DIGITAL LANDUSE CLASSIFICATION IN HIMALAYAN REGION FROM REMOTELY SENSED DATA

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A B S T R A C T

In the present study, Parallellopiped and Minimum Distance classification methods were employed under supervised classification approach, using LANDSAT Computer Compatible Tape (CCT) of March 8,1977 on Multispectral Interactive Data Analysis System (MIDAS), for digital mapping of Landuse classes at 1:25,000 scale in a portion of Northern Himalayan region (INDIA). From the results, it was found that both the methods produce the Landuse maps of nearly same accuracy, however, Parallellopiped method is relatively cheaper as it took nearly half of the computer time than Minimum Distance classification method. The overall Landuse classification and mapping accuracy were also computed which came out to be about 88% and 72% respectively.

INTRODUCTION

The various needs of men make demands upon land and its resources. In order to make optimal use of land resources, it is required to develop a faster methodology, which provides nearly real-time and reliable data about the areal extent of existing Landuse classes. Remote sensing methods can fulfill all the above requirements using either manual or digital interpretation techniques. The latter technique is comparatively faster and generally requires the remotely sensed data on Magnetic Tapes called CCT's which are processed through high speed digital computers (Sharma, Jain & Garg,1984).

Thrower and Senger, 1969, prepared a Landuse map using spacecraft colour photography and they devised a system representing 9 major Landuse classes which could also be interpreted from satellite images . Steiner, D., 1969, presented a methodology for automatic photo-interpretation of rural Landuse types from aerial photographs using discriminent analysis. Before launching of LANDSAT-1, Anderson et.al. 1972, recommended a standard set of Landuse classes for use with remotely sensed data, which has very widely been applied with some minor modification (Anderson et.al. 1976) on the basis of LANDSAT-1 experience.

GEOIDENTITY OF THE AREA

The area of study, in an areal of nearly 8.4×10^3 Sq.Km., is bound by Latitude $20^{o}30'$ to $30^{o}30'$ North and Longitude $77^{o}00'$ to $78^{o}05'$ East approximately, covering the parts of three states viz; Uttar Pradesh, Haryana and Punjab in Himalayan region of Northern India (Fig.1). The Northern part of the study region is considerably undulating with dense forests while Southern and major part is generally flat and consists of cultivated fields, orchards, grass land, habitation, dry river beds and canals. Ganga, Yamuna & Hindon are the major rivers flowing through the area.

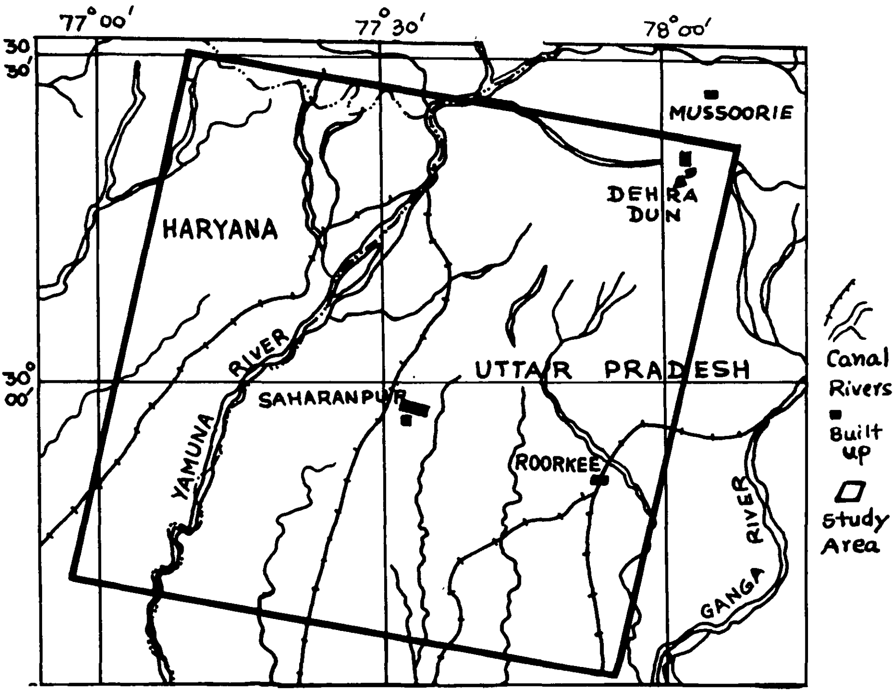

Fig. 1 Index Map of Study Area

MATERIALS AND METHODS

LANDSAT-2, CCT of March 8,1977, was analysed on Multispectral Interactive Data Analysis System (MIDAS) for digital classification & mapping of Landuse classes of the study area. For this purpose, Parallellopiped and Minimum Distance classification methods were employed using Supervised classification approach (Negi, 1983).

Supervised Approach

In this approach training samples are selected to learn the spectral characteristics of the informational Landuse classes. The data analyst in a sense 'supervises' the establishment of the decision boundaries by providing the training samples. It consists of three steps as shown in Fig.2.

Parallellopiped Method

Range of spectral reflectance values (i.e. highest and lowest digital number) for all Landuse classes in each spectral band are defined with the help of training samples. The limits formed by these range values appear as rectangles in 2-dimensional measurement space. Multidimensional analogs of these rectangles are called Parallellopipeds (Fig. 3(a)).

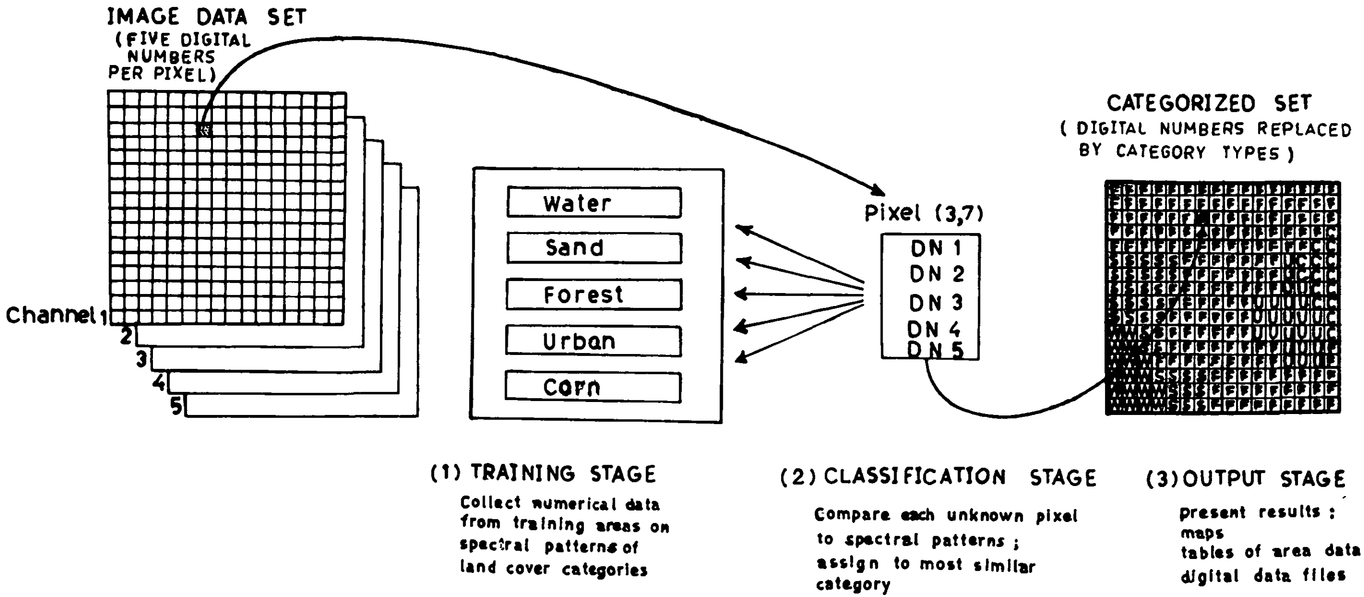

Fig.2. Steps Involved in Supervised Approach

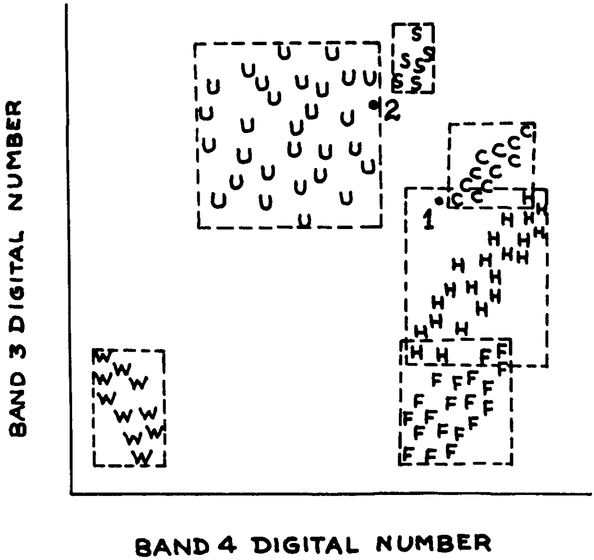

Fig.3(a) Parallellopiped Classification
(2-dimensional feature space)

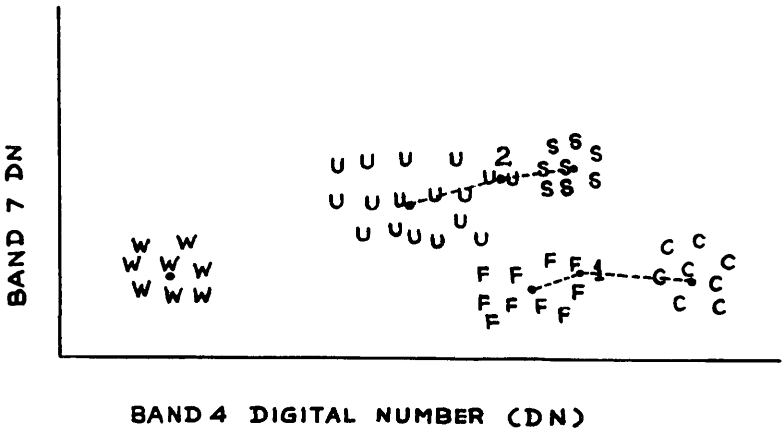

Fig.3(b) Minimum Distance Classification
(2-dimensional feature space)

Minimum Distance Method

In this method, means of the spectral reflectance values for all Landuse classes are computed. The distances of all individual pixels (the visual representation of one spatial sample area is called a pixel) are then determined from the centroids (positions of the mean values in the multidimensional feature space) of all Landuse classes. Each pixel is assigned to that class for which its distance is minimum (Fig. 3(b)).

The Landuse classes, identified from the above methods using CCT on MIDAS, are given in table 1, and the various programmes alongwith their function, used for Landuse classification & mapping are given in table 2 (Negi,1983).

TABLE-1. LANDUSE CLASSES ADOPTED FOR DIGITAL CLASSIFICATION

S.No.	Landuse class	Description
1.	Forest - 1	Dry mixed deciduous dense forest mainly Khair (Acacia Ca techu), Sissoo (Dalbergia Latifolia), Semul (Salmalia Malabarica) and Haldu (Adina Cordifolia).
2.	Forest - 2	Dense forest mainly Sal (Shorea Robusta).
3.	Cultivation - 1	Rabi crop mainly sugar cane.
4.	Cultivation - 2	Rabi crop mainly wheat.
5.	Water - 1	Deep water.
6.	Water - 2	Shallow water.
7.	Soil - 1	Dry sand/soil.
8.	Soil - 2	Wet sand/soil.
9.	Built-up	Built-up mainly 'PAKKA' houses.
10.	Scrub	Scrub.

Accuracy Assessment

From the categorization table (generated by Programme CT), the accepted values of correct classification for each Landuse were selected. Ground visits were also made wherever feasible to collect field test samples, which were compared with the classified map printed by the computer. A confusion matrix was then framed to compute the (i) mapping accuracy of each Landuse class (ii) overall classification accuracy and (iii) overall mapping accuracy of Landuse classes, using respectively the following equations (Negi, 1983) -

$$M_i = (N_i/(N_i + E_i)) \times 100 \qquad (I)$$

$$K = \left(\sum_{i=1}^{n} Ni / \sum_{i=1}^{n} Ti\right) \times 100 \quad \text{and} \qquad (II)$$

$$M = \left(\sum_{i=1}^{n} Pi\,Mi / \sum_{i=1}^{n} Pi\right) \times 100 \qquad (III)$$

where Ni = No. of correctly classified pixels in Landuse class i.

Ei = No. of erroneous pixels in Landuse class i.

$\sum_{i=1}^{n}$ Ti = Total no. of pixels in all classes

Pi = $Ti / \sum_{i=1}^{n} Ti$

Mi = Mapping accuracy of Landuse class i

K = Overall classification accuracy and

M = Overall mapping accuracy.

TABLE-2. VARIOUS PROGRAMMES & THEIR FUNCTION USED ON MIDAS

S.No.	Programme	Function
1.	DSPLAY	display raw data from CCT.
2.	TPDK	transfer a standard or non-standard sector of CCT data to the disk.
3.	DDUMP	generate a Decimal Dump of data on any magnetic tape file.
4.	GRAY	plot the grey map (scale 1:20,000) of the training set areas alongwith the coordinates on Line Printer.
5.	TSET	used for creation, modification and selection of training sets or to obtain a listing.
6.	STAT	compute training sets statistics like mean, variances, covariances and correlation coefficients.
7.	CT	generate a categorization table, giving the the percentage of training sets area classified into correct Landuse classes.
8.	MINPAR/MINDIS	Parallellopiped classification/Minimum Distance classification method-classify the data which can be colour displayed on T.V. screen and stored on Tape.
9.	PRPLT	generate plots of the classified data on 1:25,000 scale.

RESULTS

The area covered under each Landuse class in the area, using Parallellopiped method, has been summarized in table 3. For a part of the area in Roorkee and Dehradun regions, the percentage areal extents of Landuse classes, as obtained using Parallellopiped and Minimum Distance classification methods, have been compared and shown in table 4.

TABLE-3. AREA OF LANDUSE CLASSES FROM PARALLELLOPIPED METHOD

S.No.	Landuse Classes	Area in hectares	% Area	Mapping accuracy %
1.	Forest - 1	38343.1	4.60	77.3
2.	Forest - 2	54275.4	6.50	91.0
3.	Cultivation - 1	241111.6	28.88	95.0
4.	Cultivation - 2	337455.0	40.37	94.1
5.	Water - 1	6812.9	0.81	55.6
6.	Water - 2	14888.0	1.73	50.0
7.	Soil - 1	18045.8	2.2	87.5
8.	Soil - 2	58541.0	7.01	85.0
9.	Built-up	18740.0	2.24	57.8
10.	Scrub	47278.0	5.66	59.0
	Total area	835582.5	100	

TABLE-4 COMPARISON OF AREAL EXTENT (%) OF LANDUSE CLASSES

S.No.		Dehradun		Roorkee	
		Techniques employed			
	Landuse categories	Parallello-piped	Minimum distance	Parallello-piped	Minimum distance
1.	Forest - 1	8.2	11.8	0.5	0.9
2.	Forest - 2	12.2	14.7	1.7	3.3
3.	Cultivation - 1	9.2	7.4	17.7	18.2
4.	Cultivation - 2	24.2	22.6	59.2	58.7
5.	Water - 1	0.7	0.7	0.7	0.7
6.	Water - 2	2.7	3.1	0.8	0.8
7.	Soil - 1	0.0	0.0	2.6	2.3
8.	Soil - 2	3.9	3.0	6.9	4.8
9.	Built-up	10.1	8.4	3.7	3.3
10.	Scrub	28.8	28.3	6.2	7.0

From the confusion matrix framed above, it was computed that the (i) mapping accuracy of all the Landuse classes ranges between 95-50% (Table 3, column 5) (ii) overall classification accuracy is 88% and (iii) overall mapping accuracy is 72%.

CONCLUSIONS

It is concluded that although the approaches in both the methods are slightly different but the results (Table 4) show that (i) a very close agreement exists for most of the Landuse classes with a maximum difference of 3.6% in case of Forest-1 class and (ii) both the methods produce the Landuse map with nearly same accuracy.

In order to compare the economics of the parallellopiped and Minimum Distance classification methods, an analysis of time & cost study was made and it was found that the cost per sq.km. is nearly Rs.0.70 and Rs.0.80 respectively, indicating that the former method is relatively cheaper as the time required in processing the data is nearly half of the time required by the latter method.

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