CS 124

CHANGES IN LAND USE/ LAND COVER OVER SARADA RIVER BASIN, A P.

Deltaic Regional Centre

National Institute of Hydrology

KAKINADA

(1992-93)

CONTENTS

LIST OF FIGURES

LIST OF TABLES

PREFACE

Remotely sensing techniques seek to recognize and classify objects, their conditions and it's changes through their characteristic electromagnetic signatures. Land use and Land cover are the most important surface characteristics of a river basin. Various hydrologic processes are influences by the land use /land cover characteristics of a basin. For the hydrologic studies the land use / land cover study are significant and excellent indirect indicators of the hydrologic conditions of a region. The area chosen for land use mapping of Sarada river basin for the years 1987, 1989 and 1992 and it's temporal changes. The study area lies between lognitude 82° 30' to 83° 07' East and latitude17° 25' to 18° 17' North. Visual interpretations of LANDSAT TM and IRS LISS II data has been carried out to prepare hydrologically significant land use mapping and it's changes.

Deltaic Regional Centre of NIH engages in constituting studies and research in the area of Deltaic hydrology. In order to obtain reliable, upto date land and water information in space and time, the Remote Sensing technique is adopted in solving hydrological problems. For the hydrologic modelling of Sarada river, it has been decided to generate land use maps and to arrive at the changes of land use/land cover pattern of Sarada basin over years 1987, 1989 and 1992. This study was entrusted to Sh Y.R. Satyaji Rao, Scientist 'B', DRC, of this Institute, who has undergone 10 weeks training at NRSA, Hyderabad.

The present report is an attempt to highlight potentiality of remotely sensed data in land use studies. It is also proposed to incorporate these information in Rainfall runoff modelling of Sarada basin.

(S.M.SETH)
(DIRECTOR)

INTRODUCTION

Land is the most important natural resource on which all man's activities are based. Growing population pressure and human activities are increasing the demand on the limited land and water resources. Knowledge of the present distribution of Agriculture, forests, waste land etc., and their changing patterns are required by legislators, planners, state and local officials to determine better land use policy. Hydrological land use mapping of a basin or region provides hydrologically significant land use/land cover categories which is an essential prerequisite to water resources planning and development.

Land use and land cover are the most important surface characteristics of a basin. Various hydrological processes such as infiltration, evapotranspiration, soil moisture etc., are influenced by land use/land cover of a basin. The term land cover relates to the type of feature present on the surface of the earth. Forest, water bodies, glacial ice etc., are all examples of land cover types. The term land use relates to the human activity associated with a specific piece of land. The land use of any area may be Built-up, crop,lumbering,recreation, wild life sanctuary or various combinations of activities.

The pattern of available resources and demand for resources are constantly changing. Since, land use and land cover are dynamic features over space and time, it is difficult to get real information through conventional methods. The conventional ground method takes several years to acquire and compile the

data to produce a current land use map and by the time such a map reaches the public or planners or user agency, it becomes outdated.

In recent years satellite Remote sensing techniques have been developed which are of immense value for preparing quickly, economically, Reliable land use map and monitoring it's changes at regular periodic intervals of time. The repetitive coverage of same area provided by the space crafts gives a better idea of the changes that have taken place in land use practices. The space image is a permanent and authentic record at any time, showing the land use interrelationships and broad resource conditions, With the advantages of Remote sensing data, it is evident that the data could effectively be used to prepare land use and vegetal cover mapping and to monitor its changes. The hydrological information extracted from these maps are needed in hydrological modells.

In the present study land use/land cover maps have been prepared for the years 1987,1989 and 1992 and are compared for the changes using LANDSAT TM and IRS LISS-II images at 1:250000 scale through visual interpretation. These information may be useful in Rainfall-Runoff modelling, water Resources management and bureaucrats in decision making of water Resources planning.

REVIEW

Study of earth resources using satellite data has been a matter of great entrust since the launching of first weather satellite like Nimbus series in 1958.The technique of remotesensing has ushered in a revolutionary change in the methods of studying,surveying forest cover and land use types and it's phenomena. It can give information of large area with less time,cost and efforts for ground surveys. The capability to provide real time information makes it possible to have meaningful repetitive surveys ,which can show how the changes that have taken place, so that the problems can dealt after studying their nature and causes, Unni(1983).

Gautam N,C & Narayan E.R.A (1983) have carried out study on land use/land cover inventory and mapping for Andhra pradesh . This study deals with the techniques of remote sensing and how far it helps in the rapid study of geographical phenomena especially land.use within a very short time. It evaluates how well data from the LANDSAT MSS could be used to detect, identify and delineate land use features whithin the Andhrapradesh state. The main objective was to prepare a small scale land use map from satellite imagery showing the broad distribution of landuse patterns to serve as a base for monitoring land use changes.

Remotesensing data provides excellent information with respect to spatial distribution of vegetation types and land use in less time and at a lower cost, if parameters like, tonal variations on image, land and hydrological features are taken into account for interpretation (Roy et al.,1985).

Singh (1986) has stated that side by side comparison of two photographic images or overlaid images of two different periods can be carried out for the land use/land cover changes. The fundamental assumption is that any change in the land use will result in change in the reflectance value, which is sufficiently large to register and despite other variables.

The land use map of Sabarmathi basin and Upper Yamuna catchment had been prepared by Chowbey(1989), Bhar(1986) respectively, using multiband landsat imagery. The hydrologically important seven land use categories were carried out from imagery and stated that the information will be useful in runoff estimation.

Nguen(1990) et al has carried out study on analysis of LANDSAT TM and IRS LISS-II data for land use/land cover mapping and change detection and concluded that the above sensors images are most useful in land use/land cover mapping and change detection, if same sensors data are not available.

Kachhwaha T.S (1992) carried out study on detailed forest/vegetation cover mapping using LANDSAT TM and IRS LISS-II images and concluded that selection of suitable date of imagery is very essential to obtain desirable results. The study was highlighted the summer season images are most suitable for tropical moist deciduous forest in foot hills and the importance of temporal and multisensor data in vegetation studies.

The land use/land cover classification is shown in table no 1 which was prepared by NRSA Hyderabad. The same classification adopted for Nation wide land use/ land cover mapping at 1:250000 scale. In the present study Nine

Hydrologically important land use/land cover categories are chosen for mapping and change detection.

LAND USE/LAND COVER CLASSIFICATION SYSTEM
TABLE NO.1

LEVEL I	LEVEL II	LEVEL III
1.BUILT-UP LAND	1.1 Built-up land	1.1.1 Urban 1.1.2 Rural
2.AGRICULTURAL LAND	2.1 Crop land	2.1.1 Irrigated crop land
	(i) Kharif	2.1.2 Unirrigated crop land
	(ii) Rabi	
	(iii) Double cropped	
	2.2 Fallow	2.2.1 Fallow
	2.3 Plantation	2.3.1 Types of plantation : casuarina, coconut, tea etc.
3.FOREST	3.1 Evergreen/ semievergreen	3.1.1 Dense/closed 3.1.2 Open
	3.2 Deciduous	
	3.3 Degraded scrub land	
	3.4 Forest blank	3.4.1 Degraded forest 3.4.2 Forest blank
	3.5 Forest plantation	3.5.1 Types of plantation eg, teak, sal etc.
	3.6 Mangrove	
4.WASTELANDS	4.1 Salt affected land	
	4.2 Water logged land	
	4.3 Marshy/swampy land	
	4.4 Gullied/ravenous land	
	4.5 Land with or without scrub	
	4.6 Sandy area (Coastal & desertic)	
	4.7 Barren rocky/stony areas	
5.WATERBODIES	5.1 River/stream	
	5.2 Lake/reservoir/ tank/canal	
6.OTHERS	6.1 Shifting cultivation	6.1.1 Current 6.1.2 Old/abandoned
	6.2 Grassland/grazing land	6.2.1 Grassland/ grazing land
	6.3 Snow covered/ glacial area	6.3.1 Snow covered/ glacial area
	6.4 Mining area	6.4.1 Mining dumps

Note : Land use/Land cover categories at different levels and corresponding scales for mapping are as follows :
Level - I categories - 1:1,000,000 scale
Level - II categories - 1:250,000 scale
Level - III categories - 1:50,000 scale and 1:25,000 scale

[Source: Land use/ Land cover manual, NRSA, Hyderabad.]

STATEMENT OF THE PROBLEM

The various hydrologic variables are required to be examined for their amenability and adaptability to remotesensing and subsequent use in hydrologic modelling. Remote sensing can help in identifying surface cover and other land surface features and these information can be used to infer the hydrologic features like run-off potential, infiltration, evaporation potential etc. A hydrologically significant land use map is of immense use to infer about run-off potential of each category of land use and could be a valuable input for hydrological modelling of watershed.

The Sarada river basin has been chosen for land use/land cover mapping for the years 1987,1989,1992 and its temporal changes between these years through visual interpretation using LANDSAT TM and IRS LISS-II imageries at 1:250000 scale.

DESCRIPTION OF THE STUDY AREA

The area under study is the Sarada river basin. The basin area is 2590 sq km. and lies between longitude 82 30'to 83 07'E and latitude 17 25' to 18 17 N. Sarada river is one of the minor river basins that drains the area between Eastern Ghats and the Bay of Bengal in the north eastern coastal area of Andhra Pradesh. The entire basin is situated in the 19 administrative mandals of Visakhapatnam district and one mandal of Vijayanagaram district. The river is bounded by Anakapalli minor drainages and Naravagedda minor basin on the eastern side, Sileru river a tributary to Godavari on the Northern side and Vardha river basin on the Western side.

Maximum length of the basin from east to west is 63 kms. and from north to south is about 95 kms. The Sarada river is originating in the Anantagiri reserved forest area of Eastern Ghats near Lakshmipuram village of Chodavaram mandal. The river flows in the southern direction until it reaches Anakapalli, then it takes a southwestern turn from Anakapalli to Medupaka and thereafter again southernly direction until it joins the sea. The river is not perennial, it being a hill stream is characterised by occasional floods. The drainage pattern of the basin was observed as dendritic type. The elevation of the river at its origin is about 1447.80 mts. above M.S.L. The study area is shown in fig no. 1

4.1 Geology and Soils :

The basin consists of pleistocene unconsolidated formations near sea coast and archean complex of unclassified crystalline khondalites and granites. The typical soil types in this basin are (1) Red loamy soil, (2) Red sandy soil and (3) Coastal sands and alluvial soils. Red sandy soils covered the largest area in the basin. The acidic granites, gneisses, quartzites and felpathic are subordinate rock types rich in iron and magnesium bearing minerals are responsible particularly for the formation of red soils, and at certain places for formation of yellow, gray or even black colored soils. Coastal sands and alluvial soils occur in the coastal belt of the basin.

4.2 Climate :

The climate of the basin varies in different parts of the basin. Near the coast, the air is moist. There is a marked fall in the temperature in the month of November. The highest temperature of the basin received at the Anakapalli during the years 1985-90 is 43.8 C and lowest temperature is 12.3 C. During December, which may be taken as representative of winter months, the mean temp. ranges from 29°.3 C to 17°.2 C. During May,which may be taken as representative of summer months, the mean temparature ranges from 37°.9 to 25°.1 C.(CBI&P Project No. 5.8.2.82).

The basin lies in medium rainfall zone 700 to 1000 mm. Most of the rainfall in this region is received during southwest monsoon from June to September than northeast monsoon.

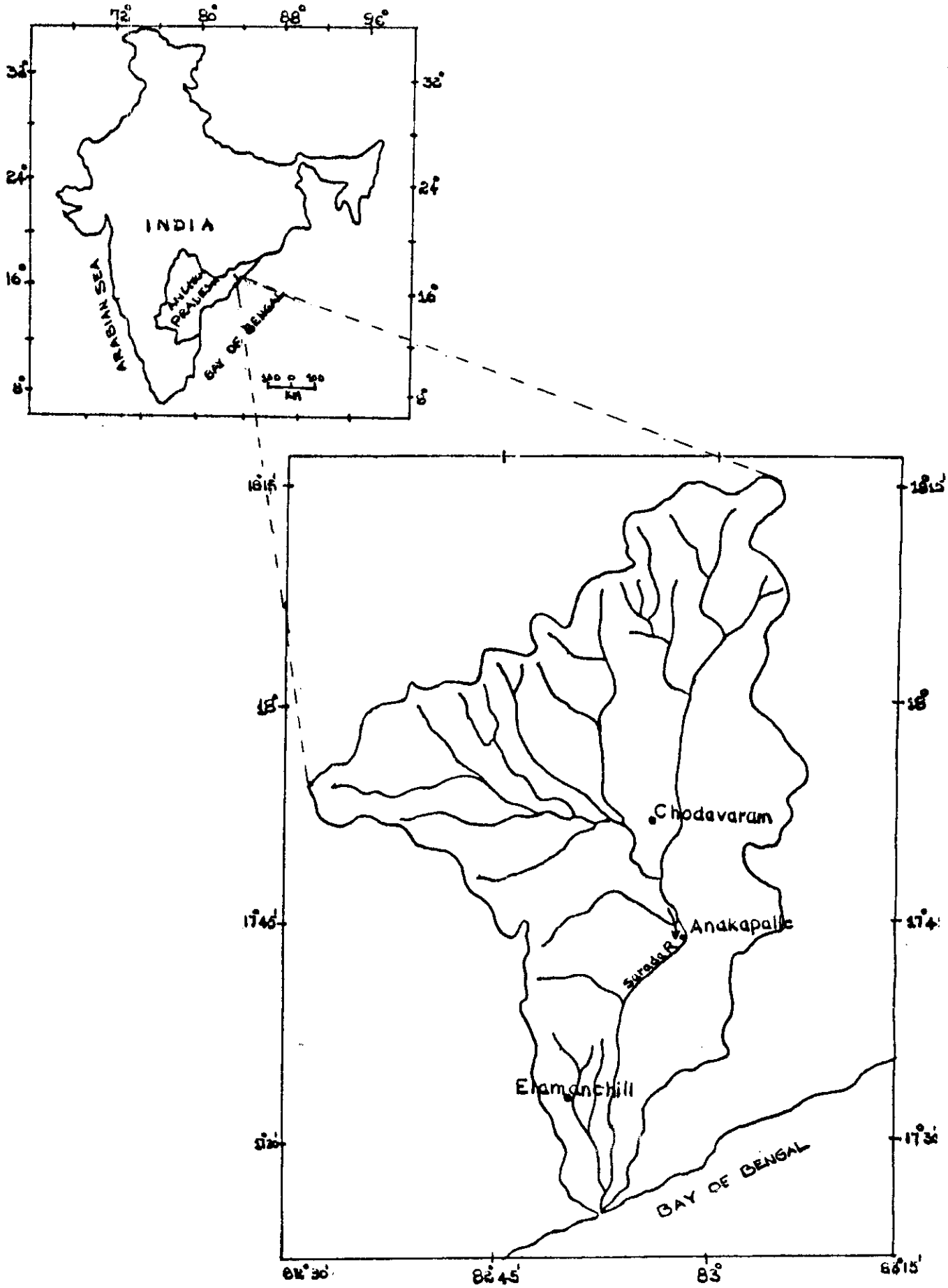


FIG.1 STUDY AREA

AVAILABILITY OF DATA

This study is carried out for preparing land use/land cover map of the year 1987,1989,1992 and its changes through visual interpretation. For this study the available satellite data used are LANDSAT TM and IRS LISS-II images at 1:250000 scale. The conventional data such as survey of India toposheets and other reference material like district level land use/ land cover map (NRSA ,Hyderabad),statistical data have been refered in this study.

The study area is covered in four LISS-II images and two TM images. The IRS imagery index which covers the study area as shown in fig no.2. The following table no.2 presents the details of satellite sensor, path/row ,bands,image product and scale which were used in the present study.

Table no. 2

SNO.	MONTH/YEAR	PATH/ROW	SATELLITE SENSOR	BANDS	PRODUCT	SCALE
1	Dec.1987	148/47	TM	2,3,4	FCC	1:250,000
2	Dec.1987	148/48	TM	2,3,4	FCC	"
3	Dec.1989	22/55	LISS II A2, B2	2,3,4	FCC	1:250,000
4	Dec.1989	22/56	LISS II A1, B1	2,3,4	FCC	"
5.	Dec.1992	22/55	LISS II A2, B2	2,3,4	FCC	"
6.	Dec.1992	22/56	LISS II A1,B1	2,3,4	FCC	"

The study area is covered in four survey of India toposheets at 1:250,000 scale. The base map of Sarada river basin has been prepared from topo sheets. The basin covered in 65J,65N,65K and 65 O toposheets which are shown in Topo map index fig. no.3.

Details of False Colo.r Composite Bands

S.no	Satellite sensor	Band	wave length (micro meters)	colour
1	LANDSAT TM	b2	0.52-0.60	Blue
		b3	0.63-0.69	Green
		b4	0.76-0.90	Red
2	IRS LISS-II	b2	0.52-0.59	Blue
		b3	0.62-0.68	Green
		b4	0.77-0.86	Red

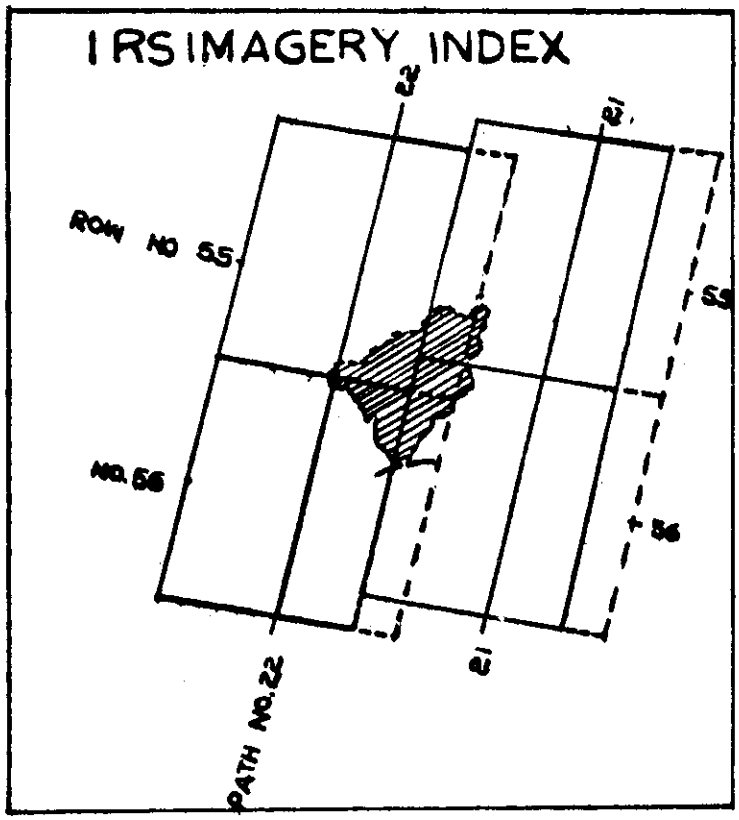

IRS IMAGERY INDEX
ROW NO 55
NO. 56
PATH NO. 22
21
21
55
56

FIG. 2

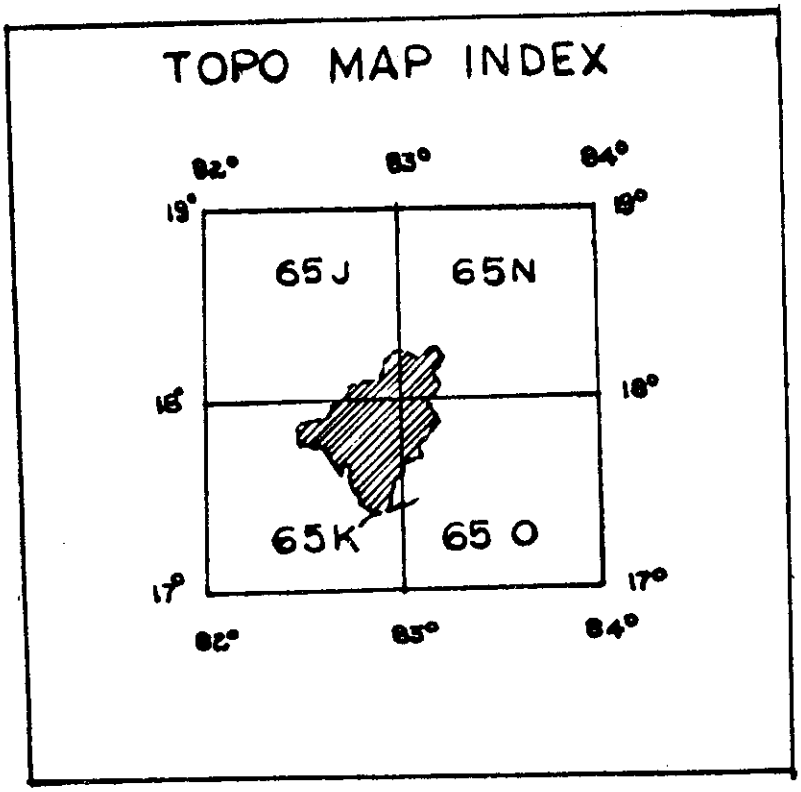

TOPO MAP INDEX
82°
83°
84°
19°
18°
17°
65J
65N
65K
65 O

FIG. 3

METHODOLOGY

In the present study Visual interpretation technique was employed to delineate hydrologically important land use/ land cover features. The base map of sarada basin has been prepared from toposheets at 1:250000 scale and permanent features like Roads, Railway lines, rivers, dams etc., were marked on the map to register the satellite image. Visual interpretation was carried out with the help of light table, magnifying lenses and standard interpretation techniques which are based on elements such as tone, texture, pattern, location, association, shape and size. Single interpreter has carried out the interpretation to get consistency in delineating the features. Limited ground truth was obtained by consulting toposheets. Ground information also collected from the literature already available from central,state Govt's and academic institutions.

The Nine hydrologically significant classes were delineated for the area. The table no 3 shows the land use/ land cover classifications and it's interpretation key which is adopted for present study.(land use/ land cover manual NRSA,HYD).

The area of each classification was measured by a planimeter. The accuracy of planimeter is +5%. The comparison of temporal changes had been done by each category in different years. The measured area of each land use/ land cover classification for the years 1987,1989 and 1992 have been compared for it's changes. The bar charts of forest cover which is included deciduous and degradaded forest,Built-up,crop and water bodies have been prepared to observe it's temporal changes.

Table no.3

S.no	Landuse/ Land cover Category	Tone/Colour	Size	Shape	Texture	Pattren	Location	Association
01.	Built-up Land	Dark bluish green in the core and bluish on the periphery	Small to big	Irregular & discontinuous	Coarse & mottled	Clustered to scattered & non-contiguous	Plains, Plateaus, on hill slopes, deserts, waterfront, road, rail canal etc.	Surrounded by agricultural lands, forest cover, wasteland network of river, road and rail etc.
02.	Crop land	Bright red to red	Varying in size	Regular to irregular	Medium to smooth	Contiguous to noncontiguous	Plains, hill slopes valleys, cultivable wastelands etc.	Amidst irrigated (canal, tank, well etc.) and un-irrigated (rainfed/dry farming arable lands proximity to rivers streams etc.
03.	Fallow land	Yellow to greenish blue (depending on soil type and moisture)	Small to large	Regular to irregular	Medium to smooth	Contiguous to noncontiguous	Plains, valleys, uplands, etc.	Amidst crop land as harvested agricultural fields etc.
04.	Plantation (Agriculture)	Dark red to red	Small to medium	Regular with sharp edges	Coarse to medium	Dispersed, contiguous	Plains, foot hills and uplands	Dry lands or unirrigated lands, uplands occasionally amidst cropland, proximity to and on gentle hill slopes.
05.	Deciduous forest	Dark red to red	Varying in size	Irregular, discontinuous	Smooth to medium depending upon crown density	Contiguous to noncontiguous	Medium relief mountains/hill slopes and within notified areas	Different forest types/sub types of species which shed leaves
06.	Degraded forest or Scrub land	Light red to dark brown (subject to canopy cover)	Varying in size	Irregular, discontinuous	Coarse to mottled	Contiguous to noncontiguous	Mountain slopes, isolated hills and foot slopes and within notified forest areas	Hill slopes having skeletal soil, different forest types/sub types and where aboitic interference
07.	Land with or without scrub	Light yellow to brown to greenish blue (subject to surface moisture and cover)	Varying in size	Irregular, discontinuous	Coarse to mottled (subject to vegetation cover)	Contiguous dispersed in patches	Terrain with varying lithology and land forms	Gentle relief with moderate slope in plains and foothills and surrounded by agricultural lands
08.	Barren rocky stony waste Sheet-rock area	Greenish blue to yellow to brownish (subject to varying rock type)	varying size	Irregular and discontinuous	Very coarse to coarse and medium	Linear to Contiguous and dispersed	Steep isolated hillocks, hill slopes/crest, Plateau and eroded plains	Barren and exposed rock/stony wastes, lateritic out-crops mined areas and quarried sites, boulders
09.	Lake/Reservoir Tank/Canal	Light blue to dark blue (subject to large vegetation)		Small/ medium to large	Regular to irregular	Smooth to motted subject to vegetation	Non-contiguous dispersed linear for canals	Tanks and lakes in in lowlands/plains, reservoirs surrounded by hills and across rivers, canals in plains

RESULTS AND DISCUSSIONS

Land use mapping has been found to be very advantageous using LANDSAT TM and IRS LISSII images because of synoptic, repetitive, high resolution and multi spectral coverage of the data. The maps have been prepared for the years 1987, 1989, and 1992 using standard FCC(2,3,4 BANDS) at 1:250000 scale. The hydrologically important Land use/Land cover category are given in table no 3 for the years 1987, 1989 and 1992. The percentage of each category is shown in table no 3. Direct comparison of each polygon in each category is not possible because of difference in acquisition dates for the two sensors. The LANDSAT TM for year 1987 and IRS LISS-II for years 1989 and 1992 were used in preparation of land use/land cover maps. The temporal changes have been observed from the maps and shown in table no 3.

Deciduous forest area has been observed in year 1987 was 447.32 sq.km and year 1992 it was only 327.79 sq km. The reason shows that the decrease in deciduous forest area may be due to the increasing of degraded forest area. From table no 3 the decreased area of deciduous forest between years 1987, 1989 and 1992 was 70 and 50 sq km respectively. The increased area of degraded forest between years 1987,1989 and 1992 was 69 and 54 sq km respectively. so, the overall decreased deciduous forest area is same as increased forest area from 1987 to 1992.The reasons in decreasing deciduous forest and increasing degraded forest may be depend upon the climatic conditions, Environmental changes, public interference etc.

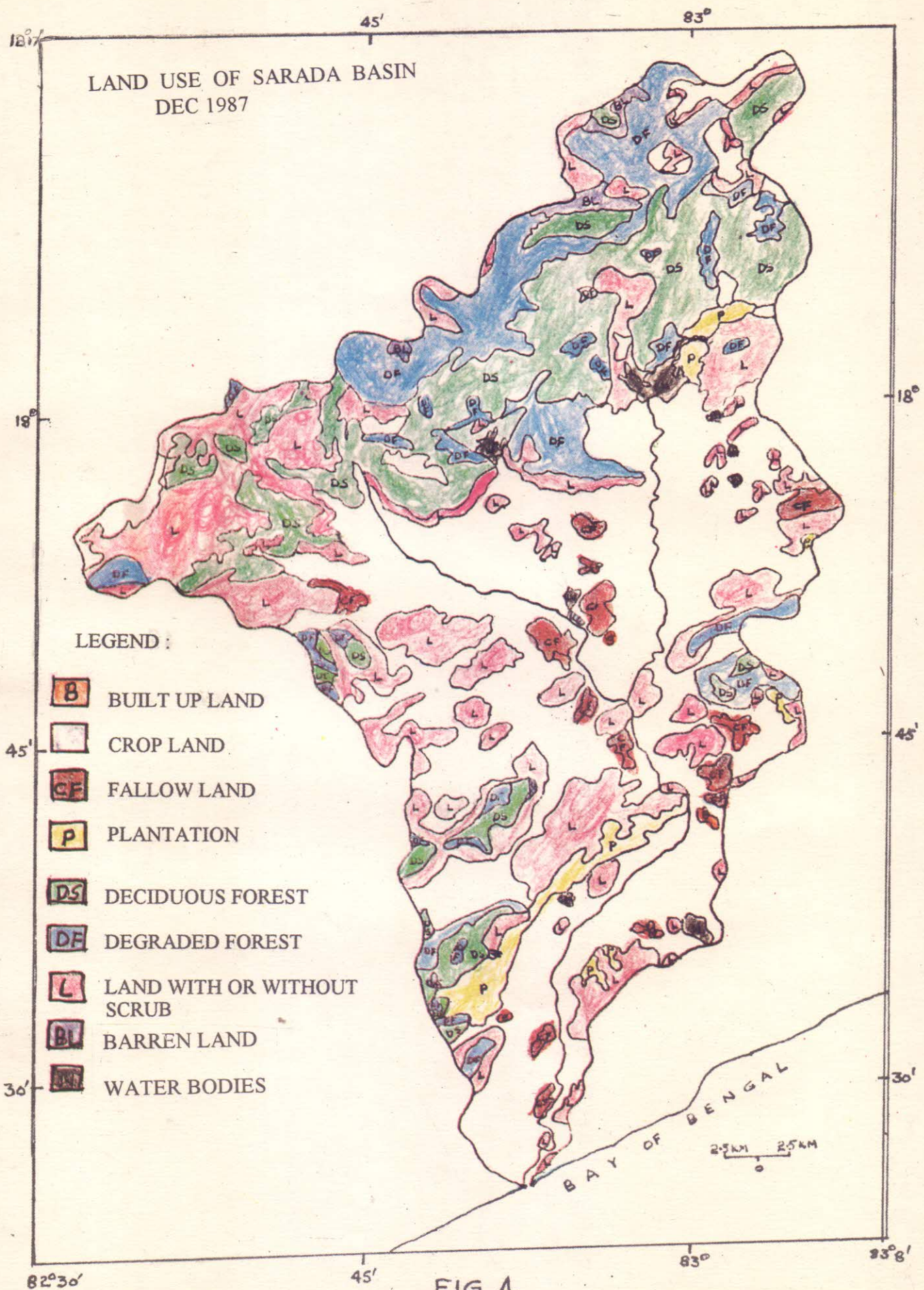

LAND USE OF SARADA BASIN
DEC 1987
LEGEND :
B BUILT UP LAND
CROP LAND
CF FALLOW LAND
P PLANTATION
DS DECIDUOUS FOREST
DF DEGRADED FOREST
L LAND WITH OR WITHOUT SCRUB
BL BARREN LAND
WATER BODIES
BAY OF BENGAL
2·5 KM 2·5 KM
0
45'
83°
18°
18°
45'
45'
30'
30'
82°30'
45'
83°
83°8'

FIG. 4

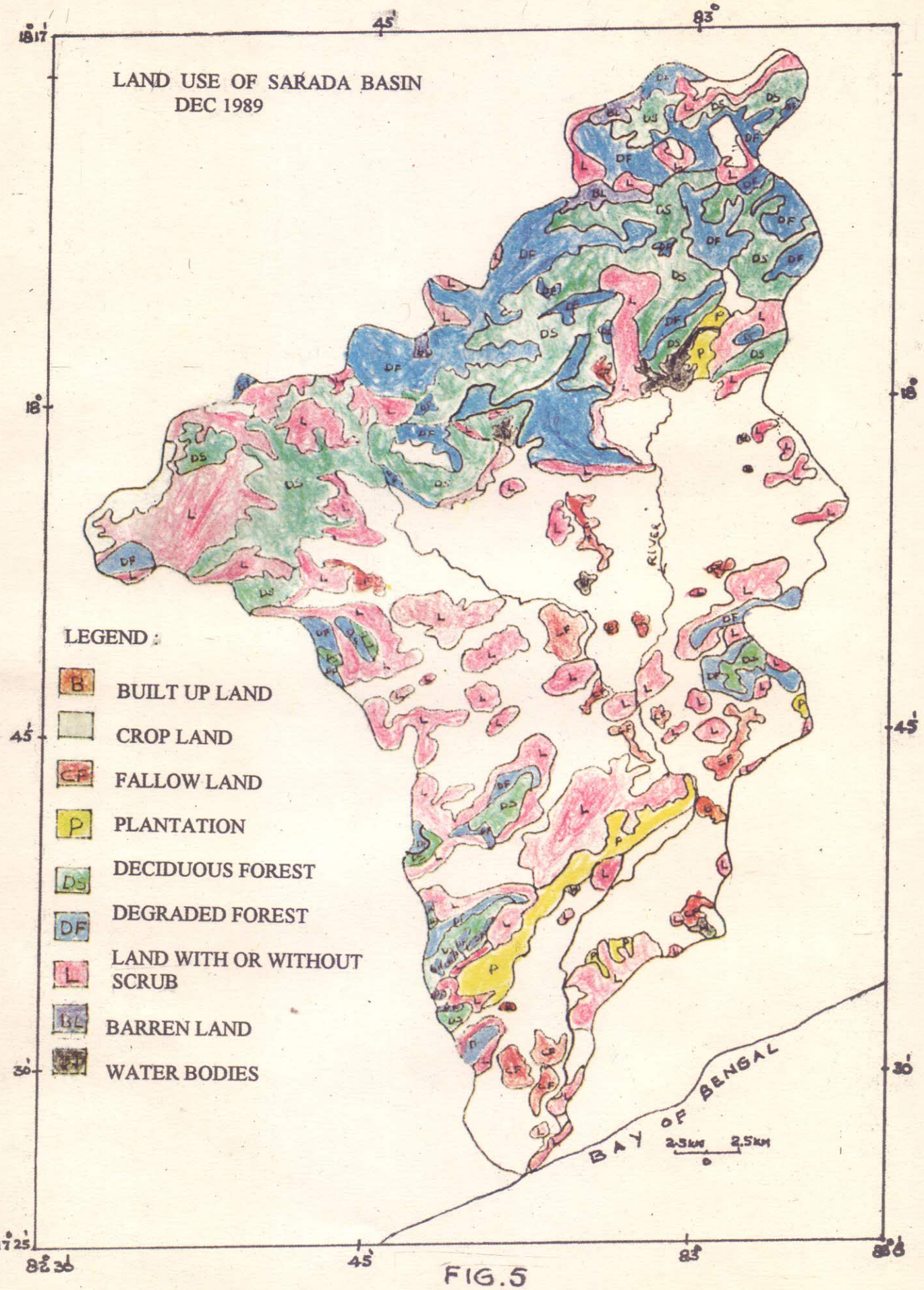

LAND USE OF SARADA BASIN
DEC 1989
LEGEND :
B BUILT UP LAND
CROP LAND
CF FALLOW LAND
P PLANTATION
DS DECIDUOUS FOREST
DF DEGRADED FOREST
L LAND WITH OR WITHOUT SCRUB
BL BARREN LAND
WATER BODIES
RIVER
BAY OF BENGAL
2.5KM 2.5KM
18°17'
45'
83°
18°
45'
30'
17°25'
82°30'
45'
83°
85°0'

FIG.5

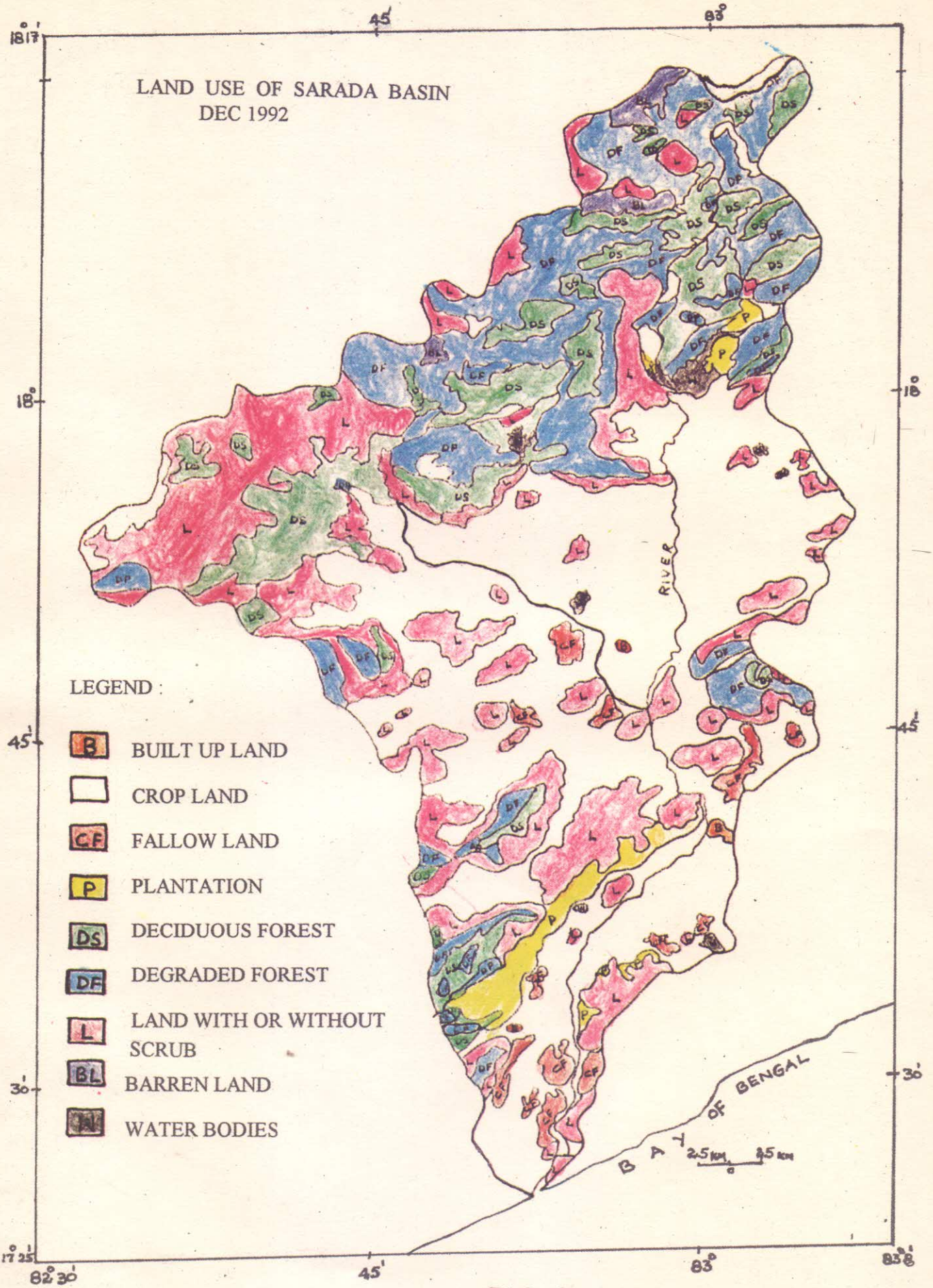

LAND USE OF SARADA BASIN
DEC 1992
LEGEND :
B BUILT UP LAND
CROP LAND
CF FALLOW LAND
P PLANTATION
DS DECIDUOUS FOREST
DF DEGRADED FOREST
L LAND WITH OR WITHOUT SCRUB
BL BARREN LAND
W WATER BODIES
RIVER
BAY OF BENGAL
25 KM
0
25 KM
18° 17'
45'
83°
18°
45'
30'
17° 25'
82° 30'
45'
83°
83° 8'

FIG. 6

Table no.4

Aerial Distribution of land use/land cover features over Sarada river basin.

Description	Year 1987		Year 1989		Year 1992	
	Area sq.km	% of Area	Area sq.km	% of Area	Area sq.km	% of Area
Deciduous forest(DS)	447.32	17.27	377.52	14.58	327.79	12.65
Agricultural Plantation(P)	68.56	2.65	64.85	2.50	62.34	2.41
Barren Land(BL)	16.30	0.63	16.47	0.63	25.85	1.00
Waterbodies(W)	23.04	0.89	21.92	0.85	20.23	0.78
Built-upland(B)	5.90	0.23	7.31	0.28	8.42	0.32
Current fallow land(CF)	68.27	2.63	80.36	3.10	58.72	2.27
Cropland(C)	988.12	38.15	939.60	36.28	1026.54	39.63
Land with or without scrub (L)	655.54	25.31	696.38	26.89	619.85	23.93

The area of Agriculture plantation has been observed, that it was slightly decreased from 1987 to 1992. The .pa area in 1987 was 68.56sq km and in 1992 it was 62.33sq km. The percentage of plantation area in 1987, 1989 and 1992 was 2.65%, 2.5% and 2.41% respectively.

The barren land area was increased from 1987 to 1992. In 1987 it was 16.3sq km and 1992 it was 25.85 sq km. Some places the degraded forest became a barren land which it appeared on the image. The percentage of barren land area in year 1987,1989 and 1992 was 0.63%, 0.63% and 1.0% respectively.

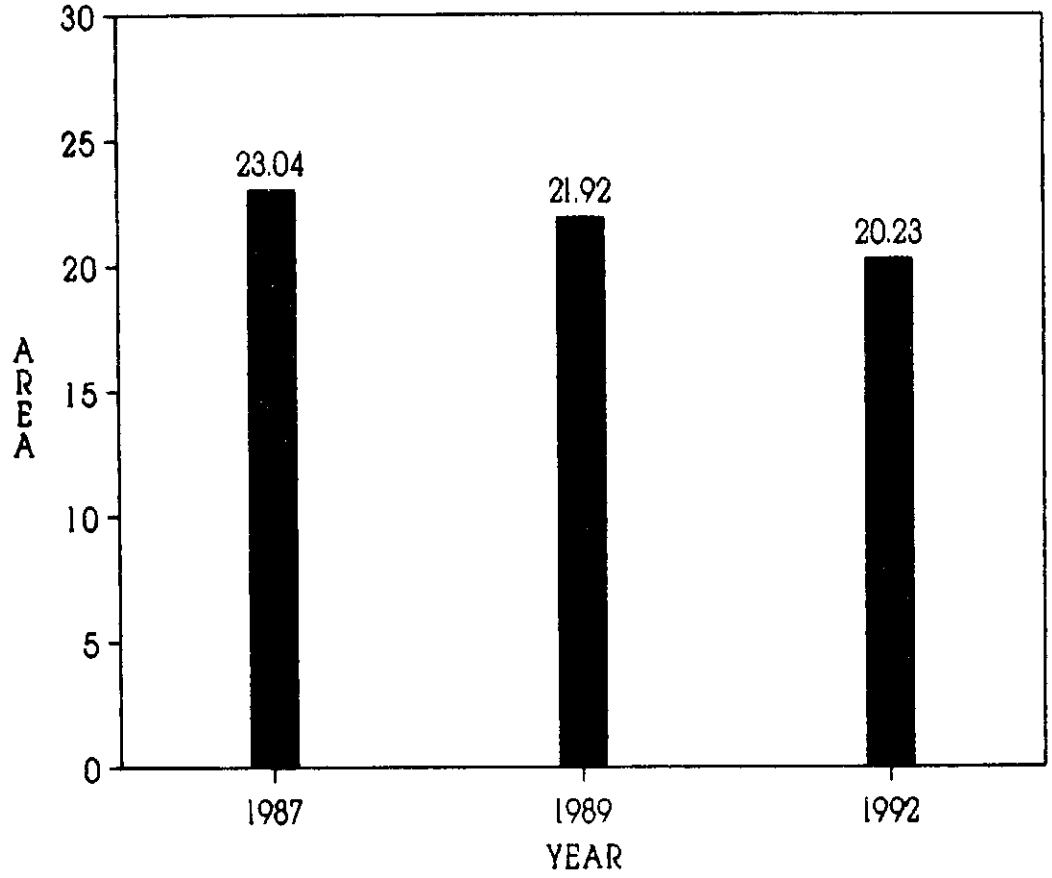
The area of waterbodies was slightly decreased from 1989 to 1992. The area in 1989 was 23.04 sq km and 1992 it was 20.23 sq km. The number of irrigation ponds in the area has been reduced from 1989 to 1992 except the major reservoirs, these changes have been observed on image very clearly due to the more contrast between water and other features. The percentage of waterspred areas in 1987, 1989 and were observed 0.89%, 0.85% and 0.78% respectively.

The Built-up area has been increased from 1987 to 1992. The major towns of basin were only delineated due to poor contrast between built-up area and other features. The places like Elamanchilli,Anakapalle and Chodavaram were marked on the maps,the percentage of area in year 1987,1989 and 1992 was 0.23%, 0.28% and 0.32% respectively.

The current fallow land area has been observed in 1987, 1989 and 1992 was 68.27 , 80.36 and 58.27 sq km respectively. This area is not following any increasing or decreasing trend. So, it may indicate that the changes are very temporary and depend on current crop area,climatic conditions etc.

The crop area has been increased from 1987 to 1992. The area in 1987 was 988.12 sq km and in 1992 it was 1026.5sq km. This is the largest area covered over sarada river basin. But in 1989 this area is less than 1987and 1992. In same year 1989 the current fallow land is increased. The area of crop is depend on climatic conditions, and also the date of image which it was taken. The percentage of crop areas in 1987, 1989 and 1992 was 38.15%, 36.28%and 39.63% respectively.

The Land with or without scrub area in year 1987, 1989 and 1992 was 655.31sq km 696.38 and 619.85 sq km respectively. This is the second most largest area covered over the basin. This area was distributed as isolated places all over the basin. The area has been decreased from 1987 to 1992. The percentage of land with scrub without scrub in years 1987, 1989 and 1992 was 25.31%, 26.89% and 23.93% respectively. The barcharts of Hydrologically important features like water bodies,forest,crop, and built-up area are shown in fig no.7 & 8 respectively.



Water Bodies over Sarada Basin (Sq.Kms)

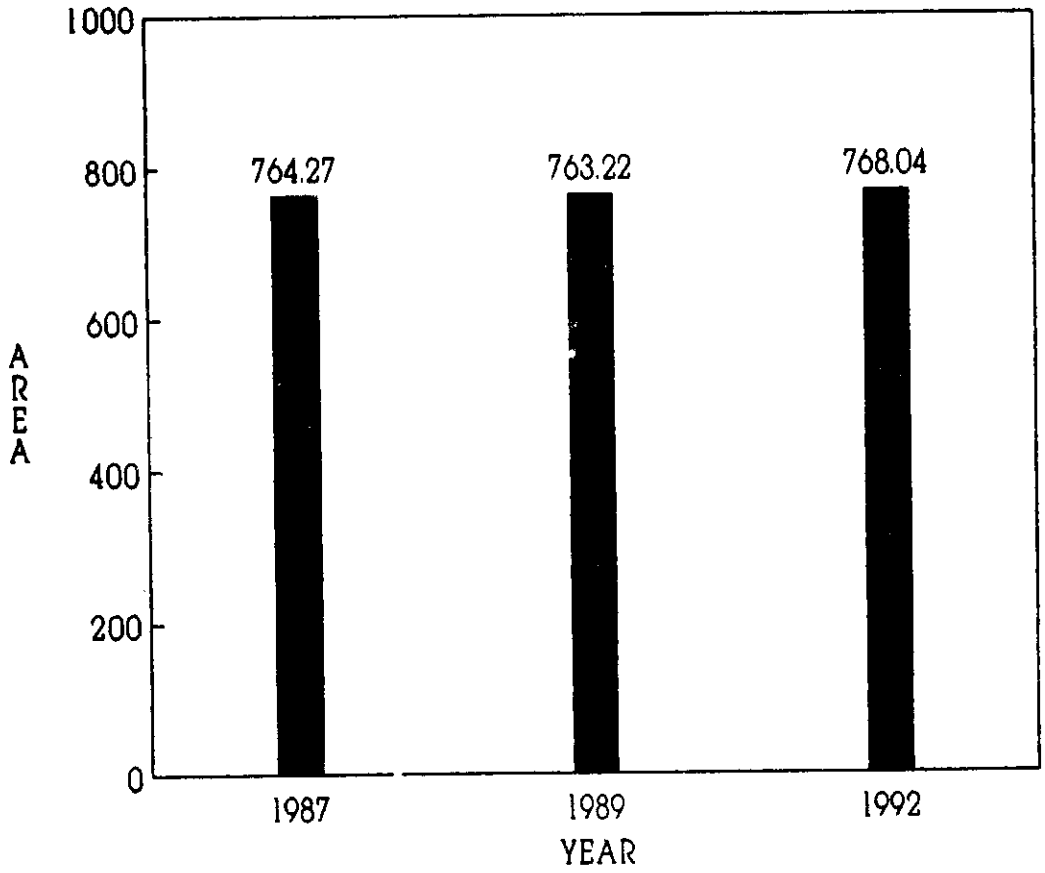
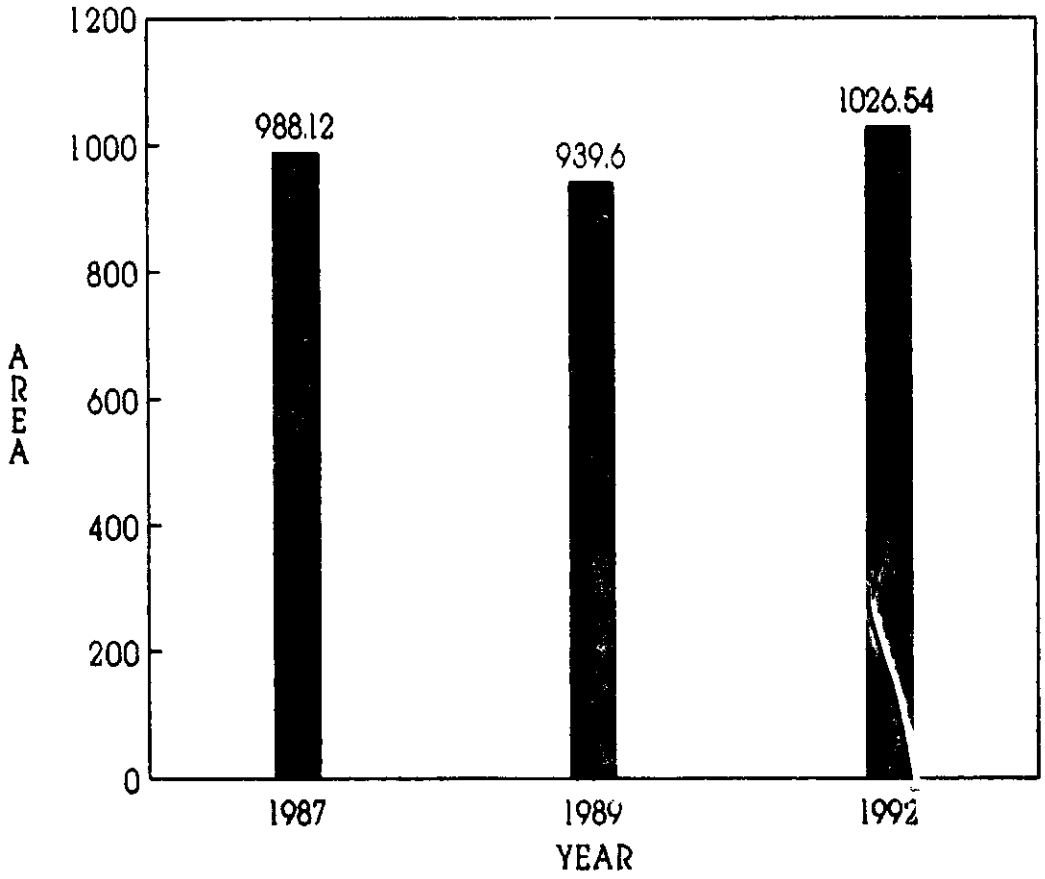


FIG. 7 Forest cover over Sarada Basin (Sq.Kms)



Crop Land over Sarada Basin (Sq.Kms)

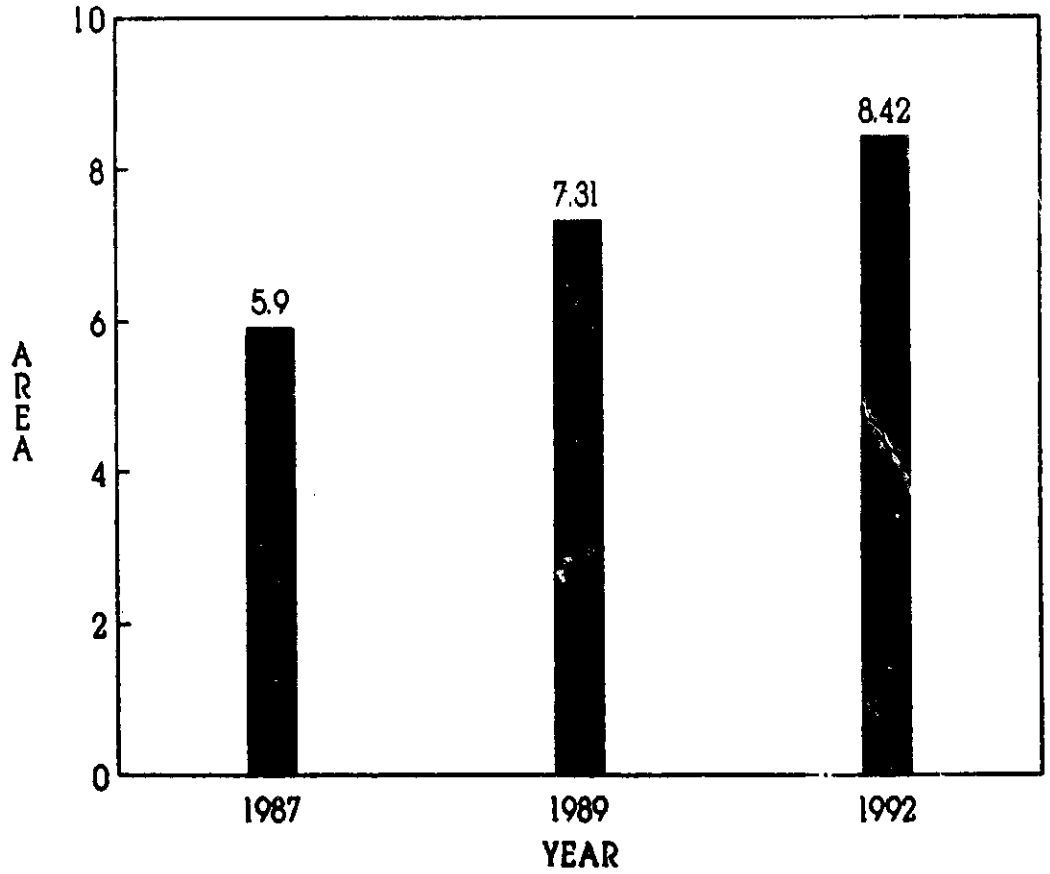


FIG8 Built-up Land over Sarada Basin (Sq.Kms)

CONCLUSIONS

The land use/Land cover maps of Sarada basin have been prepared for the years 1987, 1989 and 1992 using LANDSAT TM and IRS LISS II imageries, and compared it's temporal changes of Hydrologically important land use features. The following categories like deciduous forest, Agricultural plantation, waterbodies has been decresed by 4.62%., 24% and 11% respectively years 1987 to 1992. The other features like Degraded forest, Builtup land, Barren land areas has been increased by 4.76%, 0.09% and 0.37% respectively from years 1987 to 1992. The features like land with scrub/without scrub and current fallow land area has been incresed by 1.58% and 0.47% respectively from year 1987 to 1989 and both the areas decresed in 1992 with compare to the 1987 by 1.38%, 0.36% respectively.

Finally the crop area of Sarada basin is increased by 1.5% from years 1987 to 1992.

ACKNOWLEDGMENT

The author expresses his sincere thanks to Dr Satish Chandra, Director who allowed him to undergo 10 weeks training at NRSA, Hyderabad and to take up this study. The author is greatly indebted for valuable guidance of Dr P.V. Seethapathi, Scientist'F', Coordinator of this regional centre in preparing this report. The author is also express his thanks to colleges and staff members for their co-operation in completing this report.

REFERENCES

1. Ashbindu singh (1986) change detection in the tropical forests environment of North-Eastern India using Landsat data. Remote Sensing and Tropical land Management Ed. Eden & J.T. Perry John Willey & sons. PP 237-253.

2. Bhar A.K et al (1986-87), Land use mapping of upper yamuna catchment using remotely sensed data, CS-14, NIH, Roorkee.

3. Chowbey V.K (1988-89) et al Sabarmathi basin Land use/Land cover map, CS-26, NIH, Roorkee.

4. Description and classification of Land use/Land cover Manual, NRSA, Hyderabad.

5. Gautam N.C (1983) satellite (LANDSAT) data for Land use/Land cover Mapping and its applications:A case study of Bundelkhand Region proceedings of Remote sensing to Natural Resources, Environment Land use and problems relating to training and Education, at CSRE IIT, Bombay, March 3-4, 1983.

6. Kachhwaha T.S (1992) Detailed forest/vegetation mapping and corridor identification for planning and management of Rajaji National park, UP India using large scale landsat T.M and IRS IA LISS II satellite images. ICORG-92, Remote sensing applications and Geographic information systems, Recent Trends, Ed. I.V Muralikrishna J.N.T.U, Hyderabad, India.

7. Management and optimization in Development of surface and Ground water system of Sarada river basin Andhra pradesh. (CBIP&P project No:5.8.2.82), Central Board of irrigation & power, Govt of India, New Delhi.

8. Nguen et al (1990) Analysis of LANDSAT TM and IRS LISS II data for Land use/covermapping and change detection.ISRS, Proceedings of the National Symposium on Remote sensing for Agriculture applications held at New Delhi,Dec 6-8, 1990.

9. Roy P S et al (1985) Forest type stratification and delineation of shifting cultivation in the Eastern part of Arunachal pradesh using LANDSAT MSS DATA. INT.J.Remote sensing 6, 411-418.

10. Unni N V M (1983) Forest survey and management using Remote sensing Edited by B L Deekshatulu and Y S Rajan ind. Acad. of sciences, Bangalore 1984, 115-133.

REFERENCES

1. Ashbindu singh (1986) change detection in the tropical forests environment of North-Eastern India using Landsat data. Remote Sensing and Tropical land Management Ed. Eden & J.T. Perry John Willey & sons. PP 237-253.

2. Bhar A.K et al (1986-87), Land use mapping of upper yamuna catchment using remotely sensed data, CS-14, NIH, Roorkee.

3. Chowbey V.K (1988-89) et al Sabarmathi basin Land use/Land cover map, CS-26, NIH, Roorkee.

4. Description and classification of Land use/Land cover Manual, NRSA, Hyderabad.

5. Gautam N.C (1983) satellite (LANDSAT) data for Land use/Land cover Mapping and its applications:A case study of Bundelkhand Region proceedings of Remote sensing to Natural Resources, Environment Land use and problems relating to training and Education, at CSRE IIT, Bombay, March 3-4, 1983.

6. Kachhwaha T.S (1992) Detailed forest/vegetation mapping and corridor identification for planning and management of Rajaji National park, UP India using large scale landsat T.M and IRS IA LISS II satellite images. ICORG-92, Remote sensing applications and Geographic information systems, Recent Trends, Ed. I.V Muralikrishna J.N.T.U, Hyderabad, India.

7. Management and optimization in Development of surface and Ground water system of Sarada river basin Andhra pradesh. (CBIP&P project No:5.8.2.82), Central Board of irrigation & power, Govt of India, New Delhi.

8. Nguen et al (1990) Analysis of LANDSAT TM and IRS LISS II data for Land use/covermapping and change detection.ISRS, Proceedings of the National Symposium on Remote sensing for Agriculture applications held at New Delhi,Dec 6-8, 1990.

9. Roy P S et al (1985) Forest type stratification and delineation of shifting cultivation in the Eastern part of Arunachal pradesh using LANDSAT MSS DATA. INT.J.Remote sensing 6, 411-418.

10. Unni N V M (1983) Forest survey and management using Remote sensing Edited by B L Deekshatulu and Y S Rajan ind. Acad. of sciences, Bangalore 1984, 115-133.

DIRECTOR	Dr S M SETH
COORDINATOR AND HEAD	Dr P V SEETHAPATHI
STUDY GROUP	Sri Y R SATYAJI RAO