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ABSTRACT

Aerospace remote sensing comes as an indispensable aid in forest management in the later half of twentieth century by providing a synoptic view of our forest resources particularly its location, extent and spatial distribution. With the launching of Landsat series of satellite since 1972, an authentic and reliable database is available to the managing our dwindling forest resources. Scientific forest management came to India in 1860's and forest, which was a state subject, was transferred to the concurrent list in 1976 by the 42nd Amendment of the constitution. The present study was undertaken to prepare the forest map showing area, type, density and to identify the potential sites for afforestation using the IRS 1B LISS II satellite data. The forest area comprises only scanty, xerophytic and widely dispersed vegetation due to the increase in the population and the demand of rural masses in terms of fuel, timber and fodder etc. The major indegenous tree species of the area are *Acacia nilotica, Dalbergia sissoo, Azadirachta indica , Prosopis cineraria etc.*

1.0   INTRODUCTION

India is the second most populous and seventh largest country in the world. It has an area of 32,87,265 sq.km. and its population as per 1991 census is 846.3 million. It has a land frontier of 15,200 km. and its seacoast runs a length of 6100 km. The main land extends from 8°N to 37°N and 68°E to 97°E. it measures 3214km. and 2933km. between extreme latitudes and longitudes. As per 1997 assessment, made by Forest Survey of India based on satellite data interpretation, actual forest cover of India is 63,3397 sq.km. which is 19.25% of the total geographic area of the country. Of this 36,7260 sq.km. (11.17%) is the dense forest (cover crown density - 40% and above), 26,1310 sq.km. (7.94%) is open forest cover (cover density 10% to less than 40%) and 4827 sq.km. (0.14%) is the mangrove area. The forest cover has decreased by 5482 sq.km. in 1997 assessment incomp`arision to the assessment made in 1995 (FSI-1996,1998). An area of 721 sq.km. of tea gardens earlier shown as forest cover has been excluded from forest cover. (FSI-1995,1996,1998). The actual forest cover of Haryana State accounts for 604 sq.km. which is 1.4% of the total geographical area (44212 sq.km.) (FSI , 1998). The present project on Mapping of Forests in Haryana State using Satellite Remote Sensing technique is being undertaken using IRS 1B LISS II FCC

Diapositive satellite data and Survey of India topographical maps in delineating the Reserve forest areas , Block Plantation, Potential sites for afforestation and Waterbodies.

2.0 AIMS AND OBJECTIVE

Mapping of forests in Kurukshetra District of Haryana State using Satellite remote sensing techniques was undertaken to prepare the forest map showing area , type and to identify potential area sites for afforestation purpose.

3.0 REVIEW OF LITERATURE

Satellite remote sensing has played a key role in providing information about forest cover, vegetation type and their changes on a regional scale. One of the major application of remotely sensed data obtained from Earth-Orbiting satellite is change detection because of repetitive coverage at short intervals (Nelson, 1983). Monitoring of changes in the forest cover has been quite important because of its significant impact on climatic change. A study was carried out using Landsat MSS data to monitor the conversion of vegetation cover into categories of different canopy cover in tropical Indian forest region which has undergone very rapid industrialization during 1982 to 1989 (Jha and Unni, 1994).

Relevance of Satellite Remote Sensing

The first major project operational application of Satellite remote sensing in India was the nationwide forest cover mapping (NRSA 1983). This project was taken up in 1982 to map the closed and open /degraded forests of the whole country and monitor them using temporal Landsat Multispectral scanner (MSS) data pertaining to 1975-77 and 1980-82 period on 1:1 million scale. This project was completed in September 1983 and declared operational in the beginning of 1984. The result showed large scale deforestation and forest degradation in the country. This exercise acclaimed national appreciation and dispelled the fears and doubts in the mind of resource managers who were till than not convinced with this new technology. This work helped remote sensing to achieve the operational status from wither to experimentation alone. This project is credited for the preparation of the first forest map of India. The technical know how has been transferred to Forest Survey of India, Dehradun for the follow up action.

The Forest Survey of India has taken up biennial forest monitoring task on 1:250,000 scale for the entire country on a routine basis. Additionally forest areas undergoing rapid changes, for example those affected by shifting cultivation are being monitored annually on 1:50,000 scale The aim of this exercise is to keep a watch on the dynamics of forest change with time. (FSI, 1995, 1996,1998). Now, with the availability of IRS-1D/P3 data improved information on forest stock mapping, biomass estimation studies, monitoring of strip plantation tree fell of areas and vegetation index mapping will be carried out.

Vegetation mapping using interpretation of satellite remote sensing data provides qualitative characteristics of vegetation and can be adjusted to the requirements/objectives of the survey (Kuchler, 1988a, 1988b). It has been observed that topographical data would help in detailed classification of vegetation types which are controlled by altitude and aspect. William and Nelson (1986) have discussed use of remotely sensed data for assessing forest stand conditions in eastern United States. Structural variations in plant communities modulates spectral signatures, thus remote sensing data give basis to describing qualitative characters of community structure (Thomas et al., 1993).

4.0   STUDY   AREA

Location and Area

The Kurukshetra district lies between $29° 54'30"$ and $30°15'10"$ North latitude and $76° 27' 0"$ and $77°7'0"$ East longitude . On its north lies the district of Ambala and Patiala district of Punjab state. Patiala district boundary is extended upto the north west. To its west and south west is the district of Jind, Karnal district lies on its south and south east. Yamuna river makes the eastern boundary of the district and across the river lies the Saharanpur district of Uttar Pradesh state. The total area of the district is 1217 00 hectares. The district head quarters is located at Kurukshetra. It is represented by in the part of Survey of India topographical maps 53B, 53C, 53F and 53G on 1:250,000 scale. The average annual rainfall 568 mm (Fig. 1)

On the whole the district is a plain which slopes from north-east to south and south-west. The plain is remarkably flat and within it are the narrow low-lying flood plains, known as either Bet or Khadar or Naili. The old alluvium lying between Khadar of the Yamuna river and the Naili and Bet of the northern rivers (Markanda, Ghaggar) is known as Bhangar in the district .Yamuna is the perennial river which makes the eastern boundary of the district Ghaggar (Rig vedic Sarasvati) and Markanda and are the important rivers of the district. A good net work of canals providing the Irrigational facilities.

5.0   MATERIALS AND METHODS

The following materials are used for mapping of forests in Kurukshetra division:

DETAILS OF SATELLITE DATA

Sl.No	Satellite	Sensor	Data product	Date Path/Row	Scale
1.	IRS IB	LISS II	FCC covering toposheets 53B/ 8,12,16	25.10.92	1:50,000

<table>
<tr><td></td><td></td><td></td><td></td><td>53C/5,9,13
53F/4
53G/1</td><td></td></tr>
<tr><td>2.</td><td>IRS IB</td><td>LISS II</td><td>Diapositive</td><td>1.5.92
P029-R46</td><td>1:1
million</td></tr>
<tr><td>3.</td><td>IRS 1B</td><td>LISS II</td><td>Diapositive</td><td>2.5.92
P030-R46</td><td>1:1
million</td></tr>
</table>

5.1 Other ancillary data and Instruments used :

• Survey of India topographical maps on 1:50,000 scale. (Fig. 2 & 3)

  53B/ 8,12,16
  53C/5,9,13
  53F/4
  53G/1

• Ground truth data collected during field work in two periods
  i,e October-November, 1992 and April - May 1992.
• Statistical report (Government of Haryana) Chandigarh.
• Forest Stock and Location Maps with Forest division and their range boundaries
  supplied by forest department, Haryana

♦ **Instruments used:**

  • Procom-2
  • Light table
  • Dynascan

5.2 Methodology

Forest mapping was completed in the following steps :

i. **Base map preparation:** Base maps were prepared using Survey of India topographical maps on 1:50,000 scale showing permanent features such as roads, railway line, canals, village boundaries, and bunds etc.

ii. **Visual Interpretation of data:** The preliminary interpretation of satellite data of IRS-1A/1B LISS-II October - November 1992 (FCC) on 1:50,000 scale and Diapositive satellite data of IRS-IB LISS-II May 1992 on 1:1 million scale was also used in this regard to delineate water logged areas and scrub plantations which were present in satellite imagery of October-November, 1992 clear forest and block plantations were interpreted and marked correctly. This was done by visual interpretation technique based on Image characteristics such as colour,

texture,tone,pattern, size, shape and association etc. following broad cover types were delineated:

Reserve forest areas (closed forest, degraded forest/blank), Block plantation, Strip plantation, Degraded Block Plantation, Scrub land and Grazing land/Degraded Pasture.

iii. **Ground truth data collection:** Field checks estimation were conducted to verify the classification for this study having doubtful and confusing signatures , interpreted images, working sheets and Survey of India topographical maps was carried out to the field and necessary corrections were made by incorporating the details on the spot. The officials of the forest department were also consulted during the above study.

iv. **Final map preparation:** The information regarding different categories of potential areas and existing status of forest as delineated and mapped were transferred onto the base map on 1:50,000 scale.

v. **Area calculation:** The areas of different classes was calculated by using dot grid method.

6.0 RESULTS

Mapping of forest in Kurukshetra district by using Satellite Remote Sensing techniques, it has been found that there are very less forests in this district. The reserve forest area accounts for 1324 hectares which is 1.087 % of the total geographical area of the district where as the total forest cover which includes reserve forest areas, degraded forest/blank ,strip plantations and block plantations accounts for - 8567 hectares which is 7.03 % of the total geographical area of the state. (Table I). On the basis of different classes adopted for mapping of forest and other areas related to potential sites for afforestation schemes etc. and the areas calculated by dot grid method are listed as follows:

6.1 EXISTING FOREST LAND

As per the classification adopted by United Nations Educational Scientific and Cultural Organisation (UNESCO-1973) which is based on the crown cover or cover density, the reserve forests have been categorized under the following broad heads on the basis of their canopy cover with respect to the ground area exposed under beneath. The said classification as such been adopted by Forest Survey of India (Ministry of Environment & Forests-Govt. of India) Dehradun:

i. **Closed Forest:** It is an area with in the notified forest boundaries where the vegetation density (crown cover) is 40% or above which accounts for 1324 hectares. In this category plants belonging to species *Morus alba, Butea monosperma, Syzium cummini, Dalbergia sissoo, Eucalyptus sp., Prosopis*

Block Plantation	7144
Degraded Block Plantation	400

B. POTENTIAL SITES FOR AFFORESTATION

Scrub Land	7900
Grazing land/ Degraded Pasture	720

6.2 POTENTIAL SITES FOR AFFORESTATION

i. **Scrub lands**: These lands are mostly occupied by relatively higher topography like uplands or high grounds with or without scrub in open land, near agricultural fields, near roads, canals and river.. This category accounts for 7900 hectares. and mostly having plant species of *Acacia sp.*, *Prosopis specigera* etc. and *Ziziphus* sp.

ii. **Grazing land/Degraded pasture** : Which accounts for 720 hectares which is the maximum in all the classes mapped. They are mostly present surrounding the villages, Mostly species of *Acacia sp. and Prosopis sp.* are present. This area is recommended for potential site for afforestation plan by the forest department also.

7.0 DISCUSSION

On the basis of data supplied by the Department of Forest (Govt. of Haryana). The reserve forest area is 1400 hectares while in our study by using satellite remote sensing technique the reseve forest area comes to 1324 hectares which is 1.15 percentage and 1.08 percentage to the geographical area of the district respectively. While the total forest cover which includes reserve forest areas, strip plantations, and block plantations which accounts for 8567 which is 7.03 percentage to the total geographical area of the district. The forest blank areas within the reserve forest boundary are due to non germination of the seeds of the plants. but the measures are being taken by the forest department to plant species belonging to *Acacia, Dalbergia sissoo and Prosopis juliflora* etc.

The major indigenous tree species of the area are Kikar *(Acacia nilotica)*, Shisham *(Dalbergia sissoo)*, Neem *(Azadiracta indica)*, Jandi *(Prosopis cineraria)*, Beri *(Zizyphus jujuba)*, Jal *(Salvadora oleoides)*, Jamun *(Syzygium cumini)*, Siris *(Albizzia lebbeck)*, Bakam *(Melia azadiracta)* and Rohru *(Tecomella undulata)* etc. The prominent exotic species planted are *Prosopis juliflora, Eucalyptus* sp., *Populus* sp., *Acacia tortilis,* and *Ailanthus* sp., Besides, there are innumerable associated as well as scattered species etc.The forest area in Kurukshetra division comprises only scanty, xerophytic and widely dispersed vegetation, due to increase in population and the demand of rural masses in terms of fuel,timber, fodder etc. The existing vegetation has degraded to large extent. The adverse environmental factors also create the problem of seedling establishment and plantation. As, the result of this the seedling mortality is high and forest area is less despite the best efforts of the state forest department. Due to over exploitation of trees,

juliflora, Azadiracta indica , Acaica sp., Dhak, Arjun, Guava and Papri etc. There are 9 **Reserve forest** areas are as follows:-

(i) Nikatpura (ii) Sonthi (iii) Bir Barason (iv) Bakhli (v) Helwa (vi) Ramgarh (vii) Seonsar (viii) Bir Sujra (ix) Bhilai

ii. **Degraded Forest/Blank:** It is an area within the notified forest boundary where the vegetation density (crown cover) is below 10%. While in forest blank areas are also in the notified forest boundary without any tree cover (generally barren rocks, stony waste etc.). This category accounts for 57 hectares.

iii. **Block Plantation :** It is an area of man-made and or naturally growing trees of forestry as well as social importance raised/grown on other than notified forest lands, which accounts for 7144 hectares and mostly present near agricultural land, open field, near roads etc.The most common species of plants present are *Acacia sp. Dalbergia sissoo, Prosopis specigera, Eucalyptus sp. Mangifera indica, Psidium guyava, Populus sp.* and *Syzgium cumini.*

iv. **Strip Plantation:** Strip plantation are mostly present on the banks of canals, roads, railway lines and at times on the boundary demarcation of agricultural fields etc. They are not easily interpreted on satellite imagery/diapositive have been included in the final report directly as per data supplied by forest department, Haryana. For this reason they account for 42 hectares. In this category, plants present mostly are *Eucalyptus sp, Dalbergia sissoo, Acacia sp., Prosopis sp.* and *Populus sp.*

vii. **Degraded Block Plantation:** These areas are mostly present within the block plantation. These areas are mostly blank either due to unfavourable soil conditions for plant growth, forest fire or hard rocky surface etc. They can be recommended for potential sites for afforestation schemes. Their areas accounts for 400 hectares.

TABLE – I

DISTRIBUTION OF DIFFERENT MAPPED CLASSES AND THEIR AREA

S.No.	Class	Area in hectares
A.	**EXISTING FOREST LAND**	
	Closed forest	**1324**
	Degraded forest/blank	**57**
	Strip Plantation	42

the region has been facing the shortage of fuel, fodder and timber with the coming of World Bank aided social forestry project in the state of Haryana, a large number of villages woodcuts and large scale plantations in farm forestry sector has taken place. The main objectives of this program is to meet the fuel and small timber requirements of the population, to develop forestry as a support to rural economy, to increase the production from forestry section and thus to optimize the use of land. Forests in Haryana are in very small patches or along the canals, roads, railway lines network. The estimates made in present study are close to the estimates available with Department of Forest, Govt. of Haryana, who has classified forests only as per administrative classification. The Satellite picture also included tree plantation on private lands and village community lands also .

Awareness of rural masses for the trees and economic gains from the tree have encouraged the farmers to take up agro-forestry practices. In agro-forestry, crops are grown along with the trees. The trees have been planted either all along the farm boundaries or with in the fields. The most common tree species planted for this purpose are *Eucalyptus* and *Populus*. The cutting of *Prosopis sp.* is considered as anti-religious by the farmers. It is reared by farmers and is extensively grown in the farm lands pastures or other arable crops. *Prosopis sp.* has no effect on the crop yield and in arid region it enhances the yield of the crop growing near it by conserving moisture and nutrient.

It is not easy to interpret and put the compartment boundary within the Saraswati plantations reserve forest areas by using IRS-1B LISS-II satellite data but the visual interpretation of the satellite data of the complete reserve forest areas has been done and their areas have been calculated respectively. But now, with the availibility of IRS 1C /1D data information on forest mapping and its application on vegetation index mapping, biomass estimation, preparation of forest stock maps, compartment boundaries etc. could be carried out by using merged product of LISS-III and PAN of the above IRS 1C/1D satellite data. Although, mapping on 1:50,000 scale are quite encouraging, but it is felt that full potential for mapping forest plantation in Haryana State can only be realised on 1:25,000 scale using operational Satellite data of IRS-1C/1D.

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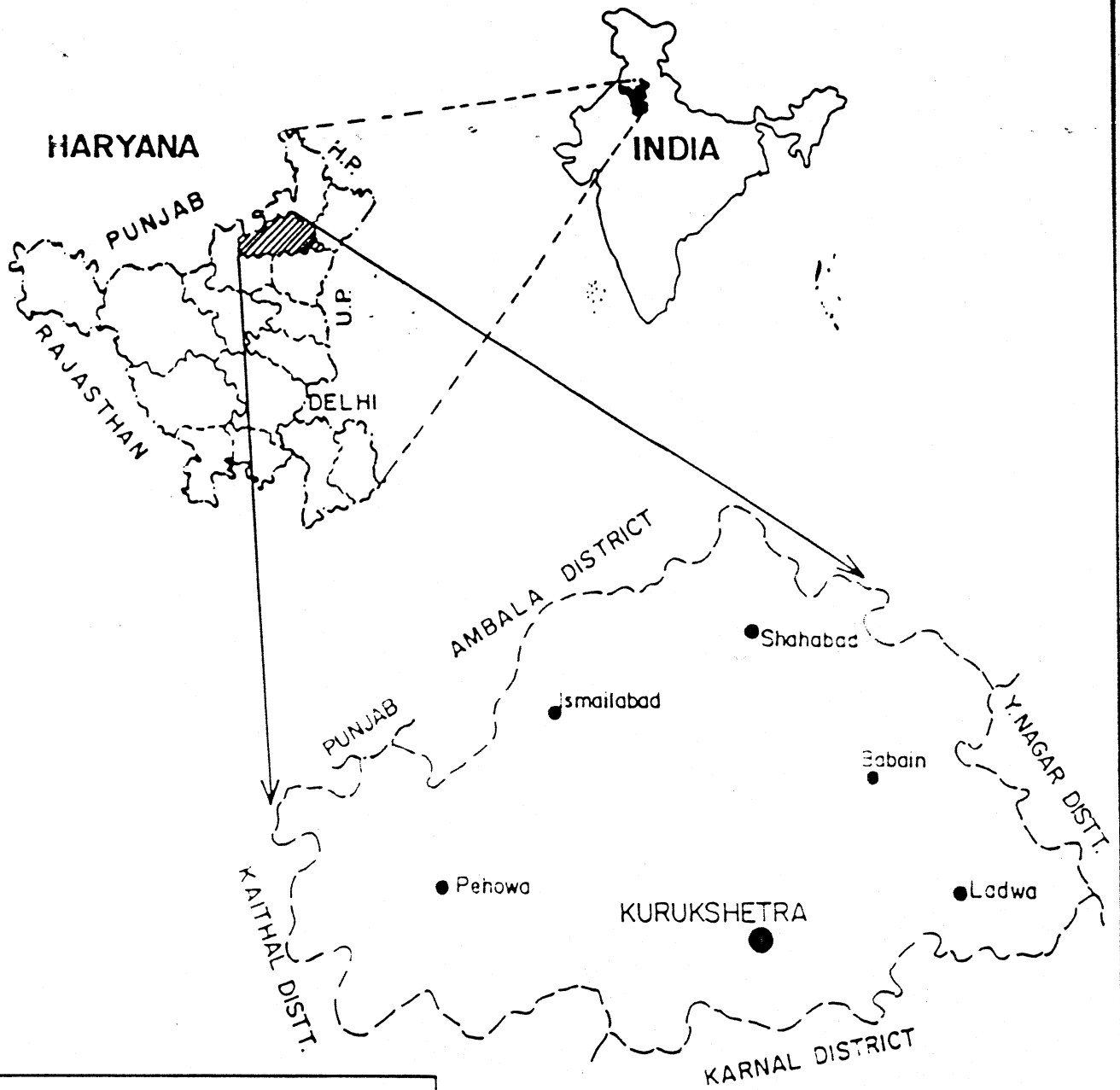
LOCATION MAP OF KURUKSHETRA DISTRICT
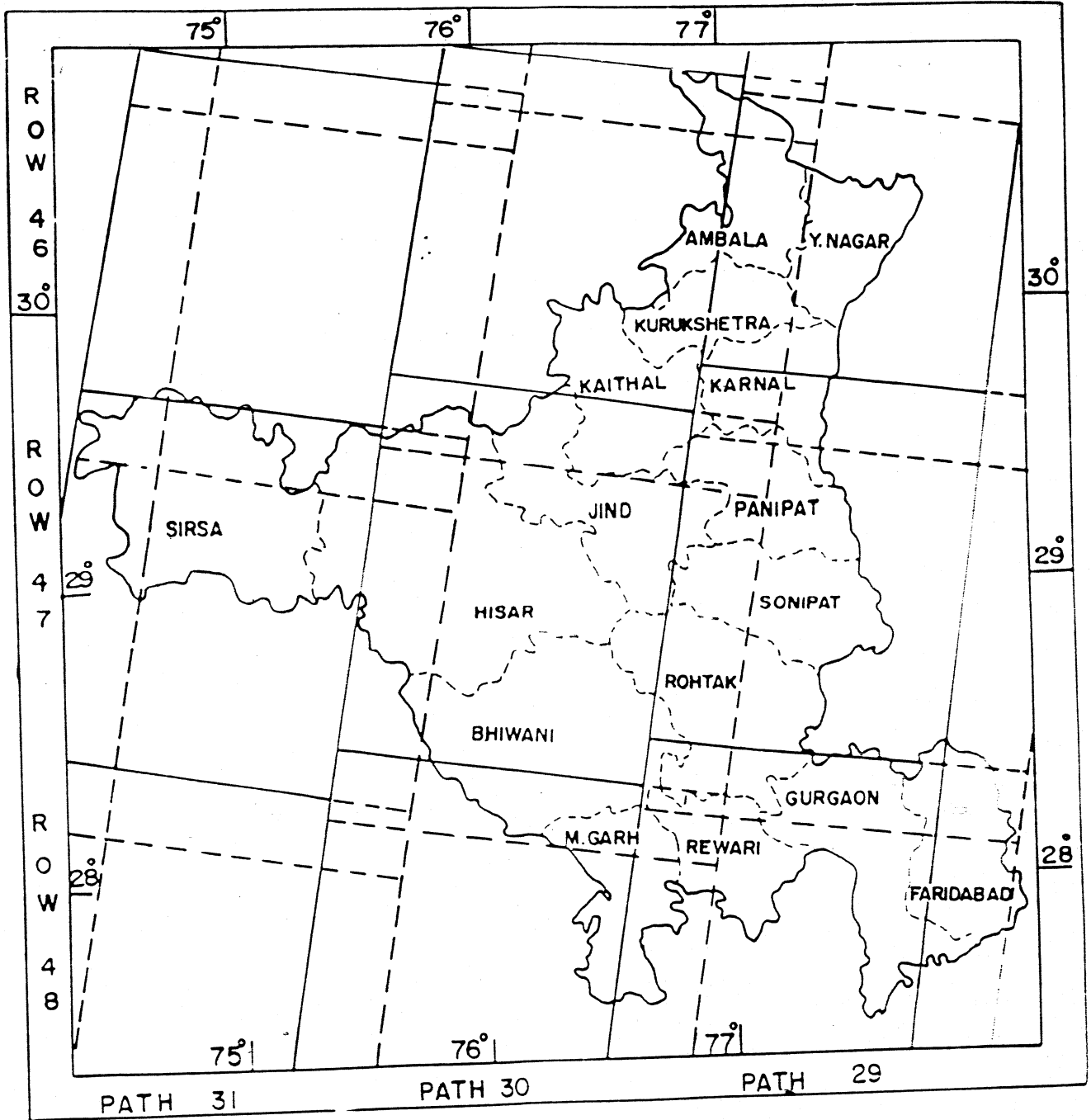### HARYANA

Fig. 1

Fig-2

IRS SATELLITE COVERAGE OF HARYANA

Fig. 3