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RESEARCH ARTICLE

LAND USE/ LAND COVER MAPPING FOR UPPAR ODAI SUB-WATERSHED, TAMIL NADU, INDIA

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ABSTRACT

Land use mapping is important for evaluation, management and conservation of natural resources of an area and the knowledge on the existing land use is one of the prime pre-requisites for suggesting better use of land. In this study, three mapping approaches (unsupervised, supervised and GIS post processing) were used to identify, demarcate and map the land use/ Land cover categories in the Uppar Odai Sub-Watershed, Tamil Nadu, India. The following land cover classes were discriminated: Evergreen forest, Deciduous forest, Rabi only, Kharif only, Current fallow, Scrub / Degraded forest and Built-up. The results showed that the cultivated land still covering about 39 % of the Uppar odai sub watershed. While current fallow covers 35 % of the total sub watershed. The Uppar odai sub watershed land cover map confirmed the intensive agricultural activities. This paper also showed that Landsat-like sensors can provide feasible land cover maps of Uppar odai sub watershed, although ancillary data are required to help image interpretation.

INTRODUCTION

The study of land use is important not only in agriculturally dominated, over populated developing regions but throughout the world because of its relationship with different human phenomena. It has been observed that, remote sensing technique is the most efficient scientific tool in conjunction with ground truth and toposheet for collection of spatial information and very useful in identification, classification and mapping of the land use units (Nageshwara Rao and Vaidyanadhan, 1981). In case of India explosive growth of population and their diverse needs has steadily increased the need for optimum utilization of our land resources. Now the country requires sufficient quantities of food grains to feed its huge population, various raw materials for a sound industrial base and creation of adequate job opportunities for the large majority of unemployed people. The systematically planned and proper way utilization of our land resources can play a major role in solving these problems. Therefore, the proper utilization of land according to its capability should be the prime concern of people and our government. However, present research aimed to suggest the potential land use for sustainable development in the Uppar Odai sub-watershed.

METHODS

Study Area

The present investigation is restricted to Uppar Odai sub-watershed, which lies in part of Tiruchirappalli and Perambalur districts of Tamil Nadu. The watershed lies between 10° 54′ and 11° 15′ North latitudes and 78° 36′ and 78° 49′ East longitudes. The total area of the sub-watershed is 520 sq km and the total number of villages in the watershed is 97.

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Data sources

Remote sensing image data: LANDSAT 8 (spatial resolution 30m) for 2013 in the study. These images were selected for this study because they provided suitable cloud-free spatial coverage with relatively high spatial and spectral resolutions. Compatible with the mapping scale (1:250,000), and relatively large swath width of 185 km. Geometric correction: Accurate registration of multispectral remote sensing data is essential for analyzing land use and land cover conditions of a particular geographic location. In this study, geometric correction of remote sensing data is done for the distortions and degradations caused by the errors due to variation in altitude, velocity of the sensor platform, variations in scan speed and in the sweep of the sensors field of view, earth curvature and relief displacement. The images were georeferenced using the polyconic projections with Root Mean Square Error (RMS) of 0.345 and 0.325 respectively. Ground reference data: In image analysis, ground reference data play important roles to determine information classes, interpret decisions, and assess accuracies of the results (Thapa and Murayama, 2009). Substantial reference data and a thorough knowledge of the geographic area are required at this stage. In this study, for collecting ground truth data. A hand held Global Positioning System (GPS) equipped with a data entry form were used for collecting the geographic data and recording perspective views of the locations. Classification scheme: Classification schemes provide frameworks for organizing and categorizing information that can be extracted from image data (Thapa and Murayama, 2007). A proper classification scheme includes classes that are both important to the study and discernible from the data on hand (Anderson, Hardy, Roach, & Witmer, 1976). Image enhancement, contrast stretching and false colour composites were worked out and the interpretation of images were carried out using the various interpretation keys like the shape, size, pattern, tone, texture, shadows, location, association and resolution. Using the shape man-made features as well as the natural features like the river, and hills were Identified from the image. Using pattern, the airstrip, railway tracks as well as the road networks were identified. Though roads and railway tracks looks linear but both can be distinguished from each other as the major roads are associated with steep curves and many intersections with the minor roads (Joseph, 2005). Shadow shows the height of the terrain. Taller features will show larger shadows than the shorter features. Tone shows the brightness of the object based on the reflection, emittance, transmission or absorption character of an object. Using the tonal variations the vegetation status of the area was identified. Vegetated areas have a relatively high Reflection in the near infrared and a low reflection in the visible range of the spectrum. Clouds, water and snow have larger visual than near infrared reflectance. Rock and bare soil have similar reflectance in both spectral regions (Cees and Farifteh, 2001).

Image Classification Techniques: The overall objective of the image classification procedure is to automatically categorize all pixels in an image into land cover classes or themes (Lillesand, Kiefer, and Chipman, 2008). Classes have to be distinguished in an image and classification needs to have different spectral characteristics. This can be analyzed by comparing spectral reflectance curves. Image classification gives results to certain level of reliability. The principle of image classification is that a pixel is assigned to a class based on its feature vector by comparing it to predefined clusters in the feature space. Doing so for all image pixels result in a classified image (Janssen. 2001). In this study unsupervised, supervised approach, and GIS post-processing were used for image classification and land use mapping of the study area.

Unsupervised Classification: The unsupervised classification approach is an automated classification method that creates a thematic raster layer from a remotely sensed image by letting the software identify statistical patterns in the data without using any ground truth data (Leica Geosystems, 2005; Lillesand et al., 2008). The unsupervised classification was carried out. The spectral classes obtained from the unsupervised classification are based solely on natural groupings in the image values. The spectral classes obtained from the image were not initially known. So taking the reference values, the classified data was compared and the spectral classes were identified.

Supervised Classification: Here the image analyst supervises the pixel categorization process by specifying, to the computer algorithm, numerical descriptors of various land cover types present in the image. Training samples that describes the typical spectral pattern of land cover classes are defined. Pixels in the image are compared numerically to the training samples and are labeled to land cover classes that have similar characteristics. All the classification techniques like the maximum likelihood classification (MLC), parallelepiped and minimum distance to mean classification have been applied for the images and the best classification technique was then found out. It was observed that Maximum Likelihood Classification (MLC) was giving good results as compared to the other two techniques.

GIS post-processing approach: A combination of more approaches in mapping provides better results than just using a single approach (Kuemmerle, Radeloff, Perzanowski, and Hostert, 2006; Lo and Choi, 2004). The main goal of the post-processing of raster image (after polygon generation) is an optimization of vectorization results (Lou and Huang, 2005). A GIS post-processing approach combines the two approaches (unsupervised and supervised) to produce an improved land use and land cover map (Thapa and Murayama, 2009). The maps here are derived from the unsupervised and supervised approaches and then combined utilizing the GIS function. Land use clusters identified by both unsupervised and supervised classifications produce the best results, by extracting the common land use pixels from the map. The resulting classification map revealed that the most likely homogeneous features were represented by common pixels; the more heterogeneous features were left empty. In the present study a post-classification low pass filter in the maps generated from unsupervised, supervised and GIS post-processing approaches was done before the accuracy assessment.

Accuracy assessment: In thematic mapping from remotely sensed data, the term accuracy is used typically to express the degree of ‘correctness’ of a map or classification (Foody, 2002). A thematic map derived with a classification may be considered accurate if it provides an unbiased representation of the land cover of the region it portrays. In essence, therefore, classification accuracy is typically taken to mean the degree to which the derived image classification agrees with reality or conforms to the ‘truth’ (Campbell, 1996; Janssen and van der Wel, 1994; Maling, 1989; Smits et al., 1999). A set of reference pixels representing geographic points on the classified image is required for the accuracy assessment. Randomly selected reference pixels lessen or eliminate the possibility of bias (Congalton, 1991). A random stratified sampling method was used to prepare the ground reference data. This sampling method allocates the sample size for each land use based on its spatial extent (Shalaby and Tateishi, 2007).

Land Use Classification System for Uppar odai sub watershed

1. Forest
1.1 Dense Forest
1.2 Open Forest
1.3 Forest Blank
2. Cultivated Land
2.1 Cropped Land
2.2 Plantation

2.3 Fallow Land
3. Grazing or Range Land
4. Waste Land
i. Unculturable Waste
4.1 Rocky waste
4.2 Gullied Land
ii. Culturable Waste
5. Water bodies
5.1 River
5.2 Lake/Tank
5.3 Reservoir
6. Built-up Land
6.1 Urban
6.2 Rural
6.3 Road/Railway

Table 1. Uppar odai sub watershed - Area under Land use and Land cover (In Percent) 2013

SL.NO	LAND USE / LAND COVER	HECTARES	PERCENTAGE
1	Evergreen forest	540.285844	1.038316
2	Deciduous forest	2338.231405	4.49359
3	Rabi only	19297.708538	37.086146
4	Kharif only	1043.576133	2.005534
5	Current fallow	18443.924477	35.445352
6	Scrub/ Degraded forest	10228.756152	19.657523
7	Built- up	142.335046	0.273538
	TOTAL	52034.817595	100

The land use map of Uppar odai sub-watershed adopting the above mentioned classification scheme was prepared. Map shows the distribution and extent of different land utilization units. These units could be interpreted on photographs by studying the pattern, association and variations of the image characteristics of the object in the photographs. The land use classification of Uppar odai sub watershed has been attempted on 1:50,000 scale using FCC. Many objects are inferred and identified by means of logical search and resorting to probabilities by studying and correlating photo-elements and existing knowledge. Major portion of the study area is occupied by agricultural land use. Agricultural lands are distinguished by check-board pattern of fields, which indicates the individual field. Similarly, check-board pattern with wells indicated irrigated croplands. Built-up areas or settlement whether rural or urban are distinguished from density pattern. In this way taking into account the photo-elements, associated features and fieldwork, land use map has been prepared

Conclusions

Assimilating spectral and radiometric properties of image data is more important than spatial resolution in improving computer-assisted land use and land cover classification accuracy. In order to improve mapping accuracies from remotely sensed data, relying on only one approach is not enough. In this study, three approaches, unsupervised, supervised and GIS post processing and their accuracies to extract land use and land cover information using LANDSAT data for 2013 were used. Supervised method shows great potential for dealing with heterogeneous surface features in urban residential areas showing very low difference in the errors of omission and commission. The supervised approach exhibited a lower difference between the user's and producer's accuracies for the vegetation, agricultural field and water classes. The land use types of the area comprises 5.52 % of forest cover (Evergreen and Deciduous),39.08 % of agricultural land (Rabi and Kharif), 35.44 % of current fallow, 19.65 % of Scrub / Degraded forest and 0.27 % of built-up land.

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