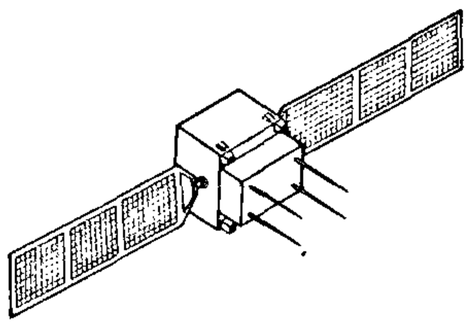

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IRS-1A Applications for Urban Planning

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ABSTRACT: *IRS data has been extensively used in mapping and monitoring urban sprawl, urban land use, transport network zoning and demographic studies. Amongst the case studies presented in this paper, land use mapping of Nagpur city helped detection of unauthorised construction and encroachment of slums and other residential areas onto good agricultural lands. Urban sprawl mapping of Srinagar city reveals onslaught of urbanisation on lacustrine environment. In case of Bhimavaram town, a settlement index (NIR–B/NIR+B) was used to estimate the total population. The accuracy of the results was found to be of the order of 91 per cent.*

INTRODUCTION

The urban or urban dependant population in India is very largely distributed in more than 3000 urban centres which are progressively expanding in size and number. Based on the current urbanisation trend, it is estimated that by 2001 A.D., the number of metropolitan cities will increase to 22 and with the current rise in urban population, to 240 million. As a consequence, haphazard urban growth and encroachment of industrial activities on productive agricultural land cannot be ruled out. Systematic mapping and periodic monitoring of urban land uses are, therefore, necessary for proper planning, management and policy making.

Besides conventional methods, large scale photographs are widely used to extract accurate information for urban planning. The timely acquisition of aerial photographs of desired scale and seasons with regular periodicity is extremely difficult in our country. On the other hand, the major strength of satellite-borne sensor data is its routine, periodic acquisition over the same area. Furthermore, its digital form makes it possible for more objective analysis for mapping and monitoring the changes.

APPLICATIONS FOR URBAN PLANNING

IRS-1A satellite data with its dual resolution (LISS-I: 72.5m and LISS-II: 36.25 m) capability offers both an overview of large areas as well as a detailed in-depth look at comparitively small areas on a contiguous basis with better radiometric sensitivity. The best band-widths suitable for urban feature discrimination are between 0.45 and 0.55 micron (blue region) and 0.69 and 0.80 micron (near infrared region) of the sprectrum, concluded from the spectral reflectance studies using portable spectro- radiometer[1]. These bands correlate with IRS bands 1 and 4.

IRS data has been extensively used so far to map and monitor urban sprawl, urban land use, transport network, urban land use zoning, change detection and urban demographic studies by NRSA, SAC, IIRS, RRSSCs and State Remote Sensing Centres for different user organisations involved in urban planning. Some of the studies are discussed in the following sections.

URBAN LAND USE MAPPING

Nagpur city has been mapped for urban land use with the participation of Nagpur Improvement Trust. The data used is IRS-1A LISS-II (Path 23, Row 53) of 19th May 1988. The interactive digital image processing system at RRSSC, Nagpur has been used for data enhancement. Of the four spectral bands available, the FCC with a combination of 1, 3 and 4 bands is found effective for delineating the urban land use units. Edge enhancement using Laplacian

Figure 1. Urban land use map of Nagpur city.

filter is performed on individual bands of 1, 3 and 4, and the resultant output images were used for generating an edge enhanced FCC which is deblurred and edges sharpened. Visual interpretation techniques were used to delineate the urban land use boundaries.

Major urban land use categories like residential, industrial, transportation, recreational and vacant land have been demarcated (Figure 1). Public and semi-public utilities were identified with the aid of collateral data. Under commercial land use category, only Agricultural Produce Marketing Complex (APMC), which is an isolated big structure, was delineated.

Residential category has been further delineated as dense, moderate, sparse and with tree cover. Row type housing colonies and slums have been isolated. The boundaries of garden and stadia were clear.

Urban sprawl studies

IRS satellite data has been used along with that of Landsat TM, SPOT, PLA & MLA data and Survey of India toposheets to monitor urban sprawl and change detection. A recent study completed by NRSA for the Madras metropolitan area has clearly shown an increase of built-up area from 235 sq. km (20%) to 491 sq. km (42%) and a decrease of agricultural land from 791 sq. km (67%) to 488 sq. km (41.8%) between 1974 and 1988. Similarly, the urban sprawl of Srinagar city mapped by visual interpretation clearly depicted its overall development, particularly the encroachment of built-up along the margins of Dal lake between 1968 and 1988 (Figure 2).

Urban demographic studies

IRS spectral bands 1 (blue) and 4 (near infrared) were used to develop a 'Settlement Index' (NIR-blue/NIR+blue) to discriminate the built-up areas from vegetative cover in the town. The population of Bhimavaram town of Andhra Pradesh is estimated at 77,000 (1988) based on Settlement Index values

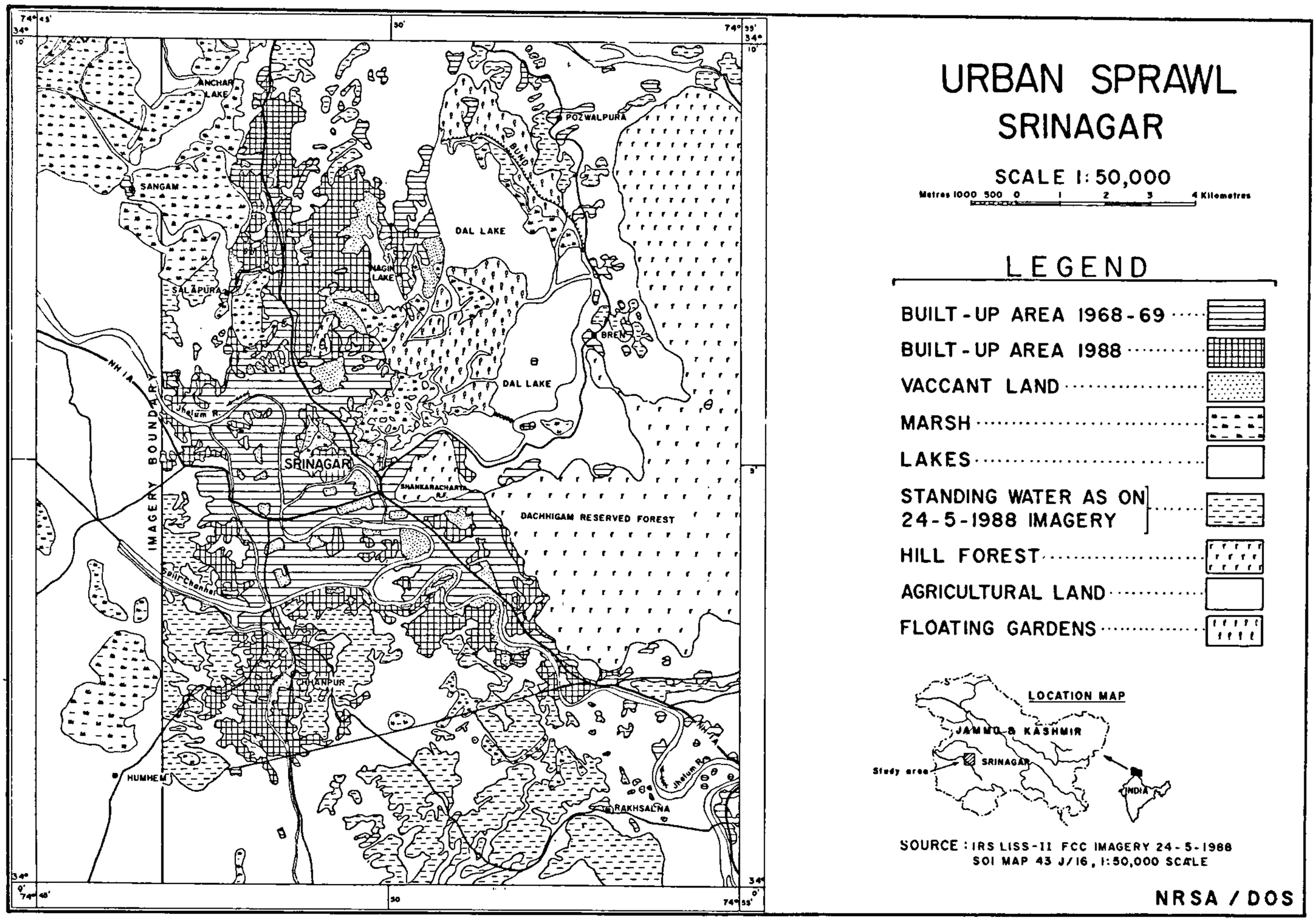

Figure 2. Urban sprawl – Srinagar city.

against a reported population of 85,000 (1990 census) with an error of 9 per cent[2].

Urban Land Use zoning

Spatial data analysis techniques have been used by SAC in urban land use zonation by utilising IRS data for the generation of thematic maps like land use, urban sprawl, flooding hazard, geomorphology, groundwater potential, erosion and integrating them with collateral data, like transport network, soil depth, soil texture, slope and population with the aid of Geographic Information Systems for Delhi and Bombay Metropolitan regions. Four zones of suitability for urban development, emphasising the limitations of the land to urban activities were demarcated.

Discussion and conclusions

IRS LISS-II data has been found useful to prepare various urban oriented maps on 1:50,000 scale and are comparable with Landsat TM and SPOT MLA data. The spectral responses of most of the man-made features are similar, and pattern recognition techniques using point classifiers are found unsuitable to classify the level-II urban land uses such as residential, industrial, commercial, public and semi-public, etc. Digitally enhanced IRS data gave better contextual relationships between features, aiding better delineation. Edge enhanced band 4 (near infrared) of IRS LISS-II is ideal for delineating transport network. IRS LISS-II data, when merged with higher spatial resolution satellite data like SPOT PLA, increased the interpretability of urban features upto level-II with high confidence and level-III with the help of ground data. High resolution, edge enhanced colour composite generated by merging IRS LISS-II bands 3 and 4 with SPOT PLA covering part of Nagpur city clearly depicts the new layouts and encroachments onto notified areas like green belts (Figure 3).

IRS data has been found effective for the generation of different inputs for urban planning, like urban land use, urban sprawl, population, location of existing and new quarry sites for building material, encroachment of residential and slums onto

Figure 3. High resolution edge ennanced colour composite – part of Nagpur city.

agricultural and other notified areas, existing city transportation network and proposing new and alternate ring road alignments and site suitability for the development of new townships. Different thematic files extracted from IRS data and integrated with collateral data in GIS framework are found useful for calculating weighted indices in applications, like land capability analysis, siting analysis, environmental sensitivity analysis and suitability analysis. Temporal studies using IRS data will help in monitoring implementation of the proposed development plan and identifying the deviations.

The future IRS-1C satellite with a better spatial resolution data of 10 m and 23 m are promising for applications in urban planning. Contextual and syntactic algorithms and an expert systems approach will aid in better automated extraction of urban related information with high confidence.

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REFERENCES

1. Subudhi, A. P. and Debajit Mishra, Study of spectral reflectance characteristics of an urban environment – Case study of Kanpur city, *Photonirvachak*, 1989, **17**, (3).
2. Ramani, Census from space – A case study of Bhimavaram town, *Unpublished Tech. Rep.* 1991, NRSA, Hyderabad.