CLASSIFICATION TECHNIQUES FOR IDENTIFICATION OF WATERLOGGED AREA USING REMOTE SENSING DATA

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Abstract

The study area is a part of Darbhanga and Samastipur districts, Bihar which lies between 25º, 27', 35" N to 26º, 26', 35" N and 85º, 31', 39", E to 86º, 24', 33"E longitude covering a surficial area of about 5204 sq km. In study area problem of land degradation have been seen after regular occurrence of flood, drainage congestion and topographical conditions. There identification and assessment for sustainable development is very necessary. In this situation Remote sensing data is proved useful and fast technique for making wasteland map. Supervised classification technique was applied on IRS-1C LISS III data of Rabi season for discriminating waterlogged area and other land use features. Overall accuracy for whole classified image was examined and it show 92.70 % accuracy. NDVI index was applied on all three season data sets for seeing the effect of land degradation unit and their severity effect on crop. Classified NDVI helps in discrimination of the vegetation and other land features. Higher NDVI values are associated with greater density, large leaf area and large green biomass of the canopy.

Keywords

Supervised Classification, NDVI, LISS III data etc.

Introduction

Land, a non-renewable resource, is central to all primary production systems. Over the years, the country's landmass has suffered from different types of degradations. Degradation of land is caused by biotic and abiotic pressures. Excessive irrigation in areas with poor drainage causes waterlogging and salinization of the soil. When water does not penetrate deeply, it raises the water table. Air spaces in the soil are filled with water, and plant roots suffocate. Consequently, waterlogged conditions adversely affect crop yields. About 8360 sq km (16%) out of total area of 52312 sq km in North Bihar is waterlogged. With the population density of 880 per sq km in Bihar, this means that about 7.5 million people stay in the waterlogged area (Chatterjee et. al., 2003). Water resources management and agricultural development require a multidisciplinary approach that integrates analysis of spatial and non-spatial data parameters so that decision makers can implement plans for water use in problematic areas. The study is very useful for monitor the changes in the wasteland in terms of their spatial extent and distribution for the reclamation of degraded lands due to increasing waterlogged areas. Geo-database creation for wasteland would serve as a guideline for planning and mange the stressed land resource to obtain the best possible production from them and providing solution for food security to the world without affecting ecological balance by adopting Remote Sensing and GIS techniques.

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Study Area

A study was taken up to delineate and monitor the spatial distribution pattern of waterlogged area and other land use features in Buri-Gandak, Bagimati, and Kosi command areas covering an area of 5204 sq km parts of Darbhanga and Samastipur districts of Bihar state using multi season data of Indian Remote Sensing Satellite (IRS-P6, LISS III, year 2005 & 2006). The study area is bound by 25º, 27', 35" N to 26º, 26', 35" N latitude and 85º, 31', 39", E to 86º, 24', 33"E longitude.

Data and Methodology Used

For delineation and mapping of waterlogged area, geo-rectified IRS-1C LISS-III data acquired during 2005-2006 is used for on screen visual interpretation. And SRTM data is used for extracting the contours and generating the relief map. Survey of India topographic maps on 1:50000 scales will be used for the identification of natural and cultural features and for planning ground truth collection

Information on waterlogged areas is derived from multi-temporal data both by digital analysis and visual interpretation. Supervised classification was performed using LISS –III data. In supervised classification the basic steps followed are: (1) select training samples which are representative and typical for that information class; (2) perform classification after specifying the training samples set and classification algorithm; (3) assess the accuracy of the classified image through analysis of a confusion matrix which is generated either through random sampling or using test areas as reference data (Congalton et. al. 1999).

Combining the fieldwork survey of the study area and also the image classification objective, there are six information classes need to be identified for image classification. These information classes are agriculture, settlement, sand, fellow land, water bodies, waterlogged. Training samples are selected according to the ground truth from the field work. During fieldwork, coordinates for homogeneous land cover areas are recorded by GPS receiver. These homogeneous areas are identified to form the training samples for all the information classes. What is important to be mentioned here is that the ground truth used for training sample for classification are different from the ground used for the accuracy assessment in order to evaluate the quality of the classification result

One spectral indices used in the study area is Normalized Difference Vegetation Index which is ratio of (Near Infra Red –Red)/ (Near Infra Red+ Red). This NDVI index is further classified in no. of land feature classes. NDVI reflects vegetation vigor, percent green cover, Leaf Area Index (LAI) and biomass. It varies in a range of -1 to +1. Classified NDVI are generated on all three kharif, rabi and zaid season of IRS-1C LISS III data.

Result & Discussion

Supervised Classification using Maximum Likelihood Classifier

Agriculture class is considerably extracted perfectly from the image. Total area covered by study area is 5204 sq km out of which 1416 sq km area is classified as agriculture land. Sand pixels can't be separated between fallow land because fallow land made up same material as sand that is why both classes mixed with each other, only pure dry sand classified perfectly. The area covered by sand class 35 sq km. Water bodies' area can be extract perfectly but it is also mixed with waterlogged class, because water bodies and waterlogged class has a same property that's why both class mixed with each other. The area covered by water bodies are 54 sq km. In this category all the water bodies, river water, ponds classified as in same class. Waterlogged area mixed with the fallow land and settlement class. In this class pixels can't be separated between fallow land and settlement because fallow land and settlement class and is appearing likely same tone and color. The area covered by classified class is 122 sq km. Fallow land has classified as an area of 3527 sq km. Details of area covered by each classes are shown in the Table 1.

Land Use Class	Area (sq km)
Agriculture land	1416
Settlement	50
Water bodies	54
Waterlogged	122
Fallow land	3527
Sand	35
Total	5204

Table - 1 Area covered by different land use class in sq. km.

No classification is complete until its accuracy has been assessed (Lillesand and Kiefer 2001). In this context, the "accuracy" means the level of agreement between labels assigned by the classifier and the class allocations on the ground collected by the user as test data. For calculating accuracy for each classified class confusion matrix is generated (Table 2). After generating confusion

Class	Agriculture	Sands	Settlement	Fallow Land	Waterlogged Area	Waterbodies	Total
Agriculture	**1286**	0	0	1	0	0	1287
Sands	0	**89**	0	57	0	0	146
Settlement	0	0	**202**	8	42	2	254
Fallow Land	1	1	30	**1169**	50	0	1251
Waterlogged	0	0	6	84	**211**	7	318
Water bodies	0	0	0	0	5	**780**	785
Total	1287	90	238	1319	308	789	**4031**

Table - 2 Confusion Matrix

matrix, producer and user accuracy is collected for each class. Overall accuracy for classified image is collected as 92.70 % (Table 3) and overall kappa accuracy is collected 0.8761.

Producer Accuracy (%)		User Accuracy (%)
Agriculture	1286/1287 = 99.92	1286/ 1287 = 99.92
Sands	89/90 = 98.88	89/ 146 = 60.95
Settlement	202/238 = 84.87	202/254 = 79.52
Fallow Land	1169/1319 = 88.62	1169/1251 = 93.44
Waterlogged	211/308 = 68.50	211/308 =68.50
Water bodies	780/789 = 98.85	780/785 =99.36
Overall Accuracy	(1286+89+202+1169+211+780/4031) =92.7065 %	

Table - 3 Producer and User Accuracy

Vegetation index

Normalized Difference Vegetation Index (NDVI) has been largely used for consistent vegetation discrimination for seeing the effect of waterlogging on crop, NDVI maps and values were generated for all three season data and temporal assessment were monitored by comparing the index value of image. Higher NDVI values are associated with greater density, large leaf area and lar ge green biomass of the canopy. NDVI is transformed index of reflected radiation in the visible and near infrared bands. It is the function of green leaf area and biomass. Classified NDVI are generated on all three kharif, rabi and zaid season of IRS-1C LISS III data. In classified NDVI image of Kharif season (Fig. 2) water bodies is reflected in category -0.88 to -0.21. Bare

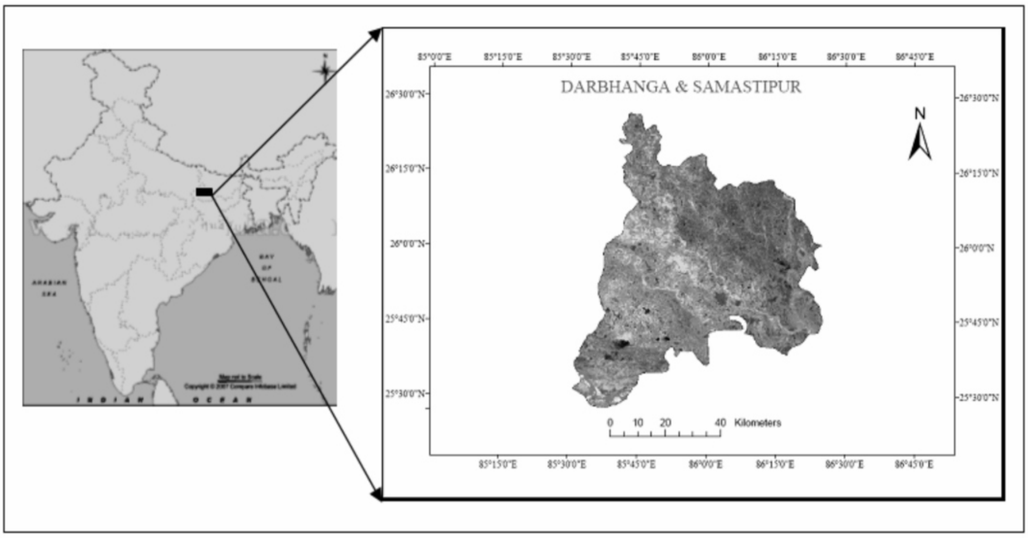

Figure - 1 Location of the study area as viewed on IRS-1C LISS III data

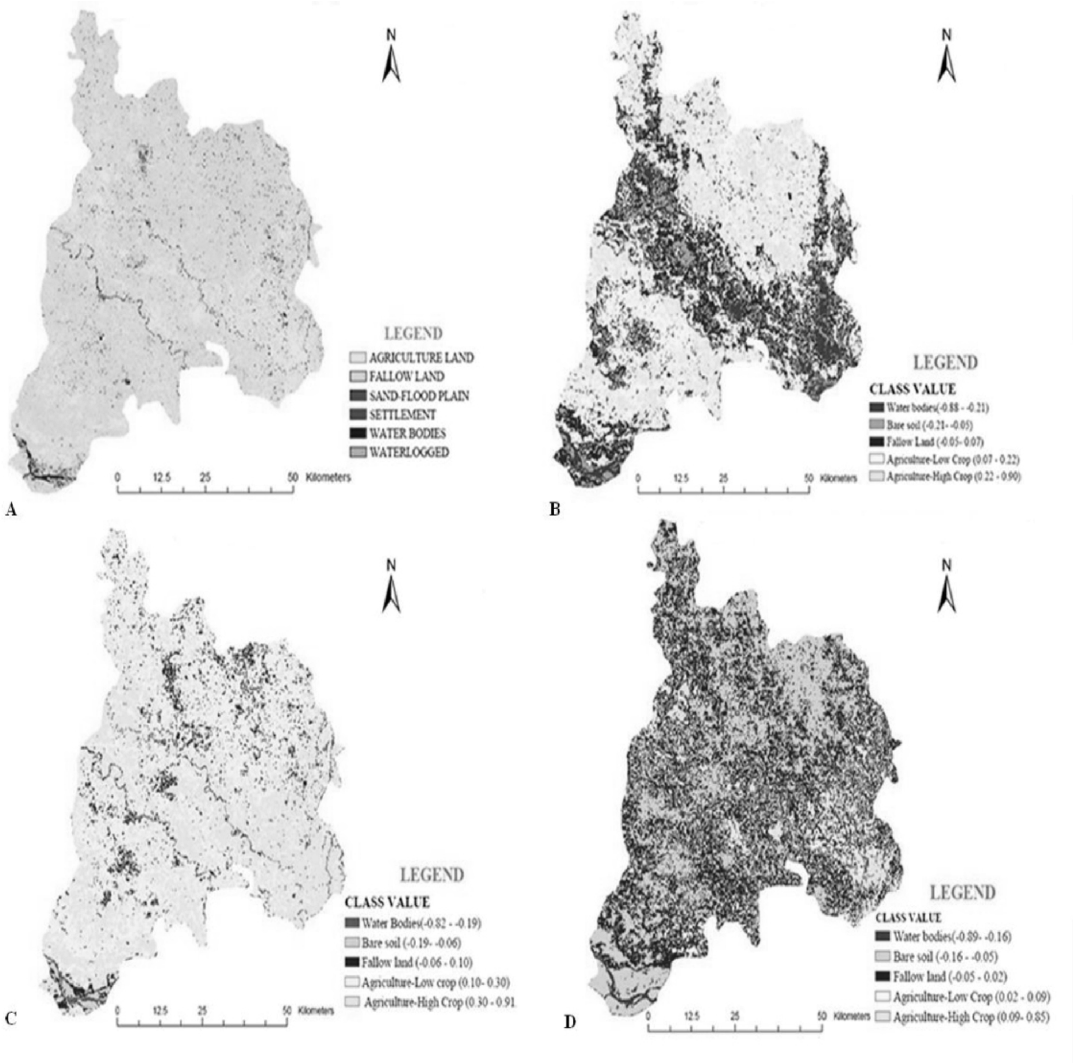

Figure - 2 Supervised classification map of the study area (A), Classified NDVI image of Kharif season (B), Classified NDVI image of Rabi season (C), Classified NDVI image of Zaid season (D)

soil exhibit similar reflectance in both visible and near IR regions and the index values are near zero. NDVI Value used for bare soil ranges from -0.21 to -0.05. NDVI value for agriculture high crop is between 0.22 to 0.90. NDVI index value in Rabi season has been change slightly for all class. Water bodies' category NDVI index value in Rabi season has been changed as -0.82 to-0.19. Agriculture high crop values in Rabi season is 0.30 to 0.91 (Fig. 3). In the Zaid season NDVI index value for agriculture crop area has been quantified as 0.09-0.85 (Fig 4). Change in the composition, morphology and density of green biomass can be assessed by comparing three season NDVI index value of image. Higher NDVI values are associated with greater density, large leaf area and large green biomass of the canopy

Conclusions

Extraction of information about land degradation, for this purpose on screen visual image interpretation techniques and supervised classification using Maximum Liklihood classification are very much helpful for identification of different land degradation type and other land use features types. Supervised classification technique was applied on LISS III data of Rabi season for discriminating different land degradation type. Overall accuracy for whole classified image was examined and it show 92.70 % accuracy. In LISS III image discrimination of sand patches, fallow land and waterlogged area with settlement is not possible; these units mix with each other. The area covered by waterlogged class is 122.00 sq. km. Classified NDVI index was applied on all three season data sets for seeing the effect of land degradation unit and their severity effect on crop. For seeing the effect of waterlogging on crop NDVI maps were generated for all three season data and temporal assessment were monitored by comparing the index value of image.

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