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SABARMATI BASIN LANDUSE/LANDCOVER MAP

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1988-89

PREFACE

Land use and land cover are the most important surface characteristics of a river basin. Various hydrologic processes such influences by the land use/land cover characteristics of a basin. The data on land uses potential and the conservation needs can help planning for uses that will maintain the quality of land. Disasters can result in the absence of land use management authority, collecting and disseminating upto data land use information. For the hydrological studies, land use and land cover study are significant, as they determine to a large extend the process of runoff generation and are excellent indirect indicators of the hydrologic conditions and the geomorphic characteristics of the region. The role of spare image in providing a synoptic view and improves perspective of the problem relating to land use been illustrated by the present study. The area chosen for land use mapping is sabarmati basin. The study area lies between longitude 71°15' to 73°30' East and latitude 22° 00' to 24° 45' North. Visual interpretation of landsat imagery were carried out for the preparation and analysis of hydrologically significant land use mapping.

The National Institute of Hydrology engages in constituting studies and research in the area of hydrology. In order to obtain reliable, uptodate land and water information in space and time. The Institute has established a Remote Sensing Applications Division, with major objective to apply remote sensing techniques in hydrological problems. For the hydrologic modelling of Sabarmati river, it has been decided to first generat land use/land cover information, hence this study was entrusted to Sh. V.K. Choubey, Scientist 'C' and Sh. S.K. Jain, Scientist 'B' of this Institute.

The present report is an attempt to highlight potentiality of remotely sensed data in land use studies. It is proposed to conduct more exhaustive studies in number of river basin.

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1.0 INTRODUCTION

Land use and land cover are the most important surface characteristics of a basin. Various hydrological processes such as infiltration, evapotranspiration, soil moisture status etc. are influented by landuse/-landcover characteristics of a basin. The data on land use potential and the conservation needs can help planning for uses that will maintain the quality of land. Disasters can result in the absence of landuse management authority collecting and disseminating upto date land use information. It is as well known that many area in the country, which had never seen floods before, get flooded now as a result of hapazrd and excessive land development activities and of network of canals etc.

The term land cover relates to the type of feature present on the surface of the earch. Urban building, lakes, glacial ice etc. are all examples of land cover types. The term landuse relates to the human activity associated with a specific piece of land. As the land cover of any area may be overgreen fores, out the land-use may be lumbering, recreation, wild life sancturary or various combinations of activities.

Since land use and land cover are dynamic features over space and time, it is difficult to get real time information through conventional means. Also, these methods are time consuming, labourious and with high costs often when the study has time limitation, the planners and specialist in various disciplines are forced to use existing data on the land use which is usually outdated because of the pattern of available resources and demand for resources are constantly changing. For economical development of a region, planners need upto date information which can only be obtained quickly, economically and accurately through remote sensing technique.

Space imagery obtained through satellites in specially very suseful for landuse mapping and specific benefits can be summarised as follows:

i) The space image is a permanent and authentic record at any one time, showing the land use inter relationships and broad resource conditions.

ii) The repetitive coverage prodited by the space crafts give a better idea of the changes that have taken place in land use practices.

iii) It provides a good base and reduces the need for extensive field work and the cost involved for such field work.

iv) It gives an improved definition of broad vegetational eco-tones because of reduced resolution and scale.

1.1 Land use/Land Cover Classification for Remote Sensing Data

The generation of remotely sensed data/images by various types of sensors flow abroad different platforms at varying heights above the terrain, at different time of the day and the year, does not lead to a simple classification system. To data, comparatively the most successful attempt in developing a general data has been attempted by Anderson et.al. (1976).

This classification system is commonly referred to as USGS classification system. (Table 1). This system was designed according to the following criteria:

i) The minimum level of interpretation accuracy using remote sensor data should be atleast 85%.

ii) The accuracy of interpretation for the several categories should be about equal.

iii) Repetitive results should be obtainable from one interpreter to another and from one time of sensing to another.

iv) The system should be applicable over extensive areas.

v) The system should be suitable for use with remote sensor data obtained at different time of the year.

vi) Categories should be divisible into more detailed subcategories that can be obtained from large scale imagery.

vii) Aggregation of categories must possible.

viii) Comparison with future land use and land cover data should be possible.

ix) Multiple uses of land should be recognised when possible.

The classification system has four levels of categorisation. Level I information can be used at inter-state and statewise level of planning; Level II at state wide to regional scale of planning; Level III at regional to local scales of planning, whereas level IV information can be used at local or micro level planning.

Table 2

Classification and corresponding typical data Characteristics

Classification Level	Typical data characteristics
I	Landsat type of data
II	High altitude (12 km. or above) aircraft imagery; scale less than 1:80,000.
III	Medium altitude (3-12 km) imagery
IV	Low altitude imagery (upto 3 km) scale more than 1:20,000.

The classification discussed earlier is most general in nature. However, for hydrologic purpose it can be modified to suite the requirements. The classification scheme presented in Table -3 is the one suggested by NRSA for hydrologic studies.

Table 1

Classification system of land use and land cover for for use with remote - sensor data (UPTO LEVEL II ONLY)

Level I	Level II
Urban or buil up land	Residential Commercial and Services Industrial Extractive Transportation, Communications, and utilities Industrial and commercial complexes Mixed urban or built up land Other urban or built up land
Agricultural land	Croplandand pasture Orchards, groves, vineyards, nurseries, and ornamental horticultural areas confined feeding operations Other agricultural land
Rangeland	Herbaceous rangeland Shrub and brush rangaland Mixed rangeland
Forest land	Deciduous forest land Evergreen forest land Mixed forest land
Water	Streams and canals Lakes Reservoirs Bays and estuaries
Wetland	Forested wetland Nonforested Wetland
Barren Land	Dry salt flats Beaches Sandy areas other than breaches Bare exposed rock Strip mines, quarries, and gravel pits, Transitional Areas Mixed barren land

Tundra	Shrub and brush tundra, Horbaceous tundra Bare - ground tundra, Wet tun-dra, Mixed tundra,
Perennial snow or ice	Perennial snowfields Glaciers

Table 3

Hydrologic Land use Classification Scheme

	Level I	Level II
1.	Agricultural land	1.1 Standing crop 1.2 Fallow land
2.	Waste land	2.1 Sand dune like 2.2 Riverine grass
3.	Riverine features	3.1 Dry river bed/ Ephemeral stream 3.2 Wet sand deposite 3.3 Swamp/Marshy vegetation
4.	Water	4.1 Shallow water river/ canal 4.2 Deep water in river/ Headwork pondage 4.3 Vegry deep water in reservoir
5.	Forest	5.1 Decidous forest 5.2 Evergreen Forest
6.	Built-up Area	
7.	Snow/Cloud	

2.0 REVIEW

Study of earth's resources using satellite data has been a matter of great interest since the launching of first weather satellite like Nimbus series in 1958. Since then there had been substantial contribution to this field from various parts of the world. Probably systematic efforts towards the use of satellite data for study of earth's resources began with the availability of orbital photographs from Gemine satellite series. The Apollo programme was further step forward in orbital photography. It was realised during the Apollo program that only one first filter combination may not be efficient if space photography has to be used efficiently. Thrower and Sengar (1969) constructed a landuse map by interprating space craft photography. Interpretation resulted in the delineation of a number of identifiable land use phenomena and/or association, which was supported by air photographs and ground information.

The land use classification and mapping has been widely practiced after Anderson and his Coworkers (1972) developed a classification system. Their study is hierarchial with each minor categoric subdivision, nested within the higher level of classification. Based the above, earth Satellite corporation (1974) suggested land use classification at different levels. Baldev Sahai (1983) review the state or art in India and suggested a three ties approach; i.e. satellite, aerial, ground which provide the complete or optimum information. It gives the land utilisation classes as follows:

i) Forests

ii) Area under non-agricultural uses.

iii) Barren and uncultivable land

iv) Permanent pastures and other grazing lands

v) Miscellaneous trees crops and groves not included in the net area sown.

vi) Culturable waste

vii) Fallowland other that current fallows

viii) Current fallows

ix) Net area sown

This classification scheme is quite incompatible with remotely sensed data (Baldev Sahai, 1983).

Landsat series of satellite was first launched in July 23, 1972 and so far five satellites have been launched. First three landsat satellites have collected over 1 million images of earth's surface. Landsat-4 and 5 have improved sensors, resolution and more sensitive ranges of bandwidth. Table 4 furnishes the multi-spectral scannel and the thematic Mapper spectral bands and their application.

Early experiments on those of landsat data for landuse/land cover mapping were mostly based on visual interpretation methods. Variation in tone, texture and shape form the basis for visual interpretation.

Table 4

Sectral Ranges of Bands in Landsat - 4 & 5

Sensor	Band Number	Spectral range (m)	Application
Multi-Spectral Scanner	1	0.5 to 0.6 visible green	Water penetration sediment, turbidity studies
Resolution=79 m	2	0.6 to 0.7 visible red	Vegetation discrimination
	3	0.7 to 0.8 Near infrared	Land cover discrimination
	4	0.8 to 0.11 Near infrared	Water discrimination
Thematic Mapper	1	0.45 to 0.52	Water penetration
	2	0.52 to 0.60	Measurement of visible green reflectance
	3	0.63 to 0.69	Vegetation discrimination
Resolution=30 m	4	0.76 to 0.90	Delineation of water bodies
	5	1.55 to 1.75	Differentiation of snow and cloud
= 120m for Band - 6	6	10.40 to 12.50	Thermal mapping
	7	2.08 to 2.35	Geological mapping

Krebs (1977) demostrated advantages of false colour composites over single bal black and white imagery. However, he suggested use of black and white imagery of some other date to detect the changes and improve classification accuracy. By this way he was able to achieve and accuracy of 90 percent in land cover mapping Denali project area in Alska, USA.

A low cost visual interpretation technique based on the use of diazo films has been recommended by Naik et al. (1978), various image enhancement procedures such as contrast stretching, bandrationing, etc. can be employed using this technique. He suggested that by exposing a combination of diapositive of one band and negative of another band, a band ratio is produced. This ratioed image is helpful in delineating vegetation.

The areas where January imagery has red tone but in March imagery has reduced or negligible red tones are deciduone forests which shed their levees. Such comparisons not only help in understanding the phenological behaviour of forests over large areas but also help in differentiation and delineation of different broad type of forests such as ever green from deciduone etc. (Madhavan Unni & Roy, (1979).

Visual interpretation of black and white imagery and false colour composite have been successfully used for preparation of land use and land cover maps at 1:250,000 m scale with 10 categories of land use and land cover in drought monitoring study of Dharworm,Belgaum and Bijapur districts of Karnataka. These maps were used to delineate irrigable non-irrigated areas (NRSA; 1980).

Gautam N.C. & Narayan E.R.A. (1983) have carried out study for land use and land cover conventory and mapping for Andhra Pradesh. This study deals with the techniques of remote sensing and how for it helps in the rapid study of geographical phenomena especially land use within a very short time. It evaluates how well data from the land sat MSS could be used to detect, identify and delineate land use features within the Andhra Pradesh 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 change.

Chinnamani S. (1983) et.al., investigated land use changes in relation to hydrology of Bhawani basin using R.S. techniques. Visually interpreted Landsat MSS data of two different dates in conjunction with the historic data acquired from the Survey of India topographic maps and field data were used in this investigation. Also landuse changes over two test sites in the basis were studied using aerial photographs. During the study, it has been observed that a direct correlation exists between the rainfall and the area to be quite remarkable, especially the 1:250,000 Fcc in assessing rapidly the temporal landuse changes of a region at a cheeper cost.

A soil and landuse survey of Mewat area, Haryana, was carried out using the aerial photographs of 1:50,000 (S. Natarajan et.al., 1986). Four major physiographic units namely hills, piedmont plain, intermontante basin and Yammuna alluvial plain were recognized. The landuse was studied in relation to the physiographic units. The leg and adopted for land use classification has physiographic at first level authority at second level and management and identification at third and fourth levels respectively.

3.0 STATEMENT OF THE PROBLEM

Landuse/Landcover are the most important surface characteristics of a basin. Various hydrologic processes such as infiltration evapotranspiration, soil moisture status etc. are influenced by Land use/Land cover characteristics of a basin. Remote sensing can best help in identifying surface cover and other land surface features and this can be used to infer the hydrologic features like runoff potential, infiltration, evaporation potential etc. A hydrologically significant landuse map is of immense use to infer about runoff potential of each category of land use and could be a valuable input for hydrologic modelling of watershed.

The Sabarmati basin has been chosen for study as a number of dams, barrages and irrigation projects are being developed in the area at Hadol, Valasna, Vijapur Sadra, Narora and Ahemadabad Landuse/Landcover and related information of the basin is required for rainfall -runoff modelling for different sub-catchments at various projects sites. The objective of the study is to prepare a detailed map at 1:250,000 showing various landuse/landcover categories.

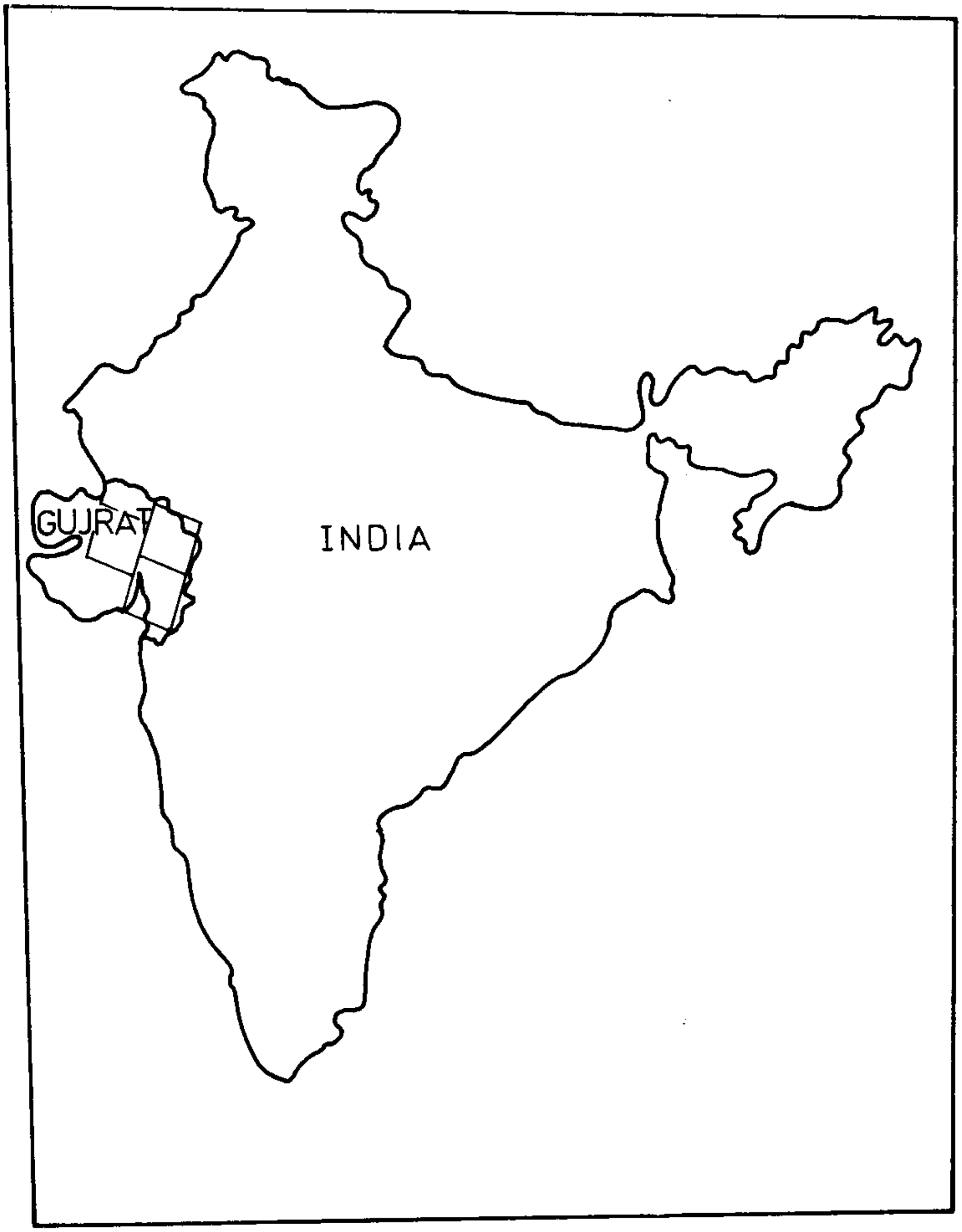


FIG. 1-IMAGE INDEX OF LANDSAT 5 OF STUDY AREA

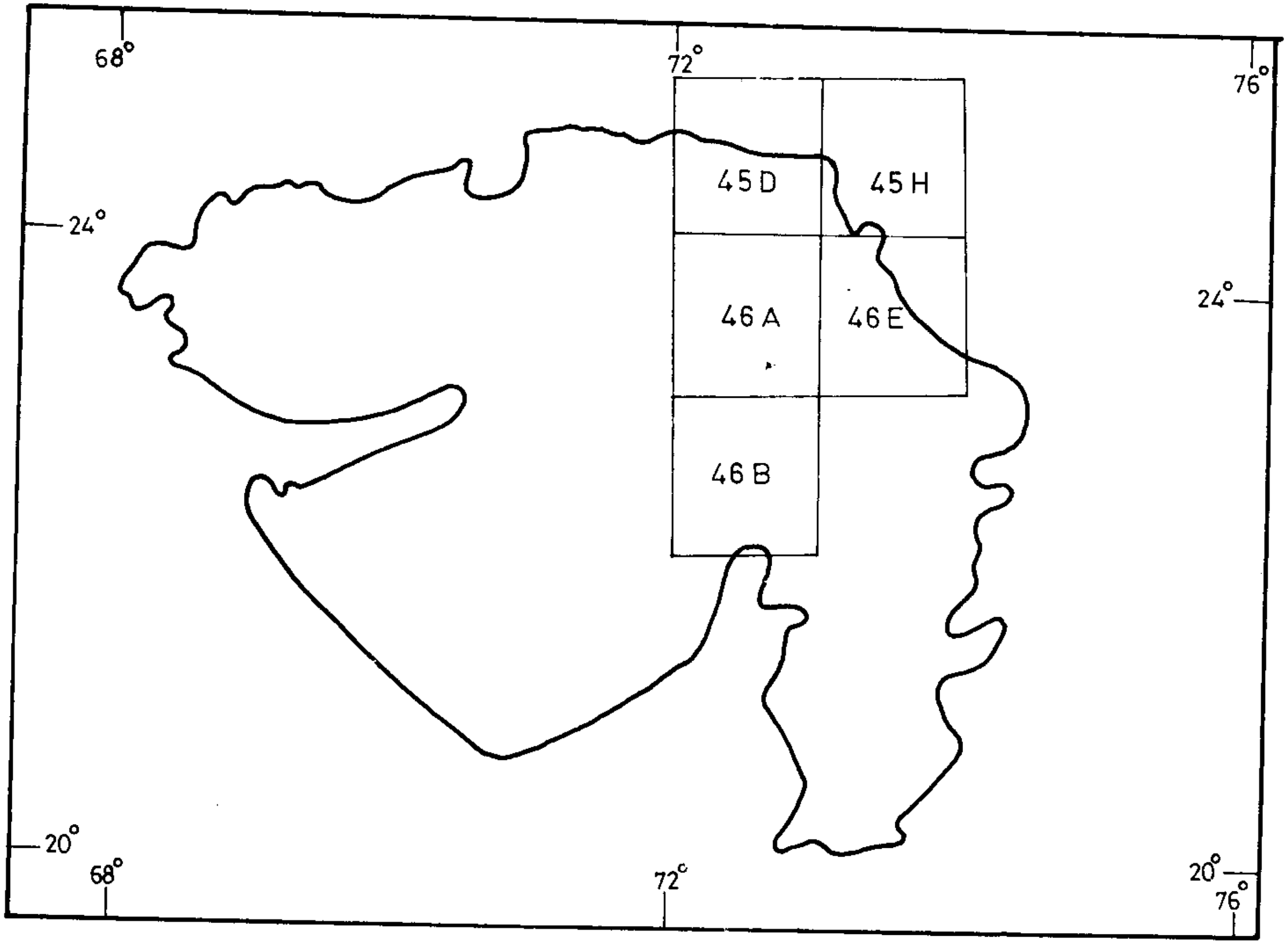


FIG.2-TOPOSHEET INDEX OF STUDY AREA

4.0 DESCRIPTION THE STUDY AREA (SABARMATI BASIN)

The area under study is the Sabarmati basin. The basin area is 23823.44 Sq.Km, and lies between longitude 22°71°15 to 73° 30 and latitude 22° to 24 45.

The Sabarmati system consists five main rivers, Sabarmati, Sei, Wakal, Harnav and Hathmati. It originates from the Aravalli Hills in Rajasthan state, not far off from the popular shrine of Amab Bhanrani. It Hraresseks a length 105 miles in South Westerly direction winding among jungle covered hills, over a bed strewn with shingle and bounderies before it enteries Dharoi gorge. From here the river comes into the plains of Gujarat and flows outh, with a slight westerly trend, till it passes Ahemadabad, and ultimately falls into the Gulf of cambay, after, having covered about 250 miles from the sources.

The major structure located are Dharoi dam near Hadol and Subhash Bridge and Wasne Barrage both an U/s & D/s of A' Bad. The Dharoi dam is located at a distance of 165 Kms. Us of the city of A'Bed.

The river sei & Wakal join the river Sabarmati U/s of Dharoi dam. E ch of these tributaries has been claim built on them, Sei dam or river and Wakel river.

The river Harnav spills its water directly in the Dharoi reservoir. In the head reaches it has Harnav dam.

The river Hathmati joins the river Sabarmati at a distance of 70 Kms/d/s of Dharoi dam. In the head reaches it also has Hathmati dam which is ungated dam.

The river Watrak joins the river Sabarmati at a distance of 40 Km d/s of A'bad. In the head reaches it has watrak dam at Bhemgoda. It receives the water of kajhan and Meshwa on the right side and shedi on left bank.

Near about the end of river Sabarmati river Omkar joins which receives the water Bhogva river.

Hadol, Valasan, Vijapur, Sadra, Narora A'bad are located on the bank of river Sabarmati other important lowers which are located in Sabarmati basin are Idar, Himat nagar, Hohanpur, Sanagli, Mehraj, Modass, Dhanpura, Baya, Prautij, Dehgam, Kapad Ganj, Balasiner, Mahudha, Dakar, Anand, Madied, Sojitra, Matar, Kaira & Mehmadabad.

Geology - The Geology of the area as evident from the geological records belongs to the archameans, Marine Jamasic, Gretacedns, basalt and recent to sub recent aluvium, and marine and aeolian deposits.

Age	Formation group
Quaternory	Alluvium, aeotian sand, laterite
Upper cretaceous to eocens	Deccan trap
Cretaceons	Lime stone and sandstone (Bogh belts) sandstone (Himat Nagar)

Precambrain	Grauite, gneiss cale gneiss schist limestone (Delhi) quartizite and phyllite (Ararallis)

Climate: - The climate of the area is tropical, semi arid monsornic type characteristics by three well defined seasons viz monsoon, winter and summer the south-west monsoon comes from third week of June and last upto the end of Sept. The average annual rainfall is 603.70 mm the intensity of rainfall is high during the months of July and August. The winter season starts from November to February. The summer season starts from March to May. The summer maximum tempt. 45° in the month of May the mean winter tempt. 12.60 the humidity is quite high during monsoon period and less during summer months.

5.0 AVAILABILITY OF DATA

This study is carried out using landsat MSS imagery together with conventional data such as Survey of India toposheets and other reference material on the subject.

5.1 Landsat Imagery

The study area is covered in four, three frances of landsat imagery (fig. 1). The imageries which were used for the study are given herein (Tables).

Table availability of Landsat data

S.No.	Path & Row No.	Satellite sensor	Bands	Fee
1.	147-044	MSS	4,5 & 7	FCC
2.	147-045	MSS	4,5 & 7	FCC
3.	148-044	MSS	4,5 & 7	FCC

5.2 Toposheets

The study area is covered in five Survey of India toposheets at 1:250,000 scale. A suitable base map of the study area was prepared from these toposheets.

The following are the toposheets used:

45 D

45 H

46 A

46 B

46 E - Index for these toposheets is shown in Fig. 2.

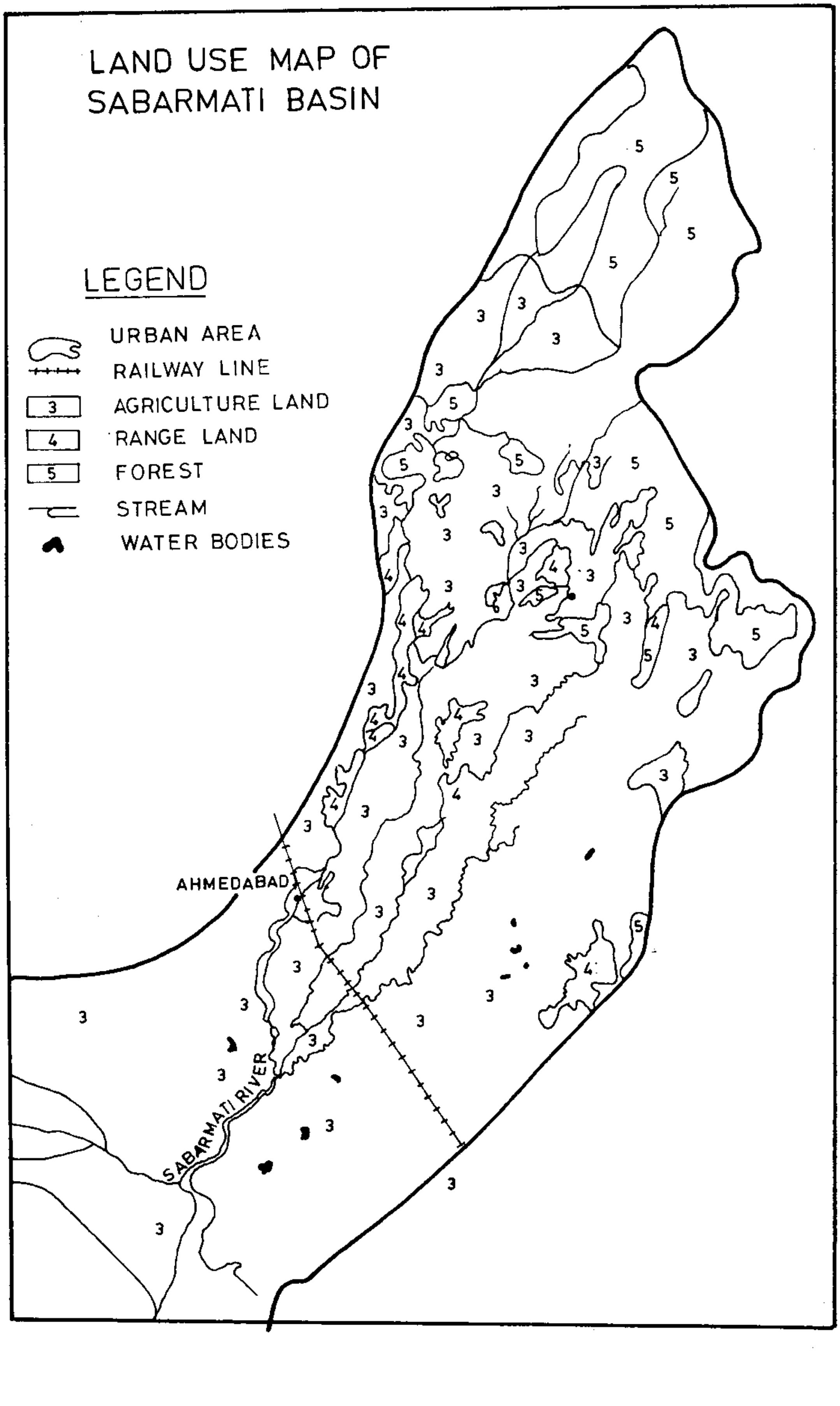
7.0 ANALYSIS AND RESULTS

Landuse mapping has been found to be very advantageous using landsat imagery because of synoptic, repetitive and multi spectral coverages of the data. The most appropriate band or combination of bands of landsat imagery should selected for each interpretive use. For the present study, bands 5 and 7 and FCC of MSS were found to be most suitable for mapping the land cover of Sabarmati basin. Standard false colour composite (FCC) area of great help in visual interpretation and mapping of landuse features as the grey tones of 3 bands (band 4,5 & 7) is colour coded and presented so that information of the 3 bands can be compared and assessed in one glance.

7.1 Visual Image Interpretation:

The Landsat B& W negative images of the area were enlarged from 1.1 in scale to 1,250,000 scale using image enlarger and B & W prints were prepared. Fabe colour composite (FCC) using overlays made by exposing bands 4,5 & 7 negatives of images to dizo films of yellow, magneta and ryan respectively were optical pentograph with magnification of 4 X.

The various categories of land use/land cover were delineated using visual interpretation technique. The informations from toposheets and other available maps used for obtaining ground truth information. The characteristics features of the different landuse/landcover


LAND USE MAP OF
SABARMATI BASIN
LEGEND
URBAN AREA
RAILWAY LINE
3 AGRICULTURE LAND
4 RANGE LAND
5 FOREST
STREAM
WATER BODIES
AHMEDABAD
SABARMATI RIVER

classes used as key in interpretation are given in Table 6.

Table 6

Signature of various Land use categories on Landsat images

Sl. No.	Category	Tone in bands	Tone in band 7	Colour ir FAC
1.	Deciduous forest	Dark grey	Ligh grey	Red
2.	Agricultural land	Grey	Ligh grey	Red with dark blue pathches in irrigation area (rough texture)
3.	Urban/built up area	Ligh grey	Dark grey	Yellow ir hight brown
4.	Streams	Grey	Dary grey	Blue
5.	Water bodies	Grey	Grey	Black

The landuse/landcover features were then transferred to the base map to prepare the landuse/landcover map of Sabarmati basin (Fig. 3)./

7.2 Land Cover Distribution:

Attempts have been made to delineate various hydrologically important land use categories. The various categories recognised in the area are as follows:

1. Deciduous forest
2. Range land
3. Agricultural land

4. Urban/built up land

5. Streams

6. Water bodies

7. Railway

8. CONCLUSION

The land use map of Sabarmati basin has been prepared using multiband landsat imagery. Seven land use categories of hydrologic importance could be deciphered from the imagery. About 17.3 percent of the area has forest cover both dense and thin. These information will be useful for runoff estimation. Agricultural activities are prominent and constitute about 79.4 percent of area. The percentage of image land both Shrub and pasture is about 2.9 percent.

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