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VEGETATION COVER MAPPING OF GAURIGANJ BLOCK, SULTANPUR DISTRICT (U.P.)-USING SATELLITE REMOTE SENSING

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Abstract

The present study is aimed to map out the green vegetation cover in Gauriganj block (lies between 2607' 5" to 260 10' 5" N latitude and 810 36'45" to 810 45' 18" E longitudes), Sultanpur District, (U. P.) using modern geo-technique of remote sensing . The multispectral high resolution satellite data IRS P6, LISS III, January, 2006 has been processed in ERDAS IMAGINE version 9.1 software to map and analyze the spatial pattern of vegetation cover. The spectral enhancement of satellite image was carried out applying Normalized Difference Vegetation Index (NDVI) approach. The output NDVI map demonstrates the high spatial variation in vegetation cover. According to NDVI ranges (-0.54 to 0.69), the study area has been divided into six categories of vegetation cover. The output of the study may prove better input in planning for eco-conservation and sustainable development in the study area.

Introduction

The status and condition of green vegetation cover is one of the most important characteristics currently used as an indicator for assessing ecological health of any region . The vegetation not only provides food, fodder and fiber but also play a vital role in holding soil in place , increasing water infiltration and promoting the availability of soil minerals. The health and productivity of any ecosystem ultimately depend on the condition of the vegetation cover. The excessive removal of green vegetation cover due to increasing population pressure is causing serious threat to environmental sustainability. The greening of land surface for environmental sustainability is the greatest challenge before environmental scientists, agriculturists, planners, geographers and decision makers. Mapping of vegetation cover is a useful tool for eco-development planning . Remote sensing provides a powerful mechanism, not only to monitor natural resources and environmental change but also permits the analysis of information of other environment variables (Marble et al., 1983). Remote sensing data from space- born sensors, due to its perspective view, multi-spectral, multi-resolution and frequent monitoring capability can provide various spatial information amenable to vegetation pattern analysis. The recent advancement in digital image processing techniques have brought about a profound acceptance of the application of satellite remote sensing data in forest inventory and mapping (Guyot et al,1989; Derrien et al.,1992;Chen and Cihlar,1996; Fassnacht et al.1997; Turner et al., 1999; Treitz and Howarth, 1999; Datt, 1999; Roy and Joshi,2000; Elmore and Mustard , 2004 ; Pu et al., 2005,2008; Joshi et al. ,2006.). Keeping in view of potential of satellite remote sensing in deriving information on the quality of vegetation cover , a study was taken up to map out and analyze the spatial pattern of vegetation cover in Gauriganj block , Sultanpur District, (U. P.).

Aims and Objectives

The main objective of the paper is to draw a map of the vegetation cover of Gauriganj block, Sultanpur District,(U. P.) by using satellite remote sensing and analysis of spatial pattern of vegetation cover .

Study Area

The Gauriganj block, Sultanpur District, Uttar Pradesh lies between 2607' 5" to 260 10' 5" N latitude and 810 36'45" to 810 45' 18" E longitude(Fig.1) covering an area of 207.56 sq. km. and a population of 1,20,892 persons (as per 2001 census). The community development block of Gauriganj consists of 100 revenue villages. Physiographically, it is a part of the vast Indo-Gangetic plain which is recent in origin. The study area enjoys semi-arid sub-tropical monsoonal climate, characterized by hot summer and cold winter seasons. The average annual rainfall is 977 mm, mainly received between July and September (Sharma et al., 2001). The winter rains are irregular and scanty. The mean maximum and minimum annual temperatures are 47.50C and 4.10C, respectively. The soils of the study area have been classified as Aquic Petrocalcic Natrustalf belonging to the fine loamy, mixed, thermic family (Soil Survey Staff, 1994) and represent a large area of sodic soils occurring in the Indo- Gangetic alluvial plains. The block is economically backward and majority of the population (78.50 % of the working force) earns livelihood from agriculture and other allied activities. Land degradation is a major agro-ecological problem in the block.

Database

The present study is based on high resolution multispectral satellite data obtained from LISS III sensor carried by IRS P6 satellite in the month of January, 2006 (Table-1). The area falls in path-101 and row -53 of LISS III sensor. The Survey of India (SOI) toposheets (numbered 63 F/11, 63 F/12 and 63 F/16 of year 1974 on 1:50, 000 scale) and block boundary map developed by RRSC, Lucknow U.P (scale 1:50000) were used for reference and base map preparation.

Methodology

Digital image processing techniques are employed to map out the green vegetation

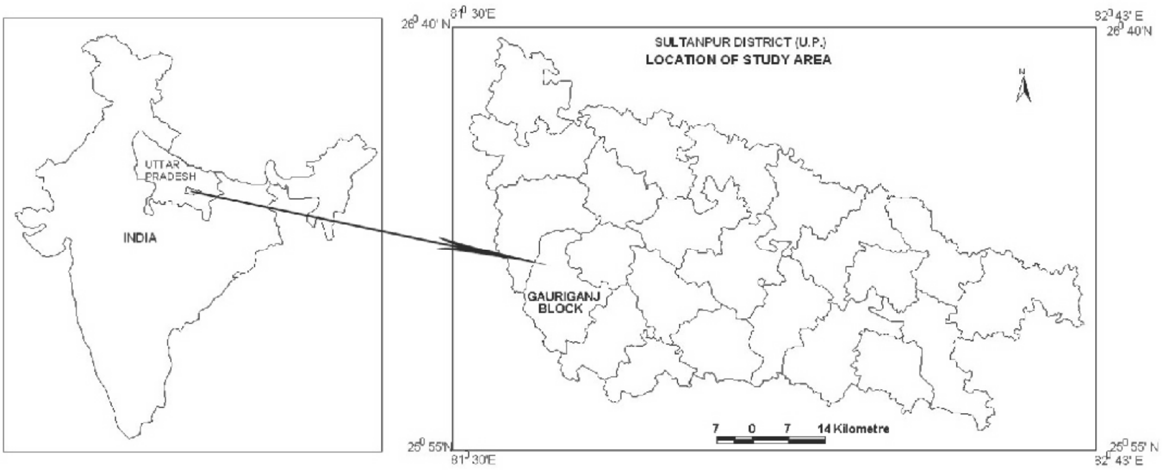

Fig. 1

Table 1
Feature of IRS P6, LISS III data (NRSC)

Sensor LISS III	(Linear Imaging Self Scanning -III)
Spatial resolution	23.5 m at nadir
Spectral bands	B2-Green 0.52-0.59 micro meter B3-Red 0.62-0.68 micro meter B4-NIR 0.77-0.86 micro meter B5-SWIR 1.55-1.70 micro meter
Swath	141 km

cover on IRS P6 LISS III data in ERDAS IMAGINE, 9.1 software. The base map of study area has been prepared from SOI toposheets and block boundary map on 1:50,000 scale and saved in computer environment. This map was imported into image processing software ERDAS Imagine 9.1 and geo-referenced by taking various control points .The projection type used is polyconic with the spheroid and datum as Everest. The satellite digital data were registered through image to image registration approach and after that radiometrically normalized to reduce the variation in spatial reflectance due to sun elevation differences and radiometric gain setting. Initially, the DN values were converted into radiance values using following formula (1) (IRS P6 Data Users Hand Book,2004):

L* = (Lmax-Lmin)/ Qcalmax *Qcal + Lmin- ----------- (1)

Where,

L* = spectral radiance at the sensors aperture W/(m2.sr.um)

Qcal = Calibrated Digital Number

Qcalmax = maximum possible DN value (255 for LISS-III products),

Lmax & Lmin = maximum/minimum scaled spectral radiance value for a given band (provided in the header file)

The radiance values are converted into reflectance using the following formula (2):

$^{\rho}P=(\pi * L\lambda * d^2)/(ESUN\lambda * \cos\theta s)$---------- (2)

Where,

$^{\rho}P$ = unit less effect planetary reflectance;

Lλ = (w/m2/ster/µm) is the band radiance;

d = Earth-Sun distance in astronomical units (d=0.997052 for this case);

ESUNλ = Mean solar exo-atmospheric irradiances for given wavelength in watts/m2/ µm/ster

θs = Solar zenith angle in degrees.

ERDAS modeler was used for the above calculations.

Normalized Difference Vegetation Index (NDVI):

In the present study, reflectance image was processed to calculate NDVI in ERDAS IMAGINE 9.1,software . The vegetation absorbs a great part of incoming radiation in the visible portion of the spectrum (VIS 0.22- 0.68 µm) and reaches maximum reflectance in near infra red channel (NIR 0.73-1.1 µm). The NDVI, defined as the ratio, respects the absorption of photosynthetic active radiation and hence it is directly related to the photosynthetic capacity and energy absorption of plant canopies (Sellers, 1985; Myneni et al., 1995). The NDVI also reflects the productivity of the ecosystem or the availability of free energy. Indeed both productivity and availability of energy are assumed to be the major determinants of species richness (Currie, 1991; Rosenzweig and Abramsky ,1993; Currie and Paquin ,1987). Goward et al.(1985) showed that vegetation indices such as NDVI are related to net primary production (NPP, gm-2 year-I). Kumar and Monteith (1981) showed that the fraction of photosynthetically active radiation (PAR) absorbed by the vegetation cover is related to the ratio of red reflectance (R) to near-infrared reflectance (NIR). The formula to calculate NDVI is :

NDVI = (Near IR band - Red band) / (Near IR band + Red band)

By design, the NDVI varies between -1.0 and +1.0, but vegetation values typically range between 0.1 and 0.7. Higher index values are associated with higher levels of healthy vegetation cover, whereas index values near zero indicates the less green vegetation.

Categorization and Mapping

The mapping of vegetation cover in the study area was performed in Raster Attribute Editor in ERDAS Imagine through giving different colours to NDVI ranges.

Results and Discussion

Spatial Patterns of Vegetation Cover

The study indicates that the NDVI values varies from minimum of -0.54 to a maximum of 0.69, having mean value of 0.07 and standard deviation of 0.36 for January, 2006 dataset .In order to quantify and analyse the spatial variation of vegetation cover clearly, the NDVI values of all pixels of the satellite data have been grouped into following six classes (Table 2 and Fig 2).

The values NDVI below 0.00 (class I) are observed in the strongly salt affected lands, built-up area , water bodies with out hydrophytes etc . A total number of 26098 pixels (1503.24 ha,7.18 % of study area) were identified in this category. Class II of NDVI range (0.00 to 0.10) comprising a large area of about 29.74 % (6221.43 ha.) of the study area and observed in mostly over moderately wastelands. This class covers 108011 pixels on the satellite image .

The class III (ranging-0.11 to 0.20) constitutes about 25.43 % (92341 pixels, 5318.84 ha.) of the study area which represents basically bare soils and moderately degraded lands. Class IV ranges between 0.21 to 0.30 NDVI values comprising merely 19.16 %

Table 2
Gauriganj Block: Distribution of Green Vegetation Cover as per NDVI (January, 2006)

NDVI Classes	NDVI range	Mean NDVI	SD NDVI	No. of Pixels	Area in ha.	Color given in NDVI map
Class I	Below 0.00	-0.27	0.16	26098	1503.24	Red
Class II	0.00 – 0.10	0.05	0.03	108011	6221.43	Light Yellow
Class III	0.11 – 0.20	0.15	0.03	92341	5318.84	Gray
Class IV	0.21 – 0.30	0.24	0.03	69604	4009.19	Yellowish Green
Class V	0.31 – 0.50	0.40	0.06	61592	3547.70	Green
Class VI	above 0.50	0.60	0.06	5457	314.32	Dark Green

Source: Derived by author from IRS P6,LISS III,Jan.,2006,data

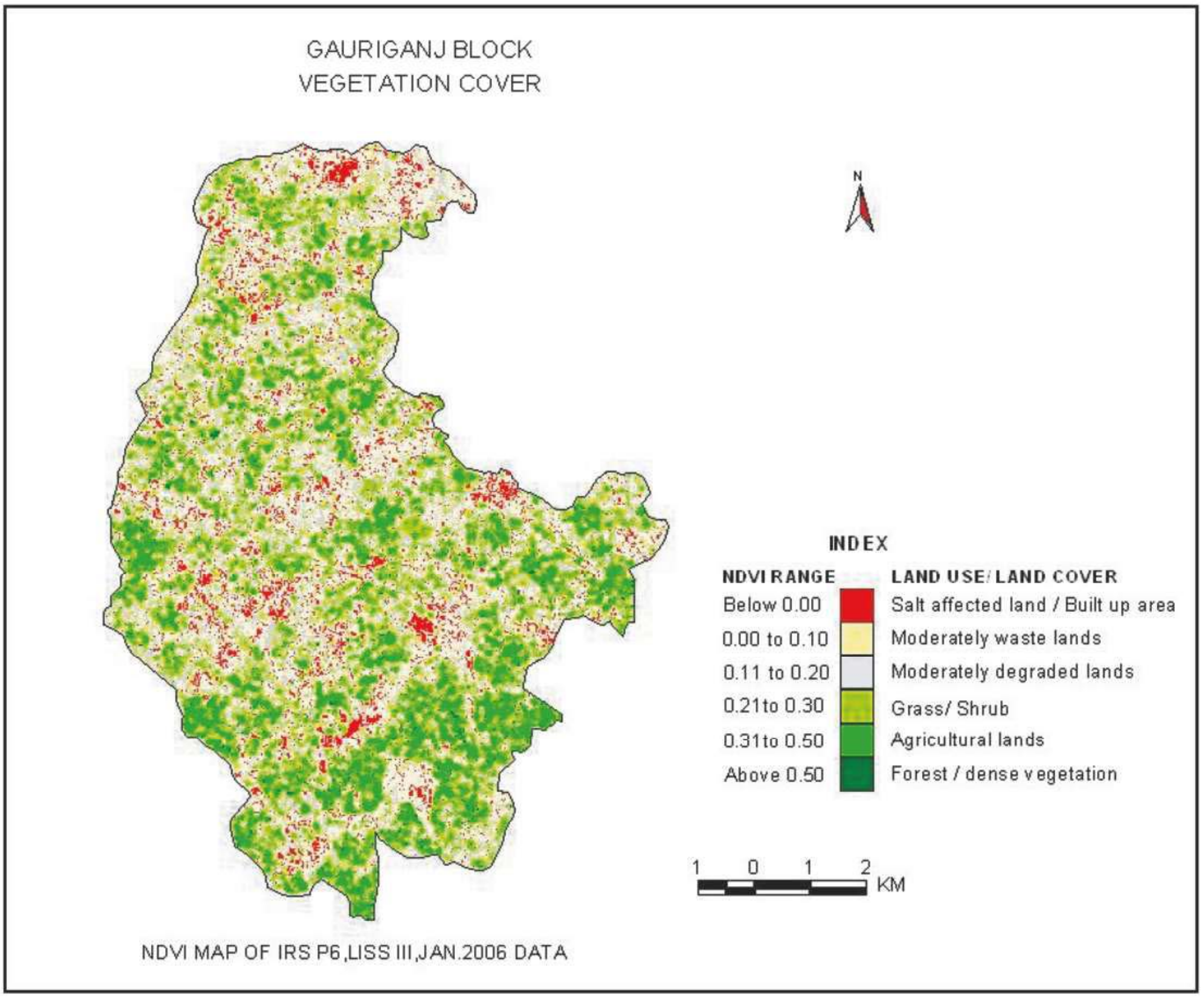

Fig.2

(69604 pixel, 4009.19 ha.) having mostly grass/shrub. Class V (NDVI ranging 0.31 to 0.50) occupies about 16.96 % (61592 pixel, 3547.70 ha.) of the study area. This range is NDVI values are concentrated on good agricultural lands. Above 0.50 NDVI values (Class VI)occupies a very small area of about 1.5 % (5457 pixels , 314.32 ha.) and found in certain pockets of forest /dense vegetation cover in the block.

Conclusion

The study has amply demonstrated the utility of IRS P6 LISS III data for assessment and mapping of vegetation cover. Vegetation cover can be assessed using digital image processing techniques for the block level and can be compared according to extent and magnitude of vegetation cover to provide input for land use planning. Satellite data can provide prioritized location which helps in taking decision for carrying out surface greening measures. The study also demonstrate the distinctive variations in green vegetation cover in the study area. The NDVI ranges from the lowest -0.54 to the highest of 0.69.It is evident from the NDVI map that about 62.36 per cent of the total geographical area of the block has extremely low range of NDVI values. Immediate attention needs to be paid for improving the vegetation cover in these areas. This would facilitate in improving the soil and environmental health for better livelihood of the people.

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