very steep gradients observed in the upper and middle parts of the study area generally consists of thick overburdened material with exposed rock intermittently observed in stream cuts or shear slopes. other. The outcrops show varying degrees of weathering, from very strong to moderate weathering depending on slope and other local factors. Image details are as on the table (Table I). used to describe the topography of the study area.

III. Materials and Methods

A. Image Acquisition

Images of the study area were collected during the months of February and March.

B. Image Processing

1. Overlapping: The superposition of raster processing bands is done on Arcmap 10.3 software.
2. Projection: Image downloaded in Universal Transverse Mercator projection and reprojected as Geographic WGS 84, spherical and Everest data.

C. Determination Of Changes

The classification of images for both years (2009 and 2016) is done through the NDVI, including the following steps: research. Map of the study area drawn in 1990-91 (June) at 1:25000 scale used for analysis Linear and self-scanning image sensor (LISS III) with 4.5 multi-lens, resolution 24 meters/pixel Digital overlay classifies according to the NDVI process, based on topographic knowledge used to perform the classification. Arc GIS 10.3 is a powerful tool for extracting land use, and land cover, from study area maps and satellite images.

IV. Results and Discussion

The weight of population growth and random repetition of land use has a surprising influence on the specific land cover. Vast vegetation has turned into arable land, alluvial land and characteristic lowlands are threatened by drought. The concern about variation in LULC was taken into account after understanding the effects of this process on the atmosphere and biological systems of the region. In the present investigation, two images (2009 and 2016) were grouped based on the Standard Distinguishing Vegetation File (NDVI), a vegetation file identified by Equation (1).

$$NDVI = \frac{NIR-RED}{NIR+RED} \quad (1)$$

The NDVI is a record that depends on the spectral reflectance of the soil surface component. Each element has its characteristic reflectance that fluctuates with wavelength. The NDVI value ranges from -1 to +1.

European Journal of Environment and Earth Sciences
www.ej-geo.org

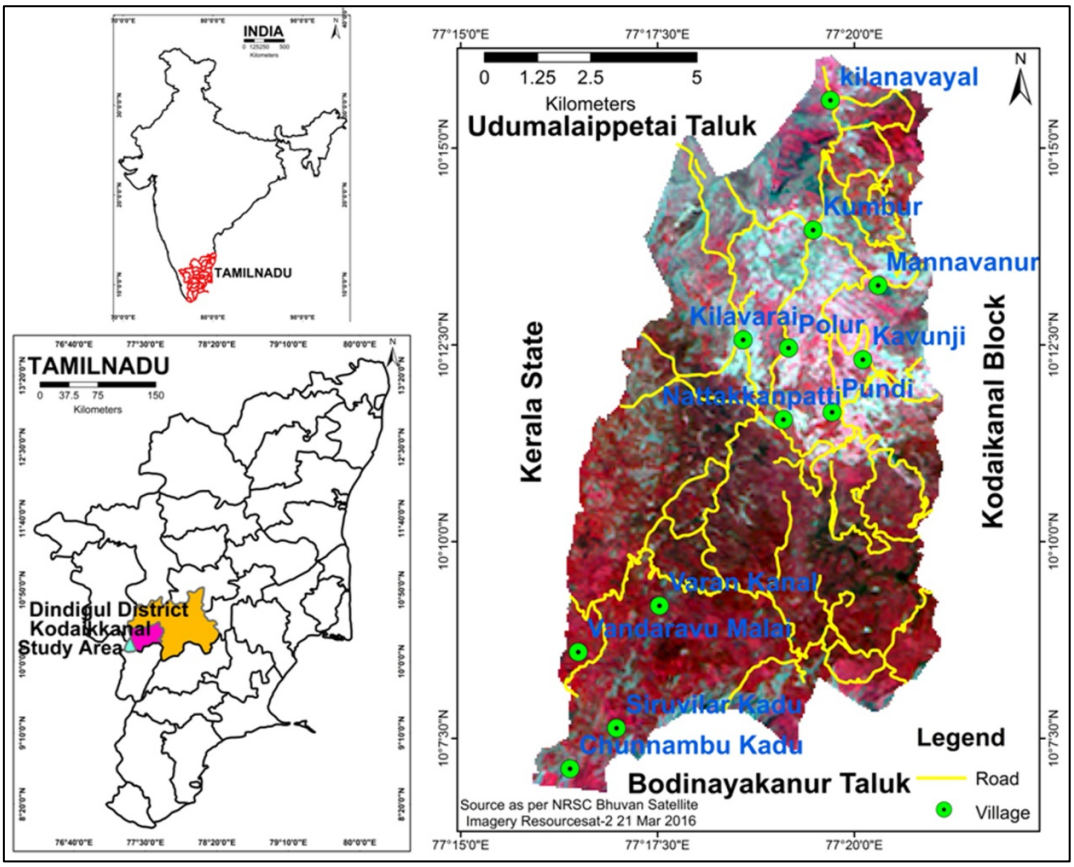

Fig. 1. Location Map of the Study Area.

The NDVI's upper estimate indicates close proximity to hard vegetation in the area while its lower estimate is an indication of sparse vegetation. NDVI has been used to measure progress in many things [1] and [6].

The estimated NDVI determined from Resourcesat2 LISS III satellite images of the territories in 2009 ranges from 0.78 to 0.03. The highest estimates of NDVI were found in the upper part of the Vandaravu Malai region and at the border of the chunnambu kadu locality south of the Kumbur stream (Fig. 2a). The upper part of the area with a higher NDVI is located in the Umaiyar block's reserved forest. The lowest estimates of NDVI are found in streams and delta localities in the study area. Unlike 2009, the estimated NDVI for 2016 shows a large regional variation, and its value decreases from 0.66 to 0.03 (Fig. 2b). Higher NDVI was found in scattered spots.

A. Land Cover Change

Land use/land cover change from 2009 to 2016 was assessed using satellite imagery of the area. The entire area was classified into five layers according to supervised classification (maximum probability method) and feature-managed (maximum probability technique) using image processing software on Arc Map 10.3 2016. The classes are as follows: Construction land, Cropland, Lowland, Jungle Forest and reserve forest areas. The layout satellite images of 2009 and 2016 show a remarkable change in land use/use in the survey area. The layout image of 2009 (Fig. 3) shows that about 63% of the area is dense forest and classified forest. (Board 2). The thick wood is observed in the southern part of the area, near the eucalyptus and acacia plantations and along the slopes of the Vandaravu malai region, north of the Kizhanavayal Rhodomyrtus tomentosa region, with bamboo, hops, eucalyptus and casuarina plantations. (Fig. 3). The 2016 taxonomy (Fig. 4) shows a large variation in land use and land use. The area of forest cover has changed significantly, where about 60% (3.19%) of forest land was compromised between 2009 and 2016. Advancement basically happened due to human encroachment and the increase in agriculture.

The growing population has altered land cover patterns through the overexploitation of land assets for subsistence, as populations living near forested areas depend on valuable timber from forests and agriculture [3]. The extension (for most potatoes, broccoli, green beans, butter beans, carrots, cauliflower, peas, cabbage, and garlic, yield and stand have become a risk to cover forest, an increase of more than% compared to 2009 (Fig. 4). According to the images of Resourcesat 2 LISS III from 2009, vegetation covers nearly 66.03 km^2 of the study area (Table II). 62.69 km^2 during the 2015-2016 period. I did. Almost 42% of forest land (Fig. 3 and Table II) was found to have been converted to urban areas, arable land, lowlands, and urban areas in eight years by human intervention, urbanization, and migration.

Cultivated land, construction land area has an area of 13.80, 6.79 km^2 of land in 2009, increased to 15,09,7.99 km^2 in 2016, From Fig. 3, one can see that land forests have been converted to arable land, which has been filled with land (developed) for agricultural cultivation for the most part [14]. It indirectly shows that part of the land is also occupied by agricultural activities, which was previously forest. For example, cardamom plantations and mixed plantations are the main types in the present development area, while acacia, cover forest Vandaravu Malai, Siruvilarkadu, Varan kanal Chunnambu kadu are present. It is clear that these models show the conversion of forest land into agricultural and construction land.

European Journal of Environment and Earth Sciences
www.ej-geo.org

TABLE II: CHANGE IN LAND COVER/LAND USE OF THE STUDY AREA

Year	2009	2016	2009	2016	2009	2016
LU LC Category	Area (km^2)		% of total area		km^2	Change %
Built-Up Land	6.79	7.99	6.48	7.63	-1.2	-1.15
Crop Land	13.80	15.09	13.17	14.41	-1.29	-1.23
Low Land	18.15	18.99	17.32	18.13	-0.84	-0.80
Reserved Forest	31.20	29.20	29.78	27.87	2	1.91
Dense Forest	34.83	33.49	33.24	31.97	1.34	1.28
Total	66.03	62.69	63.02	59.84	3.34	3.19

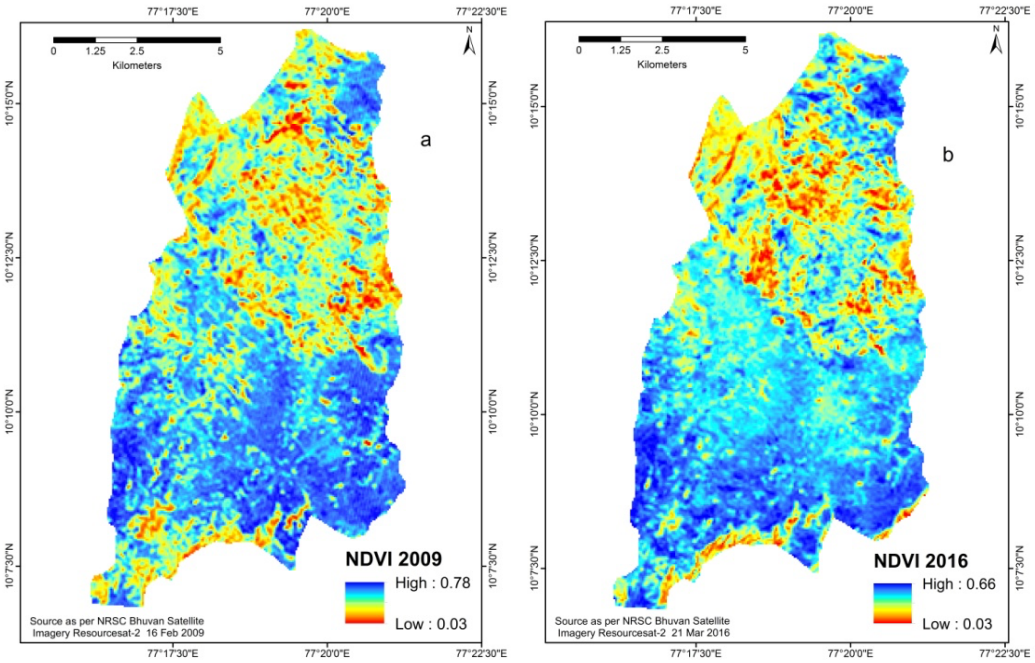

Fig. 2. NDVI Variation in the study area a) in 2009, and b) in 2016.

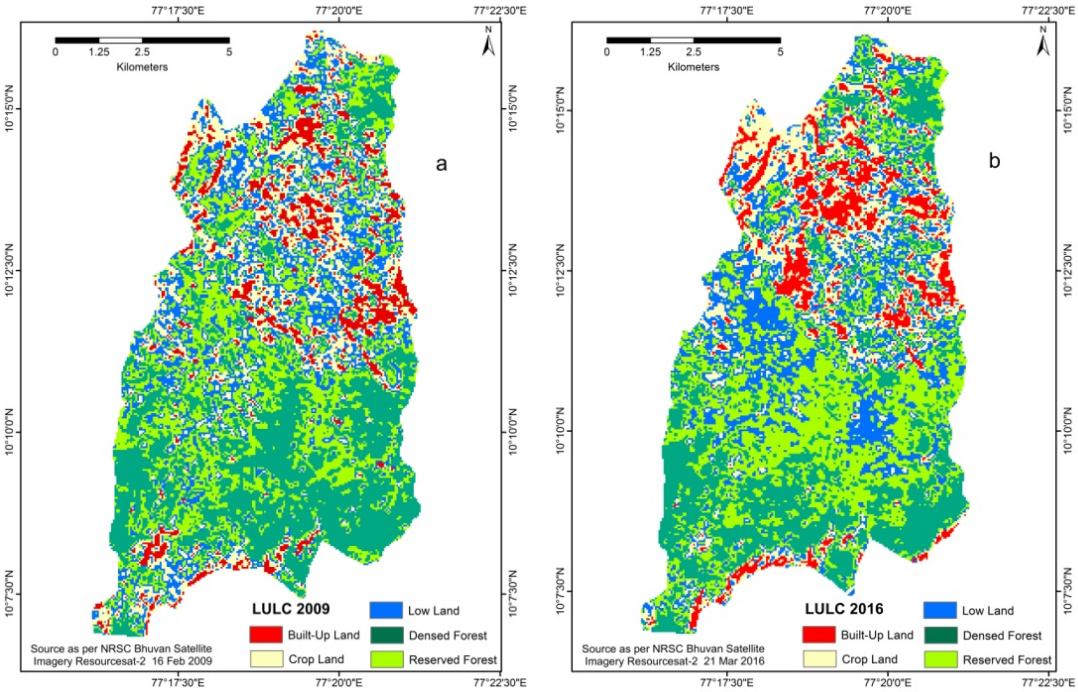

Fig. 3. Change in Land Use/Land Cover in the study area a) in 2009, and b) in 2016.

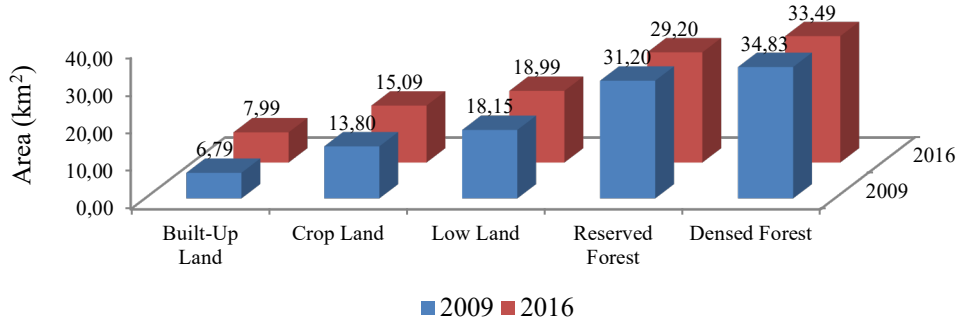

Fig. 4. Graphical presentation of change in Landuse/Landcover of study area.

Lowlands (water bodies) include lakes, reservoirs, ponds, rivers and streams in and around the study area. Lowlands covered about 18.15% of the study area in 2009 and increased to 18.99% in 2016 (Fig. 3). This change can be attributed to the amount of rainfall during the monsoon season. Even floodplains and low-lying areas in scattered parts of the study area can be classified as water bodies. The fact is that the Kumbur River Basin, a mountainous area, also serves as a catchment area for rivers and streams.

V. Conclusion

Unlike 2009, 2016 shows significant changes in land use and land cover. In recent times, modernization, population expansion pressure and overpopulation have become significant dangers to forest cover decline and forestland loss in the survey area. 66 square kilometers of absolute forest cover, including 7.99 square kilometers of built-up land and 15.09 square kilometers of arable land, was lost between 2009 and 2016 due to agricultural escalation and encroachment by People. This worrisome condition is necessary for sound land use management to rationally improve in the area.

References

[1] Ahl DE, Gower ST, Burrows SN, Shabanov NV, Myneni RB, Knyazikhin Y. Monitoring spring canopy phenology of a deciduous broadleaf forest using MODIS. *Remote Sensing of Environment*. 2006; 104; 88-95.

[2] Anderson JR, Hardy EE, Roach JT, Witmer RE. A land use and land cover classification system for use with remote sensor data. *Geological Survey Professional Paper No. 964*, U.S. Government Printing Office, Washington, DC. 28. 1976.

[3] Bhattacharjee PR, Nayak P. Socio-economic rationale of a regional development council for the Barak Valley of Assam. *Journal of NEICSSR*. 2003; 27 (1): 13-26.

[4] Campbell JB. *Introduction to Remote Sensing*. London and New York: Taylor and Francis. 2002.

[5] Chilar, J. Land Cover Mapping of Large Areas from Satellites: Status and Research Priorities. *International Journal of Remote Sensing*. 21 (67): 1093-1114. 2000.

[6] De Boer ME. Landcover monitoring: an approach towards pan European land covers classification and change detection. *Scientific report*. Delft, Beleids Commissie Remote Sensing (BCRS) 2000.

[7] Di Gregorio A, Jansen LJM. Land Cover Classification System (LCCS): *Classification Concepts and User Manual*, 2000.

[8] Fraser RH, Olthof I, Pouliot D. Monitoring land cover change and ecological integrity in Canada's national parks. *Remote Sensing of Environment*. 2009; 113:1397-1409.

[9] Goulding KWT, Blake L. Land Use, Liming and the mobilization of potentially toxic metals. *Agriculture, Ecosystem and Environment*. 1998; 67: 135-144.

[10] Green K, Kempka D, Lackey L. Using remote sensing to detect and monitor land-cover and land-use change. *Photogrammetric Engineering and Remote Sensing*. 1994; 60: 331-337.

[11] Huang S, Siegert F. Land cover classification optimized to detect areas at risk of desertification in North China based on SPOT VEGETATION imagery. *Journal of Arid Environments.* 2006; 67: 308-327.

[12] Lunetta RS, Knight JF, Ediriwickrema J, Lyon JG, Worthy LD. Land-cover change detection using multi-temporal MODIS NDVI data. *Remote Sensing of Environment.* 2006; 105 (2): 142-154.

[13] Mahajan S, Panwar P, Kaundal D. GIS application to determine the effect of topography on land use in Ashwani Khad watershed. *Journal of Indian Society of Remote Sensing*. 2001; 29: 243-248.

[14] Mahesh R, Baskaran R, Anbalagan R. Detection of Land Use and Land Cover Changes: A Case Study of Kumbur River Basin Journal of Geography, Environment and Earth Science International. 2018; 17(1): 1-9.

[15] Maselli F. Monitoring forest conditions in a protected Mediterranean coastal area by the analysis of multiyear NDVI data. *Remote Sensing of Environment*. 2004; 89: 423-433.

[16] Mukherjee S. Role of Satellite sensors in groundwater exploration. Sensors. 2008; 8 (3): 2006-2016.

[17] Myers N. The Primary Source: Tropical Forests and Our Future. W.W. Norton: New York. 399. 1984.

[18] Nielsen AA, Conradsen K, Simpson JJ. Multivariate alteration detection (MAD) and MAF post processing in multispectral, bitemporal image data: new approaches to change detection studies. *Remote Sensing of Environment.* 1998; 64: 1-19.

[19] Singh RP, Singh N, Singh S, Mukherjee S. Normalized Difference Vegetation Index (NDVI) Based Classification to Assess the Change in Land Use/Land Cover (LULC) in Lower Assam, India, *International Journal of Advanced Remote Sensing and GIS.* 2016; 5(10): 1963-1970.

[20] Stow DA, Chen DM, Parrott R. *Enhancement, identification and quantification of land cover change*. In: Morain, S.A., and Lopez Barose, S.V., Raster imagery in geographical information systems. 1996; 307-312.

[21] Turner HBL. Linking the Natural and Social Sciences. The Land use/cover Change Core Project of International Geosphere-Biosphere Programme (IGBP) IGBP Newsletter, 1995; (22).

[22] Vitousek PM. Beyond global warming: ecology and global change. Ecology. 1994; 75: 1861-1878.

[23] Woodcock CE, Macomber SA, Kumar L. Vegetation Mapping and Monitoring. In: Skidmore, A.K. Environmental Modelling with GIS and Remote Sensing. London, UK: Taylor and Francis. 2002.

[24] Yuan D, Elvidge CD, Lunetta RS. *Survey of multi-spectral methods for land cover change analysis*. In: Lunetta RS, Elvidge CD. Remote sensing change detection: Environmental monitoring methods and applications, Ann Arbor Press. 21-39. 1999.