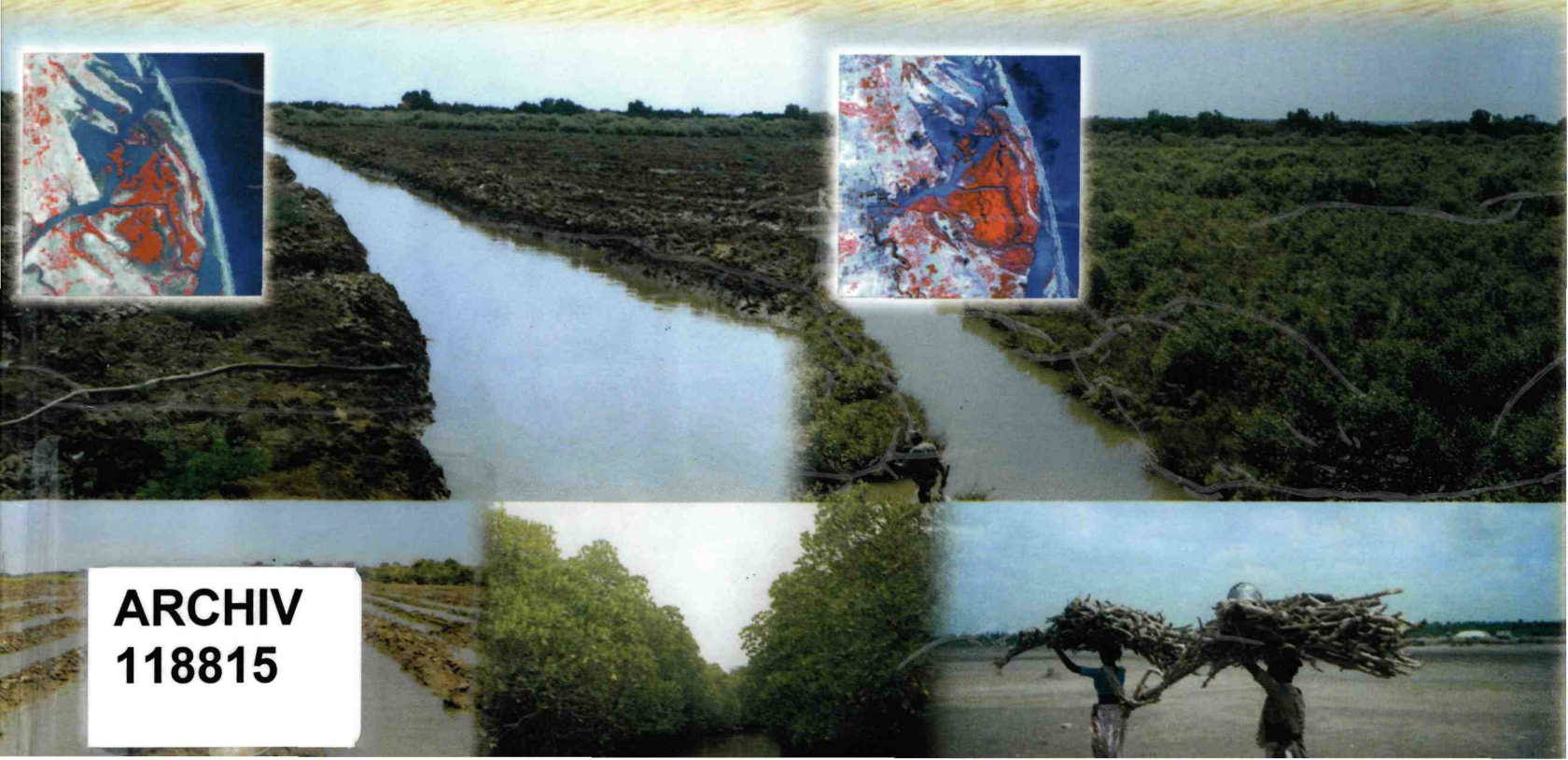
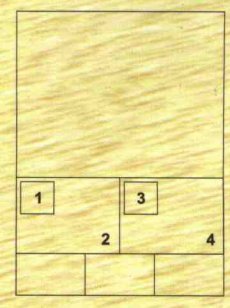
Atlas of Mangrove Wetlands of India

Part 1 - Tamil Nadu





Front Cover
Pichavaram
1 - Landsat 5 TM Remote Sensing data of 1986
2 - Degraded area
3 - IRS 1D LISS III Remote Sensing data of 2002
4 - Restored Mangroves

ATLAS OF MANGROVE WETLANDS OF INDIA

Part I - Tamil Nadu

V. Selvam, L. Gnanappazham, M. Navamuniyammal,
K. K. Ravichandran and V. M. Karunagaran

M. S. Swaminathan Research Foundation
Chennai, India

M.S.Swaminathan Research Foundation

3rd Cross Street, Institutional Area,

Taramani, Chennai 600 113, India

Telephone : + 91(44) 2541 229

+ 91(44) 2541 698

Fax : + 91(44) 2541319

E-mail : msswami@mssrf.res.in

executivedirector@mssrf.res.in

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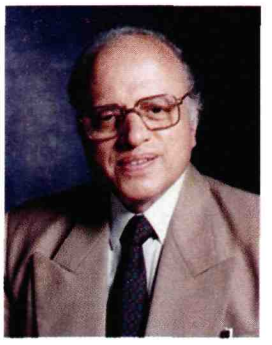
FOREWORD



Soon after its establishment in 1990, MSSRF started its work on Mangrove Wetlands. Activities during 1990-92 included the following:

- Organisation of an International Workshop on Mangrove Genetic Resources
- Organisation of an international training course on the Conservation and Management of Mangrove Genetic Resources
- Preparation of a strategy for the conservation of unique mangrove ecosystems in Asia, the Pacific Region and West Africa
- Establishment of Mangrove Genetic Resources Centre at Pichavaram, Tamil Nadu
- Organisation of a Mangrove Ecosystem Information Service
- Fostering an International Society for Mangrove Ecosystems

These activities were funded by the International Tropical Timber Organisation (ITTO) located at Yokohama, Japan. In addition, the Department of Biotechnology (DBT), Government of India provided funds for initiating an anticipatory research programme for meeting the challenge of a potential rise in sea level due to global warming. The DBT - supported research has resulted in significant achievements in identifying and transferring genes for salinity tolerance from mangrove species to annual crops like mustard, rice and pulses.

MSSRF initiated a detailed study of Mangrove Wetlands Management (the term management is used to denote conservation, sustainable use and equitable sharing of benefits) in 1996 in the States of Tamil Nadu, Andhra Pradesh, Orissa and West Bengal with generous financial support from the India-Canada Environment Facility (ICEF). Earlier the Norwegian Agency for Development (NORAD) had supported mangrove rehabilitation work in Orissa. An important component of the ICEF project is the chronicling of the current status of mangrove ecosystems in a GIS format. To achieve this purpose, it was decided to prepare a comprehensive Mangrove Atlas for India, using the available data. The present volume relating to the mangrove wetlands of Tamil Nadu is the first in this series. Subsequent volumes will relate to Andhra Pradesh, Orissa and West Bengal .

We are indebted to Dr.V.Selvam, Director of the Gulf of Mannar Biosphere Project, for his painstaking efforts to prepare this volume. Ms.Gnanappazham and Ms. Navamuniyammal did outstanding work in preparing the maps. Particular thanks are due to Mr. Bernard Boudreau, Project Director, ICEF and Ms.Jaya Chatterji, Senior Project officer, ICEF for their encouragement and active support. Thanks are also due to Prof. P C. Kesavan, Executive Director and Homi Bhabha Chair, Mr. S. Sankaramurthy, former Project Director, and Prof. S. Chelliah, former Project Director, ICEF supported Mangrove Wetlands Project for their support and guidance.

I hope this atlas will help to stimulate appropriate public policies and actions designed not only to concern the mangrove atlas of Tamil Nadu but also enhance their ecological and economic value for current and future generations.

Chennai
November 2002

(M.S.Swaminathan)

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CONTRIBUTORS

M.S.Swaminathan Research Foundation

Prof. S. Chelliah	:	Former Project Director
Mr. S.Sankaramurthy	:	Former Project Director
Mr. K.Johnson	:	Former Project Officer
Dr.V.Selvam	:	Mangrove Ecologist
Mr. K.K.Ravichandran	:	Mangrove Ecologist
Dr. V.M.Karunagaran	:	Mangrove Ecologist
Dr. R.Somasundaram	:	Botanist
Ms. L. Gnanappazham	:	GIS Specialist
Ms. M. Navamuniyammal	:	GIS Specialist
Mr. A. Albin	:	GIS Specialist
Mr. D.Ramakrishna	:	Hydrogeologist
Mr. J.Raju	:	Fishery Biologist
Mr. K.G.Mani	:	Agronomist
Dr. P.Thamizoli	:	Social Anthropologist

Tamil Nadu Forest Department

Mr. S.M.A.Siddique	:	Range Officer
Mr. R.Venkatachalapathy	:	Range Officer
Mr. R.Munusamy	:	Forester
Mr. S.Manickam	:	Forester

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ATLAS OF MANGROVE WETLANDS OF INDIA

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CHAPTER 1

Introduction

The mangrove wetland forms a dynamic ecotone between land and sea. It is one of the dominant features of the tropical coastline where salinity undergoes constant variation due to freshwater flow and where the substratum is composed of accumulated deposits of sediment. For luxuriant growth, mangroves require high humidity, high tidal amplitude (difference between the high tide and low tide) and high rainfall evenly distributed throughout the year.

The mangrove wetland is a multiple use ecosystem that provides protective, productive and economic benefits to coastal communities. The economic value of the mangrove wetland stems from:

i. availability of wood products ranging from timber, poles and posts to firewood

ii. availability of non-wood produce such as fodder, honey, wax, tannin, dye and plant materials for thatching

iii. availability of aquatic products such as fish, prawn, crab, mussel, clam and oyster

Apart from these, mangrove forests and associated wetlands provide a variety of amenities. Mangrove forests and associated wetlands together

i. act as a barrier against cyclones and prevent entry of saline water inland during storm surges

ii. act as a buffer against floods and prevent coastal erosion

iii. provide nursery grounds for a number of commercially important fish, prawn, crabs and molluscs

iv. enhance the fishery production of nearby coastal waters by exporting nutrients and detritus

v. provide habitats for wildlife ranging from migratory birds to estuarine crocodiles

Because of such multiple uses, mangrove forests are considered sacred forests. A mangrove tree, viz. *Excoecaria agallocha*, locally called Thaillai has been worshipped as a temple tree *(Sthala viruksham)* at the Lord Nataraja Temple at Chidambaram in Tamil Nadu. The images of the *Excoecaria agallocha* are seen carved in rock sculptures and being worshipped. These sculptures were made in the Nataraja Temple, probably in the 2nd century AD.

1.1 Mangrove management

Mangrove forests and associated wetlands are naturally resilient and have withstood severe storms and changing tides for many millennia, but now they are being destroyed on a large scale due to human greed. Today mangrove forests are among the most threatened habitats in the world, overall as much as mangrove forests have been lost (Kelleher *et al,* 1997) One of the factors for such large-scale destruction is that until recently the mangrove wetlands were considered as wastelands and their management was given little importance. Most of the mangrove management plans give importance only to the forest component of the mangrove wetlands and very limited or

no attention is paid to the hydrological and sedimentary processes which are responsible for the stability of the mangrove wetlands. Secondly, insufficient attention is given to the inter-relationship between the health of the mangrove wetlands and the land and water use practices that are followed in the regions adjacent to mangroves. In addition, in most of the mangrove management plans a limited or insignificant role is given to the local community as participants. Consequently community participation in mangrove conservation and enhancement is lacking. These deficiencies of the mangrove management plans are mainly due to:

i. limited site-specific information on mangrove resources, inter-relationship between the physical and biological components and interactions between ecological processes and human needs;

ii. limited orientation among the staff of the management agencies towards the scientific principles of mangrove management, particularly a holistic or systems approach, and

iii. inadequate skills of the management agencies to collect and process multiple sources of data needed to develop an integrated, multi-disciplinary, human-centred and process-oriented approach to mangrove wetland management.

The Mangrove Atlas of India is one of the steps to bridge this knowledge gap between the scientific community and the user agencies.

1.2 Mangrove Wetland Ecology

A brief account of the ecology of mangrove wetlands is given for a better understanding of this ecosystem. The health of the mangroves in terms of hydrological and soil conditions and the wealth of the mangrove wetlands in terms of species diversity, biomass and productivity are determined by the following factors:

- degree of protection against high-energy waves
- quantity and duration of freshwater inflow
- larger tidal amplitude with gently sloping coastline and
- sediment supply

i. Protection against high-energy waves:

Mangrove seedlings settle and grow well only in coastal areas where wave energy is low or in places where the mangrove wetlands are protected by a sand barrier against high wave energy. The coastline of the Muthupet region of Tamil Nadu and also that of the Sunderbans are the best examples of areas of low wave energy where mangroves grow along the coastline. In the Pichavaram mangroves of Tamil Nadu and the Godavari mangroves of Andhra Pradesh, the wave energy along the coast is high but a sandy beach, located between the sea and the mangrove wetlands, protects these mangroves.

ii. Quantity and duration of freshwater inflow

Though some mangrove species such as *Avicennia marina* are capable of tolerating soil salinity of around 90 parts per thousand (ppt which is equal to grams per litre), for most mangrove species the optimum salinity lies between 5 and 15 ppt (Robertson and Alongi, 1992). In most of the mangrove species seeds germinate in the tree

itself (vivipary) and mangrove seedlings attain maximum growth only in these low salinity conditions. On the basis of salinity tolerance mangrove plant species are divided into 3 types:

a) salt excluding species - the roots of these species possess an ultra-filtration mechanism by which water molecules from the seawater are taken in by reverse osmosis process and salts are excluded in the root zone itself

b) salt excreting species - these species take saline water as such but water molecules and essential salts are retained in the tissue of the plants, whereas excess salts are excreted through salt glands.

c) salt accumulating species - these species accumulate a high concentration of salts in their cells and tissue and overcome salt toxicity by developing succulence

It is observed that mangrove species belonging to all these categories are present in a mangrove wetland which receives inflow of freshwater during most parts of the year. Salt excreting and salt accumulating type of species dominate the mangrove wetland, which receives only limited quantity of freshwater for a short period of time during a year. Thus, the quantity and periodicity of freshwater inflow determine species diversity as well as growth and biomass of plant species of mangrove wetlands. Due to these factors, the species diversity and biomass of Sunderban mangroves of West Bengal and Bhitarkanika mangroves of Orissa are much higher than that of Tamil Nadu mangroves, which receive a low amount of freshwater, and that too only for a short period (October to December).

iii. Larger tidal amplitude and gently sloping coastline

The tidal amplitude of the coastal areas and the slope of the coastline distinctly determine the area of the mangrove wetland. For example in the Sunderbans of West Bengal, tidal amplitude reaches as much as 6 m and the slope of the coastal area is very gentle.As a result, tidal water migrates up to 90 km to the land and wherever tidal water propagates, the mangrove is present. These mangrove wetlands occupy more than 4,00,000 ha. In the case of Tamil Nadu, the tidal amplitude is only 60 to 80 cm and the area of mangrove wetland is also restricted to a few thousand hectares.

iv. Sediment supply

For the luxuriant growth of mangroves, continuous supply of sediment is necessary as it brings in large amounts of nutrients (absorbed on sediment particles) and provides a suitable substratum for mangrove propagules to establish and grow. Some of the mangrove wetlands, apart from the supply of nutrients from river flow, also depend on the nutrients supplied by the sea during high tide.

1.3 Mangrove Wetlands of India

The area of the mangrove wetlands of India has been estimated variously from 681000 ha by Sidhu (1963) to 5,00,000 ha by the Forest Survey of India, 1998 (Figure.1.1). The major mangrove wetlands of India are located along the East Coast of India. All along the east coast the tidal amplitude as well as the periodicity of freshwater flow decreases from the Sunderban mangroves in the north to the Pichavaram and Muthupet mangroves located in the southernmost end of the east coast. This clearly indicates the influence of the freshwater inflow and tidal amplitude on the health and wealth of the mangrove wetlands located along the east coast of India as

shown in Table 1.1 and Figure.1.1

Table 1.1 Basic ecological characters, area and species diversity of the mangrove wetlands of the east coast of India

Mangrove area	Tidal amplitude (m)	Freshwater inflow	Area (ha)	Species diversity
Sunderbans -West Bengal	4 to 6	Perennial	400000	48
Bhitarkanika - Orissa	2 to 4	July to January	30000	36
Godavari - Andhra Pradesh	1.5 to 2	July to November	33200	16
Pichavaram and Muthupet - Tamil Nadu	0.20 to 0.50	October to December	14000	13

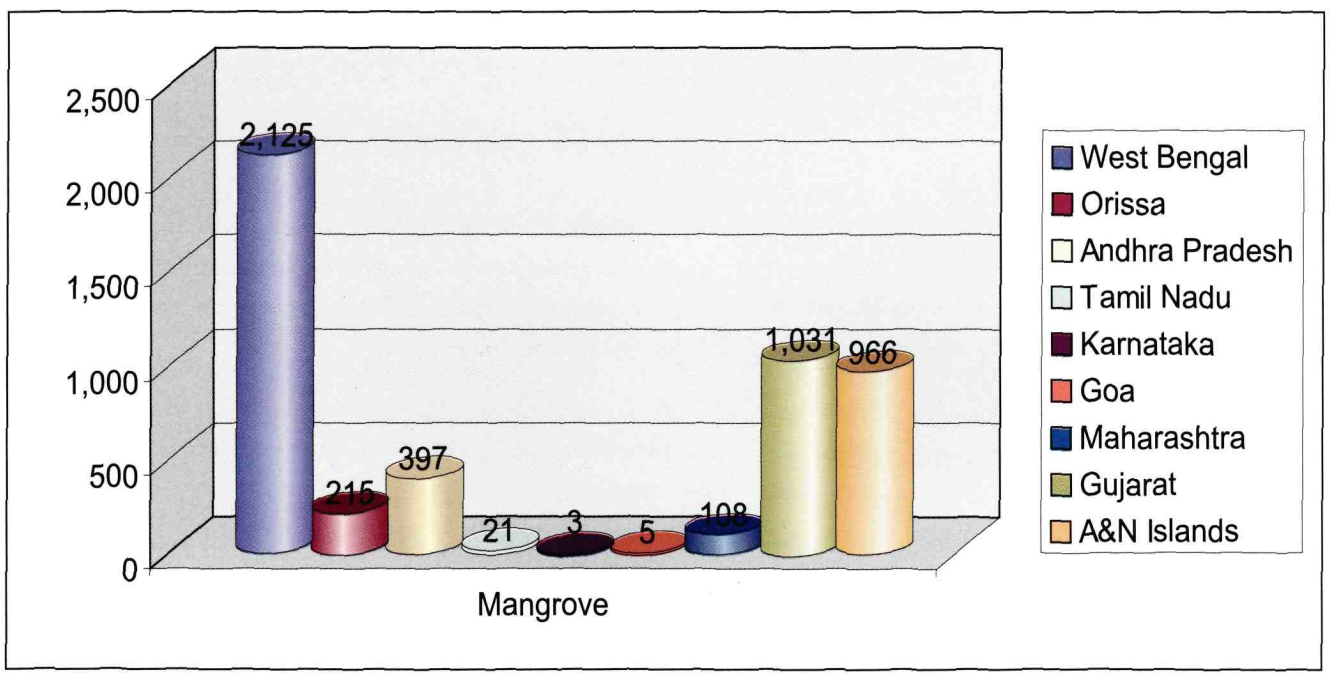


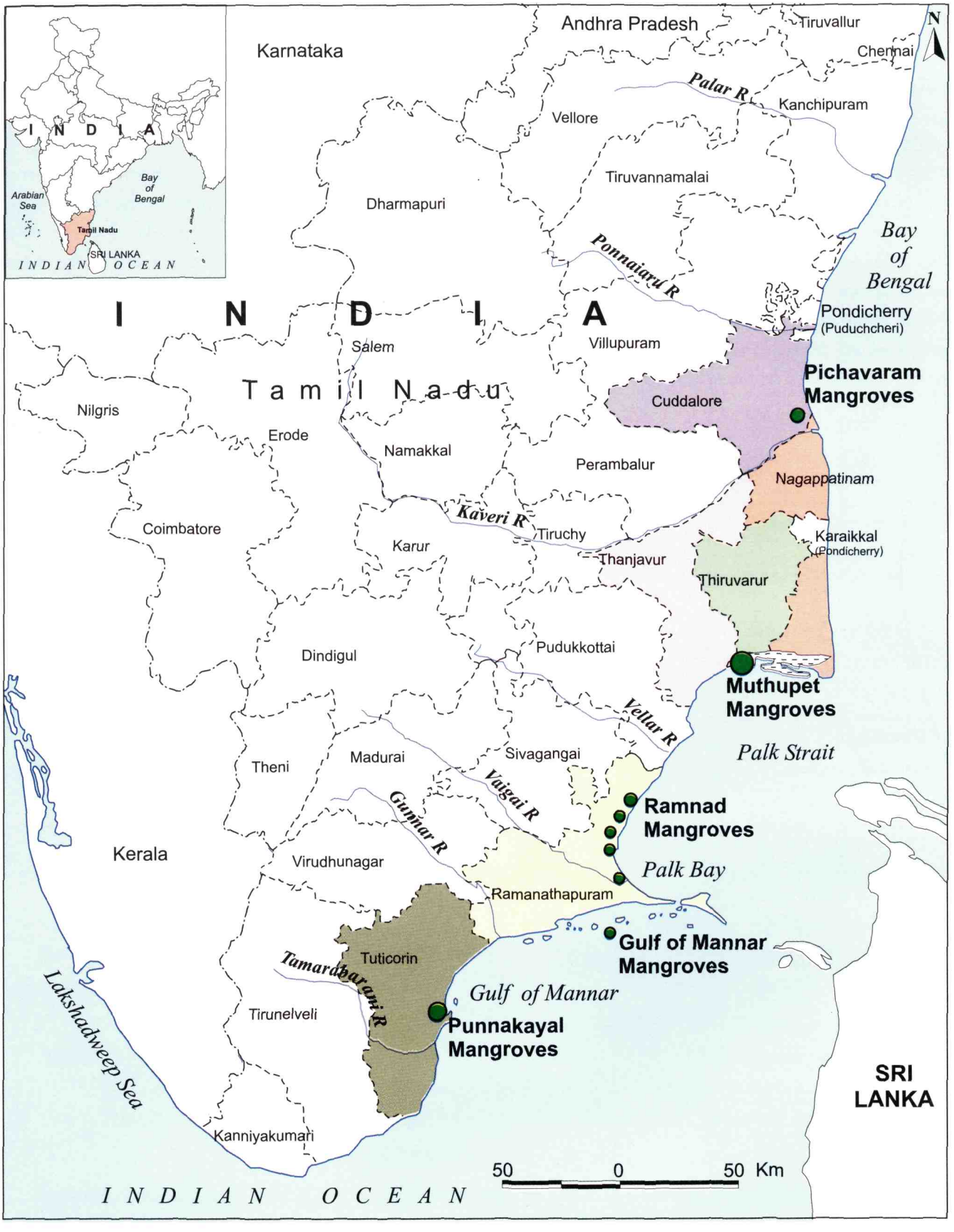
Figure. 1.1 Area of different mangrove wetlands of India

1.4 Mangrove Wetlands of Tamil Nadu

Tamil Nadu has a coastline of about 950 km. The coastal zone of Tamil Nadu is very narrow except in the Vedaranyam-Muthupet stretch of Thiruvarur-Thanjavur District where extensive mud flats are present. The Cauvery and its distributaries, the Palar and Tamarabarani are considered the major rivers of Tamil Nadu. The coastal area of Tamil Nadu is considered a rain-shadow area because of the low rainfall it receives during the Southwest monsoon (June to September). However, during the Northeast monsoon season (October to December) most parts of the Tamil Nadu coast receive high rainfall, particularly during the months of November and December. Table 1.2 shows the location of the major and minor mangrove wetlands of Tamil Nadu (Map 1.1). As indicated in Table 1.2, the major mangrove wetlands of Tamil Nadu are located in the deltaic regions of the river Cauvery. A large patch of healthy mangroves is present in the Devipattinam area, bordered by Palk Strait in the east, in Ramanathapuram District. In the islands of the Gulf of Mannar Biosphere Reserve, mangroves are present in a few hundred hectares. These mangrove patches consist of a true mangrove species namely, Phemphis acidula, which is not present in any other Indian mangrove wetland.

Table 1.2. Major and minor mangrove wetlands of Tamil Nadu

Location-District and estuary	Name of the Mangrove wetland	Area (ha)	Forest Division
Cuddalore: Uppanar-Coleroon estuarine region	Pichavaram	1357	Villupuram Forest Division
Thanjavur: Coleroon estuarine region	Pudhupattinam	800	Thanjavur Forest Division
Thiruvarur-Thanjavur: Distributaries of Vennar	Muthupet	12000	Nagapattinam Wildlife Sanctuary
Ramanathapuram: Islands of the Gulf of Mannar	Gulf of Mannar Marine National Park	30	Gulf of Mannar Division
Ramanathapuram: At the mouth of small tidal creeks at 11 places in the mainland	Palk Strait	700	Gulf of Mannar Division
Tuticorin: Tamirabarani estuary National Park	Gulf of Mannar Marine	148	Gulf of Mannar Division



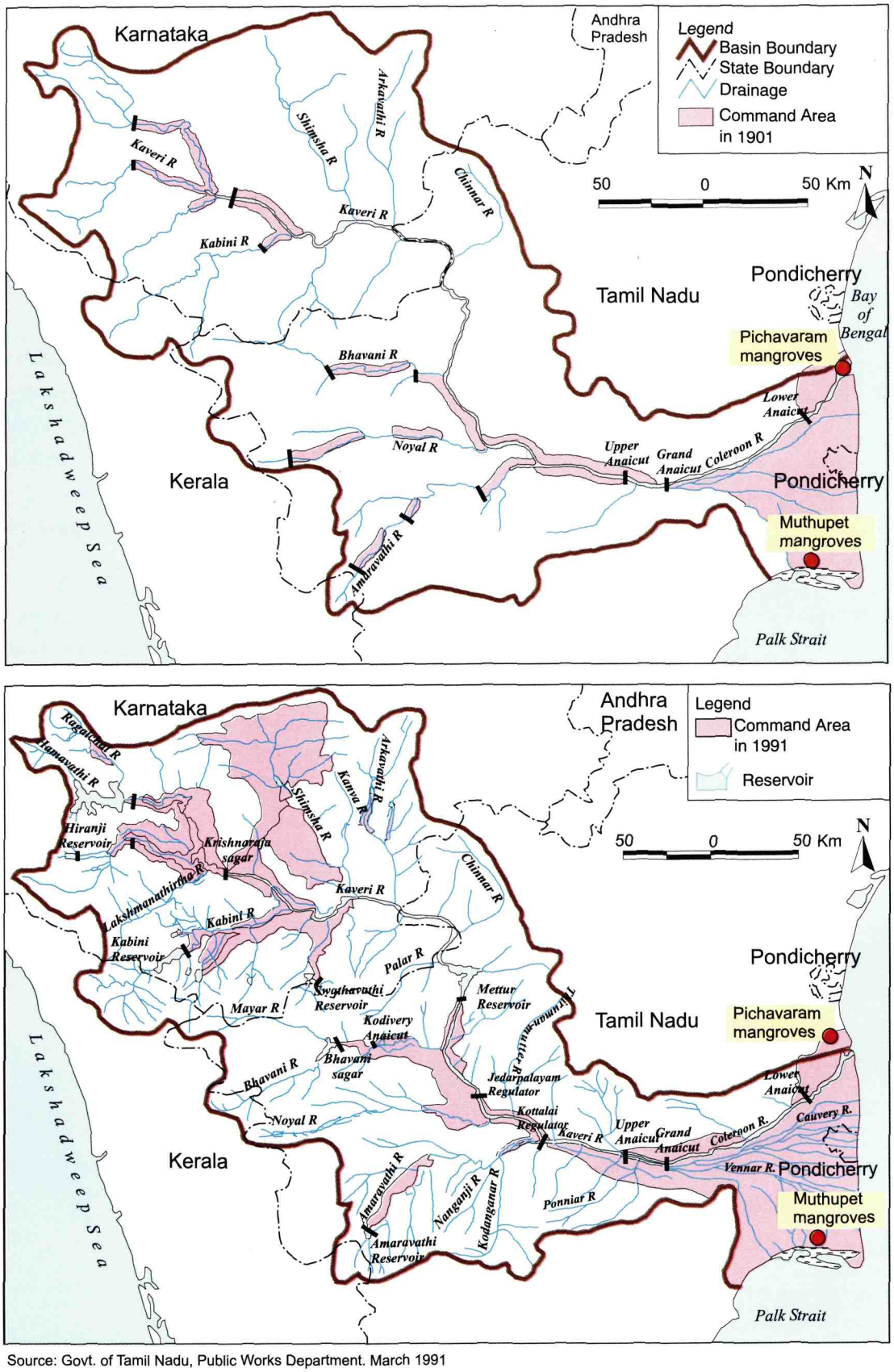
Map 1.1 Location of Tamil Nadu Mangroves

1.4.1 Mangroves of Tamil Nadu and Cauvery Delta

The river Cauvery is the main supplier of freshwater to the Cauvery delta in which the major mangrove wetlands of Tamil Nadu, namely Pichavaram and Muthupet, are located. The Pichavaram mangrove is located in the northernmost end of the Cauvery delta whereas Muthupet mangrove is located in the southernmost end. The Pichavaram mangrove wetland receives freshwater from the Coleroon river, which is one of the distributaries of the Cauvery riverine system. The Coleroon river receives freshwater from the Cauvery river through Lower Anaicut (Anaicut - small dam), located about 70 km west of the Pichavaram mangroves. A number of small distributaries of the Cauvery riverine system, namely Pamini, Korayar, Marakkakorayar and Kilaithangi, supply freshwater to Muthupet mangrove wetlands.

The Cauvery rises at Thalacauvery on the Bramagiri Hills of Western Ghats in the state of Karnataka and runs through Tamil Nadu, before joining the Bay of Bengal. The total catchment area of the Cauvery is about 81155 km^2, of which 34273km^2 lies in the State of Karnataka, 2866 km^2 in the State of Kerala and 44016 km^2 in the State of Tamil Nadu. The upper part of the Cauvery basin receives rainfall during the Southwest Monsoon (June to September) season and the lower part, lying in Tamil Nadu, during the Northeast Monsoon (October to December) season. The flow of freshwater in the Cauvery reaches a peak during the Southwest monsoon season when the rainfall is high.

Till 1924, both the Pichavaram and Muthupet mangrove wetlands received freshwater for nearly 6 months, from July to December. Since 1924, a number of major and minor dams have been constructed both on the River Cauvery as well as its tributaries and distributaries. Consequently the anaicut area has increased and a large quantity of freshwater is being diverted for irrigation (Map 1.2). This has resulted in the gradual decline of the quantity as well as the periodicity of freshwater discharged into the Pichavaram and Muthupet mangrove wetlands. The discharge data from Lower Anaicut to Coleroon river, from which the Pichavaram mangroves receive freshwater, collected from the Public Works Department of Tamil Nadu from 1934 to 1999 shows that in the 1930s 73 TMC of water was let out into the Coleroon river, which reduced to 31 TMC in the 1980s and further to 3 to 5 TMC in the 1990s. As a result of this, the amount and periodicity of freshwater discharged and sediment supplied along with it into the Pichavaram and Muthupet mangrove wetlands has reduced (Figure.1.2) resulting in the development of high annual average salinity. This in turn resulted in the disappearance of a number of mangrove plant species, which are sensitive to increase in salinity.



Source: Govt. of Tamil Nadu, Public Works Department. March 1991

Map 1.2. Cauvery delta and changes in the command area

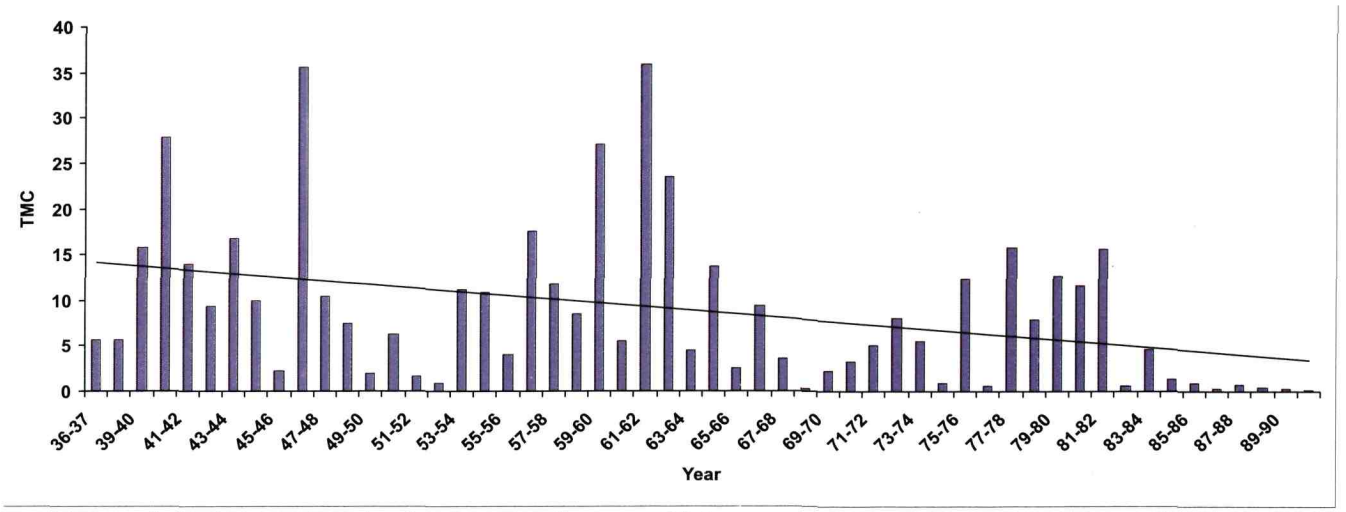


Figure 1.2 Reduction in freshwater flow to Pichavaram mangrove wetland from 1936 to 1990 (Source: Public Works Department, Government of Tamil Nadu)

1.4.2 Extinction of mangrove species in Tamil Nadu mangroves

Available literature shows that salinity-sensitive mangrove species like *Xylocarpus granatum, Kandelia candel, Bruguiera gymnorrhiza* and *Sonneratia apetala,* which were once present in large numbers in the Pichavaram mangroves, have completely disappeared now (Caratini *et al* 1973). The first three species were collected from the Pichavaram mangrove wetland by the Botanical Survey of India, Coimbatore and French Institute, Pondicherry and are still preserved in their herbarium. Similarly, the palynological studies carried out by Tissot (1979) showed that species belonging to *Sonneratia* and *Rhizophora*, which dominated Muthupet mangrove wetlands about 150 years ago, have now completely disappeared.

According to Blasco (1984), palynological studies analyse pollen, spores and other micro fossils found in soil samples and relate them to the source of vegetation. The interpretation of reconstructed flora assemblages and vegetational development usually leads to palaeo-environmental conclusions, as it is generally agreed that changes in vegetation, whether climatic, edaphic or biotic reflect local ecological changes. The reduction of freshwater flow can be considered as one of the major ecological changes that affected the species diversity of the Pichavaram and Muthupet mangrove wetlands of Tamil Nadu.

The palynological study carried out by Tissot (1979) in the Pichavaram area reveals three main groups in the stratiographic sedimentary record:

i) auochthonous pollens of *Rhizophoraceae, Avicennia, Sonneratia* and *Excoecaria,*

ii) allochthonous pollen of *Cypreaceae* and *Germineae* and

iii) pollens of cultivated plants and weeds. The analysis indicates, as shown in Figure1.3 that *Sonneratia*

species and species belonging to *Rhizophoraceae* dominated the mangrove vegetation of the Pichavaram mangroves till recently and dominance of *Avicennia* species started only very recently. It is to be mentioned that at present only one individual of *Sonneratia apetala* is found in the Pichavaram mangrove wetland and compared to the population of *Avicennia marina* the population size of the species beloning to *Rhizophoraceae* such as *Rhizophora* species, *Ceriops* and *Bruguiera* is very small.

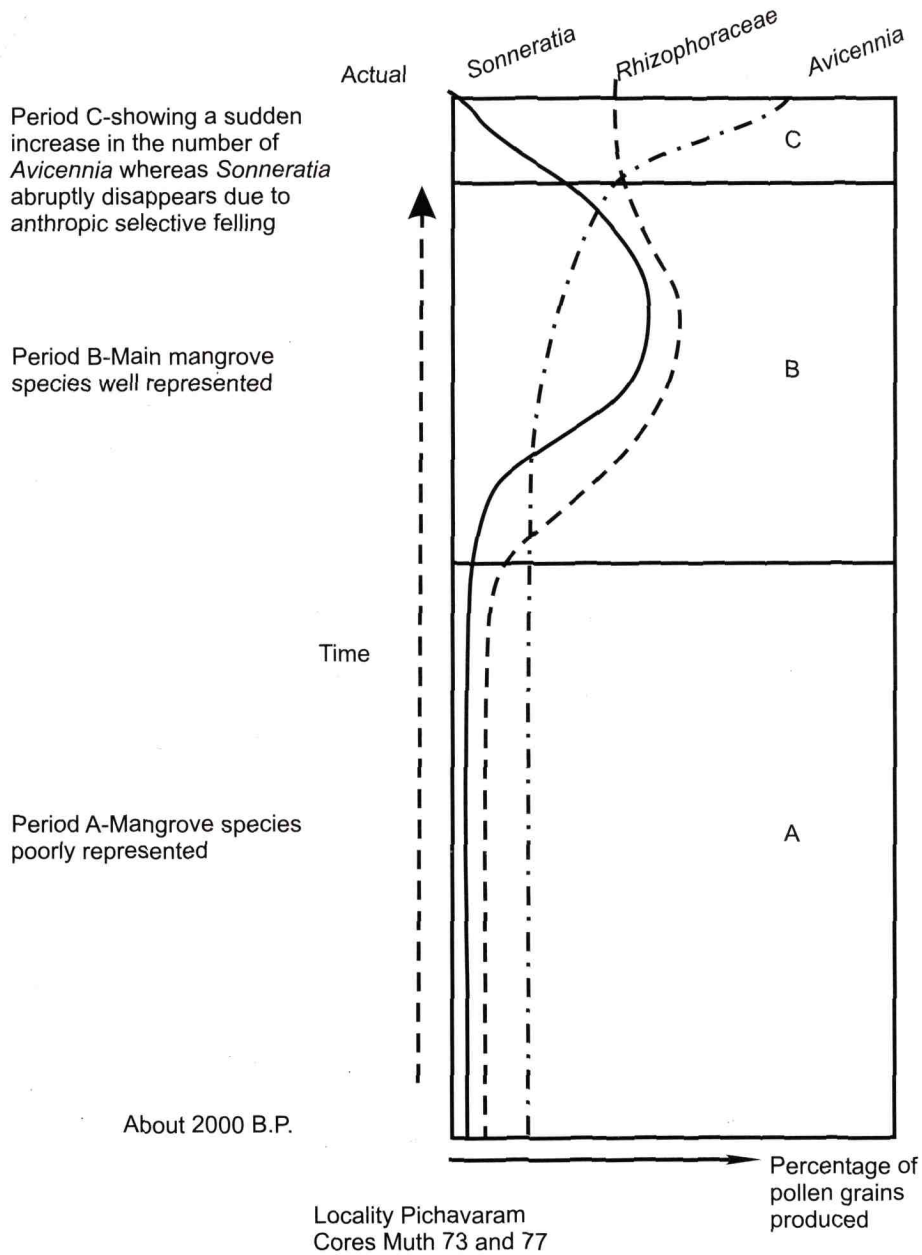


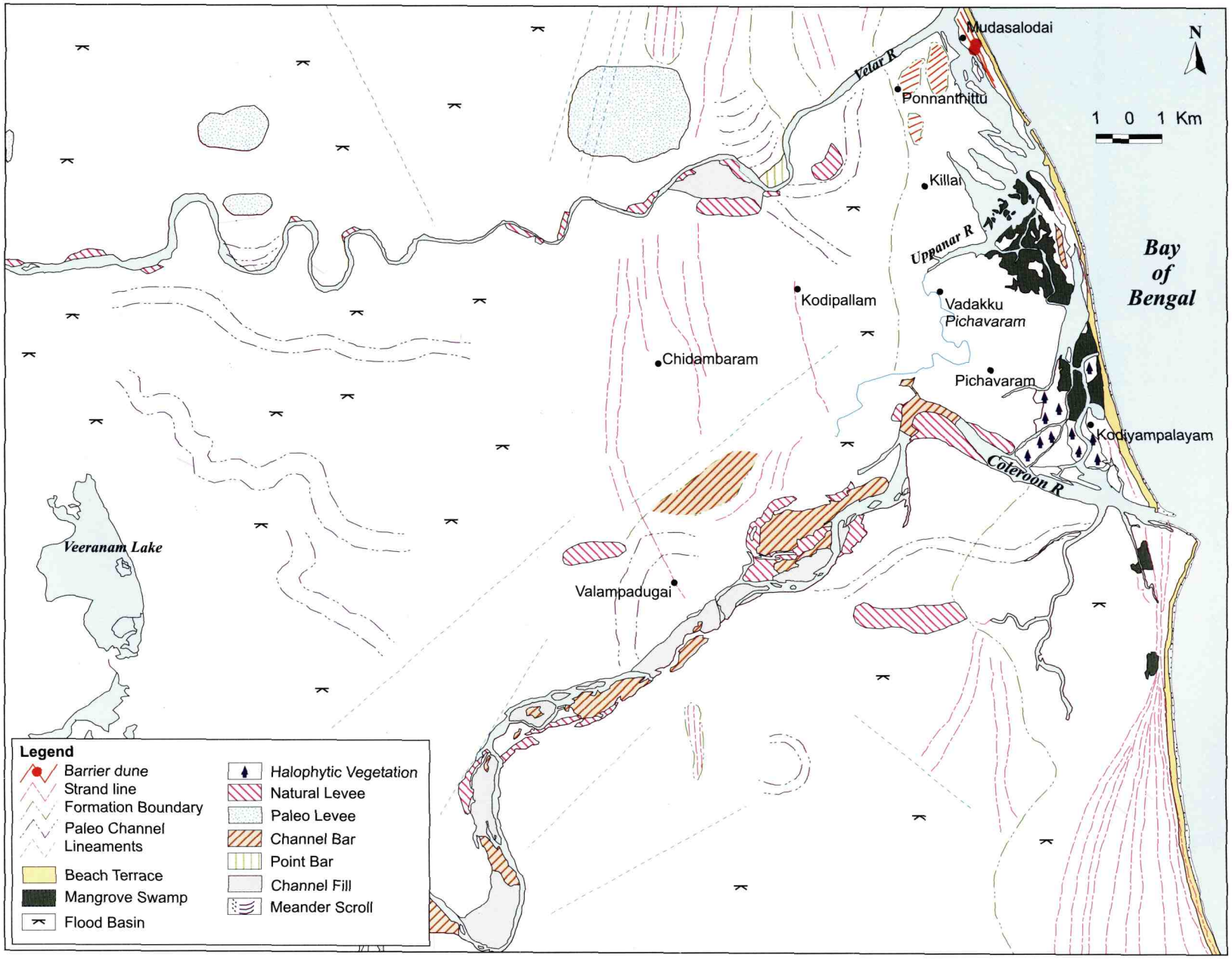
Figure. 1.3 Dominant species of Cauvery delta over a period in accordance with fresh water availability (Source: The Mangrove Ecosystem Research Method)

CHAPTER 2

Pichavaram Mangrove Wetland

2.1 Geomorphological setting

Movements of the crust form the primary relief elements (mountains, valleys, plains etc) of the Earth's surface. Geomorphology is the systematic study of the origin of secondary topographic features, which are either carved by erosion in the primary elements or built-up from the erosional debris. The Pichavaram area is a vast plain with a gentle slope towards the Bay of Bengal. Rivers Uppanar and Coleroon, which are distributaries of the river Cauvery, drain the area. The major geomorphic formations of this region are the Portonovo formation, the Mutlur formation and the Vellar-Coleroon formation (Map 2.1). The major landforms in the Portonovo formation are the beach, barrier dunes, estuary, tidal and mud flats, mangrove and halophytic formations, spit/tidal bar, beach terrace and strand line. The beach is very narrow with an average width of 50 m from the south of Portonovo to the Coleroon mouth. The continuity of the beach is broken at the mouths of the Vellar, Uppanar and Coleroon. The strand lines (paleo shorelines) have been found up to a distance of 15 km from the coast and 1km west of Chidambaram. This indicates that at the close of the Tertiary period (60 million years ago), the shoreline was a few kilometers west of Chidambaram. A compound spit is seen at the southern tip of the Coleroon river mouth. It also helps in the development of cuspate foreland, which is triangular in shape. The Mutlur formation has a number of paleo tidal flats and inter-distributary flood basins. In the Vellar-Coleroon formation, landforms such as paleo levees, point bars, meander scroll (indicating the past position of the river), channel bar, channel fill, flood basins and paleo back swamps are seen. The paleo channel of the Coleroon river indicates that the river once entered the sea just west of Vallampadugai, a small village located 6 km south of Chidambaram town.



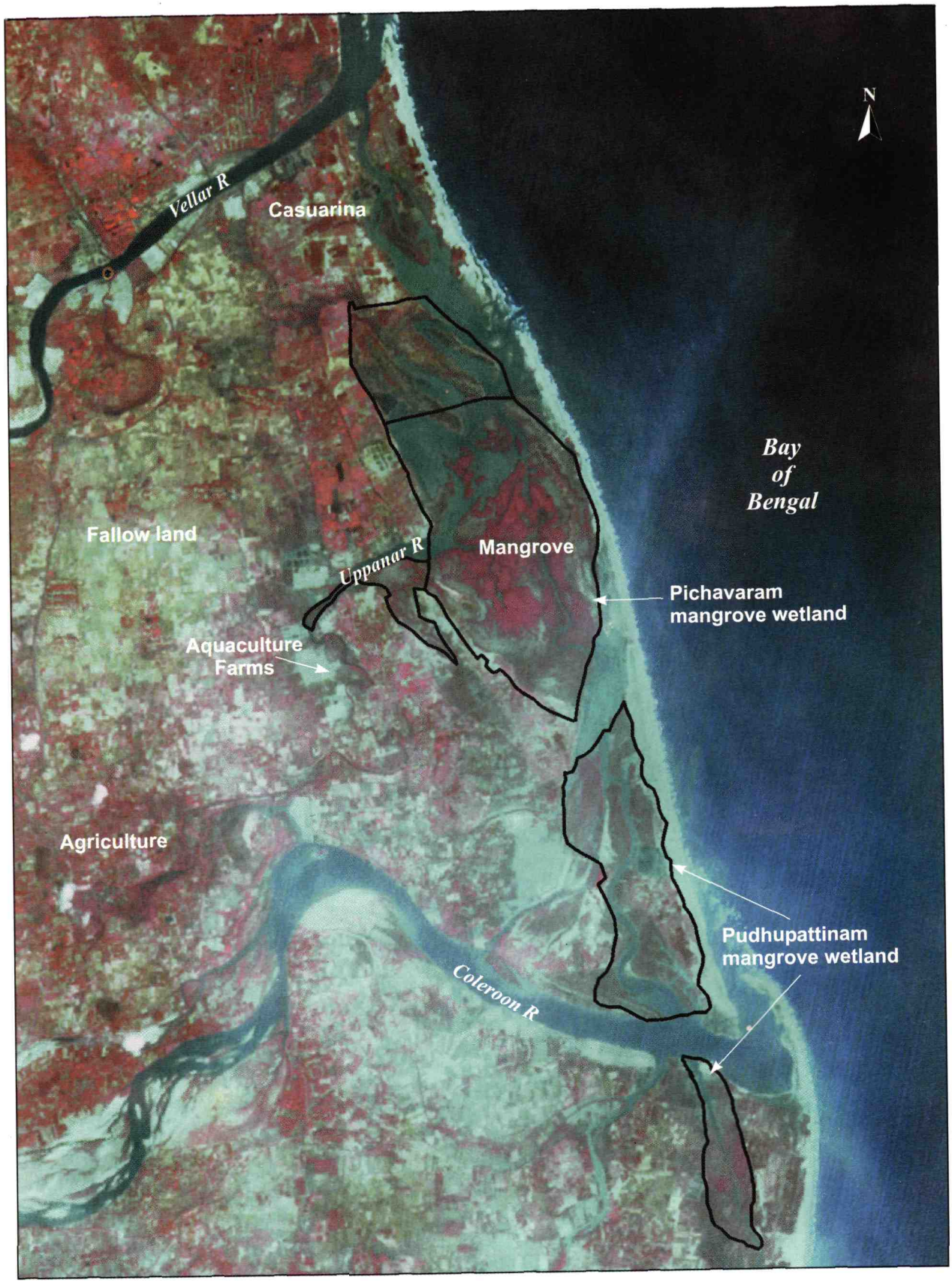
Map 2.1. Geomorphological setting

2.2 Remote Sensing Imagery

The remote sensing imagery of the Pichavaram mangrove wetland (IRS 1D dated 24th January 1999) shows that the mangrove wetland is located between the Vellar river in the north and the Coleroon river in the south and connected to the estuaries of these two rivers by backwaters. The backwater in the south is deep and well-marked whereas the backwater in the north is almost silted up. The mangrove forest can be identified by its bright red colour with smooth texture (Figure 2.1) whereas other vegetation such as casuarina plantations can be identified by their dark red to red colour with coarse to medium texture. Agricultural crops such as groundnut in sandy areas is shown by light pink colour with smooth texture; yellow to greenish blue colour indicates fallow land. The degraded area within the mangrove wetlands is also visible by its dark to light brownish red colour with rough to moderate texture (Figure 2.2). The sandy beach along the coastline is represented by white to yellowish white colour with smooth texture. Other sandy areas are pure white in colour.

Figure 2.1 A view of the Pichavaram mangrove forest (shown as bright red colour in the imagery)

Figure 2.2 Degraded mangroves (shown as dark to light brownish colour with rough to moderate texture)



Map 2.2. Remote Sensing Imagery

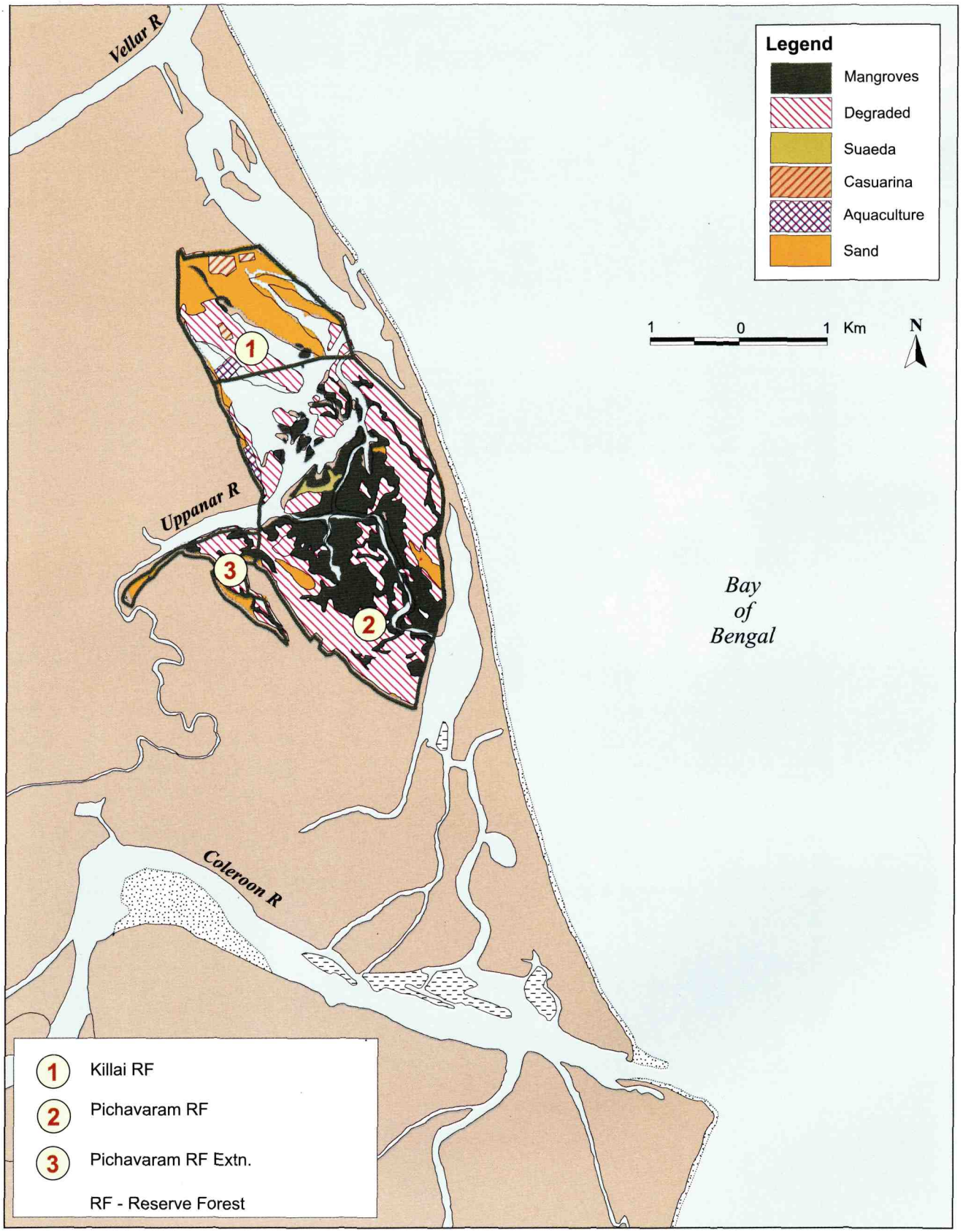
2.3 Reserve Forests

The Pichavaram mangrove wetland consists of 3 Reserve Forests (RF) *viz.*, Killai RF, Pichavaram RF and Pichavaram Extension Area. The Killai and Pichavaram mangrove wetlands were declared as Reserve Forests in 1893 with a total area of 1266 ha. Later, in 1897, an area of 92 ha was included in the Reserve Forest as Extension area. Thus, the total area of the Pichavaram mangrove wetland is about 1358 ha. However, the analysis of the remote sensing data of 1996 (IRS 1C dated 22nd June) shows a total area of 1447 within the Reserve Forest boundary. The methodology followed was that the RF boundary shown in Survey of India Toposheet (1970) was overlaid on the remote sensing data (Map 2.2). Then, a training site was given to each category which was analyzed digitally. The selection of the training site is based on ground truthing. The area of different categories of mangrove wetland and associated dry land (Figure 2.3) found within the RF boundary (Map 2.3) is given in Table 2.1.

Table 2.1. Different categories of mangrove wetland (1996) in Hectare

Category/ RF	Killai RF	Pichavaram RF	Extension Area	Total
Healthy mangroves	8.11	370.07	21.24	399.42
Degraded mangroves	71.73	445.58	47.73	565.05
Water body	87.76	215.05	5.56	308.37
Sand dune	142.62	24.90	14.58	182.10
Casuarina	16.39	-	-	16.39
Total	326.61	1055.60	89.11	1471.33

Fig 2.3 Small sand dunes with terrestrial vegetation found within the Pichavaram mangrove wetland



Map 2.3 Reserve Forest map - Pichavaram

2.4 Biophysical and Hydrological Conditions

2.4.1 Species composition and zonation

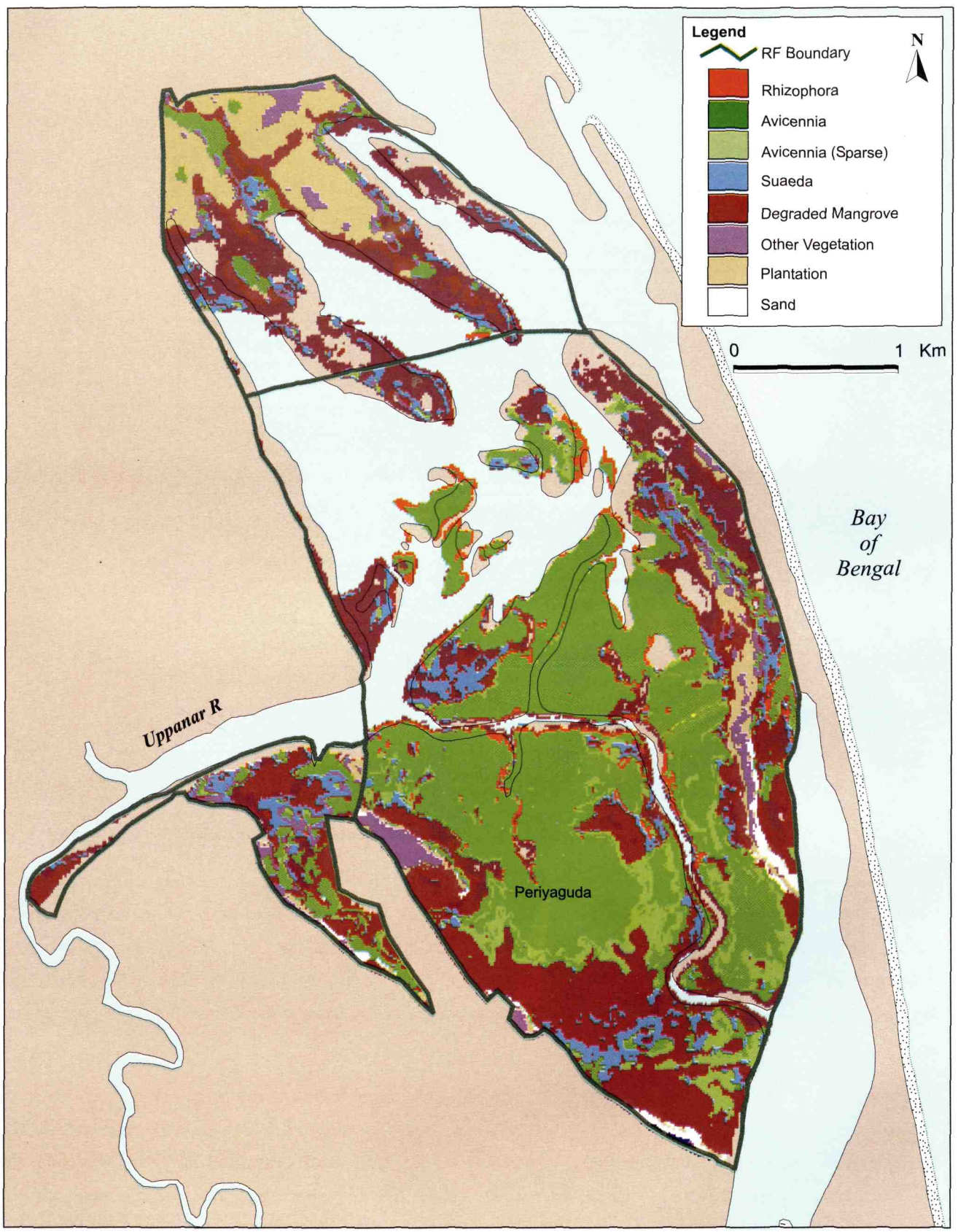
The Pichavaram mangrove wetland is characterized by the presence of the 13 exclusive mangrove species listed in Table 2.2.

Table 2.2. Mangrove species present in the Pichavaram mangrove wetland

Name of the species	Family
Acanthus ilicifolius L.	Acanthaceae
Aegiceras corniculatum (L.) Blanco	Myrsinaceae
Avicennia marina (Forsk.) Vierh.	Avicenniaceae
Avicennia officinalis L.	Avicenniaceae
Bruguiera cylindrica (L.) Blume	Rhizophoraceae
Ceriops decandra (Girff.) Ding Hou.	Rhizophoraceae
Excoecaria agallocha L.	Euphorbiaceae
Lumnitzera racemosa Wild	Combretaceae
Rhizophora apiculata Blume	Rhizophoraceae
Rhizophora mucronata Lam.	Rhizophoraceae
Rhizophora lamarckii	Rhizophoraceae
Xylocarpus mekongensis (Prain) Pierre	Meliaceae
Sonneratia apetala Buch-Ham	Meliaceae

Suaeda maritima, *Suaeda monica* and *Salicornia brachiata* are the important associated species of the mangrove wetlands. A number of terrestrial species are present in the sand dunes associated with the mangrove wetland but their distribution is restricted and they can be considered only as strand species. Among the 13 species of true mangroves *Avicennia marina* is the dominant species, constituting about 74% of the total population, followed by *Rhizophora* species (15%). Among the associated species, *Suaeda maritima* is the dominant species (Map 2.4).

The zonation or spatial distribution pattern of the mangrove flora indicates the microhabitat preference of different species in that particular mangrove wetland and thus this study is important with reference to the development of site-specific action plans for plantation activities. In the Pichavaram mangrove wetlands, the spatial distribution of the flora shows three different zones viz, the *Rhizophora* zone, the *Avicennia* zone and the *Suaeda* zone. The *Rhizophora* zone occurs as a narrow strip along the tidal creeks and channels and its breadth varies from 4 m to 10 m. It is interesting to note that out of the 13 mangrove species present in the Pichavaram



Map 2.4. Species composition and zonation

mangrove wetland, the distribution of 10 species, except *Acanthus ilicifolius*, *Avicennia marina* (Figure 2.4) and *Excoecaria agallocha*, is restricted to this narrow *Rhizophora* zone. The *Rhizophora* zone is characterized by the presence of dense, evergreen trees of *Rhizophora* species of 4-7 m high (Figure 2.5). Other species in this zone such as *Bruguiera* and *Ceriops* grow like bushes, reaching a height of 1-3 m. The breadth of the *Avicennia* zone varies from 20 to 90 m depending on the size of the island and topography of the area (Figures 2.6 and 2.7).

Figure 2.4 *Avicennia marina*

Figure 2.5 *Rhizophora mucronata*

Avicennia marina and *Rhizophora mucronata* and *R. apiculata* are the dominant speices of the Pichavaram mangrove wetland.

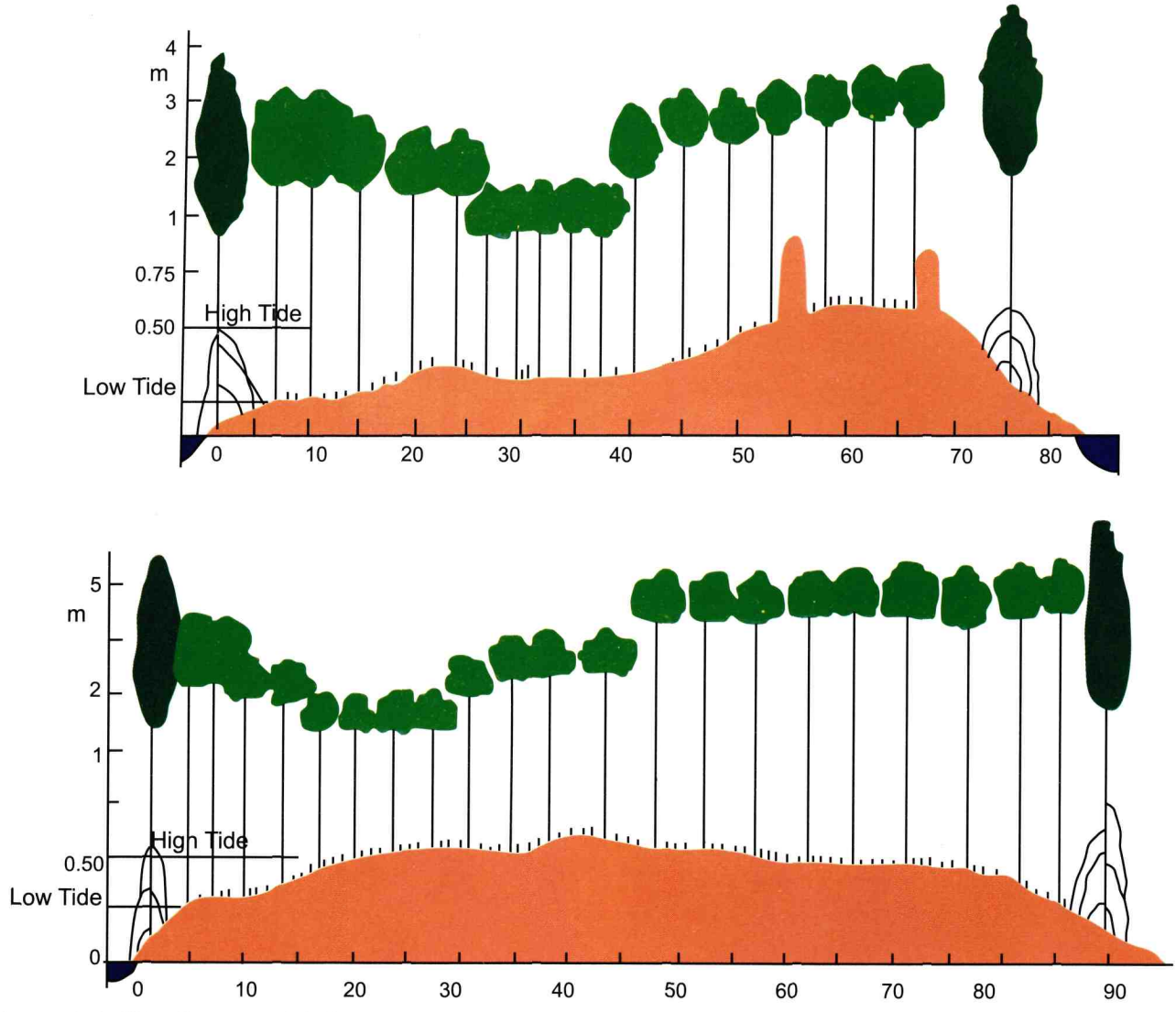


Figure. 2.6 Distribution of different species of mangroves with reference to topography and tidal inundation

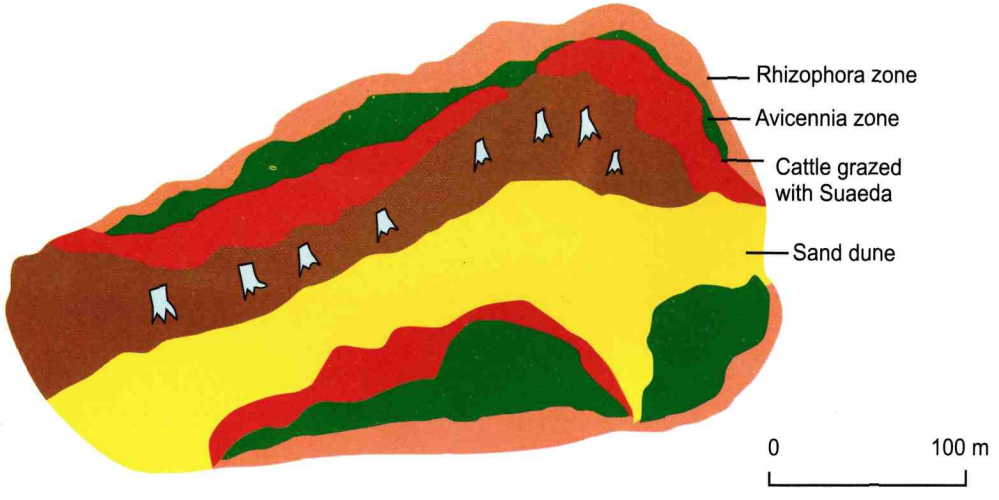


Figure.2.7 Zonation of the mangrove flora in one of the islands of the Pichavaram mangroves

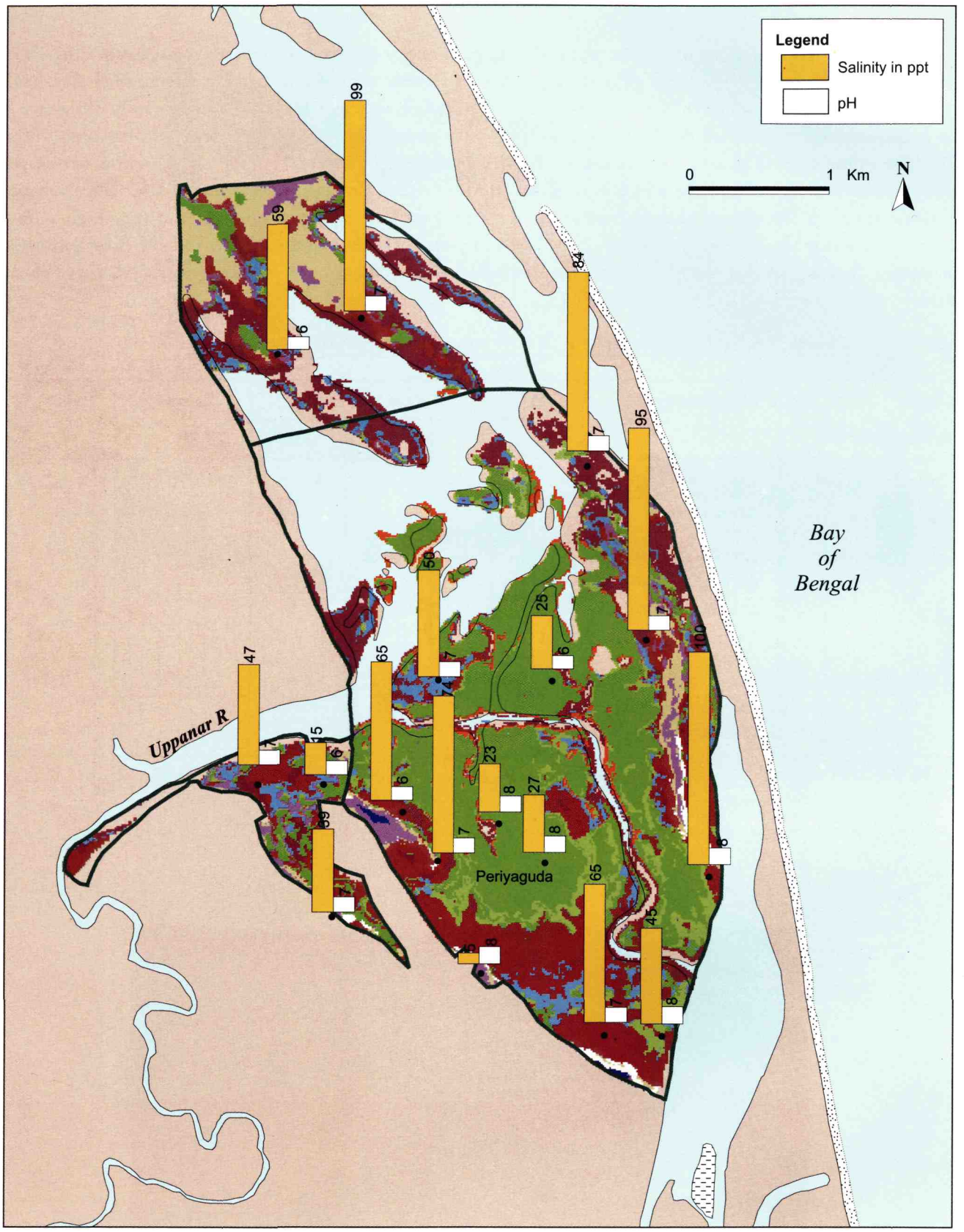
2.4.2 Soil properties

The soil of the Pichavaram mangrove wetland is in general dry for most of the year and highly firm. From the geochemical point of view, soils are clayey and rich in alkaline and alkaline earth elements such as calcium and magnesium (Blasco *et al* 1985). Soil analysis done by MSSRF indicates (Map 2.5) that there is difference in the granulometric features of the *Rhizophora* and *Avicennia* zone; soil salinity, in general, is very high (Table 2.3). The mineralogical studies carried out by Blasco *et al* (1985) indicate that the clay fraction of the soil contains a mineral called smectite which is responsible for the poor drainage regime of the soil. The stagnation of saline water in the trough shaped portion of the degraded area is responsible for the very high salinity noticed in the degraded mangroves (Figure 2.8). The soil salinity clearly indicates that a suitable drainage system for proper flushing of the mangrove wetlands needs to be introduced both in the degraded area and in the healthy *Avicennia* zone where soil salinity is high.

Table 2.3. Soil properties of different zones of Pichavaram mangrove wetland

Zone/ soil properties	Morphology	Grain size %			Salinity ppt	pH
		Clay	Silt	Sand		
Rhizophora zone	Dark grey-blue, clayey, firm, fibrous	22-37	13-21	42-65	15-20	7.4-7.5
Avicennia zone	Oxidized horizon, grey blue with red and brown mottle, clayey, dry and compact	48-68	22-34	10-15	23-45	7.8-8.1
Degraded area	Bare, trough shaped with a thin layer of salt, clayey and very dry	36-41	13-17	42-52	65-100	7.2-7.6

Figure 2.8 Salt encrusted land



Map 2.5. Soil properties

2.4.3 Hydrological conditions

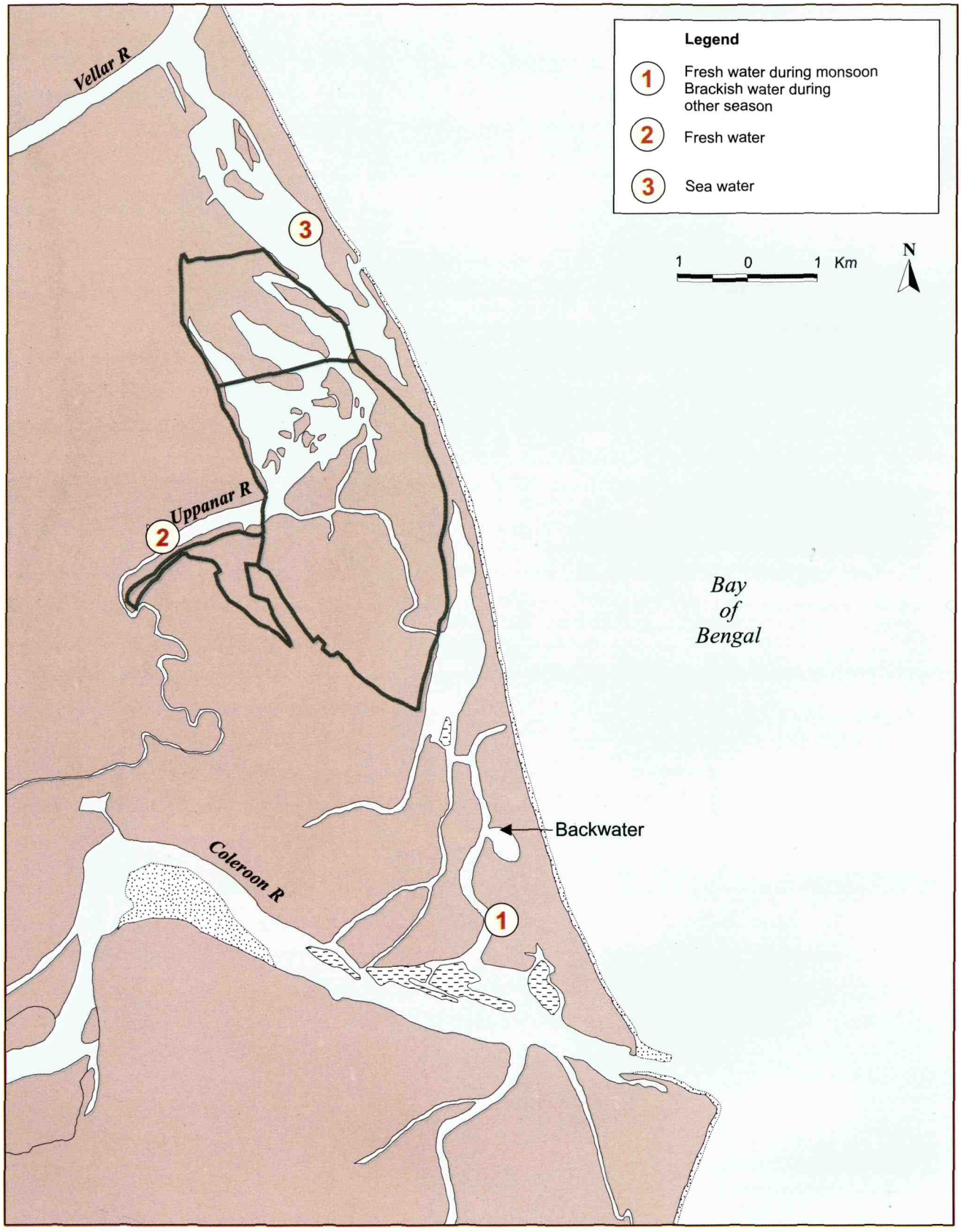
The Pichavaram mangrove wetland is interconnected with the estuaries of the Vellar river in the north, the Coleroon river in the south and the Uppanar river in the west. The large open water body found associated with the Pichavaram mangrove wetlands is the estuarine region of the Uppanar river (Map 2.6).

Bathymetry: The bathymetry study of the Pichavaram mangrove wetland shows that in most of the areas the depth of the water is between 0.63 to 1.63 m except in the mouth region at Chinnavaikal where the depth ranges from 3.63 to 5.63 m.

Freshwater inflow: The Pichavaram mangrove wetland receives copious inflow of freshwater during the northeast monsoon season (October-January) through the Coleroon and Uppanar rivers. From February to September (including the southwest monsoon period extending from June-September) freshwater discharge into the mangrove wetland is negligible, mainly due to the construction of dams and barrages in the upstream region of the river Cauvery. However, whenever the surplus water from Lower Anaicut is discharged into the Coleroon river during the non-monsoon period, particularly during the months of July and August, it reaches the Pichavaram mangrove wetland through the backwater. No freshwater is discharged from Vellar river to Pichavaram mangrove wetland.

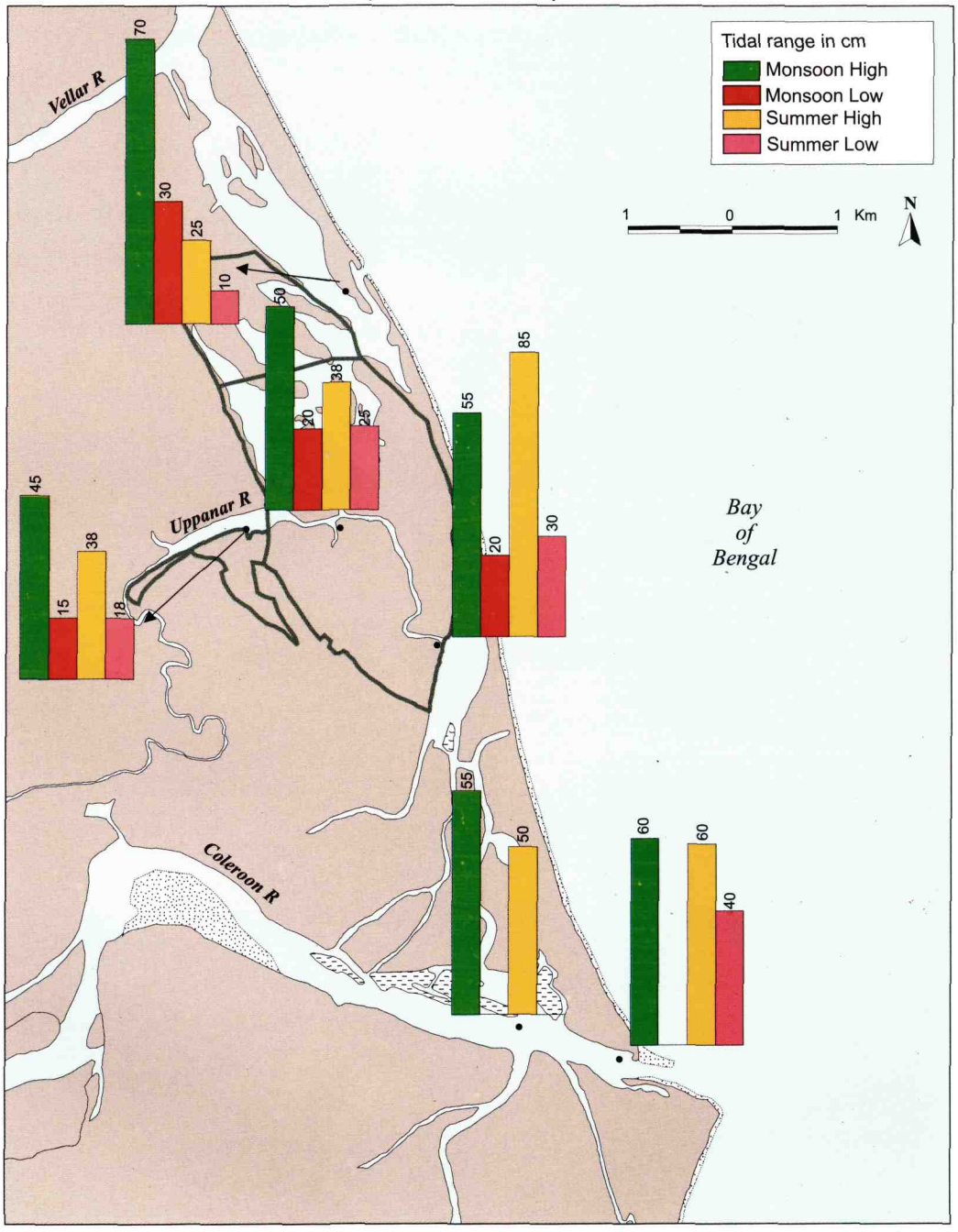
Tidal water exchange: The Coleroon estuary is the main source of tidal water for the Pichavaram mangrove wetland. It is observed that a significant quantity of tidal water enters into the Pichavaram mangrove wetland from the Coleroon estuary through the backwater system (indicated as No.1 in Map 2.6) that connects the mangrove wetland with the estuary. The effect of such inflow of tidal water is felt even on the northern side of the Pichavaram mangrove wetland. The mouth located at the Chinnavaikal (indicated as No.3 in Map 2.6) is unstable and it is fully opened only during the monsoon period due to the pressure built by the inflow of a large amount of freshwater. During the remaining period it is partially opened and tidal exchange is also very small. This affects both the mangrove wetland and entry of fish and prawn into mangrove wetlands, affecting the livelihood of the fisherfolk.

All this indicates that for the long-term survival of the Pichavaram mangrove wetland, flow of water in the backwater system that connects the Coleroon river with the Pichavaram mangrove wetlands should not be obstructed. Maintenance of uninterrupted flow through the connecting backwaters from the Coleroon estuary is essential for the proper management of the Pichavaram mangrove wetland.



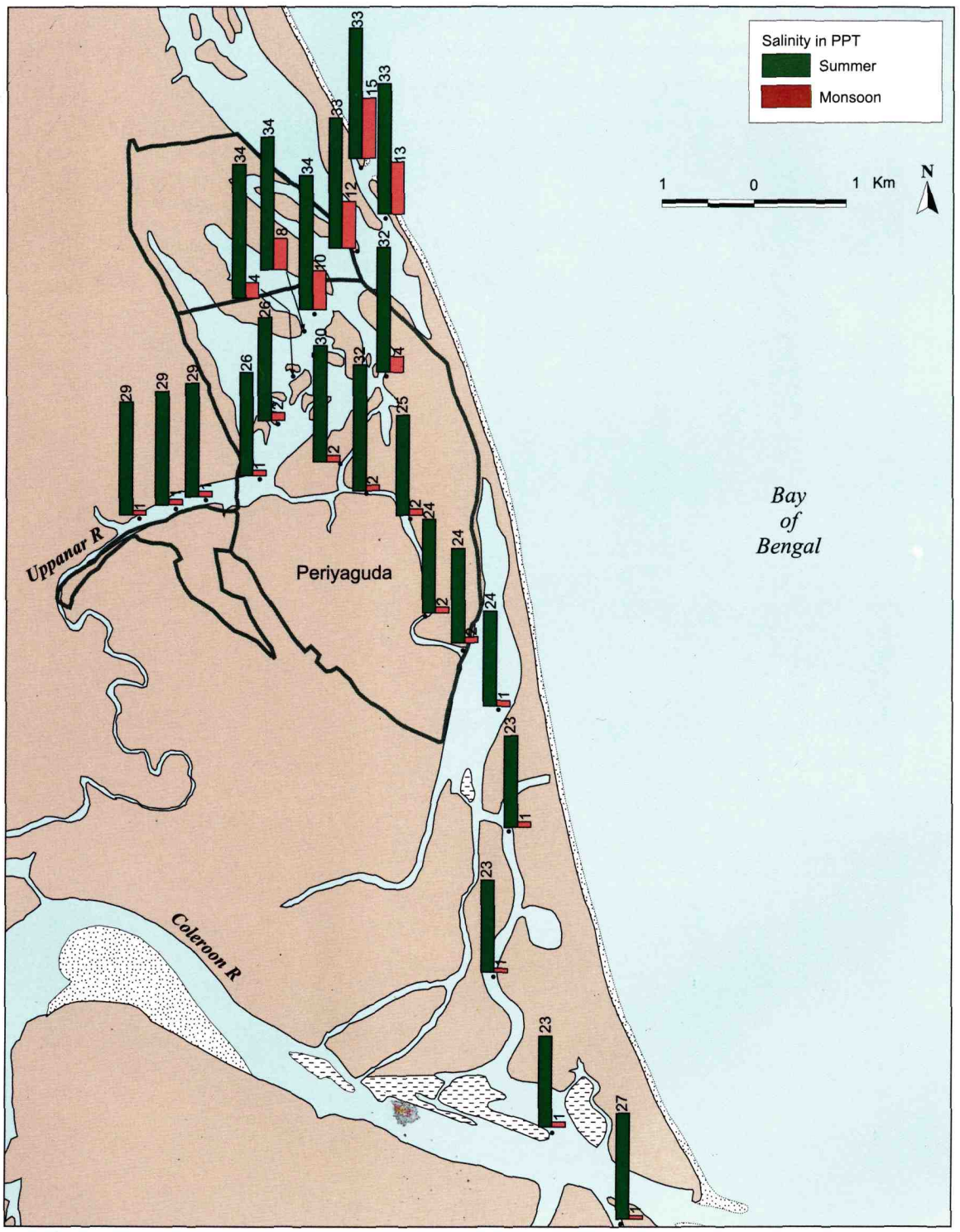
Map 2.6 Sources of fresh and tidal water

Tidal amplitude: The tide is of semi-diurnal type with slight inequality. The approximate spring tidal range in the open sea off Pichavaram mangrove wetland is about 0.82 cm and neap tidal range is 0.34 m. Inside the mangrove wetland, particularly near the healthy mangroves located at Periaguda region, the maximum tidal variation during the northeast monsoon is 50 cm while the minimum variation is about 20 cm. In summer, the maximum variation is 38 cm and the minimum is about 25 cm (Map 2.7). The study on the time lag occurrence of high and low tide with reference to open sea tides indicates that the tidal propagation into the Pichavaram mangrove wetland is taking place from the estuary of the Coleroon river.



Map 2.7 Tidal amplitude

Salinity: During the summer months (May and June), salinity in the estuarine system of Pichavaram mangrove wetland is of the order of 23-34 grams per liter with relatively low value in the backwater system and Periaguda region. During the monsoon period salinity is relatively low over the entire system with slightly higher value in the Chinnavaikal mouth area (Map 2.8).



Map 2.8 Water salinity

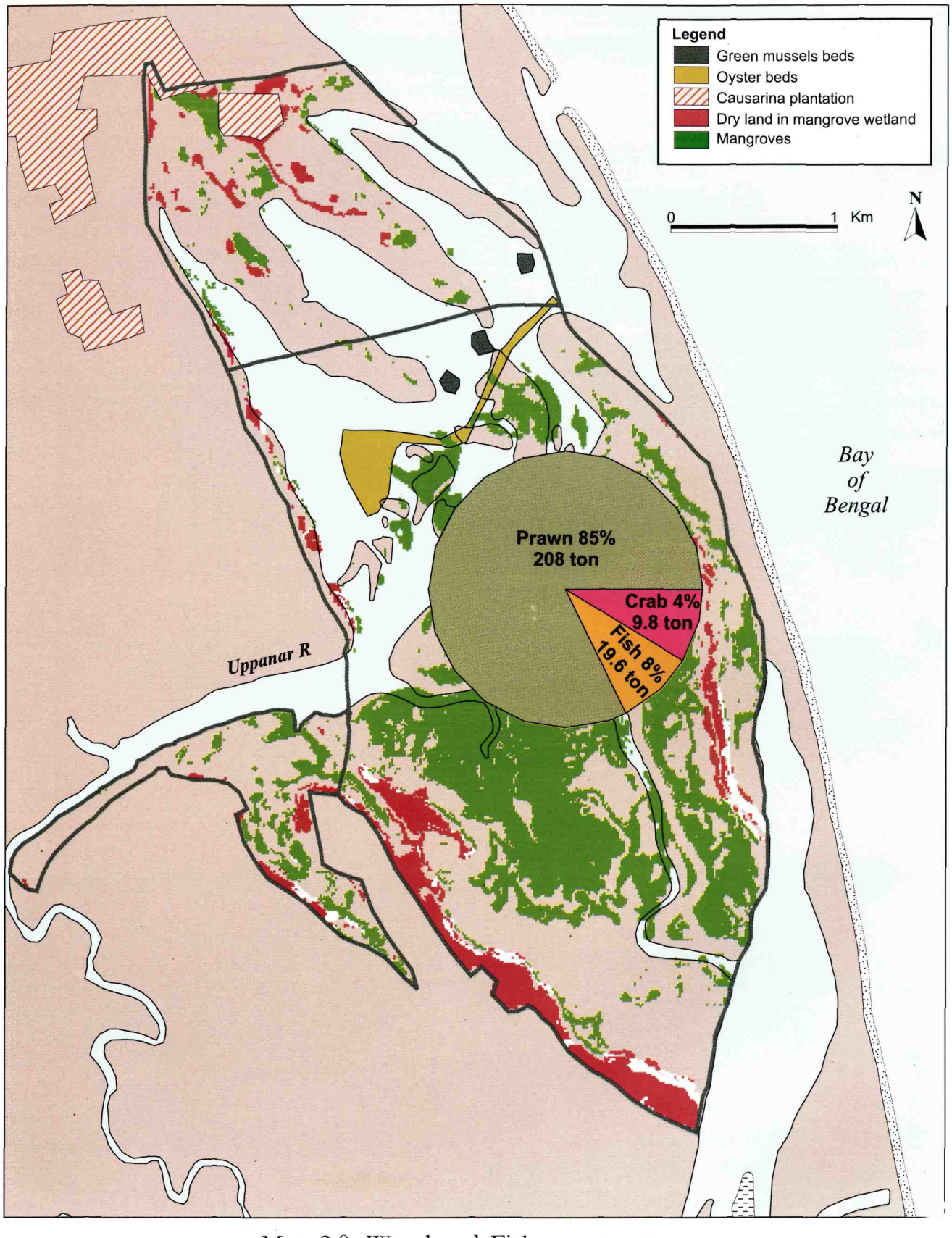
2.5 Wood and Fishery Resources

The harvestable forest resources are limited in the Pichavaram mangrove wetland. No timber or non-timber forest produce is available. Fodder and limited firewood are available but collection is banned. Till the 1980s, the Forest Department permitted grazing in the peripheral areas of the mangrove wetland through a permit system but this has now been stopped in order to prevent the adverse effects of overgrazing.

The Pichavaram mangrove wetland is rich in fishery resources. According to Chandrasekaran and Natarajan (1993) about 237 tons of fishery produce is harvested every year from the Pichavaram mangrove wetlands, of which prawns alone constitute 208 tons (82% of the total fish catch) whereas fish and crab (Figure 2.9) constitute 19 and 9 tons respectively (Map 2.9).

The other aquatic produce available are oysters and green mussels. Extensive oyster beds are seen in the northern part of the Pichavaram mangrove wetland but the fisherfolk do not exploit it. The green mussel is harvested during the summer month of May mainly for commercial purposes. Strict regulation is necessary on the size of green mussels harvested for commercial purposes.

Figure 2.9 Prawn and crabs are the main source of income for the fisherfolk of the Pichavaram mangrove wetland



Map 2.9. Wood and Fishery resources

2.6 Changes in the mangrove forest cover between 1970-1996

2.6.1 1970-1987

The changes in the forest cover of the Pichavaram mangroves were studied between the years 1970 and 1987 (remote sensing data Land Sat 5 TM) and 1987 and 1996 (remote sensing data IRS IC). Between 1970 and 1987 the mangrove forest cover had reduced from 640 ha to 372 ha (Map 2.10 -about 60% reduction). This was mainly due to changes taking place in the topography due to the coupe felling system of management followed by various government management agencies since 1911. In this system of management healthy mangrove forests were clear felled for revenue generation in 15 to 20 years rotation. Clear felling of the mangrove forest in the coupes caused various changes in the biophysical condition of the mangrove wetlands leading to development of hyper saline condition, which prevented natural regeneration of mangrove species (Figure 2.10)

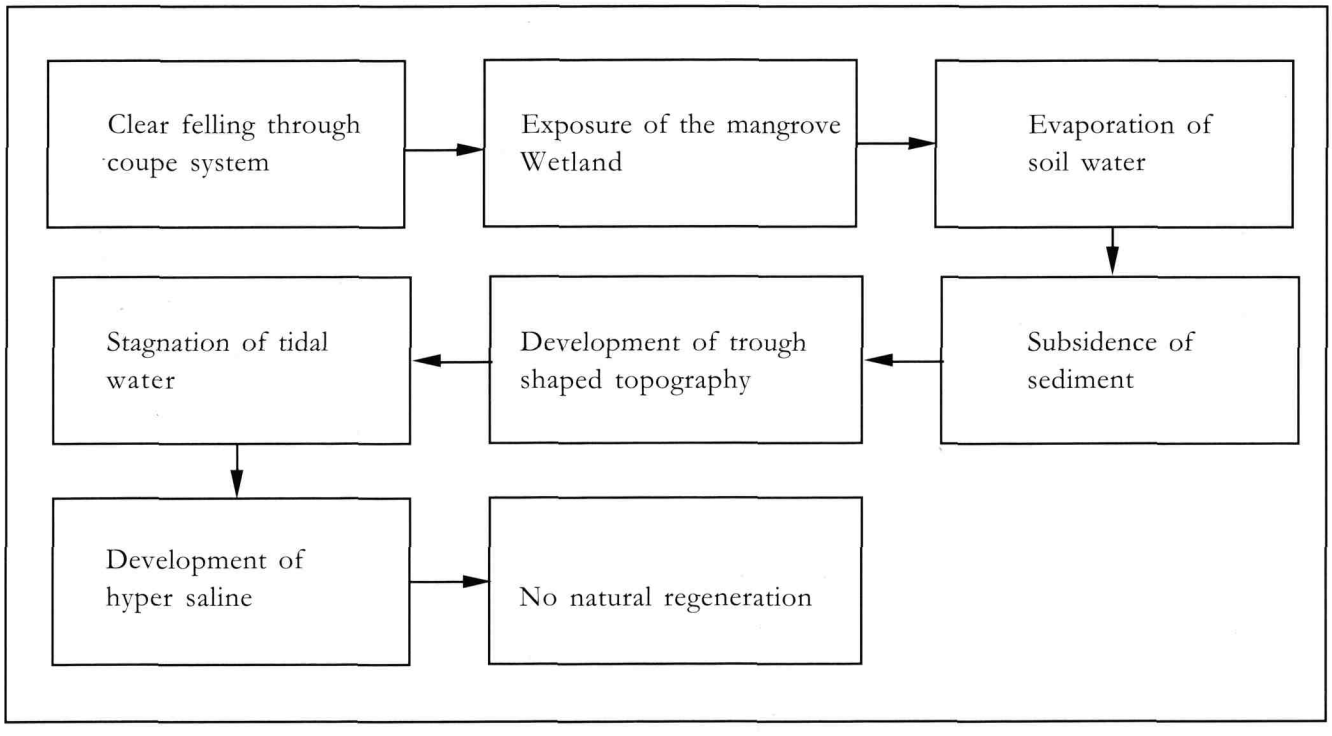
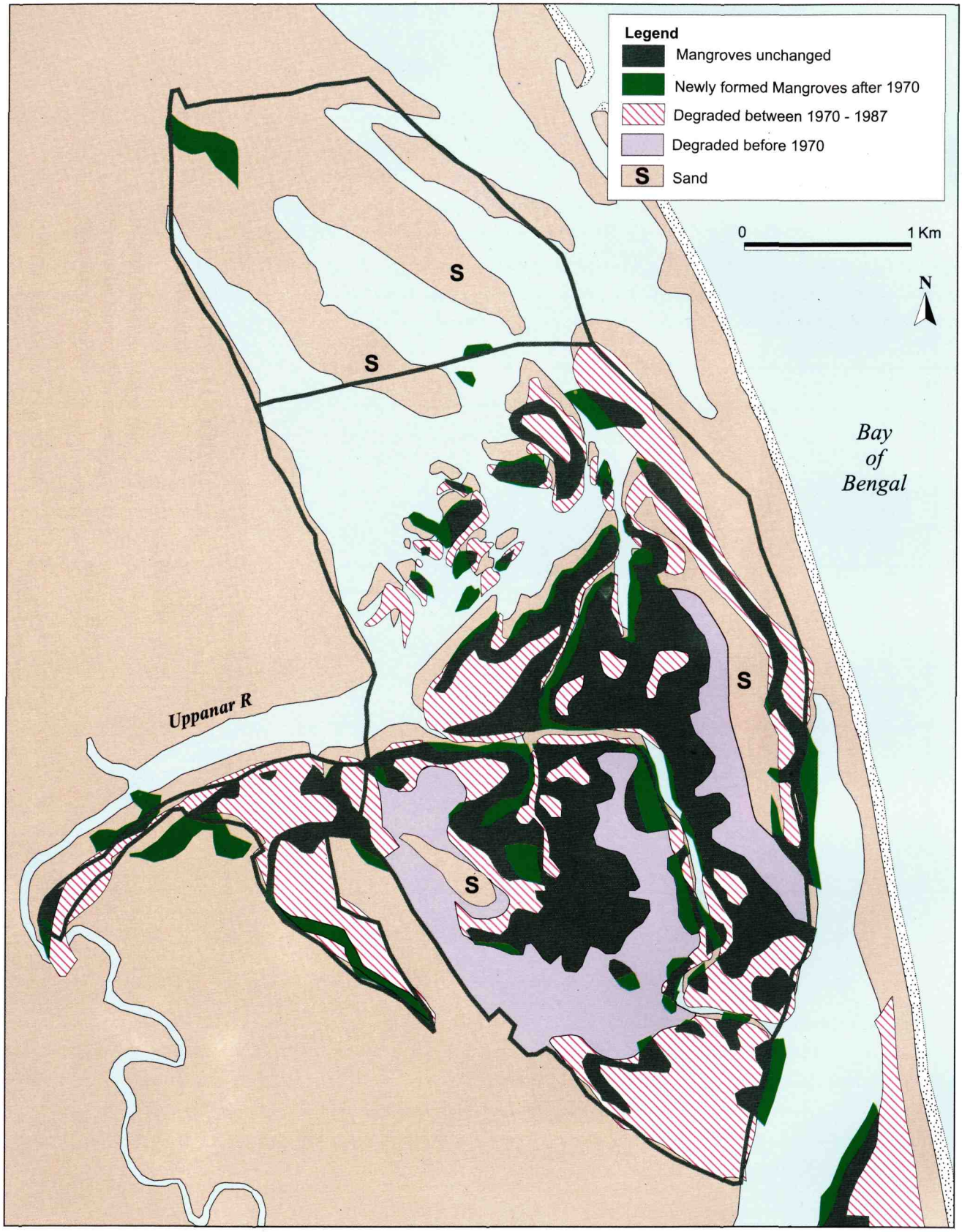


Fig 2.10 Biophysical changes caused by clear felling

Microtopographical studies carried out at the Pichavaram mangrove wetland have provided necessary evidence for the above changes. The study on tidal water flushing with reference to microtopography indicated that wherever coupe felling was not effected the topography is smooth and soil moisture and salinity are low due to regular and free flushing by tidal water during the high tide and low tide. On the other hand, wherever coupe felling was followed, the topography is trough shaped and tidal water enters into the trough and becomes stagnant leading to the development of hyper saline condition (Figure 2.11).



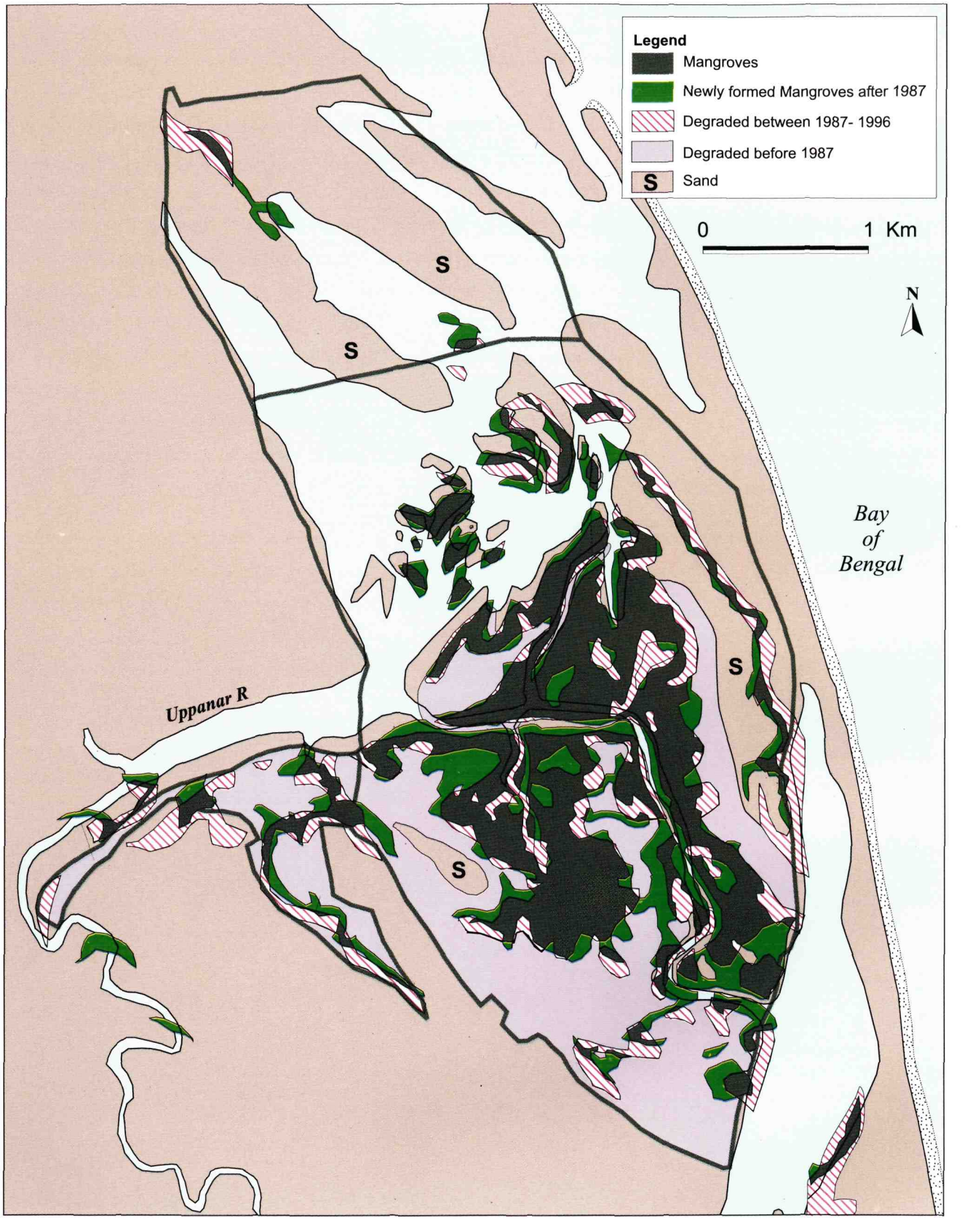
Map 2.10. Changes in mangrove forest between 1970 and 1987

2.6.2 1987-1996

Analysis of the remote sensing data of 1996 showed that the mangrove forest cover has increased by about 60 ha compared to the area in 1987 (Map 2.11), which is mainly due to the restoration effort taken (Figure 2.12) collaboratively by the Tamil Nadu Forest Department and MSSRF with the participation of the local communities. As explained in section 2.6.1, development of hypersaline condition due to changes in the topography is the main cause for the degradation of the Pichavaram mangrove wetland. On the basis of this observation, MSSRF developed a method for the restoration of degraded area and successfully demonstrated the same. This method involves construction of large canals between the trough shaped degraded areas and nearby natural waterways (Figure 2.13). This provided facility for the tidal water to move freely in and out of the degraded areas during high tide and low tide. A number of feeder canals are constructed from the main canal for complete flushing of the entire degraded areas (Figure 2.14). As a result of the free movement of tidal water soil salinity is reduced and soil moisture is also maintained to a desirable level for the healthy growth of mangroves. Demonstration of the restoration technique started in 1994. After seeing the success, in 1998 the Tamil Nadu Forest Department adopted this technique and applied to restore about 300 ha of degraded mangroves (Figures 2.15 to 2.19).

Apart from the stagnation of tidal water, the other factor for degradation is heavy grazing by cattle. About 3000 cattle graze in the mangrove areas during the monsoon season when regeneration and growth of the mangrove seedlings reach the peak. The best way of arresting degradation due to grazing is the Joint Mangrove Management, which is being currently demonstrated in four hamlets collaboratively by the Forest Department and MSSRF. In Map 2.12 an area degraded only due to stagnation of tidal water and an area degraded due to a combination of tidal water stagnation and grazing are shown.

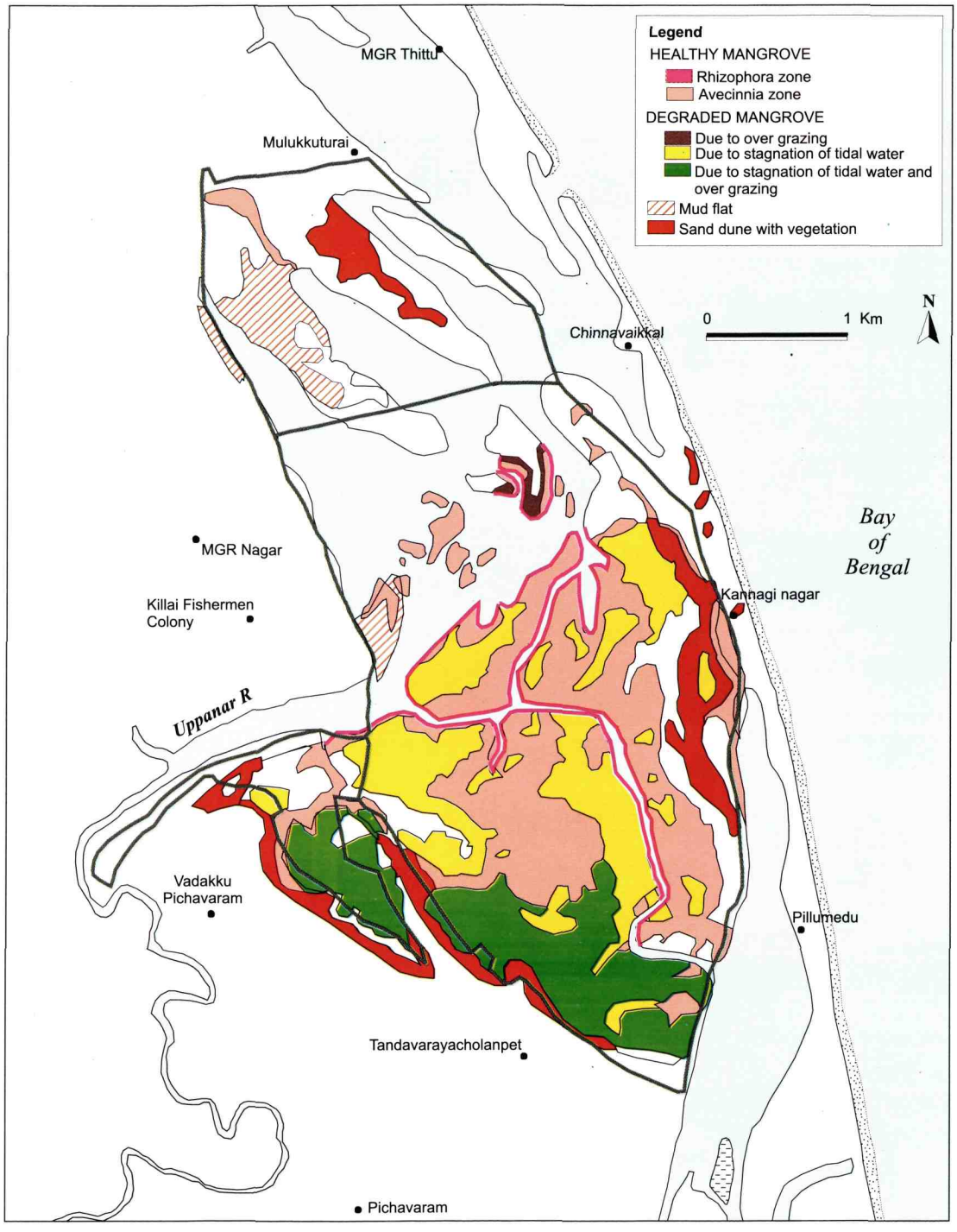
No significant changes were noticed in the area of the water body and sand dunes associated with mangrove wetlands between 1970 and 1996.



Map 2.11. Changes in Mangrove forest between 1987 and 1996

Area of mangrove wetland degraded due to different causes

In Map 2.12 the location of degraded area within the Pichavaram mangrove wetland and causes for degradation are shown. In the interior region of the mangrove wetland the degradation is mainly due to stagnation of tidal water in the trough shaped area whereas in the peripheral region degradation is due to a combination of stagnant tidal water and heavy grazing. In all these areas, the canal method of restoration can be followed for restoration.



Map 2.12 Degraded areas due to different factors

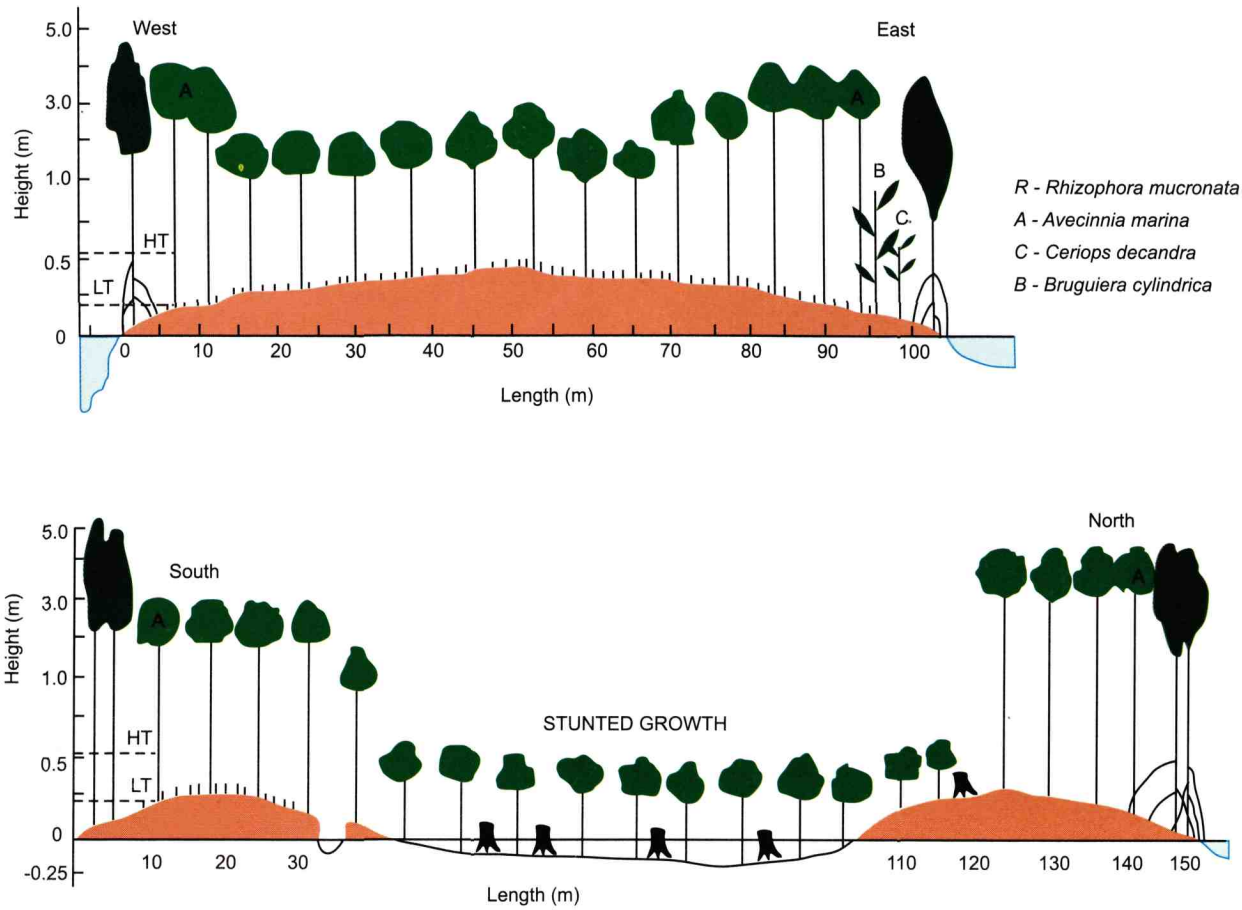


Figure 2.11 Topography of the coupe felled and non-coupe felled areas: development of trough shaped Topography in the coupe-felled area and stagnation of tidal water in the toughs is the main cause of degradation of the Pichavaram mangroves.

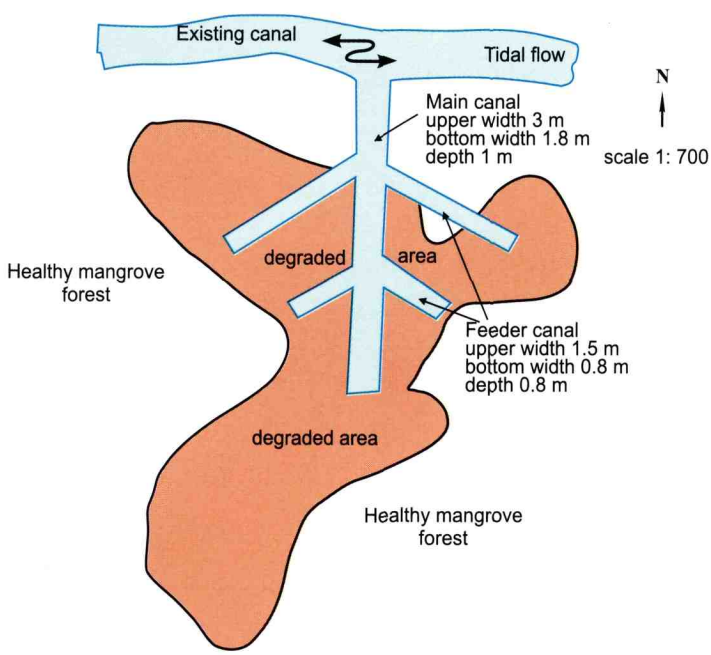


Figure 2.12 Demonstration of restoration technique: connecting trough shaped degraded areas with nearby natural waterways by artificial canals facilitates free movement of tidal water in and out of the degraded areas leading to reduction in soil salinity and increase in soil moisture.

Figure 2.13 Trough shaped degraded area selected for demonstration

Figure 2.14 A view of the canals constructed in the degraded area (1994)

Figure 2.15 Same area after restoration in 2002, indicating the effectiveness of the restoration technique

Extension of restoration activities with the participation of the local community:
Degraded area of the Mangrove Management Unit of MGR Nagar, a participating village

Figure 2.16 Villagers visit the area long with the Forest Department and MSSRF and plan for restoration activities (1998)

Figure 2.17 Canals constructed in the restoration site for free tidal flushing

Figure 2.18 Mangrove plantation work in degraded area.

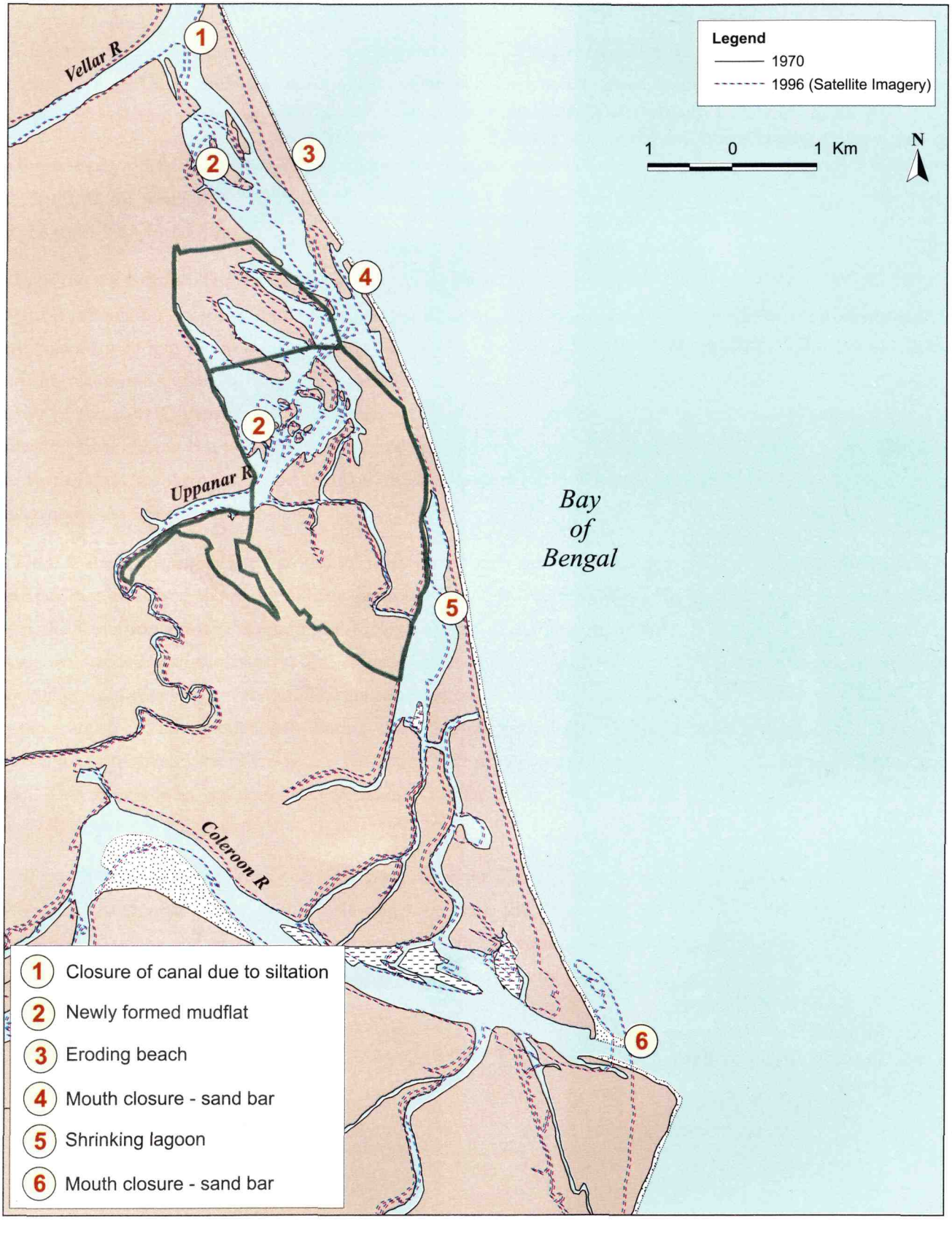
Figure 2.19 Mangrove vegetation in the restored area (2002)

2.7 Shoreline changes and its impact on the Pichavaram mangrove wetland

The changes along the coastline of the Pichavaram and associated wetlands between the years 1970 (SOI Toposheet) and 1996 (Remote Sensing data - IRS IC) are shown in Map 2.13.

Due to siltation the link between the Pichavaram mangrove wetland and Vellar estuary in the north is almost lost and this has resulted in the formation of large mud flats in the backwater. Another important feature is that the beach that separates the mangrove wetland and the Bay of Bengal is getting eroded at the rate of 12 m per year. If the erosion continues at this rate, the Pichavaram mangrove wetland may be directly exposed to the sea in future. It is also clear from the data that within the Pichavaram mangrove wetland erosion and sedimentation occur simultaneously. Another serious problem indicated by the coastline changes is the formation of sand spits in the mouth region of the Pichavaram mangrove wetland and river Coleroon (Figure 2.20). These sand spits reduce the amount of tidal water inflow into the mangrove wetland, which has serious repercussions on the mangrove forest and associated fishery resources. A detailed study on the impact of shoreline changes on the Pichavaram mangrove wetland is needed for developing proper long-term management plan.

Figure 2.20 Mouth closure and beach



Map 2.13 Shoreline changes between 1970 - 1996

2.8 Socio-economic profile of mangrove user villages and hamlets

The socio-economic profile of the user villages (Figures 2.21 and 2.22) of the Pichavaram mangrove wetland was prepared on the basis of the results obtained by conducting Rapid Rural Appraisal (RRA) in the villages (Maps 2.14 and 2.15) and a questionnaire based survey. The RRA was conducted only in selected fishing and farming hamlets where group discussion and semi-structured interviews were used as the main methods. In some cases information was collected from key informants. A benchmark survey was conducted in the mangrove user villages with the help of the Society for Social Forestry Research and Development, Chennai and Tata Economic Consultancy Services, Chennai. The sampling of the survey was done as follows. In each village detailed ward-wise recent voters lists were obtained from relevant panchayats, on the basis of which sample households were selected. A random sample of every tenth householder in the list was selected for interview.

Mangrove-user villages : Poverty among the local community is another important reason for the degradation of the Pichavaram mangrove wetlands.

Figure.2.21 MGR Nagar: a tribal fishing hamlet

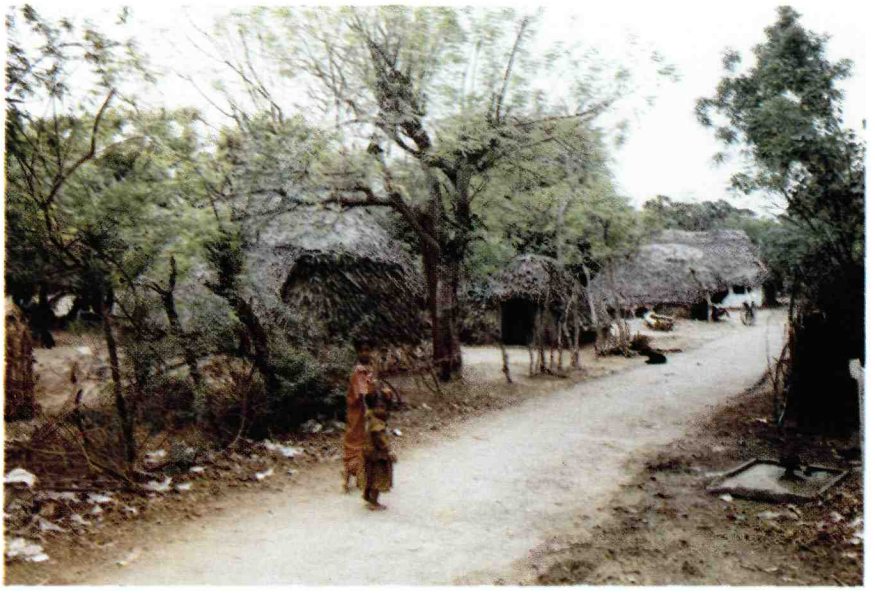
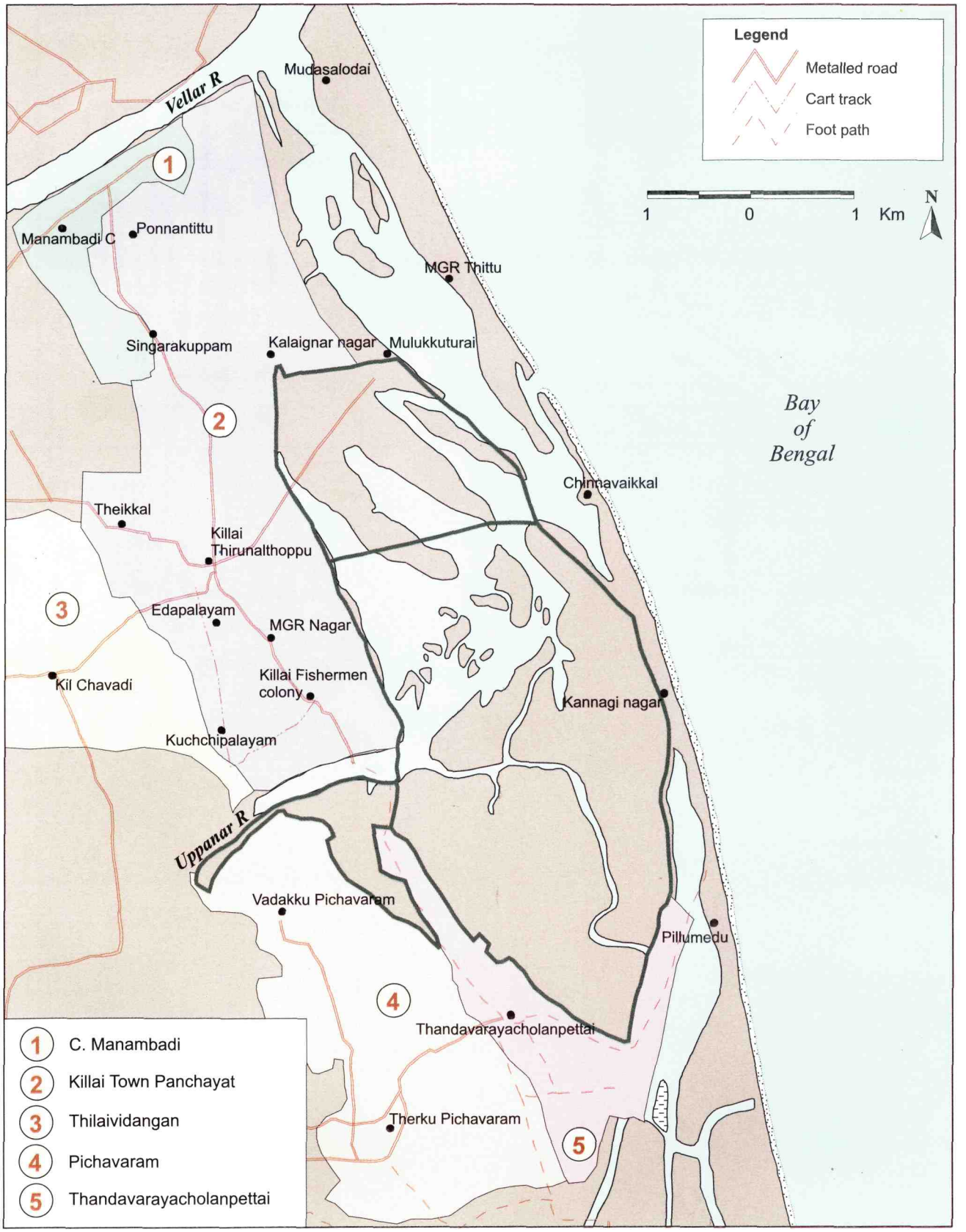
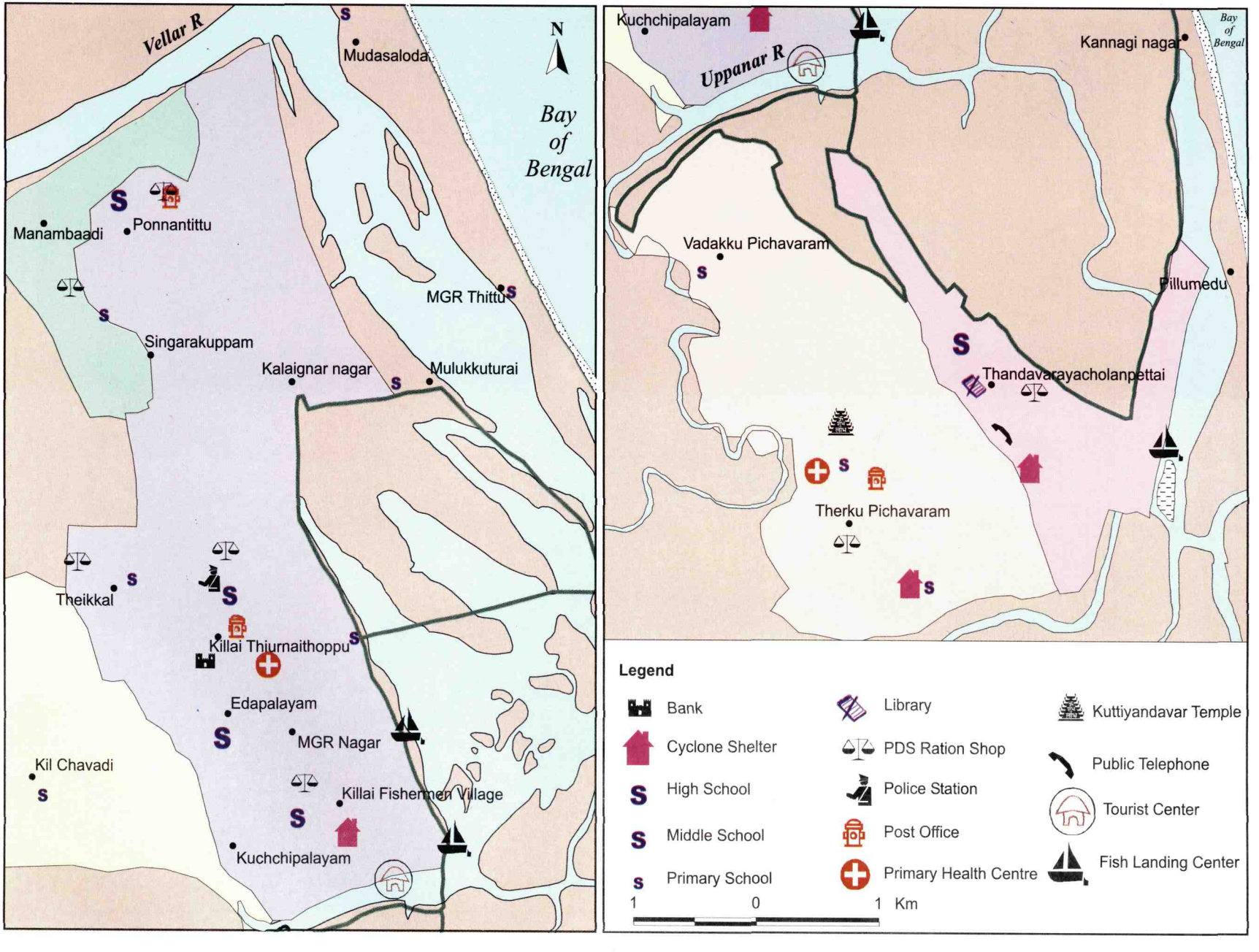


Figure.2.22 Vadakku Pichavaram: a farming hamlet that use the mangrove wetland as cattle grazing ground



Map 2.14. Mangrove user villages and hamlets



Map 2.15 Infrastructure

2.8.1. Mangrove-user villages and hamlets (Map 2.14 to 2.17)

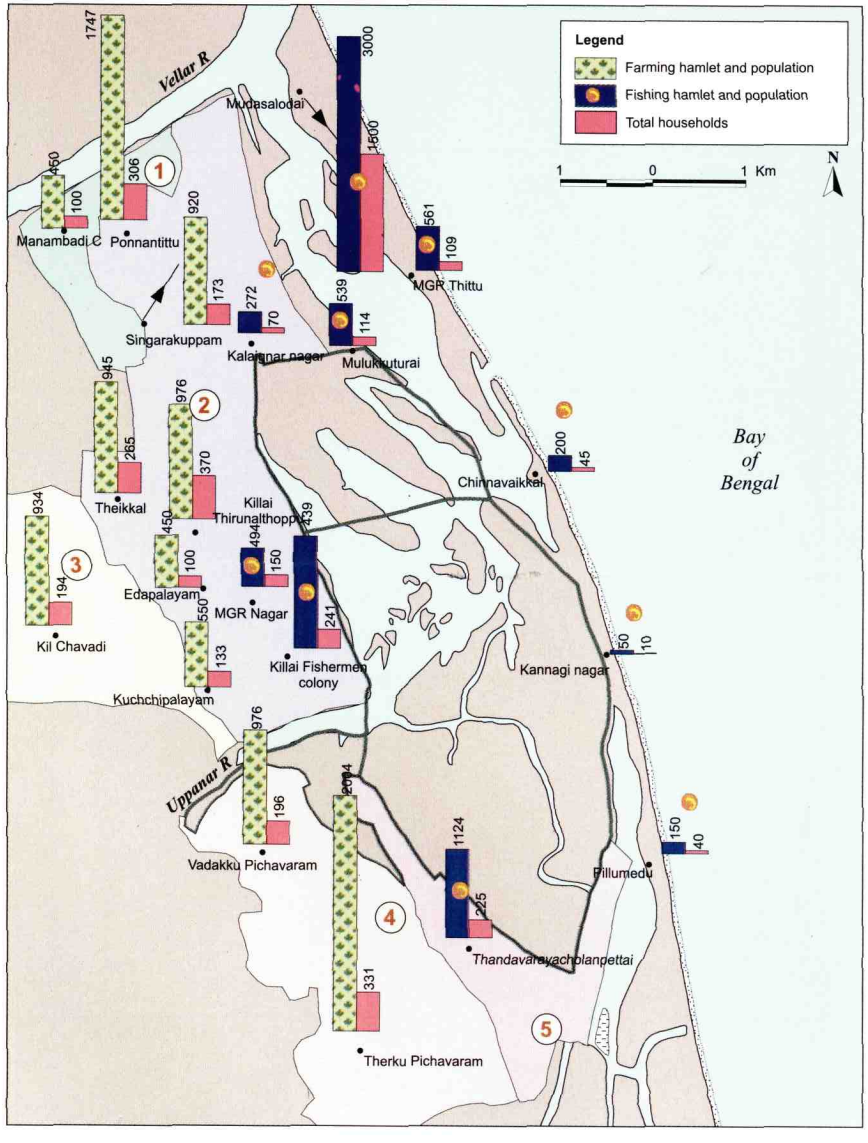
The people belonging to 17 hamlets of 5 revenue villages namely, C.Manambadi, Killai town panchayat, Pichavaram, Thandavarayan Solan Pettai and Thillaividangan utilize the wood, non-wood and fishery resources of the Pichavaram mangrove wetland. Among the 17 hamlets, 9 are fishing hamlets and 8 are farming hamlets.

2.8.2. Population, occupation and literacy

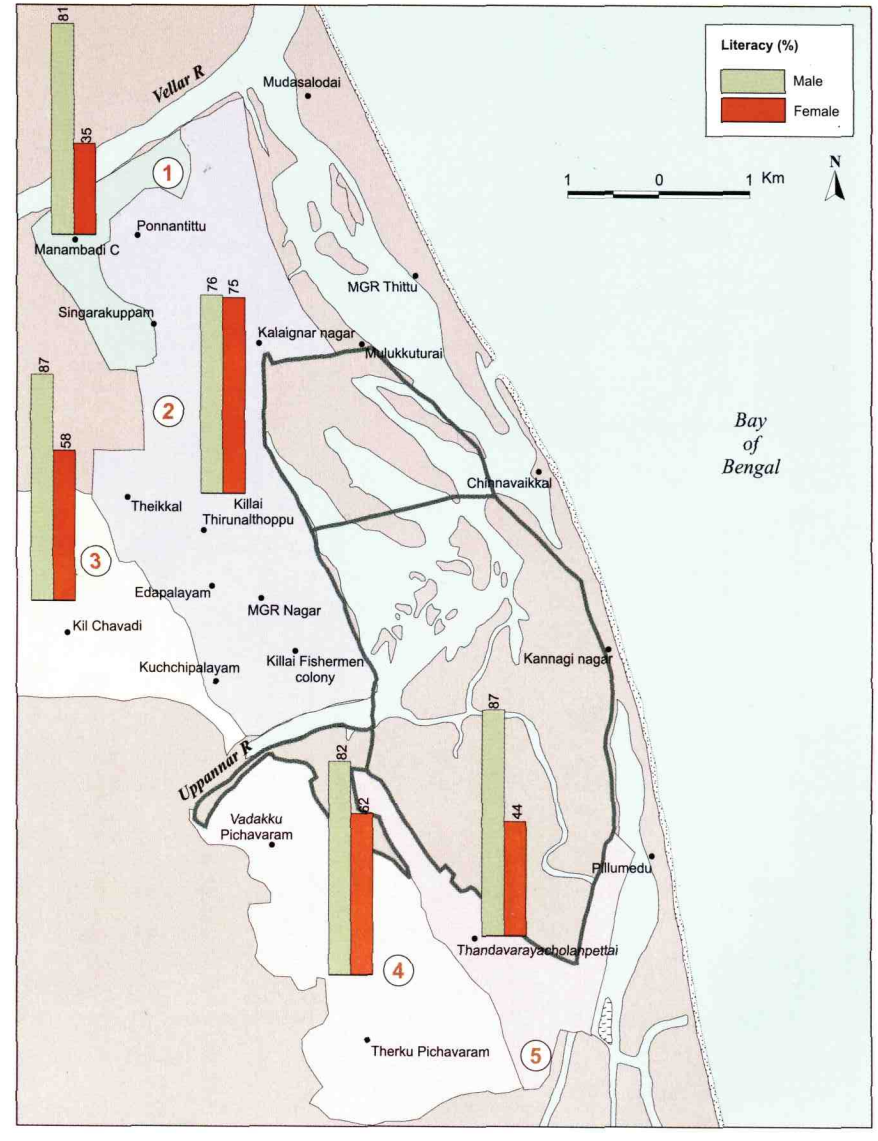
As shown in Table 2.4 the total households and population of these hamlets are approximately 4760 and 17780 respectively. The benchmark survey conducted in the 5 villages indicates that fishing (36.6%) and agriculture (35.4%) are both equally important occupations (Map 2.16). However, more people find employment as agricultural wage laborers (20%). The literacy rate for the entire village showed values from 76 to 87% for men and 35 to 75% for wemen (Map 2.17). The survey also indicates that about 41% of the employable age (15-55 years) has no stable occupation (Table 2.4)

Table 2.4 Details of mangrove user villages and hamlets

Village	Hamlet	Total households	Total Population	Occupation
C. Manambadi	C. Manambadi	100	450	Agriculture
Killai	MGR Nagar	150	494	Fishing
	Kalaingar Nagar	70	272	Fishing
	KillaI Fihsermen village	241	1439	Fishing
	Chinnavaikkal	45	200	Fishing
	Kannagi Nagar	10	50	Fishing
	Pillumedu	40	150	Fishing
	Muzhukkuthurai	114	539	Fishing
	Mudasalodai	1500	3000	Fishing
	MGR Thittu	109	561	Fishing
	Ponnanthittu	306	1747	Agriculture
	Singarakuppam	173	920	Agriculture
	Thaikkal	265	945	Agriculture
	Killai (Thirunalthoppu)	370	976	Agriculture
	Edappalayam	100	450	Agriculture
	Kuchchipalayam	133	550	Agriculture
Thillaividangan	Keelachavadi	194	934	Agriculture
Pichavaram	Therku Pichavaram	331	2004	Agriculture
	Vadakku Pichavaram	196	976	Agriculture
Thandavaraya-chozhanpettai	Thandavarayachozha n pettai	225	1124	Agriculture & Fishing
	Total	4672	17781	



Map 2.16. Population and Occupation



Map 2.17. Literacy

2.8.3 Income and income sufficiency (Map 2.18 - 2.19)

The following table shows the level of income in the five revenue villages which utilize the mangrove resources. The annual income for a majority of the population falls within Rs.25000 (Figure 2.23). At a minimum requirement of Rs.30 to buy a family's daily food of 2400 calories, it would mean that a family of 5 would spend Rs.10800 on food alone. This would imply that most of the families in the area spend more than 50% of their earnings on food alone. In all the five villages there is homogeneity in the economic class. A large number of the families (59%) fall between Rs.10000 and 25000 annual income groups.

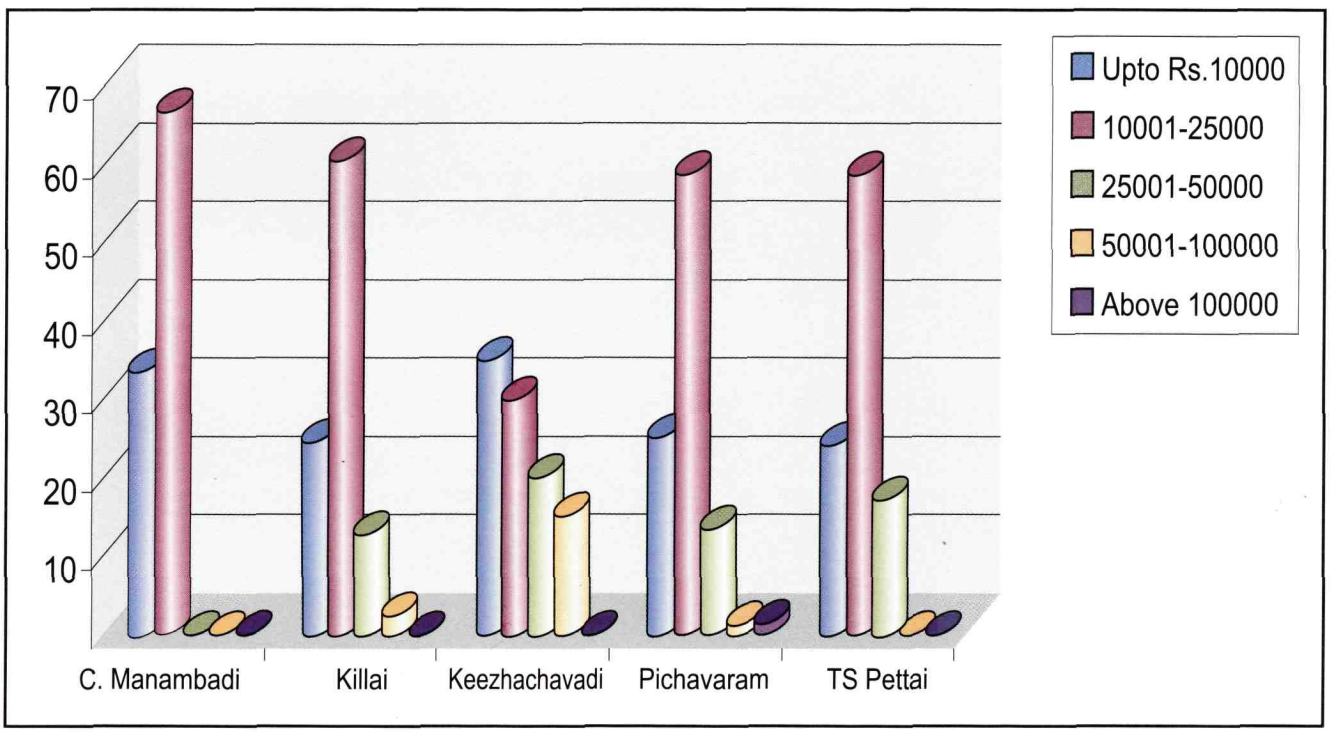
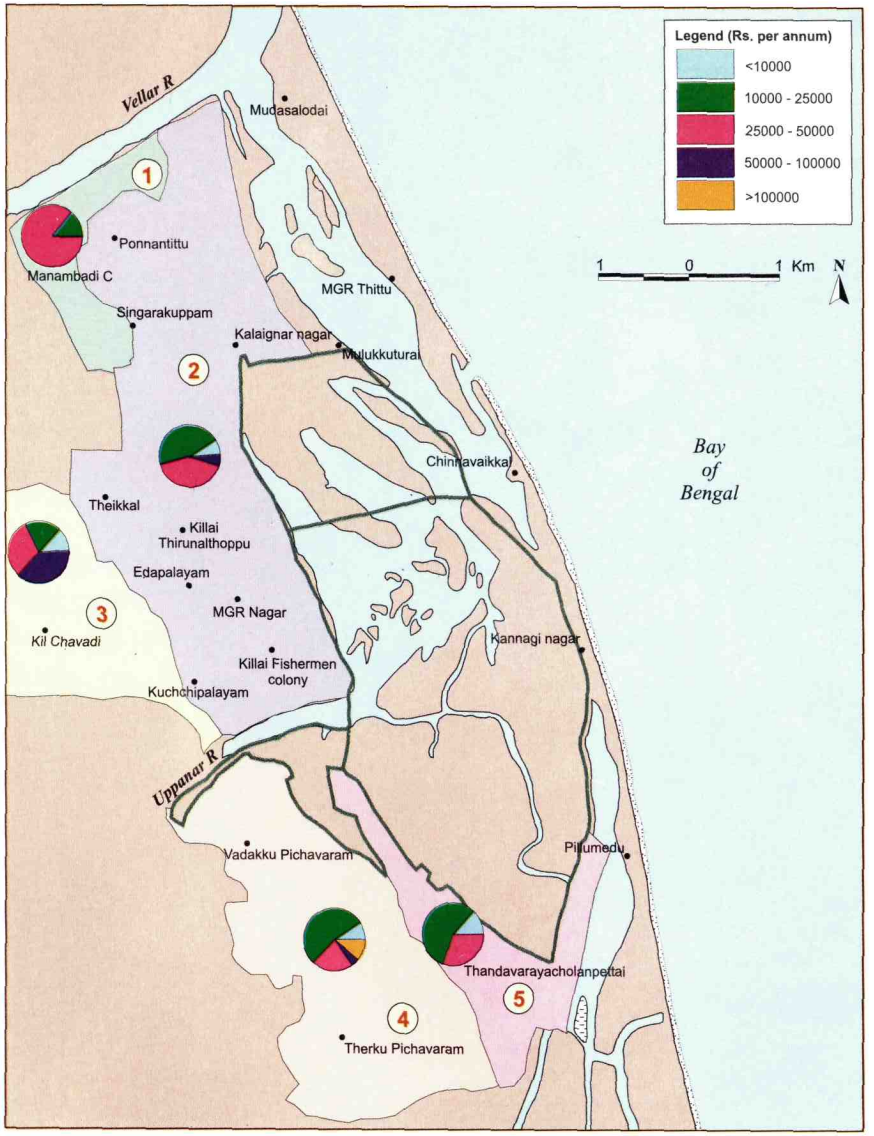
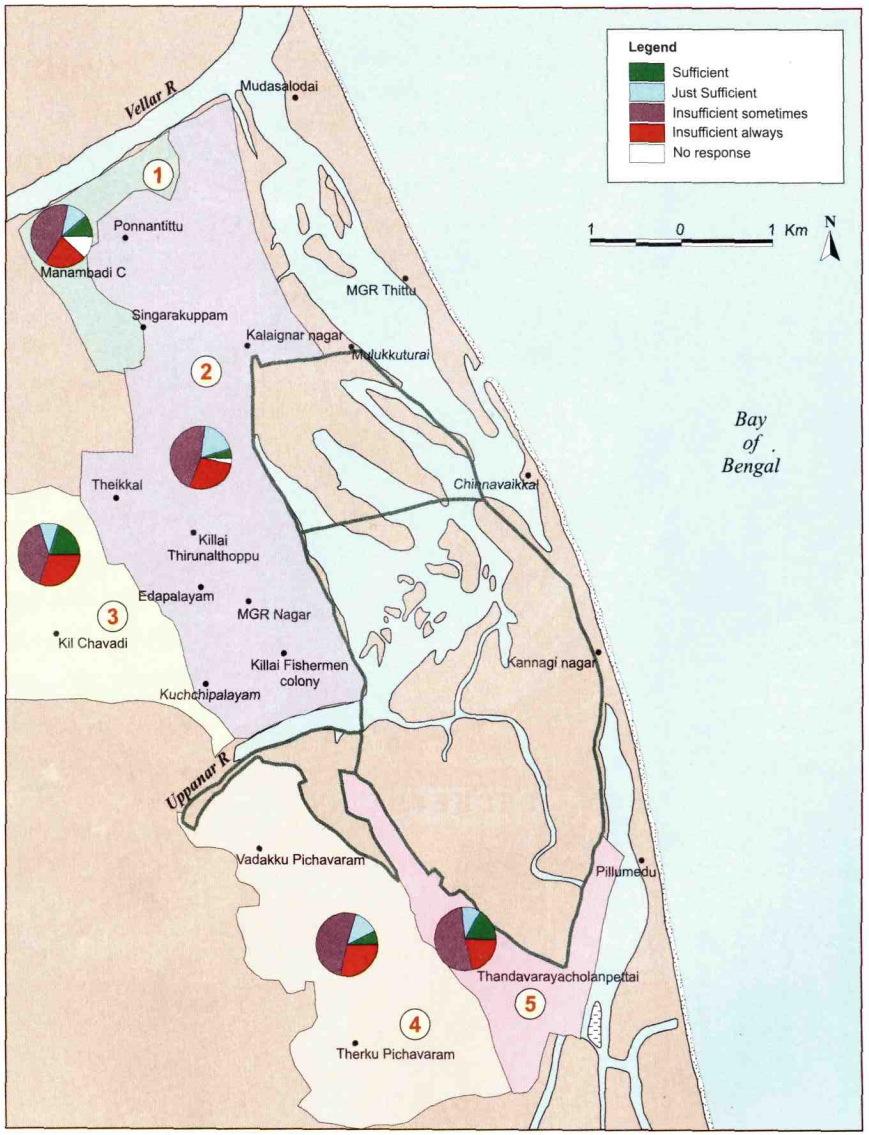


Figure 2.23 Distribution of households over income range (%)

Regarding income sufficiency level nearly 48% of the households feel that the annual income is insufficient most of the time and 24.8% of the households feel that their income is sufficient. In the entire 5 villages sufficient annual income is seen in only 7.1% of the households (Maps 2.18 and 2.19)



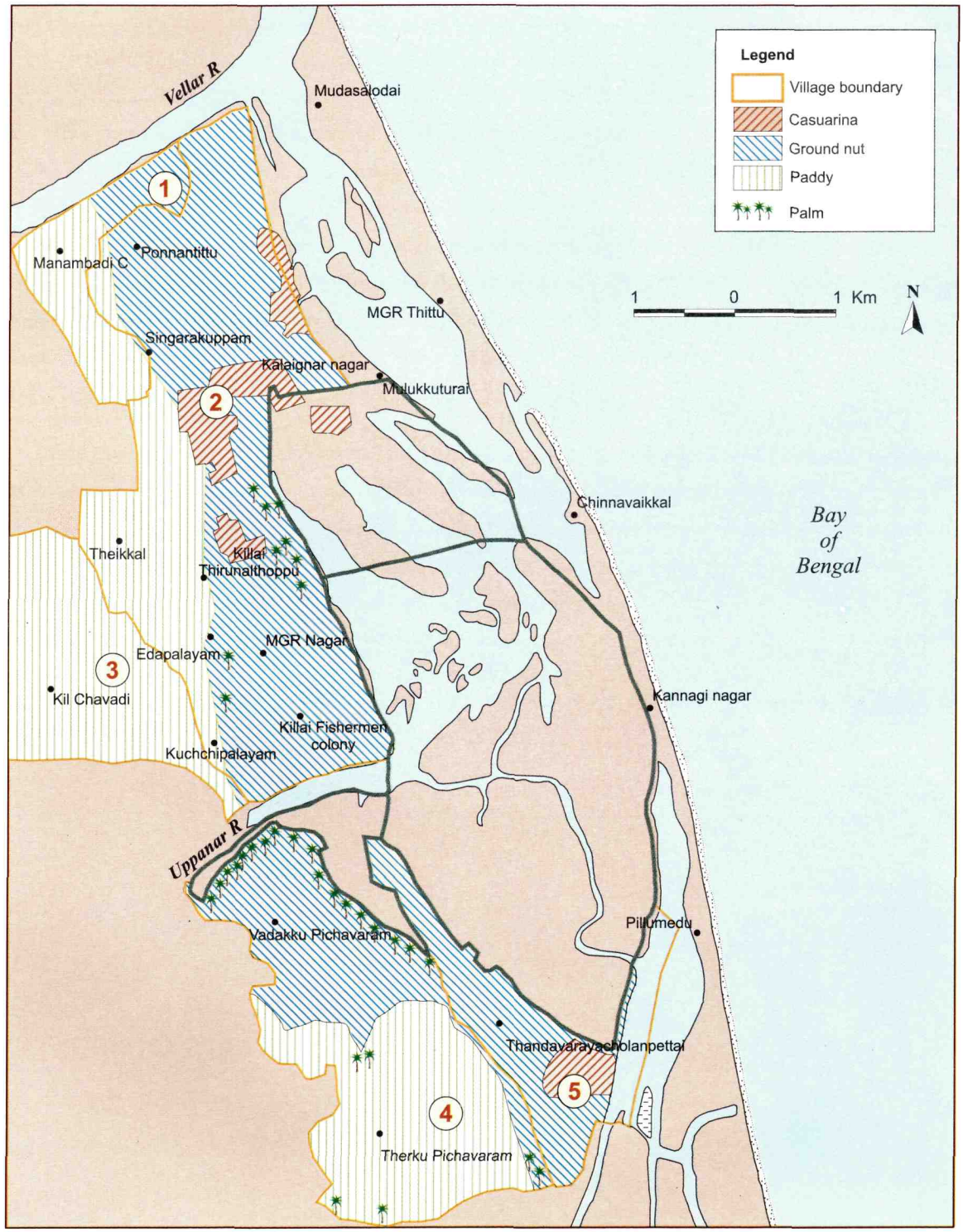
Map 2.18 Income range



2.19 Income sufficiency

2.8.4 Cropping pattern

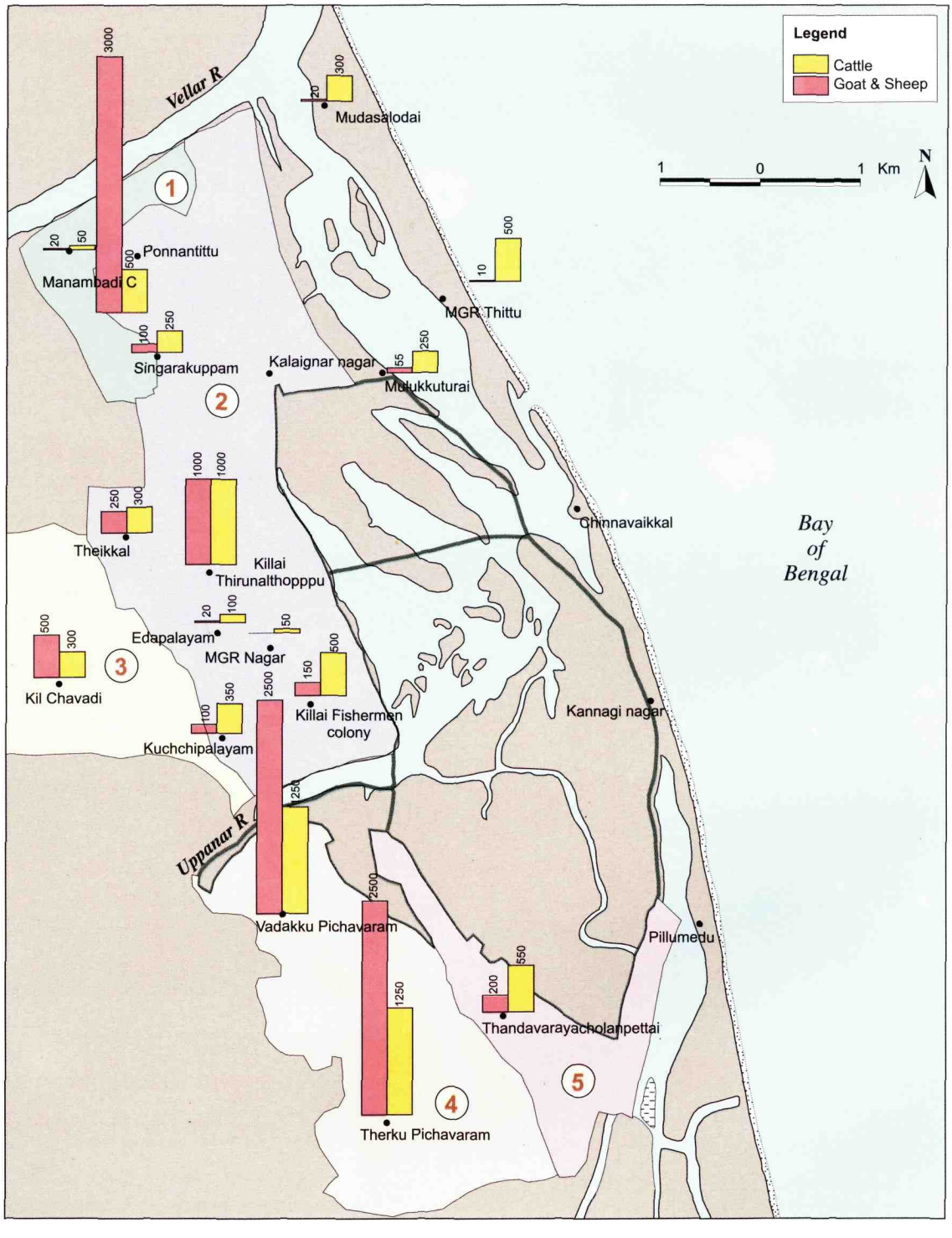
Groundnut and paddy are the major crops cultivated in the villages situated around Pichavaram. Paddy is cultivated only once during a year, from September to January. Groundnut is cultivated in the elevated sandy areas from the middle of December to the middle of March (Map 2.20).



Map 2.20 Cropping pattern

2.8.5 Livestock

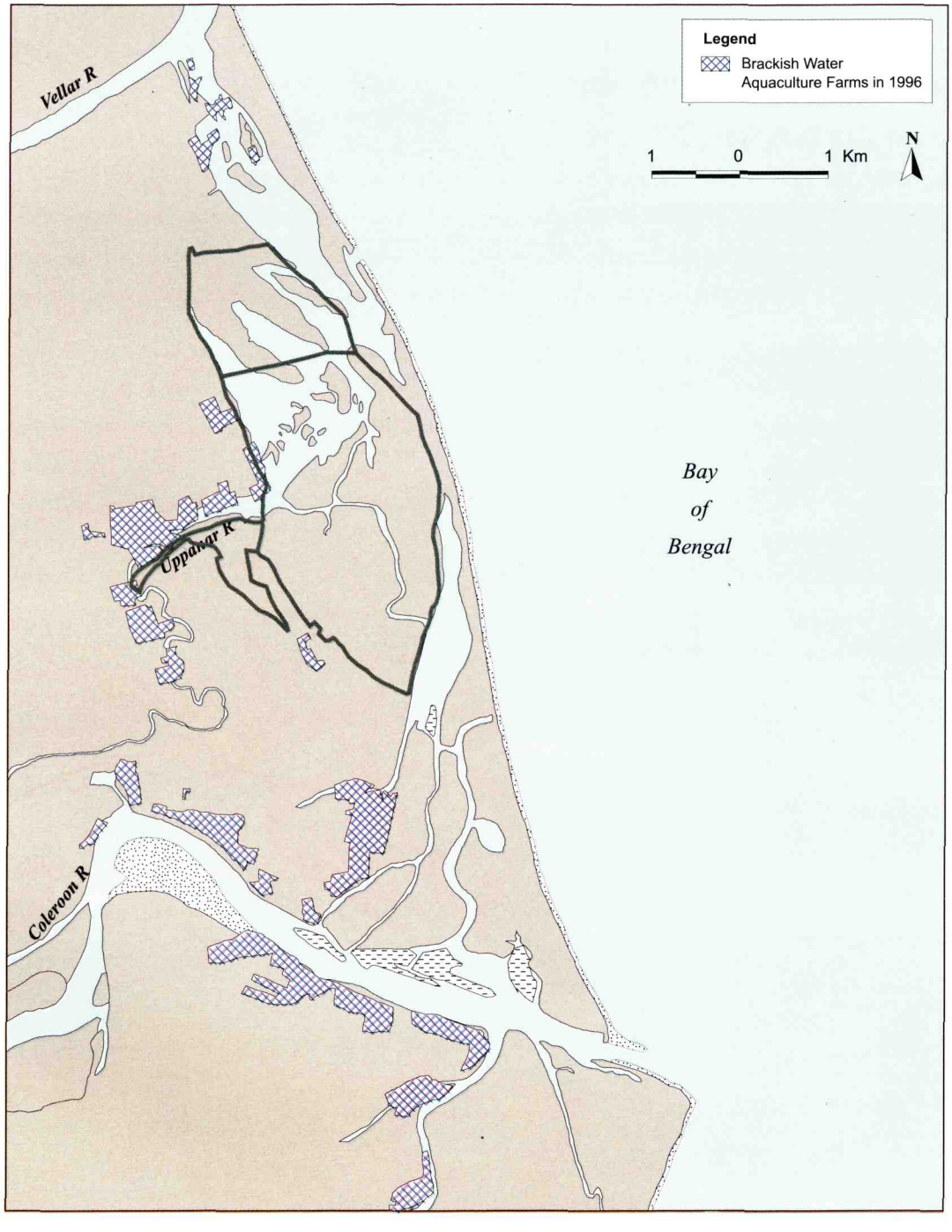
The farming community owns the livestock in the mangrove user villages mainly for the purposes of milking, manuring and ploughing. In addition, the local community considers cattle as one of the important and more reliable sources of hard cash at critical time. The total heads of livestock present in the user hamlets is about 6460, of which 2924 (45%) are cattle, 2653 (41%) are goats and 879 (14%) are sheep (Map 2.21).



Map 2.21 Livestock

2.8.6 Aquaculture

Brackish water aquaculture is a new pattern of landuse in this region. It was introduced in the Pichavaram region around 1992. Aquaculture farms were not found in 1987 and limited were found in 1994. According to the 1996 remote sensing data brackish water aquaculture is being practiced in about 685 ha in the area spreading from Vellar estuary in the north to Coleroon estuary in the south. Around the Pichavaram mangrove wetland aquaculture is being practiced in about 200 ha. Prawn is the major species cultivated in the aquaculture farms, mostly following the semi-intensive method of farming (Map 2.22).



Map 2.22 Aquaculture

2.9 Dependency on mangrove wetland

2.9.1 Grazing

About 3000 livestock, including about 2000 cattle and 1000 goats graze in the Pichavaram mangrove wetlands seasonally (Map 2.23). The villagers manage their livestock in the following two ways:

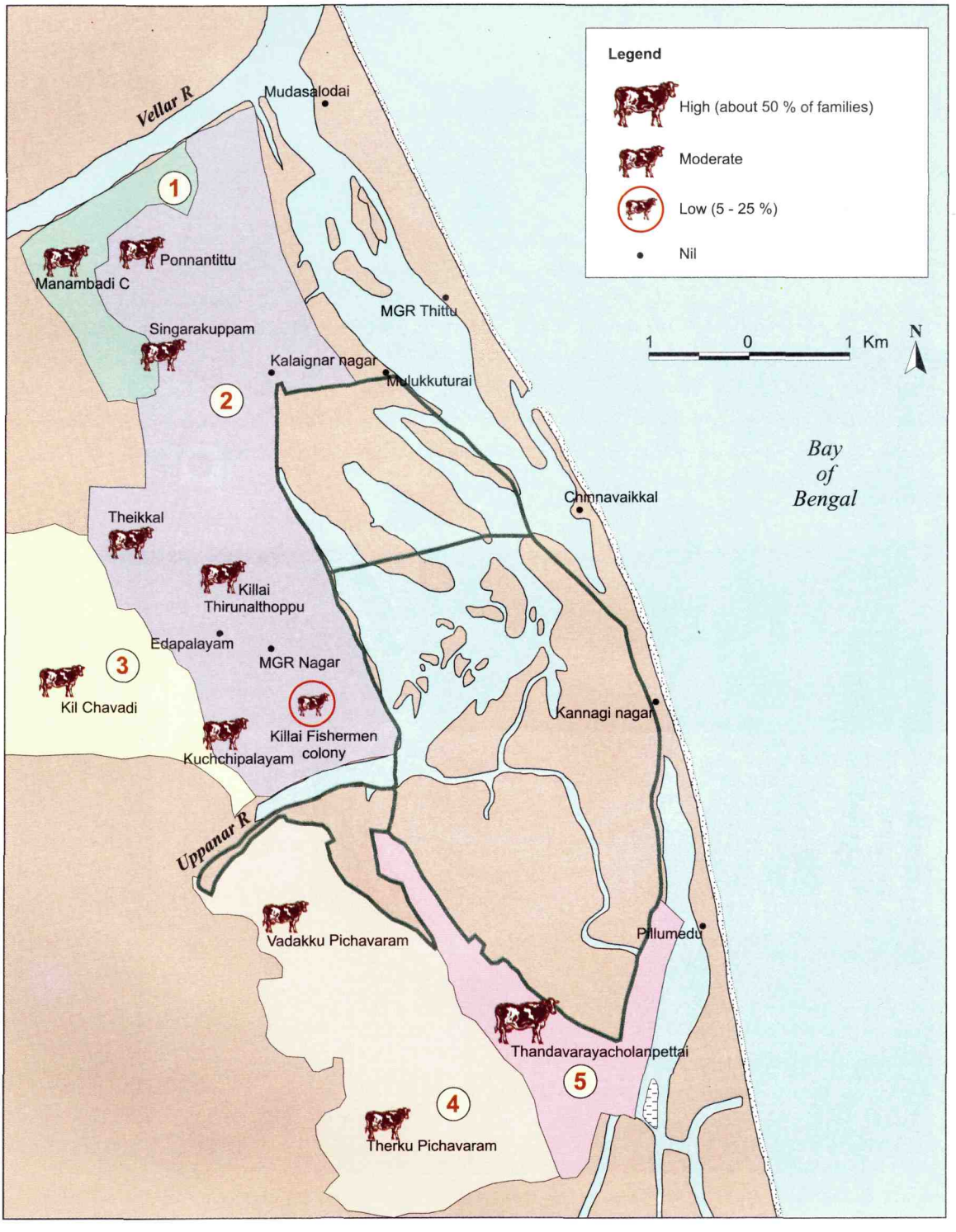
a) Milch and plough animals are kept with the farming families throughout the year. They are grazed in the harvested field for about 7 months, from February to August. In September they are stall fed or grazed around the paddy fields. From October to January milch and plough animals are grazed in the peripheral area of the mangrove wetlands.

b) Dry and aged cattle are given to the traditional cattle gatherers for grazing and maintenance. They graze these animals in the agriculture fields during the off-season. Once agriculture activities start in September, they send the cattle to the mangrove wetlands where the cattle stay permanently for about 5 months. The villagers take no care when these dry and aged cattle are sent to the mangroves. In February, cattle gatherers take back the cattle and graze them in the harvested paddy fields.

Grazing in the mangrove wetland is one of the important factors that affect the mangrove vegetation. Field observation indicates that cattle feed heavily on leaves, propagules and seedlings of *Avicennia marina*. In the Pichavaram mangrove wetland A. *marina* produces propagules and seedlings only during the monsoon season and heavy grazing during this time affects the regeneration rate of this species. In addition, seedlings of most of the mangrove species reach maximum growth during the rainy season and hence, grazing during this period also affects the growth rate of the mangrove seedlings. Stunted mangrove bushes can be seen in almost all the areas of the Pichavaram mangrove wetland where cattle grazing is heavy. The villagers reported that reduced availability of fodder, increased cost of cattle feed and lack of common grazing ground are the main reasons for increased dependency on mangroves for grazing.

2.9.2 Firewood collection

The dependency of the villagers on the mangrove forest for firewood collection, both for domestic use and commercial purpose, is very limited. The main reason is the availability of plenty of alternate fuel wood resources such as casuarina, prosopis and palm residue.



Map 2.23 Dependency on mangrove for cattle grazing

2.9.3 Fishing in the mangrove waters

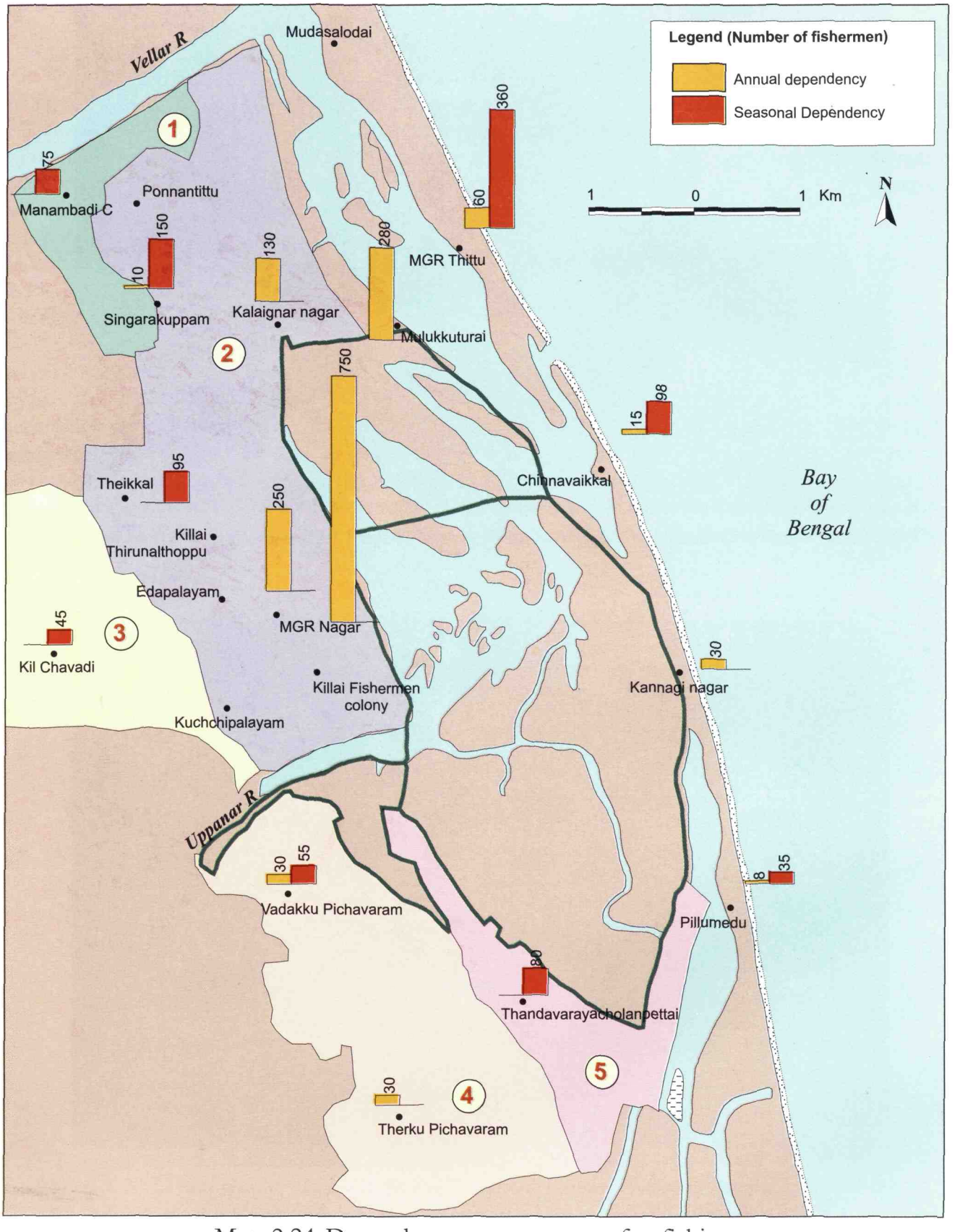
A total number of 2600 fisherfolk depend on the mangrove wetland for their livelihood (Map 2.24). Out of this, 1770 (68%) fisherfolk are traditional fisherfolk whereas 830 fisherfolk (32%) belong to non-traditional fishing communities such as Irulars, Vanniayars and Scheduled Caste. Irulars constitute nearly 70% of the non-traditional fisherfolk. Among the traditional and non-traditional fishing community 2 groups can be identified: i) fisherfolk fishing in the mangrove water throughout the year and ii) fisherfolk depending on the mangrove water only during peak fishing season. The total number of annual and seasonal fisherfolk of the mangrove wetland is about 1590 (61%) and 1010 (39%) respectively. In the utilization of fishery resources, traditional fisherfolk use conventional fishing gear such as cast net, drag net, gill net and stake net and the use of these nets do not affect the mangrove wetland. The non-traditional fisherfolk, particularly Irulars, follow some unconventional fishing methods, which affect the mangrove vegetation (Figures 2.24 to 2.26). The Irular fisherfolk are poor and have no craft or gear for fishing. Both men and women of the Irular fisherfolk sit in knee to waist deep water and blindly search in the mud for prawn. Some other Irular fisherfolk construct mud embankments of about 30 to 40 cm height around mangrove forests in three to four acres. The mud embankment is opened in 3 or 4 places with small openings. The tidal water, along with fish and prawns, enters into the embankment during the hightide. When the water begins to recede during the low tide, the openings in the embankments are closed with a net or pen, which allow only water to pass through. The trapped fish and prawn are collected and sold in the market. As this method obstructs free flushing by tidal water it affects the mangrove vegetation. In the past about 100 to 150 Irular fisherfolk followed this method of fishing, which has currently reduced to 30 to 40 since most of the Irular fisherfolk have started using conventional nets for fishing.

Fishing methods

Figure 2.24 Hand picking of prawns by the women of a tribal fishing community called Irular

Figure.2.25 Bunding method of fishing is another unconventional fishing method followed by Irular

Figure. 2.26 Gill net is the most commonly used gear by the traditional fisherfolk for fishing in the mangrove water



Map 2.24 Dependency on mangrove for fishing

Improving income of the farming and fishing families to reduce pressure on mangrove resources

Figure 2.27 Increasing income from agriculture by introducing a new technology is an option to improve the income of the farming families

Figure 2.28 Most of the cattle in the mangrove dependent villages are dry and aged and yield low milk; replacing them with crossbred cows increase the income and also reduces dependency on mangroves

Figure 2.29 Fish market in one of the villages: establishing a fish-processing and storage unit and training local fisher folks in marketing is one of the options to improve income from fishing in the mangrove wetlands

2.10 Management issues

The following are the important concerns that need attention for sustainable management of the Pichavaram mangrove wetlands:

- Restoration of degraded areas and introduction of Joint Mangrove Management system
- Arresting heavy grazing in the mangrove wetland
- Preventing activities that would block the free flow of water in the backwater canals that connect the Pichavaram mangroves with the Coleroon river
- Keeping the mouth of the mangrove estuary at Chinnavaikal permanently open
- Preventing development of aquaculture farms near the mangrove wetlands

a) Introducing Joint Mangrove Management System

The major causes for the degradation of the mangrove wetland are the development of trough-shaped topography and stagnation of tidal water in the troughs and subsequent increase in soil salinity. The method of restoring such degraded areas is already well established and currently being followed to restore large degraded areas. However, the canals constructed for free flow of tidal water in and out of the degraded trough shaped area need to be maintained by desilting every year. Secondly, the restoration plantation also needs to be protected against grazing. These can be achieved only if the local people participate in activities starting from planning to monitoring and evaluating the mangrove restoration work.

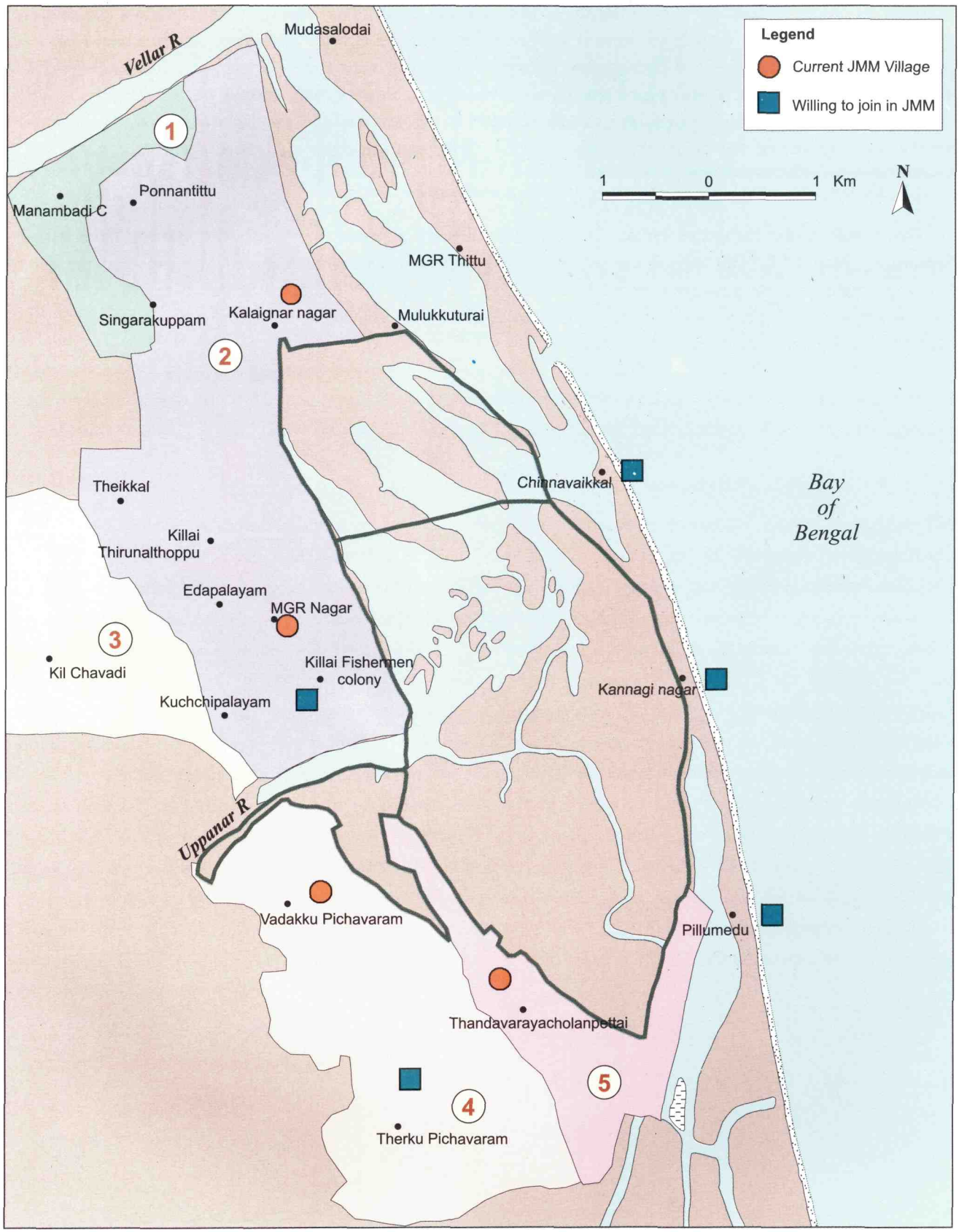
This is possible through the Joint Mangrove Management system which is being established in the Pichavaram mangrove wetland. The Forest Department of Tamil Nadu and MSSRF are implementing a Joint Mangrove Management programme on a demonstration scale in 4 hamlets since 1996 (Map 2.25). Each of these 4 hamlets has a Village Development and Mangrove Council with representation by the Forest Department and MSSRF. Similarly, each hamlet has a Mangrove Management Unit in the mangrove wetland. The Council discusses, decides, plans and implements activities to restore, maintain and protect the mangrove wetlands of the Mangrove Management Unit (Figure 2.27). So far the results are encouraging and people themselves have taken a number of initiatives to restore and protect the mangrove wetlands. This successful model can be replicated in other fishing and farming hamlets.

b) Reducing grazing pressure on mangroves

In order to reduce grazing pressure on mangroves, a model has been created in a village called Vadakku Pichavaram. This village had a total number of about 450 cattle, of which about 160 are dry and aged cattle. Only these dry and aged cattle were grazed in the mangrove wetland. Through the Joint Mangrove Management operation a system was introduced to reduce the number of dry and aged cattle. According to this system, one crossbred cow was provided to a family, which was willing to sell all of its dry and aged cattle. In this way about 100 dry and aged cattle have been removed from the village. The income of the family, which received crossbred cows as a replacement to dry and aged cattle has also increased by about Rs.1500/- per month (Figure 2.28). This system is becoming popular in this village and can be replicated in other villages, which graze their cattle in the mangrove wetlands.

c) Preventing further reduction in freshwater flow

As explained in earlier sections, reduction in freshwater discharge into the Pichavaram mangrove wetland affects the diversity and population of the true mangrove species. Considering the current socio-economic and



Map 2.25 Hamlets participating in Joint Mangrove Management

political situation, it may be very difficult to increase the freshwater flow into the Pichavaram mangrove wetlands. However, it is possible to prevent further reduction in freshwater discharge. As shown in Map 2.6, at present, freshwater reaches the Pichavaram mangrove wetland from the Coleroon river through backwater canals. Any activity that would block the flow of water into these canals should be prevented so that the current level of freshwater flowing into the Pichavaram mangrove wetland can be maintained. This should be on the main agenda of the management plan for the Pichavaram mangrove wetland.

d) Keeping the mouth of the mangrove estuary permanently open

The mouth of the mangrove estuary is completely closed for about 5 to 6 months, starting from March to September (Map 2.13). This affects the amount of tidal water reaching the mangrove wetland and the entry of fish and prawn into the mangrove wetlands, which in turn affects the livelihood of the local fisherfolk. Keeping this estuarine mouth permanently open should be another important task on the agenda of the management plan for the Pichavaram mangrove wetlands.

Chapter 3

Muthupet Mangrove Wetland

The Muthupet mangrove wetland is located in the southernmost end of the Cauvery delta in the districts of Nagapattinam, Thiruvarur and Thanjavur. It is part of a large coastal wetland complex called the Great Vedaranyam Swamp. As in the case of the Pichavaram mangrove wetland, the quantity and duration of the freshwater inflow into the Muthupet mangrove wetland has reduced over the years due to the construction of dams and barriers in the upstream area, resulting in increased annual average salinity of both water and soil. The Muthupet mangrove wetland has a long history of being managed by a number of government agencies.

Management

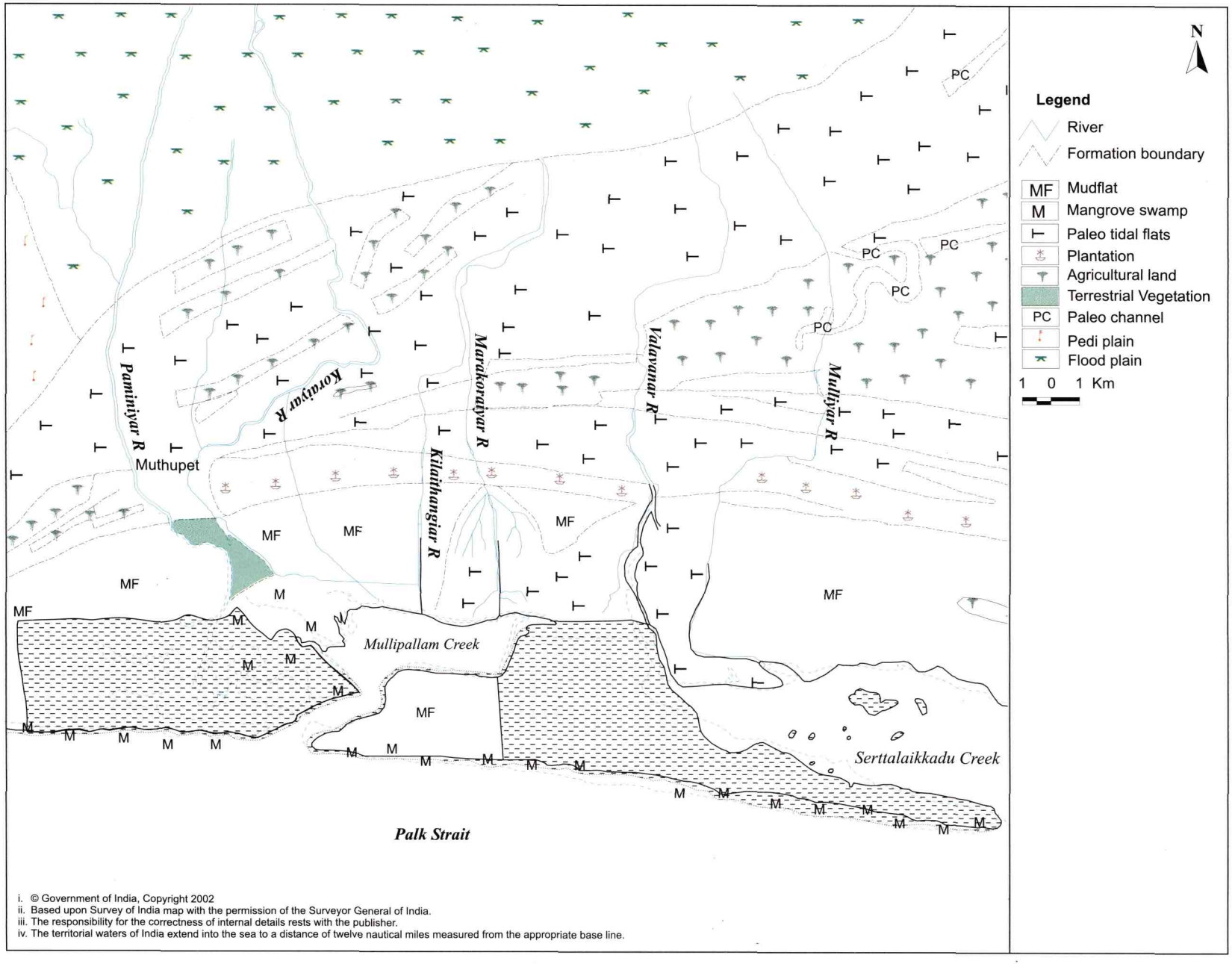
Available records indicate that the management of the Muthupet mangrove wetland started as early as 1740. The Maratha rulers of Thanjavur built a number of rest houses (locally called *Chatrams*) for north Indian pilgrims who visited Rameswaram in the south. To maintain these *Chatrams* the Maratha rulers established a separate department called the Chatram Department. In order to meet the expenses of the rest houses, the Chatram Department earned revenue by clear felling the mangrove forests of the Muthupet mangrove wetland. The forest beat covering the portion of the Muthupet mangrove wetland is still called the *Chatram beat*. After the British took over control of Thanjavur in 1799, the entire Muthupet mangrove wetland was surveyed and boundaries were demarcated. The British also authorised the Chatram Department to clear fell the mangrove forest for revenue generation. This practice was continued till 1912 when the first working plan for Muthupet was prepared. This working plan also prescribed clear felling with 12 years rotation and this continued till 1936. Later the Muthupet mangrove forest was handed over to the Forest Department which also clear felled the mangrove trees but with 20 years rotation. This practice was continued till 1971. Subsequently clear felling of mangrove forests was stopped due to large-scale degradation and poor regeneration in the clear felled areas. Currently, the Muthupet mangrove wetland is managed by the Tamil Nadu Forest Department under the supervision of the Wildlife Warden, Nagapattinam. At the field level, a Range Officer oversees the protection and other management activities.

Causes of degradation

The ecological study conducted by MSSRF indicates that the Muthupet mangrove wetland is also degraded due to clear felling effected by various management agencies as explained earlier. As in the case of the Pichavaram mangrove wetland, clear felling triggered a chain reaction, starting with the development of a trough-shaped topography (Figure 3.1), leading to stagnation of tidal water in the troughs, evaporation of the stagnant water and development of hypersaline condition in the soils of the Muthupet mangroves.

In the present Atlas, some of the biophysical and hydrological characters of the Muthupet mangrove wetland are given along with socio-economic profile of the mangrove-user communities and efforts taken to restore degraded areas with the participation of the local communities. Major management issues relating to conservation and sustainable management of the mangrove wetlands are also highlighted.

Figure 3.1 Trough-shaped topography of the Muthupet mangrove wetlands



Map 3.1 Geomorphological setting

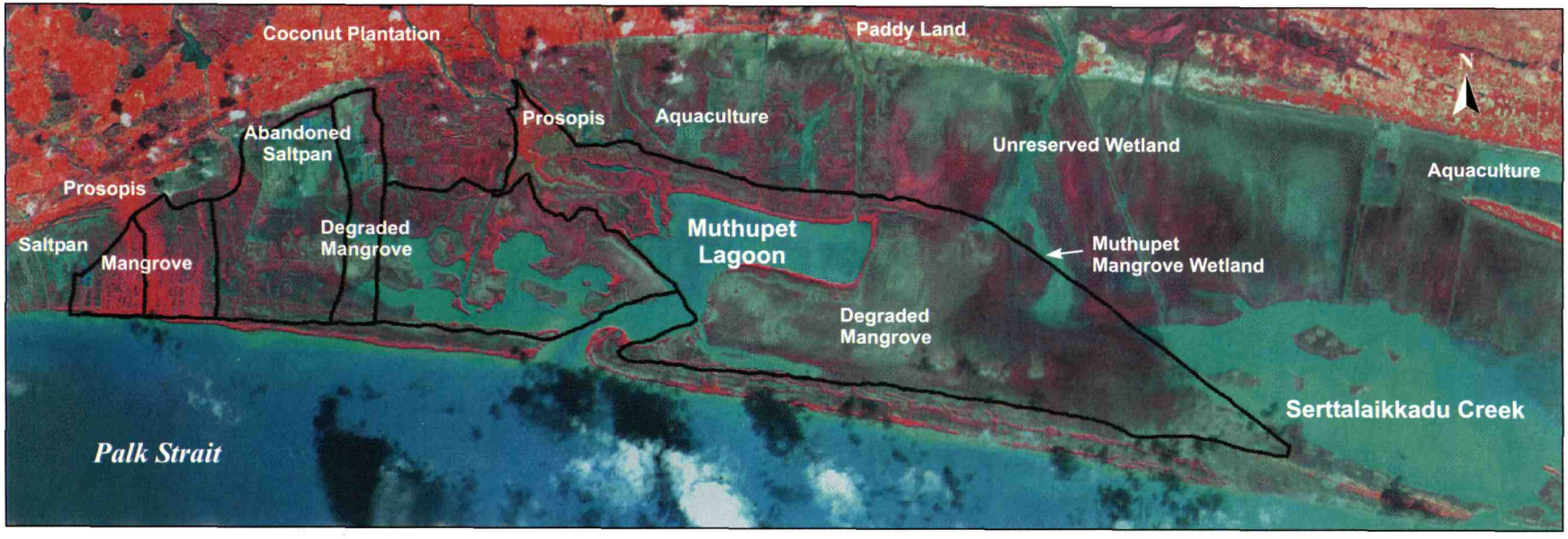
3.1 Geomorphological Setting

The Muthupet coastal wetland forms the southern extremity of the Cauvery delta with a gentle slope towards the Palk Strait of the Bay of Bengal (Map 3.1). This area is drained by the distributaries of the Cauvery viz., Nasuviniyar, Pattuvanachi, Paminiyar, Korayar, Kilathangiyar and Marakkakoryar. The delta has evolved from the sediment piling on a basin that was formed after northeast-southwest (NE-SW) trending fault and transverse trough faults. The delta formation commenced only after the Cretaceous. Palaeocene and Neocene sediments dominate the filled up basin. Sedimentation during Mio-Pliocene was continental. The eastern part of the basin, the Point Calimere region, suffered subsidence during late tertiary while the western and southwestern parts, especially Pattukkottai-Mannargudi line, were gently uplifted. This also accounts for the depth to basement, which has reached 1600 m in the Pattukkottai-Mannargudi line, while at the eastern part, the basement occurs only at a depth of 3500 m accounting for the huge thickness of marine sediments. This is probably one of the main reasons for the increasing shallowness of the lagoon in the Muthupet mangroves.

The alluvial pile rests on the Cuddalore sandstone with an intervening layer of laterite of 5 to 6 m thickness. Since Pleistocene to the present period, a number of oscillations of the sea level are well reflected by the strand lines up to a distance of 6 to 23 km from the present coast. The alternation of strand lines represented by narrow linear ridges with halophytic vegetation, lagoon, mangrove swamp and tidal flats depict a Chenier plain. The entire coastal tract between Muthupet and Vedaranyam represents an east-west disposed arm of a cuspate foreland bar, formed due to the action of the long shore currents. Formation of sub-aerial deltas is a very recent phenomenon, not more than 100 years old.

3.2 Remote Sensing imagery

The Remote Sensing imagery of the Muthupet mangrove wetland (Map 3.2) shows that it is located between the Palk Strait in the south and extensive mudflats in the north. Many of the drainage arteries of the Cauvery delta *viz.,* Nasuviniyar, Pattuvanachi, Paminiyar, Korayar, Kilathangiyar and Marakkakorayar empty their water into the Muthupet mangrove wetland. The Muthupet mangrove wetland comprises different categories of wetland such as healthy mangroves, degraded mangroves, lagoon, tidal creeks and man-made fishing canals. The mangrove area can be identified by the dark red colour with smooth texture (Figure 3.2) while the degraded area and mud flat are represented by dark to light brownish red colour with rough to moderate texture. Other vegetation such as *Prosopis* can be identified by bright red colour.



Map 3.2 Remote Sensing Imagery

Figure 3.2 Thick stands of mangrove vegetation along the tidal creeks

3.3 Reserve Forests

For administrative purpose the Muthupet mangrove wetland is divided into 6 Reserve Forests (RFs) *viz.*, Palanjur RF, Thamarankottai RF, Maravakkadu RF, Thuraikkadu RF, Thambikottai, Vadakadu RF and Muthupet RF (Map 3.3). The area under each of the RF in the Muthupet mangrove wetland is presented in Table 3.1.

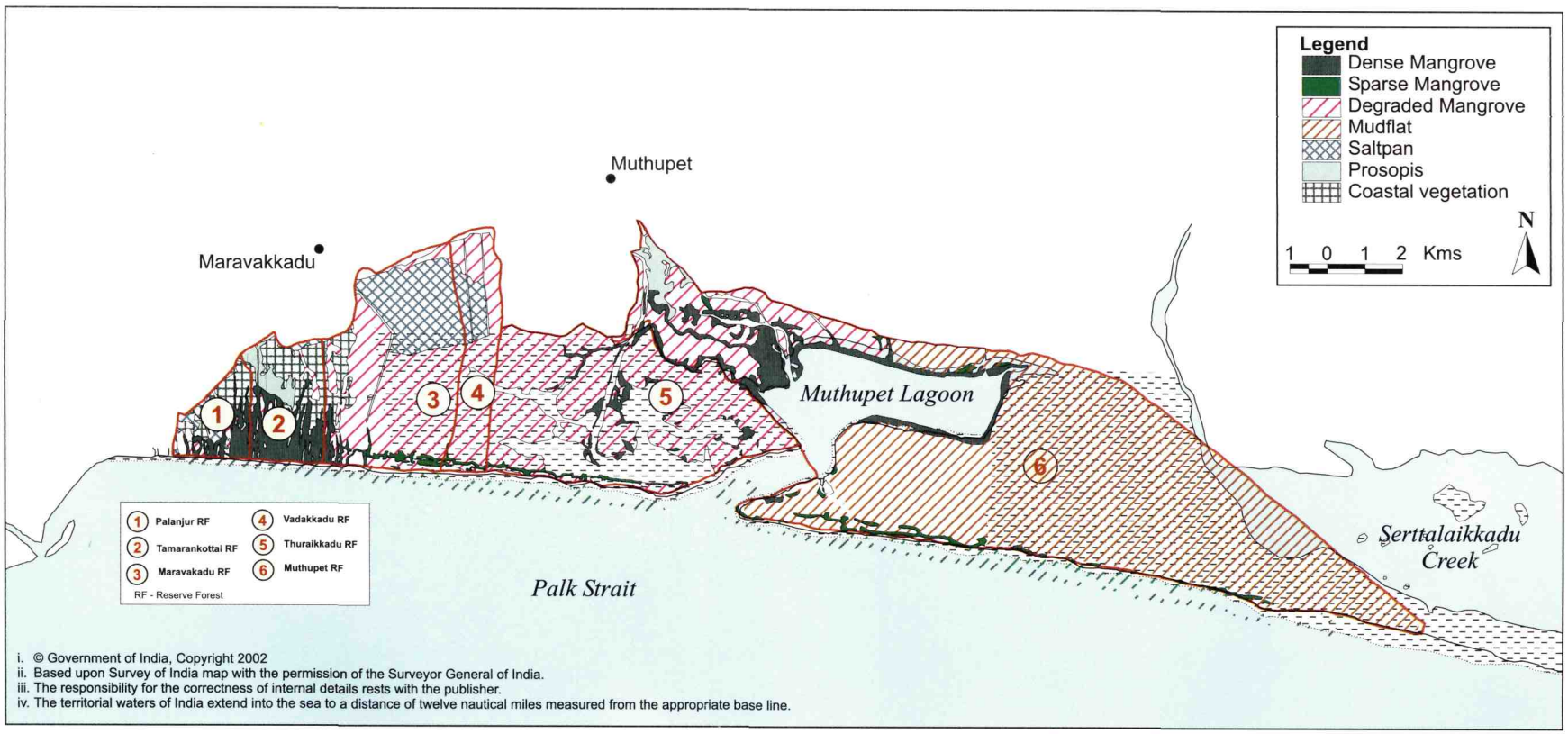
Table 3.1. Reserve Forests and area

Reserve Forest	Area (ha)
Muthupet	6803
Thuraikkadu	2637
Thamarankottai	320
T. Vadakadu	1356
Maravakkadu	530
Palanjur	172
Total	11,818

However, the analysis of the IRS 1C remote sensing data of 1996 shows a total area of 12020 ha within the forest boundary. The area of the different categories of mangrove wetland, associated vegetation (mainly *Prosopis*) and saltpan are presented in Table 3.2. As shown in the table, healthy mangroves occupy only 15% of the total area whereas degraded mangroves (including saltpan) constitute about 68%.

Table 3.2. Categories of wetlands in Muthupet RF (Area in ha)

Category/ RF	Healthy mangroves	Degraded mangroves	Water body	Other vegetation	Saltpan	Total
Palanjur RF	70	74	0	25	20	189
Thamarankottai RF	350	27	0	150	0	530
Maravakkadu RF	75	525	0	0	890	1490
T. Vadakadu	60	312	0	0	2	372
Thuraikadu RF	350	1687	600	0	0	2637
Muthupet RF	950	4553	1100	200	0	6803
Total	1855	7178	1700	375	912	12021



Map 3.3 Reserve Forests

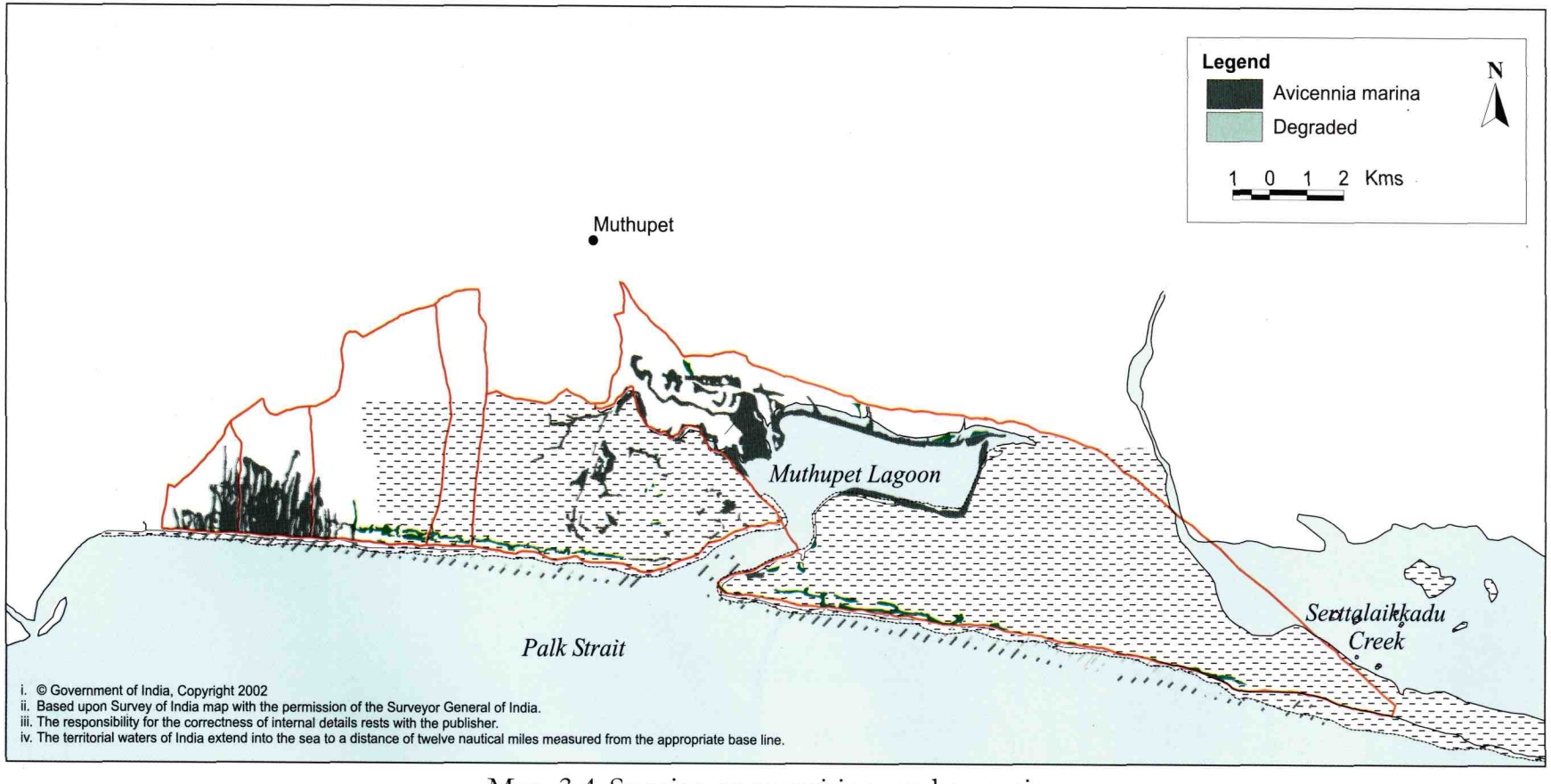
3.4 Biophysical and hydrological condition

3.4.1 Species composition and zonation

The Muthupet mangrove wetland is characterised by the presence of the following exclusive mangrove species 1. *Acanthus ilicifolius*, 2. *Aegiceras corniculatum,* 3. *Avicennia marina*, 4. *Excoecaria agallocha*, 5. *Rhizophora mucronata* and 6. *Lumnitzera racemosa.* Among the six species of true mangroves, *A. marina* is dominant, constituting more than 95 per cent of the total population (Map 3.4). It is followed by *A. corniculatum* and *E.agallocha.* The population of *R. mucronata* and *L. racemosa* is limited to a few individuals. *Suaeda maritima*, *S. monica* and *Salicornia brachiata* are the main associated species found in the Muthupet mangrove wetlands. Both *S. maritima* and *S. monica* are widely distributed and *S. brachiata* is sparsely distributed. Another notable feature is the presence of *Prosopis juliflora* in the mangrove wetlands. Large tracts of monospecific stands of *P.juliflora* are found all along the landward margin.

In the Muthupet mangrove wetland, the zonation or spatial distribution pattern of the flora shows two distinct zones *viz.*, *Avicennia* zone and degraded zone. The *Avicennia* zone occurs in the fringe area of the tidal creeks, man-made fishing canals and along the muddy shore of the Palk Strait. Its breadth varies from a few meters in the fringe to 2.5 km in the canal fishing regions of the mangrove wetland. The *Avicennia* zone is characterised by the presence of dense evergreen trees of *Avicennia marina* 3 - 8 m (Figure 3.3). Other species of this zone such as *Aegiceras corniculatum* and *Excoecaria agallocha* are present as small bushes of about 1 - 2 m.

Figure 3.3 Pure stands of *Avicennia marina*, the dominant species of the Muthupet mangrove wetland



Map 3.4 Species composition and zonation

3.4.2 Soil properties

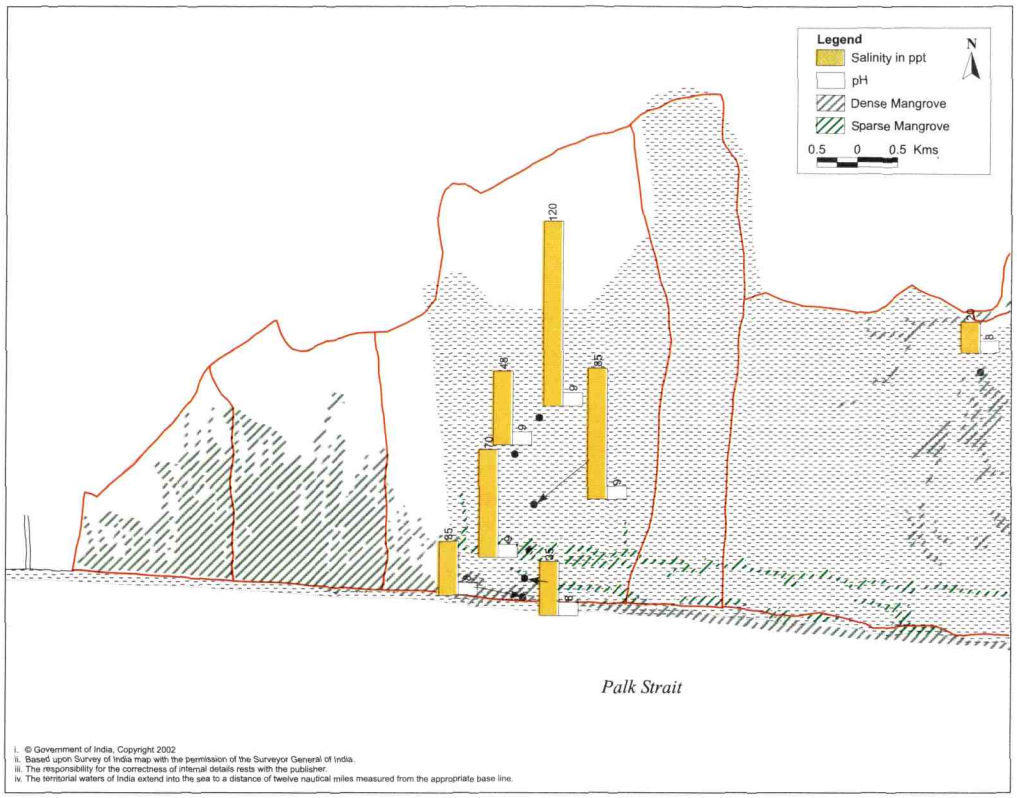
The soil of the Muthupet mangrove wetland is in general dry for the most part of the year and hard. During the summer period, the mangrove wetland is inundated once in 15 days, by spring tides. During the monsoon season (November to December), the entire mangrove wetland is immersed in about 2 to 3 feet of rainwater. Soil analysis indicates that there is difference in soil salinity in different regions (Table 3.3) and the values range from 12.5 to 125 ppt. The stagnation of saline water in the trough-shaped portion of the degraded area is responsible for the very high salinity noticed in the degraded mangroves (Maps 3.5 a & b).

The soil salinity clearly indicates that a suitable drainage system for proper flushing of the mangrove wetland needs to be introduced both in the degraded area and in the healthy *Avicennia* zone where the soil is hard.

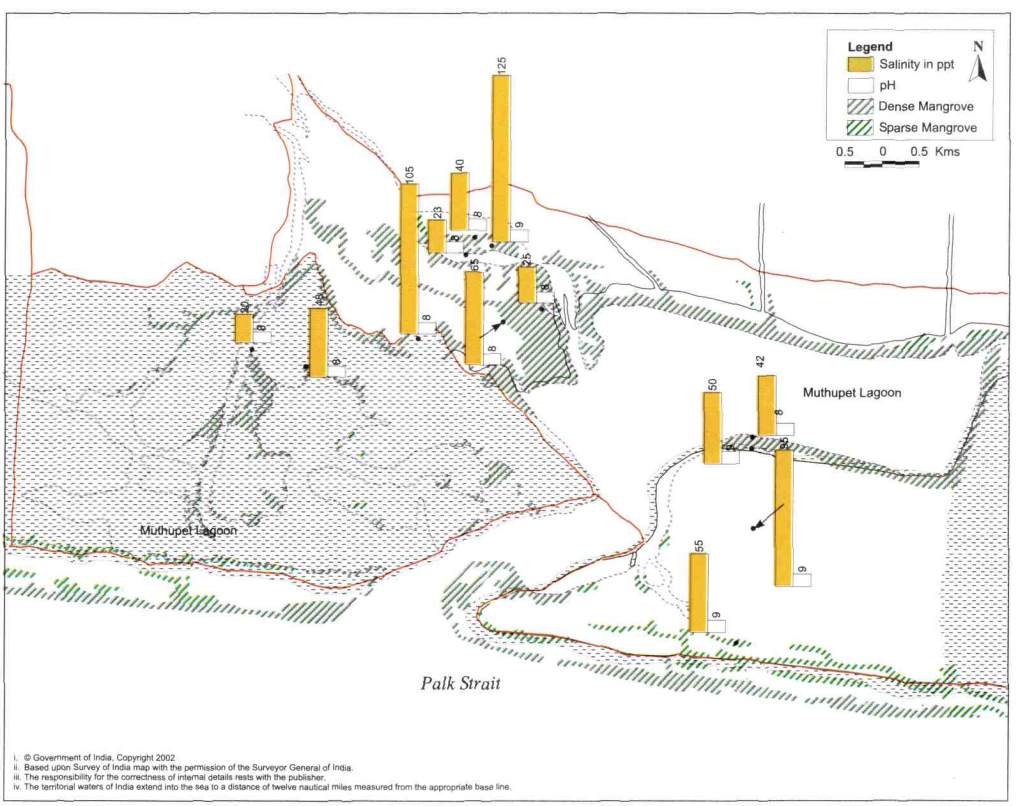
Table 3.3 Soil Salinity and pH in different zones of the Muthupet mangrove wetland

Zone	Soil salinity (ppt)	pH
Avicennia zone	20 - 85	7.25 - 8.60
Suaeda zone	12.5 - 95	7.65 - 8.83
Degraded area	45 - 125	7.62 - 8.71

Figure 3.4 *Suaeda* zone with salt encrusted area



Map 3.5a Soil Properties



Map 3.5b Soil Properties

3.4.3 Hydrological conditions

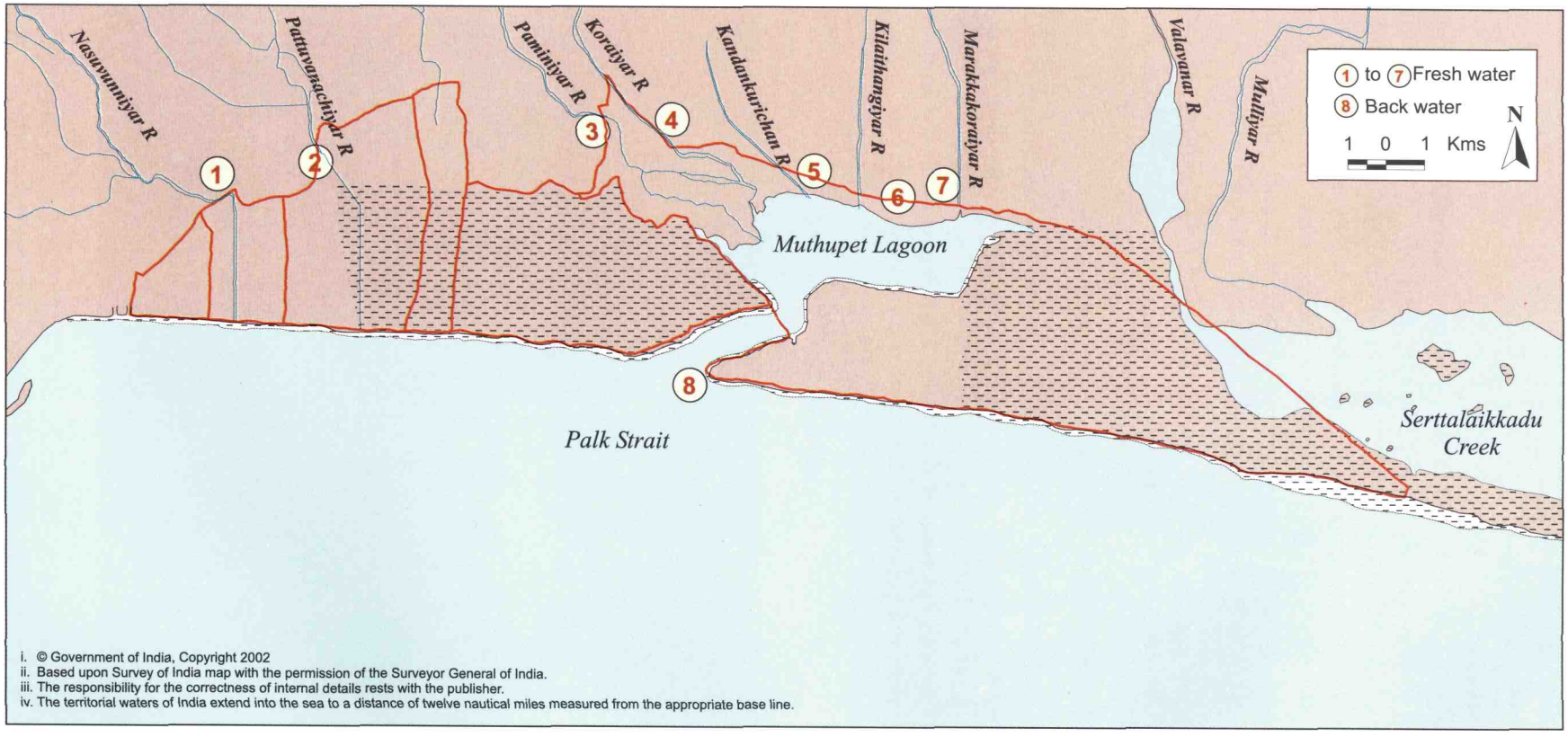
Freshwater flow

The Muthupet mangrove wetland receives inflow of freshwater during the Northeast monsoon (October - January) through the drainage arteries of the Cauvery delta viz., Nasuviniyar, Pattuvanachiyar, Paminiyar, Korayar, Kilathangiyar and Marakkakorayar (Map 3.6). From February to September freshwater discharge into the mangrove wetland is negligible. This is mainly due to the construction of dams and barrages in the upstream regions of the Cauvery. However, whenever water from the Mettur dam is discharged into the arteries of the Cauvery during the non-monsoon period, particularly from July to September for paddy cultivation, surplus water if there is any, reaches the Muthupet mangrove wetland through the drainage arteries.

The Muthupet lagoon near the mangrove wetland is shallow in depth, ranging from 0.2 to 2.0 m. The eastern portion of the lagoon is very shallow and the average depth is about 0.3 m. The western portion of the lagoon and a newly formed waterbody located west of the lagoon are 0.5 to 1.0 m deep. In the mouth region of the lagoon, the depth ranges from 1.0 to 2.0 m.

As in the case of the Pichavaram mangrove wetlands, the Muthupet mangroves also received freshwater during the months of July, August and September from the Mettur dam. But due to the increase in irrigated area in the upstream Cauvery delta, the amount of freshwater reaching the Muthupet mangroves, which are located in the tailend region, has reduced drastically. Such reduction in the amount of freshwater flow has affected both the diversity and population density of many mangrove species.

Figure 3.5 Shoot die-back syndrome observed in *Avicennia marina* due to hyper salinity



Map 3.6 Sources of fresh water

Salinity of tidal water

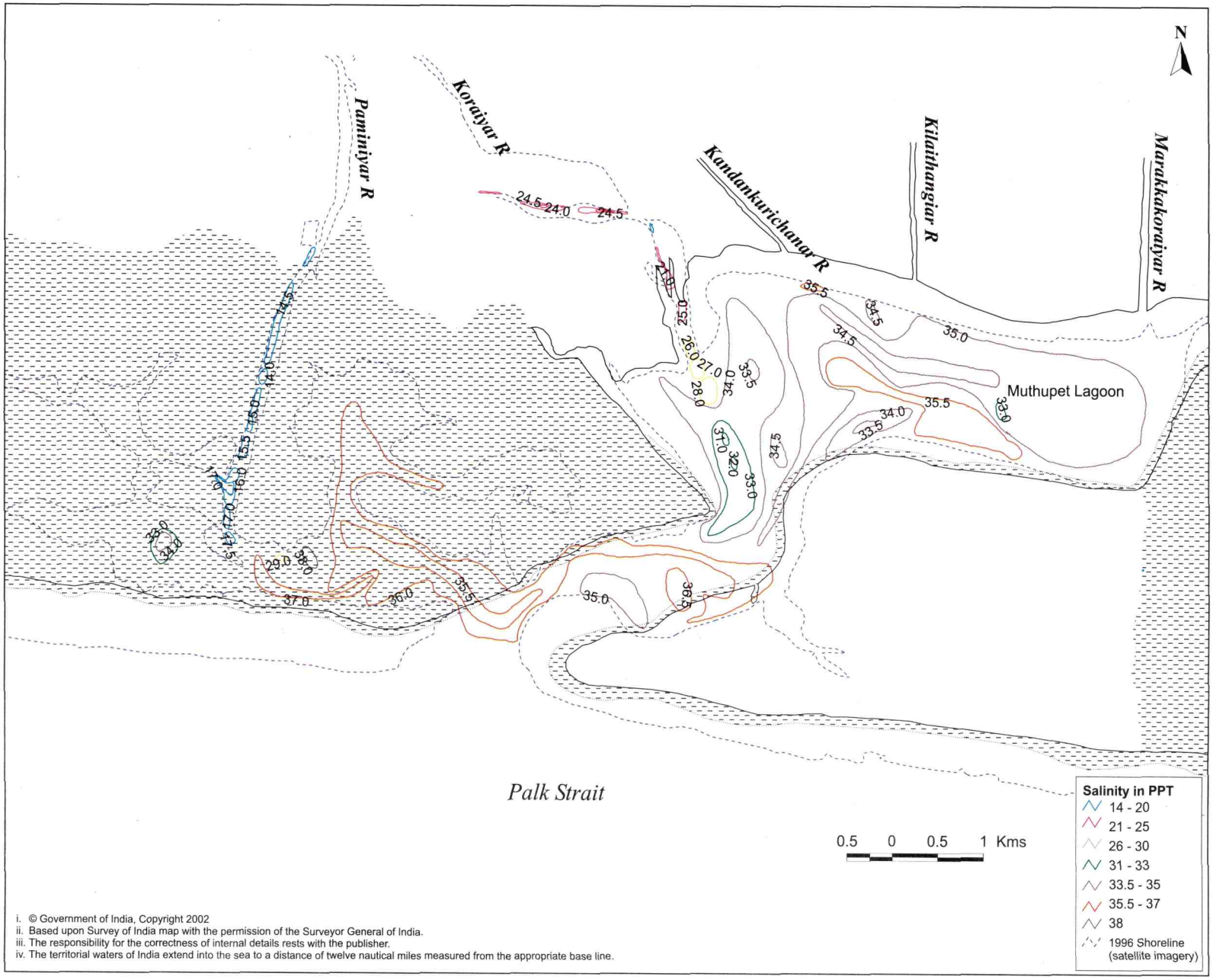
As in the case of Pichavaram mangroves, the tides in the Muthupet mangrove wetland are micro and semi-diurnal (with two high tides and two low tides in a day). During the post-monsoon season, salinity in the lagoon and the other water bodies of Muthupet mangrove wetland is in the order of 14 - 38 ppt with relatively low value in the upstream end of the Paminiyar River and high in the mouth region of the lagoon (Map 3.7). The salinity during the summer months varies from 35.5 to 42.5 ppt with higher values in the north and eastern portion of the lagoon (Map 3.8).

3.5 Wood and Fishery resources

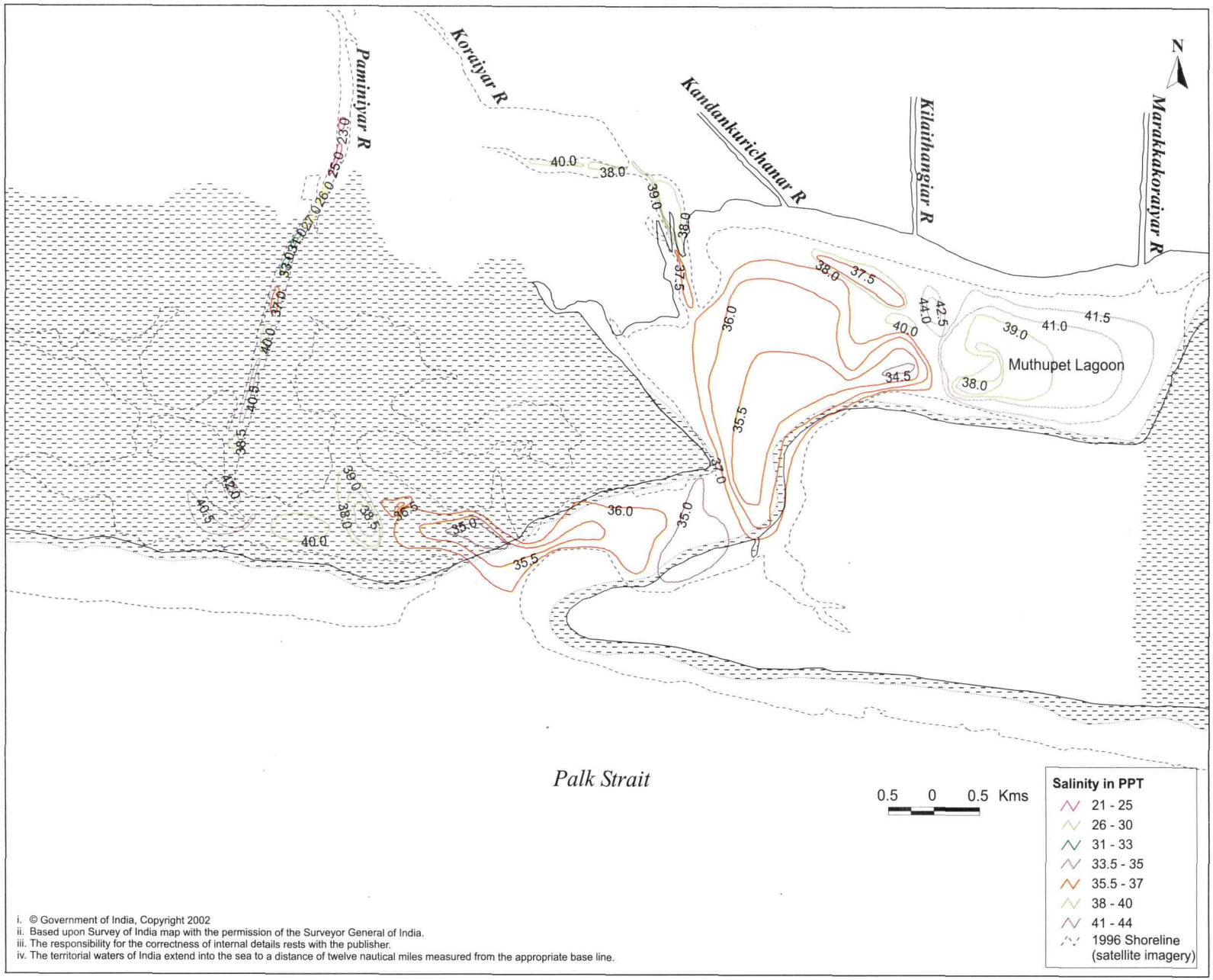
The harvestable forest resources are very limited in the Muthupet mangrove wetland. No timber or non-timber forest produce is available. Though fodder is available in the wetland, no regular grazing is practised in the mangroves since access to the main forest is very remote, except to the Palanjur and Thamarankottai RFs. However, around 150 aged and dry cattle, particularly from Adiramapattinam, Earipurakkarai and Jambavanodai villages, are let into the mangroves with markings. They stay in the mangroves permanently until the owner of the cattle takes them back.

Only a limited number of families, particularly from Karaiyur, Earipurakkarai and Manganangkadu hamlets, collect dead wood and dried twigs for their own use as firewood. The destitute women from these hamlets collect firewood from the mangroves and sell it to the local tea shops and hotels for their livelihood.

Figure 3.6 Fish /Prawn harvested from the Muthupet mangroves are sold at a local market



Map 3.7 Water salinity - Post monsoon



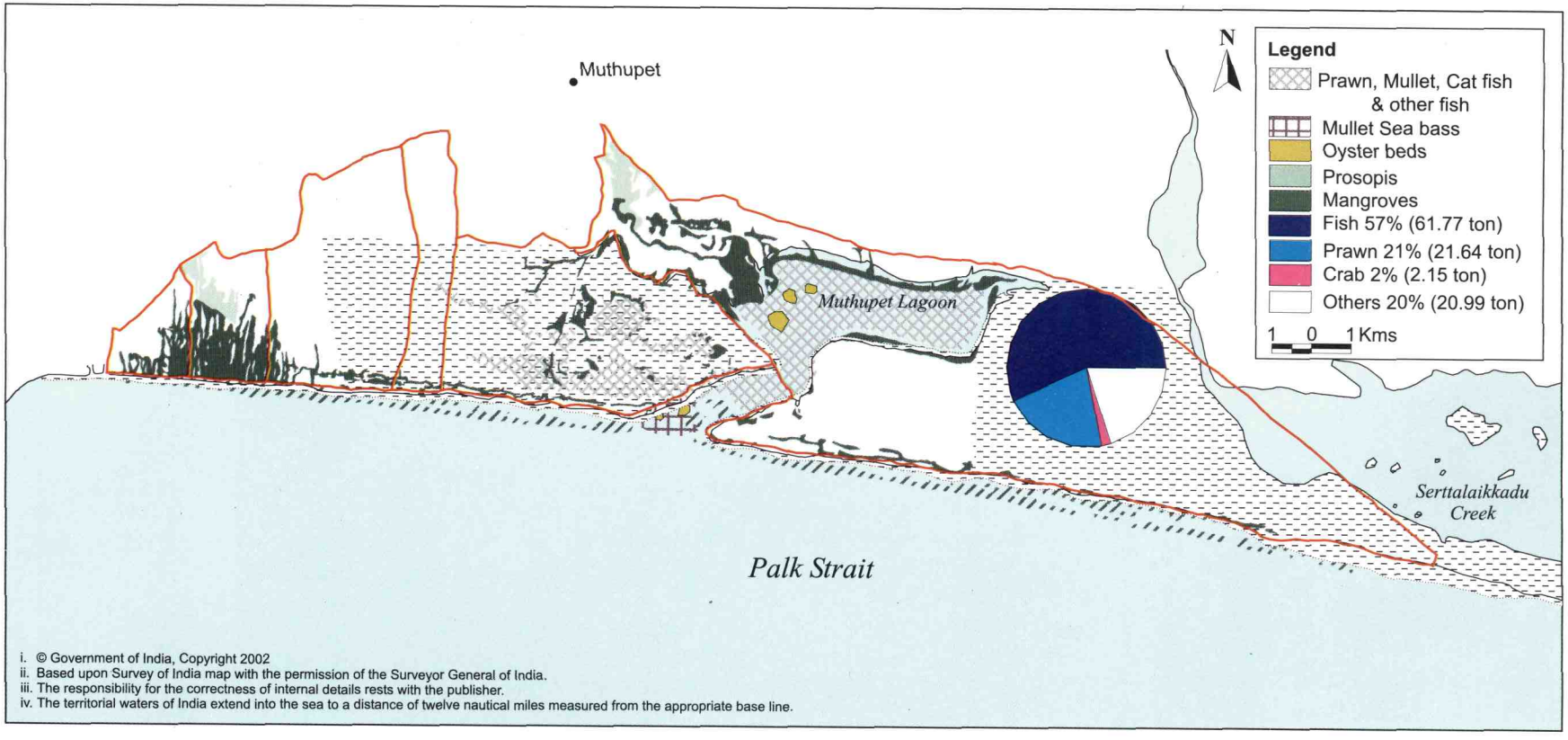
Map 3.8 Water salinity - Summer

Fishery resources

The Muthupet mangrove wetland is characterized by the presence of a vast lagoon, occupying an area of about 1700 ha and providing livelihood for the population of about 15 hamlets (3200 families). In the western part of the mangrove wetlands, about 1000 families are engaged in fishing in the Palk Strait which forms the southern boundary of the mangrove wetland. About 80 families are practising canal fishing in the mangrove wetlands for a period of 4 - 7 months every year (Figures 3.7 and 3.8). The preliminary study on fishery potential of Muthupet mangrove wetland conducted by MSSRF indicates (subject to verification) that about 106.55 ton of marine products are harvested every year from the lagoon and adjacent waterbodies, of which fish constitute 61.77 ton (57% of the total catch) and prawn 21.64 ton (21%). It is interesting to note that compared to Muthupet, prawn catch in the Pichavaram mangrove wetland is very high, constituting nearly 83% of the total marine products (Map 3.9)

Figure 3.7 Fishing in the shallow water by cast net

Figure 3.8 Sea bass caught in the mouth region of the mangrove lagoon



Map 3.9 Wood and Fishery resources

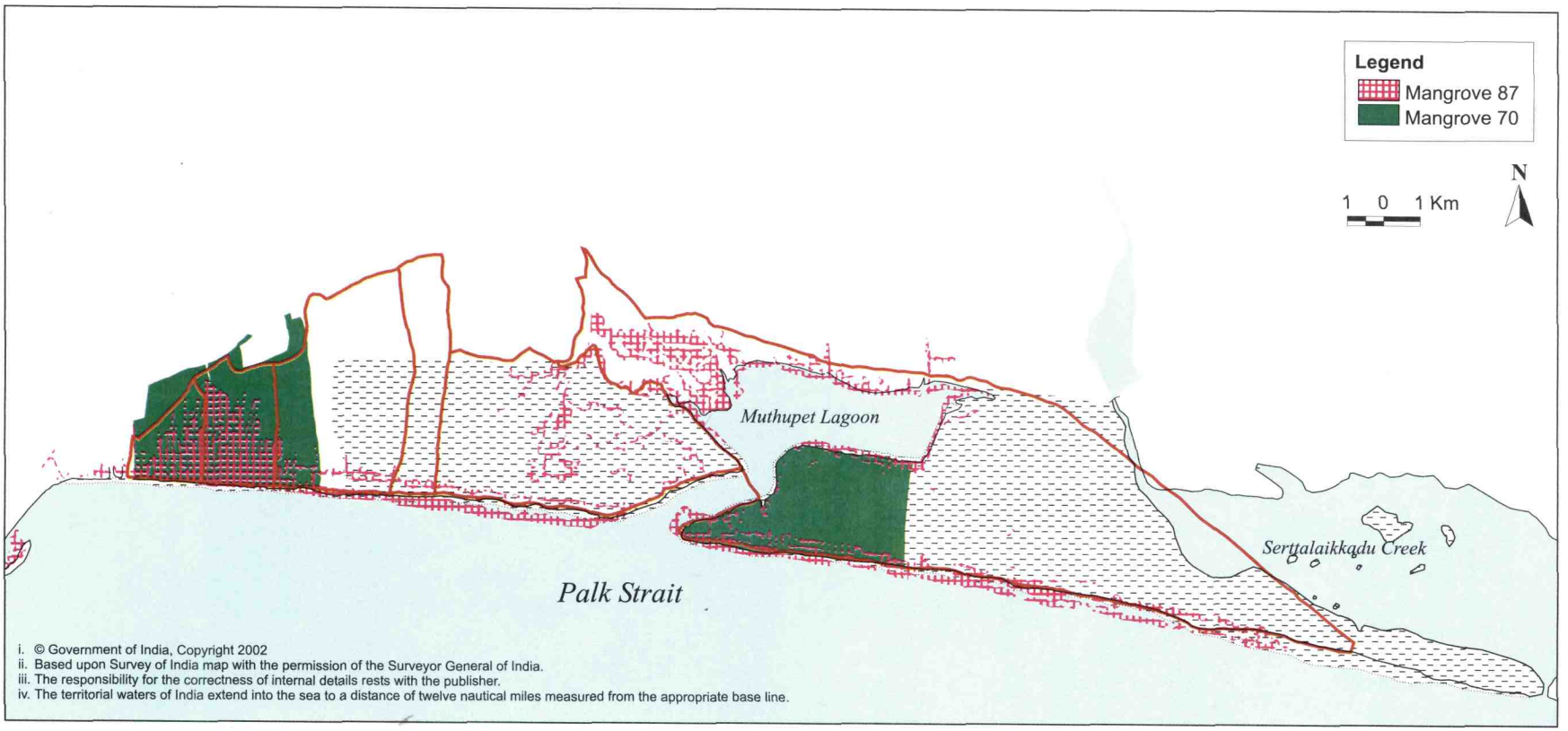
3.6 Changes in the mangrove forest cover and causes for degradation - 1970 to 1996

The changes in the forest cover between the years 1970[1] and 1986 (Remote sensing data Landsat TM 5) and 1986 and 1996 (Remote Sensing data IRS IC LISS III) were studied. Between 1970 and 1986, the mangrove forest cover reduced from 2762 ha to 1767 ha (about 65%) (Map 3.10). Between 1986 and 1996 the mangrove forest has increased by about 100 ha (Map 3.11). As per the 1996 remote sensing data, the total area of the degraded mangroves is about 7100 ha.

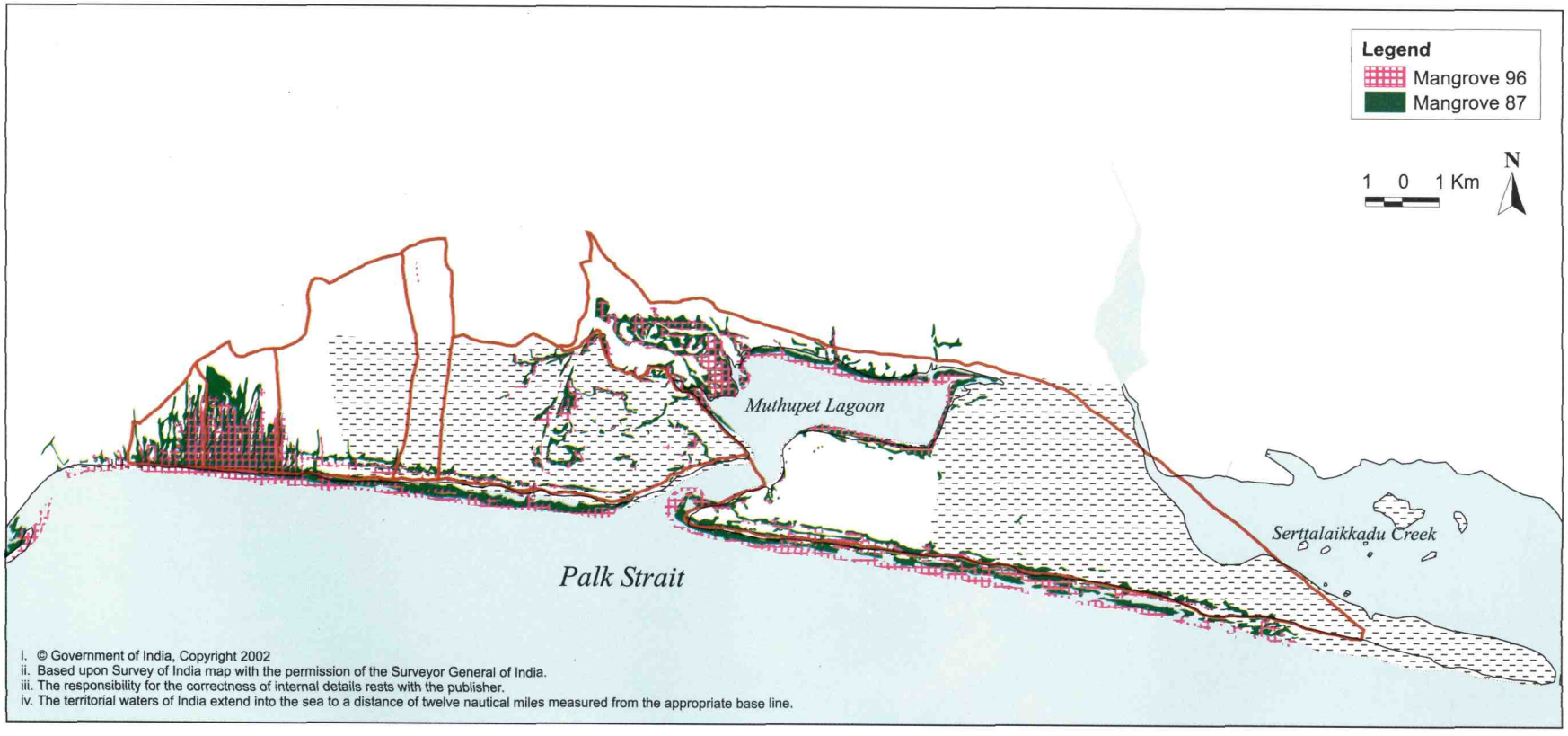
The degradation of the mangrove wetland is due to the hypersaline condition of the trough-shaped portion of the mangrove wetlands. The problem is further aggravated by the reduction in the inflow of freshwater. It was also observed that hypersaline pore water found in the trough-shaped areas moves laterally to the adjacent healthy mangroves and kills them. The *shoot die back syndrome* (Figue 3.9) that was observed in a number of mangrove trees found adjacent to hypersaline mangrove areas indicates the lateral movement of the hypersaline water. This aspect needs further investigation for developing proper management strategies. The recent increase in the mangrove forest cover is due to the restoration efforts of the Forest Department and new mangroves developed in the recently accumulated mud along the coastline.

Figure 3.9 Nearly 65% of the Muthupet mangrove wetland is degraded due to hypersaline condition

[1] data collected from the Survey of India toposheet – survey was undertaken during late 1960s and published in 1970



Map 3.10 Changes in mangrove forest between 1970 and 1986



Map 3.11 Changes in mangrove forest between 1986 and 1996

3.7 Socio-economic profile

The socio-economic profile of the user villages of the Muthupet mangrove wetland (Map 3.12) was prepared on the basis of the results obtained by conducting Rapid Rural Appraisal (RRA) in the villages and also by a questionnaire based survey as in the Pichavaram mangrove wetland. A benchmark survey was also conducted in the mangrove user villages with the help of Society for Social Forestry Research and Development and Tata Economic Consultancy Services, Chennai. The methodology of the survey was similar to that followed in the mangrove user villages of the Pichavaram mangrove wetlands.

3.7.1 Mangrove user villages and hamlets

People belonging to 26 hamlets of 16 revenue villages are living around the Muthupet mangrove wetland. Out of 26 hamlets, 22 are fishing hamlets. During the monsoon season fisherfolk of all the fishing villages are engaged in fishing in the mangrove wetlands including the lagoon and trough-shaped degraded area (locally called *thottam*) whereas during non-monsoon seasons, some of the fisherfolk fish in the water bodies within the mangrove wetlands. The poor and poorest sections of a few hamlets and destitute women from Karaiyur, Manganangkadu are engaged in the collection and sale of dead wood from the mangrove forest for subsistence.

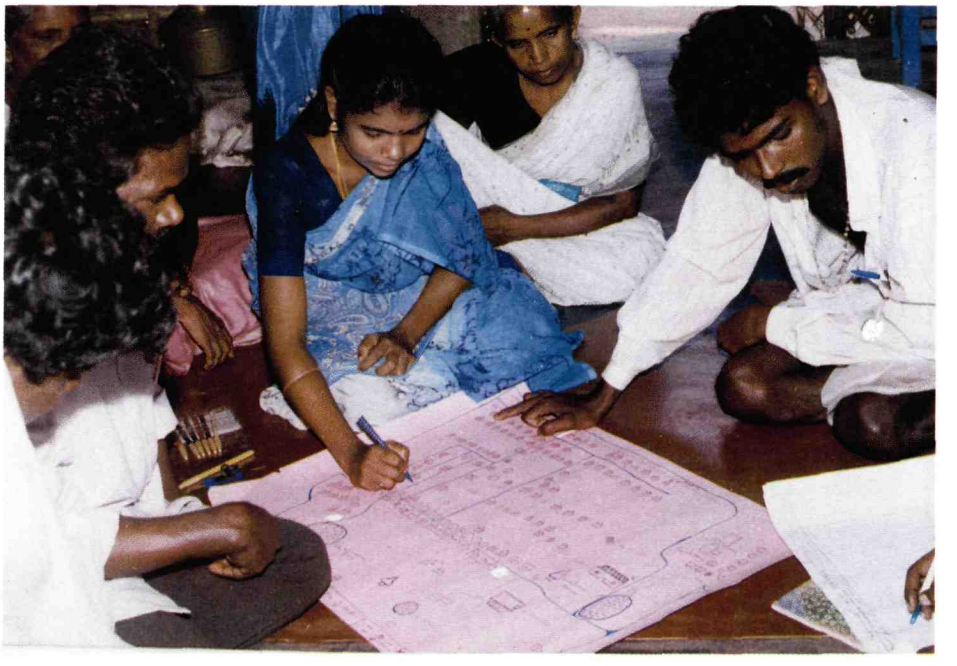
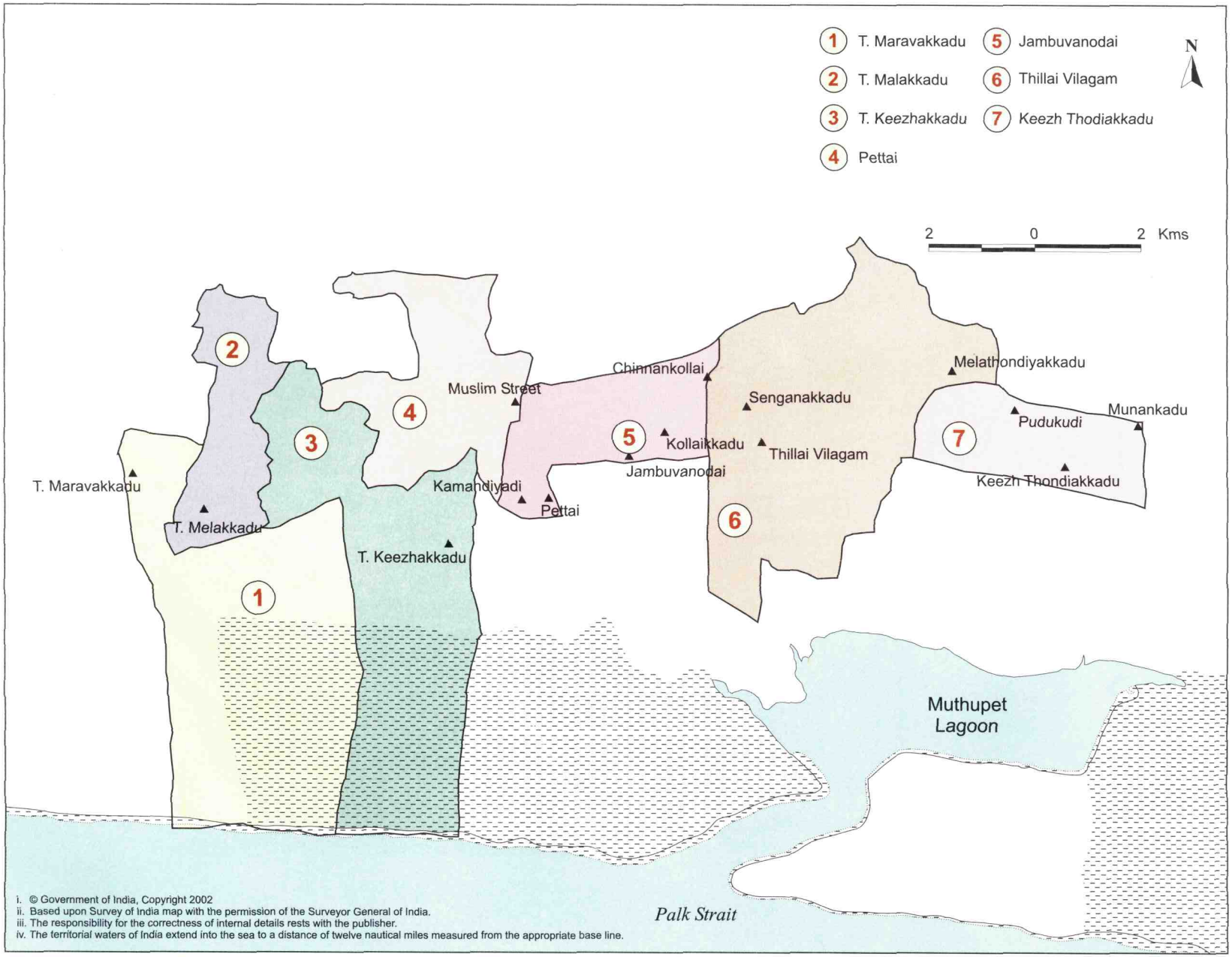


Figure 3.10 Fishing community of Veerankoil, a village participating in Joint Mangrove Management activities



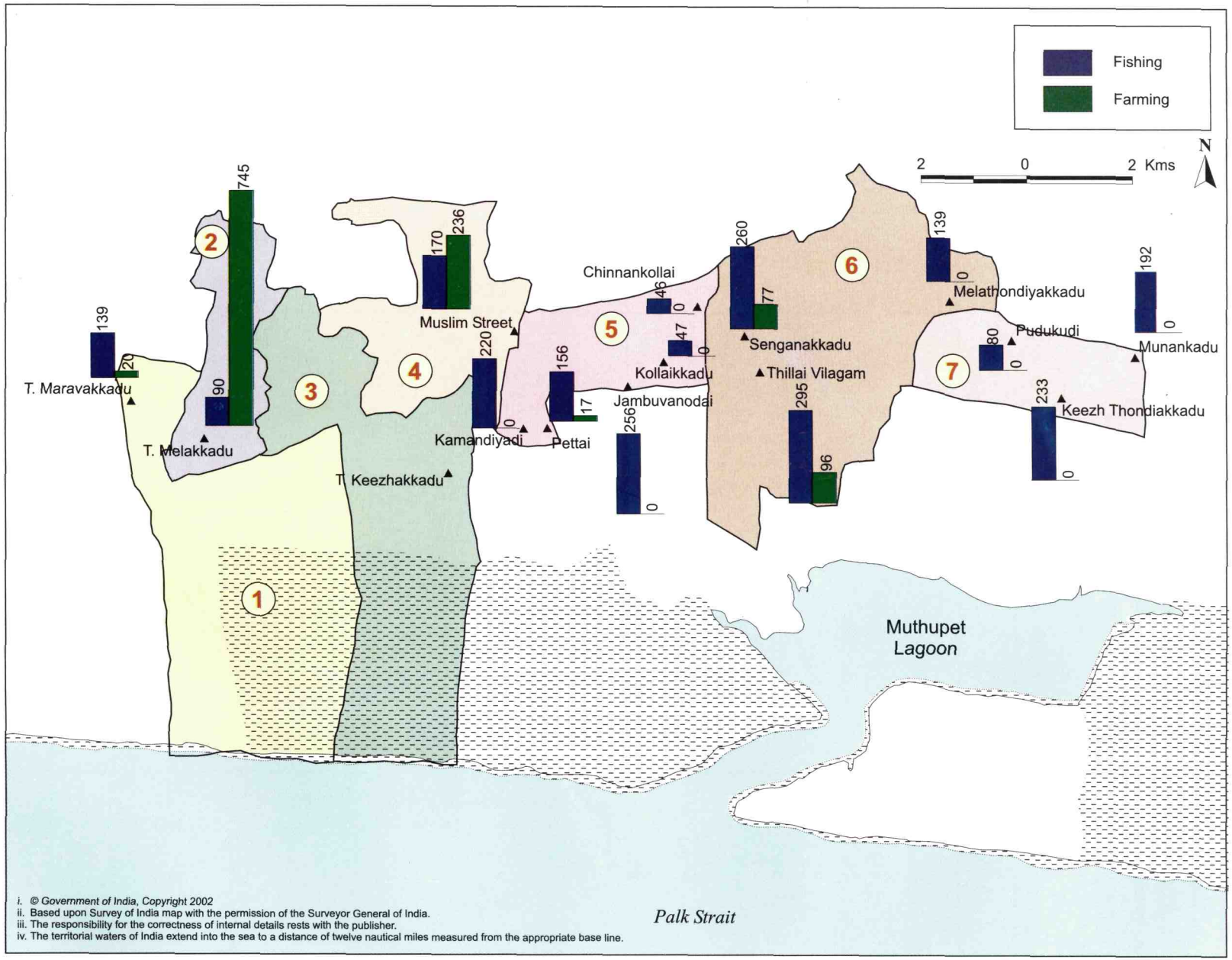
Map 3.12 User villages and hamlets

3.7.2 Population and occupation

As shown in Table 3.4 the total number of households and population of mangrove user villages and hamlets are about 8200 and 37250 respectively (Map 3.13). The benchmark survey conducted in the 7 villages indicates that in 53% of the households fishing is the major occupation and 47% of the households depend mainly on agriculture. However, a considerable number of people work as agriculture wage labourers (21%) during the monsoon and post-monsoon months (October - February). Only men are involved in fishing whereas men and women work as agricultural wage labourers.

Table 3.4 Details of mangrove user villages and hamlets

Village	Hamlet	Total households	Total population	Occupation
Adiramapattinam	Karaiyur	325	1907	Fishing
Sundaranayakipuram	Manganangkadu	110	571	Fishing
Thamarankottai	Karisaikkadu	180	464	Fishing
	Manjavayal	501	1882	Agriculture
T. Maravakkadu	Veerankoil	159	1342	Fishing
T. Vadakadu	T. Vadakadu	969	3903	Agriculture
T. Melakkadu	T. Melakkadu	835	3071	Agriculture
Sundaram	Keezhakkadu	576	2337	Agriculture
Puthukottagam	Puthukottagam	87	358	Agriculture
Thuraikkadu (Pettai)	Kovilanthoppu	173	743	Fishing
	Kamandiyadi	220	1100	Fishing
	Muslim street	406	1625	Fishing
Muthupet	Azad Nagar	225	674	Farming
	Maruthangavali	500	2056	Farming
Jambuvanodai	Jambuvanodai Therkku	256	1270	Fishing
	Kollaikkadu	47	141	Fishing
	Chinnakollai	46	230	Fishing
Veeranvayal	Veeranvayal	257	1068	Fishing
Thillaivilagam	Thillaivilagam Therkku	391	1702	Fishing
	Sengangkadu	337	1558	Fishing
Thondyakadu	Keezh Thondyakadu	233	908	Fishing
	Melathondyakadu	139	504	Fishing
	Puthukudi	80	374	Fishing
	Munangkadu	192	908	Fishing
Alangkadu	Alangkadu	615	4061	Fishing
Uppur	Uppur	357	2498	Fishing
	Total	8216	37255	



Map 3.13 Population and occupation

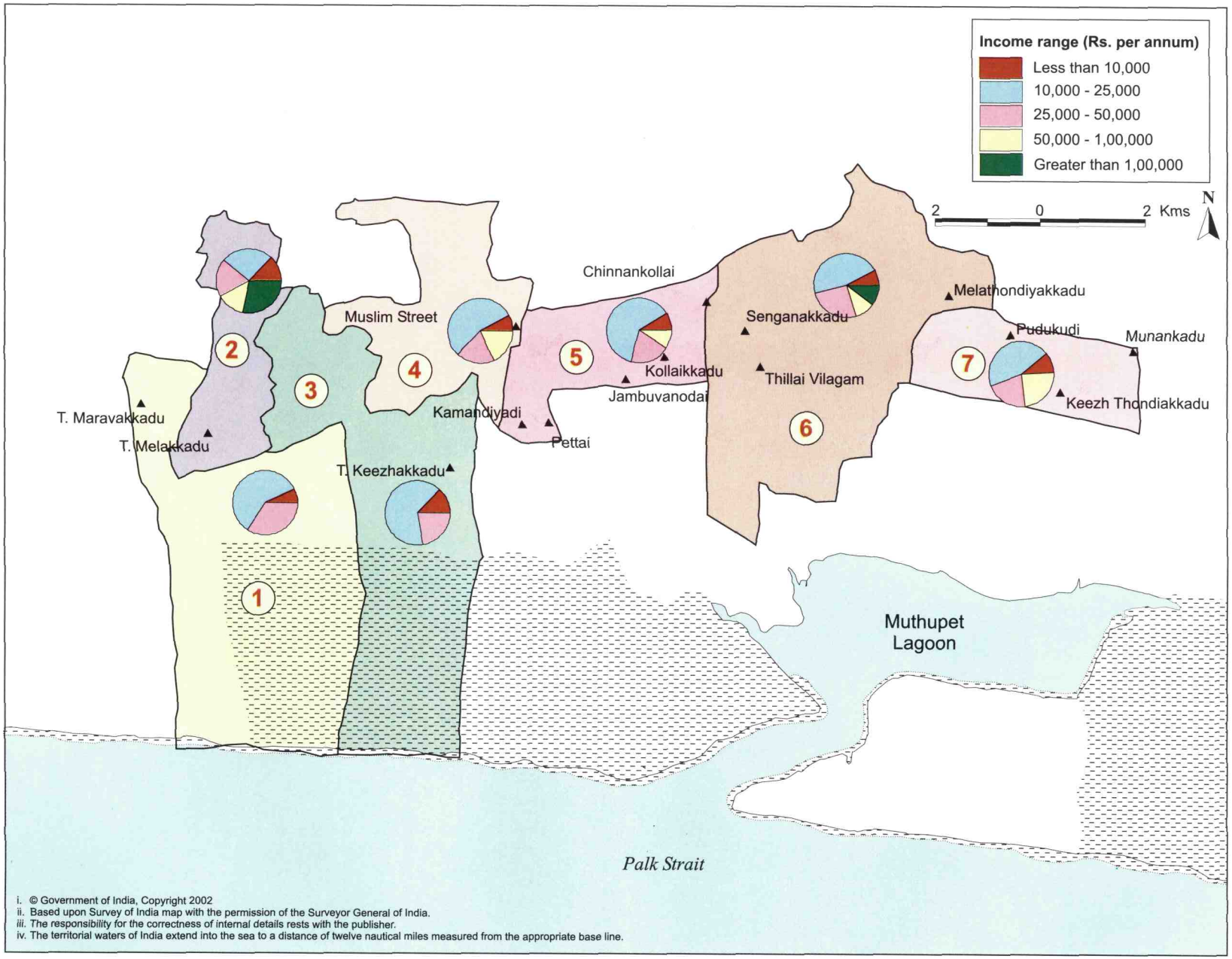
3.7.3 Income and Income sufficiency

Map 3.14 shows the level of income in the seven revenue villages which are dependent on the mangroves. The annual income for about 50% of the population falls in the range of Rs. 10000 to 25000/-. The Participatory Rural Appraisal conducted in one of the fishing hamlets found that about 55% (Rs. 18650/-) of the expenditure of a family of 4 members was spent on food alone and nearly 65% of the total income of a just-sufficient group is utilized for food.

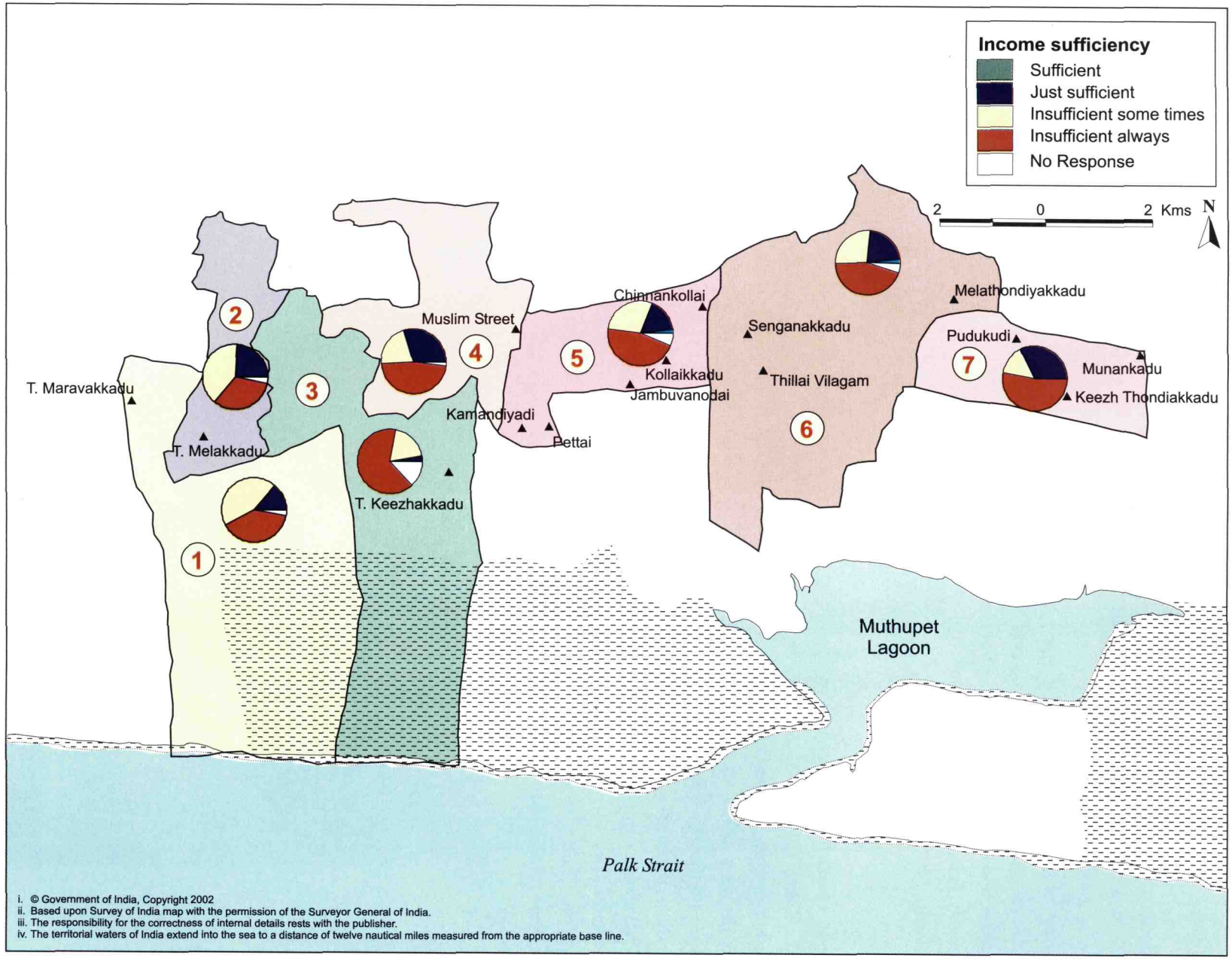
Regarding the income sufficiency level, about 51% of the households feel that the annual income is insufficient most of the time and 20.3% of the households feel that their income is sufficient. In the 7 villages annual income is sufficient only for 0.6% of the households (Map 3.15).

Fig 3.11 Some destitute women make their livelihood by collecting and selling dead mangrove wood

Fig 3.12 Most of the fisherfolk are poor and have minimum crafts and gear for fishing



Map 3.14 Income range



Map 3.15 Income sufficiency

3.7.4 Land use pattern

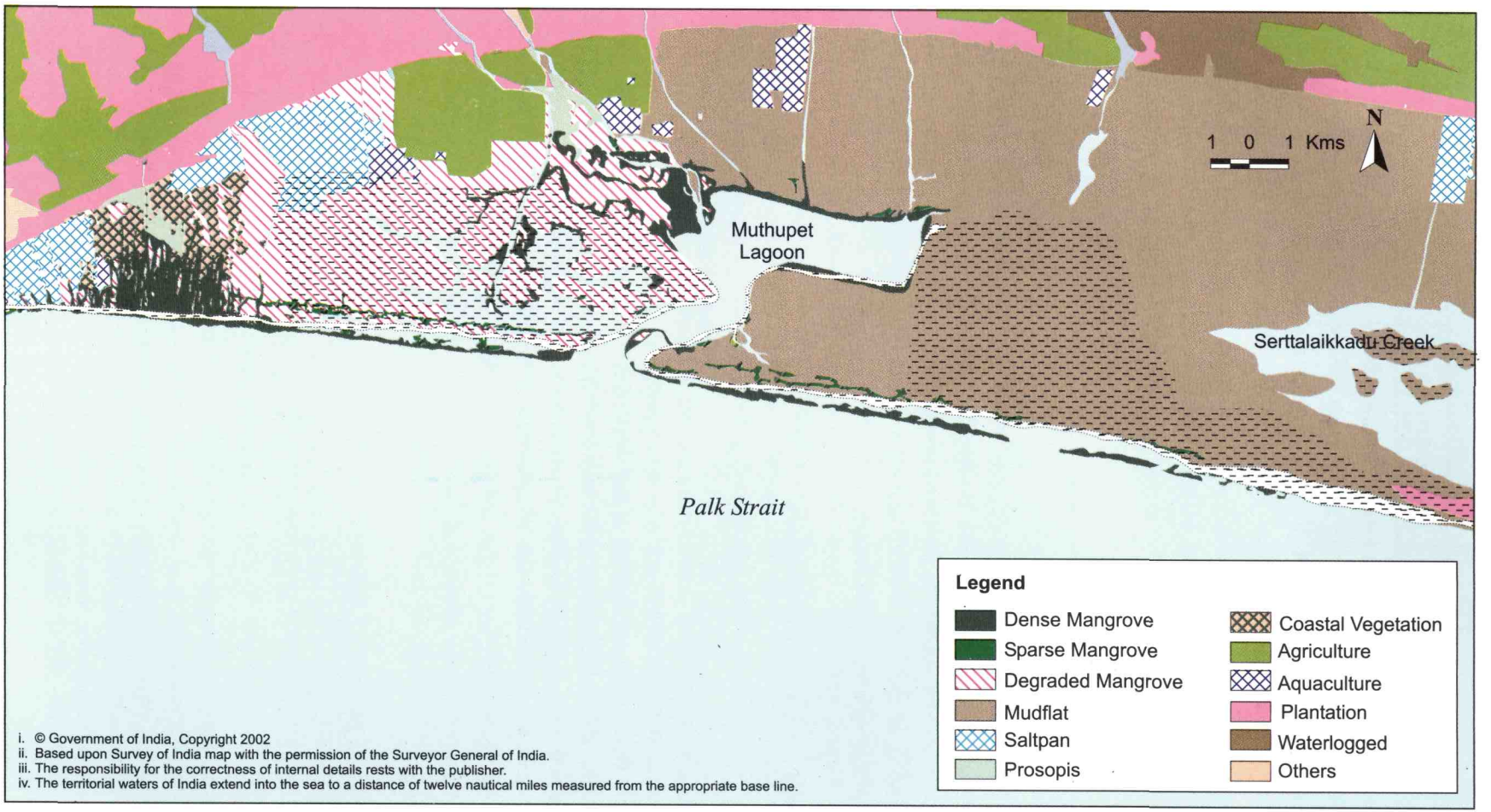
Agriculture

Coconut and paddy are the major crops cultivated in the villages situated around the Muthupet mangrove wetlands (Map 3.16). Since the region is situated in the tail end of the Cauvery deltaic system, paddy is cultivated only once, during the monsoon and post-monsoon period of every year, from October to February. Paddy cultivation in this region is mainly dependent on freshwater released into the rivers Paminiyar, Koraiyar, Kilaithankiyar, etc., from Grand Anaicut of Cauvery riverine system. Coconut groves cover large areas between paddy fields and mangrove wetlands. Other minor crops like black and green gram are cultivated as relay crops in the paddy fields. The seeds are sown before harvesting paddy. These crops do not need watering as they are grown during the winter season.

Saltpan

About 14 saltpans, occupying an area of about 4082 acre are present around the Muthupet mangrove wetland. These saltpans are located very close to the Palanjur, Thamarankottai, Maravakkadu (western part of the Muthupet mangrove wetland) and Muthupet reserve forests (eastern part). Most of the saltpans located on the western part of the Muthupet mangrove wetland were constructed as early as 1855 whereas the saltpans located on the western part (near Thillaivilagam village) are newly constructed. Out of the 14 saltpans, the Salt Corporation of the Government of India owns 13 saltpans and the Tamil Nadu Salt Corporation Ltd owns one. The saltpan owned by Government of Tamil Nadu is developed in the degraded mangrove wetland of the Maravakkadu Reserve Forest. Salt production in this saltpan was stopped in 1997 following a directive from the Supreme Court. Most of these saltpans produce salts for industrial chemicals. The saltpans located on the western part of the Muthupet mangrove wetland draw seawater from the Palk Strait through canals for salt production.

Figure 3.13 Saltpans located in the landward margin of the Muthupet mangrove wetland



Map 3.16 Landuse pattern

Aquaculture

Apart from the saltpans, prawn farms are located close to the mangrove forest. The total area of these farms is about 1000 acres. Of this 796 acres are located on the western side of the Muthupet mangrove wetlands and 204 acres are located on the eastern side. In these farms the modified extensive system is followed. All these farms draw water either from the sea through canals or from the mangrove wetland. In the modified extensive farms water exchange is done once in 3 days. The water level maintained in the farms is about 110 to 115 cm. Normally 25 kg of prawn feed is used per 0.5 ha of pond. About 250 to 350 kg of lime is used per 0.5 ha of pond to increase the soil pH. A variety of antibiotics such as oxytetracycline, wolmid, muzophore and germicides are used to control diseases. The impact of these aquaculture farms on mangrove wetlands has not been studied.

Prosopis

About 375 ha of mangrove wetland in the northern regions of Palanjur, Thamarankottai and Muthupet Reserve Forests was invaded by *Prosopis.* The bushes of *Prosopis* densely cover the banks of Koraiyar, Paminiyar and Nasuviniyar rivers in and out of the Reserve Forest boundary. The *Prosopis* zone acts as a buffer zone and prevents cattle grazing in the core area of healthy mangrove forest. The Forest Department of Muthupet Range allows collection of wood from *Prosopis* in the fringing zones.

3.7.5 Dependence on Mangrove Wetland

Grazing

About 250 livestock (cattle) from Adirampattinam and Karisaikkadu graze in the peripheral regions (eastern and northern regions of Palanjur RF and northern portion of Thamarankottai RF) of Muthupet mangrove wetland seasonally. These portions belong to the west of the Muthupet mangrove where dense forest cover is present. Based on the field observation, cattle consume leaves, propagules and seedlings of *Avicennia marina*, causing stunted growth of mangroves and poor establishment of seedlings in the peripheral regions where the freshwater flow is more during the monsoon and post-monsoon seasons. The villagers say that reduced availability of *poramboke* land in and around the villages has prompted them to depend on mangrove wetlands for grazing their cattle.

Firewood collection

Only a very limited number of fisherfolk families, particularly those who live in villages like Karaiyur, Manganangkadu, Kovilanthoppu, etc., (Table 3.5) collect firewood from the mangroves for their own use. The fisherfolk collect mangrove firewood only during the late summer or early pre-monsoon period and store them for use in the monsoon season.

In some of the villages like Manganangkadu and Karaiyur, poor and destitute women alone are involved in collecting and selling firewood in the local market. The women engaged in collecting firewood in the mangroves for their livelihood, do it regularly since there is a good demand from the local teashop owners and illicit arrack distillers. Mangrove firewood fetches more money as collection of firewood is the most difficult job. For example one bundle of mangrove firewood is sold at approximately Rs. 40 to 50/-. During the monsoon season more mangrove firewood is collected by towing a number of bundles linked to one another in the

Table 3.5. Number of families dependent on the mangrove firewood for livelihood

Hamlet	Occupation	No. of families
Karaiyur	Fishing	25
Manganangkadu	Fishing	4
Kovilanthoppu	Fishing	15
Pettai-Muslim street	Fishing	12
Manjavayal	Farming	5
Jambavanoodai Therku	Farming	12
Total		73

Fishing

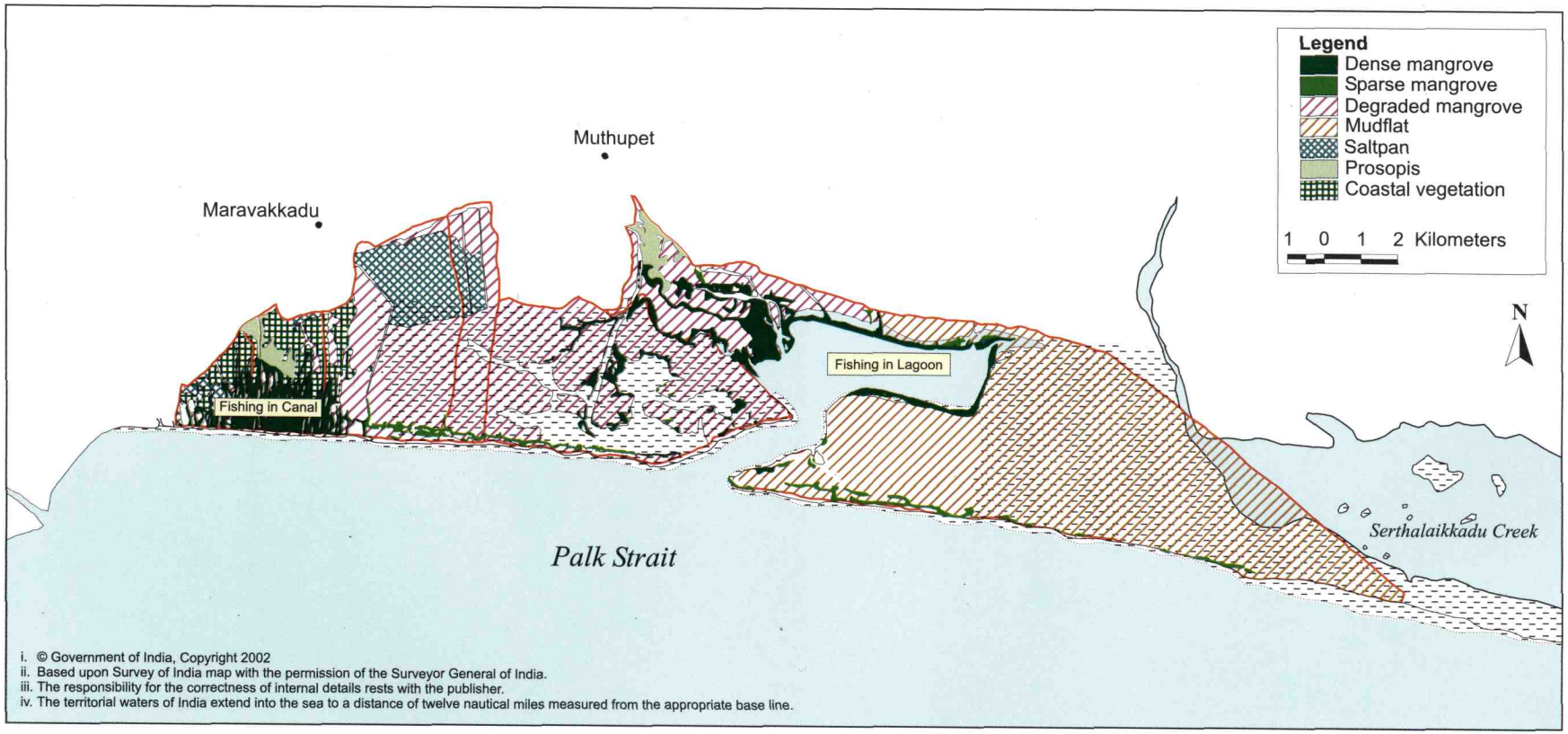
As shown in Table 3.6 about 4300 fisherfolk fish in the Muthupet mangrove wetland and adjacent sea (Map3.17). Almost all of them are artisan fisherfolk, using small non-mechanized boats for fishing. Nowadays, these non-mechanized boats are being replaced gradually by moulded *catamarams* with *lambadi* engine fabricated and marketed by Tamil Nadu State Apex Fishermen Co-operative Federation (TAFCOFED). In the mangrove wetlands, fishing is free in the lagoon whereas in the trough-shaped area (*thottam*) fishing right is given to fishermen co-operative societies on a lease basis for a nominal fee. Apart from these, a group of local fisherfolk fish in man-made canals, which integrate fisheries development with mangrove conservation. As shown in the table, in some villages the entire population is involved in fishing whereas in others some of them are involved in fishing and others in agriculture. The fisherfolk living around the Muthupet mangrove wetland use the following gear for fishing in the mangrove waters:

1. *Adappu Valai* is a type of gill net used in the mangrove waters mainly for fishing mullets. It is about 18 m in length and 2 to 2.5 m in breadth. The mesh size is about 2 cm. Once a shoal of mullets is seen by the fisherfolks, the gill net is deployed at about 10 to 15 m from the shore. During low tide, fish start moving away from the shore and are trapped in the net. This net is operated in the open lagoon water as well as in the tidal creeks and canals bordering the mangroves.
2. *Koduva valai* is another type of gill net used exclusively for fishing sea bass. It is about 30 m in length and 4.5 m in breadth. The mesh size is about 8 to 10 cm. It is mostly used in the lagoon, near the lagoon mouth area and along the shore bordered by the mangroves. This net is deployed in the muddy bottom with the help of wooden poles.
3. *Izhuppu valai* is a small size drag net used mainly for prawns; sometimes fish like mullets and catfish are also caught with the help of this net. This net is about 30 to 40 m in length. The mesh size is small, about 2 to 3 cm. During operation, each end of the net is held by a person and moved slowly towards each other, making a circle or the net is slowly moved towards the shore.
4. *Chippi valai* is the most commonly used gill net. This net is also used for catching a variety of small fish like *Tholli, Vellampodi, Thogaipodi* and prawns. It is about 20 m in length. The mesh size varies from 2 to 4 cm. Two types of *chippi valai viz., oonuchippi valai* and *vazhichippi valai* are used in the mangrove waters.
5. *Nanduca valai* is specially designed to catch crabs, particularly samba crab *(Scylla serrata).* It is about 8 to 10 m in length and the mesh size varies from 7 to 9 cm. It is used across the water current. It is used mostly in the mouth of the lagoon.

6. *Yendhu valai* is a scoop net used in the mangrove waters by the poor fisherfolk. This net contains a round wooden form with a handle and a net with mesh size varying from 1 to 2 cm. This net is mainly used in the estuarine regions of the rivers, tidal creeks and canals where the speed of the water current is low.

Table 3.6 Fishing and farming population of the mangrove user hamlets

Village	Fishing	Farming	Total
Karaiyur	325	0	325
Manganangkadu	105	5	110
Karisaikkadu	124	56	180
Manjavayal	196	305	501
Veerankoil	139	20	159
T. Vadakadu	0	969	969
T. Melakkadu	90	745	835
Keezhakkadu	153	423	576
Puthukottagam	20	61	81
Kovilanthoppu	156	17	173
Kamandiyadi	220	0	220
Muslim street	170	236	406
Azad Nagar	75	150	225
Maruthangavali	0	500	500
Jambuvanodai Therkku	256	0	256
Kollaikkadu	47	0	47
Chinnakollai	46	0	46
Veeranvayal	257	0	257
Thillaivilagam Therkku	295	96	391
Sengangkadu	260	47	307
Keezh Thondyakadu	233	0	233
Melathondyakadu	139	0	139
Puthukudi	80	0	80
Munangkadu	192	0	192
Alangkadu	506	109	615
Uppur	250	107	357
Total	4334	3846	8180
Percentage	53	47	100

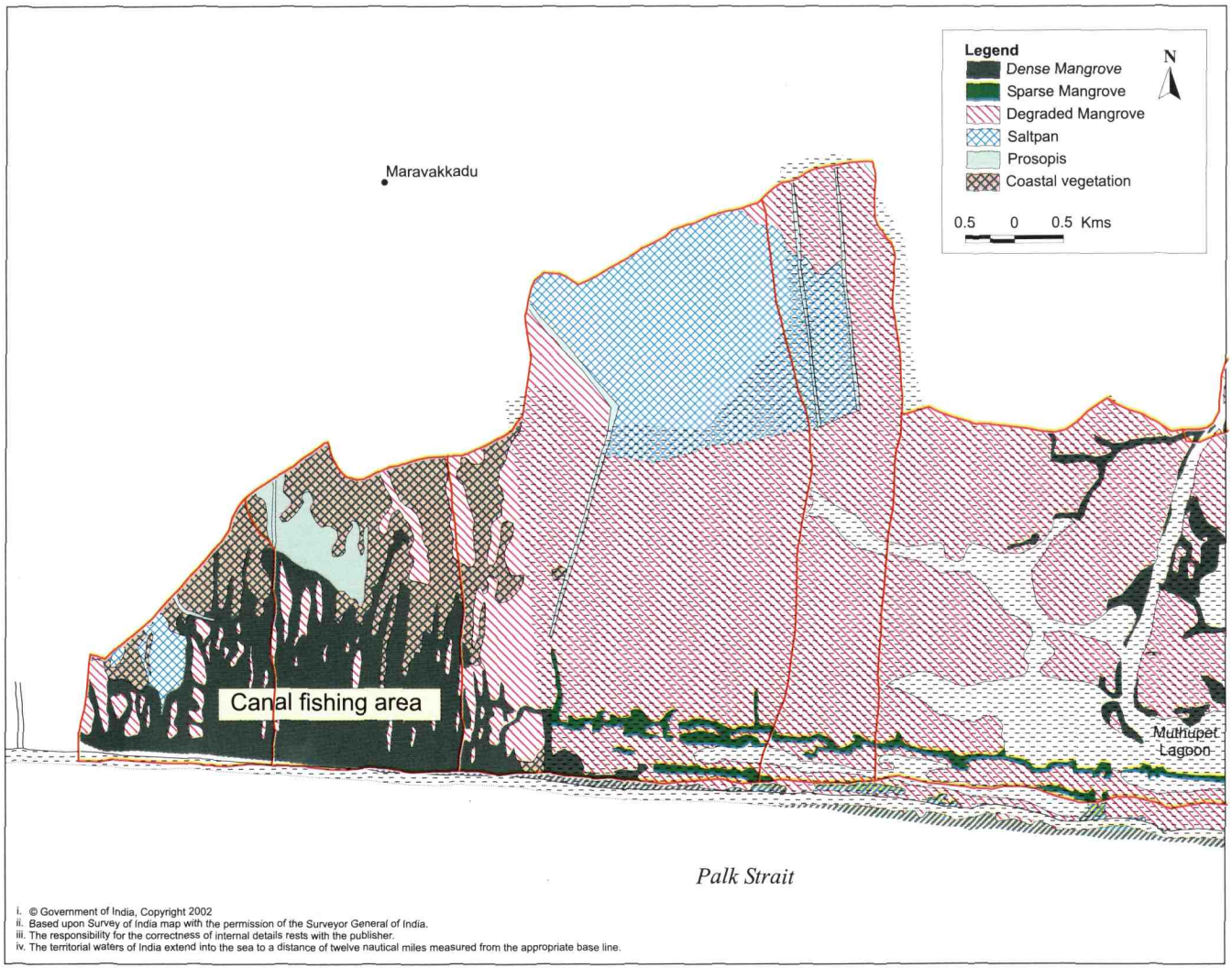


Map 3.17 Dependency on Mangrove for fishing

3.8 Restoration of degraded areas

Canal fishing - scope for restoration

In the western part of the Muthupet mangrove wetland, a traditional method of fishing called canal fishing (locally called *vaaikkal meenpidippu*) is followed (Map 3.18) which integrates fishery development with mangrove regeneration (Figure 14). In this method, canals are constructed across the mangrove wetland in the north-south direction. In the south, canals open to the Palk Strait and in the north they are closed. The length of these canals varies from 1.5 to 2 km. The upper width of these canals varies from 1.8 to 2 m whereas the lower width is about 1 to 1.2 m. The distance between the canals varies from 20 to 30 m. During the high tide, particularly during the Northeast monsoon season (October - December), when freshwater inundates the entire mangrove wetlands, large quantities of fish and prawn seedlings move into these canals. After this, the mouth of the canal is closed with a pen, which allows only water to pass through. The trapped fish and prawn are harvested periodically, as they grow. Annually prawn and fish worth Rs. 20000 to 30000 are harvested from each canal. At present 71 such canals are found in the western part of the mangrove wetland.



Map 3.18 Canal Fishing

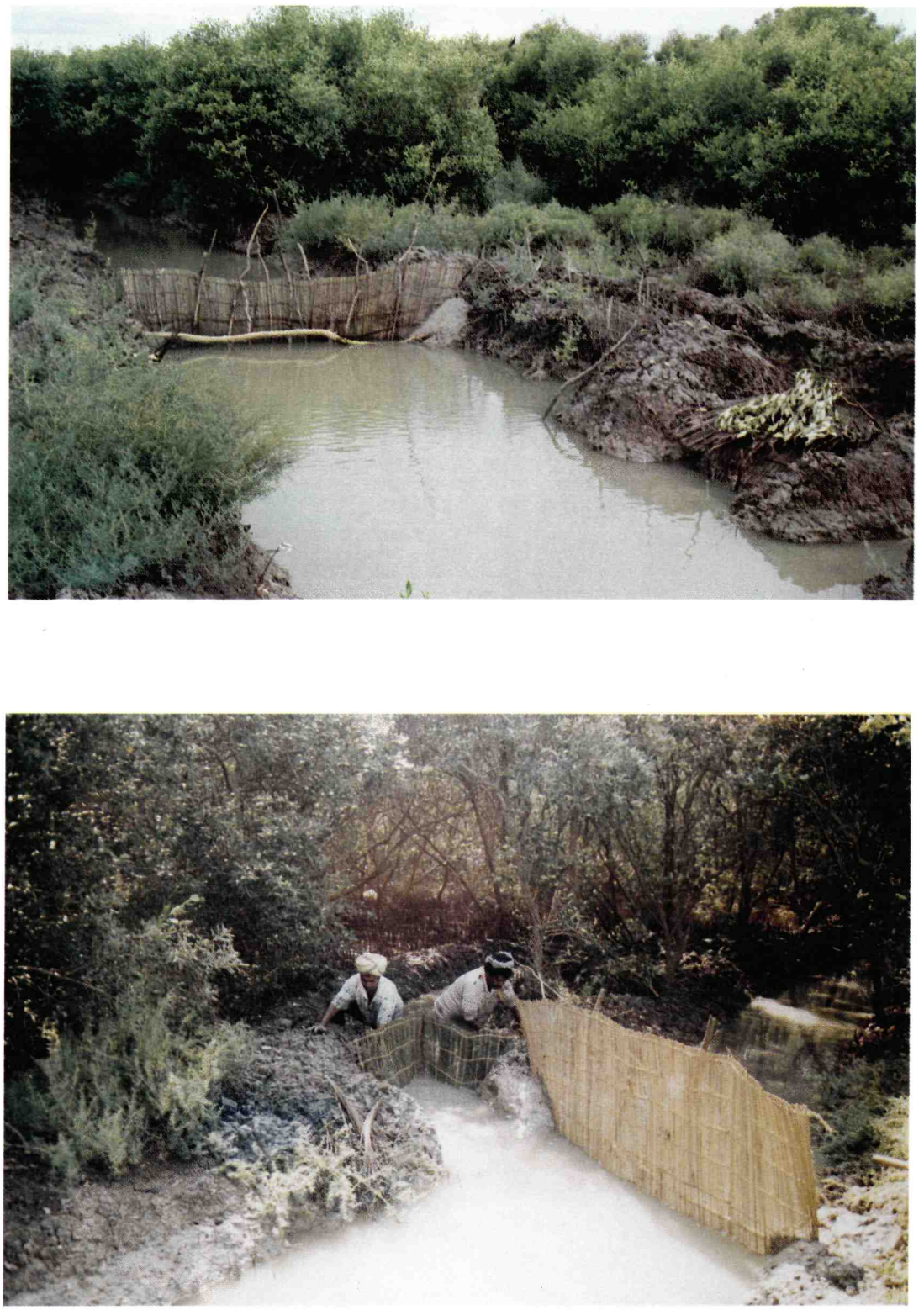


Figure 3.14 Canals constructed across the mangrove wetlands for fishing avoid stagnation of tidal water and create a favourable condition for mangrove establishment and growth

Figure 3.15 a. Desilting of the canals is one of the important tasks of mangrove management

Figure 3.15 b

Figure 3.16 Following canal fishing method, long canals are dug in the degraded area for free tidal flushing

Figure 3.17 Local communities fish in the restoration canal and to reciprocate this benefit, they maintain the canals by desilting.

It is noticed that in the entire Muthupet mangrove wetland, a large patch of healthy mangrove is present only in the area where canal fishing is practised. This is mainly due to the fact that canal fishing prevents stagnation of tidal water in the mangrove wetland during the summer season and thereby helps in maintaining a soil salinity that is suitable for mangrove regeneration and growth. Further, the free movement of water keeps the moisture level of the mangrove wetland high by which the bulk density of soil is maintained. This prevents subsidence of the sediment in the mangrove wetland. The free movement of the tidal water is maintained by desilting the canals regularly (Figures 3.15a and b). Otherwise, the fisherfolk will not be able to get a good harvest of fish in the fish trap. The siltation occurs heavily during the post-monsoon and summer months (January to July). Desilting is labourious work that has to be carried out in each and every canal. This requires lot of manpower. Therefore, the canal fishing method can be effectively utilised to restore the degraded mangrove wetland, provided periodical desilting of the canal is assured. This method of restoration will enhance ecological benefits from fishing to the mangrove-dependent communities (Figures 3.16 and 3.17) .

3.9 Joint Mangrove Management (JMM)

In order to restore the degraded mangrove forests, the Forest Department of the Tamil Nadu Government and MSSRF are implementing Joint Mangrove Management programmes with the participation of the local people. The canal fishing method is being adopted to restore degraded mangrove forests with the minor modification of feeder canals along one side of the main canal to enhance the free flow of tidal water and prevent the stagnation of saline water in the trough-shaped areas.

To start with, 4 hamlets have been selected to implement JMM activities on a demonstration scale. In each hamlet, a Village Development and Mangrove Council has been formed with representatives of the Forest Department and MSSRF. The Village Development and Mangrove Councils of three hamlets *viz.,* Veerankoil, Manganangkadu and Karisaikkadu, have started implementing restoration and other JMM activities by adopting the traditional canal fishing method. The restoration canals have been allotted to poor fisherfolk for fishing with an agreement to desilt the restoration canals periodically. Table 3.7 gives the details of the canals provided to poor fisher families and area restored.

Table. 3.7 Number of families involved in canal fishing in the newly constructed canals

Name of the hamlet	Number of Families	Number of canals allotted	Number of canals proposed	Area restored (ha)
Veerankoil	33	19	14*	100
Manganangkadu	6	4	2	100
Karisaikkadu	12	12	-	125
Mudukkukadu	4#	-	4	40

*- Proposed by Forest Department; # - To be alloted

Currently the Forest Department of the Government of Tamil Nadu is restoring vast areas of degraded mangroves with the participation of the local communities, adopting the canal fishing method as a restoration technique.

3.10 Management issues

The following are the important concerns of the local communities living around the Muthupet mangrove wetlands:

1. Reduction in freshwater: As the Muthupet mangrove wetlands are situated at the tail end of the Cauvery riverine system, fresh water reaching this region is very minimal due to the construction of many dams upstream of the Cauvery river. This affects agriculture and the nutrient and sediment transport to the mangrove environment.

2. Silt deposition in the mouth region of the lagoon in the last 20 years has caused shrinking of the lagoon, which ultimately caused the reduction in the migration of the fish, prawn and crabs and their juveniles into the mangrove wetlands.

3. Silt deposition in the lagoon: In the eastern region of the lagoon siltation is severe where the depth of the water is not even 30 cm during high tide. Due to the shallowness marine fish that seasonally migrate into the lagoon in large schools for breeding and feeding are no longer seen even near the mouth region of the lagoon.

4. Over-exploitation of the fishery resources in the nearby neritic water by trawlers: About 100 to 150 trawlers in the Palk Strait close to the mangrove forest engaged in fishing with purse seine net caused a decline in the fish catch in the mangrove waters. The fishing net deployed from the trawlers scoop all the fish, prawn and crabs including the young ones. As a result the quantity of the fish migrating into the lagoon has reduced drastically.

5. Restoration of large areas of degraded mangrove forests: It is widely accepted by the key stakeholders, Forest Department as management agency and local community as consumer of the mangrove resources, that restoration of mangrove forests will enhance the fishery potential of the region and also act as a cyclone barrier.

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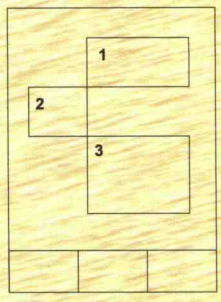

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2 - Traditional hand fishing - Pichavaram

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