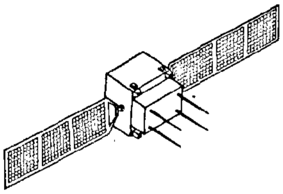

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IRS-1A Applications in Forestry

N. V. Madhavan Unni, P. S. Roy, R. N. Jadhav, A. K. Tiwari, S. Sudhakar, B. K. Ranganath and S. L. Dabral

Abstract: *Application of IRS data in forest type mapping, monitoring changes, habitat assessment and biomass estimation has been discussed. Feasibility of the operational use of IRS-1A data and the need for the development of techniques to meet certain problems of immediate concern are indicated.*

Introduction

Space technology, through satellite remote sensing, has found a very valuable application in forest management, not only for resource surveys, but also for studying the role of forests in maintaining ecological balances and elucidating their impact on global climate[1]. Studies carried out so far through satellite remote sensing contributed to the various aspects of forest management, such as forest cover mapping and monitoring changes; evaluation of ecosystems, wild-life habitats and watersheds; estimation of biomass, carbon flux and productivity, and the feasibility of developing an integrated information system[2].

Special features of IRS-1A of significance to forestry studies

Theoretically, the Linear Imaging Self Scanning Sensors I & II (LISS-I & II) with Charge Coupled Devices (CCD) and the push-broom scanning mode of IRS-1A is an improvement over the Landsat sensor systems. Improved geometric accuracy, ensured by the push-broom scanning, and improved radiometry provided by the relatively longer dwell time in case of IRS, in comparison to Landsat, have special significance in forestry applications. While the former reduces the locational errors, the latter will help in delineating the subtle differences in forest cover. The equator crossing time of IRS-1A being slightly later than the other satellites, the shadow effect is slightly reduced, which has a definite advantage in the delineation of forests, especially in mountain regions. This will also reduce the effect of the shadow of features (trees) on their pixel values and hence becoming radiometrically purer.

Data evaluation

Fundamental to any study using IRS data is the evaluation and understanding of its capabilities. In one such study covering a part of Doon Valley, the results derived from Landsat MSS, TM, SPOT and IRS data were found comparable in their content. Analytical methods like orthogonal data compression of the four bands data have revealed that most of the vegetation information can be obtained when band 4 data is used either with band 2 or 3 data; the latter two having a high correlation between themselves. However, separation of vegetation into conifer and non-conifer types is maximum in band 1. This study has also brought out that the spectral signatures of features using LISS-II data are as good as that of MSS and TM and better than that of SPOT. The incorporation of middle infrared band of TM with LISS-II bands has resulted in a drastic improvement in the separation of spectral signatures of vegetation types.

Studies on correlation between the vegetation parameters and LISS-II spectral bands for an area in Middle Andaman have revealed that band 3 data has a positive correlation with forest density, whereas band 1 data has a negative relationship with the basal area, leaf area index and stand volume. The band 4 data has shown a negative relationship with sunfleck, a measure of canopy gap of forests. These results present a possibility that IRS-1A data could be used for developing spectral models for estimation of quantitative vegetation parameters.

Forest type mapping

Forest mapping has been carried out on 1:250,000 scale with LISS-I data and on 1:50,000 with LISS-II data. Broad categories of forest types could be stratified using LISS-I data in Chandaka Wild Life Sanctuary (Orissa) with a mapping accuracy as high as 83 per cent, but it dropped considerably when further stratification was attempted in the moist deciduous forests and bamboo brakes, two predominant features of the area.

In a comprehensive study under IRS data utilisation programme[4], LISS-II images were interpreted to delineate broad forest types, and stratification of two to three categories was achieved on the basis of density. Overlaying forest compartment boundaries through digital techniques on geometrically corrected images in the form of raw data, digitally classified data, or data subjected to vegetation index ratios (IR–R/IR+R) provide valuable stock information, making it very useful for practical field forestry (Figures 1a & 1b).

Vegetation formations in Western Himalayas have been classified and delineated through digital analysis of LISS-II data which showed 85 per cent accuracy[6,7]. Although transformed divergence matrix analysis indicated good spectral separability for forest types, the separability of grass, shrub/scrub and terrace cultivation was not satisfactory. Digital classification using data of four bands of LISS-II along with data of vegetation index (band 4–band 3/band 4 + band 3) has brought out four canopy closure classes in Aglar Watershed[7].

Monitoring changes

The repetitivity of coverage of IRS-1A, as in other satellites, enables monitoring of the changes. Study of multidate images has enabled monitoring forest clear felling, encroachment and also the progress of afforestation in different parts of India[5]. This capability can be profitably used for developing a computerised Geographical Information System (GIS) with a forestry information base to which periodical changes could be incorporated in an unbiased and automated way.

As a part of the study to monitor Narmada Valley and environs from 1972 to 1989, a false colour composite of LISS-I imagery of 1989 was prepared and the submergible areas of two projects, viz. Sardar Sarovar in Gujarat and Indira Sagar in Madhya Pradesh were interpreted. The study revealed that a little forest area exists in the project area of Sardar Sarovar, whereas a considerable area of good forest will be lost in Indira Sagar area if the project is taken up as proposed[4].

Figure 1(a). FCC imagery of IRS-1A LISS-II overlayed with compartment boundaries for an area in Melghat forest division.

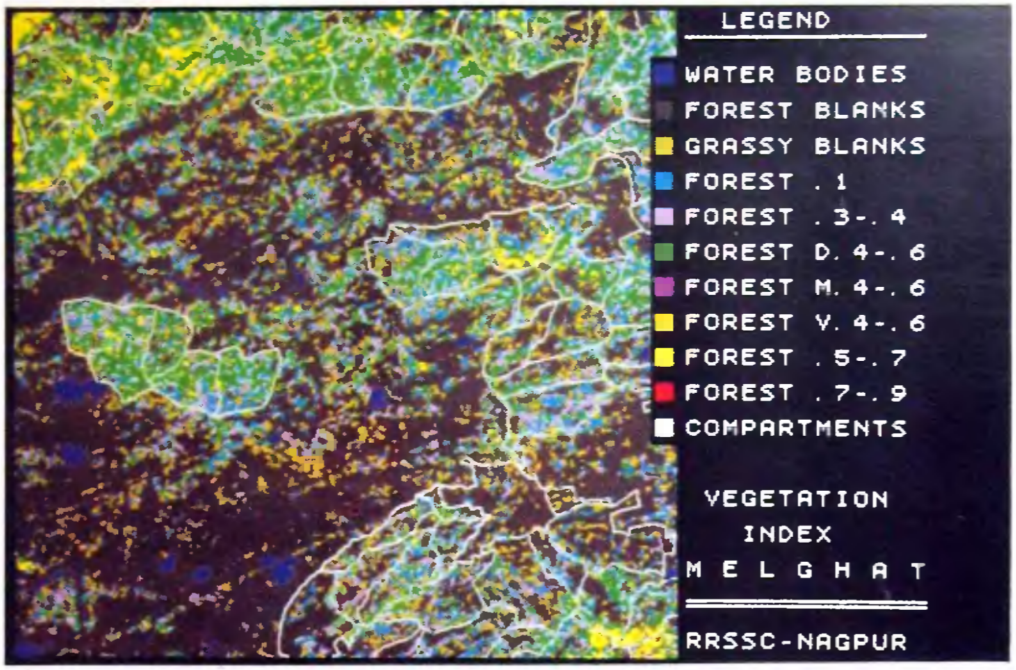

Figure 1(b). Normalised difference vegetation index showing canopy closure classes of forest in a part of Melghat divisions.

In one of the studies using digital analysis techniques for forest cover monitoring in Western Himalaya, geometric rectification for one to one registration of LISS-I data of April 1989 with Landsat MSS data of March 1983 was done. Then the balancing of radiometric values of both sets of data was effected through the regression method. Further, normalised difference vegetation index (NDVI) values were generated for the both and subtracted. The difference image was further used for generating a change matrix. The study indicated that the net depletion of forest during the period has been 2.96 per cent.

Habitat assessment

Total conversion of wild-land into agricultural land as well as its degradation due to other anthropogenic interferences devalue the wildlife habitats. The signs of this degradation has been brought out in Chandaka Wild Life Sanctuary near Bhubaneswar (Orissa) which was once a corridor for the movement of elephants.

Urbanisation in Bhubaneswar has brought in very serious changes in the vegetation type in this area, affecting the wildlife activities (Figure 2).

Inventory of forest biomass

Modelling biomass using spectral responses from vegetation has been attempted by a few in order to develop a quick and pervasive method of understanding global changes[8,9]. Application of IRS LISS-I data in such studies has been reported for Rajaji National Park and for a part of Sonbhadra district (Uttar Pradesh)[10]. The method essentially involved stratification of vegetation using its spectral properties, computation of mean biomass using weighted averages or allometric equations for each stratum

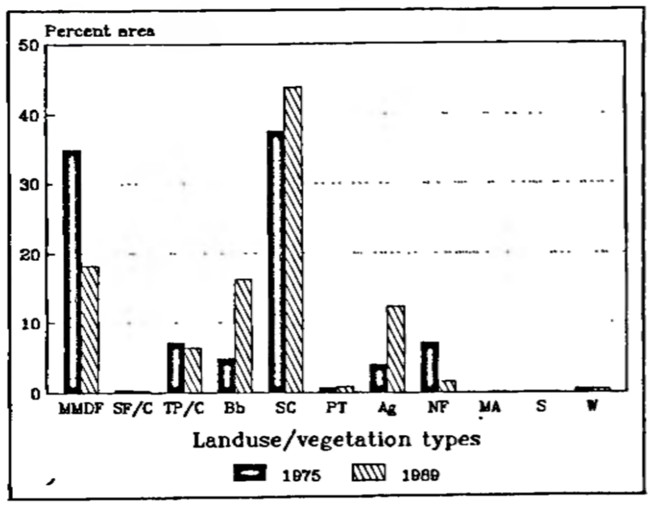

Figure 2. Assessment of changes in vegetation/land use types between 1975 and 1989 in Chandaka Wildlife Sanctuary (Orissa), using aerial photomap of 1975 and IRS-1A LISS-II imagery of 1989 in MMDF – Mixed moist deciduous forest; SF/C-Sal forest/Coppice; TP/C-Teak plantations/Coppice; BB-Bamboo, brakes; Sc-Scrub/Shrub/Brushland; PT-other plantations; Ag-Agriculture; NF-Non-forest/Blanks; MA-Mining areas; S-Settlements; W-Waterbodies.

and extending them to their areal extent to obtain total biomass. Biomass has been used as a principal variable to study the carbon dynamics for the forest eco-system of Rajaji National Park. A set of coefficients which relate biomass with flux rates was generated. The study involved estimation of net primary production, net assimilation, total release and net flux of carbon. The significant finding was that 1 km x 1 km of forest in the area sinks 0.188×10^9 gm carbon/year.

Conclusion

The capability to extract fairly accurate information pertaining to relatively homogenous primary forests using IRS data has been well established. There is a scope for developing suitable methodology for stratification of forest types in complex areas.

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NRSA EARTH STATION, SHADNAGAR, HYDERABAD

The first Indian Landsat Earth Station commissioned in 1979 and made operational on January 01, 1980 catered to the needs of the user community familiar with MSS data usage from Landsat 2 & 3 and provided RBV coverage also from Landsat 3. In addition, this station provided AVHRR data reception from NOAA series of satellites. Subsequently the Earth Station Complex has grown, with the establishment of new stations, to the present configuration of three stations meeting the demands of the user community in terms of data availability from Landsat 4 & 5, SPOT, IRS-1A and NOAA series of satellites.

Some of the salient features of the three stations are given below:

	Landsat/SPOT	IRS	Metsat
Frequency of operation	2200-2300 MHz 8025-8400 MHz	2200-2300 MHz 8025-8400 MHz	1650-1750 MHz 2200-2300 MHz
Antenna Size	10.06 m	10.06 m	10.06 m
G/T	(a) 19.6 dB/^{o}K S band (b) 31 dB/^{o}K X band	(a) 19.5 dB/^{o}K S band (b) 30.5 dB/^{o}K X band	(a) 17 dB/^{o}K L band (b) 20 dB/^{o}K S band
Tracking	S & X bands	S & X bands	L & S bands
Raw data archival	14 & 28 Track HDTR's with QL for MSS & SPOT	28 Track HDTR's with QL & Real time system	14 track tape recorder with QL

Source : NRMS Bulletin, **12**, 1990. ISRO HQ, Bangalore.