

IRS-1A Application for Wasteland Mapping

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ABSTRACT: *The advent of remote sensing has provided a major technological breakthrough in the method of acquiring information on wastelands. The mapping of wastelands in India on 1:1 million scale with the help of Landsat MSS data revealed that an area of 53.3 Mha (16.21 per cent of the total geographical area) fall under various wasteland categories. Based on these results, the second phase of wasteland mapping project of 84 critically affected districts in various states in the country has been initiated with the help of IRS-1A LISS-II geocoded data. The project is taken up under the National Remote Sensing Agency of the Department of Space at the instance of the National Wasteland Development Board. Outlining the classification system and the methodology, it is concluded that the spatial information on wasteland at a village level can be utilised for various reclamation measures and subsequent use under social forestry, agro-forestry, fuel and fodder farm forestry and afforestation programmes.*

INTRODUCTION

National Wastelands Development Board, Ministry of Environment and Forests, Govt. of India described wasteland as, "degraded land which can be brought under vegetative cover, with reasonable effort, and which is currently under-utilised, and land which is deteriorating for lack of appropriate water and soil management or on account of natural causes"¹. Wastelands are known to result from inherent or imposed disabilities related to location, environment, or soil, as well as financial and management constraints. With increasing human and animal pressure on land, the production of vegetation for food and other uses has extended to areas under great ecological stress and less favourable environment, leading to accelerated soil erosion and excessive land degradation. Vast stretches of land have thus been transformed into wasteland owing to desertification, soil salinity, waterlogging, excessive soil erosion, etc.

In India, there is an urgent need to reverse this trend and restore the wastelands to their production potential in order to meet the demands of increasing population and other developmental activities.

Although several agencies have estimated the total

extent of wastelands, their figures vary considerably. Their definitions of wastelands were equally variable. Reliable information on location, nature and extent of the different wastelands on a large scale is essential for launching a programme on wasteland development.

IRS-1A DATA FOR WASTELAND MAPPING

The advent of remote sensing has provided a major technological breakthrough in the method of acquiring information on wastelands and other natural resources. Remote sensing from space with its unique characteristics of synoptic view, repetitive coverage and reliability has opened immense possibilities for resource mapping and monitoring, resource targeting and management to achieve optimisation in resource utilisation and conservation.

The early experience of wasteland mapping in India using remote sensing techniques was through the use of Landsat data. Maps showing different categories of wastelands in India, based on visual interpretation of Landsat MSS false colour composite (FCC) diapositives on 1:1 million scale have been prepared by the National Remote Sensing Agency (NRSA) of the Department of Space². A

consolidated wasteland map of India on 1:3.5 million scale has also been compiled from the 1:1 million scale maps. The total area under wastelands in India was estimated to be 53.3 million ha which is 16.21 per cent of its total geographical area. Based on 1:1 million scale maps, 146 critically affected districts (with more than 15% area under wastelands) have been selected for detailed mapping of wasteland using Landsat TM FCC imagery on 1:50,000 scale. The FCC of TM bands 2, 3 and 4 (with wavelengths of 0.52 – 0.60 μm , 0.63 – 0.69 μm and 0.76 – 0.90 μm), was found to be ideal for delineation of different wasteland categories.

This exercise of mapping wastelands in 146 critically affected districts has resulted in identifying 23.9 million ha or 20 per cent of India's geographical area.

IRS-1A DATA

The Sensors on Indian Remote Sensing Satellites have four spatial bands similar to the first four bands of Landsat TM. An FCC imagery generated by combining IRS bands 2, 3 and 4 enables the identification of wastelands effectively.

Realising the excellent and useful information obtainable from IRS-1A data, the National Wasteland Development Board has requested the Department of Space to carry out mapping of an additional 84 critically-affected districts in various States in the country which have areas under wasteland ranging between 5 and 15 per cent. Wasteland mapping of these districts using IRS-1A LISS-II geocoded data is in progress.

WASTELAND CLASSIFICATION SYSTEM

A Task Force was identified by the Planning Commission in 1986 to evolve a suitable classification system. The classification system evolved and approved by the Planning Commission comprises of the following categories:

1. Gullied and/or ravinous land.
2. Upland with or without scrub.
3. Water-logged and marshy land.
4. Land affected by salinity/alkalinity (coastal or inland).
5. Shifting cultivation area.
6. Sandy (desert or coastal).
7. Mining/industrial wastelands.
8. Under-utilised/degraded notified forest land.
9. Degraded pastures/grazing land.
10. Degraded land under plantation crops.
11. Barren rocky/stony wastes/sheet-rock areas.
12. Steep-sloping areas.

13. Snowcovered and/or glacial areas.

METHODOLOGY FOR WASTELAND MAPPING

The methodology of wasteland mapping using IRS-1A data is shown in figure 1. IRS-1A geocoded FCC products on 1:50,000 scale generated at NRSA Data Centre are used for visual interpretation. In order to get the optimum spatial information about wasteland, Rabi season data (November to March, when there is maximum vegetation cover) are used. The image characteristics, such as colour, tone, texture, pattern, shape, size, location and association enable one to identify and delineate different types of wastelands. These delineations, however, are tentative and subject to confirmation in the field. Therefore, groundtruth forms a vital input to mapping with remote sensing data. It may be mentioned here that the key for interpretation is subject to changes depending upon the season, scale and resolution of the imagery. In the present study, certain categories of wastelands like salt-affected land, water-logged/marshy land and sandy areas were easily delineated by virtue of their spectral separability, pattern and location, whereas gullied or ravinous land, shifting cultivation, etc., were delineated with moderate success. However, the category of undulating upland with or without scrub, which is widely prevalent throughout the country, could not be easily delineated due to its merging with fallow lands and others having similar spectral reflectance patterns. However, this category was identified and delineated by using multirate imagery as far as possible.

The ancillary data that is used consists of Survey of India topographic maps on 1:50,000 scale. These maps provide not only a base for plotting thematic details of wastelands, interpreted from IRS imagery, but also provide an accurate reference for the land cover, e.g., boundaries of reserved forest, types of forests, gullied area, barren rocky area and agriculture area. However, the thematic information on these maps are outdated, since the surveys were conducted about 10 – 15 years back. Revenue and Census maps obtained from various sources provide information on village boundaries which are transferred to the maps. The final wasteland map is on 1:50,000 scale with the topo base derived from Survey of India topographical map, village boundaries drawn from Revenue and Census maps and spatial limits of different categories of wastelands derived from IRS-1A imagery. Area occupied by each wasteland category is computed using a digital planimeter. The interpretation accuracy has been found to be as high as 85–90 per cent. Here the interpretation accuracy has been calculated by applying the follow-

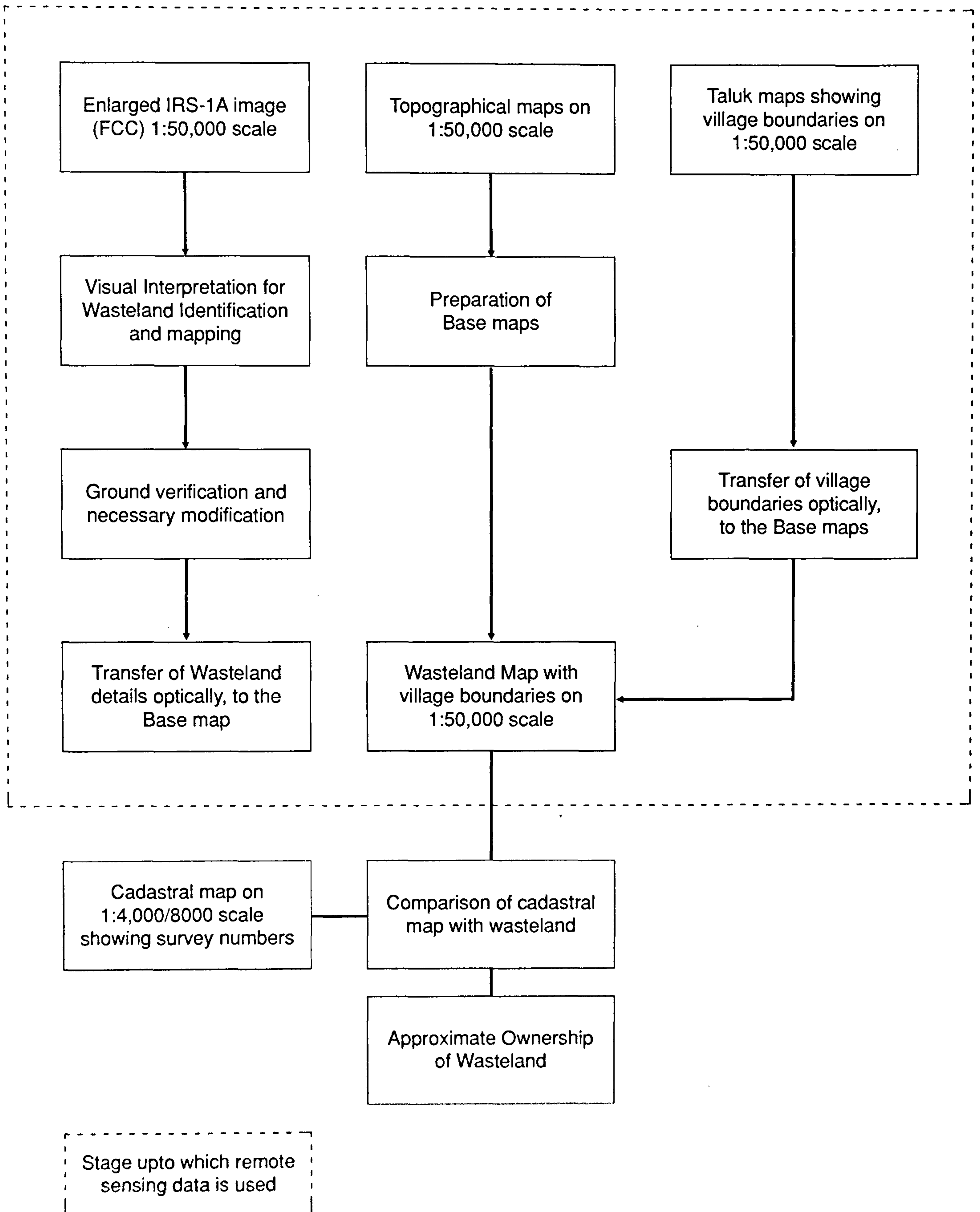


Figure 1: Methodology for Wasteland Mapping

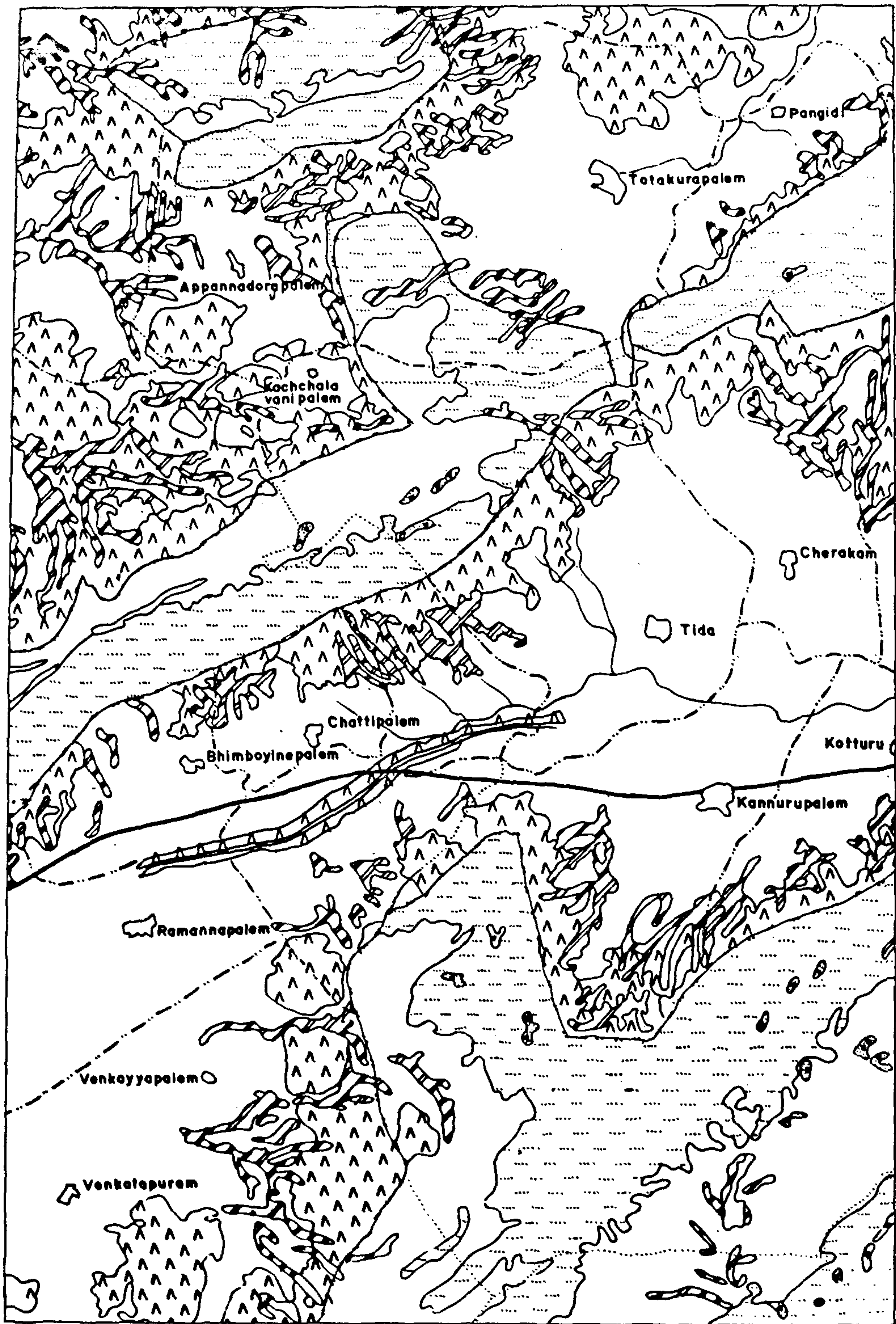


Figure 2. Wasteland map of a part of Vishakapatnam district, A.P.

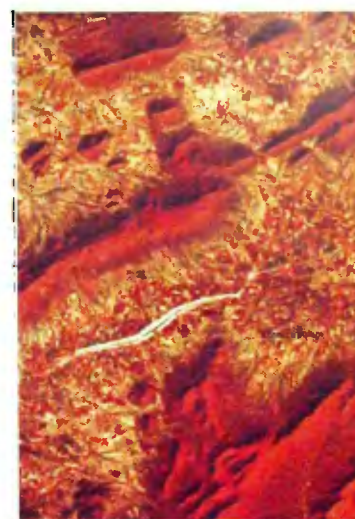
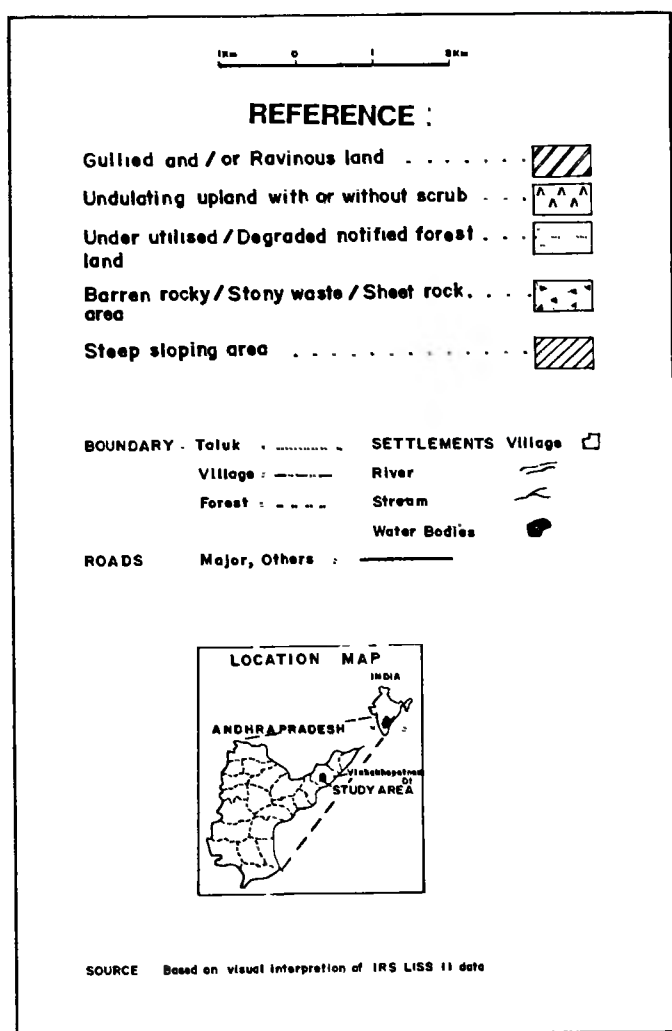


Figure 3. IRS, LISS-II FCC-part of Vishakapatnam district.

CONCLUSIONS

This study demonstrates that the data from Indian remote sensing satellite can be used to map and monitor wastelands rapidly and economically. This provides more consistent and accurate baseline information than many of the conventional surveys employed for such a task. The spatial information on wastelands at the village level can be utilised for various reclamation measures and subsequent use under social forestry, agro-forestry, fuel and fodder farm forestry and afforestation programmes. The technologies developed by CSIR and ICAR laboratories enable reclamation of wastelands for productive use.

REFERENCES

1. Anonymous, Wastelands definition and classification, *Technical Task Group report*, National Wastelands Development Board, Ministry of Forests and Environment, Govt. of India, New Delhi, 1987
2. Anonymous, Mapping of wastelands in India from satellite images, *Project report*, National Remote Sensing Agency, Department of Space, Hyderabad, 1985.
3. Fitzpatrick, Lins, K. and Chambers, M. J., Determination of accuracy and information contents of land use and land cover maps at different scales, *J Rem. Sens. Electromagnetic Spectrum*, 4, 1977, 41.

ing expression³:

$$p \pm \left\{ 1.96 \frac{[p(100 - p)]}{n} \right\} + \frac{50}{n}$$

where, p-desired proportion of estimated accuracy, expressed in per cent, n-minimum number of points (sample size) selected, and 1.96 is a constant (z value, assumed at 5% level of significance) applicable for accuracy estimations of remotely sensed data.

The wasteland map of a part of Vishakapatnam district in Andhra Pradesh and the relevant IRS-1A LISS-II FCC imagery are shown in figures 2 and 3 respectively.