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SEASONAL MAPPING OF WATER BODIES ALONG THE ANDHRA COAST USING SATELLITE DATA

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PREFACE

Indian experience of remote sensing applications during the last decade shows that satellite data has the capability for flood plain mapping, finding surface variations of waterbodies, ground water exploration, geological and landuse mapping etc. Before taking up any water resources project whether reservoir construction, anicut regulation or irrigation canal project to augment it's judicial management of water surrounding other waterbodies and its behavior in different seasons is mandatory. The conventional approach to collect such information have been ground based surveys which are both uneconomical and time consuming. Remote sensing methods admirably suits over conventional methods because of its capability to provide broad synoptic and repetitive coverage of the area in multispectral mode.

The study for mapping of pre- and post-monsoon variations of waterbodies along the Andhra Pradesh coast would serve as data base for better management of existing waterbodies and many other to be commissioned in near future. The report has been prepared by *V.S.Jeyakanthan, Sc.'B'* and supported by *S.V.Vijayakumar, Sc.'C'* under the guidence of *Dr.K.S.Ramasastri, Sc.'F'* ,Head & Co-ordinator of Deltaic Regional Centre.

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ABSTRACT

Before taking up any water resources project such as reservoir construction, anicut regulation or irrigation canal project to augment it's judicial management of water surrounding other waterbodies and its behavior in different seasons is required. Remote sensing methods admirably suits over conventional methods to collect such information because of its capability to provide broad synoptic and repetitive coverage of the area in multispectral mode. Andhra Pradesh coastal area has been selected to study the pre- and post-monsoon surface variations of the water bodies using 1:250,000 scale False Colour Composite (FCC). In this task a total of forty FCC's has been delineated for both the pre- and post-monsoon seasons. Along the coast twenty four medium to major reservoirs are identified and mapped including forty minor reservoirs/anicuts. Two major reservoirs Yeluru and Kanigiri are located in East Godavari and Nellore districts and the later district is commissioned with more number of reservoirs and tanks. The minimum area 0.25 sq.km which is measurable using the digital planimeter has been kept has the threshold to map the tanks/lakes. Kolleru a fresh water lake which serves as bird sanctuary covering an area of 853.8 sq.km and Pulicat Lake fully brackish waterbody measuring 508.1 sq.km are the special features among tanks and lakes. During monsoon season 904.8 sq.km coastal area get waterlogged which lies between West Godavari and Krishna districts'. Due to the involvement of small scale satellite data minor reservoir's/anicut's pre- and post-monsoon variations could not be analysed. Usage of 1:50,000 scale topographic and remote sensing data would give better results on the minor reservoirs and tanks.

1.0 INTRODUCTION

Water is one of the most important critical resources whether it is for drinking, irrigation, power generation, drinking purpose, manufacturing, recreation etc. India is blessed with abundant water resources, but what is required is its judicious use and efficient management (Ramamoorthi et al, 1991). Before taking up any water resources project such as reservoir construction, anicut regulation or irrigation canal project to augment it's judicial management of water surrounding other waterbodies and its behavior in different seasons is mandatory. For this reliable and up-to-date information is very necessary. Experience during the last fifteen years has shown that data acquired by remote sensing techniques from aerial and satellite platforms provide valuable information in developing and managing various water resources projects. It is in this context that remote sensing technology provides a powerful tool for inventorying and monitoring surface water measurements.

Conventional hydrologic measurements on ground suffer from the limitations of reliability, time effectiveness and adequacy. These measurements are also discrete in space necessitating aerial extrapolation. Repetitivity of ground measurements many times are scarce due to constraints on adequate manpower and funds. Measurements over inaccessible areas and inhospitable terrain are also limited. Remote sensing from space can advantageously complement and supplement measurement of surface water bodies to enable sound water resources management.

Andhra Pradesh coastal area has been selected to study the pre- and post-monsoon surface variations of the water bodies such as reservoirs, tanks and lakes using 1:250,000 scale georeferenced False Colour Composite (FCC).

2.STUDY AREA

2.1 STUDY AREA AND LOCATION

The coastal belt of Andhra Pradesh stretches over a distance of about 1,000 km from just north of Chennai to near Rushikulya basin in Orissa and the boundaries of coastal area is demarcated in by the contours of 100 m. Area included in the coastal Andhra which is considerably occupied by deltas is shown in Fig.2.1. Half the area of coastal Andhra Pradesh consists of the deltas of three major rivers, the Godavari, the Krishna and the Pennar, which together drain about 150,000 sq.km. of the Deccan Plate. The deltas which reach 64 km inland to Dowlaswaram on the Godavari and 72 km to Vijayawada on the Krishna form together over 1 M ha. of potentially highly productive lands. The natural slope of these lands varies from 1.0 m per 4.2 km in the head reaches of the deltas and are traversed by numerous depressions, former lagoons and tidal inlets. Poor natural drainage conditions form a major impediment to sustained high crop yields which are aggravated by occurrence of major storms. Nine coastal districts of Andhra Pradesh are as follows: Srikakulam, Vijayanagaram, Vishakhapatnam, East & West Godavari, Krishna, Guntur, Ongole and Nellore.

2.2 GEOLOGY:

In Andhra Pradesh, Tertiary formations are found in East and West Godavari districts and in small areas in Nuzvid taluk of Krishna district. Parts of Rajahmundry and Peddapuram taluks in East Godavari and Eluru, Tadepalligudem and Kovvur in West Godavari contain Tertiary formations of clays useful for the ceramics developed near Rajahmundry. Laterites occur in Kavali, Kovvur, Gudur and Sulurpet taluks in Nellore district. Some patches of Laterites are also found in Visakhapatnam district. The Recent deposits occupy the entire coastal plains of Andhra Pradesh except in the portions between Srikakulam in the north and Visakhapatnam in the South, more in the mainland in Guntur, Krishna East and West Godavari. More details are shown in Fig.2.2.

2.3 DRAINAGE:

Godavari is the largest perennial river in Peninsular India. After crossing the Eastern Ghats through picturesque gorge it emerges at Polavaram into the coastal plain. The width of the river is over 3 km at Rajahmundry and about 6 km at Dowleswaram. Below Rajahmundry it splits into the Gautami, Vasishta and Vainataya branches. The three branches join the sea near Yanam, Narasapur and Razole respectively.

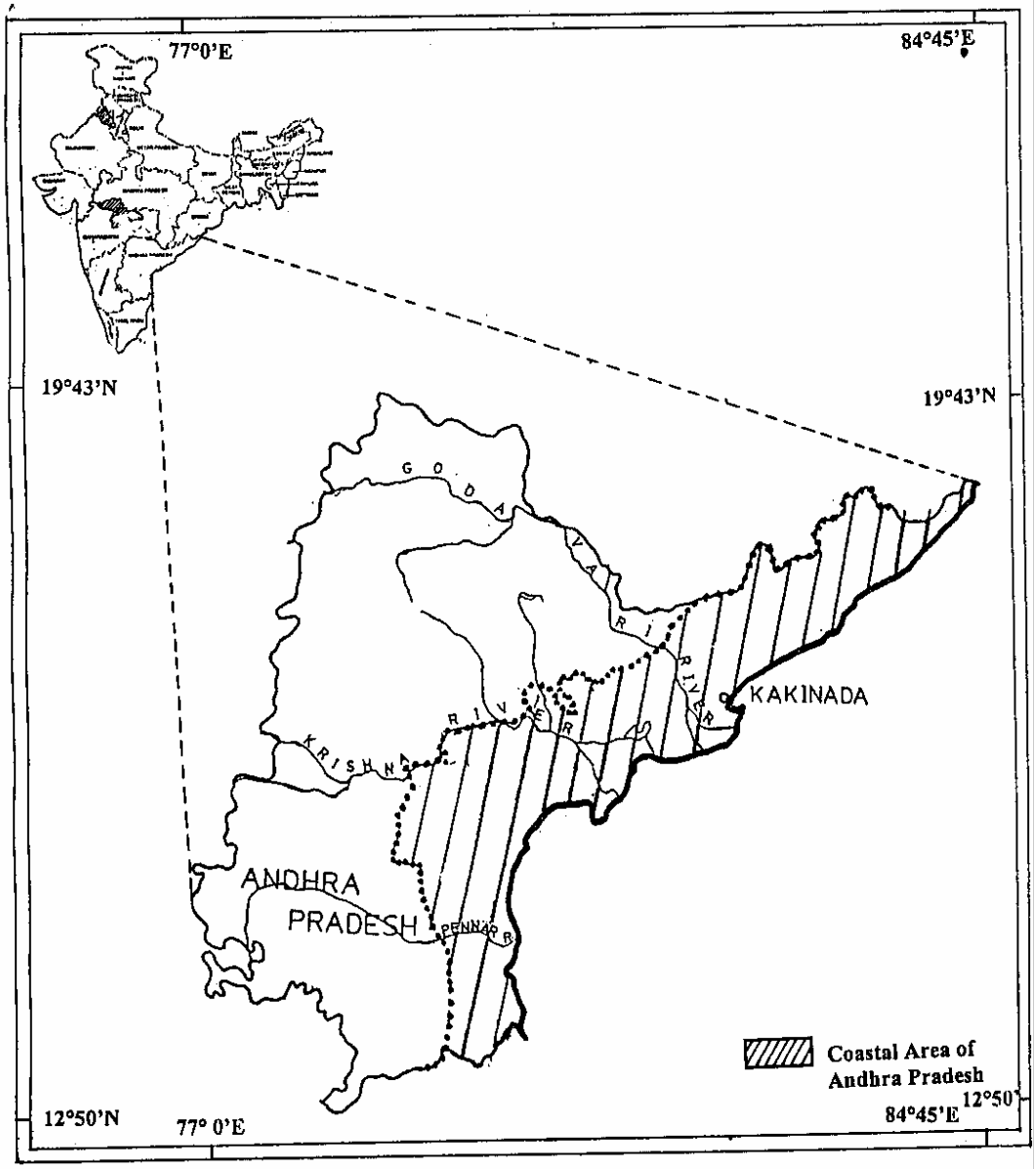

Fig.2.1 Study Area – Coastal Area of Andhra Pradesh.

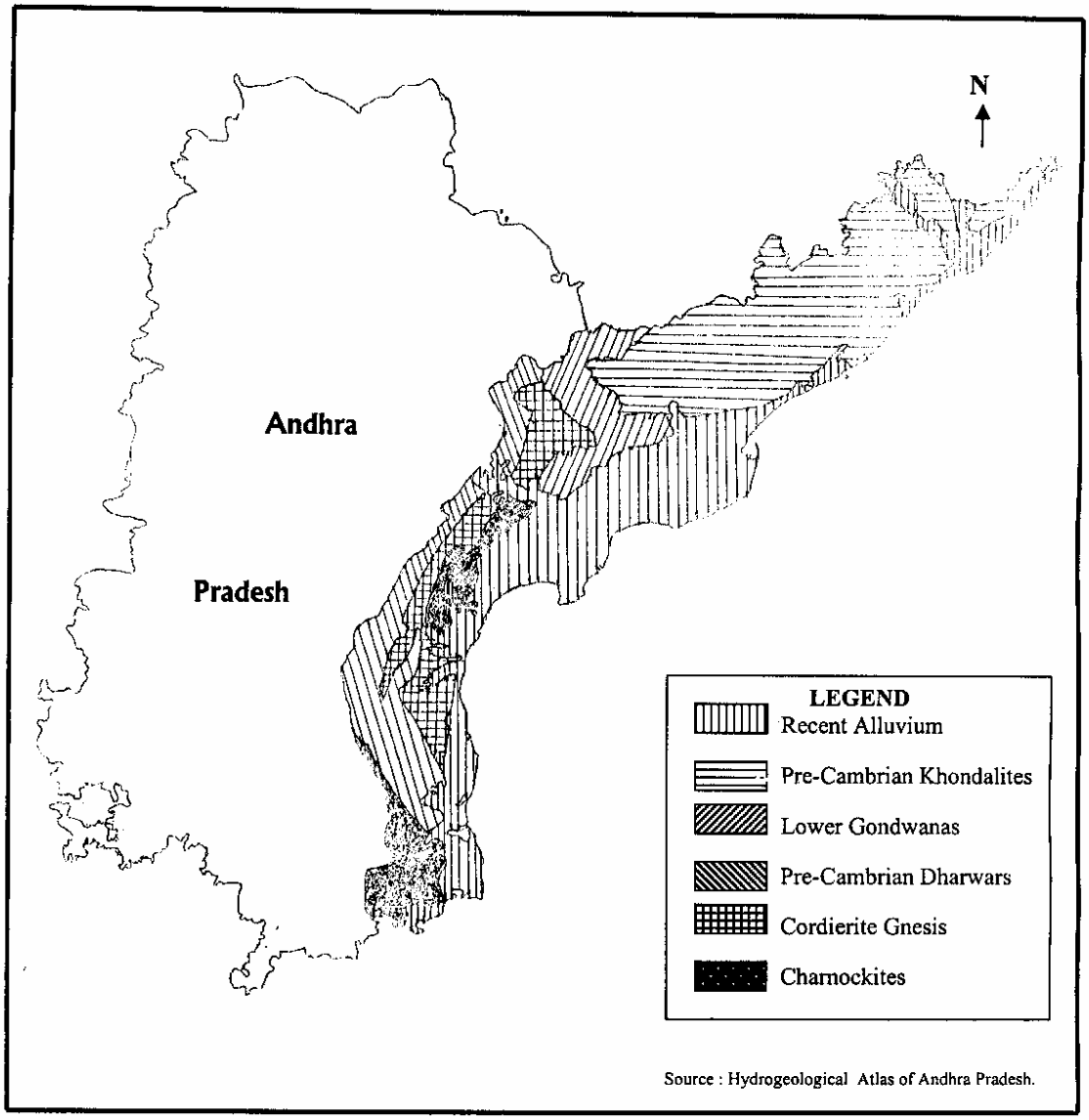

Fig. 2.2 Geology of Coastal Andhra Pradesh.

The Krishna is the second important river. It is superimposed across northern end of the Cuddapah ranges where the gradient is 0.7 m per km. Near the sea the gradient is 0.15 m per km. The river carries silt enough to cover daily an area of 12.95 sq. km to a depth of one foot during high floods. It flows into two branches near Paugadda in Krishna district enclosing the island of Diwi, and 16 km downstream splits into three branches. The Vamsadhara and Nagawali are the other notable streams of Srikakulam district.

2.4 SOILS:

The region abounds in alluvium Red soils, black Soils and laterites are also found as transported soils (Fig.2.3). Alluvial Soils are mostly found in river valleys, deltaic tracts and along the coastal area their composition and texture vary with the geological nature of the catchment area . These soils are of two types – coastal alluvium and riverine alluvium. Coastal alluvium occurs all along the coast. Riverine alluvium is found in the lower cources of the valleys of most rivers and the deltaic regions. These soils are exceptionaly fertile and highly valuable for agriculture especially paddy. The soils are generally rich in lime, poor innitrogen and phosphoric acids.

Laterites are tropical and sub-tropical soils formed by the decopmposition of gneiss. The most important components for lateritic formation are iron, alumina and silica and acid as primarymaterials for the parent rock. In Andhra it occupies parts of the godavari and Nellore Districts.

Red soils occupy considerable parts of Srikakulam, Visakhapatnam and East Godavari districts and small areas of Krishna, Guntur and Nellore of Andhra Pradesh. They are derived mainly from Archaean gneisses. The red brown colour is attributed to the diffusion of iron content. The soils are poor in lime and magnesium but rich in iron. According to texture they may be subdivided into clayey, loamy, ferruginous soils, sandy loamy soils and sandy loamy ferruginous soils.

2.5 AGRICULTURE AND THE ANDHRA COASTAL PLAINS:

Based on physical factors and economic activities, the Andhra Coastal plains can be divided into three second order regions: the Srikakulam-Visakhapatnam Lowlands or Northern Coastal Plain, the Krishna Godavari Delta or Middle Coastal Plain and Nellore or Southern coastal Plain.

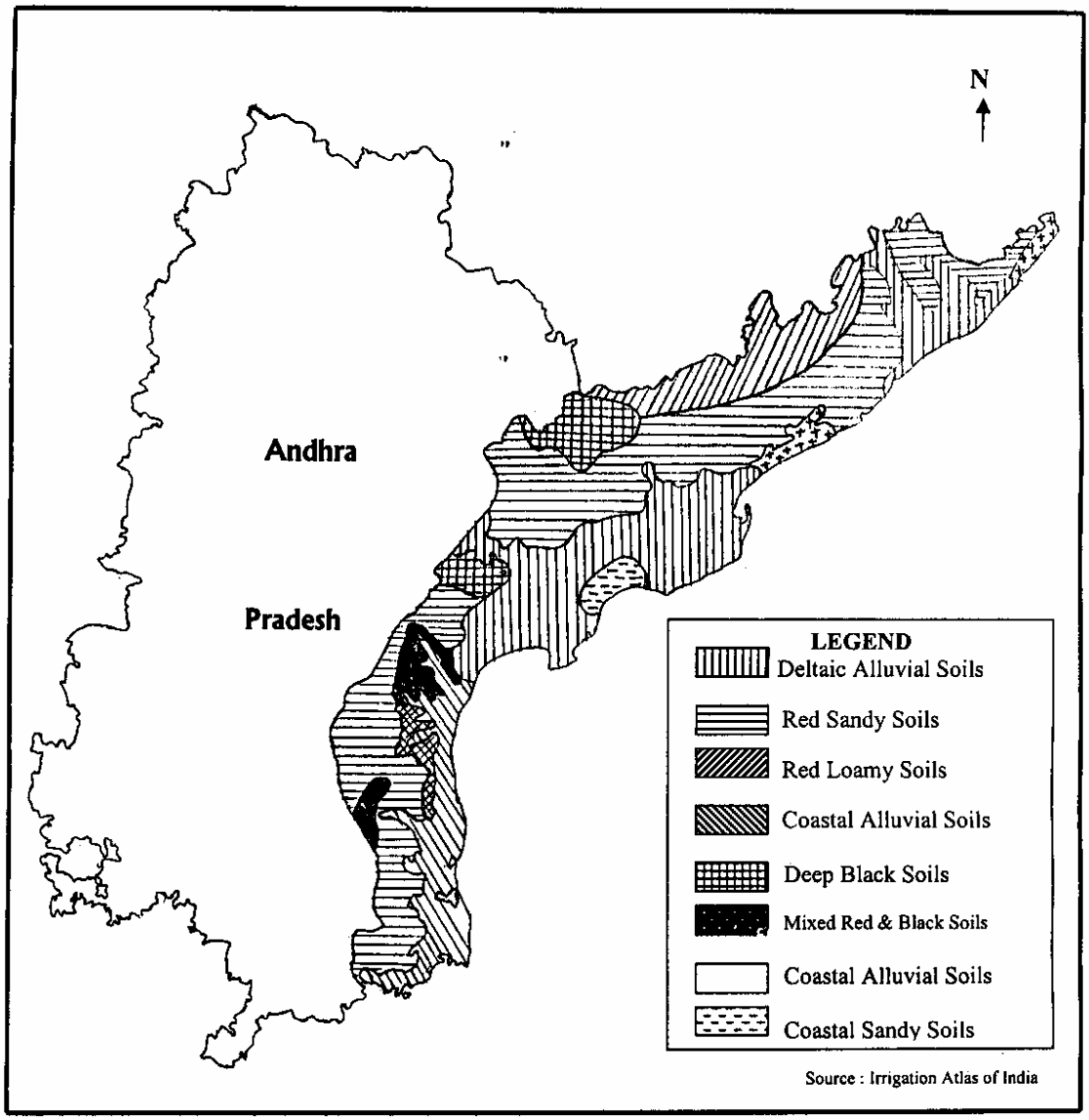

Fig. 2.3 Soils of Coastal Andhra Pradesh.

Srikakulam – Visakhapatnam Lowlands cover Srikakulam (excluding Sallur and Parvatipuram) and Visakhapatnam (excluding Chintapalli and Paderu taluks) districts. The lowland narrows down to 19 km under Mahendragiri, but on either side of this gate are embayments of the Rushikulya and the Vamsadhara. The balck soil of the valley floors grades upwards to red soils. There are numerous gneissic outcrops. Visakhapatnam lies between the Kalina ridge (490 m) and Yarada (335 m), the latter running into the Dolphin's Nose which shelters the harbor. Rice covers a third of the cultivated area, followed by Sugarcane, ragi, oilseeds, millets and pulses. Industrial development is confined mainly to jute and rice mills, and ship-building. Visakhapatanm is a industrialized city and important for port operations. The Srikakulam region is more agricultural and less developed than the Visakhapatnam region which is fairly urbanized and industrialized.

The Krishna – Godavari Delta includes the lowlands below Vijayawada and Polavaram forming the twin-delta. These lowlands are vulnerable to floods and cyclonos but form a vast expanse of rice-fields and are reputed as the "Granary of the South". Between the two deltas lies the Eluru Region where the Kolleru Lake occupies a depression cut of from the sea by siltation and serves as a good fishing ground; this region is transitional in character with Eluru and Rajahmundry as the regional hubs. The twin delta region is essentially agricultural with 80% of the area under paddy. In places jowar, sesamum and groundnuts are cultivated. Guntur, Vijayawada and Machilipatnam (Bandar) are regional centres in the Krishna delta. Nellore Coastal Plain is a transitional belt between the several urban centres. The region has rice, sugar and other agro-processing industries

2.6 CLIMATE :

The east coastal region exhibits a hot tropical climate characterized by oppressive summer, low daily range of temperature, high humidity and moderate annual rainfall. The coastal tract from Orissa to the Krishna delta experiences a tropical savanna climate; from the Krishna delta to the south it is a tropical wet and dry climate with distinct dry summer. Parts of the southern districts experience a tropical monsoon climate with a short dry winter season ; and the interior districts have a tropical arid steppe climate with winter drought. Thus this narrow strip of coast experience a tropical climate with some local variation. In general high humidity prevail throughout the year in coastal areas. Winds are of moderate strength throughout the year becoming stronger in the monsoon season (15 km per hour) and weaker in October (5-10 km). From October to January winds blow from north – east and from south-west during the summer monsoon.

3.METHODOLOGY

In the present study visual interpretation technique of satellite imageries was employed to delineate pre and post monsoon variations of waterbodies. Interpretation was carried out using 1:250,000 scale Indian Remote Sensing Satellite (IRS) imageries. Comparison of pre and post monsoon period data helped in better identification of waterbodies and other required features if the postmonsoon data is covered with snow. Imageries required for the analysis comprises a total of forty for both pre and post monsoon season. Due to the involvement of more imageries it has became necessary to arrange the imageries in a specific order (interpretation carried out from North Srikakulam to South Nellore district) before interpretation to take place. The task was performed using the software Integerated Digital Reference Scheme (IDRS), Satellite index map and other collateral data. While the preliminary analysis carried out it was found that the size of appearance of most of the waterbodies are very small to be presented in the report. This is due to small scale imageries employed. To keep the waterbodies with less reduced size so that it could be visible in the maps it was decided to present the interpreted maps Path & Row wise.

3.1 SATELLITE DATA:

Details of 1:250,000 scale False Colour Composite (FCC) of IRS, LISS-II data used for delineation are given in Table No.3.1.

Table No.3.1 Details of IRS Data Product Used.

Sl.No.	Name of the Satellite	Path – Row & SubScene	Date	
			Premonsoon	Post Monsoon
1.	IRS – IA	21 – 55 – B1	08.04.89	06.12.89
2.	IRS – IA	21 – 55 – A2	08.04.89	06.12.89
3.	IRS – IA	21 – 55 – B2	08.04.89	06.12.89
4.	IRS – IA	22 – 55 – B2	09.04.89	06.12.89
5.	IRS – IA	21 – 56 – A1	08.04.89	06.12.89
6.	IRS – IA	23 – 56 – B2	10.04.89	16.11.89
7.	IRS – IA	22 – 56 – A1	09.04.89	07.12.89
8.	IRS – IA	22 – 56 – A2	09.04.89	07.12.89
9.	IRS – IA	22 – 56 – B1	09.04.89	07.12.89
10.	IRS – IA	22 – 56 – B2	09.04.89	07.12.89
11.	IRS – IA	22 – 57 – A1	09.04.89	07.12.89
12.	IRS – IA	24 – 57 – B2	11.04.89	09.12.89
13.	IRS – IA	23 – 57 – A1	10.04.89	03.10.89
14.	IRS – IA	23 – 57 – A2	10.04.89	03.10.89
15.	IRS – IA	23 – 57 – B1	10.04.89	03.10.89
16.	IRS – IA	23 – 57 – B2	10.04.89	03.10.89
17.	IRS – IA	24 – 58 – A1	11.04.89	09.10.89
18.	IRS – IA	24 – 58 – B1	11.04.89	09.12.89
19.	IRS – IA	24 – 58 – B2	11.04.89	09.12.89
20.	IRS – IA	23 – 59 – A1	10.04.89	25.10.89

4.0 RESULTS AND DISCUSSION

4.1 RESERVOIRS:

Along the Andhra Coast twenty four medium to major reservoir were identified and mapped (Fig.1 to Fig.19) using 1:250,000 scale imageries including the minor reservoirs/anicuts nearly forty reservoirs found. Mapped reservoirs water spread area various from 1.53 sq.km to 37.50 sq.km in the postmonsoon season. It's variations in the pre- and post-monsooon period are furnished in Table 4.1. From the table it could be found that the district Nellore is commissioned with more number of reservoirs. Two major reservoirs Yeluru and Kanigiri are located in the coastal districts East Godavari and Nellore respectively. The minor reservoirs which appears very small in the imagery could not be measured using digital planimeter are marked as R (Reservoir) in their respective maps. Due to want of few toposheets instead of names of the reservoirs they are numbered as R1, R2 etc. for their easy identification.

Table 4.1 Pre and Post-monsoon Variations of Reservoirs Mapped in the Coastal Districts.

Sl.No.	Name of the Reservoir.	Water spread area in the Pre-monsoon Season (km^2).	Water spread area in the Post-monsoon Season (km^2).	Change in size(%) of Reservoirs between Pre- and Post-monsoon Seasons.	District	Reference
1.	Gadi Gedda Reservoir	0.67	1.53	56.2	Vijayana	Fig.3
2.	Goastani Reservoir	10.30	11.25	8.4	garam	Fig.3
3.	Tatipudi Reservoir	8.13	11.88	31.6		Fig.4
4.	Gonam Reservoir	1.88	2.50	24.8		Fig.4
5.	Mahadrigedda Reservoir	3.75	9.38	60.0		Fig.5
6.	Kanithi Reservoir	3.75	3.75	Nil	Visakhap	Fig.5
7.	Varaha Reservoir	1.52	2.19	30.6	atnam	Fig.6
8.	Timmaraju Cheruvu	10.00	13.75	27.3		Fig.7
9.	Yeleru Reservoir	5.75	35.63	83.9		Fig.7
10.	Pampa Reservoir	T	3.75	100.0	East	Fig.7
11.	Subareddy Sagar	0.63	1.87	66.3	Godavari	Fig.7
12.	Lubbti Reservoir	D	1.00	100.0		Fig.7
13.	Mallavaram Cheruvu	D	1.88	100.0		Fig.7
14.	Buradakalva Reservoir	D	1.88	100.0	West	Fig.7
15.	Erakalava Reservoir	9.50	12.5	24.0	Godavari	Fig.10
16.	Mappedu Reservoir	4.38	5.63	22.2		Fig.16
17.	Reservoir - R1	D	1.88	100.0		Fig.16
18.	Reservoir - R2	D	1.25	100.0		Fig.16
19.	Reservoir - R3	D	1.87	100.0	Nellore	Fig.16
20.	Reservoir - R4	D	2.50	100.0		Fig.16
21.	Ganatipalem Reservoir	5.60	8.13	31.1		Fig.16
22.	Sagileru Reservoir	3.75	7.50	50.0		Fig.16
23.	Kanigiri Reservoir	33.75	37.50	0.7		Fig.17
24.	Ralapadu Reservoir	1.25	10.00	87.5		Fig.17

Change in percentage of reservoirs in the pre and post monsoon period various between 0.7 to 100 and the average change in percentage is 61.1. The reservoirs which are included in different river basins and catchment area are given in Table.4.2.

Table.4.2 Name of the Reservoirs and their River Basins.

Sl.No.	Name of the Reservoir	River Basin or Catchment Area	Reference
1.	Gadi Gedda Reservoir	Minor Catchments between Nagavali and Sarada River Basins.	Fig.3
2.	Goastani Reservoir		Fig.3
3.	Tatipudi Reservoir		Fig.4
4.	Gonam Reservoir		Fig.4
5.	Mahadrigedda Reservoir		Fig.5
6.	Kanithi Reservoir		Fig.5
7.	Varaha Reservoir	Sarada Reservoir	Fig.6
8.	Timmaraju Cheruvu	Minor Catchments between Godavari and Sarada River Basin	Fig.7
9.	Yeleru Reservoir		Fig.7
10.	Pampa Reservoir		Fig.7
11.	Subareddy Sagar		Fig.7
12.	Lubbti Reservoir		Fig.7
13.	Mallavaram Cheruvu		Fig.7
14.	Buradakalva Reservoir		Fig.7
15.	Erakalava Reservoir	Inter Stream Between Godavari and Krishna River Basins	Fig.10
16.	Mappedu Reservoir	Manneru River Basin	Fig.16
17.	Reservoir - R1		Fig.16
18.	Reservoir - R2		Fig.16
19.	Reservoir - R3		Fig.16
20.	Reservoir - R4		Fig.16
21.	Ganatipalem Reservoir		Fig.16
22.	Sagileru Reservoir		Fig.16
23.	Ralapadu Reservoir		Fig.17
24.	Kanigiri Reservoir	Pennar River Basin	Fig.17

4.2 TANKS/LAKES:

Innumerable tanks/lakes are found along the coastal districts hence 0.25 sq.km which is the minimum area measurable using digital planimeter has been kept has threshold to measure the pre- and post-monsoon variations of the tanks and lakes. The scale 1: 250,000 have restrictions in measuring the water surface of the threshold kept tanks and lakes. To over come this problem fully submerged measurable tanks are selected from FCC's and its corresponding area in 1:50,000 scale toposheets compared and found both of them are 100% coherent. Tanks and lakes which are at the full submerged level in the post monsoon period are identified and the area thus measured are furnished in there respective districts.

While the analysis was carried out for the pre-monsoon FCC's it was found that most of the tanks/lakes were totally dry and they are termed as D. The waterbody which is having very small amount of water measured using digital planimeter gave erroneous

results are termed as T (Trace). Among the coastal districts of Andhra Pradesh Srikakulam stands first while moving from north to south. This district contains few number of saltpans (sea water is evaporated naturally to obtain salt) where more seawater is obtained into the saltpans in the premonsoon season to augment the salt making process where as in the post monsoon season its water spread area reduces. During the non-monsoon season by the tidal action considerable amount of sea water penetrates into the rivers are termed as brakish water. Tone variations is used to differentiate between brakish and fresh water bodies. Computed change in water spread area are given in the table. Cheruvu in Telugu implies Tanks/Lakes.

Table 4.3 Pre and Post Monsoon Variations of Tanks/Lakes in the Coastal area of Srikakulam District.

Sl.No	Name of the Waterbody.	Water spread area in the Pre-monsoon Season (km^2).	Water spread area in the Post-monsoon Season (km^2).
1.	Saltpans – ①	6.25	4.38
2.	Saltpans - ②	15.63	10.25
3.	Tammyyavalasa Cheruvu	D	0.48
4.	Chikatipeta Cheruvu	D	0.53
5.	Kancharam Cheruvu	D	0.25
6.	Boduru Cheruvu	T	1.00
7.	Mandavakuritu Cheruvu	T	0.80
8.	Venkatarayulu Cheruvu	T	1.43
9.	Maredubaka Cheruvu	D	0.33
10.	Vijayarampuram Cheruvu	D	0.20

Table 4.4 Pre and Post Monsoon Variations of Tanks/Lakes in the Coastal area of Vijayanagaram District.

Sl.No	Name of the Waterbody.	Water spread area in the Pre-monsoon Season (km^2).	Water spread area in the Post-monsoon Season (km^2).
1.	Kotta Cheruvu	D	0.38
2.	Jaggalahpeta Cheruvu	T	1.30
3.	Chillapata Cheruvu	D	0.35
4.	Pedda Cheruvu	T	0.58
5.	Lakidam Cheruvu	D	0.38
6.	Ravivalasa Cheruvu	D	0.23
7.	Siripuram Cheruvu	D	0.20
8.	Budatanapalli Cheruvu	D	0.35
9.	Rayindram Cheruvu	D	0.23
10.	Nelivada Cheruvu	D	0.40
11.	Goltam Cheruvu	D	0.23
12.	Pedanagipeta Cheruvu	D	0.43
13.	Chinatalaped Cheruvu	D	0.33
14.	Raju Cheruvu	T	0.73
15.	Padagalapeta Cheruvu	D	0.20

Table 4.5 Pre and Post Monsoon Variations of Tanks/Lakes in the Coastal area of Vizagapatnam District.

Sl.No	Name of the Waterbody.	Water spread area in the Pre-monsoonSeason (km^2).	Water spread area in the Post-monsoon Season (km^2).
1.	Lakshmipuram Cheruvu	T	1.43
2.	Benavolu Cheruvu	T	0.50
3.	Srirampuram Cheruvu	D	0.65
4.	Vanpadu Cheruvu	T	2.00
5.	Ramaraogari Cheruvu	T	5.05
6.	Uppu Cheruvu	T	0.85
7.	Krishnapuram Cheruvu	D	0.33
8.	Tatiparti Cheruvu	D	0.40
9.	Kodavali Cheruvu	D	0.33
10.	Narrasanna Cheruvu	D	0.60
11.	Madavapuram Cheruvu	T	0.85
12.	Ramanapalli Cheruvu	T	1.00
13.	Komaravolu Cheruvu	T	1.58
14.	Narasipatnam Cheruvu	D	0.40
15.	Lakshipuram Cheruvu	D	0.25
16.	Giduturu Cheruvu	D	0.33
17.	Tangeda Cheruvu	D	0.25
18.	Elamanchili Cheruvu	D	0.40
19.	Krishnapalam Cheruvu	T	1.28
20.	Koruprolu Cheruvu	D	0.48
21.	Gurvajupeta Cheruvu	D	0.50
22.	Sarrasiddhi Cheruvu	D	0.33
23.	Lingarajupalam Cheruvu	D	0.25
24.	Narasapuram Cheruvu	D	0.40
25.	Sanjivapuram Cheruvu	D	0.25
26.	Kottapeta Cheruvu	D	0.35
27.	Dudduwaka Cheruvu	D	0.38
28.	Antakapalli Cheruvu	D	0.23
29.	Gotivada Cheruvu	D	0.23
30.	Mallunayachepalam Ch.	D	0.33
31.	Gorapalli Cheruvu	D	0.28
32.	Iruvada Cheruvu	D	0.30
33.	Bhimali Cheruvu	D	0.40
34.	Tatituru Cheruvu	T	1.55
35.	Katamani Cheruvu	T	0.73
36.	Mukundaraju Cheruvu	T	1.03
37.	Narayanapuram Cheruvu	D	0.35
38.	Tunipolam Cheruvu	D	0.33
39.	Mudasarlova Cheruvu	D	0.33

Table 4.6 Pre and Post Monsoon Variations of Tanks/Lakes in the Coastal area of East Godavari District.

Sl.No	Name of the Waterbody.	Water spread area in the Pre-monsoon Season (km^2).	Water spread area in the Post-monsoon Season (km^2).
1.	Pedda Bapanna Cheruvu	T	0.50
2.	Bandapudi Cheruvu	D	0.25
3.	Gangamma Cheruvu	T	0.68
4.	Mulgapudi Cheruvu	T	0.73
5.	Chinnayapalam Cheruvu	D	0.38
6.	Timmaraju Cheruvu	T	2.50
7.	Subbareddi Sager	D	0.45
8.	Rangamma Cheruvu	T	0.75
9.	Doddigunta Cheruvu	D	0.25
10.	Jeggayya Cheruvu	D	0.45
11.	Jalluru Cheruvu	D	0.35
12.	Kumarapuram Cheruvu	D	0.35
13.	Gokivada Cheruvu	D	0.32
14.	Rayavarm Cheruvu	D	0.45
15.	Pattipadu Cheruvu	D	0.68
16.	Dharmavarm Cheruvu	T	0.53
17.	Dusalam Cheruvu	T	1.55
18.	Kandregula Cheruvu	D	0.38
19.	Gollalagunta Cheruvu	D	0.43
20.	Lingala Cheruvu	T	0.90
21.	Vedulla Cheruvu	D	0.54
22.	Pedda Cheruvu	D	0.43
23.	Ramavarapu Ava	T	1.48
24.	Peddapatruni Cheruvu	D	0.40
25.	Bhupalaraju Cheruvu	D	0.25
26.	Raju Cheruvu	D	0.35
27.	Dasarivari Cheruvu	D	0.23
28.	Talla Cheruvu	D	0.15
29.	Aravalu Cheruvu	D	0.33
30.	Achayampalam Cheruvu	D	0.23
31.	Keshhavaram Cheruvu	D	0.30
32.	Ragavapuram Cheruvu	D	0.32
33.	Gaddapalam Cheruvu	T	0.75
34.	Tanikonda Cheruvu,	D	0.53
35.	Achyapuram Cheruvu	D	0.33
36.	Shrirangapatnam Che.	D	0.63
37.	Pedda Cheruvu	T	1.13
38.	Kotta Cheruvu	D	0.38
39.	Konetivari Cheruvu	T	1.43
40.	Kanupuru Cheruvu	D	0.28
41.	Rajavarm Cheruvu	D	0.30
42.	Mallisala Cheruvu	D	0.38
43.	Jaggappa Cheruvu	T	1.03
44.	Venkayya Cheruvu	T	1.33
45.	Murari Cheruvu	T	1.50
46.	Gandepalli Cheruvu	T	0.58
47.	Mallipalli Cheruvu	T	1.30

48.	Chandredu Cheruvu	D	0.43
49.	Narandapuram Cheruvu	D	0.25
50.	Gundapalli Cheruvu	T	1.88
51.	Sriramapuram Cheruvu	D	0.68
52.	Narasipatnam Cheruvu	D	0.40

Due to want of few toposheets instead of names of the Tanks/Lakes they are numbered as 1, 2 etc. for their easy identification with their respective maps. The following tanks/lakes present in the Ongole and Nellore distrits are larger in size to be measured directly from the imageries.

Table 4.7 Pre and Post Monsoon Variations of Tanks/Lakes in the Coastal area of Ongole and Nellore District.

Number of the Tank/Lake mentioned in the map.	Waterspread area in the Pre-Monsoon Season (Sq.km)	Waterspread area in the Post Monsoon Season (Sq.km)	Reference
1.	2.50	2.50	
2.	0.94	0.94	
3.	0.63	0.63	
4.	2.50	2.50	
5.	1.57	1.57	
6.	2.32	2.32	
7.	3.13	3.33	
8.	3.13	3.23	Fig.15.
9.	D	3.75	
10.	D	1.88	
11.	D	1.58	
12.	D	1.25	
13.	D	1.25	
14.	D	1.88	
15.	D	3.13	
1.	D	1.25	
2.	D	0.63	
3.	D	3.75	
4.	D	7.50	
5.	D	3.13	
6.	D	1.25	
7.	D	0.78	
8.	D	1.25	Fig.17
9.	D	4.38	
10.	D	1.68	
11.	D	1.25	
12.	0.63	1.25	
13.	D	1.56	
14.	1.20	2.50	
15.	1.25	3.75	
16.	D	1.88	
17.	1.25	3.75	
18.	D	2.50	
19.	D	1.25	

20.	D	0.98	
21.	D	1.87	
22.	1.88	3.45	
23.	1.88	2.54	
24.	3.13	8.13	
25.	D	1.98	
26.	D	3.11	
27.	D	5.63	
28.	D	3.13	
29.	D	1.25	
30.	D	3.29	
31.	D	2.50	
32.	D	3.13	
33.	D	1.88	
34.	0.63	1.88	
35.	1.25	5.63	
36.	2.50	7.50	
37.	D	1.25	Fig.17
38.	D	1.15	
39.	3.13	13.75	
40.	D	1.88	
41.	D	3.13	
42.	D	1.25	
43.	D	1.88	
44.	D	2.50	
45.	D	3.13	
46.	D	2.50	
47.	D	4.38	
48.	D	1.25	
49.	D	1.88	
50.	D	2.50	
1.	D	16.25	
2.	D	2.50	
3.	D	1.25	
4.	D	1.25	
5.	D	2.50	
6.	D	1.88	
7.	D	2.50	
8.	D	4.38	
9.	D	1.88	Fig.18
10.	D	1.88	
11.	D	2.50	
12.	D	1.88	
13.	D	1.87	
14.	D	1.88	
15.	D	1.25	
16.	D	1.78	
17.	D	2.53	
18.	D	1.81	
19.	D	1.88	
20.	D	2.50	
21.	D	1.25	

Kolleru Lake: The lake (Fig.10)is unique in many aspects, it is an extensive shallow depression formed as a result of krishna and Godavari rivers located in the West Godavari district. It is designated as an international wet land and bird sanctuary suitated at 40 km away from the beach. The lake have a total water spread area of 853.76 sq.km in the post monsoon period which is classified into shallow and very shallow water spread area. Shallow area comprises 248.17 sq.km and the very shallow is 568.76 sq.km which is 29.07% and 66.62% respectively. With in the lake vegetation occupies an area of 24.38 sq.km. Due to the presence of only one outlet from the lake called Upputeru the sourrnding area gets heavily inundated if there is a huge rainfall in the catchment area of the lake. In the premonsoon season water spread area of the lake dramatically reduces to 72.6 sq.km which is only 8.5% of the total area.

Pulicat Lake: On the border of Andhra and Tamilnadu coastal districts is the Pulicat (Fig.19) a backwater lake. It is cut of from the bay by a long spit of sand and mud. The tides have free entrance and the water constantly changing in brackish. Salinity is less in monsoon period and grater in summer. The lake is 80 km long NS and 3 to 18 km across comprises several small islands within it. Premonsoon and postmonsoon water spread area of the lake is 392.50 sq.km and 508.13 sq.km respectively. Premonsoon season is classified as deep water, shallow and water receding area which are 303.75 sq.km, 88.75 sq.km and 101.25 sq.km respectively. Water spread area of postmonsoon period includes deep water and shallow water area which occupies 318.13 sq.km and 190.00 sq.km respectively.

4.3 WATERLOGGED AREA

12.5 km to 18.75 km from the coastal line of West Godavari and Krishna districts are heavily inundated during the monsoon period at different locations occupies an area (Fig.11) of 904.75 sq.km. 90% of this inundated area situated between Krishna and Godavari rivers is classified as severely waterlogged area.

Near Vijayawada (Fig.12) at the right and left bank of Krishna River an area of 61.88 sq.km and 62.5 sq.km is waterlogged during the monsoon period also an area of 153.13 sq.km is waterlogged which is located in the NE direction and at a distance of 25 km from Vijayawada.

An area of 76.50 km (Fig.14) and 195.00 sq.km (Fig.13) get waterlogged which is located at the right and left side of the Krishna river mouth.

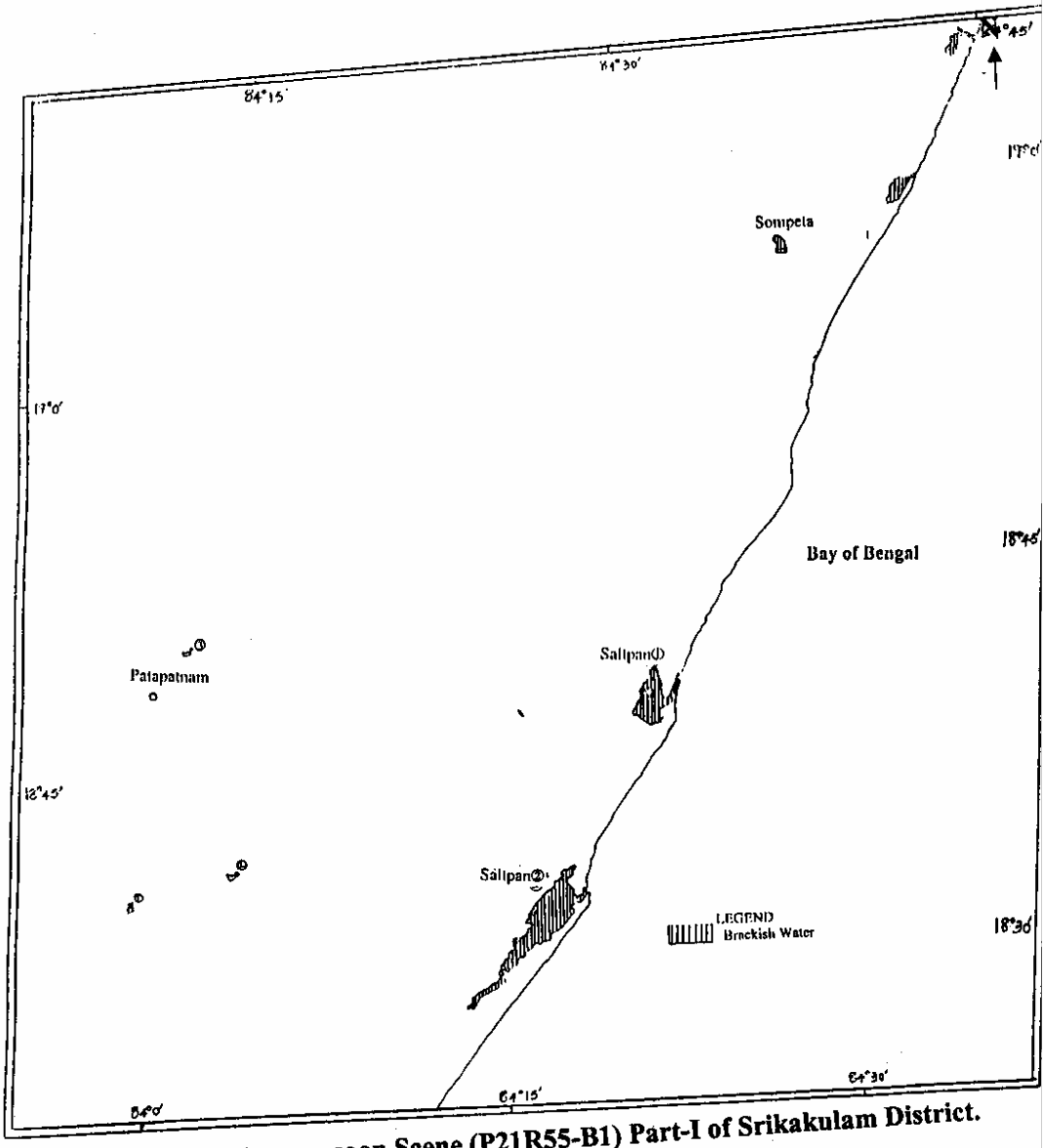

Fig.1.a. Premonsoon Scene (P21R55-B1) Part-I of Srikakulam District.

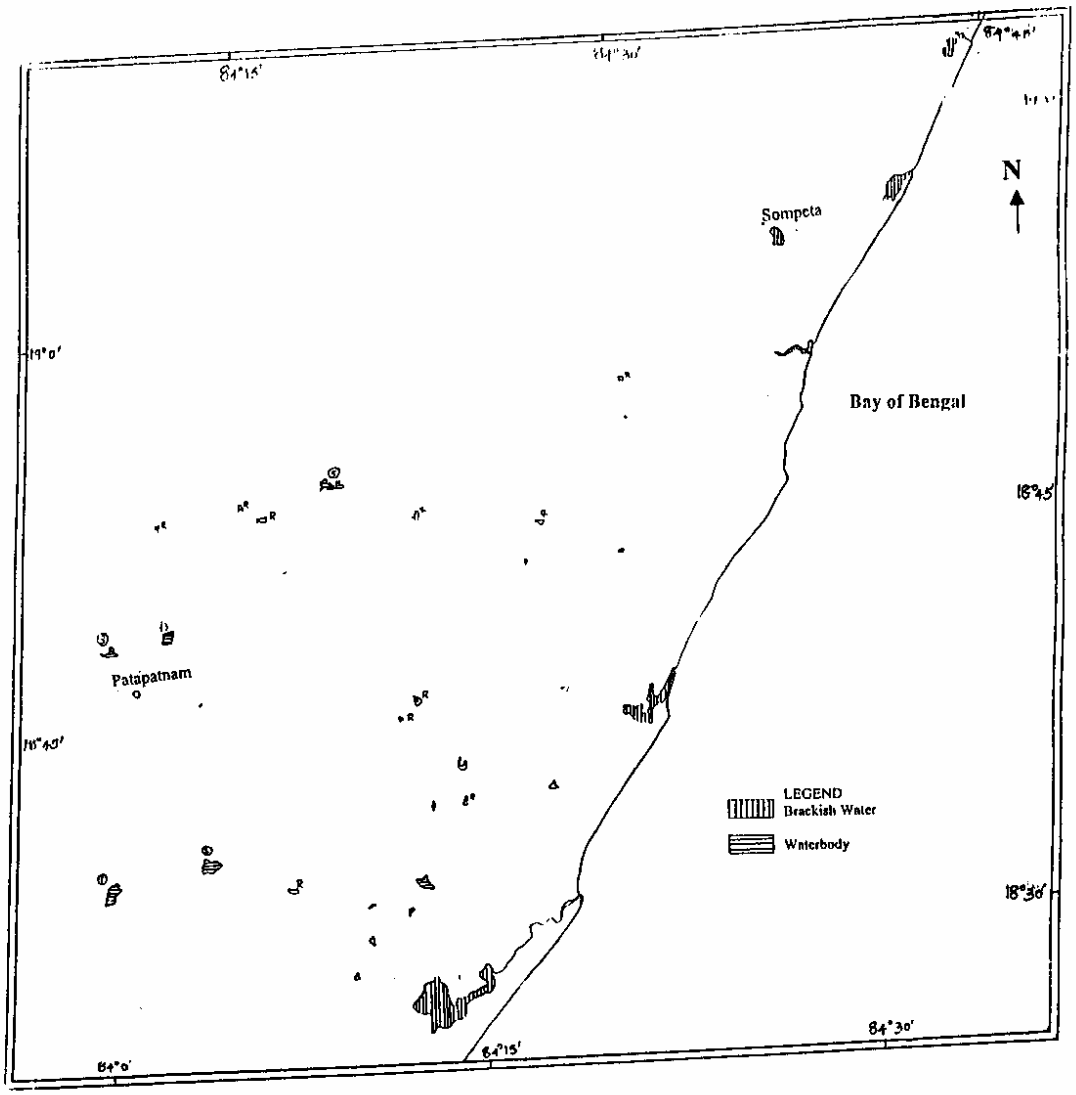

Fig.1.b. Postmonsoon Scene (P21R55-B1) Part-I of Srikakulam District.

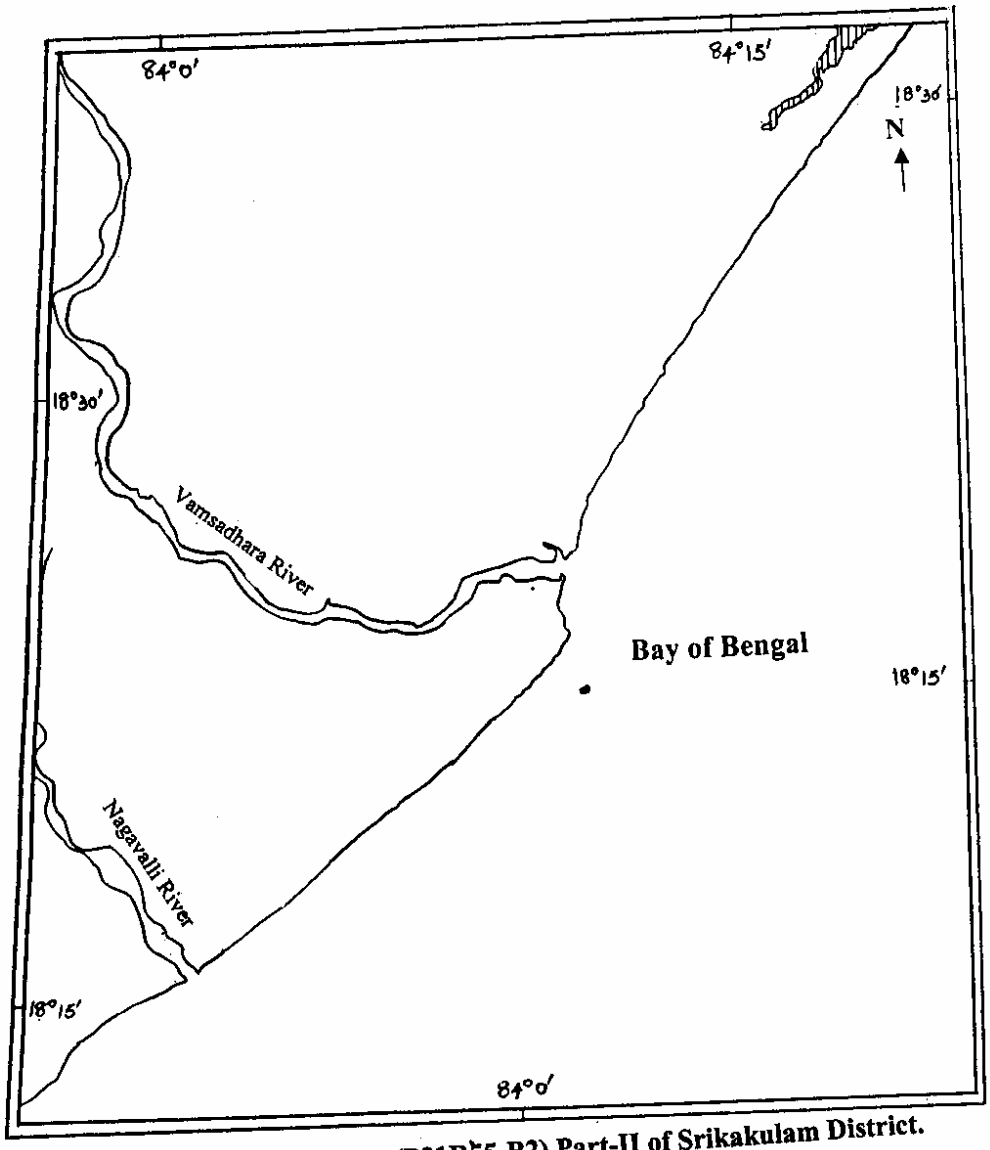

Fig.2.a. Premonsoon Scene (P21R55-B2) Part-II of Srikakulam District.

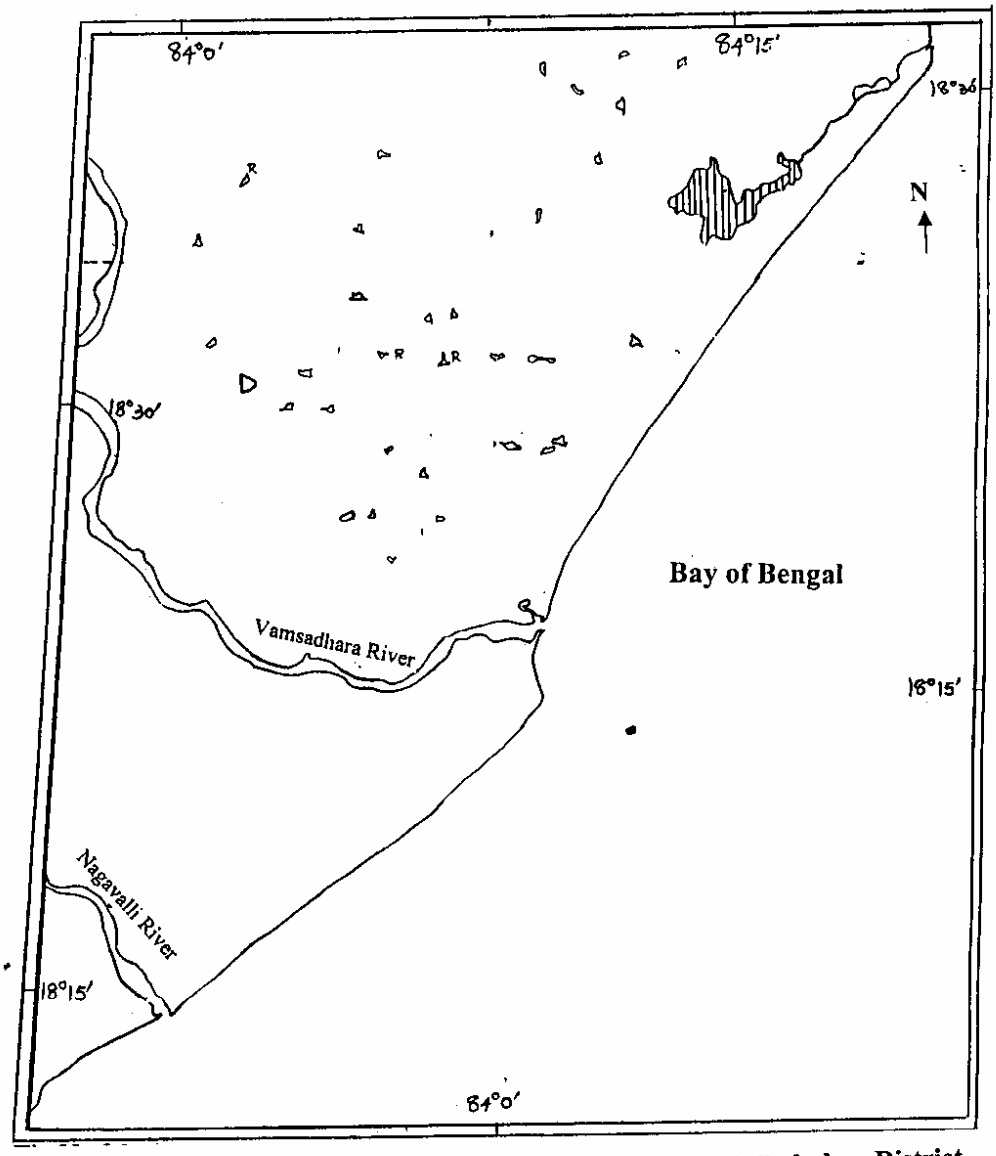

Fig.2.b. Postmonsoon Scene (P21R55-B2) Part-II of Srikakulam District.

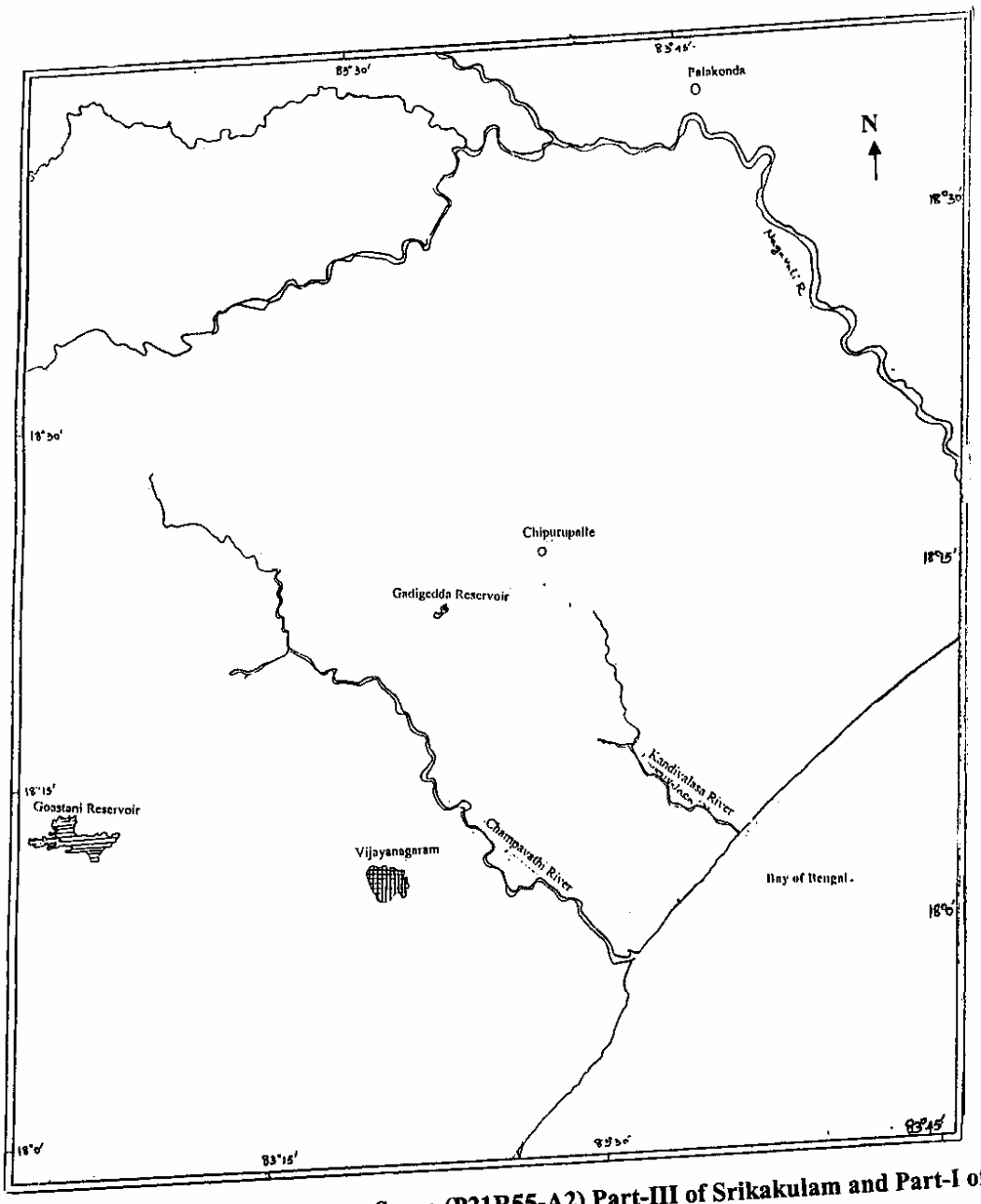

Fig.3.a. Premonsoon Scene (P21R55-A2) Part-III of Srikakulam and Part-I of Vijayanagaram District.

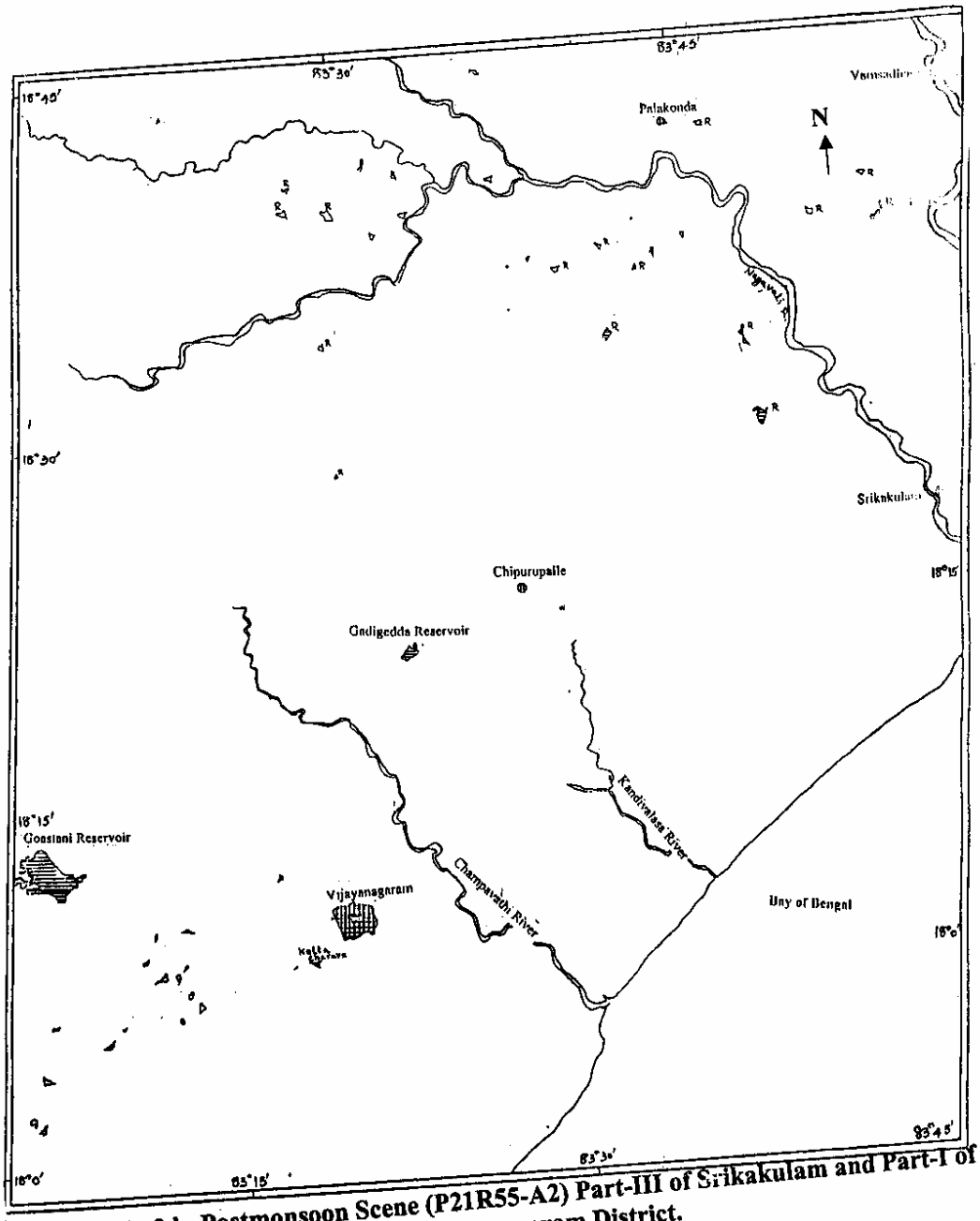

Fig.3.b. Postmonsoon Scene (P21R55-A2) Part-III of Srikakulam and Part-I of Vijayanagaram District.

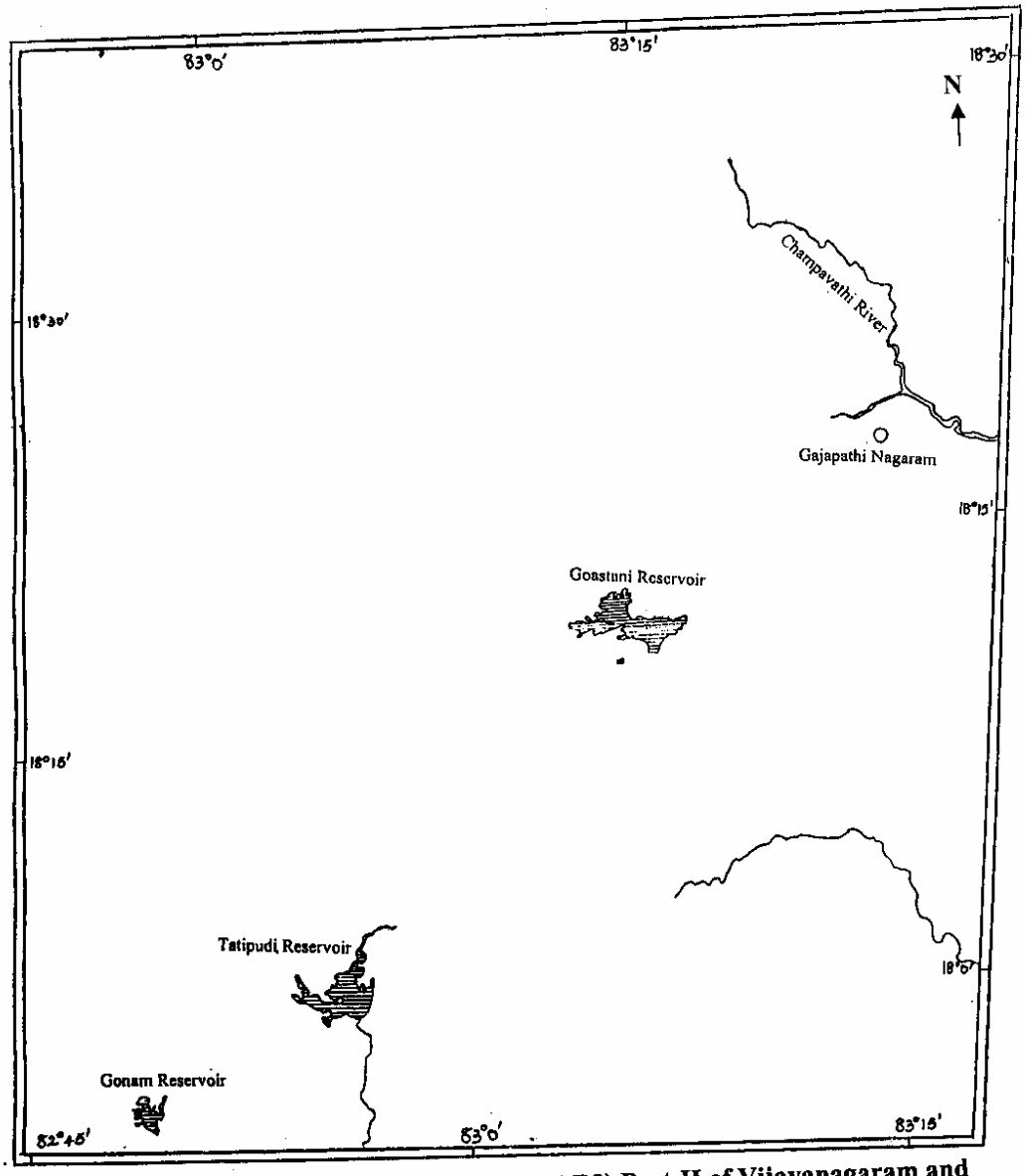

Fig.4.a. Premonsoon Scene (P22R55-B2) Part-II of Vijayanagaram and Part-I of Vishagapatnam District.

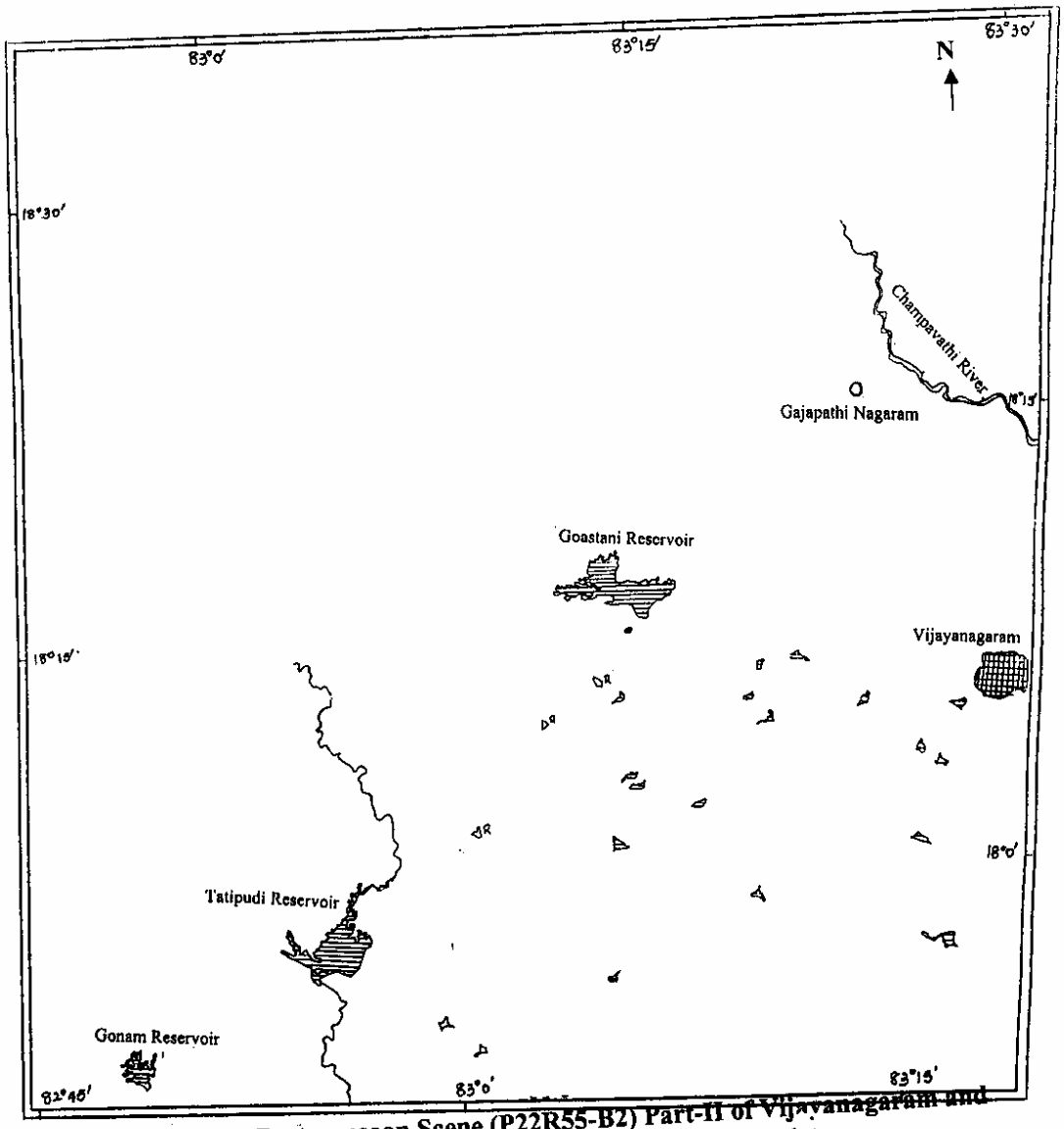

Fig.4.b. Postmonsoon Scene (P22R55-B2) Part-II of Vijayanagaram and Part-I of Vishagapatnam District.

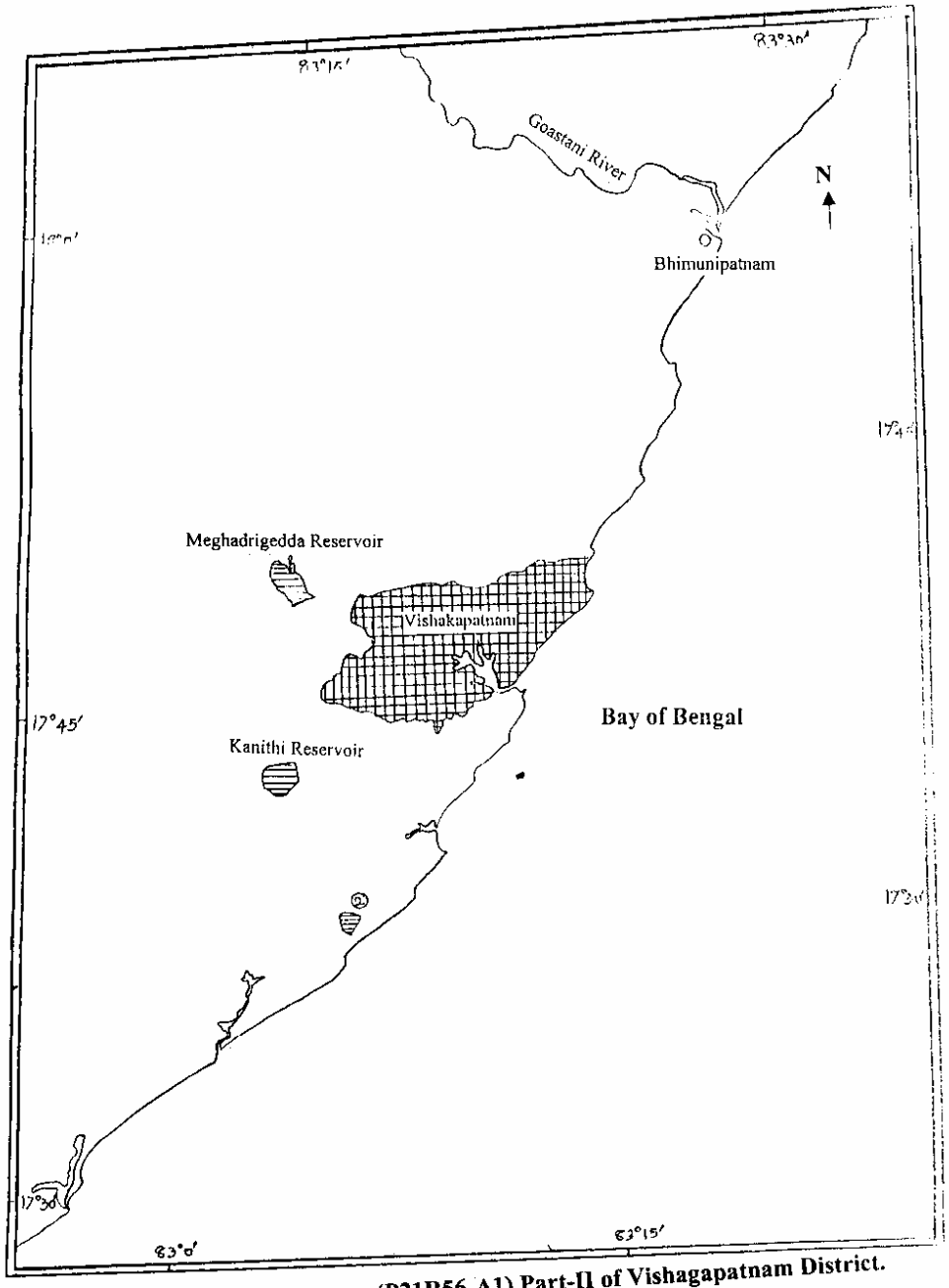

Fig.5.a. Premonsoon Scene (P21R56-A1) Part-II of Vishagapatnam District.

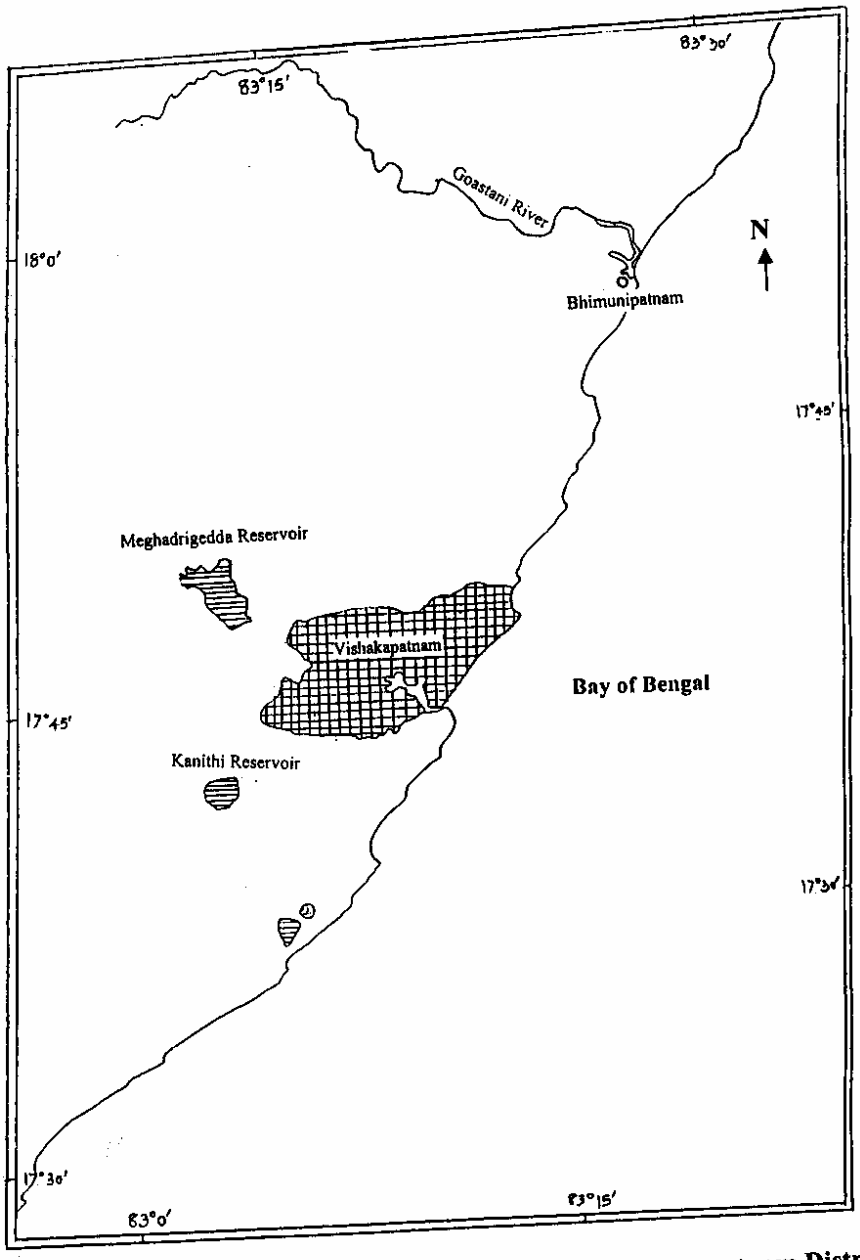

Fig.5.b. Postmonsoon Scene (P21R56-A1) Part-II of Vishagapatnam District.

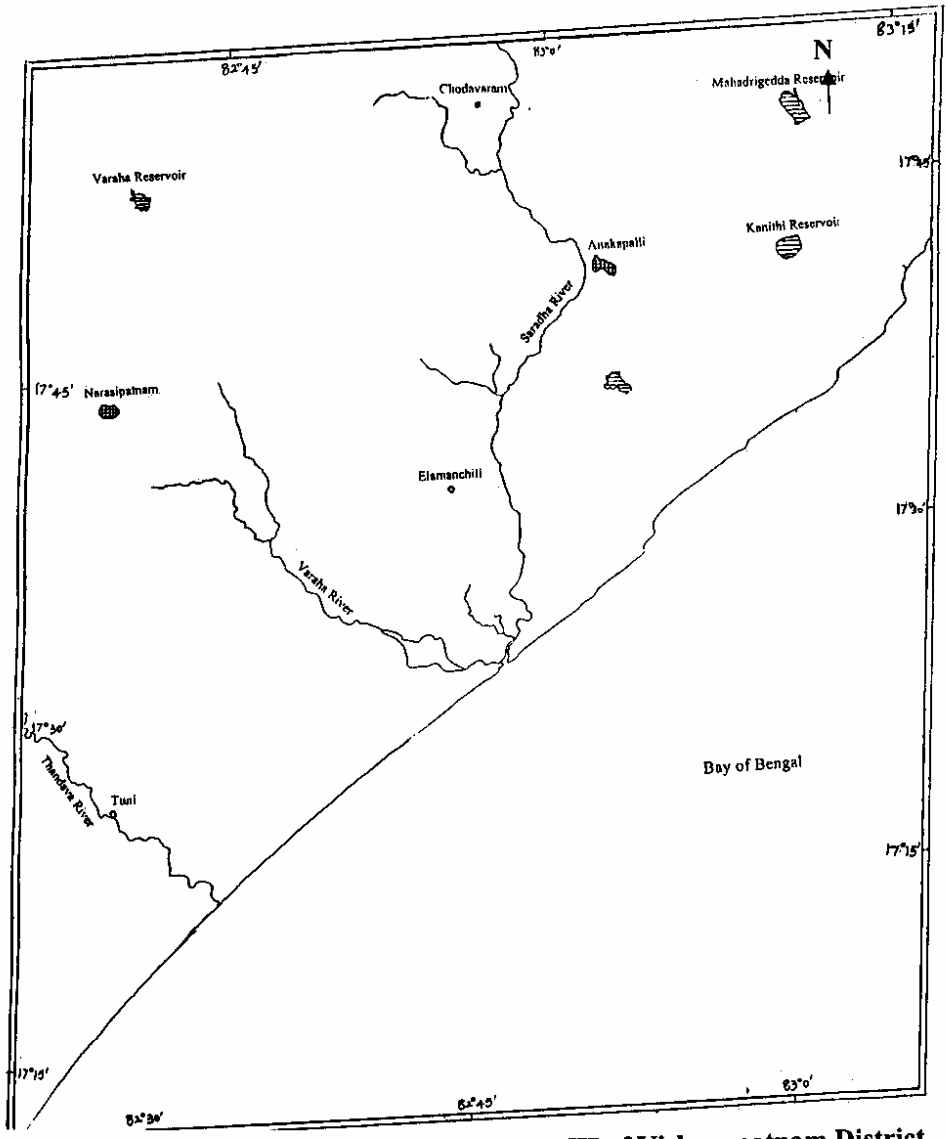

Fig.6.a. Premonsoon Scene (P22R56-B1) Part-III of Vishagapatnam District.

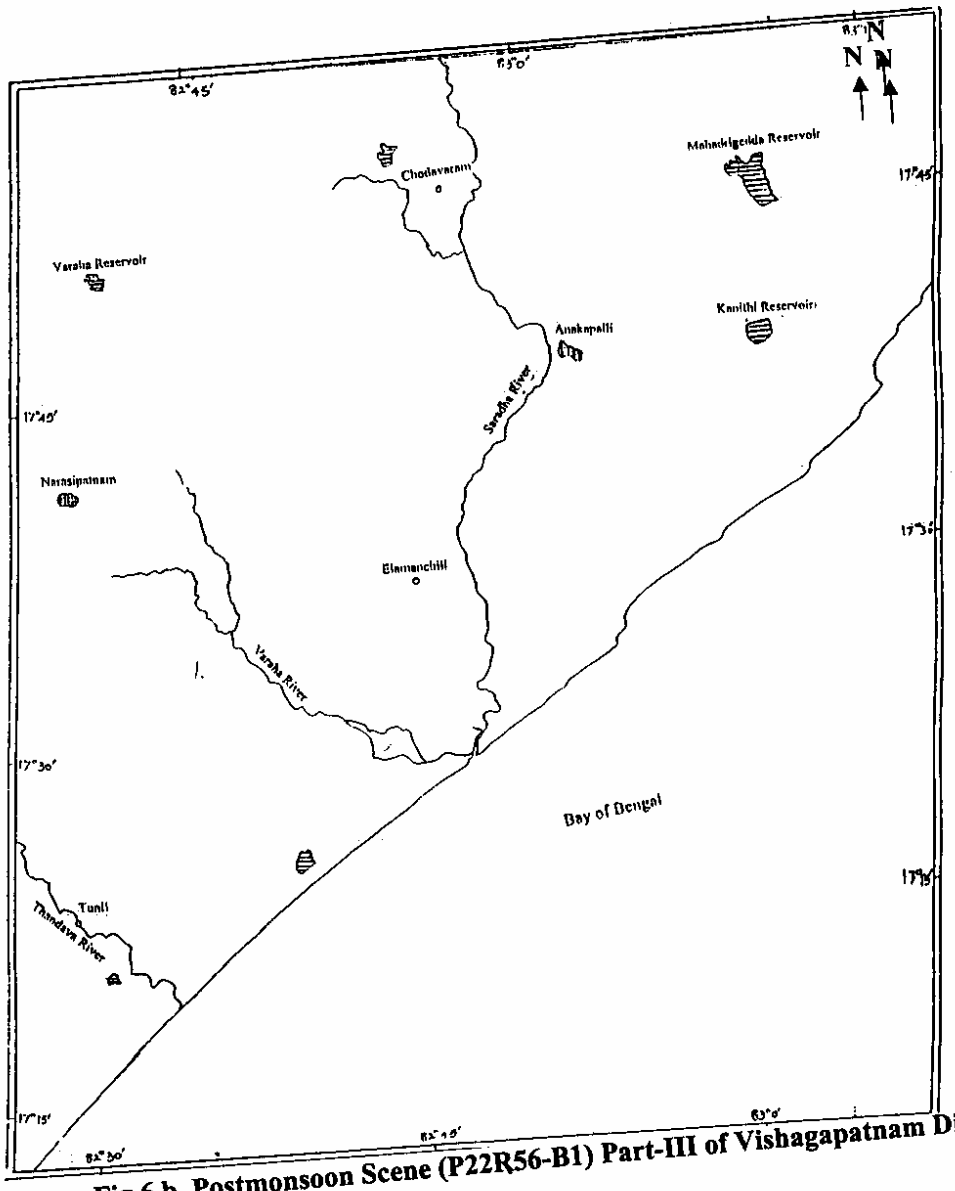

Fig.6.b. Postmonsoon Scene (P22R56-B1) Part-III of Vishagapatnam District.

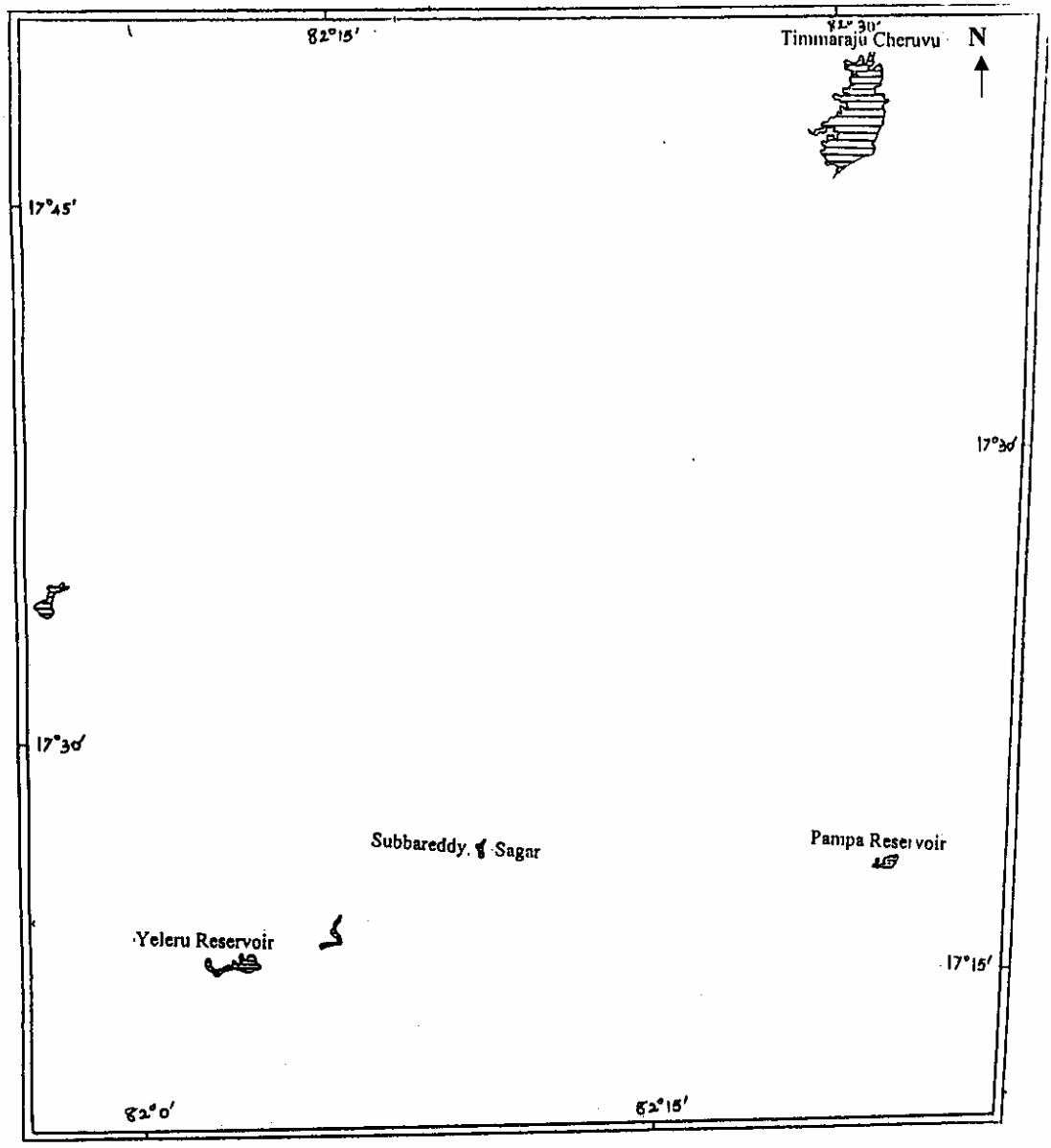

Fig.7.a. Premonsoon Scene (P22R56-A1) Part-IV of Vishagapatnam and Part-I of East Godavari District.

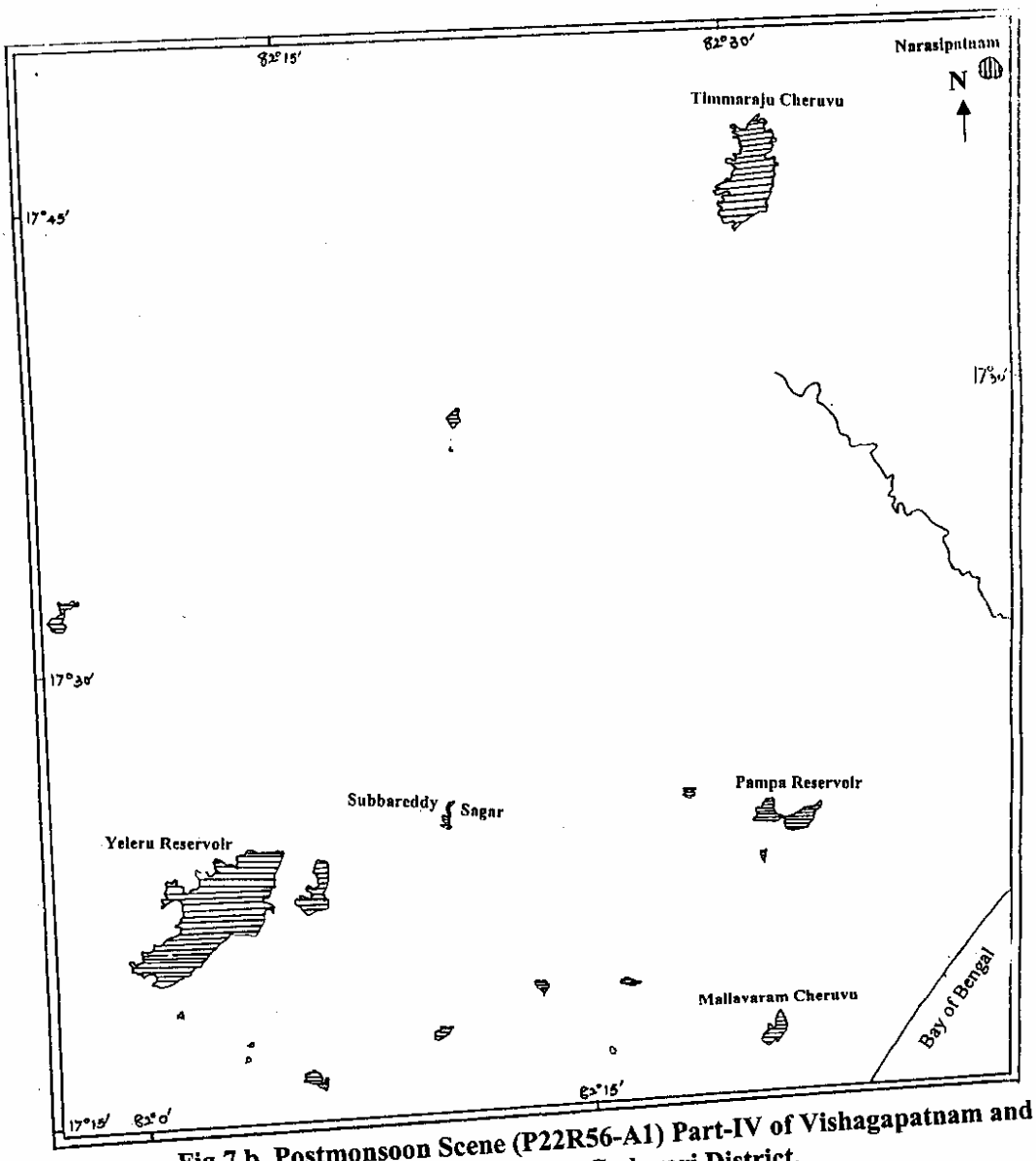

Fig.7.b. Postmonsoon Scene (P22R56-A1) Part-IV of Vishagapatnam and Part-I of East Godavari District.

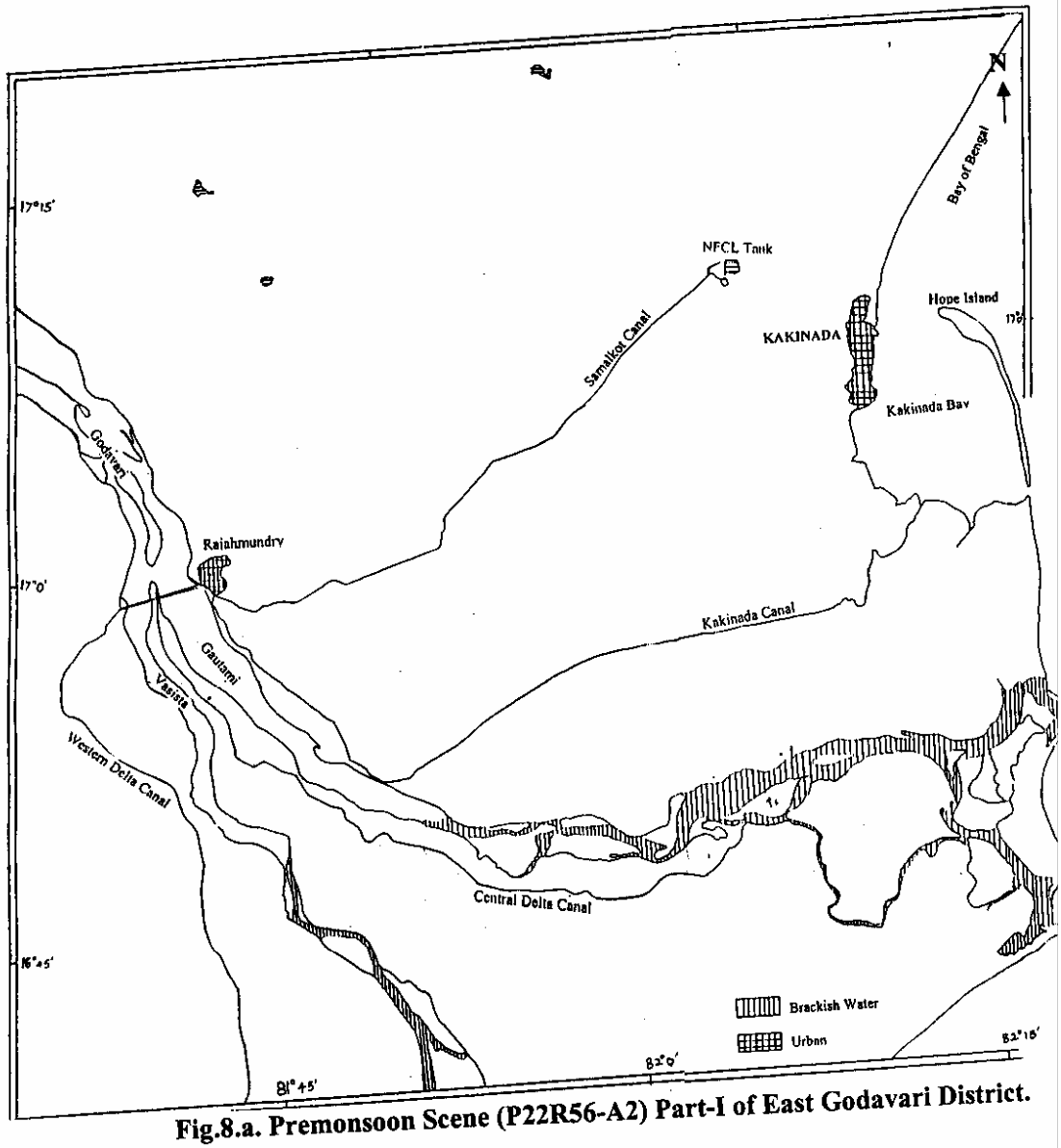

Fig.8.a. Premonsoon Scene (P22R56-A2) Part-I of East Godavari District.

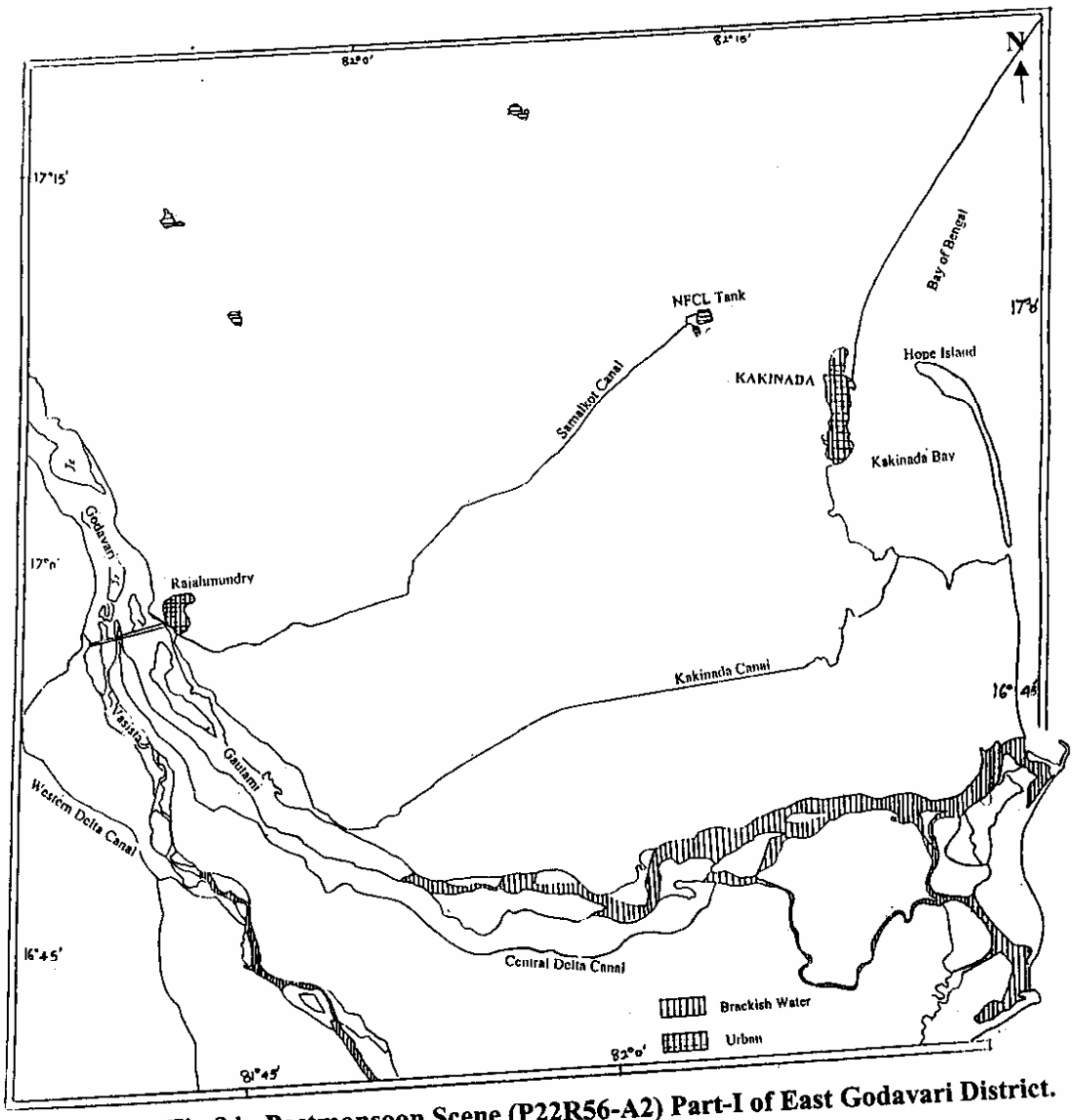

Fig.8.b. Postmonsoon Scene (P22R56-A2) Part-I of East Godavari District.

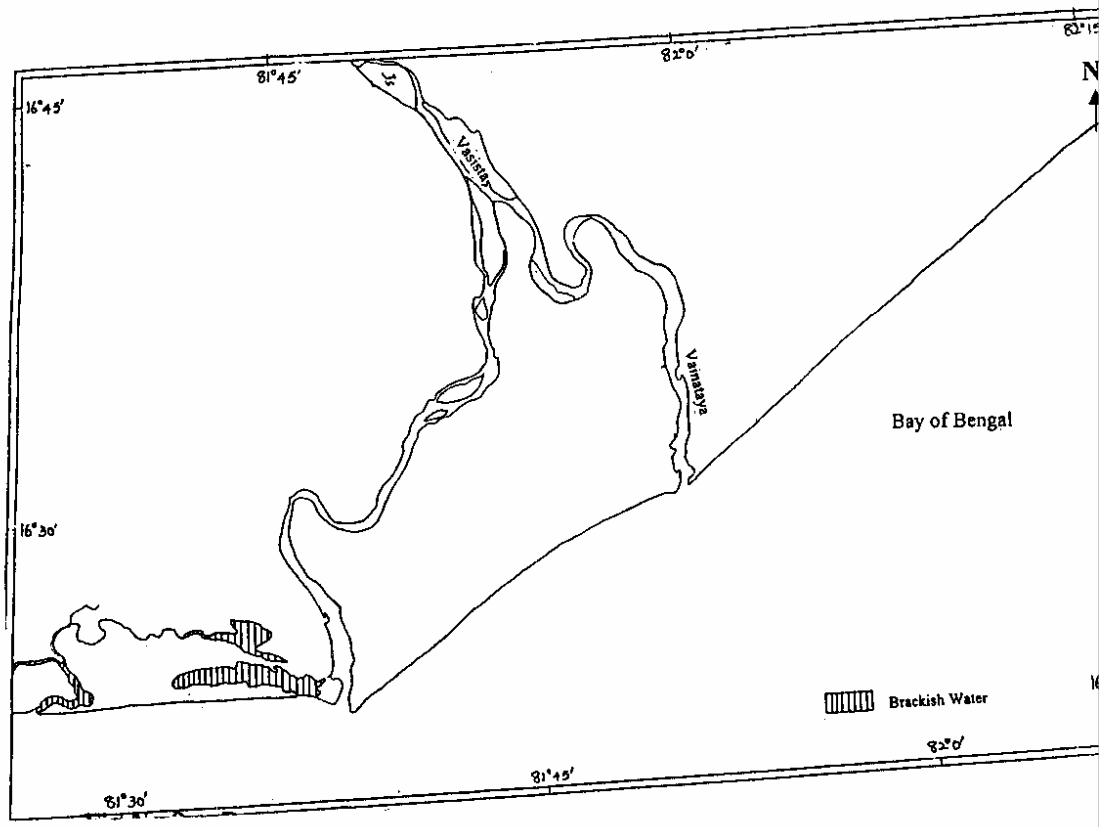

Fig.9.a. Premonsoon Scene (P22R57-A1) Part-III of East Godavari District.

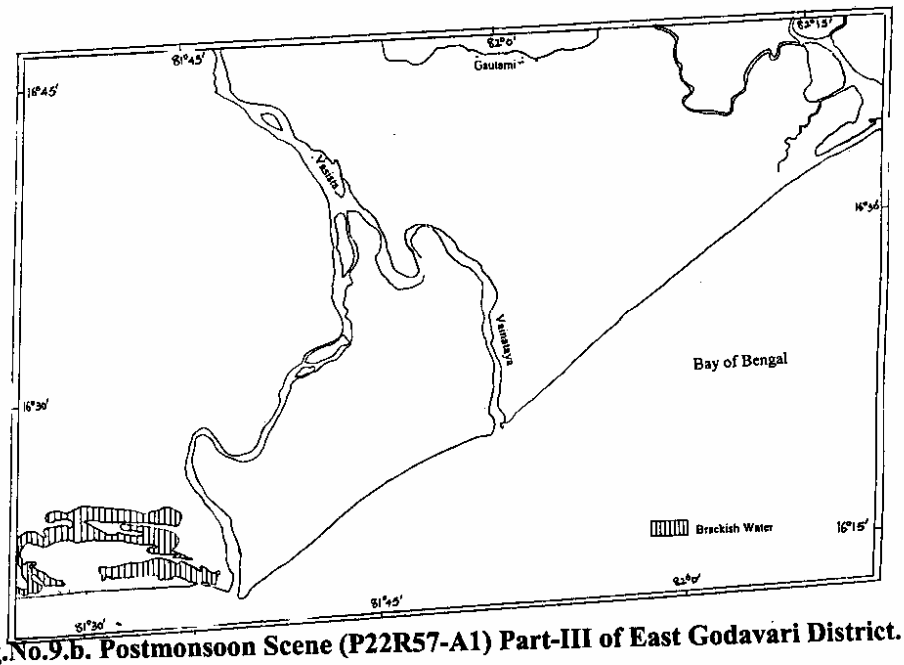

Fig.No.9.b. Postmonsoon Scene (P22R57-A1) Part-III of East Godavari District.

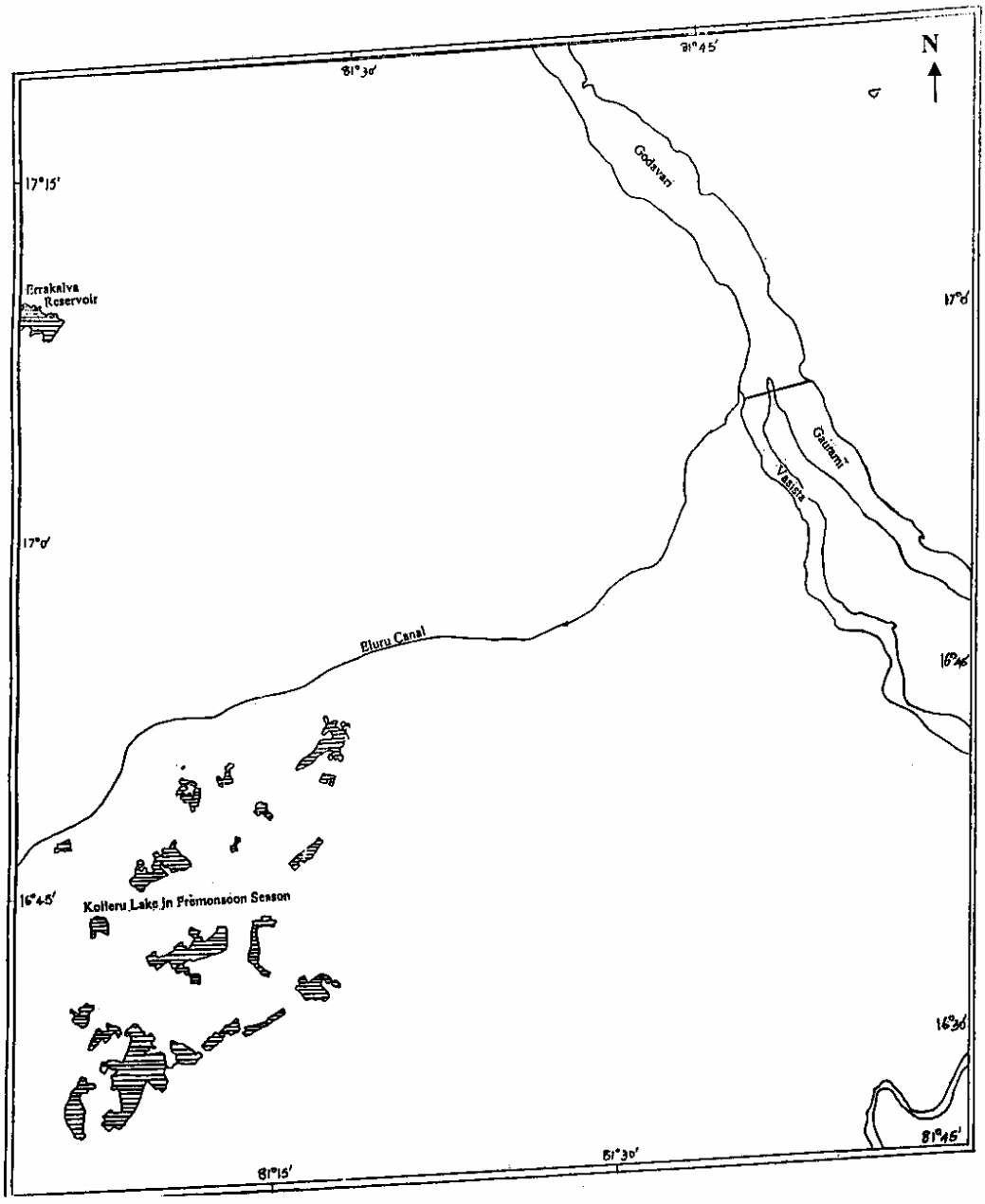

Fig.10.a. Premonsoon Scene (P23R56-B2) Part-I of West Godavari District.

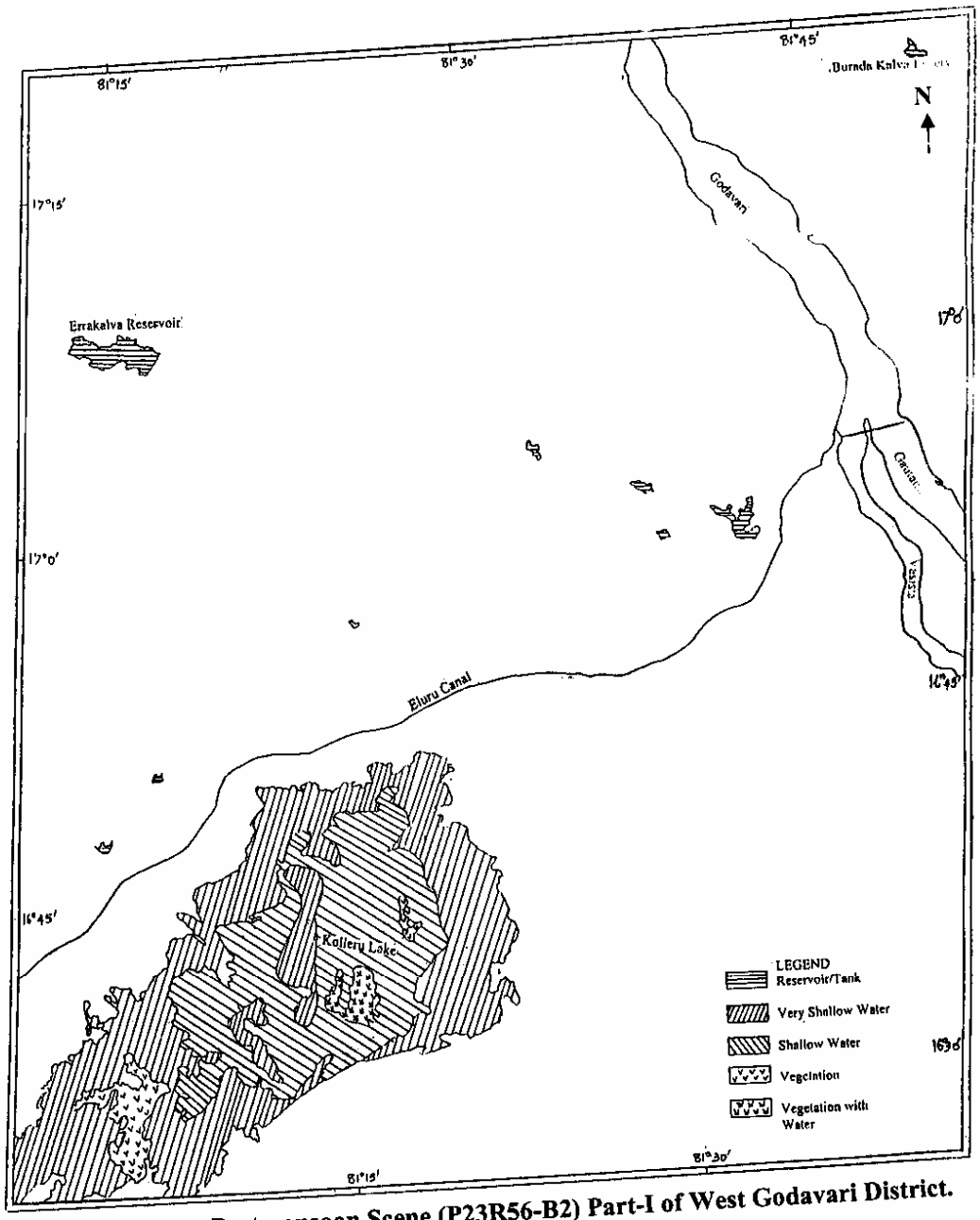

Fig.10.b. Postmonsoon Scene (P23R56-B2) Part-I of West Godavari District.

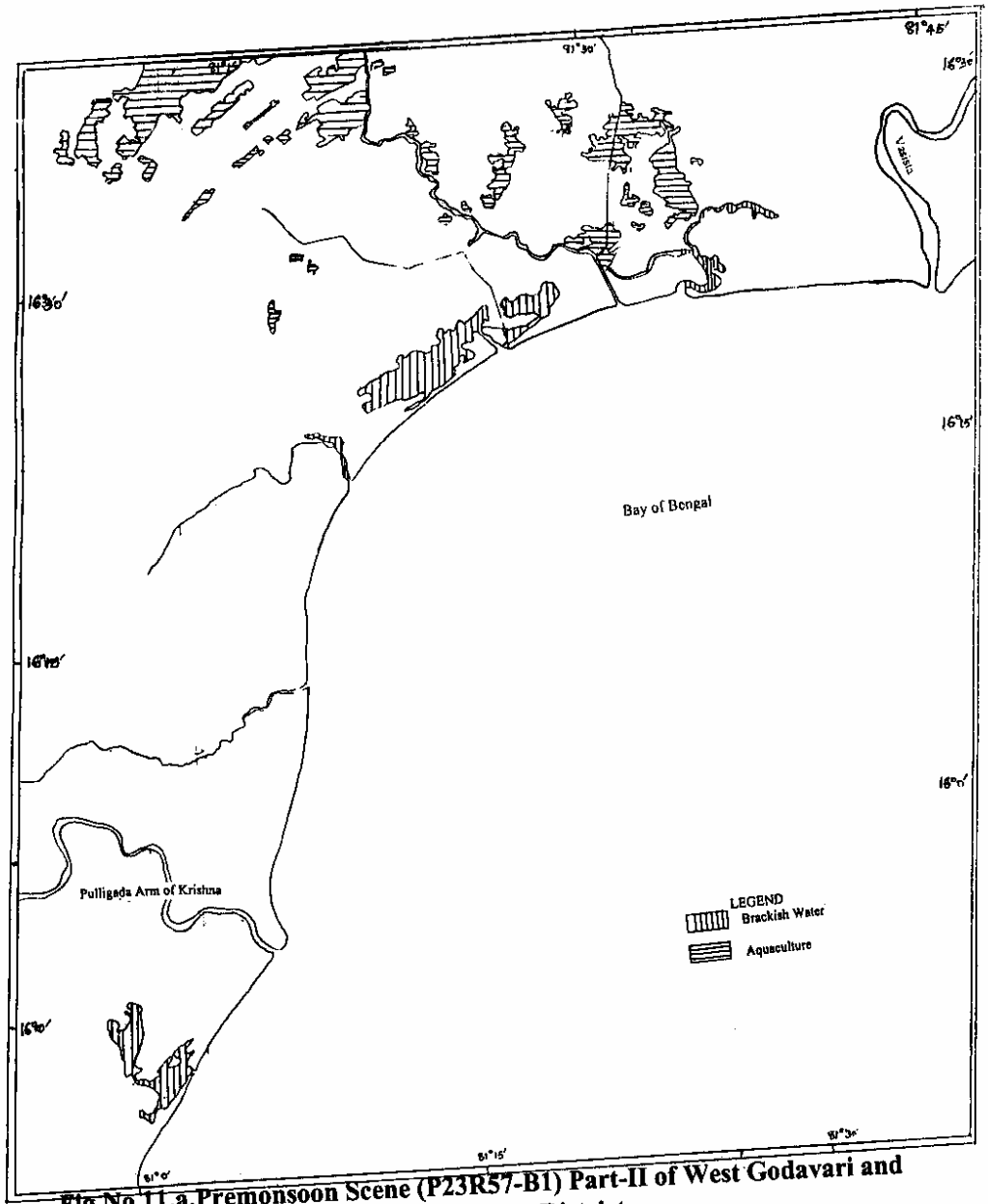

Fig.No.11.a.Premonsoon Scene (P23R57-B1) Part-II of West Godavari and Part-I of Krishna District.

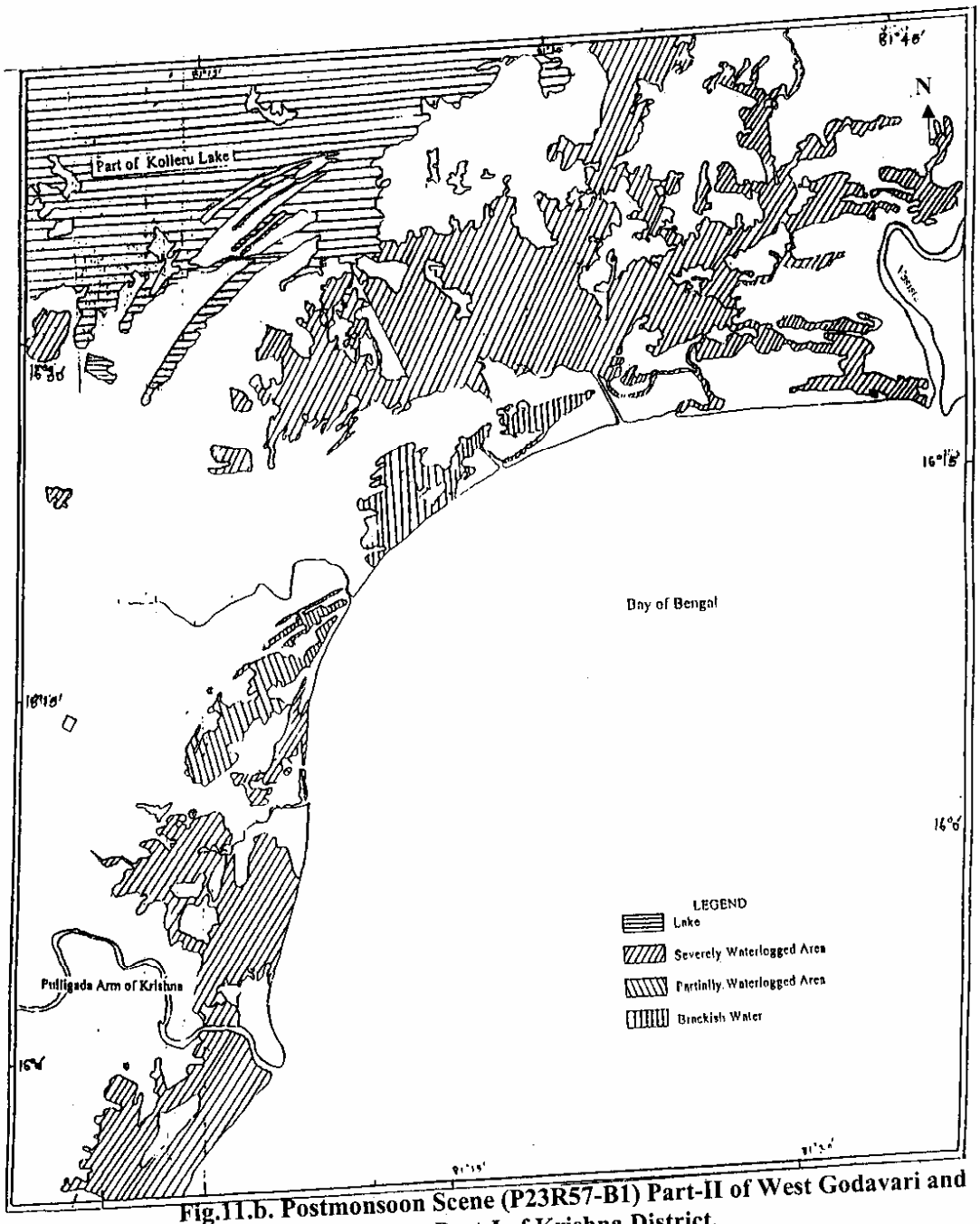

Fig.II.b. Postmonsoon Scene (P23R57-B1) Part-II of West Godavari and Part-I of Krishna District.

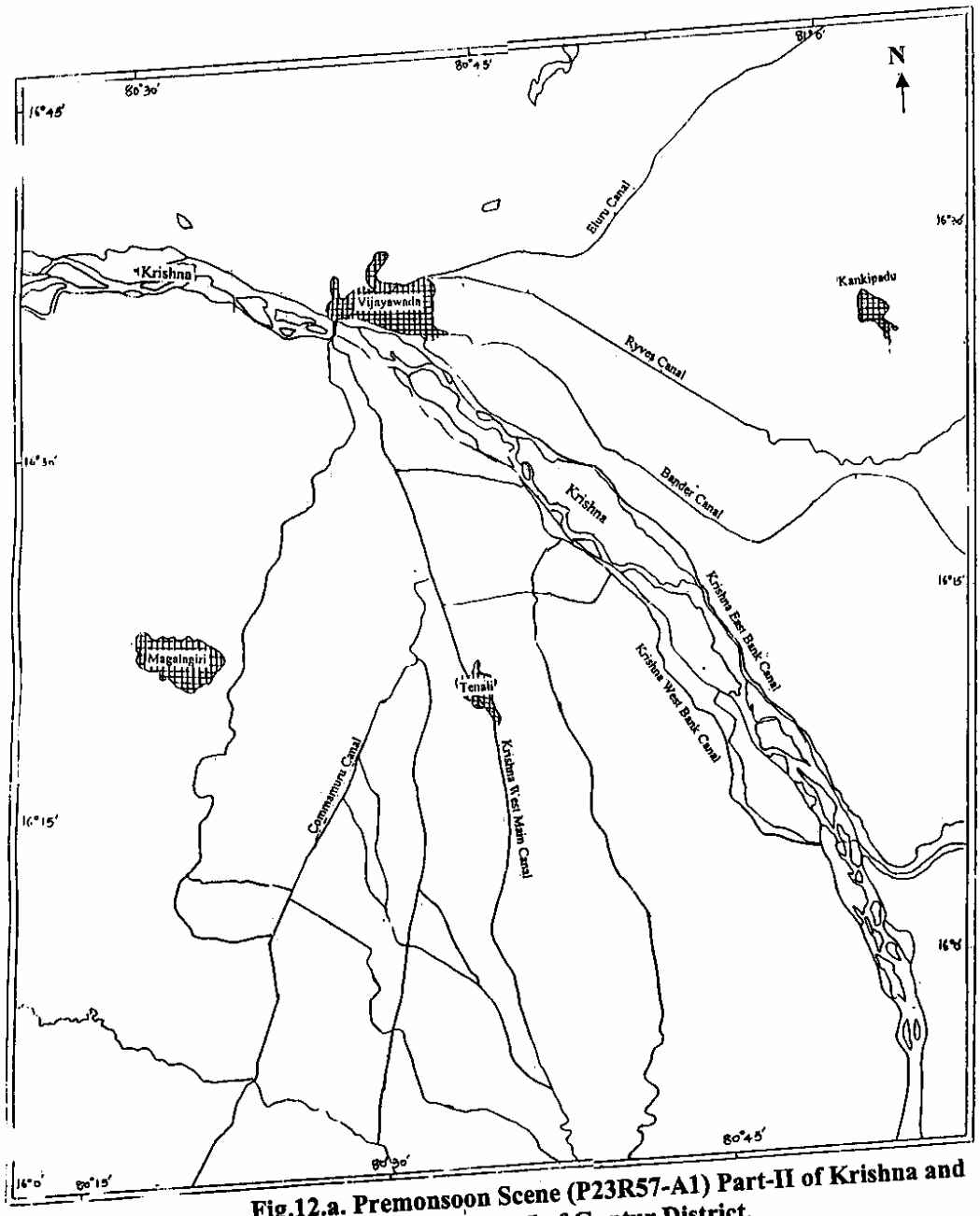

Fig.12.a. Premonsoon Scene (P23R57-A1) Part-II of Krishna and Part-I of Guntur District.

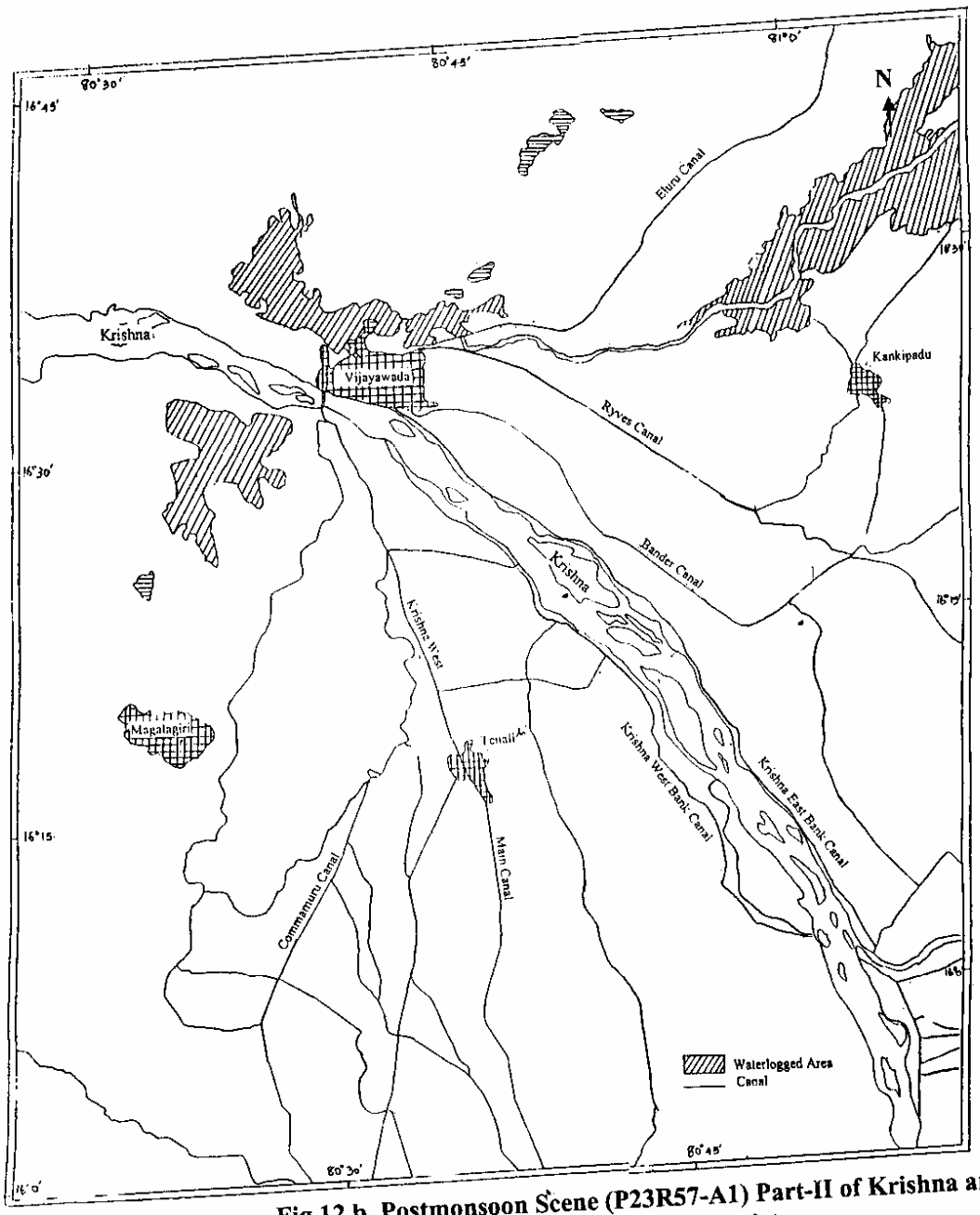

Fig.12.b. Postmonsoon Scene (P23R57-A1) Part-II of Krishna and Part-I of Guntur District.

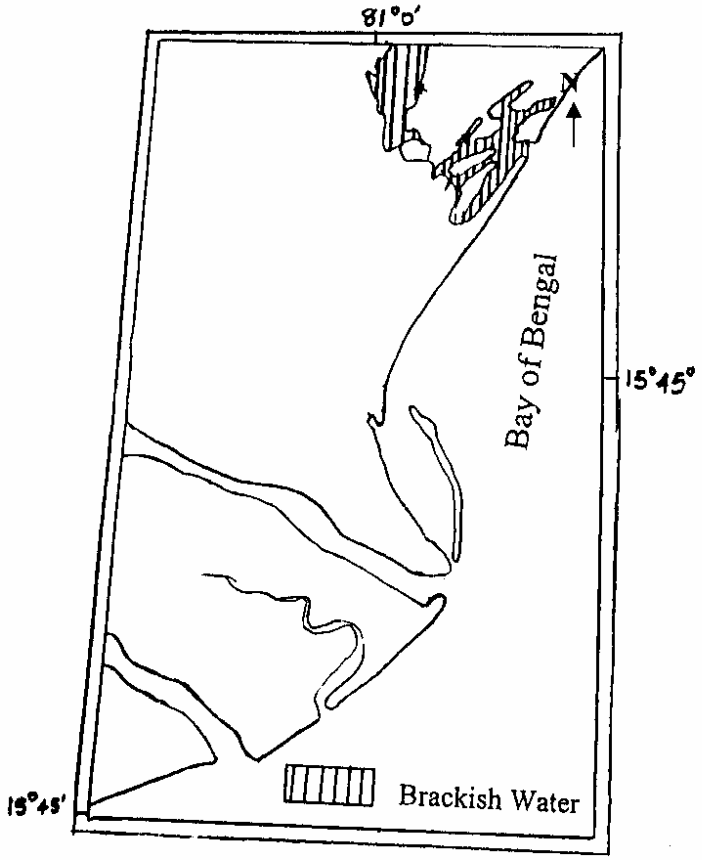

Fig.13.a. Premonsoon Scene (P23R57-B2) of Krishna River Mouth.

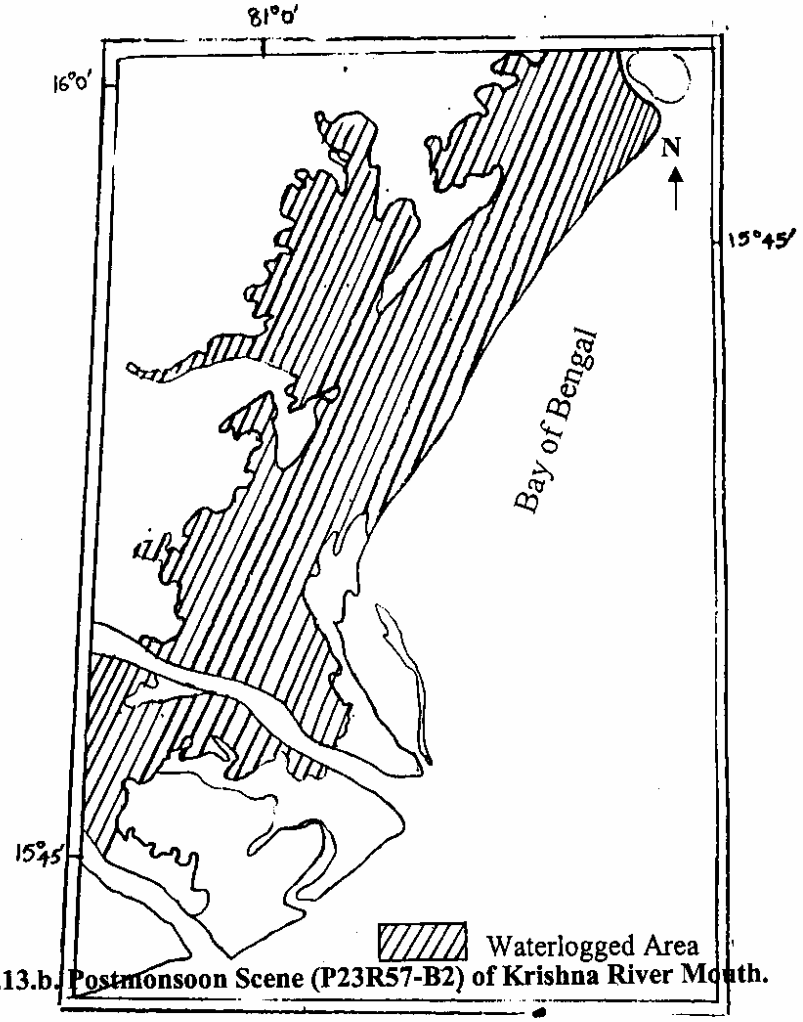

Fig.13.b. Postmonsoon Scene (P23R57-B2) of Krishna River Mouth.

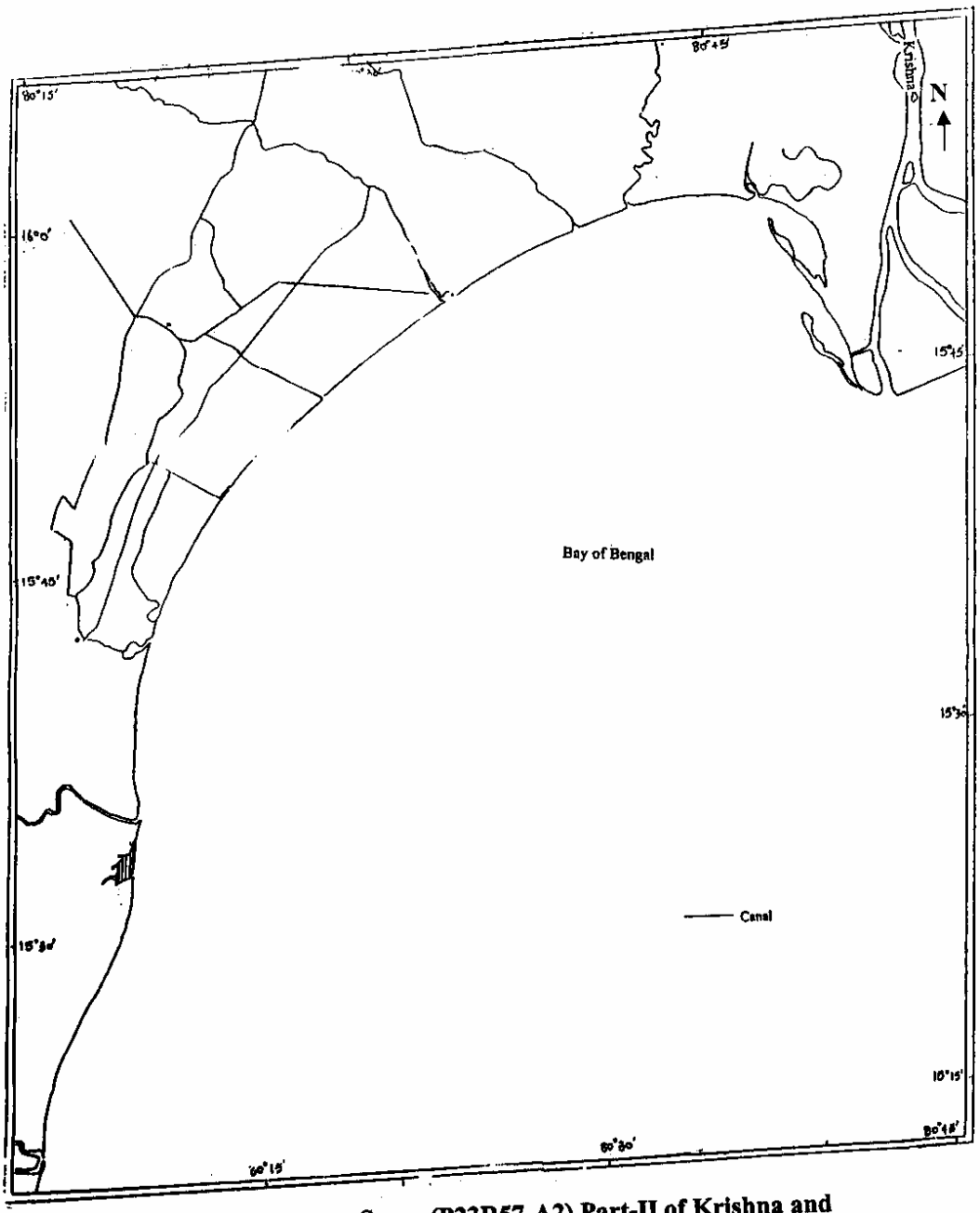

Fig.14.a. Premonsoon Scene (P23R57-A2) Part-II of Krishna and Part-I of Ongole District.

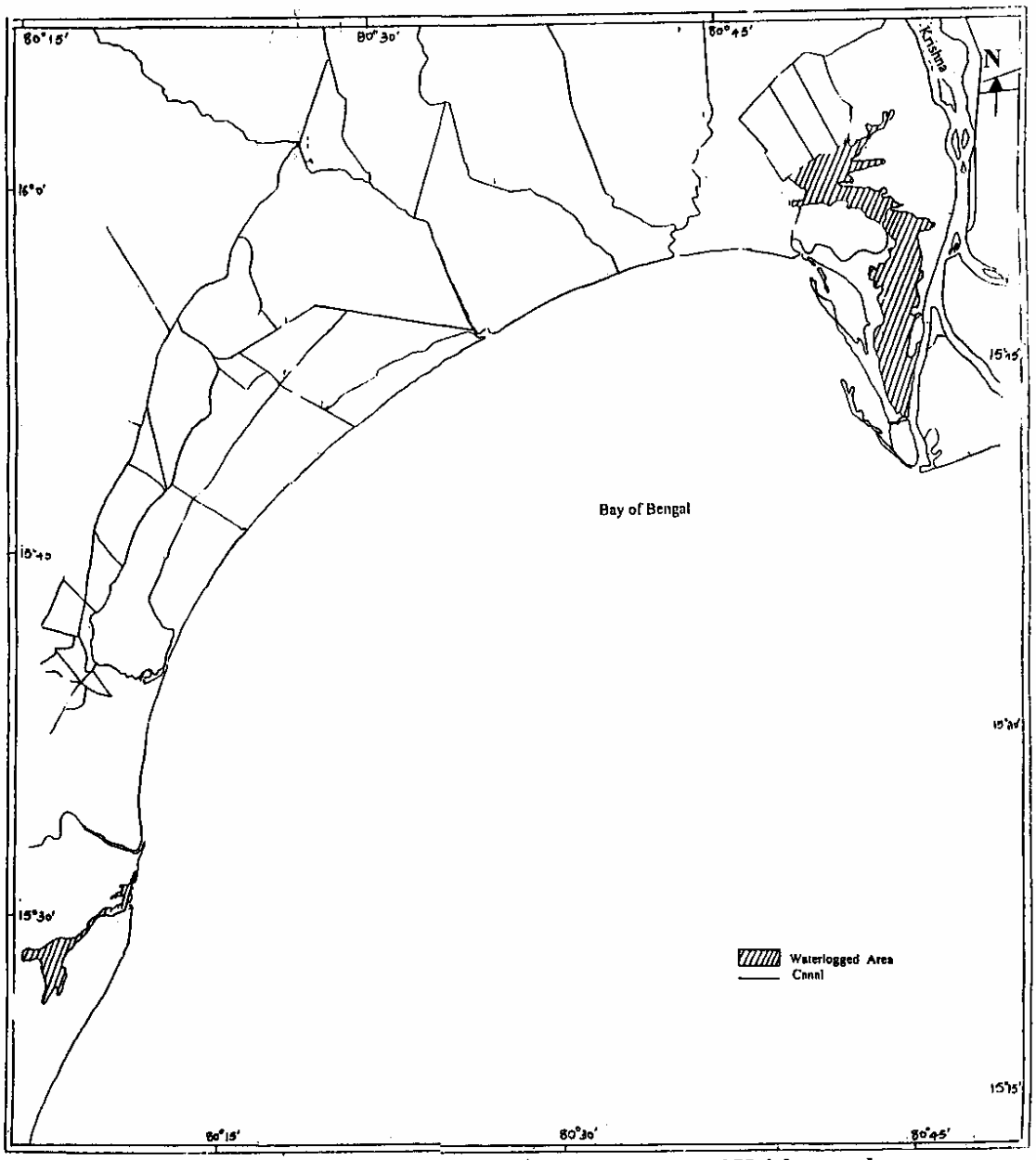

Fig.14.b. Postmonsoon Scene (P23R57-A2) Part-II of Krishna and Part-I of Ongole District.

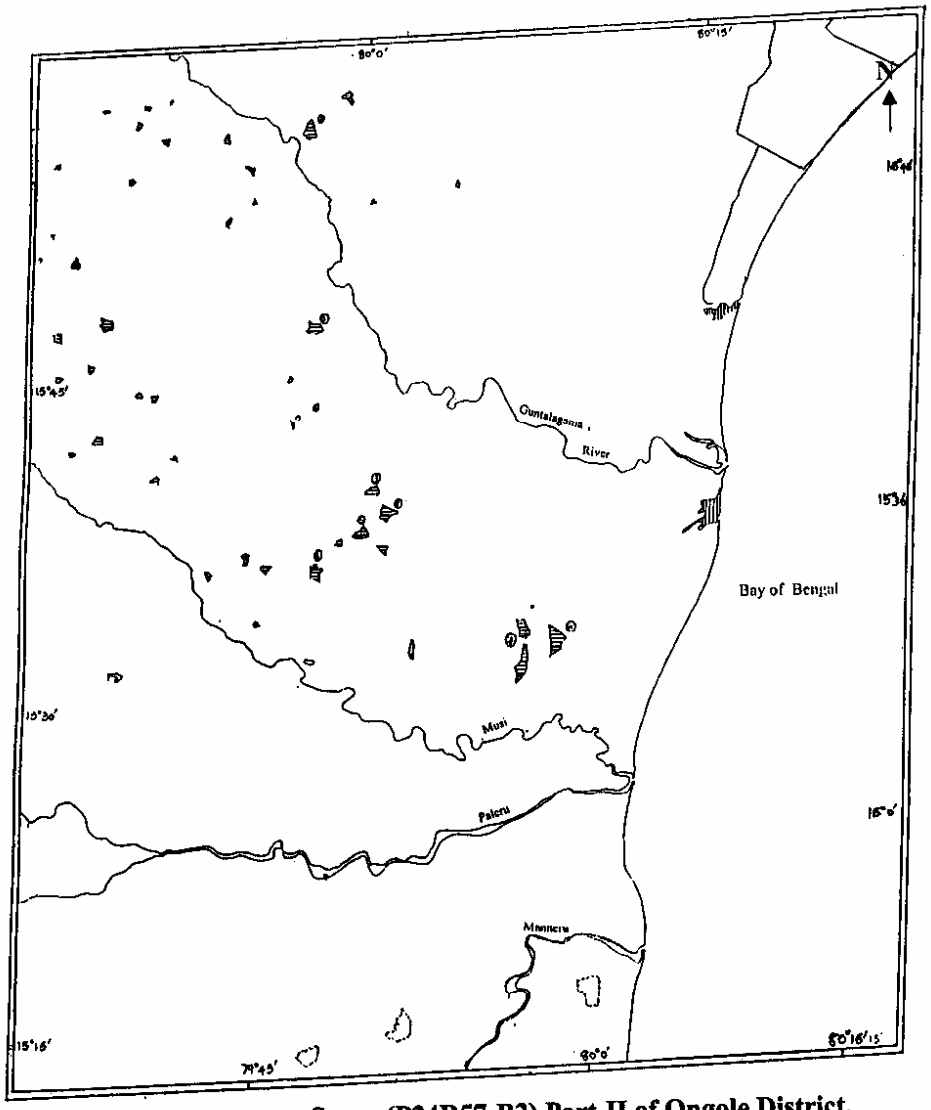

Fig.15.a. Premonsoon Scene (P24R57-B2) Part-II of Ongole District.

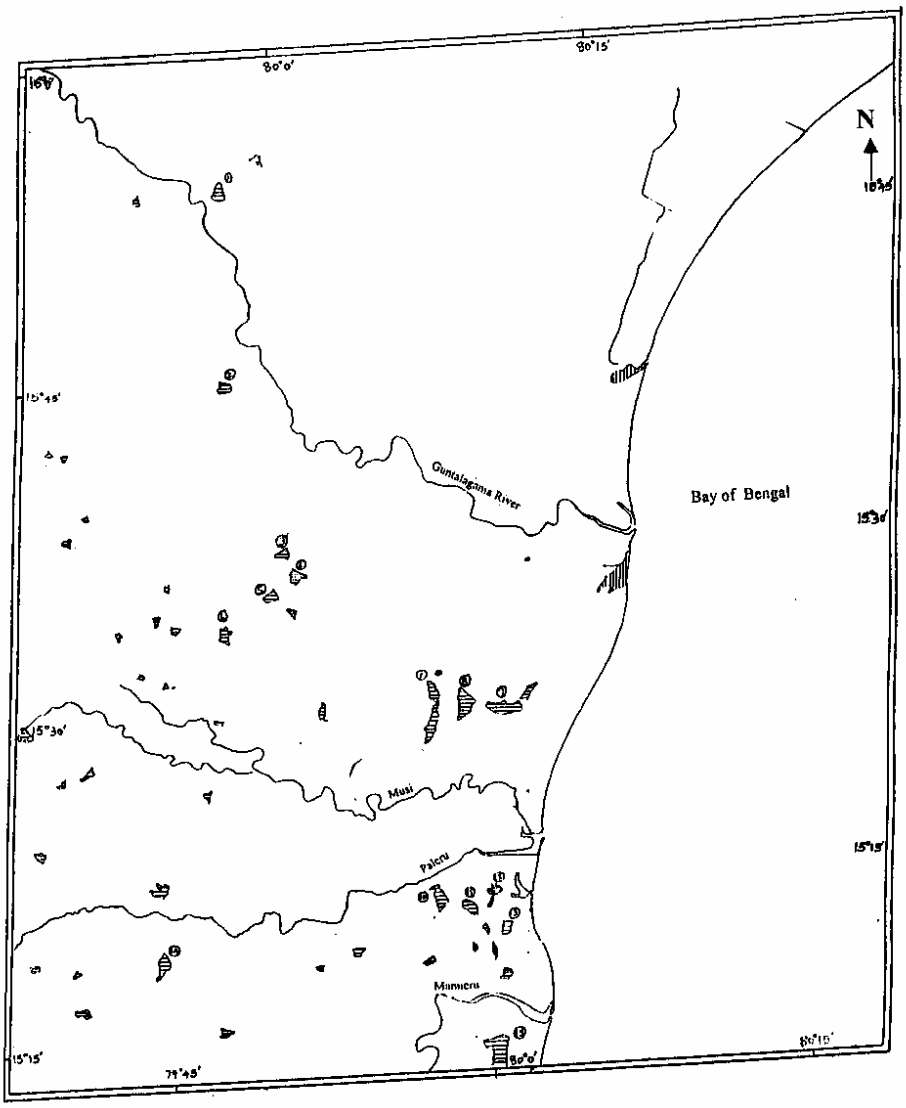

Fig.15.b. Postmonsoon Scene (P24R57-B2) Part-II of Ongole District.

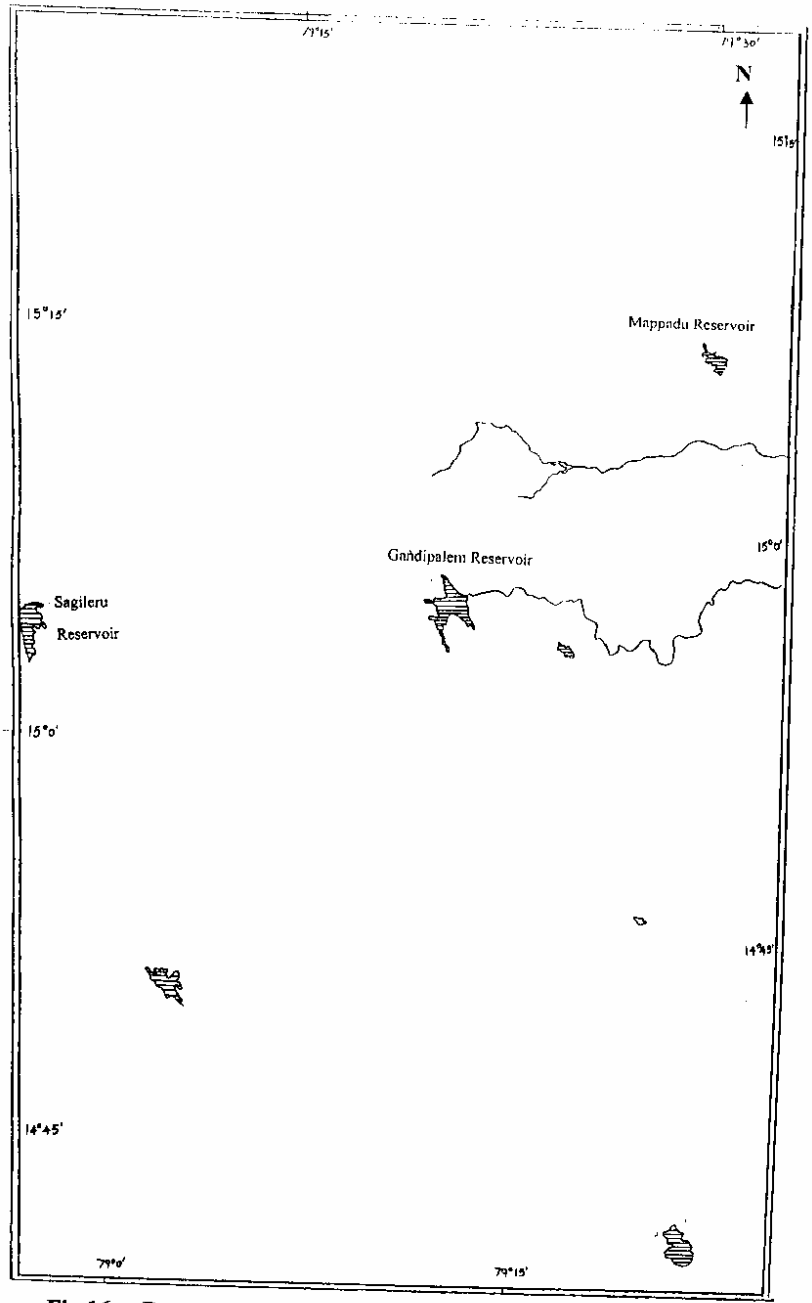

Fig.16.a. Premonsoon Scene (P24R58-A1) Part-III of Ongole District.

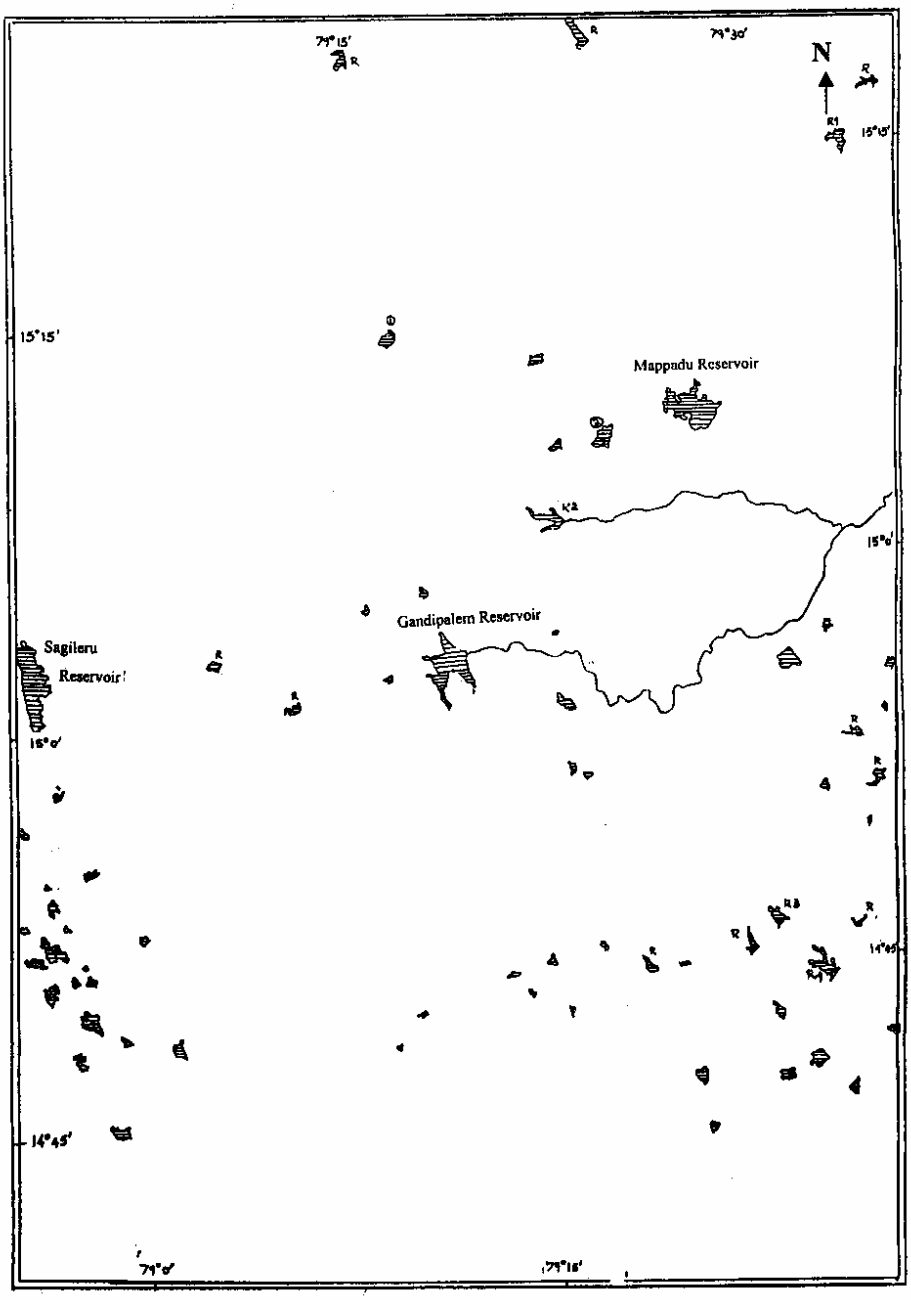

Fig.16.b. Postmonsoon Scene (P24R58-A1) Part-III of Ongole District.

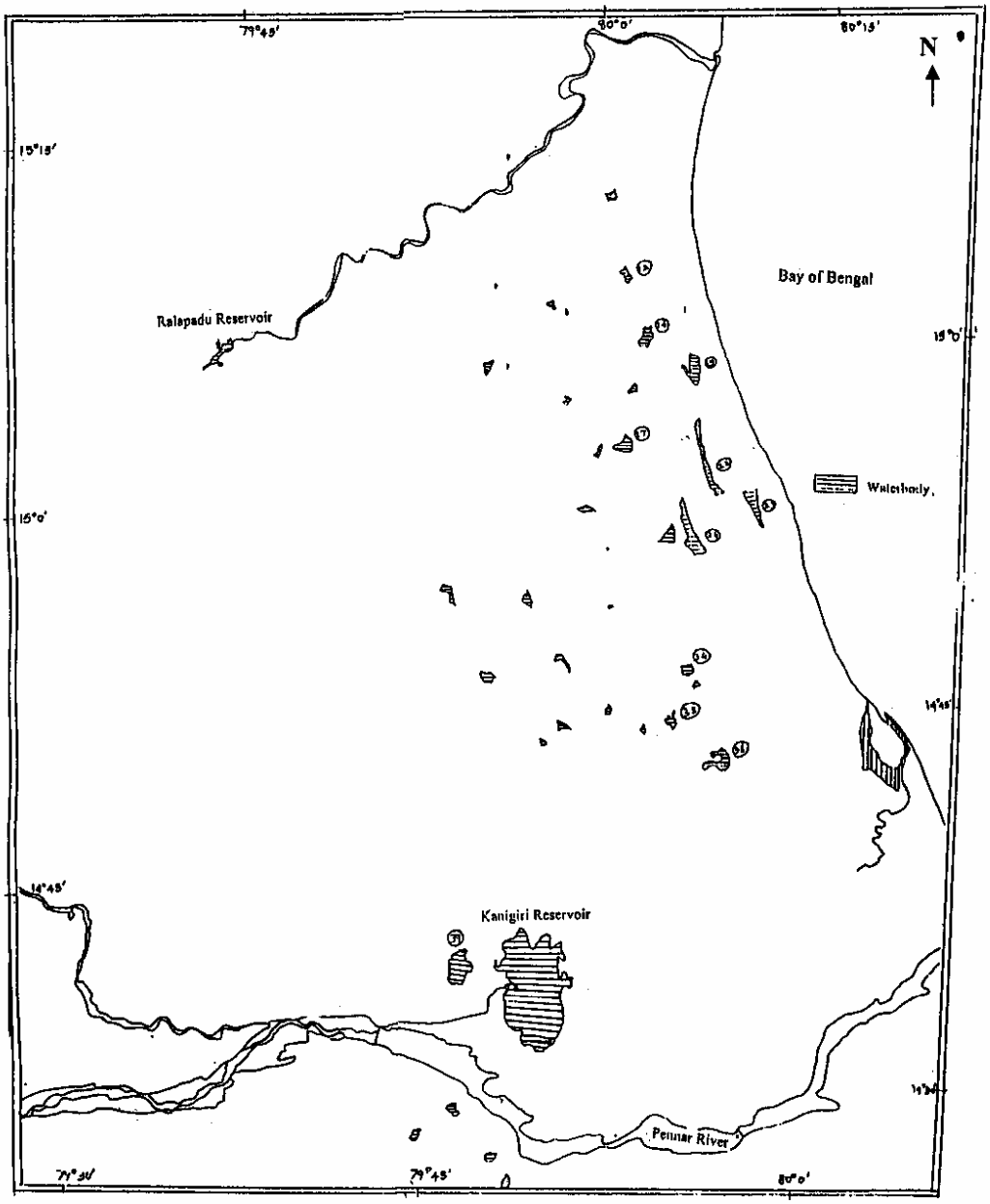

Fig.17.a. Premonsoon Scene (P24R58-B1) Part-I of Nellore District.

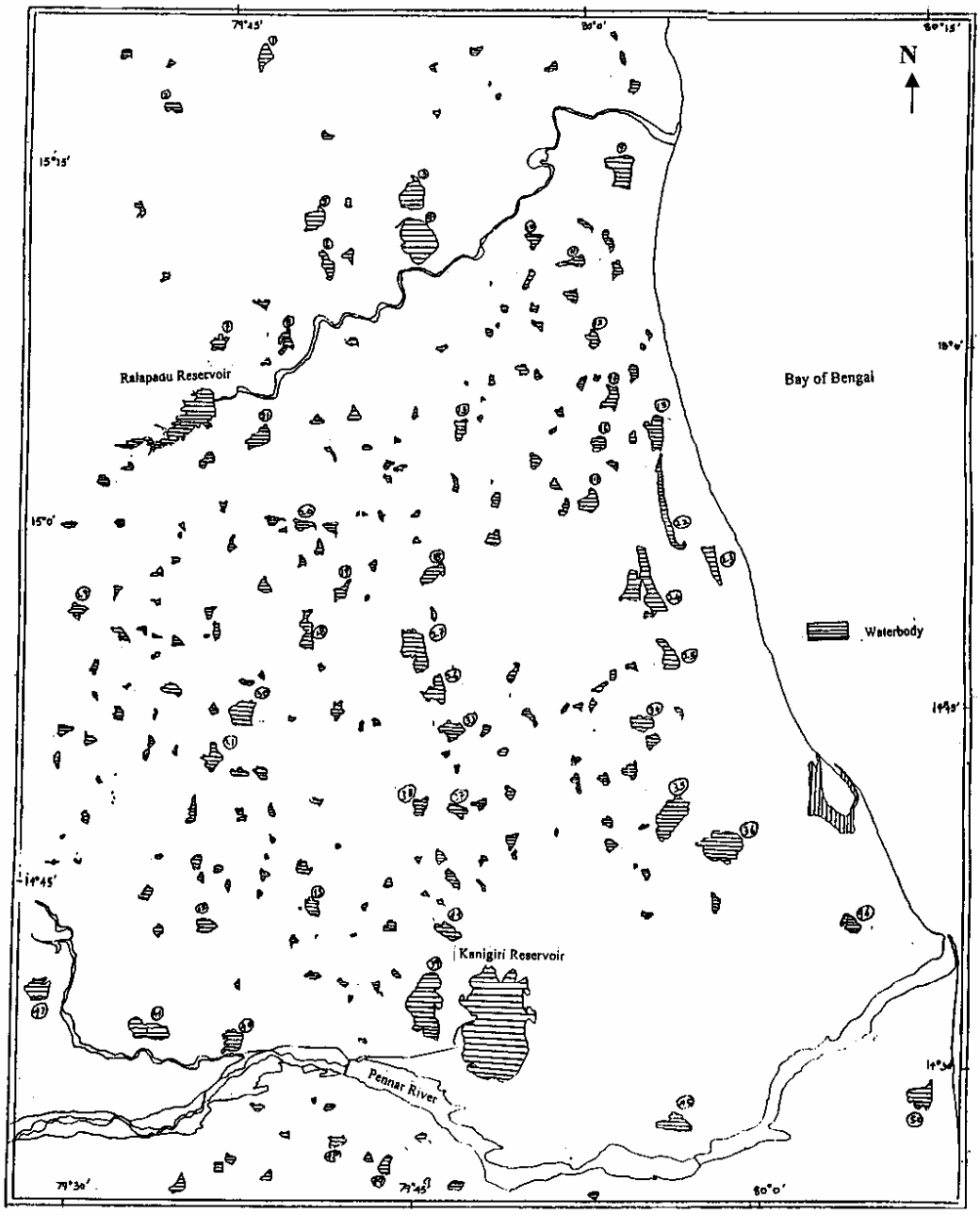

Fig.17.b. Postmonsoon Scene (P24R58-B1) Part-I of Nellore District.

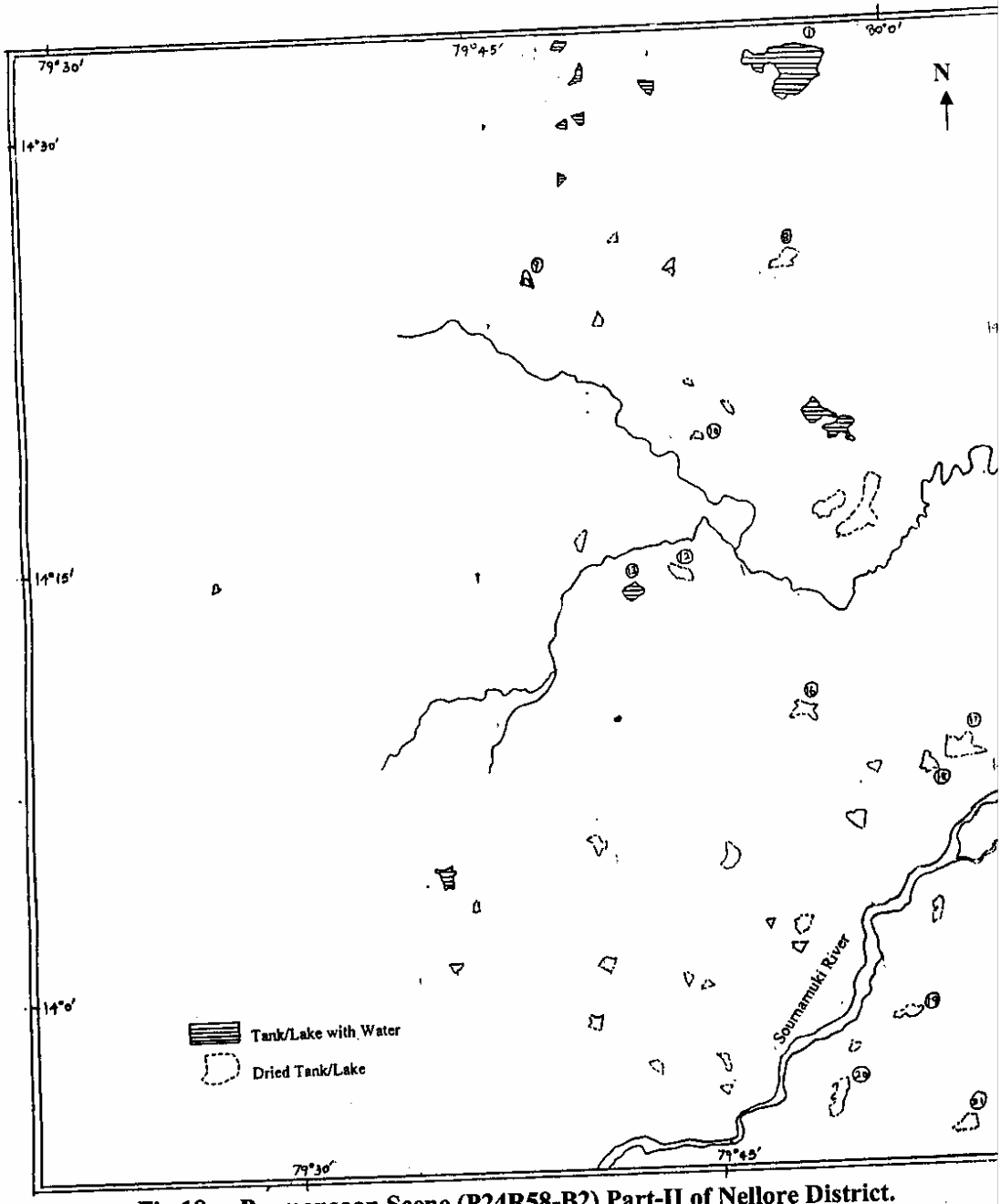

Fig.18.a. Premonsoon Scene (P24R58-B2) Part-II of Nellore District.

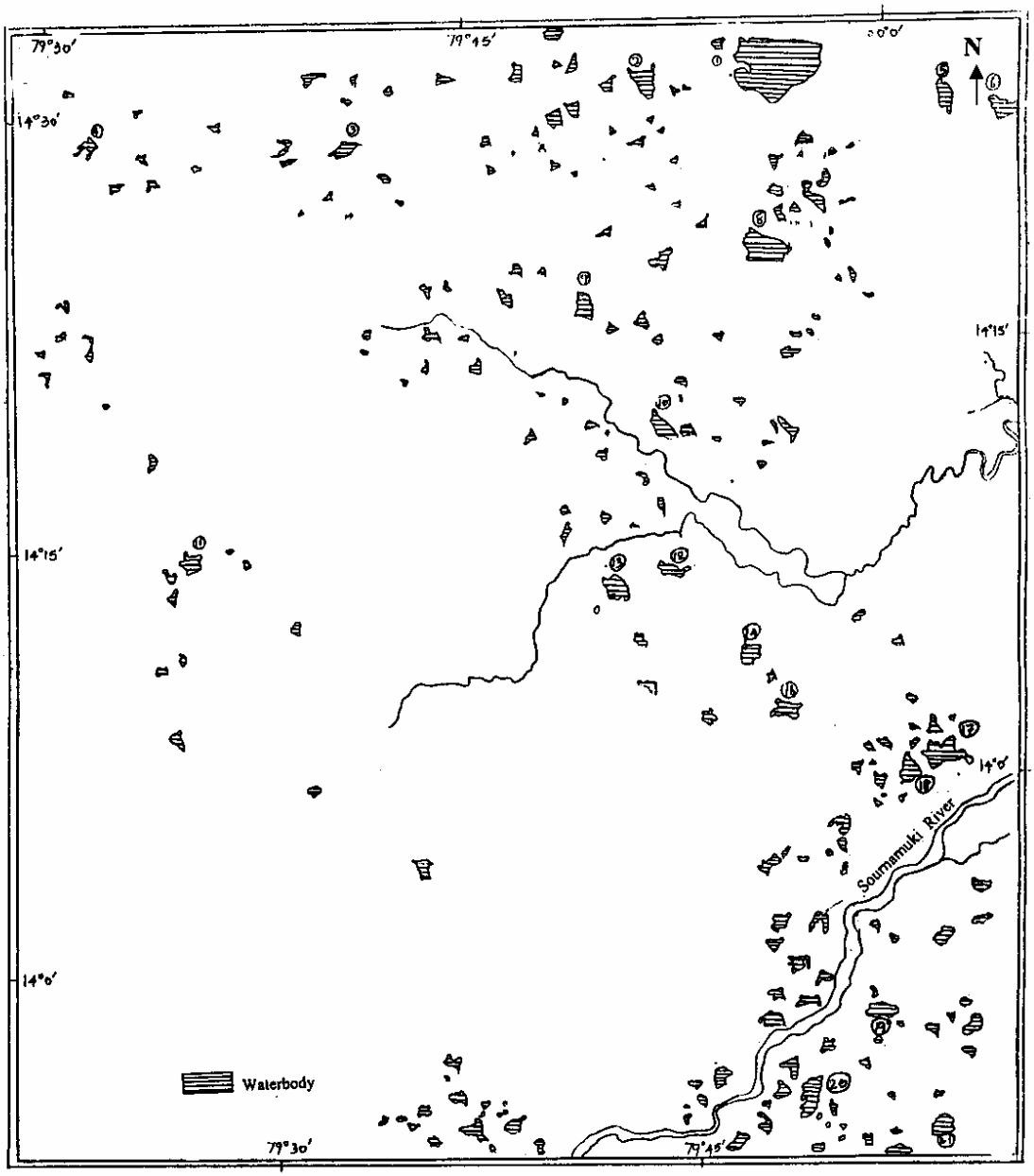

Fig.18.b. Postmonsoon Scene (P24R58-B2) Part-II of Nellore District.

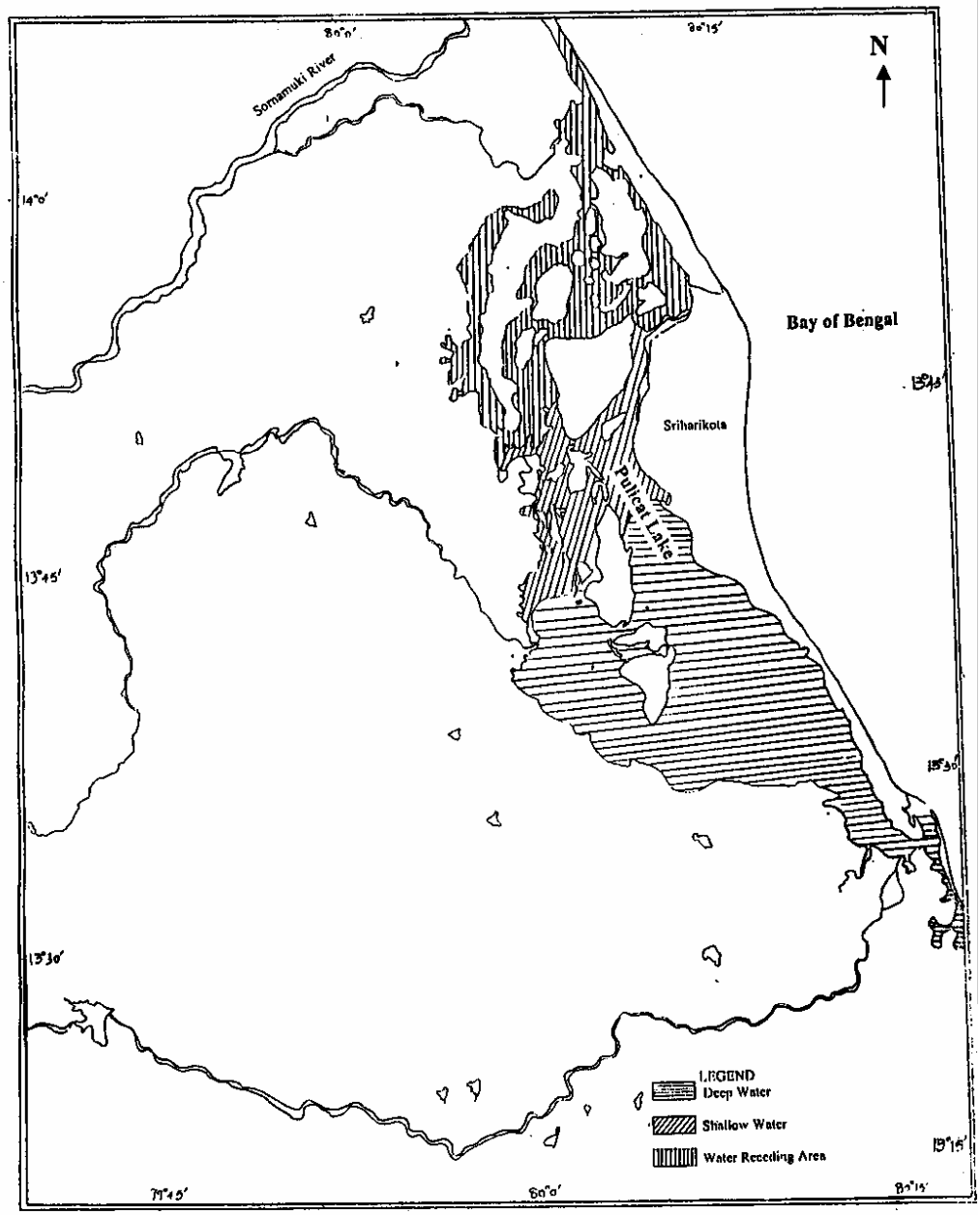

Fig.19.a. Premonsoon Scene (P23R59-A1) Part-III of Nellore District.

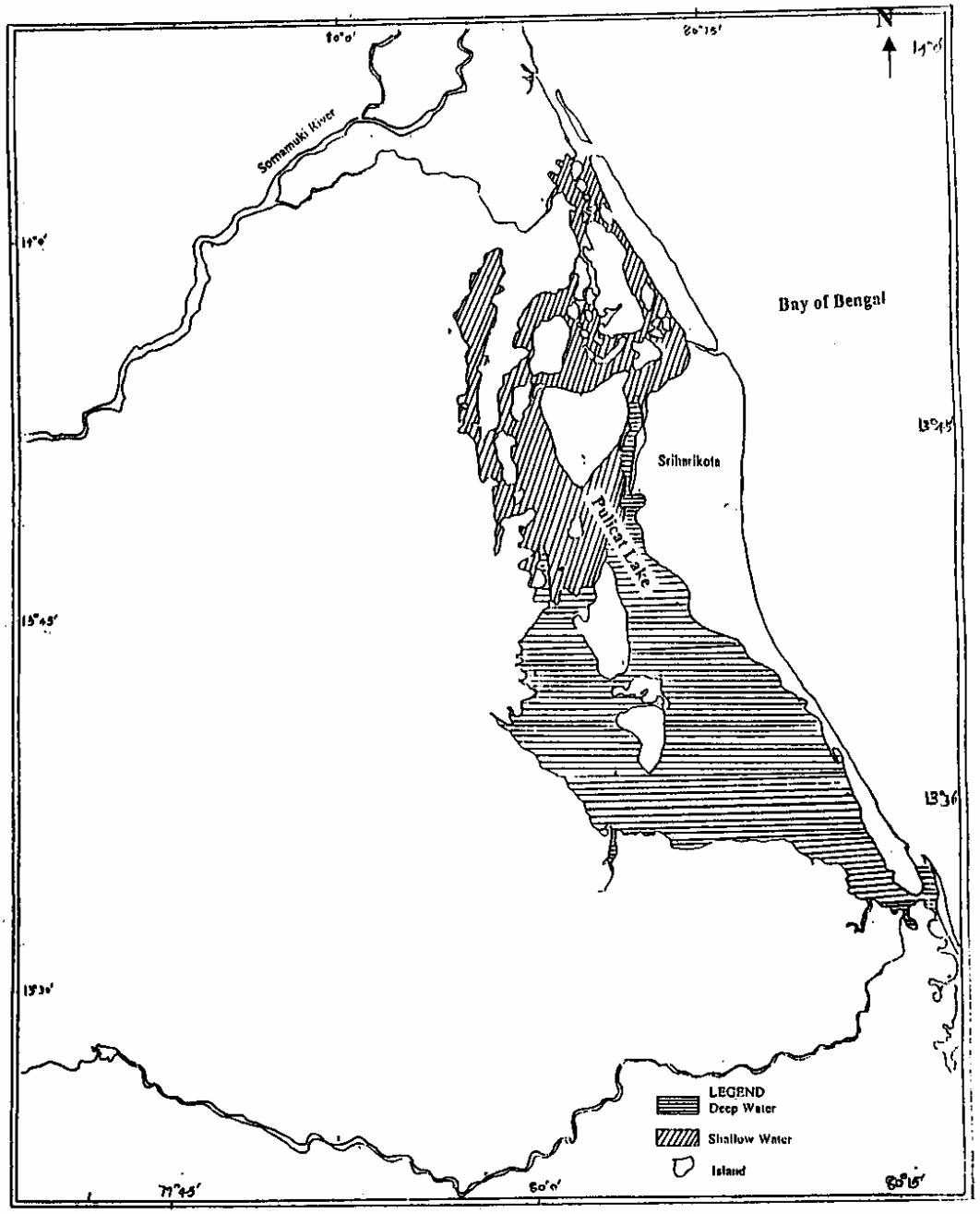

Fig.19.b. Postmonsoon Scene (P23R59-A1) Part-III of Nellore District.

5.0 CONCLUDING REMARKS:

It is evident that remote sensing methods admirably suits over time consuming and uneconomical conventional methods to analysis the pre- and post-monsoon variations of water bodies. In fact data obtained from satellite has become the reliable source to identify the problems and get solved in real time. Forty 1:250,000 scale FCC's has been interpreted including both the pre- and post-monsoon season reveals that twenty four medium to major reservoirs are existing along the Andhra coast. Mapped reservoirs water spread area various from 1.53 sq.km to 37.50 sq.km during the post monsoon season. Two major reservoirs Yeluru and Kanigiri which are measuring 35.63 sq.km and 37.50 sq.km in the post-monsoon season are located in East Godavari and Nellore district. The later district is commissioned with more number of reservoirs and considerable number of tanks/lakes are larger in size. A threshold of 0.25 sq.km has been kept to map the tanks/lakes. Kolleru a fresh water lake which serves as bird sanctuary is located in the West Godavari district covers an area of 853.76 sq.km in post monsoon season and dramatically reduces to 72.5 sq.km in the premonsoon season which is 8.5% of the total area. Pulicat Lake situated on the border districts of Andhra and Tamilnadu is a fully brackish waterbody measuring 508.13 sq.km are the special features among tanks and lakes. During monsoon season 904.75 sq.km coastal area get waterlogged which lies between West Godavari and Krishna districts. Due to the involvement of small scale satellite data minor reservoir's/anicut's pre- and post-monsoon variations could not be analysed. Usage of 1:50,000 scale data would give better results on the minor waterbodies.

It is noticed that where ever large rivers like Krishna and Godavari are found number of tanks/lakes are less compared to non-river flowing areas. This may be due to the reason that tanks/lakes were constructed to store the precipitation and runoff where there is no perennial rivers available.

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