PROTECTION MEASURES FOR TAMILNADU COAST

Final Report

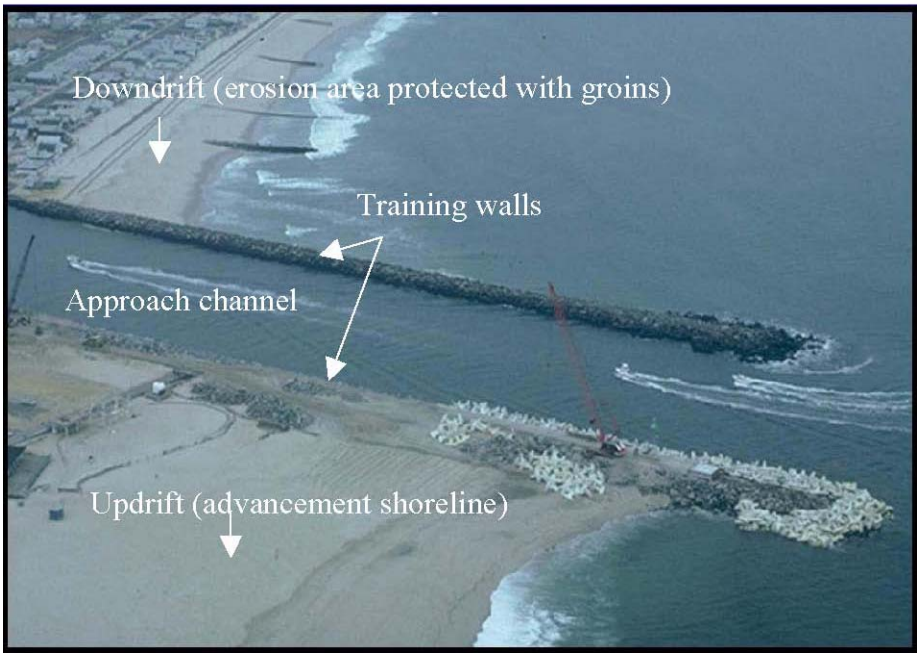
Submitted to

PUBLIC WORKS DEPARTMENT

GOVERNMENT OF TAMILNADU

By

PROF. V. SUNDAR



DEPARTMENT OF OCEAN ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY MADRAS
CHENNAI - 600 036
MARCH 2005

CONTENTS

CHAPTER - I

1. INTRODUCTION

1.1 General

Tamilnadu situated on the south east of Peninsular India is about 1,30,000 Sq.km. The length of its Coastline is about 1050 km with its significant portion on the east coast bordering Bay of Bengal. The coast line starts from Pulicat along the east coast and extends up to Erayamanthurai in Kanniyakumari District and consists of Estuaries of ecological importance, Major and Minor ports, Fishing harbours, Monuments of international heritage, Tourist locations, Pilgrimage centers, etc. The Tamilnadu state map is shown in **Fig.1.1**.

1.2 Geology of the coastline

The entire coast of Tamil Nadu consists of alluvium and beach sands overlying sedimentary formation such as laterite, limestones, clay, and stones etc. The nature of the coastal belt is as detailed in **Table.1.1**.

1.3 Wave climate

The visually observed wave data for the period April 1974 to March 1984 has been analysed to arrive at the short term statistics, the details of which are reported by Sundar(1986). The wave characteristics (wave height, its period and its direction) along the Tamilnadu coast are influenced by the prevailing seasons, viz., South West monsoon, SW (June to sept), North East monsoon, NE (Oct to Dec) and Non monsoon, NM (Jan-May). The results on the wave characteristics are accordingly derived. The annual as well as the season wise wave scatter diagram are provided in **Tables.1.2 to 1.5**. From the tables, it is seen that for the whole year, the most probable wave height ranges between 0.4m and 0.6m and the period ranges from 8s to 10s. The cumulative probability distribution of the wave climate (height, period and direction) according to the seasons are depicted in **Figs.1.2a to 1.2c**.The most probable wave height range during SW and NM Seasons is 0.4m to 0.6m, whereas, the said range for the NE season is higher to the extent of 1m to 1.2m. The most frequently occurring wave period ranges from 8 to 10 sec. The west coast is Vulnerable to both SW and NE monsoons. Although, the results on the average wave characteristics for the Tamilnadu coast are from the data collected during

1974 to 84, they would certainly be useful to describe the short term statistics which can be utilized for the prediction of sediment transport rate and its direction.

1.4 Wind

Hourly wind speed data from the Indian Meteorological Department, Govt. of India for the period 1974 to78 for Chennai harbour have been analysed by Sundar and Ananth(1988), the salient results on the season wise probability distribution of wind speed of which are provided in **Fig.1.3.** The results indicate the speed varies up to about 50 kmph and much higher when cyclone cross the coast.

1.5 Tide

The phenomenon of tide formation is due to attraction between Sun, Moon, Earth and other Celestial bodies. The average tidal range is about 1m, the effect of which, is not dominant along the Tamilnadu Coast compared to the other stretches of the coast of India.

1.6 Current

The currents off Tamilnadu coast varies up to about 1m/sec. The direction of the current varies with the seasons. The long shore current velocity which dictates the rate and direction of the littoral drift off the coast of Chennai have been calculated and found to vary upto about 0.75m/s and is in general directed towards north from Feb to September, while, during the other months the long shore current is directed towards south Sundar(2002).

1.7 Littoral drift

The wave induced sediment transport, 'littoral drift' takes place along the coast as well as normal to the shore, and however, the former mode of transport is predominant along the east coast of India in general and along the Tamilnadu coast in particular. The approximate rate of net littoral drift is $1.2*10^6$ m^3/ year along the Tamilnadu coast which is directed towards North. As we proceed northwards of Tamilnadu coast, the net drift reduces due to the interception of its movement by the breakwaters of Visakhapatnam and Paradeep ports. The said quantity is probably one of world's highest rates of sediment transport. The littoral drift can easily be calculated using empirical formulae. Some salient results on the monthly distribution of breaker angles, height and sediment transport rate along the Chennai coast have been discussed by Sundar(2002)

1.8 Occurrence of rare minerals

The coast of the Tamilnadu State contains some rare and Valuable minerals such as Illuminite, zircon, etc. These mainly occur along the Coast of Tirunelveli and Kanniyakumari district. There is also a Indian Rare earth factory at Manavalakurichi under the Control of Central Government in Kanyakumari district.

1.9 Ports and Harbours

Major ports

- Chennai
- Tuticorin
- Ennore

Minor ports

- Cuddalore
- Nagapattinam
- Valinokkam

Fishing harbours

- Chennai
- Tuticorin
- Chinnamuttam

Future projects

- Colachel
- Poompuhar fishing harbour
- Thengapattinam fishing harbour
- Veera pandi pattinam
- Rameswaram

1.10 Cyclones and storms

The coast of the state has been hit by cyclonic storms about 30 times with disastrous effects from 1900 to 2004. The districts affected were Chennai, South Arcot

district, Nagapattinam, Thanjavur, Ramanathapuram and Kanniyakumari. The storm surge ranging from 4 to 12 m have been experienced by the Tamilnadu coast.

1.11 Pilgrimage and tourist centers

- Chennai
- Mahabalipuram
- Tharangampadi
- Velankanni
- Rameswaram
- Thiruchendur
- Uvari
- Kanniyakumari

1.12 Erosion and accretion along the Tamilnadu coast

A coast is said to be eroding when the loss of sediments exceed the supply. Accretion is the process by which there is deposition of sediments. The shoreline is observed to be shifting land ward or towards the sea depending on a number of parameters like, prevailing wave climate, geomorphology, sediment characteristics, presence of natural or man made obstructions, inlets, presence of outcrops, promontories or headlands. The behaviour of the shoreline are mostly site specific calling for a critical examination of a host of parameters. The P.W.D (2002) based on the continuous monitoring of the levels of the crest of berm have found that the stretch of the coast north of Chennai harbour is being eroded at an average rate of about 6.5m/year. The details of these results are reported in **Table.1.6**.

1.13 Nature of the coastline of Tamilnadu

There are more than 40 rivers that drain into the sea off the Tamilnadu coast. The nature of coastline is generally classified as below. (**Fig. 1.4**)

- Coastline from Pulicat to Vedaranyam-Alluvial
- Coastline from Vedaranyam to Mandapam-Deltaic
- Coastline from Mandapam to Kanniyakumari-Sand Dunes
- Coastline from Kanniyakumari to Nagerkoil Barrier Beach

1.14 Strategy for coastal protection

Whenever erosion occurs, there are some guidelines to be followed. Coping erosion along a sandy coast is different from coping erosion along muddy coast, mangrove coast, and coast with clay or rock. The following are the suggested procedures:

- Verify if the erosion is temporary due to seasonal effect.
- Work out the cost of different alternatives. The costs should include not only maintenance, construction etc. but also in terms of loss of cultural values, impact on safety and the needs of the local public, etc.
- Fund/resources to combat erosion in a sustainable way.

Only after ascertaining the above basic resources and needs, proceed as follows.

- If fund / resources are available, then combat erosion permanently by proper planning.
- If enough funds or resources are unavailable, careful planning of temporary measures is essential.

1.15 Requirements for a detailed evaluation for protection measures

- Collection of seasonal field data and analyse the same critically
- Use old and new satellite imageries to assess the shoreline behaviour
- Use of G.I.S as a tool to map the coastal region of Tamilnadu. This would help in the planning process of coastal protection.
- A field visit along the coast.
- If erosion is observed continuously over a number of years, it is chronic erosion
- If a coast is stable over a long period, but subjected to occasional severe erosion (due to cyclone etc) and then recovers, it is called acute erosion.
- The effect of the recent tsunami on the shoreline should also be taken into account while detail planning is taken up. This can be accomplished using the techniques of remote sensing and G.I.S.

1.16 Coastal Protection Options

Shorelines are constantly being changed by the interaction between wind, water and land. To protect the coast and properties, there are various methods which are discussed in **Table 1. 7**.

1.17 Artificial beach nourishment

Of all the above measures, the method of artificial nourishment deserves special mention due to the following merits:-

- It satisfies the basic need of the material demand and has all the characteristics of a natural beach.
- It increases the stability of not only the beach under protection but also the adjacent shore due to the supply of materials through longshore drift.
- More economical than massive structures as the materials for nourishment may be taken from offshore area and
- Development of the technique of dredging and sand pumping have popularised this method to effect economy.
- Sand dredged from a borrow site is deposited on the eroding shoreline

Dutch design method

- Perform coastal measurements (preferably for at least 10 years)
- Calculate the "loss of sand" in m^3/year per coastal section
- Add 40 % loss
- Multiply this quantity with a convenient lifetime (for example five years)
- Put this quantity somewhere on the beach between the low-water-minus- 1-meter line and the dune foot.

This method is simple and straightforward. It does not require mathematical models and wave (or wind) data, but need good quality measurements.

Placement of sand

Usually the dredged sand is dumped close inshore using split hopper dredger or pumping directly onto the beach using floating and/or submerged pipeline.

Borrow site

Sources of sand for beach nourishment can include upland sand deposits, estuaries, lagoons, inlets, sandy shoals dredged to clear channels for navigation and deposits in the near shore area. The most common source of sand used in nourishment projects is near shore deposits.

Drawbacks

- Once placed on the beach, the quality of sand is often sub-standard or even darker in color, despite assurances otherwise.
- Quality sand sources are becoming more difficult to locate. The problem will only get worse as sources are depleted and quality sand even more expensive.
- Dredging of sand often sucks sea turtles directly off the sea floor, killing them.
- Beach nourishment is a sudden, disruptive and unnatural process.
- It is expensive.

In the Indian context, one successful project on artificial beach nourishment has the coast north of the harbour of Pondichery.

1.18 Hard solution

- **General**

Unfortunately sustainable soft solution is always not possible. In such cases, the choice is either to face the problems or to shift them elsewhere, sometimes if there is a very important land to be protected and if further down the coast there are no important features, the following hard solutions can be used. The above stated shifting the zones of problems can be overcome if the protection measures are carefully planned out.

- **Seawalls and Bulkheads**

Seawalls and Bulkheads are structures placed parallel or nearly parallel to the shoreline to separate the land from water area. The primary purpose of a bulkhead is to retain or prevent sliding of the land, with a secondary purpose of affording protection to the back shore against damage by wave action. The most common and widespread coastal engineering tool for the protection of shoreline is the seawall as a hard measure. Varieties of seawalls / dikes constructed world wide is shown in **fig. 1.5.** A typical concrete seawall cross-section is shown in **fig. 1.6.** A view of an existing concrete seawall is shown in **photo.1.1. Seawall protection is for all practical purposes an irreversible act because the beach in front of it is often removed.** The seawall will eventually have to be rehabilitated in constant intervals with bigger size stones as can be seen in **photo.1.2.** A seawall would not be more effective on coasts that experience predominant littoral drift, like the east coast of India. For example, the seawall along north of Chennai, Visakhapatnam and Paradeep ports have been suffering damages continuously. A strong

toe for seawall is very essential as in the case of the seawall for a particular stretch, north of Chennai harbour shown in **photo.1.3**. In locations, where, large size natural rocks is scanty, gabions (wire net filled with stones of smaller size) as shown in **photo.1.4** can be adopted. At locations of abundance of sand (near river mouths which may be dredged as a part of river training works) Geo-bags or Geo-tubes can be adopted as can be seen in **photo. 1.5**.

- **Single long groin**

When the long shore sediment transport threatens to cause a problem such as siltation of harbour entrance etc., a long groin can be constructed just slightly up drift from the harbour entrance or river mouth. Though, it prevents sediment movement, it can cause erosion on the other side. The different types of configurations of groins are shown in **Fig.1.7**.

- **Series of groins**

Another way of using groins is to build a series of small groins (groin field) at shorter intervals along the affected coast. This will tend to stabilize the entire coast by keeping the sand trapped between them. Typical shoreline changes due to a single groin and that due to a groin field are projected in **Figs.1.8 and 1.9** respectively. The oldest groin in the world in Vissingen, The Netherlands is shown in **photo.1.6**. The effect of the groin field as a protection measure for the Island of Nordeney, Germany is projected in **photo.1.7**, while, that of a T-groin field protecting the palm beach area of Florida, USA is shown in **photo.1.8**. Sometimes unplanned groin works may still be an effective protection measure as in the case of the coast of Cyprus depicted in **photo.1.9**. Groin fields as a protection measure for Royapuram, Chennai and Kanyakumari district are shown in **photos 1.10 and 1.11** respectively.

- **Off shore Detached Breakwaters**

Offshore detached breakwaters are structures designed to protect the beach by dissipating the energy of the incoming waves. They restrict onshore and offshore transport of sand. Typical shoreline changes due to a single offshore breakwater and that due to a series of offshore detached breakwaters are projected in **Figs. 1.10 and 1.11** respectively. Although, this measure is the most effective compared to all other hard

measures, as it is quite expensive and difficult to construct requiring special construction equipments, further discussion on this measure is not presented.

1.19 Plantations

The roots and stems of plants are natural traps for sand particles that would otherwise be carried away by wind, currents and waves. A flat beach is more favourable for such plantation. In addition marsh vegetation acts as a buffer against wave action and tsunami to some extent. **Vegetation** as a protection can both reduce loads and increase strength. Vegetation has a relatively large resistance to waves and currents, thus reducing the loads. Roots can increase the strength by protecting the grains on a micro scale or by reinforcing them. **Fig1.12** shows strength of vegetation with wave load. The outside plants are "front soldiers" and have to withstand a higher load than the inside plants. At the front, due to the high velocities, scour can also occur if the roots are not able to retain the soil. The effect can be that the outside plants are damaged or disappear. As long as the number of soldiers is large enough, the battle can still be won. Vegetation also influences the resistance against sliding. The roots clearly armour the soil, see **fig.1.13** from Schiereck, 2001.

Mangrove forests are the natural vegetation of many tropical coasts and tidal inlets; they form a highly productive ecosystem, a nursery for many marine species. Mangroves are essentially the root systems of trees and shrubs which thrive in the shallows of salt water areas (**photo. 1.12**). They provide an excellent safe habitat for small marine creatures.

Mangrove trees miraculously thrive in very dynamic circumstances. They can cope with salt water where as most other plants cannot. Seedlings have little opportunity to settle, so mangroves are viviparous, giving birth to an almost complete tree in a capsule that can travel with the tide and can turn into an upright standing young tree within a few days.

1.20 River mouths Along Tamilnadu coast

There are 46 rivers draining into the sea along the coast of Tamilnadu. Of these, the following are the important ones, which need attention are given below.

Pulicat

This is one of the ecologically sensitive estuary and the second largest in India after Chilika lake in Orissa and is notified in RAMSAR CONVENTION. This place was famous for its fish and prawn catch and it was the main trade for the village people here.

But due to closure of its mouth, the ecology got disturbed and it needs immediate attention.

Ennore

This is the estuary lying north of Chennai along the mouth of Kosasthalayar. The mouth is completely choked due to construction of Ennore port and also polluted due to discharge from thermal plants. Suitable river training measures have to be studied and remedial measures to be taken without tampering the ecology of the area.

Cooum

This estuary is situated south of Chennai harbour. Once upon a time it was a breeding ground for migratory birds. But due to low inflow and construction of harbour it has been choked and it has also become a drainage carrier. At present one groin is constructed on the south side of the mouth. This has to be extended further with a higher crest elevation and one more groin is to be constructed on the northern side.

Adayar

This lies along Bay of Bengal and it was a famous sanctuary for pelicans, turtles etc. Now due to meager flow the mouth is partially closed. Efforts are on now to dredge the river. Apart from dredging the river mouth is to be trained, by a straight cut. Some adhoc measures have been taken to protect the hamlets near the mouth.

Vellar

This is situated along Bay of Bengal near Cuddalore. The mouth is open during Northest monsoon and gets closed during the rest of period. This in turn poses problem to fishermen as they are not able to get sufficient draft. Suitable training works are to be planned.

Vellaiyar

This lies in Nagapattinam district and the famous Velankanni shrine is situated by the side of river mouth. Initially there was heavy erosion along north of river mouth.

Punnakayal

This is the estuary of Tamaraparani situated along Bay of Bengal near Thiruchendur. The closure of the mouth deprives the fisherman performing their fishing operation. This area is referred for study to Institute of Hydraulics and Hydrology, Poondi by the Fisheries Department.

Thengapattinam

This is situated along west coast of Arabian sea and the river Pazhayar of Kodayar system meets Arabian Sea. It is proposed to construct a Fishing Harbour at the mouth and model studies have been completed and report sent to Fisheries Department.

1.21 Objectives of the present study

The objectives of the present project for Tamilnadu coast will be as follows

- Identification of villages affected by inundation due to the recent tsunami
- Identification of the stretch of the coast subjected to continuous vulnerable erosion
- To propose suitable anti erosion works by taking into consideration the attack due to tsunami
- Where ever proper river training works is essential may be included

The detailed design of the anti-sea erosion works for the coast said above will not be covered in this project. **After the present project report is submitted by the IIT Madras, PWD will take necessary steps for the execution of the remedial measures after carrying out detailed numerical and physical model studies.**

1.22 Identification of vulnerable areas along the Tamilnadu coast

In order to accomplish the objectives set in the study, the discussion is based on the three regions of PWD, Government of Tamilnadu. These regions are Chennai, Trichy and Madurai, the problem, suggested remedial measures are accordingly reported in the subsequent chapters.

1.3 References

Schiereck G.J., (2001), "Introduction to bed, bank and shore protection", Delft University press, Postbus 98, 2600 MG Delft. ISBN 90-47-1683-8.

Sundar V., (1986), " Wave Characteristics off the South East coast of India", Ocean Engineering, Vol. 13. No. 4, pp. 327-338.

Sundar V., Ananth P.N., (1986), " Wind climate for Madras Harbour, India", Jr. of wind Engineering and Industrial Aerodynamics,31, pp.322-333.

----------(2002), "History of Tamilnadu coastline", IHH. Report No. 20/2002.

Table.1.1. Nature of Coast of Tamilnadu

Chennai to Marakkanam	Crystalline rocks overlaid by sedimentary and alluvial formation
Marakkanam to Coleroon mouth	Sand stone, shells, lime stone and clays
Coleroon to Ramanathapuram	Alluvial formation of beach sands and sand dunes that rest on crystalline rocks
Ramanathapuram to Kannyakumari	Alluvial formation of beach sands and sand dunes resting on crystalline rocks
Kannyakumari to Kollengode	Sand and rock

Table 1.2. Percentage Frequency of Occurrence of Wave Heights And Wave Periods Off Madras During April 1974 To March 1984

Wave height groups in (m)	**Wave period groups in sec**						
	4-6	**6-8**	**8-10**	**10-12**	**12-14**	**14-16**	**Total**
0.4-0.6	----	0.79	9.71	12.97	3.79	0.11	27.37
0.6-0.8	----	0.86	10.12	7.91	0.86	----	19.75
0.8-1.0	----	0.22	5.74	4.09	0.22	----	10.27
1.0-1.2	----	2.55	13.80	5.81	0.86	----	23.02
1.2-1.4	----	1.50	3.56	2.47	0.11	----	7.64
1.4-1.6	----	2.32	4.84	0.94	0.07	----	8.17
1.6-1.8	----	0.52	0.41	0.34	----	----	1.27
1.8-2.0	----	0.30	0.26	0.45	0.04	----	1.05
2.0-2.2	0.07	0.26	0.49	0.22	----	----	1.05
2.2-2.4	0.04	0.04	----	----	----	----	0.08
2.4-2.6	----	0.15	0.15	----	----	----	0.30
Total	0.11	9.51	49.08	35.20	5.95	0.11	100

Table 1.3. Percentage Frequency Of Occurrence Of Wave Heights And Wave Periods Off Madras During South West Monsoon

Wave height groups in (m)	Wave period groups in sec					
	6-8	**8-10**	**10-12**	**12-14**	**14-16**	**Total**
0.4-0.6	0.11	10.13	13.29	8.06	0.22	31.81
0.6-0.8	0.44	9.91	8.39	1.74	----	20.48
0.8-1.0	----	6.54	7.08	0.33	----	13.95
1.0-1.2	0.98	14.38	6.75	1.09	----	23.20
1.2-1.4	0.65	3.38	1.53	----	----	5.56
1.4-1.6	0.65	2.61	0.65	0.11	----	4.02
1.6-1.8	0.22	----	0.22	----	----	0.44
1.8-2.0	----	----	----	----	----	----
2.0-2.2	----	0.33	0.22	----	----	0.55
Total	3.05	47.28	38.13	11.33	0.22	100

Table 1.4. Percentage Frequency of Occurrence of Wave Heights and Wave Periods Off Madras During North East Monsoon

Wave height groups in (m)	**Wave period groups in sec**					
	4-6	**6-8**	**8-10**	**10-12**	**12-14**	**Total**
0.4-0.6	----	0.15	3.80	10.38	1.17	27.37
0.6-0.8	----	0.44	6.43	7.31	0.59	19.75
0.8-1.0	----	----	4.82	1.46	0.51	10.27
1.0-1.2	----	3.80	15.35	4.09	0.59	23.02
1.2-1.4	----	2.34	4.68	4.09	----	7.64
1.4-1.6	----	4.97	9.94	2.05	0.15	8.17
1.6-1.8	----	1.32	1.61	1.02	----	1.27
1.8-2.0	----	0.59	0.88	1.46	0.15	1.05
2.0-2.2	0.29	1.02	1.02	0.44	----	1.05
2.2-2.4	0.15	0.15	----	----	----	0.08
2.4-2.6	----	0.59	0.59	----	----	0.30
Total	0.44	15.37	49.12	32.3	2.8	100

Table 1.5. Percentage Frequency of Occurrence of Wave Heights and Wave Periods Off Madras During Non - Monsoon

Wave height groups in (m)	Wave period groups in sec					
	6-8	8-10	10-12	12-14	14-16	Total
0.4-0.6	1.78	13.15	14.37	1.78	0.09	31.17
0.6-0.8	1.50	12.68	7.89	0.28	----	22.35
0.8-1.0	0.56	5.63	3.19	0.19	----	9.57
1.0-1.2	3.10	12.30	6.10	0.85	----	22.35
1.2-1.4	1.69	3.0	2.25	0.28	----	7.22
1.4-1.6	2.07	3.47	0.47	----	----	6.01
1.6-1.8	0.28	----	----	----	----	0.28
1.8-2.0	0.38	0.09	0.19	----	----	0.66
2.0-2.2	----	0.28	0.09	----	----	0.37
Total	11.36	50.60	34.55	3.38	0.09	100

Table 1.6 Rate of Erosion along the Tamilnadu Coast (PWD, Tamilnadu, 2002)

Accretion Erosion

Sl.No.	Location	Length in m	Accretion/ Erosion	Rate in m/year
1	Pulicate	0.71		3.20
2	Ennore	3.27		1.30
3	Royapuram	5.38		6.60
4	Marina	2.97		1.70
5	Foreshore	2.3		1.09
6	Elliot/Astalakshmi temple site	2.08		1.28
7	Kanathur	0.24		1.4
8	Kovalam	3.15		0.81
9	Mahabalipuram	5.45		.25
10	Piondicherry	1.19		0.15
11	Cuddalore(North)	1.538		8.00
11a	Cuddalore (south)	0.483		2.98
12	Poombuhar	1.905		0.65
13	Tranquebar	.76		1.80
14	Nagapattinam	4.27		0.11

Sl.No.	Location	Length in m	Accretion/ Erosion	Rate in m/year
15	Point Calimere	0.966		3.40
16	Ammapattinam	3.6		0.72
17	Keelakarai	2.9		0.29
18	Mandapam	2.19		0.25
19	Rameswaram	3.3		0.06
20	Tiruchendur	1.53		0.33
21	Manappadu	1.6		1.10
22	Uvari	2.6		0.86
23	Kanyakumari	0.7		1.74
24	Manakkudi	3.65		0.57
25	Pallam	2.6		0.93
26	Muttom	3.0		0.17
27	Manavalakurichi	3.5		0.60
28	Colachel	1.75		1.20
29	Midalam	2.5		0.84

Table 1.7. Remedial Measures for Coastal Erosion

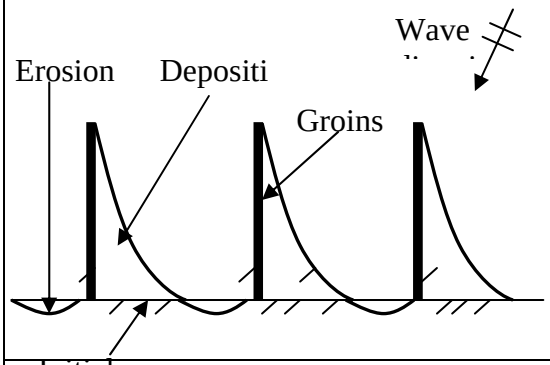
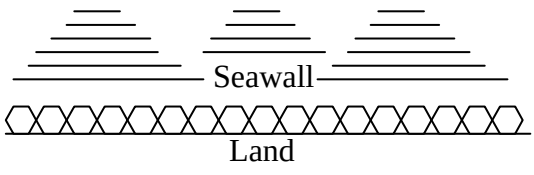
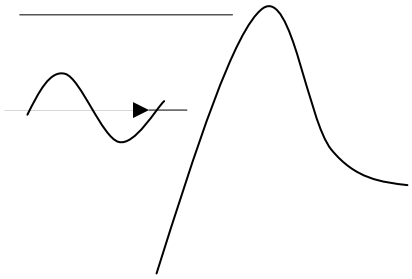
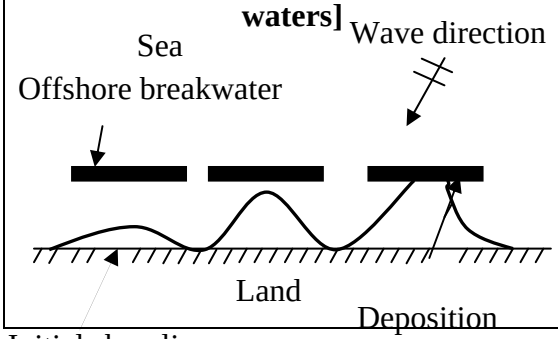
HARD MEASURES	SOFT MEASURES
Normal to the shoreline [groins] 	Replenishment of coast with sand. At the landward side of the dune[A] At the seaward side of the dune, landward of the dune base [B] At the seaward side of the dune, seaward of the dune base [C]
Parallel to the shoretline on shore [seawalls] 	
Parallel to the shore[offshore break waters] 	**Bio-Shields**

Photo. 1.1 View of a typical concrete seawall

Photo. 1.2. Seawall beyond Ernavur experiencing toe erosion

Photo. 1.3 Seawall with toe protection north of Ernavur

Photo 1.4 Use of Gabions

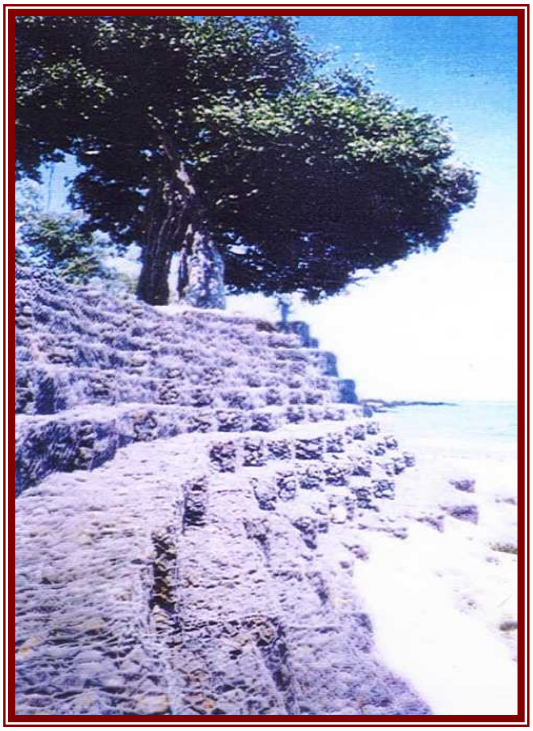


Photo. 1.5 Use of Geo-tubes to protect Island of Sylt, Germany

Photo.1.6 Oldest groins (1503),Vvissingen, Netherlands

Photo.1.7 Groins field protecting the Island of Nordeney, Germany

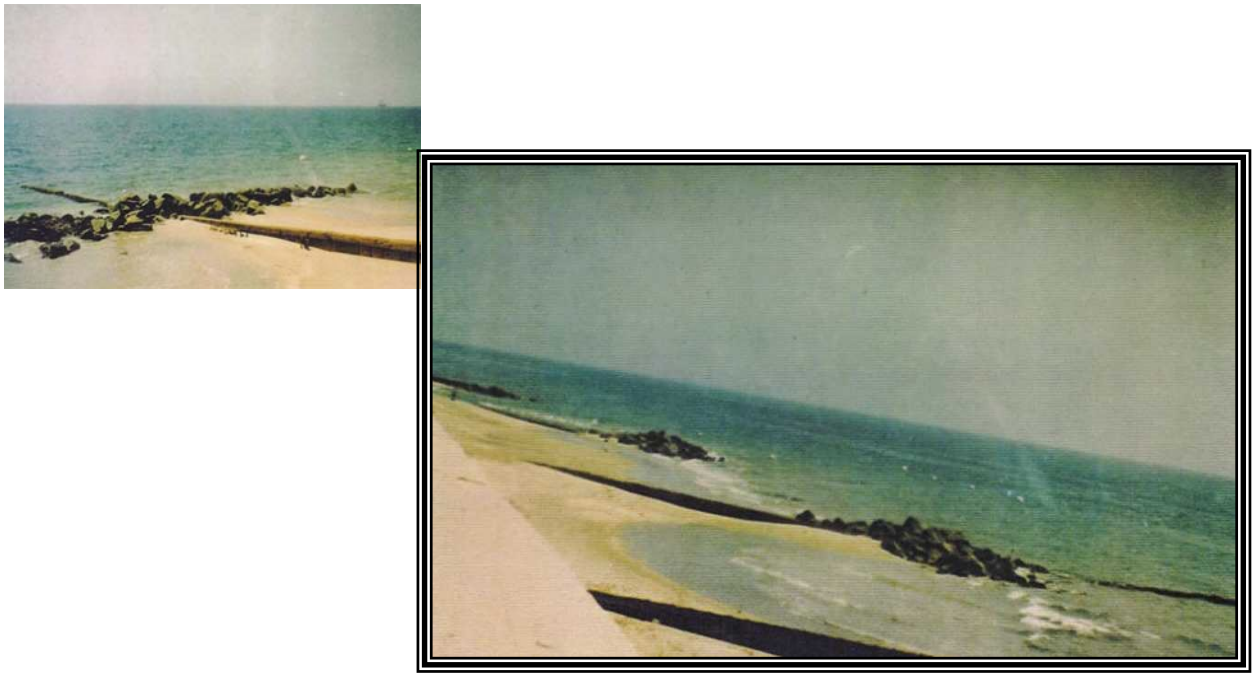


Photo. 1.8 T-Groin field protecting the coast of Florida

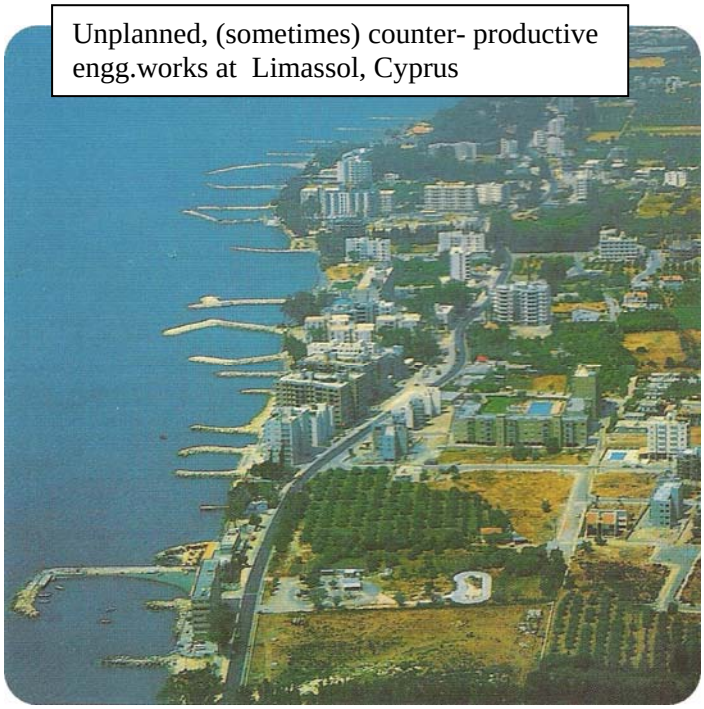


Photo. 1.9 Groins as protection measures

Photo. 1.10. Effect of Groin field in winning the beach (Royapuram, Chennai)

Photo.1.11. Effect of groins as an effective coastal protection measure (Kanyakumari District)

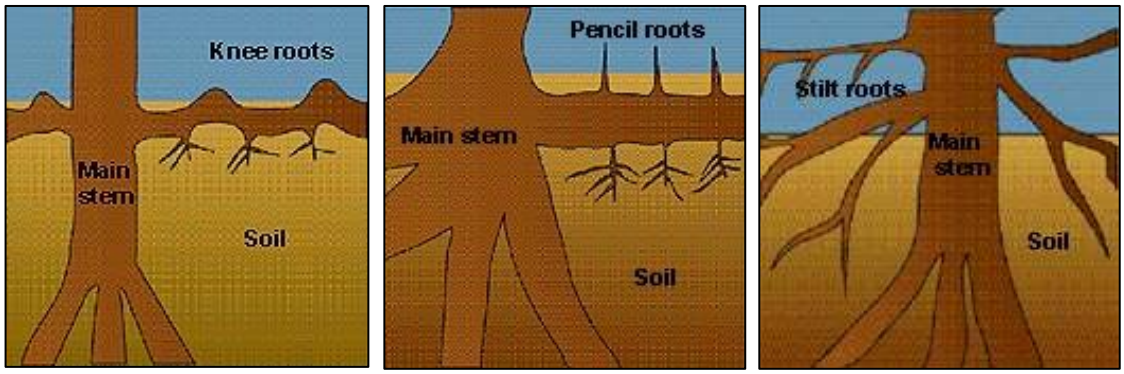


Photo. 1.12 Different root systems of Mangroves that offer resistance to scour.

Fig. 1.1 Tamilnadu State Map

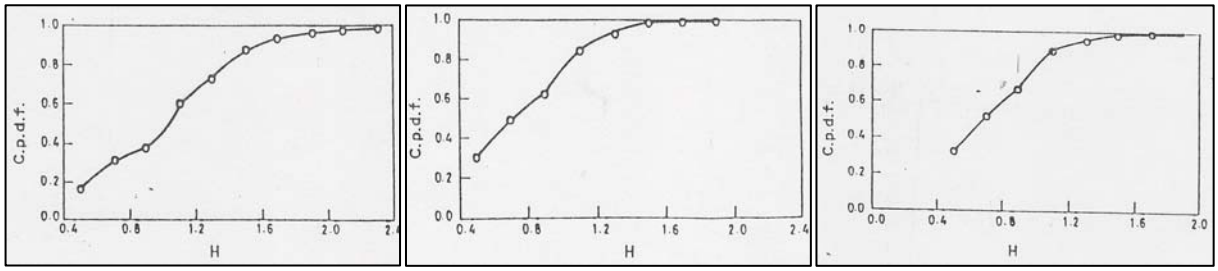


Fig. 1.2 a. Distribution of wave heights

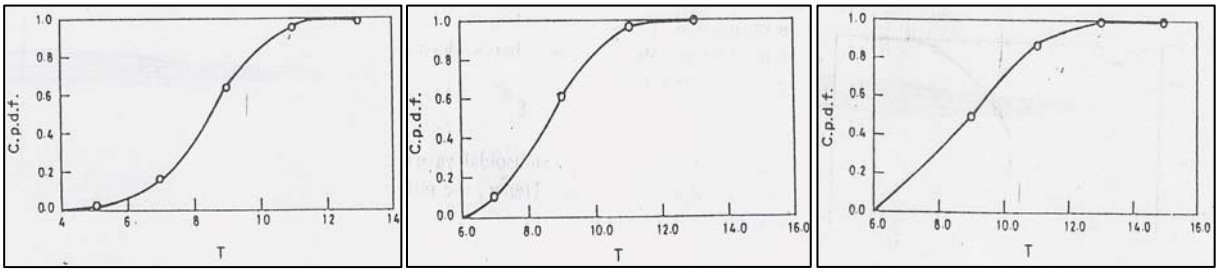


Fig. 1.2 b. Distribution of wave periods

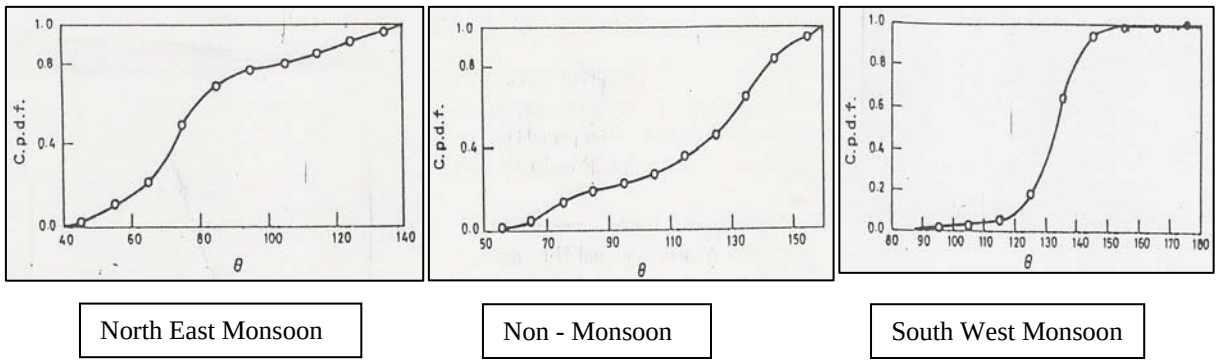


Fig. 1.2 c. Distribution of wave directions

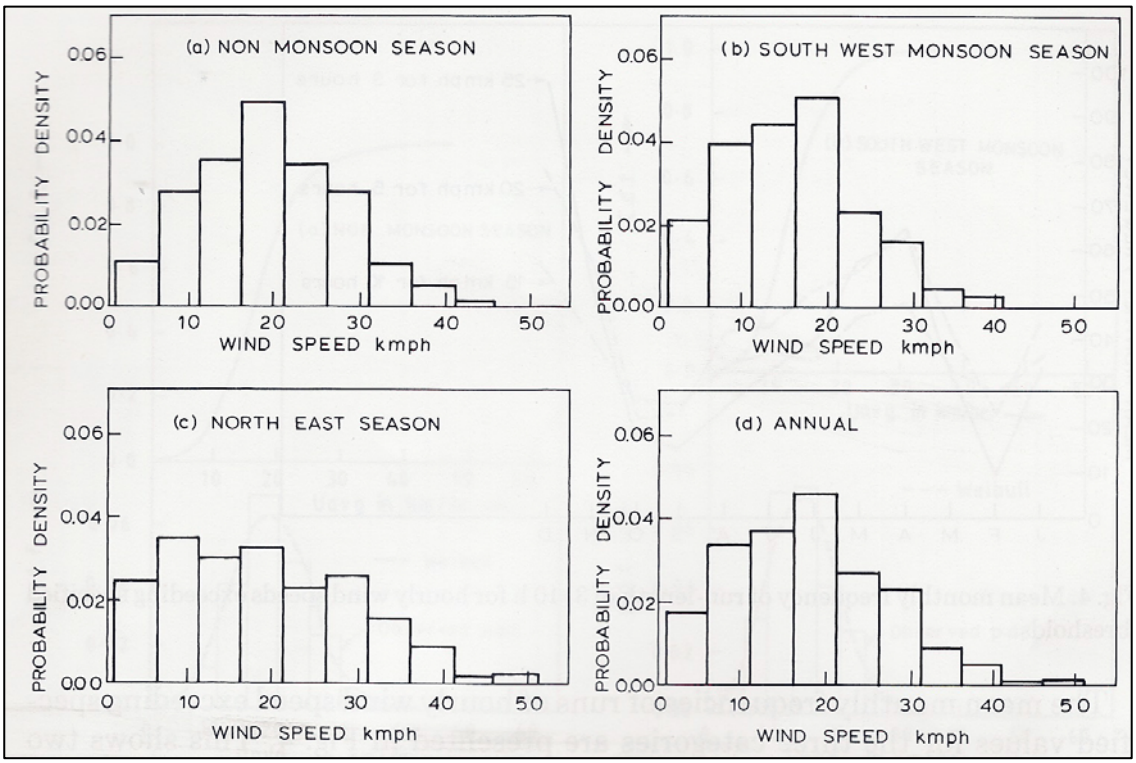


Fig. 1. 3 Seasonal and annual distribution of hourly wind speeds for Chennai Harbor

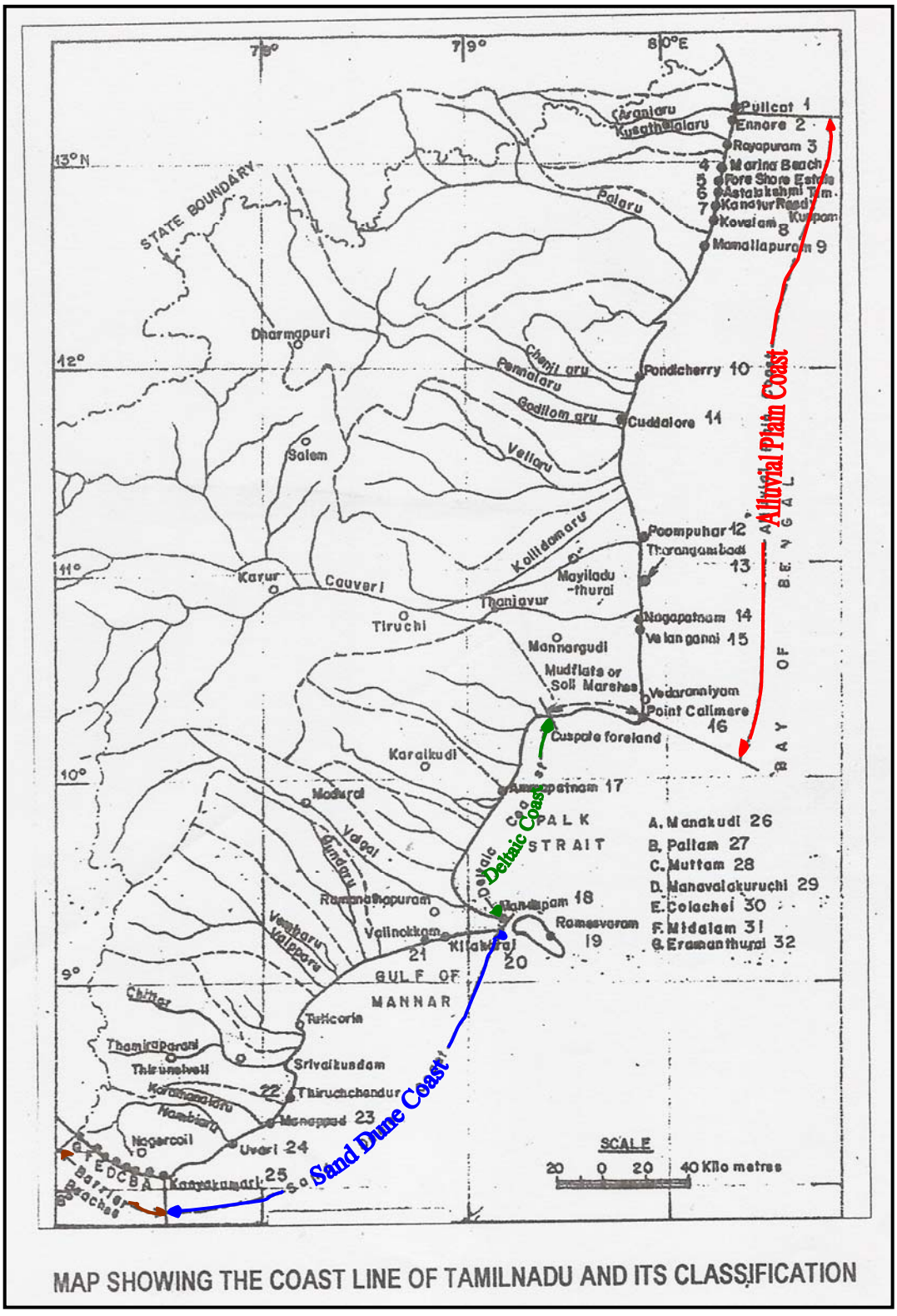


Fig. 1.4 Map showing the coastline of Tamilnadu and its classification

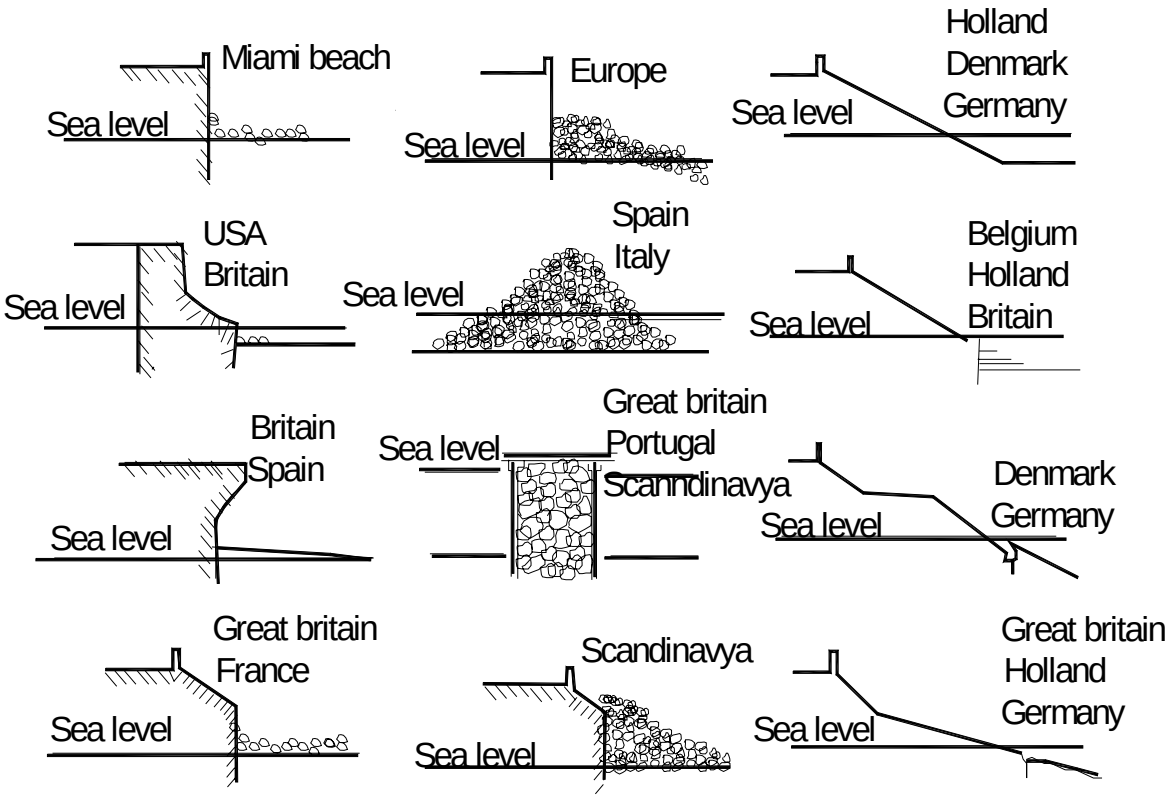


Fig. 1.5 Varieties of seawalls / Dikes

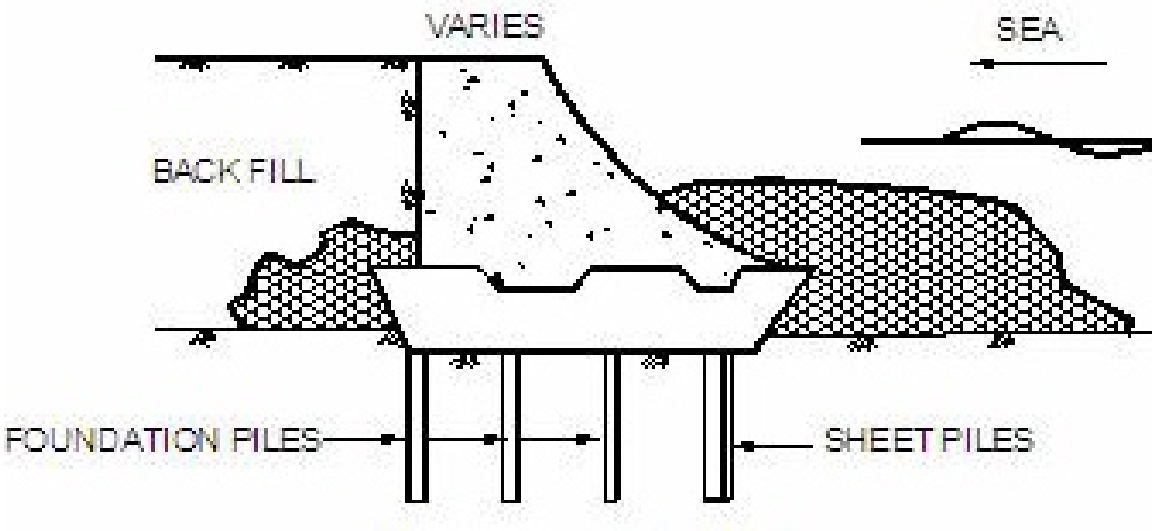
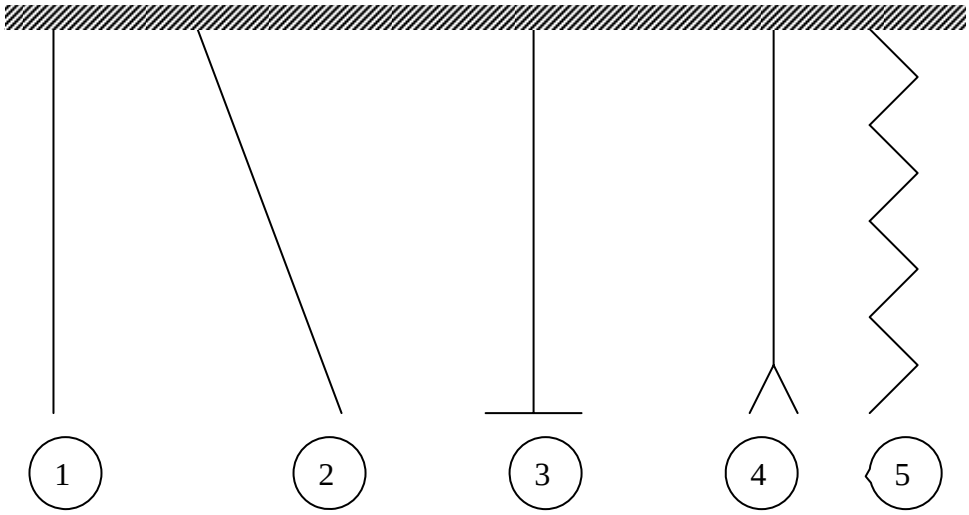


Fig. 1.6 Typical cross section and photo of a concrete seawall



1: Straight groin, 2 : Inclined, 3: T – shaped, 4: Y-shaped, 5: Zig - Zag

Fig. 1.7 Different configurations of groins

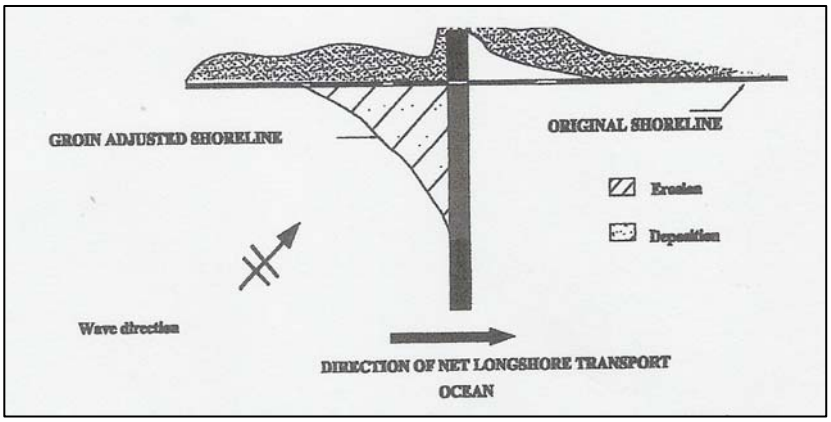


Fig. 1.8 Shoreline Configuration for Single Groin

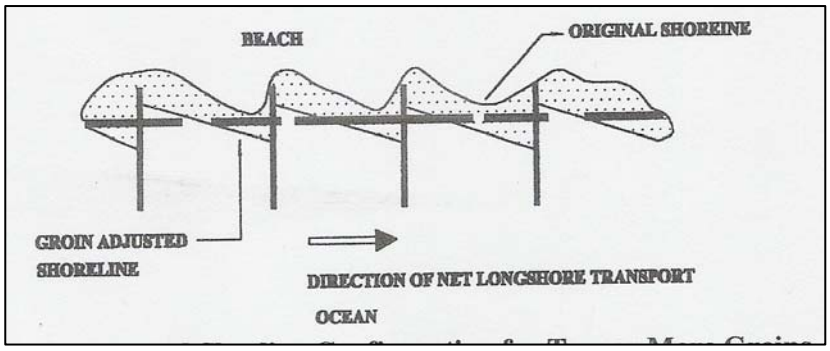


Fig. 1.9 Shoreline configurations for two or more Groins

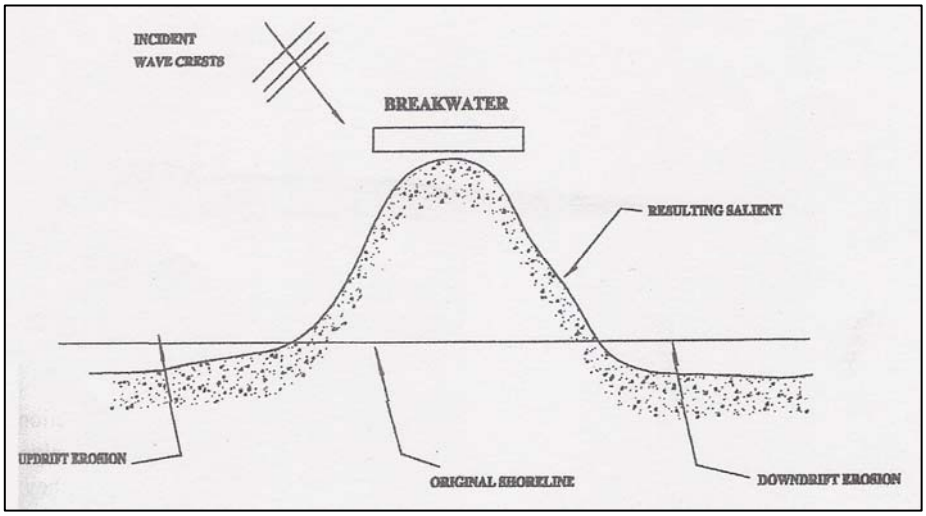


Fig. 1.10 Shoreline Evolution due to the presence of an Offshore Breakwater

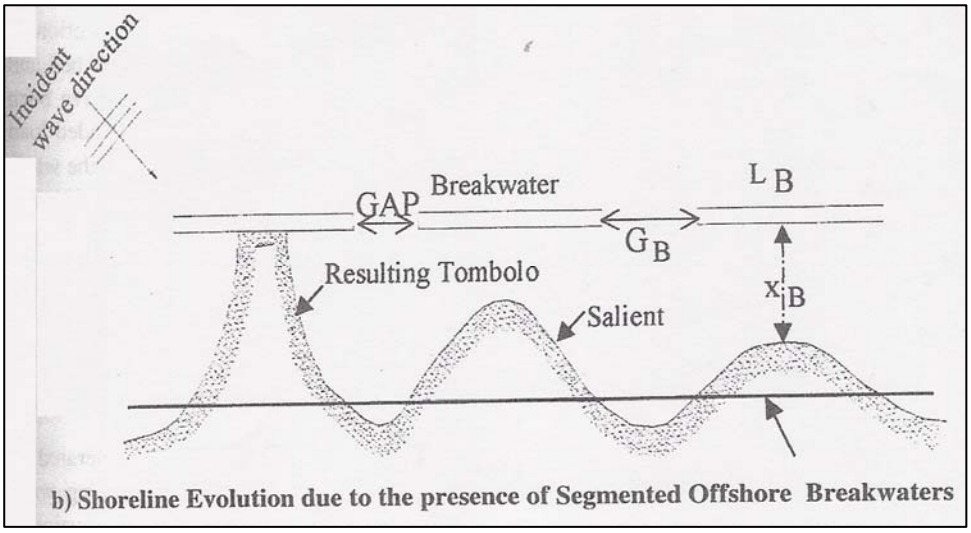


Fig. 1.11 Shoreline Evolution due to the presence of segmented Offshore Breakwaters

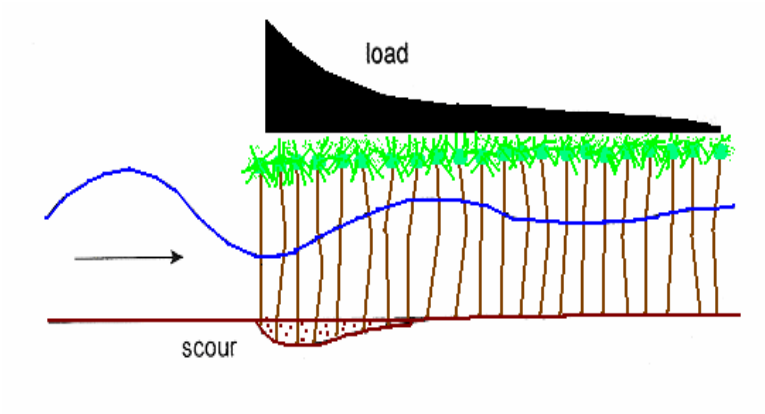
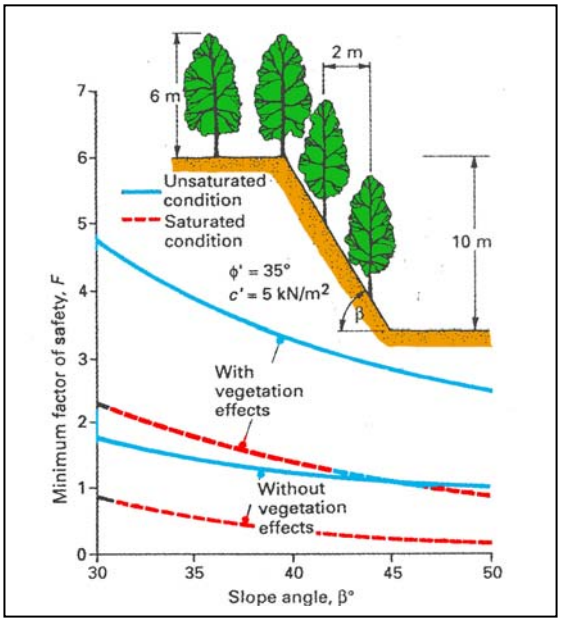


Fig.1.12 Load and Strength



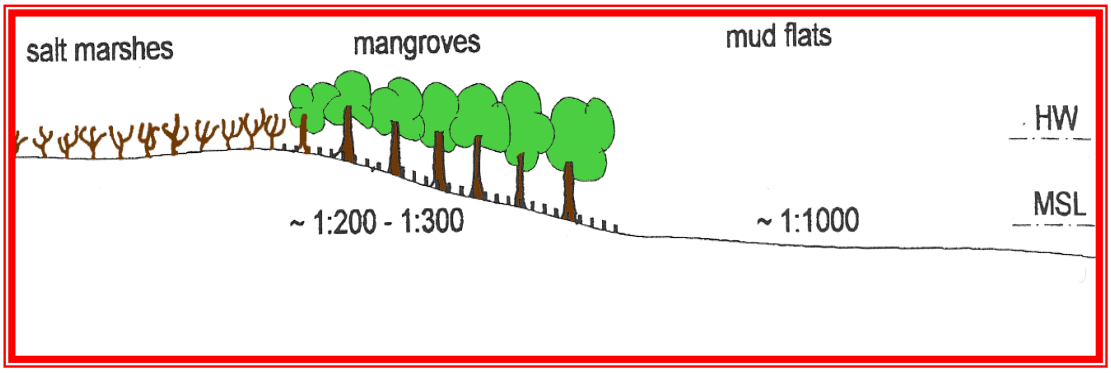


Fig. 1.13 Roots act as armour for the stem and reduces the scour Schiereck (2001)

CHAPTER 2
PROTECTION MEASURES FOR CHENNAI REGION

2.0 General

In order to detect the vulnerable coastal erosion areas along the Tamilnadu coast and to suggest the appropriate mitigation measures, Prof. V. Sundar of IITMadras accompanied by Mr. R.M. Palaniappan (AEE), Mr. Muralidharan (AE), Mr. P.K. Suresh (AD) of PWD, visited the coast with in the Chennai region on 16th January and 5th February, 2005. Mr. Subbaiah Boopandi (SE) joined the visiting team for the coast of Cuddalore. The details of the site visit along the coast of Chennai region are discussed in this chapter.

2.1 Kaatupallikuppam (N 13°18'24.4" E 80°20'48.7")

This village is situated on the north of Ennore Port and south of Pulicat lake. During tsunami, water wall of height 3 m has penetrated about 300 m into the coast. A view of the present beach at Kaatupallikuppam is shown in **photo 2.1.** The stretch of the coast north of ennore along with the location of this village is shown in **fig.2.1**. As the Ennore port breakwaters are intercepting the net northerly littoral drift, there is slight erosion at this village. This erosion may be magnified if not tackled. **Hence, soft measures like plantations and sand nourishment (dredged spoil from Ennore port) are recommended**.

2.2 Ennore Creek (N 13.13'56.9" E 80.19'51.7")

The river Kosasthalayar discharges into the Bay of Bengal at Ennore. The Ennore port is located on the north of this river mouth. The breakwaters of Ennore port are acting as permanent littoral barriers and hence trapping the sediments in to the river mouth. These trapped sediments have choked the river mouth. However, during the tsunami, the mouth of this river was opened due to the penetration of water mass from the ocean which is shown in **photo 2.2**. Presently, the dredging in full swing is in progress as can be seen in **photo 2.3**, in order to keep the river mouth open. During the site visit, it was seen that the dredged spoil was being disposed on the south of the mouth of the ennore creek, which was found resettling into the mouth. This exercise is futile as it is clear that the net littoral drift along the East coast of India is directed towards north. **In order to achieve a better solution two groins one on each side of the mouth as training walls need to be**

constructed. The southern groin can extend upto a water depth of about 5m, whereas, the northern groin can extend upto a water depth of 4m. The approximate lengths of the two groins could be about 250m and 200m. In addition, a sand trap on the south of the southern groin is proposed. A schematic representation of the stretch of the coast from Chenai harbour to ennore port along with the completed groin field for stretch I taken up by the Tamilnadu Road development Company (TNRDC) along with the proposed groins for stretch II are depicted in **fig.2.2.** The details of the proposed tentative ennore mouth improvement scheme which includes a sand trap south of the southern groin are shown **fig.2.3**.

2.3 Ennore to Royapuram
(Ennore to Ernavoor Kuppam)

The stretch of about 15km from Ennore towards its south upto Royapuram comprise of a number of fishing hamlets. Most of the reaches have been protected by a seawall and combination of seawall and groins. Even though, the reach from Chinna Kuppam (about 3km from South of Ennore creek mouth) to Ennore mouth has been protected by a seawall shown in **photo.2.4**, this stretch is liable to be eroded in future. Hence, this should be strengthened by a groin field, by which additional beach width can be gained, thereby not only stabilizing the seawall but also to win additional beach. The additional benefit will be the reduction of sand entering the ennore river mouth and also the maintenance dredging being carried out by the Ennore port. **The number of groins for this stretch of 3km will be about 10, wherein, the average length of the groin will be 150m**. The tentative proposed remedial measure for this stretch of the coast is shown in **fig.2.4**. The above-suggested scheme will protect coastal villages namely Nettukuppam, ThalanKuppam, PeriyaKuppam, ChinnaKuppam and Ernavoorkuppam. The details should be worked out after conducting a bathymetry survey.

2.4. Reach between the two groin fields (*Masthan Koil Kuppam to Popular Weigh Bridge*)

A portion of this stretch of the coast has been proposed to be protected by two groin fields in addition to a seawall, out of which one stretch with six groins is completed and the second stretch is to be taken up by TNRDC as discussed under **sec.2.2**. In between the two groin fields the expressway, industries and fishing hamlets are located along this stretch. Even though some parts of this stretch is being protected by a seawall (**photo 2.5**),

it needs further protection, as Ennore expressway adjacent to this stretch may be affected. **Hence as an immediate protection measure it is recommended to rehabilitate the existing seawall for a length of about 2km** as can be seen in **fig.2.5.** The cross section of the seawall should be carefully arrived. **The other solution that could be effective is construction of a groin field (4 groins with an average length of about 150m).**

2.5 Stretch between Savorit to Northern breakwater of fishing harbor

The existing seawall at this stretch is in a depleted condition (**photo.2.6**). The stretch of the coast from the North of northern breakwater upto stretch II of the groin field to be constructed by TNRDC is shown in **fig. 2.6**. The expressway, some hamlets and industries are located in this stretch. With a view to safeguard the above this stretch, the existing seawall has to be replenished. **Hence for this stretch of the coast of about 1km, the existing seawall needs to be strengthened preferably with a flatter section, the details of which need to be arrived. For the initial estimate purpose, the section proposed for the coast just north of Ernavur could be adopted.**

2.6 Stretch between Chennai port (N 13° 02'24.9" E 80° 16'47.5") to Foreshore estate (N 13° 02′04.9" E 80° 16'35.3")

The stretch of the coast from chennai port to foreshore estate is shown in **fig.2.7**. The Marina beach is World's second longest beach formed due to the interception of the long shore sediment transport by the Chennai harbour southern breakwater. This has resulted in the sand bar formations at the mouth of rivers Cooum and Adyar. Both the rivers run within the city of Chennai, out of which the Cooum River is more contaminated and is stagnant during most parts of the year, thus acting as an excellent breeding ground for mosquitoes which is a health hazard. The tsunami had opened the mouths of both the adyar and cooum rivers. The status of the mouth of Cooum river prior to the tsunami and after the tsunami are projected through the satellite imageries in **photos 2.7a and 2.7b** respectively. **Hence there is an urgent need for implementing river mouth improvement scheme consisting of a pair of groins as training walls.** The scheme suggested for training of the mouth of cooum river is shown in **fig.2.8.** The training wall on the south of the Cooum mouth should extend up to a water depth of about 6m, whereas, the northern groin can extend up to a water depth of about 4m. The reason for longer groins is to trap the sediments for 1.5 to 2 times the surf width. **In the case of Adyar, regular maintenance dredging of the mouth is recommended.** The imageries for the

mouth of adyar river prior to the tsunami and after the tsunami are projected through the satellite imageries in **photos 2.8a and 2.8b** respectively. The stretch in between these two river mouths need plantations.

2.7 Besant Nagar (N 12° 59'47" E 80° 16'14.2")

The beach from Besant nagar upto Kovalam is in a stable condition. Hence, no intervention is recommended, except that dwelling units have to be re-located away from the coast.

2.8 Kovalam (N 12° 47′24.9″ E 80° 15′12.1″)

The stretch of the coast from Kovalam upto Chinnakuppam **(N 12° 26′54.8″ E 80° 08′37.4″)** is shown in **fig.2.9.** A bay like formation (**Photo.2.9**), from north of the above location has formed and this formation as per the local public appears to be quite stable. This bay formation is likely due to the outcrops (**photo.2.10**) on its south acting as a natural littoral barrier. As regard to the coastal protection, it is suggested to '**do nothing**'. This bay could be thought of developing as a fishing harbour at a later stage if funds are available. A perfect road is also available up to this beach, which may be quite suitable for the development of a fishing harbor. However, this needs further assessment as regard to the Cost – Benefit analysis. A significant stretch of coast south of Kovalam has a wide beach (**photo. 2.11**) **conducive for plantations as a long-term measure for protecting the coast.**

2.9 Devaneri (N 12° 39′02.3″ E 80° 12′29.6″):

This stretch of the coast has a flat beach as can be seen in **photo 2.12**. However, in the vicinity of this coast, a large number of dwelling units has suffered damages due to the tsunami. **This stretch of the coast can be protected with a flat seawall with a higher crest elevation for 0.5km backed up by plantations in between the dwelling units and crown of the seawall.** On the south of Devaneri, existing plantations as can be seen from **photo 2.1**3 that acted as barriers in reducing the tsunami run-up. Hence, Devaneri stretch of the coast can be protected by combination of Rubble mound Seawall and plantations. The recommendation made herein is to address the mitigation measure for post tsunami events to some extent. The tsunami inundation level in the un-protected area of Devaneri coast is shown by a local villager in **photo 2.14**.

2.10 Mamallapuram (N 12° 37′11.1″ E 80° 11′53.0″):

In this stretch of the coast in between Devaneri and Mamallapuram, it is understood that the shoreline undergoes short-term changes and hence this stretch of the coast need not be considered for any hard measures and only plantations could be taken up as a long-term solution.

2.11 Meyyur Kuppam (N 12° 31′44.5″ E 80° 10′00.8″) and Sadras kuppam

This village lies south of Kalpakam Atomic Power Statiion. Local people have said the water level receded prior to the tsunami up to the intake structure (**photo 2.15**) of Kalpakam Atomic plant. The action of tsunami was quite vulnerable in this stretch. In the immediate south of this village, the presence of coconut plantations (**photo 2.16**) has given slight relief, as the land in this area is not in an elevated location. The water during the tsunami has penetrated which has risen up to 3 m, the level of which is shown in **photo 2.17**. Further south, the flat beach and the less elevated region has enabled the tsunami to exhibit its might. This stretch of the coast has a number of houses, which need to be protected. Based on the behavior of the tsunami and also due to the elevation of ground level being less, **it is recommended that this stretch of 1.5km be protected with a combination of groin field (about six with an average length of about 200m) and seawall, the crest of which should be fixed higher 2 m above Ground Level in order to protect the coast and also to serve as a buffer to handle natural hazards in future.** The suggested coastal protective measure is shown in **fig 2.10.** As a secondary effort, plantations can be done as a long-term solution.

2.12 Oyyalikuppam (N 12° 29′24.9″ E 80° 09′32.4″)

A number of dwelling units adjacent to the coast has been washed away due to tsunami and leveling of ground and debris is in progress as can be seen in **photo.2.18**. This village is north of Palar River. The Palar river traps some of the sediment transport directed towards North leading to a deficit of sediment supply, thus, leading to erosion along this stretch of the coast. A compound wall of CISF quarters in this village suffered damage, which is being rectified as can be seen in **photo. 2.19**. **Oyyalikuppam needs to be protected by groin field with an average length of about 200m for a stretch of 2 km as shown in fig. 2.11.**

2.13 Chinnakuppam (N 12° 26′54.8″ E 80° 08′37.4″)

The width of the beach south of river Palar of Chinnakuppam is shown in **photo. 2.20**. However, this area is experiencing only marginal erosion. **Two training walls upto a water depth of about 4m near the mouth of the river Palar is recommended.** The training walls of river Palar will stabilize the beaches of Chinnakuppam and Periyakuppam. After monitoring the shoreline evolution due to these training walls, a decision can be taken to provide further protection. **As a long-term solution, plantation can be started in between these two villages, as there is enough barren land.** The plantation can be as dense as shown in **photo. 2.21,** the location of which in between these two villages, is slightly far away from the shoreline. The Palar river mouth which was discussed earlier shows the formation of shoals and sand bar near its mouth (**photo. 2.22**) which needs two training walls as shown in **fig. 2.12**.

2.14 Sodanaikuppam (N 11° 57′ 33.1″ E 79° 50′ 27.4″) – Nadu Kuppam (N 11° 57′ 51.2″ E 79° 50′ 33.2″)

The locations of Sodanaikuppam, Nadukuppam, Thanthiriyan kuppam and Mudaliar kuppam which would be discussed are shown in **fig. 2.13**. The presence of an existing seawall at Sodanaikuppam is shown in **photo.2.23**. There is a dispute between the local public of Sodanaikuppam and Rahamathnagar, which is adjacent to Sodanaikuppam, locations of which are shown in the above photo. On the land ward side of the seawall mentioned above, a permanent road exists, of which a number of buildings have been damaged due to tsunami as this stretch of the coast, north of this seawall is unprotected as shown in **photo. 2.24**. Two remedial solutions are suggested. One is to connect this seawall with the seawall in Nadukuppam which is north of Rahamathnagar (to be discussed later). The distance between these two seawalls is about 850m. The other option is to construct a short transition groins. The intensities of the erosion at Rahamathnagar are shown in **photos 2.25 and 2.26**. The public of sodanaikuppam is pressing for 60 m beachfront to be kept open for their fishing activity, whereas, the public of Rahamathnagar wants to connect the seawalls. **Photo. 2.27** show the erosion near the southern tip of northern seawall at Nadukuppam. It is recommended to construct a transition groin field, whereas, the local public is demanding for a breakwater and harbour. As a technical solution and as preparedness for future, against natural hazards, **it is strongly recommended to construct a groin field for the left out portion of about 850m**

consisting of 5groins, the lengths of which would vary from 30m to 100m. For estimate purpose the average length can be considered as 50m. The proposed concept for the protection of this stretch of the coast is shown in **fig. 2.12.** Only after the bathymetry survey and investigation, the details of the groin field can be worked out. In addition, the department needs to sort out the conflict between the villages. **As the erosion at Rahamathnagar is quite alarming, constant monitoring of the shoreline is to be done and if the shoreline does not stabilize even after the construction of the groin field, this stretch should be further protected by a seawall with a higher crest elevation.**

2.15 Thanthiriyan kuppam (N 11° 58′ 08.6″ E 79° 50′ 38.2″)

The damages near this village are shown in **photo.2.28**. From this village, a stretch of about 3.5km north of this village (Muthialpet, Mudaliarchavadi, Bommayapalyam) is densely populated and hence need to be protected with a groin field (**fig.2.15**). **The groin field will consist of 9 groins with an average length of 150m. Sandy beaches are also available at a few pockets, where, plantations can be done** as a long-term measure for the protection of the coast. The width of the beach from Muttukaadu Azhagankuppam to Mudaliar Chavadi in Villupuram district after the tsunami is provided in **Table. 2.1.**

Table 2.1 Details Of Beach Width along Villipuram Coastal Belt.

Sl.No.	Names	Beach width from shoreline in (m)
1.	Muttukadu Azhagan Kuppam	67m
2.	Vasavan Kuppam	40m
3.	Kaipani Kuppam	60m
4.	Ekkiya Kuppam	35m
5.	Mandavai Kuppam	35m
6.	Panichamedu Kuppam	40m
7.	Keezhpettai Kuppam	40m
8.	Anumanthai Kuppam	35m
9.	Setti Nagar	70m
10.	Koonimedu Kuppam	60m
11.	Mudhaliar Kuppam	80m
12.	Anichang Kuppam	100m
13.	Pudu Kuppam	150m
14.	Pillai Chavadi	27m
15.	Bommiar Palayam	35m
16.	Mudaliar Chavadi	30m

2.16 Mudaliarkuppam (N 12° 03′ 43.5″ E 79° 52′ 59.6″)

The beach widths along this stretch are shown in **photos 2.29** and **2.30.** This stretch exhibits the existence of sufficient beach width for which a soft measure like plantation should be taken up immediately. Damages due to tsunami are shown in **photo.2.31**.

2.17 Thazhanguda Village (N 11° 46′ 08.1″ E 79° 47′ 37.4″) and Devanampatinam (N 11° 44′ 40.4″ E 79° 47′ 16.6″)

The views of the beach north and south of this village are shown in **photos 2.32 and 2.33** respectively. Although, the beach is about 30m wide and coconut trees have given some amount of relief, about 300 to 400 families living in this village have suffered loss of property and life due to the tsunami. The PWD officials have stated that, the beaches formed during the visit get eroded during other seasons. The tsunami has removed all the beaches upto the coconut trees and a number of coconut trees and houses were completely damaged. (**photos 2.34a and 2.34b**). There is an urgent need to protect this coast. The village is also not at an elevated location. The river (pennaiyar) training works would consist of **a pair of training walls of lengths of about 250m** which need to be constructed that has to be discussed with the Government of Pondicherry as the stretch on the north of mouth of this river comes under the jurisdiction of state of Pondicherry. **On the southern side of the mouth, a long groin is proposed followed by a groin field for a distance of about 3km upto Devanampatinam. This would consist of 8 groins with an average length of about 150m and training walls of about 250 m at the mouth of river Gadilam.** The PWD officials have started temporary protection measures by driving trunks of Palma rah trees parallel to the shoreline (**photo 2.35**). The trunks are of 6m length and driven 4m into the sea bed. If these trunks had only been driven normal to the shoreline, at regular intervals, it would have served as a permeable groin field allowing the sand to get deposited in between them leading to the formation of a beach. The respective S.E of PWD has been advised accordingly. **photos 2.36 a & b** show the choking of the mouth of pennaiyar river. Nearly 350 people have died in these villages and **hence for a stretch of 3km needs protection with a combination of groins and a high crown seawall.** Only the concept of the protection measure to be adopted for the stretch of the coast between Thazhanguda Village and Devanampatinam are shown in **fig.2.16.** Initially the groins should be constructed, followed by the seawall after monitoring the

performance of the groins in shoreline build up. The complete Engineering details have to be worked out and tested in lab to arrive at the final design.

2.18 Near Cuddalore Port (N 11° 42′ 25.5″ E 79° 46′ 33.34″)

The north of the northern breakwater of this port has a wide-open barren land (**photo.2.37**), **which can be protected with plantation**. The houses are in a much-elevated location. The tsunami has not reached the dwelling units from the sea. However, most of the damages to the village Singarathoppu, located close to the banks of Uppanar river (**fig.2.17**), from which the tsunami penetrated to result in a huge damage. **Hence, immediate steps are to be taken to shift the dwelling units to the elevated locations**.

2.19 Pudukuppam (N 11° 31′ 34.9″ E 79° 45′ 47.8″)

During the tsunami, water penetrated about 1km into the land, causing a death toll of about 200 and severe damage to the property. The beach is very flat (**photo 2.38**) for a stretch of the coast of 10km north of Parangipettai upto Samiyarpettai. The houses are located at a distance of about 500m from the shoreline except for a public convenience shown in **photo 2.39** that had been completely submerged during the tsunami. The barren land shown in this stretch of the coast as can be seen in **photo.2.40** has not offered any protection from the tsunami run-up. **Hence, dense plantations are proposed**. As dwelling units are located mostly about 200m away from the shoreline and as the seabed is very flat, without much shoreline oscillations as per the information gathered by local public, conventional hard measures like seawalls or groin field would not serve as coastal protection measure. In the case of groins, they have to be quite long in order to pierce the surf width. In the event of tsunami, the aim of the protection measure should be to reduce its speed, **for which masonry buffer blocks (4m x0.5mx0.5m) and can be constructed in two rows at a distance of 200m from the shoreline and in between these blocks and shoreline plantation as already mentioned could act as front line soldiers to reduce the speed**. The priority in this case would be plantations followed by the buffer blocks.The concept are projected in **fig. 2.18**.

Photo.2.1. A view of beach at Kaatupallikuppam

Photo 2.2 A view of the sand bar formation at the mouth of Ennore

Photo.2. 3. A view of the dredging activity at Ennore

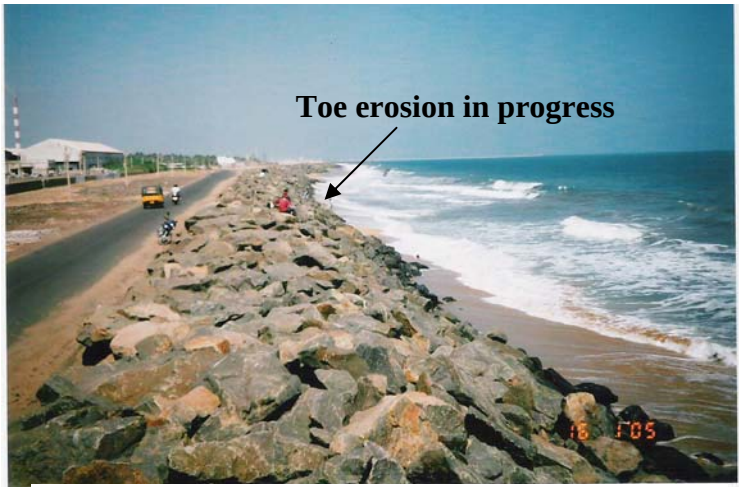


Photo 2.4. A view of the existing seawall

Photo 2.5. A view of the existing depleted seawall

Photo 2.6. A view of the existing depleted seawall north of Chennai fishing harbor

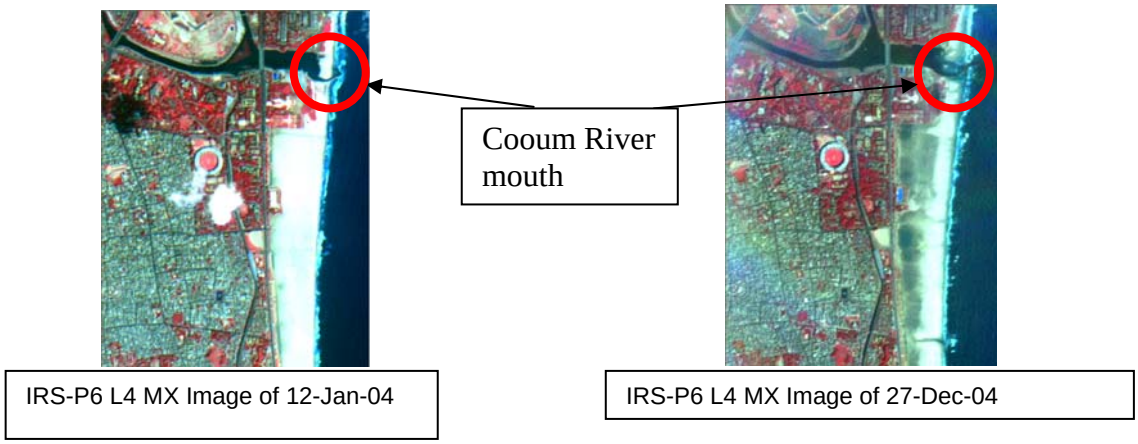


Photo 2.7 Status of river Cooum a) Before b) After tsunami

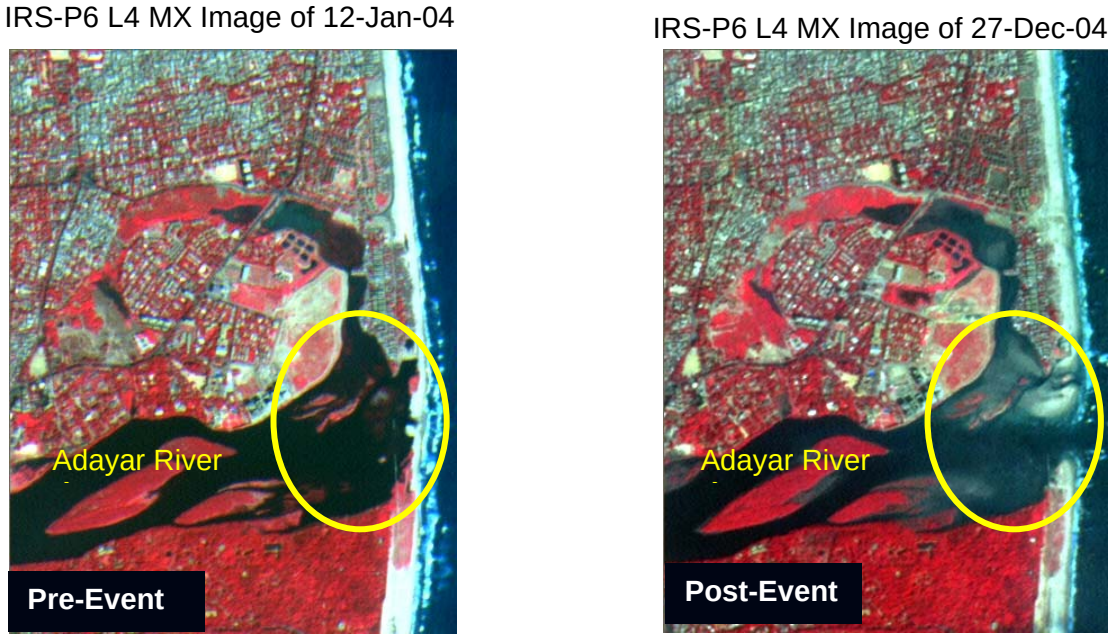


Photo 2.8 Status of river Adyar a) Before b) After tsunami

Photo.2.9. A bay like formation at Kovalam

Photo 2.10. Outcrops acting as littoral barrier at Kovalam

Photo. 2.11. Wide beach conducive for plantations

Photo 2.12. Flat beach at Devaneri

Photo 2.13. Existing plantations acting as natural barriers

Photo 2.14. A local villager showing the tsunami run-up mark on the compound wall

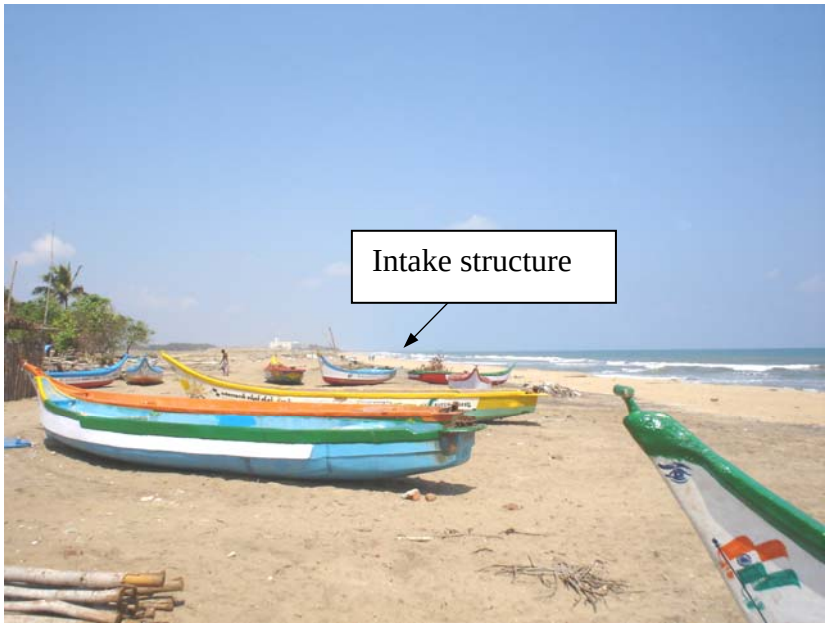


Photo 2.15. The local public reported that the water level receded up to the intake structure during tsunami

Photo 2.16. Thick coconut plantations, which acted as barriers

Photo 2.17. A local villager showing the tsunami run-up mark on a coconut tree

Photo 2.18. Leveling of the ground and clearing of debris in progress in Oyyalikuppam

Photo 2.19. Damaged compound wall due to tsunami being rebuilt

Photo 2.20. Beach width south of the river Palar

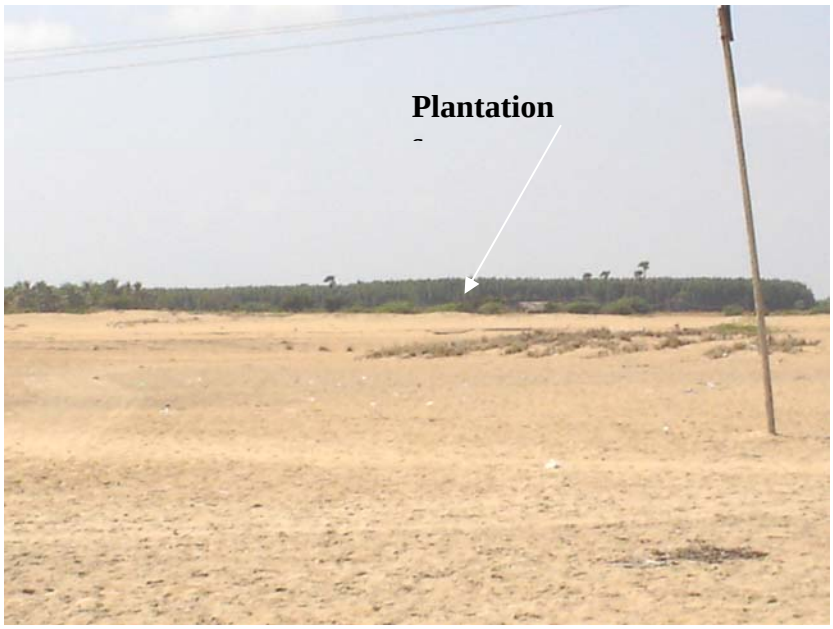


Photo 2.21. Dense plantations in between Chinna Kuppam and Voyyali Kuppam

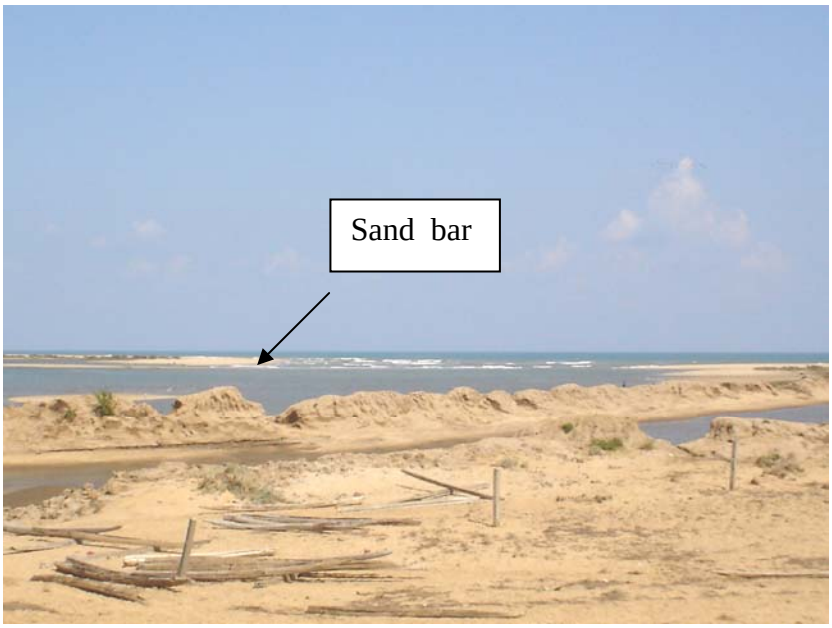


Photo 2.22. Sand bar formation at the mouth of river Palar

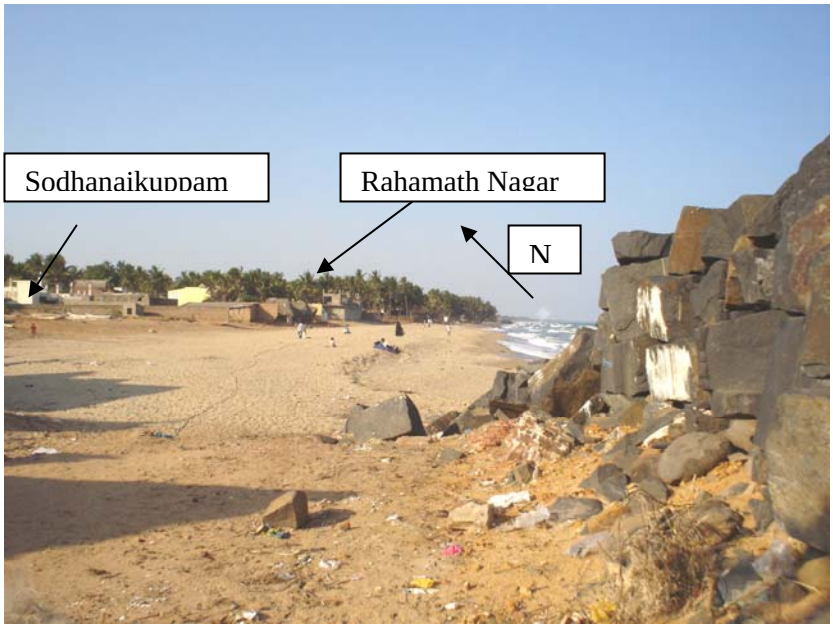


Photo 2.23. Existing seawall at Sodhanai kuppam

Photo 2.24. Damaged buildings due to tsunami in Sodanaikuppam

Photo 2.25. View of coastal erosion at Rahamathnagar

Photo 2.26. Damaged buildings due to coastal erosion at Rahamathnagar

Photo 2.27. Erosion near the seawall at Nadukuppam

Photo 2.28. Damaged buildings due to tsunami in Thandriyankuppam

Photo 2.29. The beach width North of Mudhaliyarkuppam

Photo 2.30. The beach width South of Mudhaliyarkuppam

Photo 2.31. Damaged dwelling units due to tsunami in Mudhaliyarkuppam

Photo 2.32 & 2.33. Beach widths North and South of Thazhanguda

Photo 2.34 a &b . A view of damaged coconut trees at Thazhanguda due to tsunami

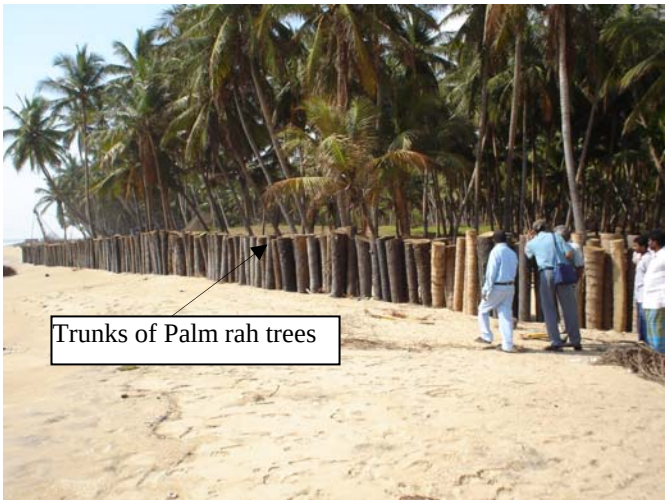


Photo 2.35 Temporary shore protection measure being adopted by PWD

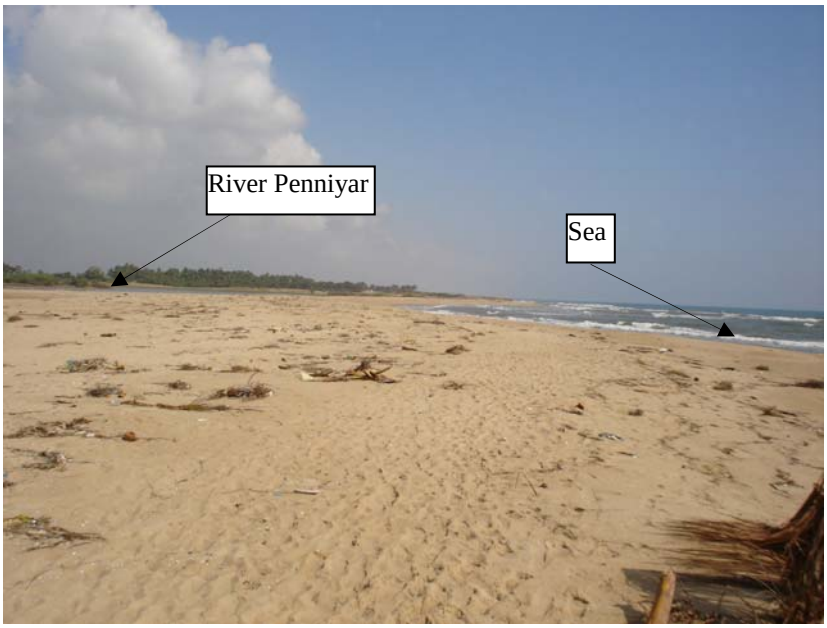


Photo 2.36 a & b. Deposition at the mouth of river Penniyar near Thazhanguda

Photo 2.37. Open Barren land north of Cuddalore port

Photo 2.38. Flat beach at Pudukuppam

Photo 2.39. View showing the public convenience adjacent to shore

Photo2.40 Barren land adjacent to shore at Pudukuppam

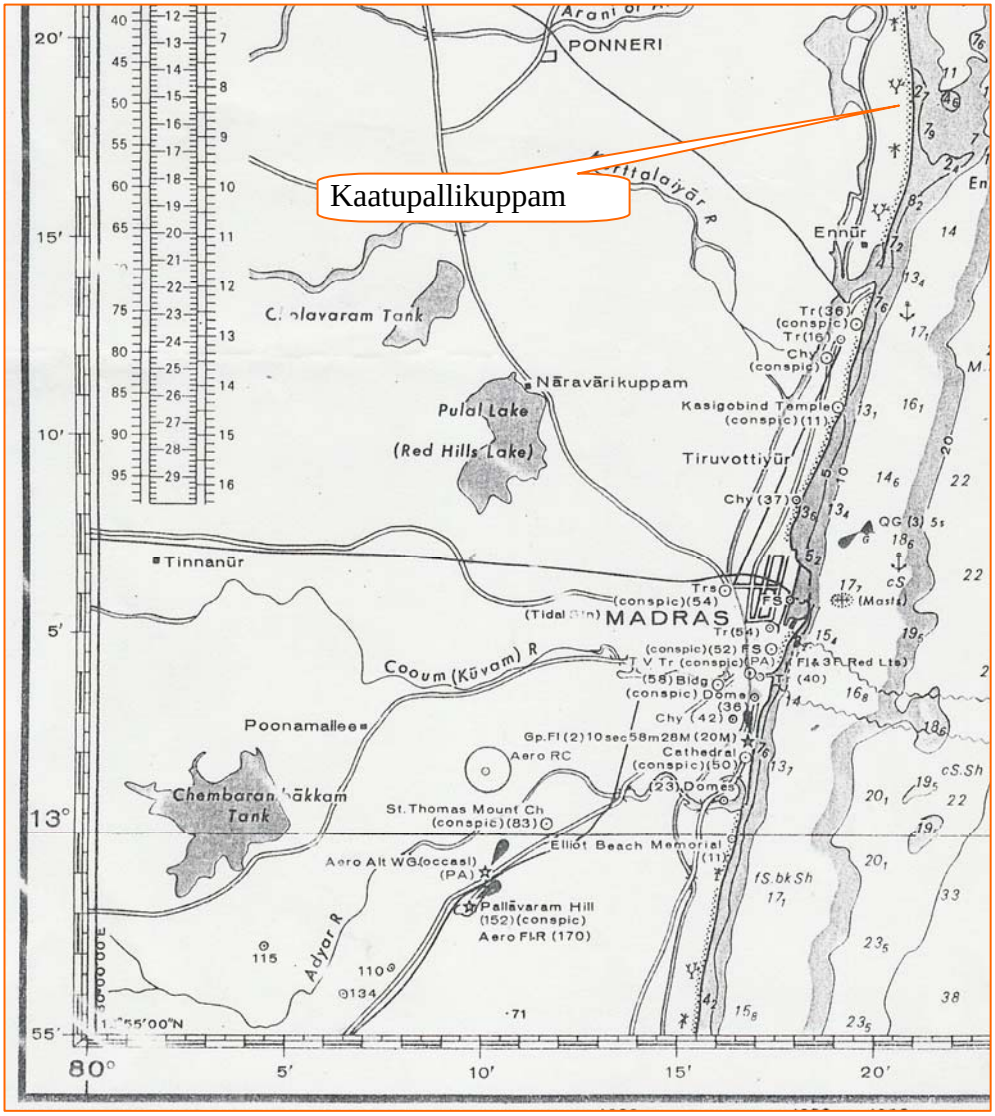


Fig. 2.1 Location map of Kaatupallikuppam

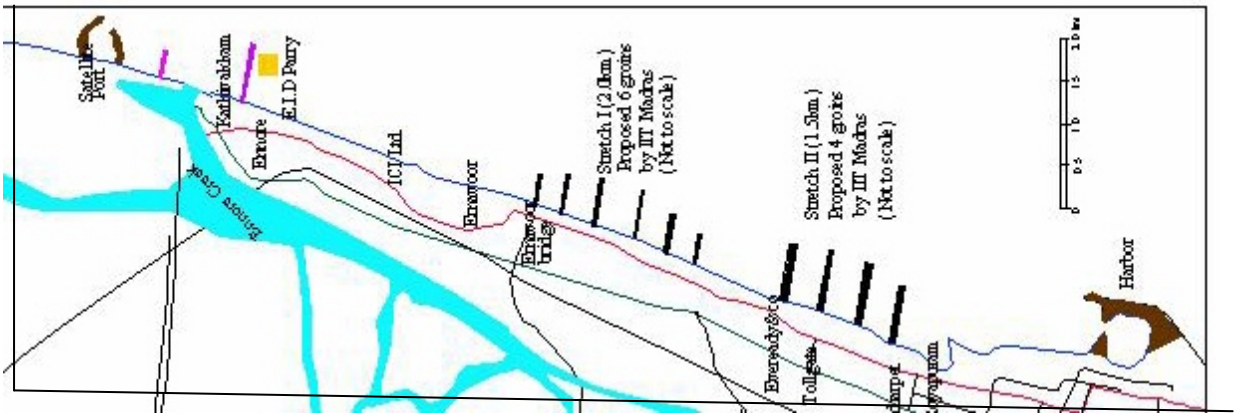


Fig. 2.2 Schematic representation of the stretch of the coast between Chennai and Ennore ports

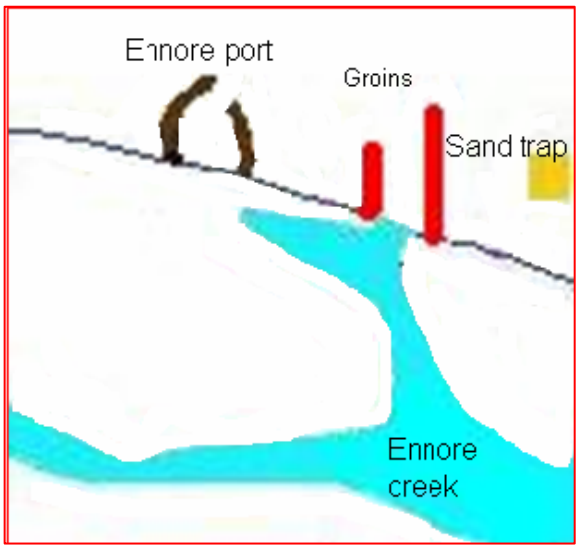


Fig.2.3 Schematic representation of training works for Ennore creek mouth

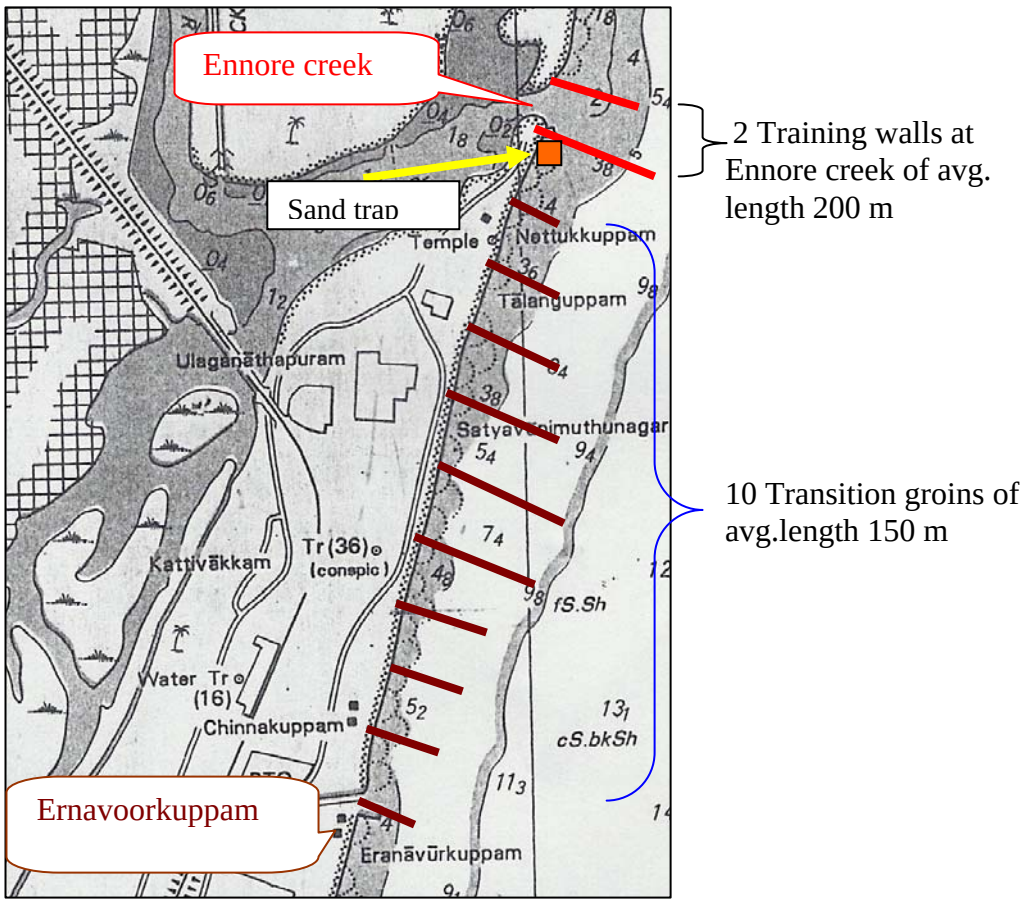


Fig. 2.4 Groin field at the stretch of the coast in between Ernavoorkuppam and Ennore creek

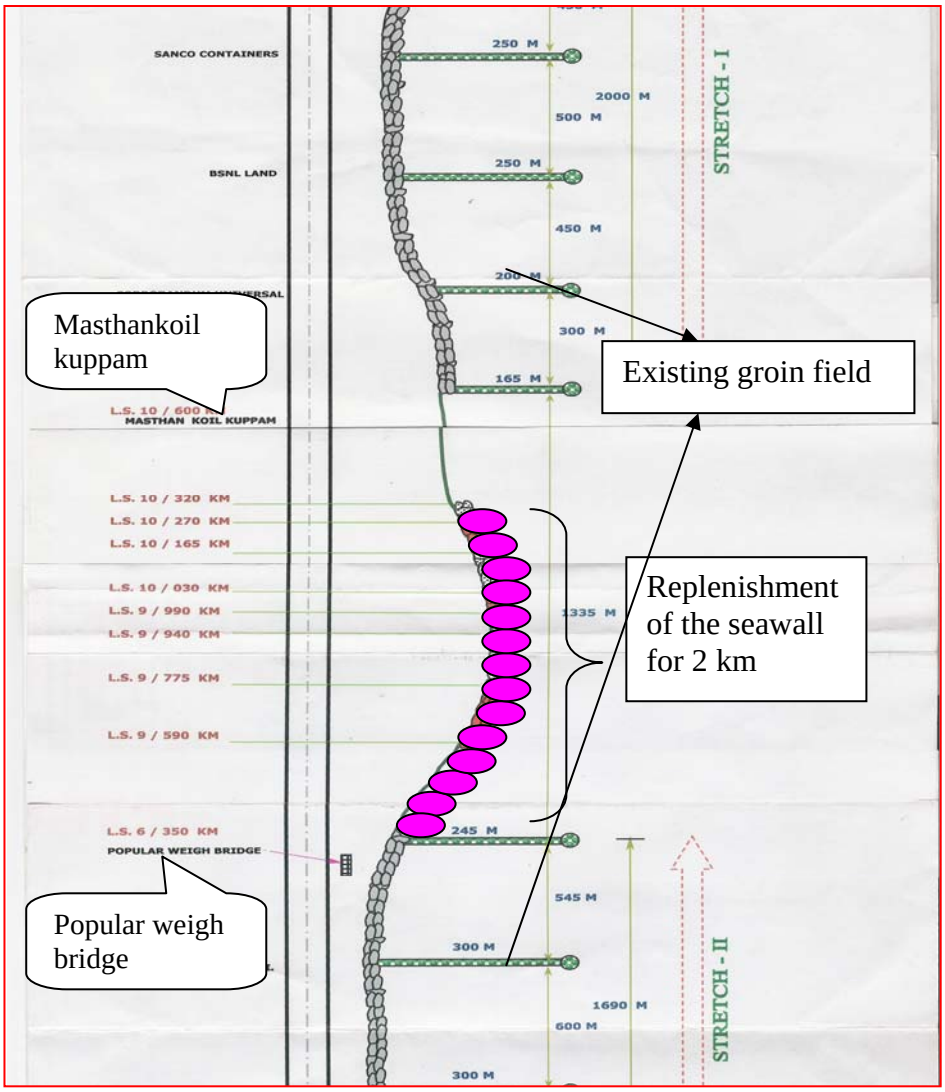


Fig. 2.5 Rehabilitation of the existing seawall between the two groin fields

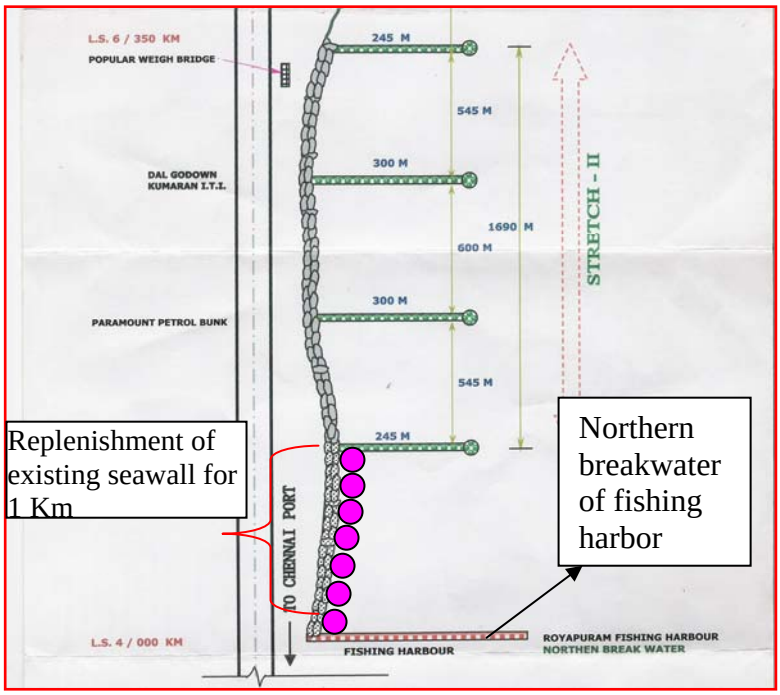


Fig. 2.6 Rehabilitation of the existing seawall between the existing groin field and the northern breakwater of fishing breakwater

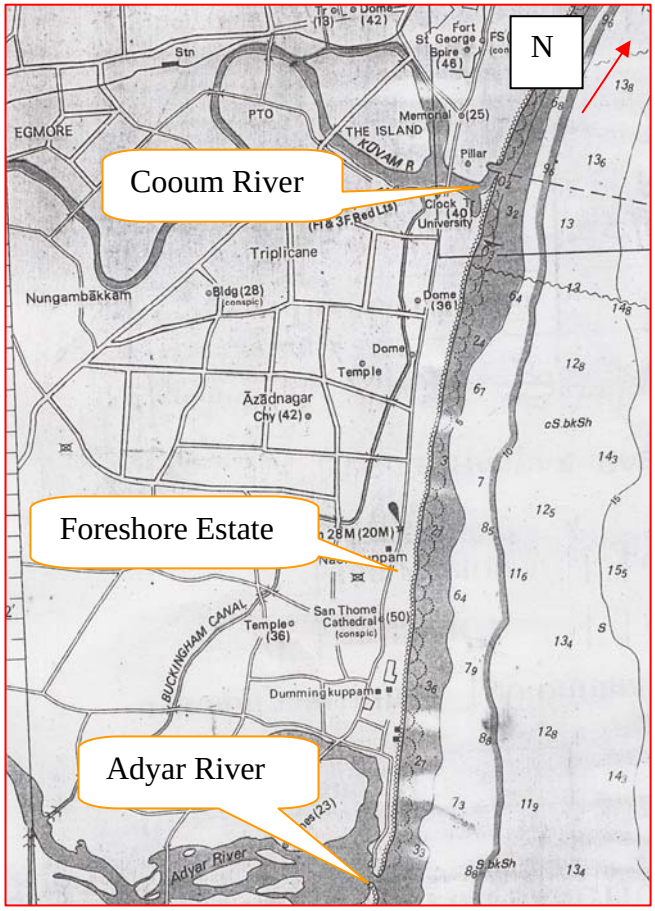


Fig. 2.7 Stretch of the coast between Cooum and Foreshore Estate

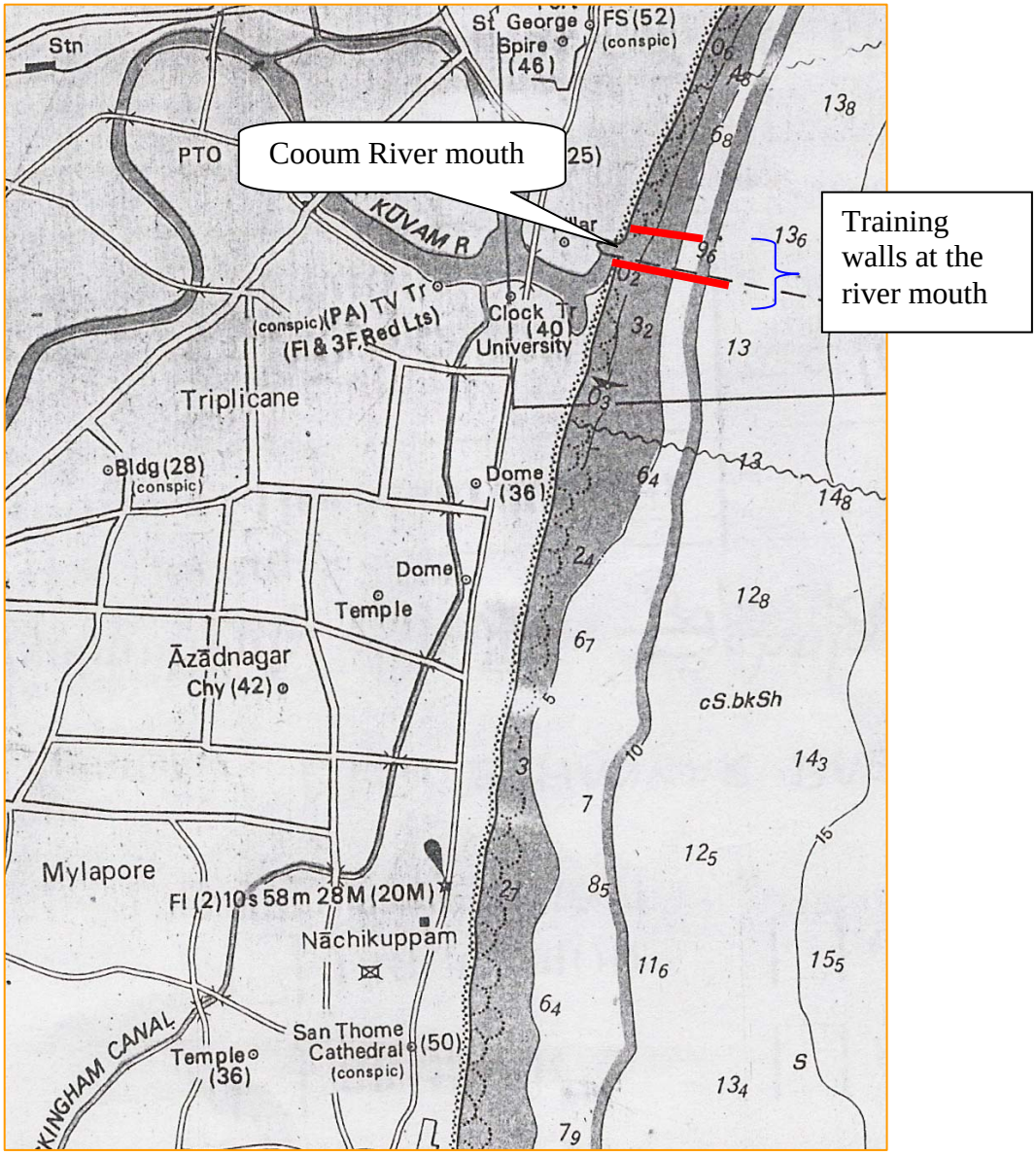


Fig. 2.8 Training walls at the Cooum river mouth

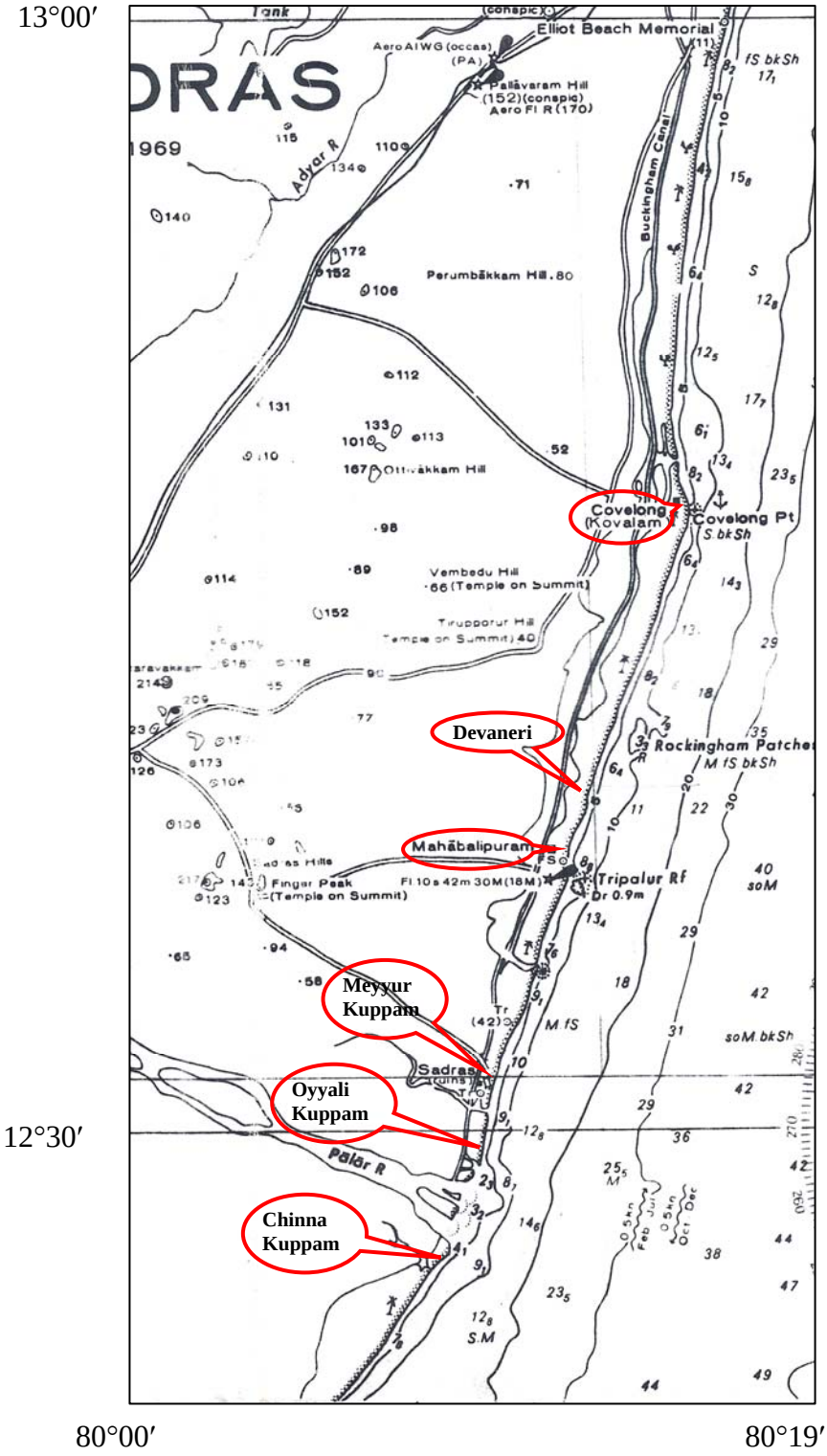


Fig. 2.9 The stretch of the coast from Kovalam to Chinnakuppam

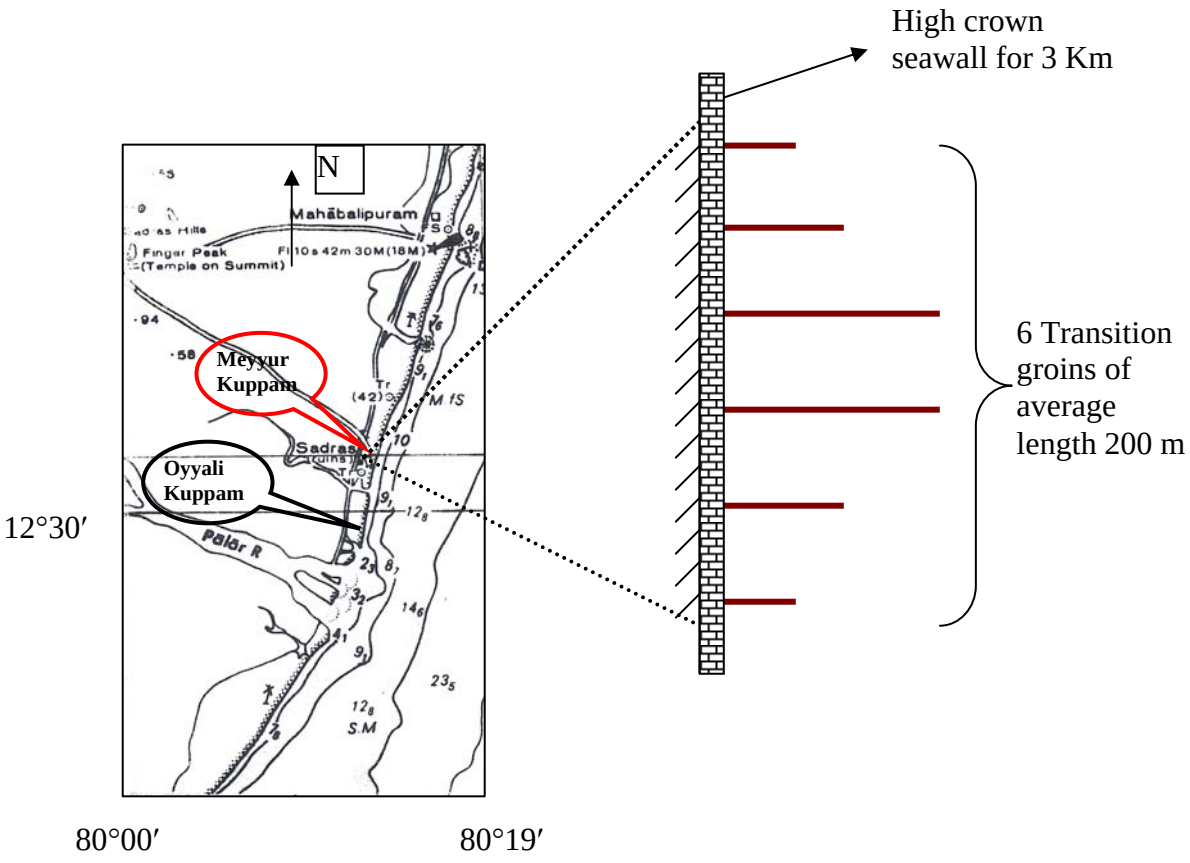


Fig. 2.10 Combination of groin field and Seawall at Meyyurkuppam

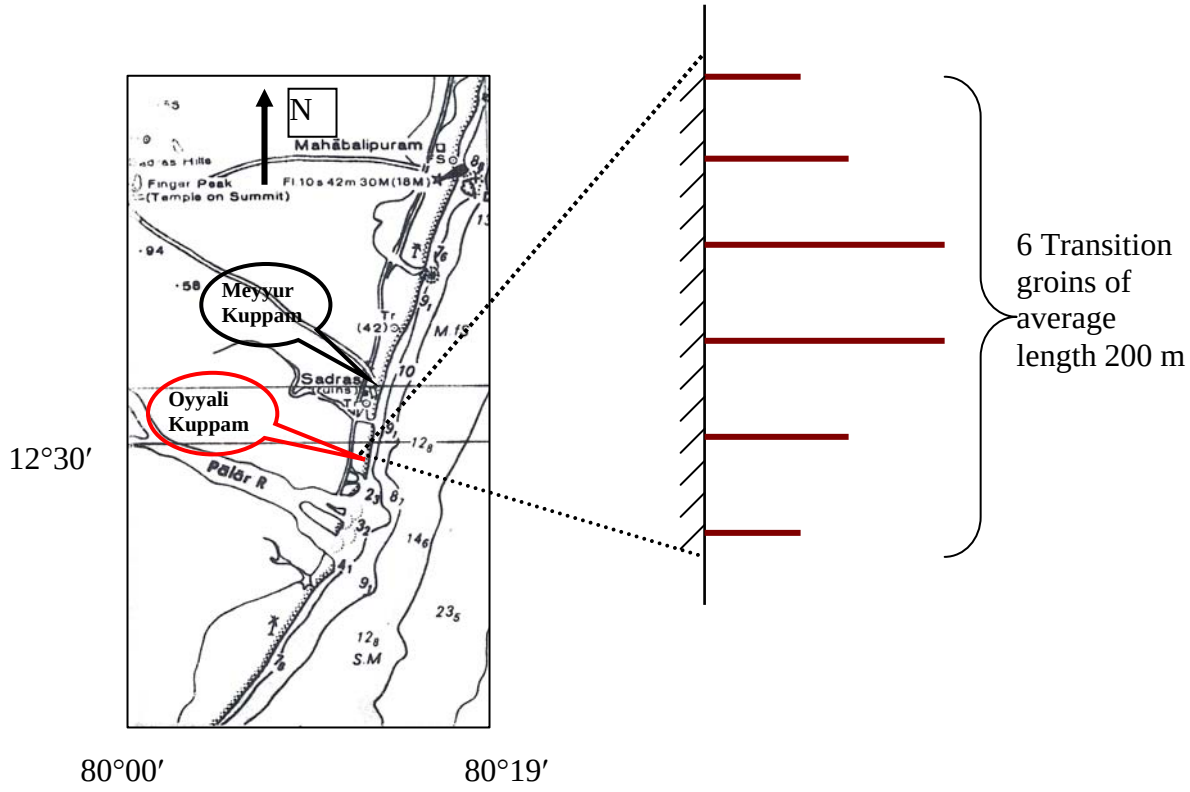


Fig. 2.11 Transition Groin field at Oyyalikuppam

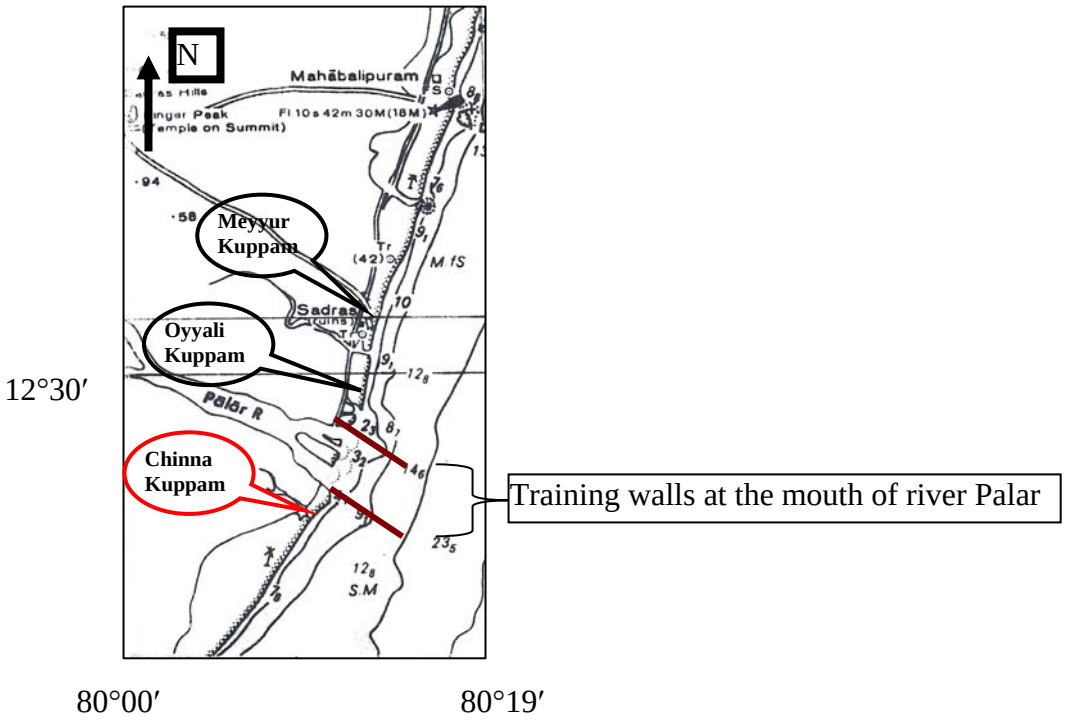


Fig. 2.12 River training works at River Palar

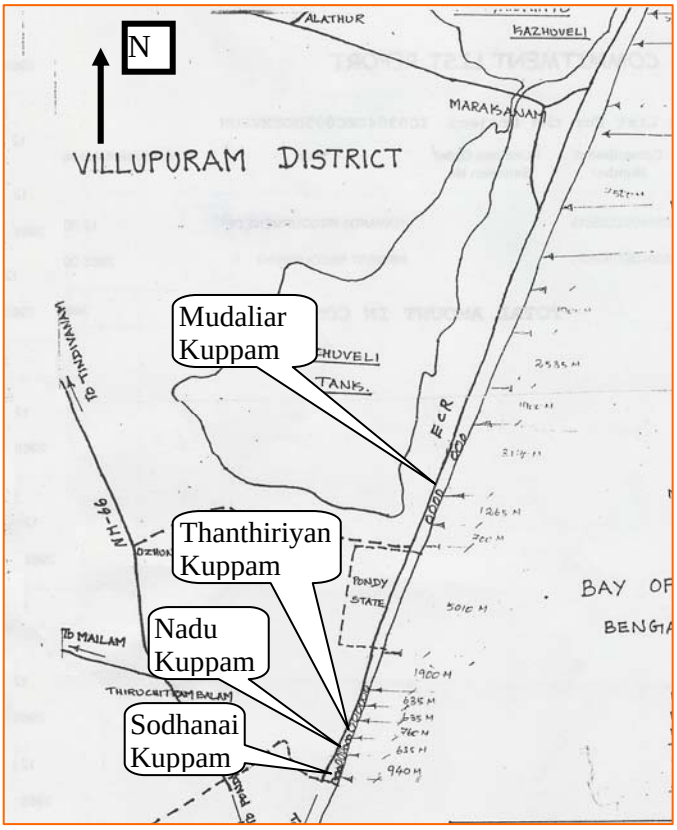


Fig. 2.13 Location map of Stretch of the coast in Villupuram District.

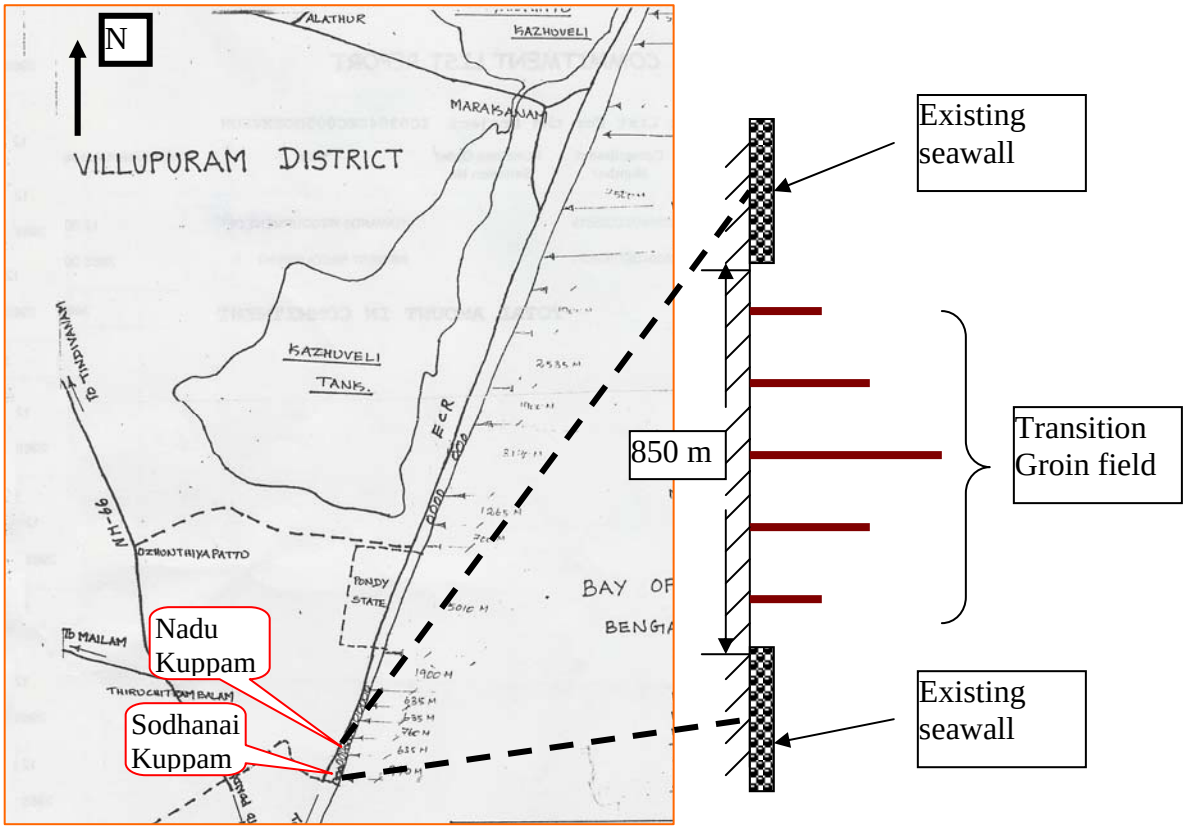


Fig. 2.14 Transition Groin field in the stretch of the coast between Sodhanai Kuppam and Nadu kuppam

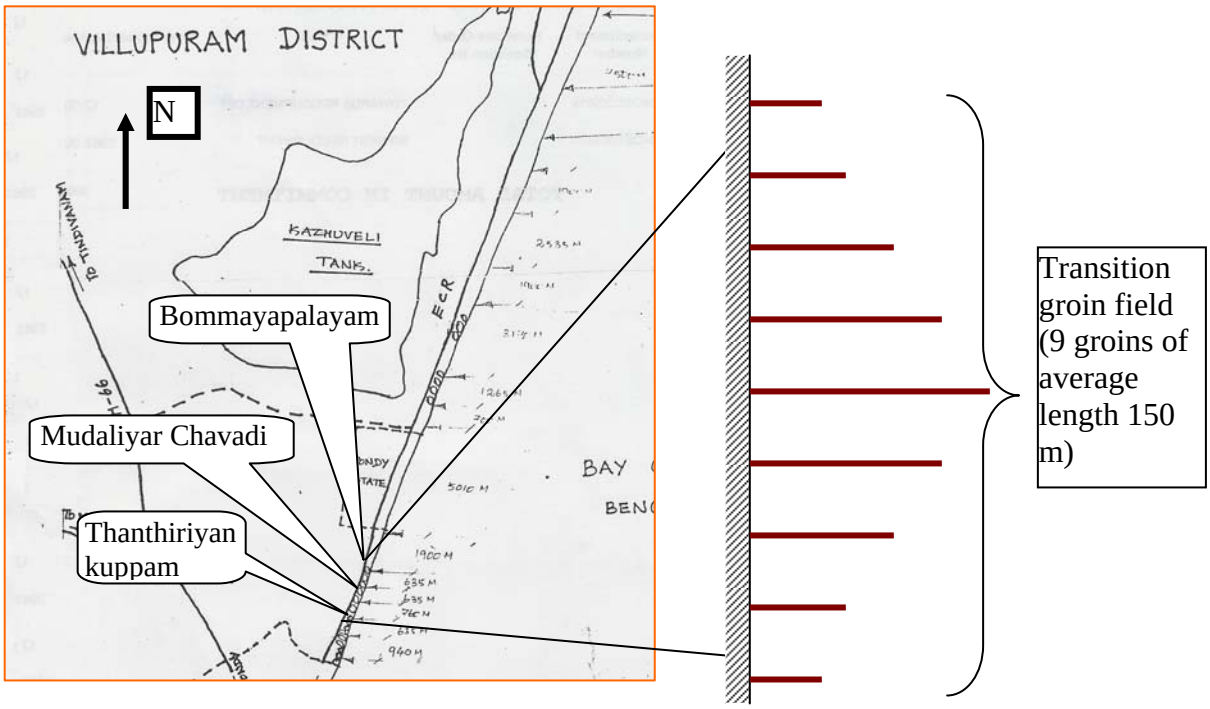
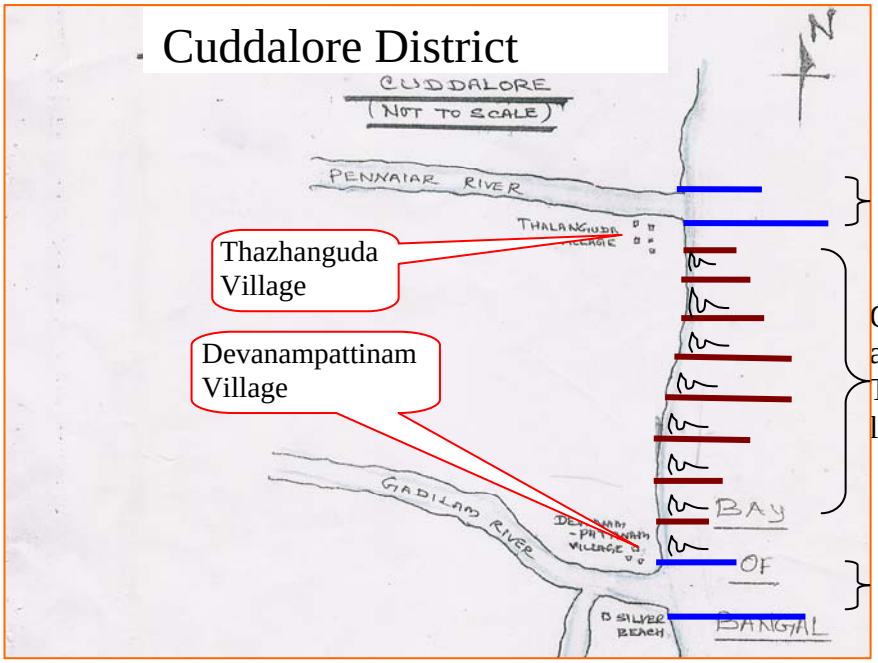


Fig. 2.15 Transition groin field for the stretch of the coast north of Thanthiriyankuppam



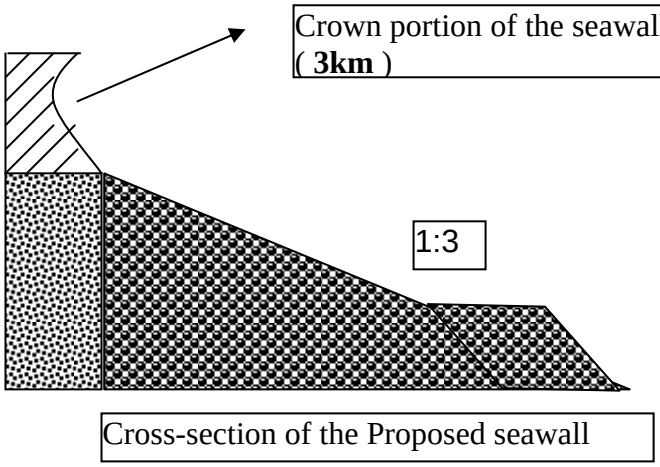


Fig. 2.16 The Combined groin field and high crown seawall along the stretch of the coast between Thazhanguda and Devanampattinam

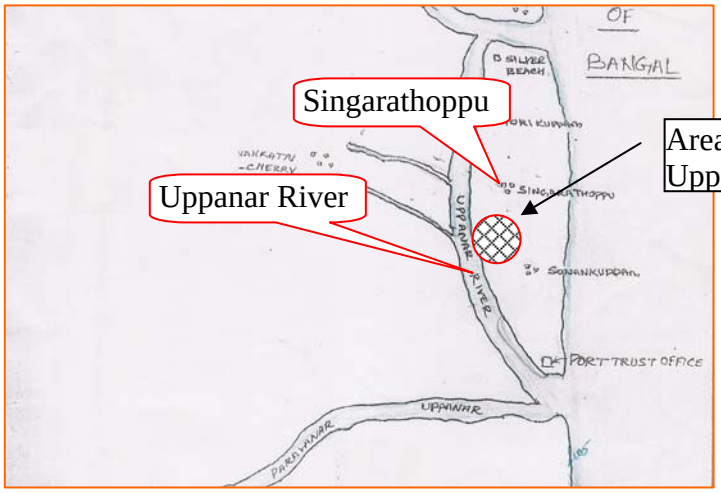


Fig. 2.17 Location map of Singarathoppu village

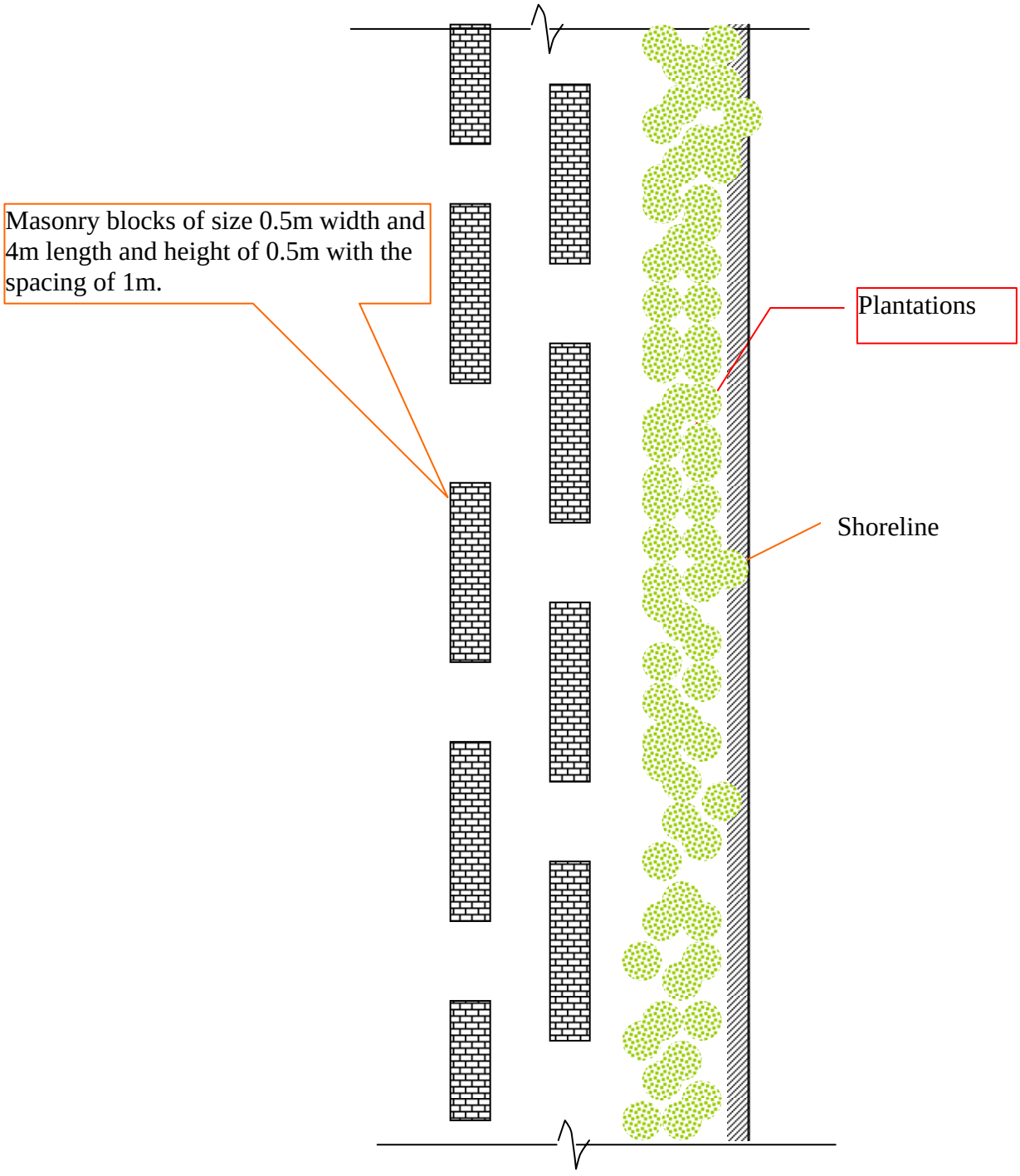


Fig. 2.18 Suggested Protection measure for the stretch of the coast at Pudukuppam in Parangipettai

CHAPTER 3
PROTECTION MEASURES FOR MADURAI REGION

3.0 General

In order to detect the vulnerable coastal erosion areas along the Madurai Region, Tamilnadu coast and to suggest the appropriate mitigation measures, Prof. V. Sundar of IIT Madras accompanied by Mr. Narayana Moorthy, E.E, Mr. Malayarasan,A.E.E, Mr. ChristuNesa Kumar,A.E.E., Mr. M. Jayapalan, D.D., Mr. P.K. Suresh, A.D., of PWD, covered the stretch of the west coast from Neerodi to Kanyakumari on 23rd February, 2005. This stretch of the coast is presented in **fig.3.1**.

3.1 Neerodi (N 8°17′24.2″ E 77°06′01.4″)

This stretch of the coast from Neerodi colony to Erayamunthurai, situated in the West coast of Tamilnadu state is shown in **fig. 3.2**. A number of dwelling units just close to the coast are facing threat of erosion. The width of the beach along this stretch of the coast is about 30 m as can be seen from the **photo 3.1,** gets washed away during the South-West (SW) monsoon leading to the entering of seawater occasionally into the dwelling units. It is observed that the beach slope in this stretch is quite steep. An existing sea wall for a length 1km is in a collapsing stage.

3.2 Marthanduthurai (N 8°17′09.9″ E 77°06′21.1″)

The stretch of the coast from Neerodi colony to Erayumanthurai covering a total distance of about 8 Km have already been protected by a seawall (**photo 3.**2), which has sunk.

3.3 Chinnathurai (N 8°15′46.6″ E 77°08′16.5″)

The seawall constructed by PWD based on the design of IIT Madras, is found to be intact with the beach width of about 15 m in front of the seawall (**photo 3.3**). The top of the seawall is found to be effectively used by fishing community for drying fish as can be seen in **photo 3.4**.

3.4 Erayumanthurai (N 8°14′38.4″ E 77°09′46.9″)

This hamlet is located on the Western side of the confluence point of the river Kulithuraiaar (**photo 3.5**). **For all of the above stretches it is recommended that the existing seawall should be stabilized or replenished, in particular Poothurai and Erayumanthurai which got affected due to tsunami.** Also, it is further recommended to fill the gaps between the seawalls as it is reported by the local public that these gaps allowed the tsunami into the land which caused damage. **It is to be recalled that the existing depleted seawall has to be rehabilitated including the raising of the top level to +5.35 m above MSL similar to that in Vallavalai.** *The scheme suggested for protecting the entire stretch from Neerodi colony to Erayumanthurai as a long term measure would be to protect with about 15 groins with an average length of about 200 m as shown in* ***fig. 3.3****.. However, this remedial measure can be taken up under phase II.*

3.5 Enayam (N 8°13′12.3″ E 77°11′03.2″)

The enlarged version of the stretch of the coast from Enayam to Muttam is shown in **fig. 3.4.** A groin at Enayam is in progress and is likely to be completed by April, 2005. The beach formed on the Eastern side is being used for parking the boats as can be seen in **photo. 3.6.** The western side of this groin has a number of dwelling units very close to the shoreline facing a constant threat due to the progressive ocean waves (**photo 3.7**). The seawall constructed is not effective in protecting the coast. The groin under construction, as per the local people, has saved the village on its lee side due to tsunami. Because of the presence of this groin, the propagation of tsunami on its western side must have been attenuated, and hence there was no damage to dwelling units adjacent to the shoreline. **A distance of 1 Km on the West of this groin has to be protected by groin field consisting of 6 short transition groins with an average length of 75 m as shown in fig 3.5**

3.6 Vaniyakudi

The PWD has already completed two groins as per the suggestions of IITM. It is to be mentioned that the six groins constructed by PWD in this stretch of the coast is not only serving as an effective protection measure, but also created a wider beach. In addition, it has acted as a great relief against tsunami saving about four villages. During a number of site visits IITM has suggested to connect a few outcrops in between the groins G5- G6 and

G7-G8 (**photo 3.8**) so as to serve as an additional groin is still pending with the PWD. **This recommendation may be taken by PWD immediately**. The above said recommendation is shown in **fig.3.6**.

3.7 Colachel Jetty (N 8°10′18.4″ E 77°15′18.2″)

The beach is found to be very flat on either side of the jetty as can be seen in **photos 3.9 and 3.10. The beach can be used for plantations. A pair of groins with a crest elevation of about 6.0 m from MSL locally called as thoondil valaivu can serve as a protection measure against severe waves particularly during cyclones and natural hazards. This proposal will also serve as a landing facility for boats and catamarans, the concept of which is projected in fig.3.7.** The existing jetty can more effectively be used if the above proposal is implemented. The length of the coast that should be covered under this proposal will be about 1km. The effect of the penetration of tsunami on the flat beach is shown in **photos 3.11, 3.12 and 3.13**, which shows the damaged buildings about 100 m from shoreline, beyond the existing road.

3.8 Kottilpadu Colachel (N 8°10′09.9″ E 77°15′47.4″)

This is one of the worst affected villages of the coast of Kanyakumari district due to tsunami and has resulted in a number of casualties about 200. About 4 rows of houses collapsed is shown in **photo 3.14**. A road is formed with the debris removed along the coast as seen in the above photo. The local public have reported that the canal, which is running parallel to the shoreline has acted as a death trap, as the people trying to escape from the attack of the tsunami should have got stranded and drowned as the number of bridges or escape routes available are less. The measurements of certain important area were made and the plan showing these details is shown **fig. 3.8**. This area needs to be protected against wave run-up during cyclone and tsunami. Local people are strongly recommended to move on to the landward side of the canal. This has to be treated as the most urgent strategy. In case the implementation of the above stated strategy is not possible, the following are recommended.

- **One more bridge adjacent to the existing one, with a higher deck slab of atleast about 1m above the present level and of greater width is recommended. The existing bridges are shown in photos 3.15 a, b & c.**

- **A seawall with a crest level of +6m with a berm and a strong toe of width about 3m along with a crown wall upto an elevation of +7.0m is recommended. In the portion between crown wall and seawall, plantations are strongly recommended.**

The scheme proposed is shown in fig.3.9. The details are to be worked out after measuring the levels at the site.

3.9 Kadiapattinam (N 8°8′7.6″ E 77°18′17″)

This stretch of the coast lies at the confluence point of the river Valliar (**photo 3.16**). It is proposed to construct two groins as training walls for this river mouth as shown in **fig.3.10.** The existence of natural outcrops can be seen in the **photo 3.17**, if supplemented by rock fill to serve as groin, should be considered.

3.10 Keezhamuttam (N 8°7′26.5″ E 77°19′19.4″)

Plantations are recommended on the East of Muttam stretch consisting of Pillathopputhurai, Melathurai and Alikkal. A close view of the existing seawall at Muttam is shown in **photo 3.18.** The crest of the seawall and land along this stretch are at same elevation. During monsoon, overtopping is reported by the local people. ***Hence, raising of the crest elevation by about 1 m is recommended (II nd phase)***.

3.11 Stretch from Pozhikarai to Mezhamanakudithurai

The enlarged version of the stretch of the coast from Pozhikarai to Manakudithirai is shown in **fig. 3.11. A distance of about 9 km from Pozhikarai to the western tip of Palayar river should be protected by 8 groins with an average length of about 200 m each of which would extend upto a water depth of 1.5 to 3 m.** The conceptual drawing of this layout is provided in **fig. 3.12,** which also includes a river training groin on the west of the mouth of the river palaiar. **The groin on the western and eastern tip of this river mouth will have groins extending up to a water depth of 5 m in order to avoid the siltation near the mouth of river Palayar.**

- **Pallanthurai** (N 8°5′57.1″ E 77°25′51″)

Damages to the houses land ward side of the shore is shown in **photo 3.19.** The beach which is formed, where the catamarans are parked as can be seen in **photo 3.20**, is of

temporary nature, as it gets eroded during the monsoon months. It is found that the land is at a lower elevation. The damage to the existing seawall is shown in **photo 3.21**. **It is recommended to raise the crest elevation of the seawall by 2.0 m. Further, two groins are recommended. The average length of the groins will be about 300 m which is included in the above figure. These two groins will act as protective measure only for the Pallanthurai stretch against erosion. Also, it is recommended to immediately stop the sand quarrying at this stretch.**

- **Mezhamanakudithurai** (N 8°5′36.3″ E 77°27′36.4″)

The sufficient beach width along this stretch of the coast is as shown in **photo 3.22 a & b**. Hence, plantations are recommended for this stretch for upto a distance of 2 Km. The damaged buildings due to tsunami in Mezhamanakudithurai is shown in **photos 3.23 a & b**.

- **Palayar River mouth** (N 8°5′20.1″ E 77°29′02.5″)

The Palayar river mouth is shown in **photo 3.24.** The collapsed bridge which is four spans with each span weighing 5000 T, due to tsunami is as shown in **photo 3.25.** This village is badly affected due to the tsunami. The existing seawall, as can be seen in **photo 3.26,** provided near the mouth of river Palayar is not stable as there is a considerable amount of erosion at the tip of the seawall as shown in the above photo. The damages just on landside of the seawall is shown in **photo 3.27.** As the damages to property and life are quite severe in this village, it is suggested that all arrangements should be made to relocate the dwelling units. Failing to do so, the groin field which is recommended in the next section should be associated with strengthening of the existing seawall with its crest elevation raised to + 5.35 m from MSL. Also the gaps in between the existing seawalls should be filled up.

3.12 Keezhamanakudithurai (N 8°5′16.7″ E 77°29′17.5″)

This village is located on the Eastern side of the river Palayar. The existing seawall completely disturbed is shown in **photo 3.28.** A number of dwelling units and churches got damaged as shown in **photo 3.29. Hence, a groin field for upto distance of 1.5 Km is recommended. Further, it is also recommended to raise the crest elevation of the existing seawall by 2.0 m.** The complete scheme of protection measure for these villages,

Mezhamanakudithurai and Keezhamanakudithurai including the training walls for the Palayar river mouth is shown in **fig. 3.13.** Western side of the palayar river will be protected with 8 groins and the eastern side of this river with 3 groins with a total average length of 200 m excluding the training walls.

3.13 Ratchagan street

This site is already protected by a series of 7 short groins. In order to achieve the required tranquility, it is proposed to extend the groins G1 and G5. Necessary rehabilitation to the existing groins which are disturbed due to tsunami is recommended.

3.14 Vaavuthurai

This is located on the western side of the Ratchagan street. This stretch is characterised by the presence of fishing hamlets. Hence, in order to protect the dwelling units along this stretch a seawall is recommended. The details of the protection measure are already planned by Nagerkoil division of PWD.

Tirunelveli district

3.15 Kootupuli (N 8°8′47.6″ E 77°36′09.5″)

The stretch of the coast of this district is shown in **fig 3.14.** The beach widths North and South along this stretch of the coast are shown in **photos 3.30 and 3.31.** The presence of the rocky outcrops offers considerable attenuation to the waves. In this stretch of the coast, the shoreline oscillates as per monsoon and the net effect is a stable shore line. **Hence, no protection is necessary at present.**

3.16 Perumanal (N 8°9′33.2″ E 77°38′52″)

This stretch of the coast is located at the confluence point of the river Hanumanadi. The view of the beaches on the northern and southern side is as shown in **photos 3.32 & 3.33.** The beach is said to be more or less stable with seasonal oscillations. Although, damages due to tsunami was very less compared with other stretches of the Tamilnadu coast, the river mouth which is shown in the above photos is completely closed and opens during the monsoon season. The coast protrudes on the northern sides of this stretch. **It is recommended that no intervention is necessary at present, except for plantations.**

3.17 Idinthakarai (N 8°10′40.5″ E 77°44′46.8″)

There is a penetration of the shoreline into the land forming a bay like feature as can be seen in the **photo**s **3.34 and 3.35.** Just south of this area, the presence of outcrops act as barriers for the propagating waves on to the land. **A long groin of about 200 m upto a water depth of 5 m on the South and two small groins on the Northern side is recommended which is shown in the fig.3.15.** This will help in enhancing the livelihood of the local fishing community, where a number of boats is in operation.

3.18 Koothankuli (N 8°12′59.4″ E 77°46′55″)

The fishing activity is quite hectic in this location and there are about 500 boats. The views of the coast on the Northern and Southern sides are shown in **photos 3.36 and 3.37.** It is learnt that there is a long pending request for a groin. A pair of groins is recommended for protecting the coast and one of the groins, i.e, the southern groin is slightly to be bent. This pair of groins will not only serve for the coastal protection but also help the local fishermen to park their boats. **The average length of the groins will be about 250 m.**

3.19 Alanthalai (N 8°27′53.7″ E 78°06′2.5″)

The beach on the Northern and Southern sides of the stretch of the coast of this location are shown in **photos 3.38 and 3.39.** This stretch of the coast of about 1.5 Km having a number of houses just adjacent to the shoreline. From the local PWD Engineers and public it is understood that this beach front which is shown in the above photos will get totally sacrificed to the sea during monsoon. Hence, the beaches shown here are seasonal formation. The fishing activity is quite hectic in this area. **This stretch of 1.5 Km has to be protected by a groin field consisting of 6 groins, each with an average length of about 250 m. The groins will be of transition type and one or two groins have to be bent to take the shape of 'Thoondilvalivu' to create the landing facility for the boats, which is as shown in fig. 3.16.** This area is a promising area for fishing and needs considerable attention to coastal protection which will also cater to the needs of the local fishermen community. It may be recalled that the PWD has already come up with a proposal for a Rubble mound seawall, but the local public has rejected the proposal, as this would hamper their fishing activity.

3.20 Punnakayal (N 8°38′12.8″ E 78°07′19.9″)

This river mouth South of Tuticorin harbor as shown in **photo 3.40** closed during most parts of the year. There is a lot of fishing activity and the fishermen are using an existing jetty. **Two long rubble mound training walls on either side of the mouth extending up to a water depth of 6 m, would be a remedial measure for this problem. The length of the training walls would be between 300 – 350 m.**

3.21 Threspuram (N 8°48′55.4″ E 78°09′47.6″)

The huge number of boats as well as a colony adjacent to the coast is shown in **photos 3.41 & 3.42.** The local public and PWD officials claim that about 100 m of beach has been sacrificed to the sea. **This is an area which can be considered for two long groins. The approximate length of the groins, the layout of the groins for this location is as shown in fig. 3.17.** This scheme will prevent further erosion of the beach and as well as help the fishermen for safe landing and operation of their boats.

Ramanathapuram District

This stretch of the coast shown in **fig. 3.18** is in the shadow of Srilanka. The island of Srilanka act as a huge barrier even in the case of future tsunami, it is felt that the damage to this coast will be minimum. Further, the stretch of the coast is in a bay formation with not much littoral drift activity.

3.22 Stretch from Devipattinam (N 9°28′22.2″ E 78°53′57.9″) to **Nambuthalai** (N 9°43′23.4″ E 79°00′25.2″)

This stretch of the coast covers Devipattinam, Thirupalakudi, Morpannai, Mullimanai and Nambuthalai. For all the above stretches, the details of the shoreline changes are not clearly evident. From local public, it was heard that there is continuous erosion but not alarming. Only during cyclones, damages have taken place. Tsunami did not affect this area. It is strongly suggested that measurement pillars may be erected for three sites to carryout the crest of berm variation for atleast 2 years. The methodology for erecting these pillars and monitoring of the shoreline is available with IHH Poondi. Their expertise may be utilized by the division in the monitoring of the shoreline changes. For the present, nothing need to be done. For Nambuhalai, in between the shoreline and an existing road there are number of hutments which are not permanent type may be

relocated. As regard to protection measure, monitoring of shoreline for another two years is needed. No hard measures are suggested for this location as the sediment transport is almost nil and the shoreline oscillations are just temporary. Enormous amount of sea grass is available. **Hence, Plantations are recommended.**

Photo 3.1 View showing the width of the beach at Neerodi Colony

Photo 3.2 View showing a number of catamarans parked adjacent to beach at Marthanduthurai

Photo 3.3 The existing seawall at Chinnathurai

Photo 3.4. The top of the seawall being effectively used by fishing community

Photo 3.5 View showing the confluence point of river Kulathuraiaar at Erayumanthurai

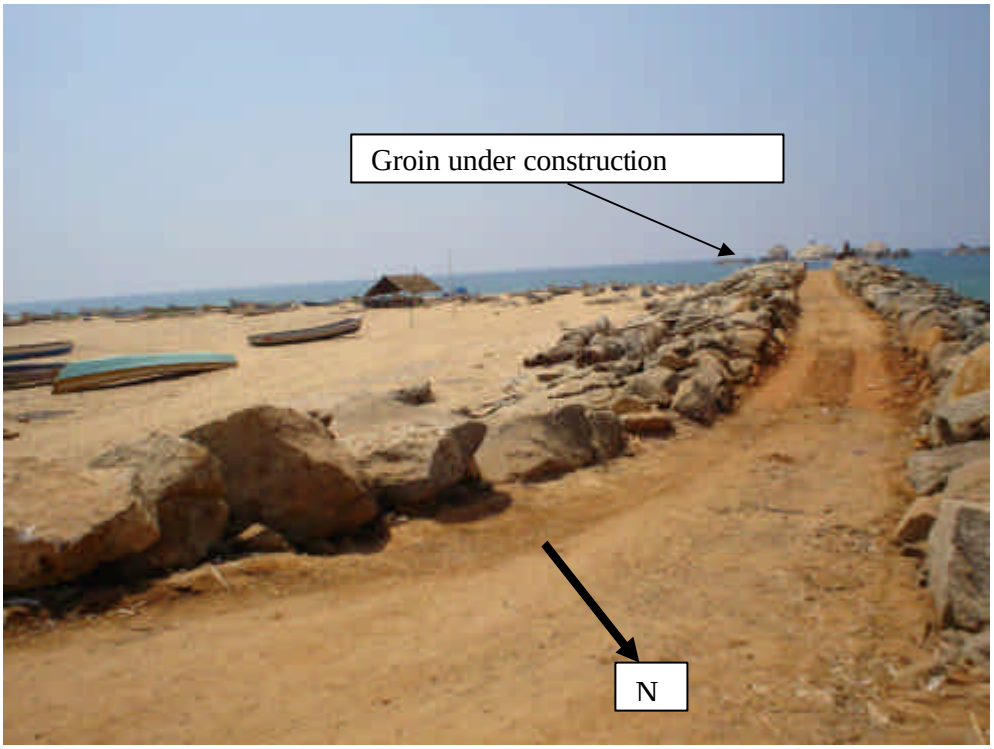


Photo 3.6 View showing the beach formed on the Eastern side of the groin under construction at Enayam

Photo 3.7 A number of dwelling units on the Western side of the groin, under threat

Photo 3.8 Outcrops east of G1G2 of Kurumbunai to connected to serve as a groin

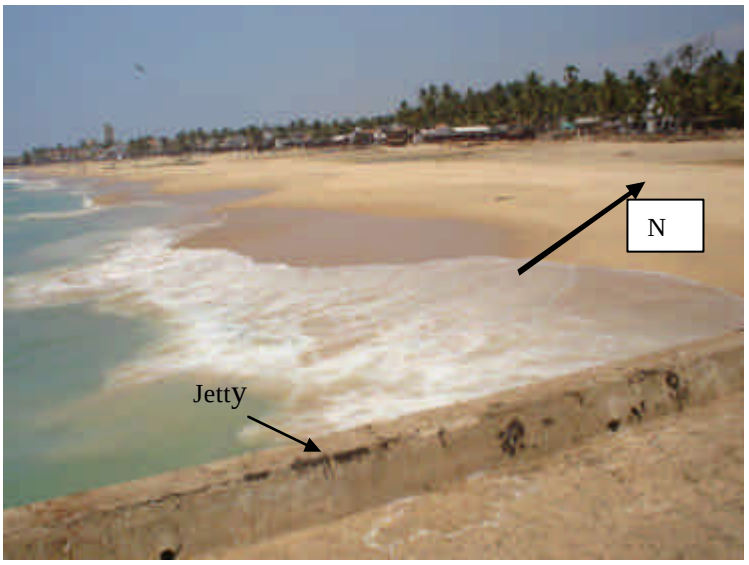


Photo 3.9 View of the flat beach on western side of Colachel Jetty

Photo 3.10 View of the flat beach on Eastern side of Colachel

Photo 3.11, 3.12 & 3.13 Views of the damage caused due to penetration of tsunami

Photo 3.14 View showing a road formed with the debris removed along the coast at Kottilpadu

Photo 3.15, a, b & c. Views of the bridges at Kottilpadu, Colachel.

Photo 3.16 The confluence point of the river Valliar at Kadiapattinam

Photo 3.17 Rocky outcrops acting as groins near Kadiapattianam

Photo 3.18. A close view of the existing seawall

Photo 3.19 The damaged houses due to tsunami at Pallanthurai

Photo 3.20 View of the seasonal beach where catamarans are parked

Photo 3.21 The damaged existing seawall at Pallanthurai

Photo 3.22 a & b Views showing the sufficient beach widths at Mezhamanakudithurai

Photo 3.23 a & b View of the damaged houses due to at Mezhamanakudithurai

Photo 3.24 View of the Palair river at Mezhamanakudithurai

Photo 3.25. The collapsed bridge on Palayar river

Photo 3.26. Erosion at the tip of the seawall

Photo 3.27. Damages on the leeside of the seawall

Photo 3.28. The damaged existing seawall at Keezhamanakudithurai

Photo 3.29. The damaged church and dwelling units

Photos 3.30 & 3.31. Views showing Beach widths North and South of Kootupuli.

Photos 3.32 & 3.33. Views showing Beach widths North and South of Perumanal.

Photo 3.34. A view showing the bay like formation at Idinthakarai.

Photo 3.35. A view showing the rocky outcrops at Idinthakarai.

Photo 3.36 and 3.37. Views showing the beaches on the North and South of Koothankuli

Photo 3.38nd 3.39 Views showing the beaches on the North and South of Allanthalai

Photo 3.40 View showing the river Punnakayal

Photo 3.41 Views showing the fishing boats at Threspuram

Photo 3.42 Views showing the colony at Threspuram

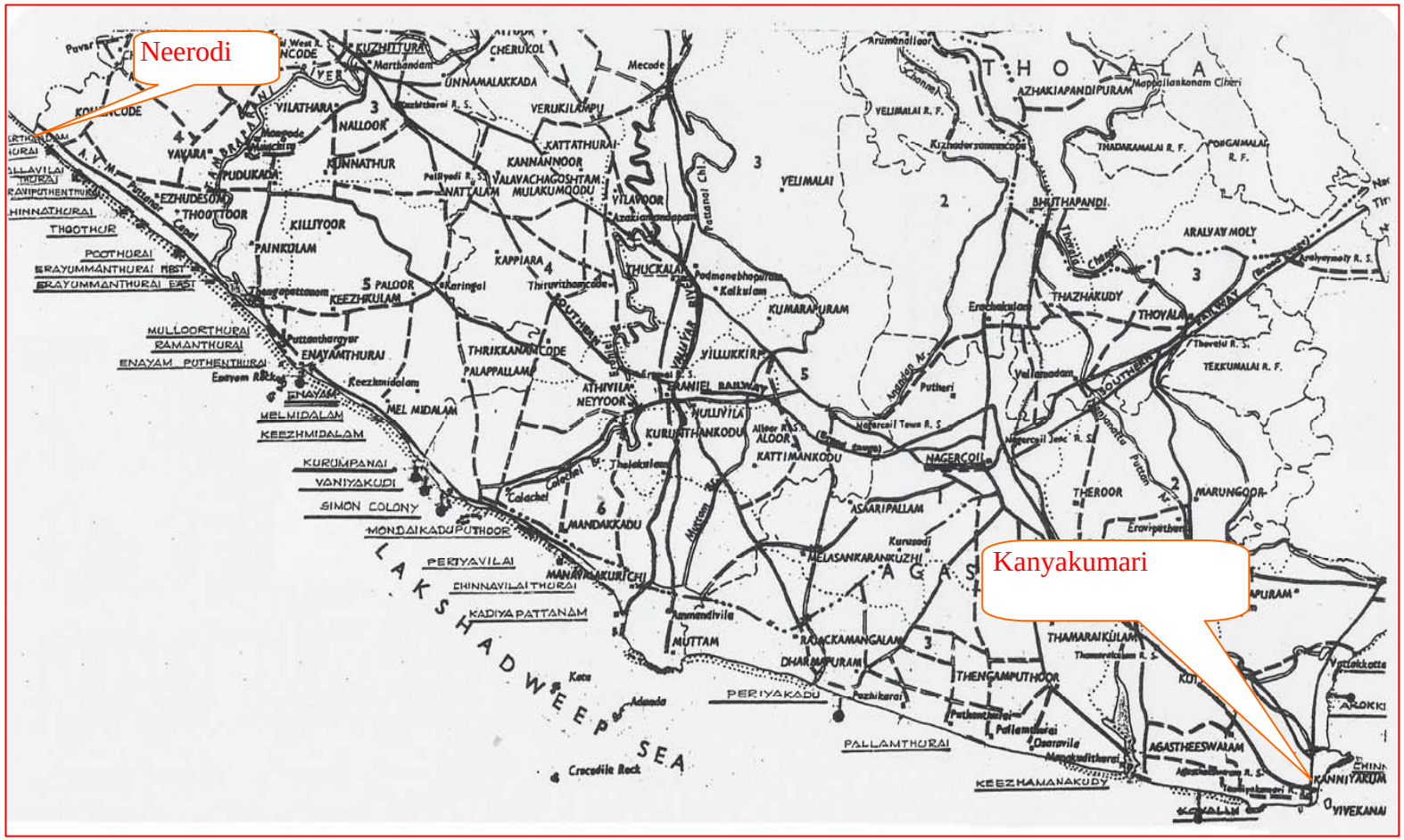


Fig.3.1 The stretch of the coast from Neerodi to Kanyakumari

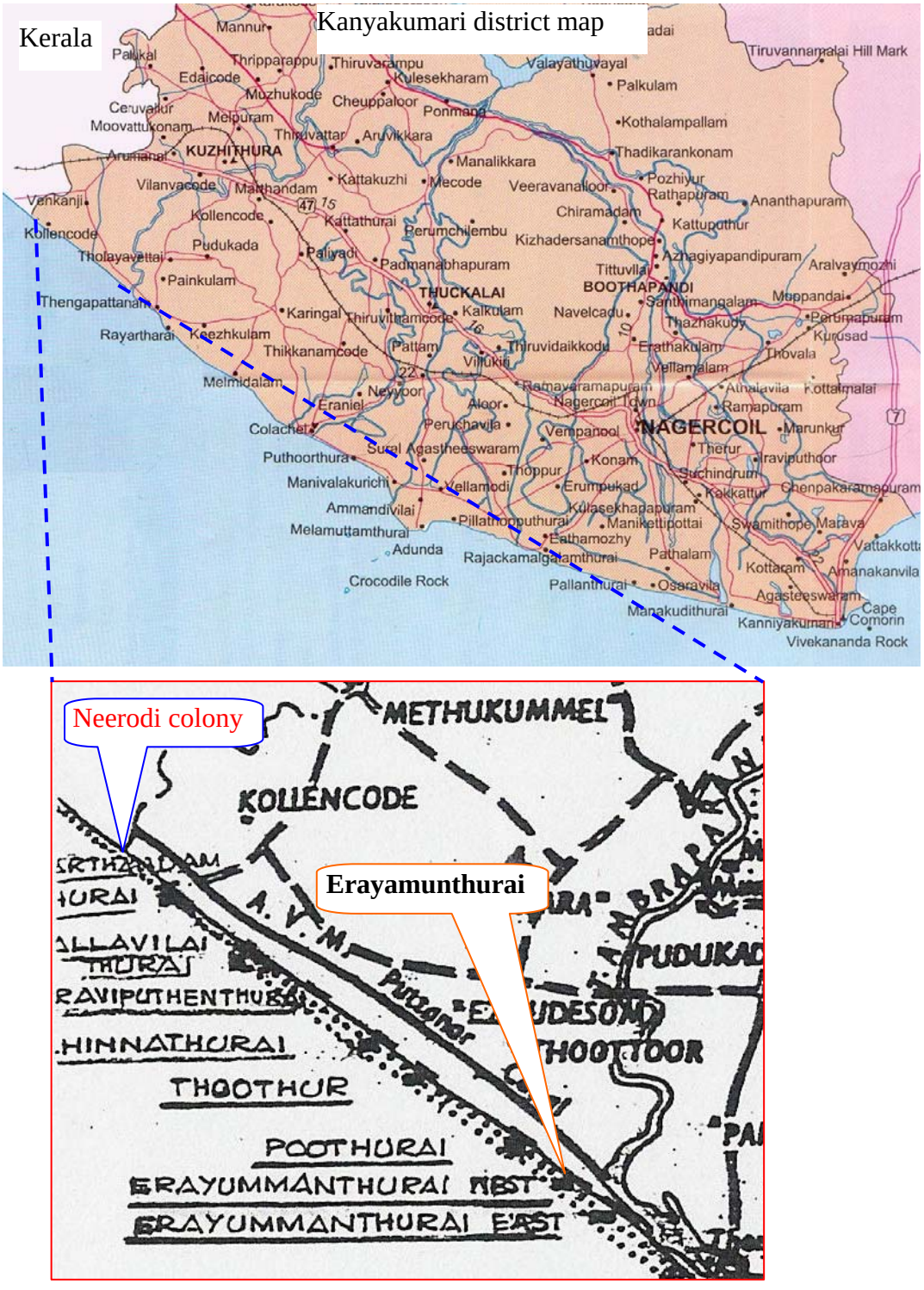


Fig.3.2 The stretch of the coast from Neerodi colony to Erayamunthurai

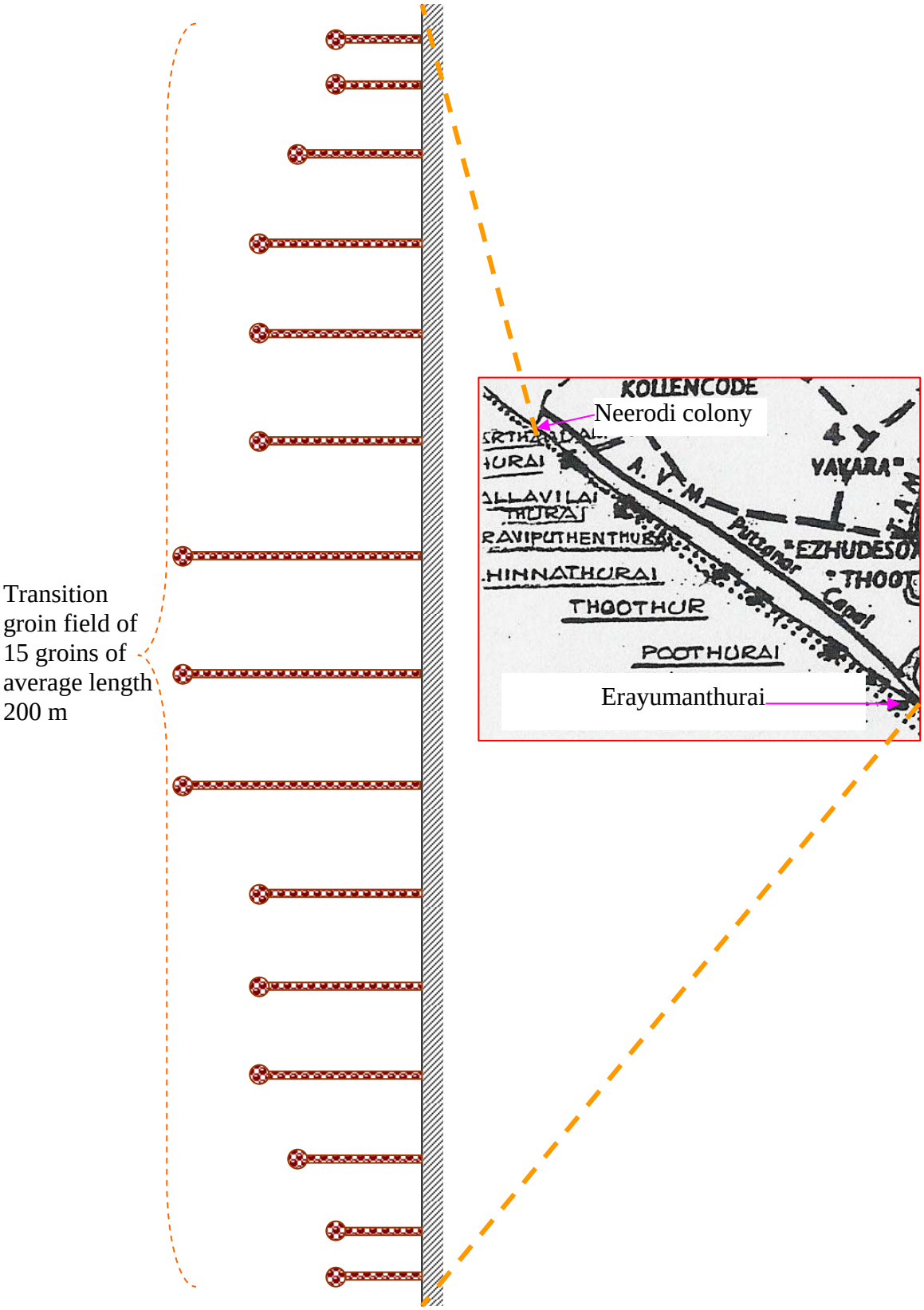


Fig.3.3. The scheme suggested for protecting the stretch from Neerodi colony to Erayumanthurai

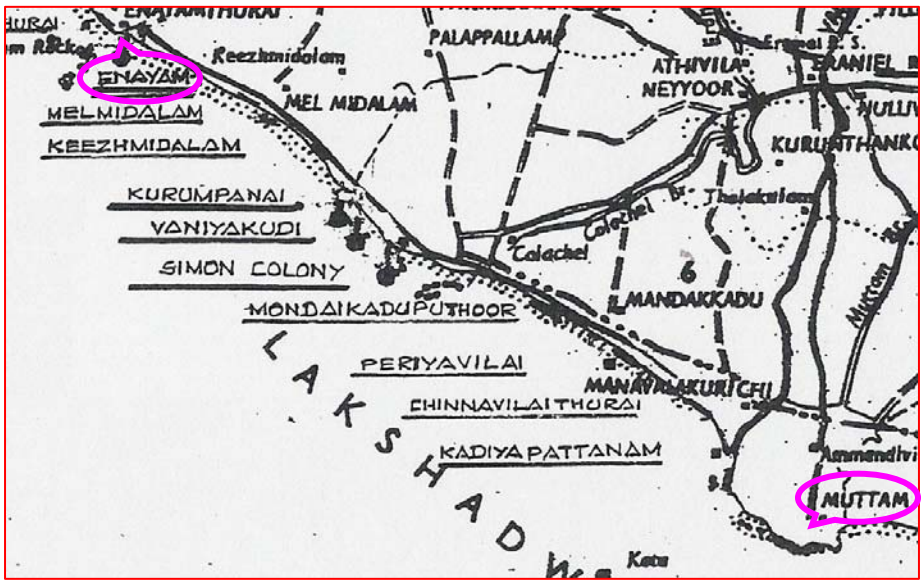


Fig.3.4 The Stretch of the coast from Enayam to Muttam

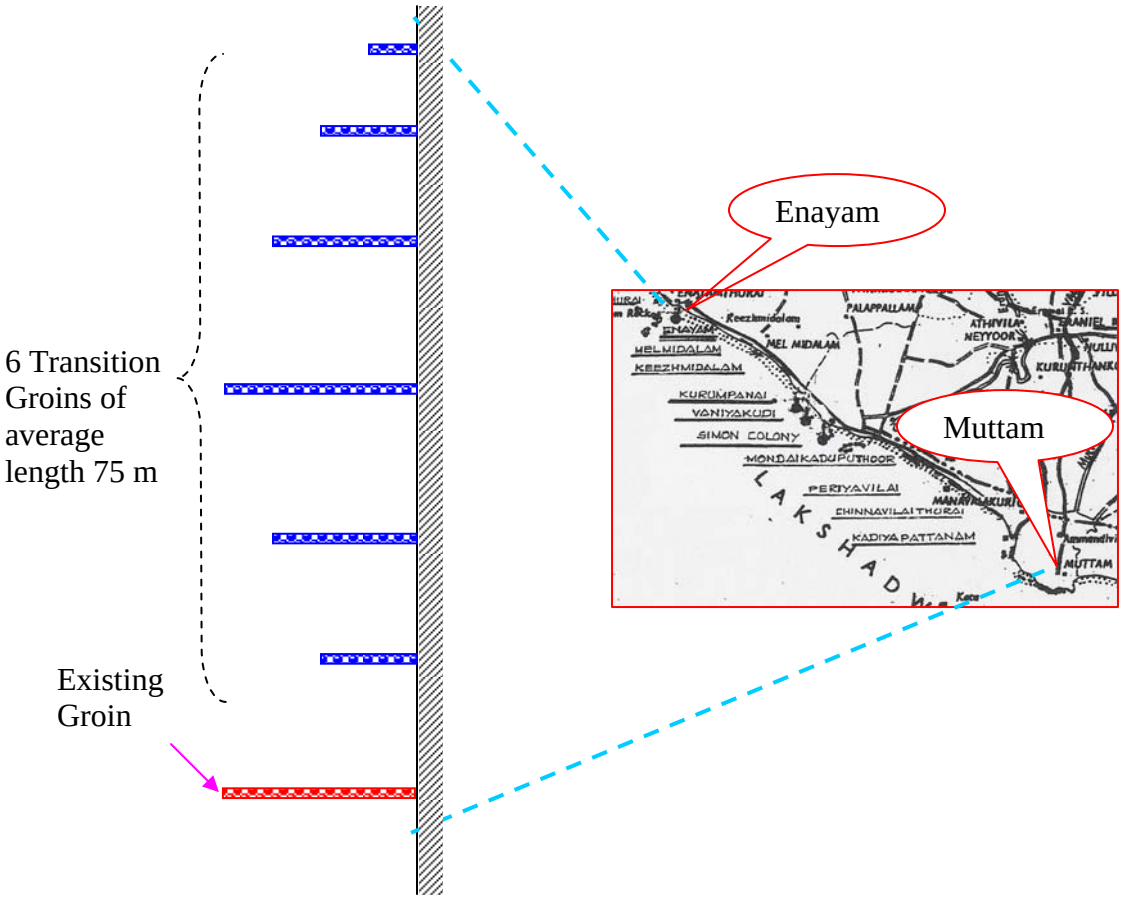


Fig.3.5 The proposed groin field for the stretch of the coast from Enayam to Muttam

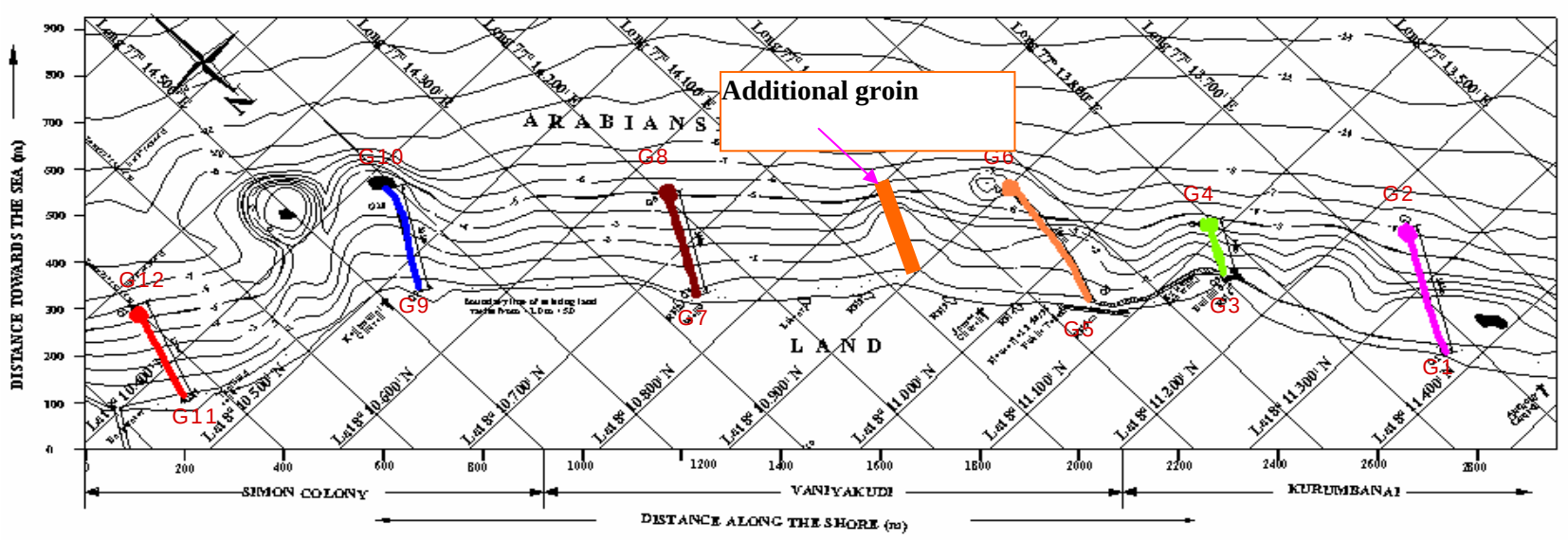


Fig.3.6 The proposed additional groin at Vaniyakudi

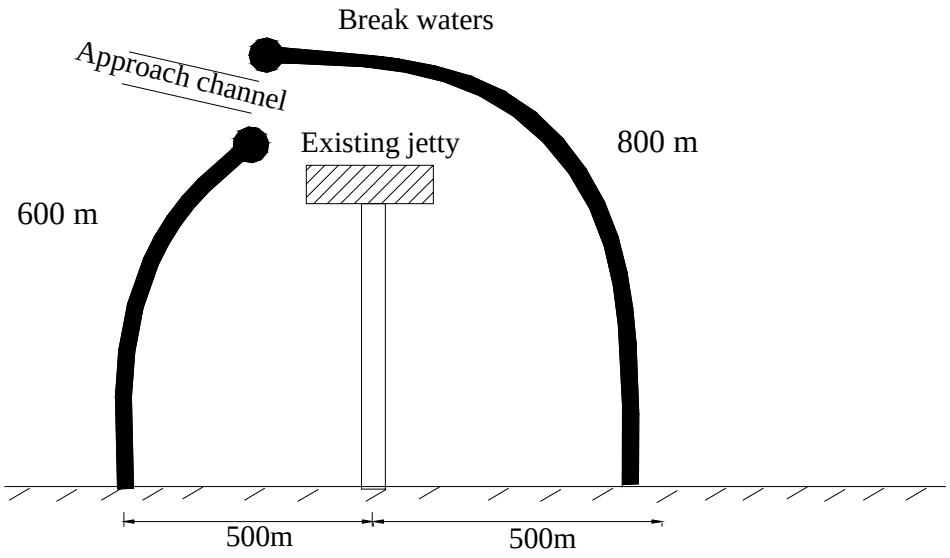


Fig.3.7 Proposed Groins (Thoondil valivu) at Colachel Jetty

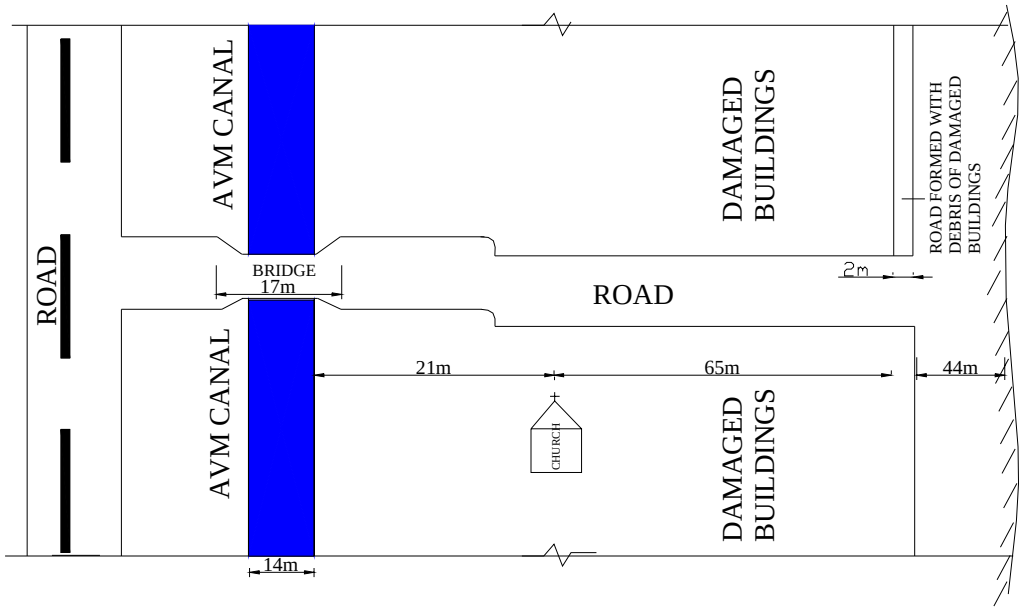


Fig.3.8 Plan of a damaged area Kottilpadu Colachel

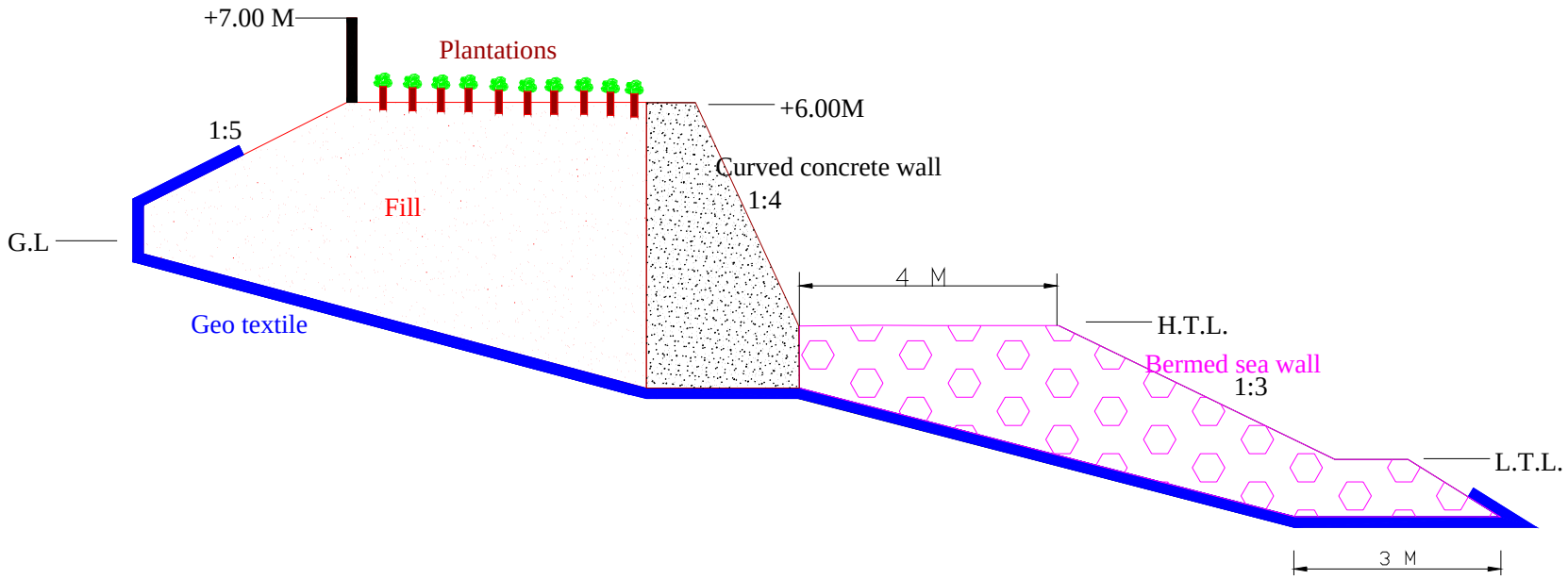


Fig.3.9 Proposed Seawall for a distance of 1 Km at Kottilpadu. Colachel

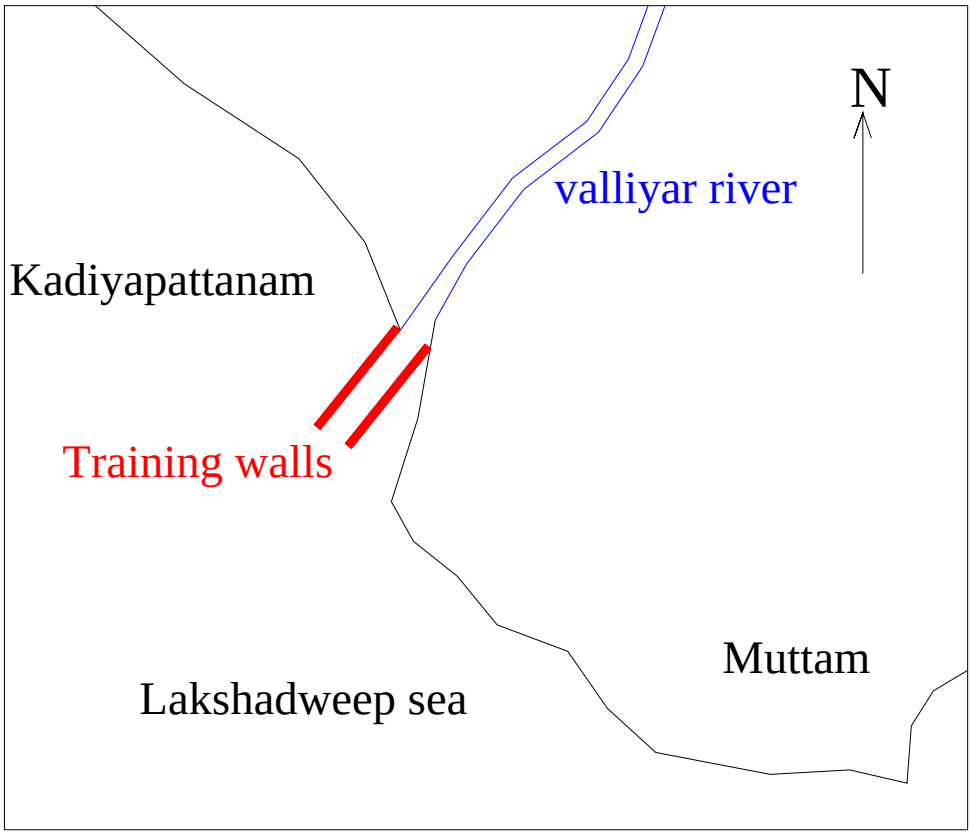


Fig.3.10 Training walls for river Valliyar at Kadiyapattanam

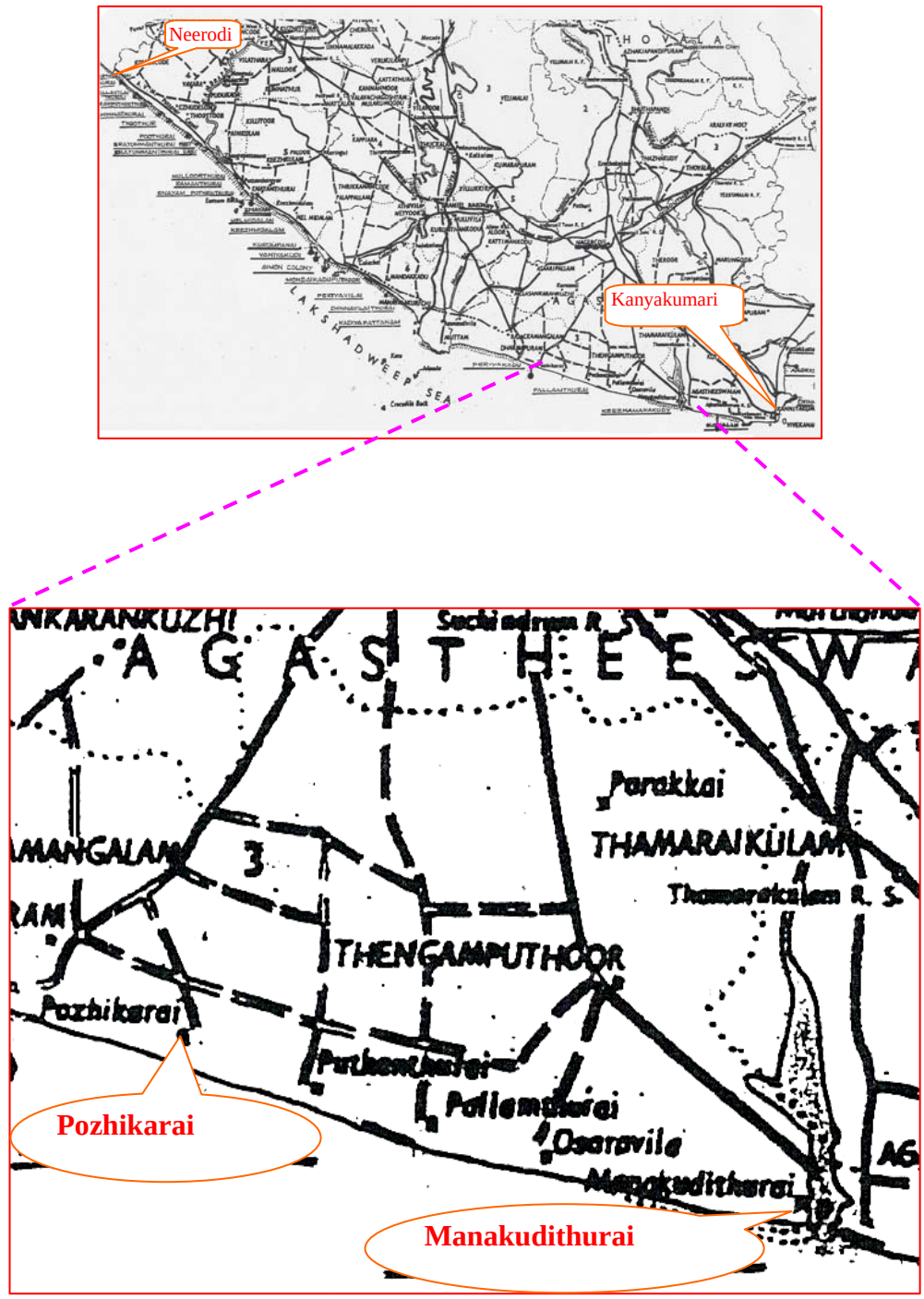


Fig.3.11 Stretch of the coast from Pozhikarai to Manakudithurai

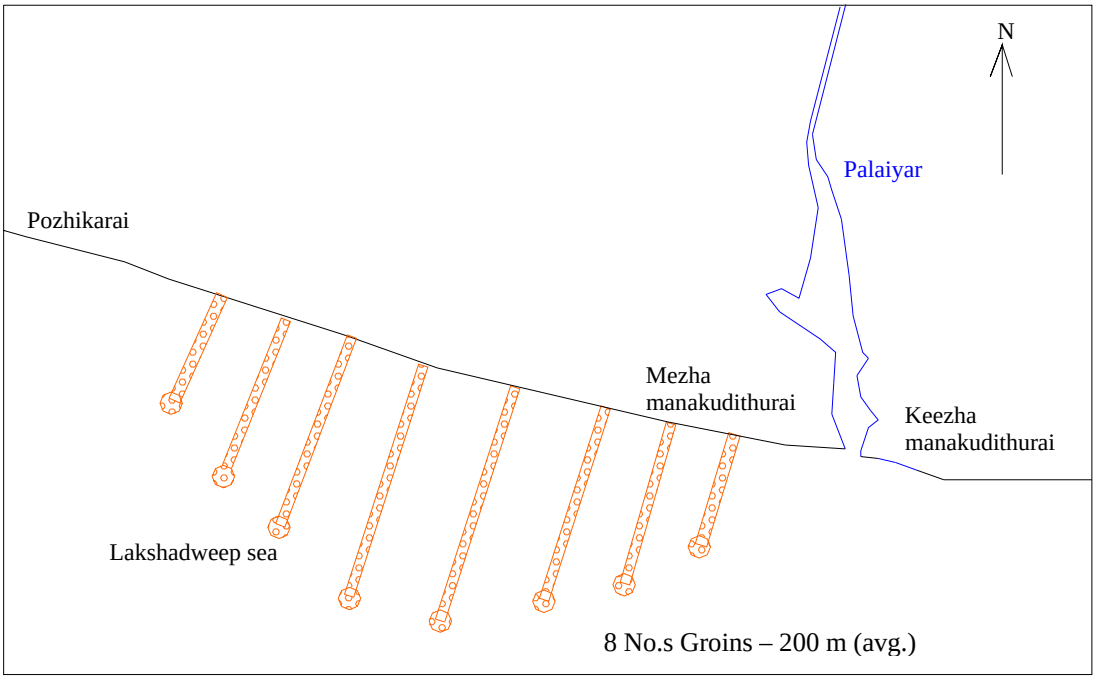


Fig.3.12 Proposed transition groin field in the Stretch of the coast from Pozhikarai to MezhaManakudithurai

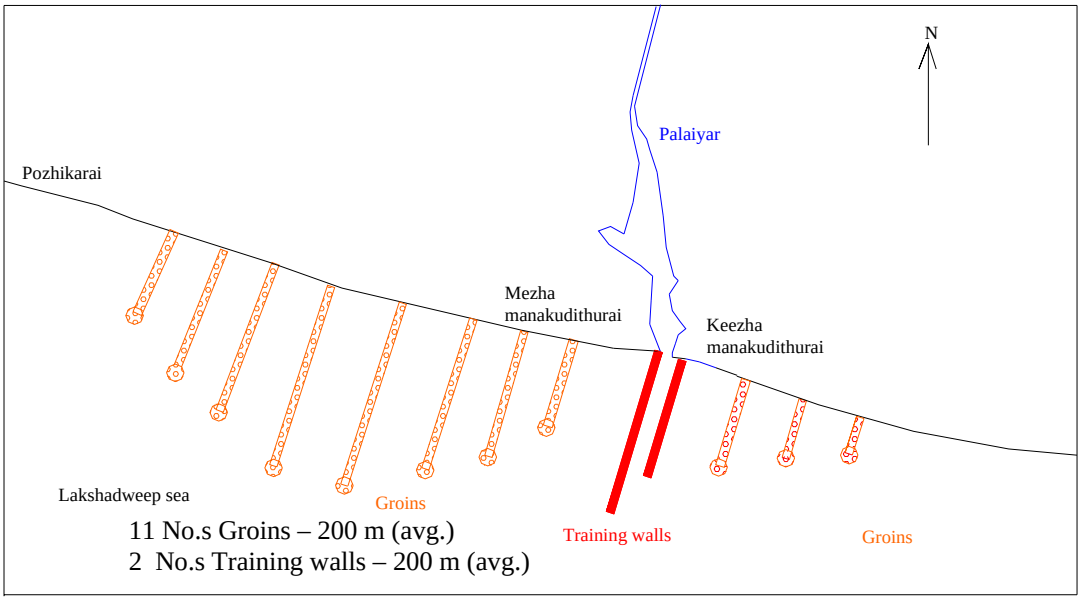


Fig.3.13 Complete Scheme of protection at Manakudithurai

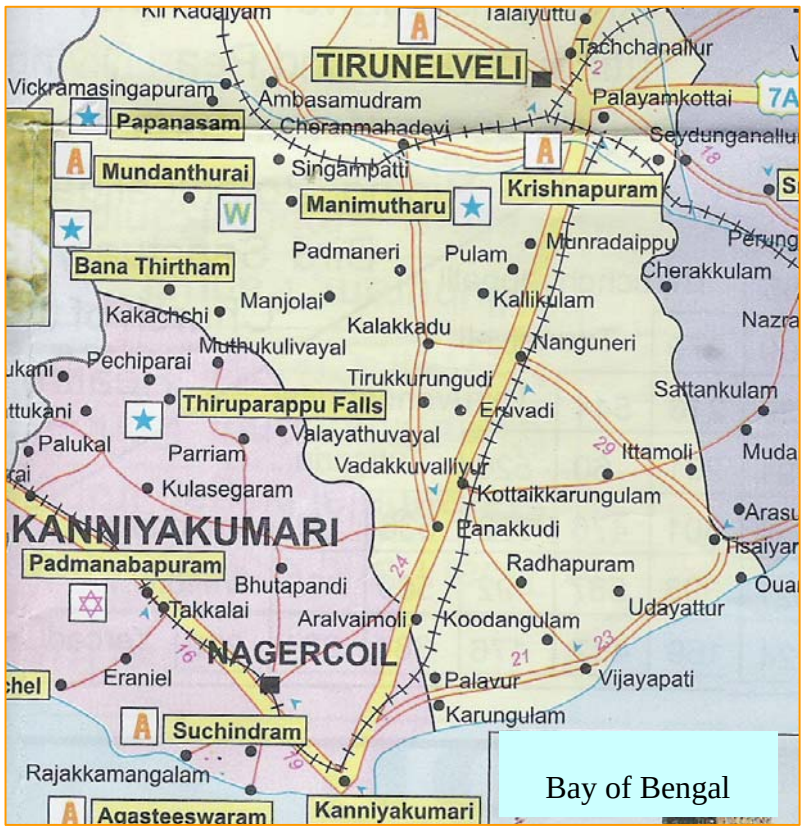


Fig.3.14 Stretch of the coast along Tirunelveli district

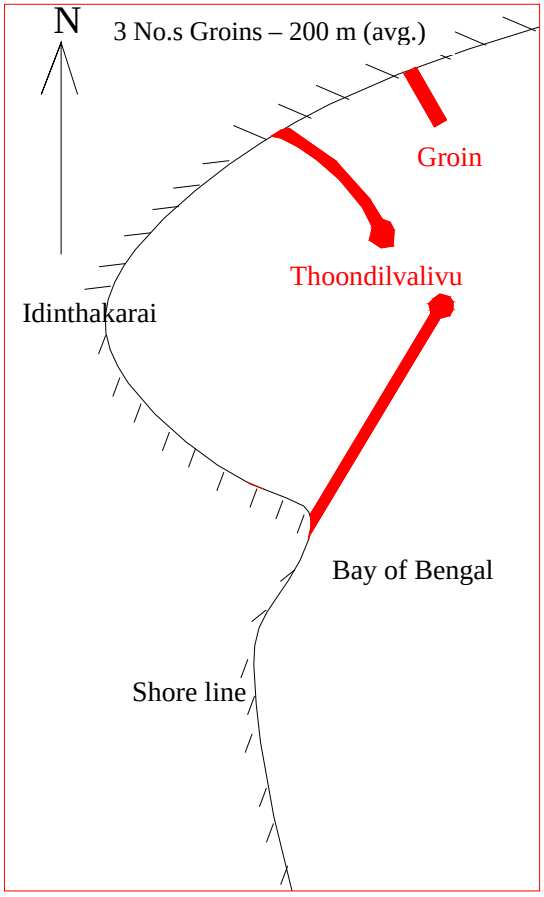


Fig.3.15 Protection measure at Idinthakarai

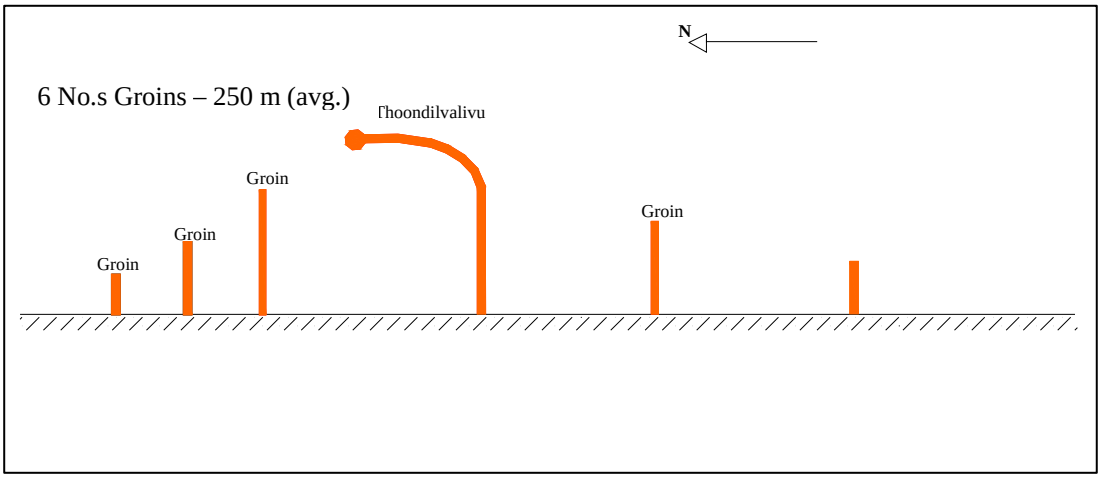


Fig.3.16 Transitional groin field at Alanthalai

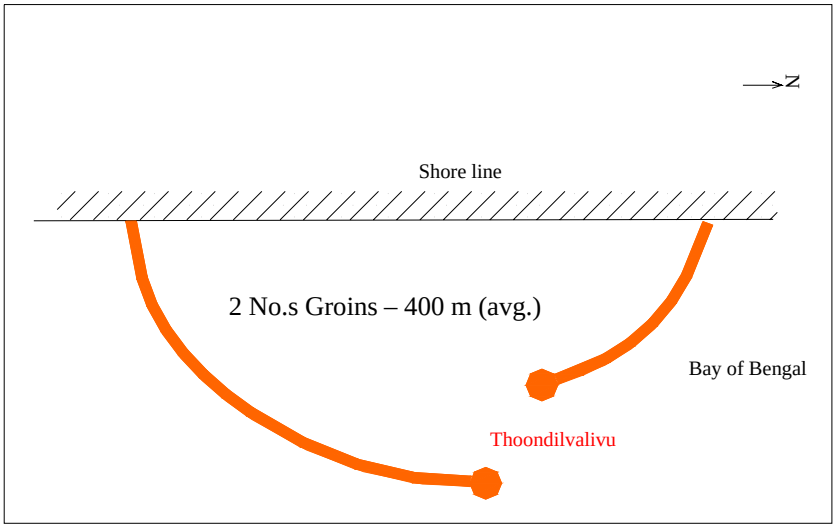


Fig.3.17 Transitional groin field at Threspuram

Fig.3.18 The stretch of the coast of Ramanathapuram District

CHAPTER 4
PROTECTION MEASURES FOR TRICHY REGION

Nagapattinam District

In order to detect the areas of vulnerable erosion in Nagapattinam and Tiruvarur districts, Prof. V. Sundar, IIT Madras accompanied by Mr. M. Moorthy, E.E., Mr. R. Sivalingam, A. E. E., Mr. S. Sakaraivel, A.E.E., Mr. Pandian, A.E., Mr. Sankar, A.E., Mr. Bhaskar, A.E., Mr. P.K. Suresh, A.D., started their survey from Nagoor, Nagapattinam District on 26th February, 2005.

4.1 Nagoor (N 10°49′18.4″ E 79°51′04.4″) to Keechankuppam (N 10°45′16″ E 79°50′57.8″)

4.1.1 General

The Nagapattinam coastal district map is shown in **fig. 4.1.** The different stretches **(A, B & C)** of the above coast are indicated in this map. The stretches are:

Stretch A Pattinacheri, Nagore to Keechankuppam

Stretch B Velanganni to Vellapallam

Stretch C Tharangampadi to Palayur

The stretch of the coast from Nagoor to Keechankuppam (**stretch A**) is at about 0.6 m above the MSL as per the PWD officials. This coast is severely hit frequently during most cyclones that had generated in Bay of Bengal in the past. During the tsunami, the water has penetrated upto a distance of about 1 Km and a run-up height of about 8.0 m with a great velocity mainly because of the flat beach that exist in this stretch of the coast. Several casualties have been reported and damage to property is shown in **photo 4.1.** The CPCL loading jetty and the beach North of this location is shown in **photo 4.2.** The beach South of this location is shown in **photo 4.3.** The watermark on a compound wall about 1 Km from the shoreline as shown in **photo 4.4** indicates the penetration distance. The shoreline in this stretch has been oscillating and the local people have stated that prior to the tsunami, the shoreline was at a location 30 – 50 m from its present location. The remedial measures are discussed in **sec.4.1.2.**

Nagapattinam port (N 10°45′57.7″ E 79°51′03.7″)

The barren land North of Nagapattinam port shown in **photo 4.5**, is an excellent place for dense plantations. The presence of the vertical wall (top level +2.7 m MSL) as shown in **photo 4.6,** constructed for the Nagapattinam port at a distance of about 60 m from the shoreline has acted as a barrier only marginally against the powerful tsunami. In spite of the presence of this wall, a number of boats were carried away to the land and water on its rear side has moved to a distance of 300 m and a height of about 8 m. The damaged boats behind the vertical wall are shown in **photo 4.7**, and the damaged portion of the vertical wall is shown in **photo 4.8.** The remedial measures are discussed in sec.4.1.2.

Keechankuppam (N 10°45′16″ E 79°50′57.8″)

This is the worst affected area with in the **stretch 'A'** due to tsunami and a number of casualties and loss of property were reported. The plantations as shown in **photo 4.9** have just begun along the coast. The artificial sand dune at this stretch is shown in **photo 4.10**. It is to be stated that the plantations should be denser compared to what has been done as of now. The tsunami has resulted in uprooting of several bridges and houses along this stretch (**Photos 4.11 a & b)**. The remedial measures are discussed in sec.4.1.2.

4.1.2.Recommendations for the Stretch 'A'

Implementation of Coastal Regulation Zone (CRZ) Act, now that the area is already been cleared, has to be enforced on top priority. Dense plantations as a long-term measure for a distance of about 9 Km is recommended (Nagoor to Keechankuppam) protecting about 6 villages with in this stretch of the coast. The recommendation is made for the two stretches namely, (**between Kallar and Kaduvayar river mouths)** and **(Nagore to Kaduvayar river mouth).** As littoral drift in this stretch is more towards the North and the coast is of sandy type, T – shaped groins would certainly trap the sediments and also retain the same with in them for the stretch between Kallar and Kaduvayar river mouths. In order to minimize the inundation of sea water into the land, a seawall is recommended. As the coast is just 0.6 m above MSL, a seawall is also recommended for the entire stretch of the coast. The details of the proposed layout for the stretch between the rivers Kaduvayaar and Kallar to protect the stretch of the coast in Keechankuppam are shown in **fig. 4.2a & 4.2b. The average length of the groin**

including the T portion for estimation purpose would be about 250 m. The construction of the groin field should be carried out in Phase – I and the construction of the seawall is recommended in phase – II after careful monitoring the shoreline. The proposal is only for planning purpose and the detailed design has to be worked out later after carrying out a bathymetry survey.

For the stretch (**Nagore to Kaduvayar river mouth), it is recommended to construct fifteen number of T-shaped groins with an average length of about 250 m as shown in fig. 4.3.** If in case the suggested remedial measure does not accelerate the beach formation, only then the construction of the seawall should be considered the cross-section of which, will be decided at the appropriate time after detailed studies.

In addition to the above, the rivers Kaduvaiyar and Kallar need to be provided with two training walls each with an average length of about 300 m as can be seen in fig. 4.4. The complete protection measures for the entire **stretch 'A'** are shown in **fig. 4.5**.

4.2 Velankanni (N 10°40′48.6″ E 79°51′09.2″)

The damaged bridge connecting Nagapattinam and Kallar in the **stretch 'B**' is shown in **photo 4.12**.The hutments close to the beach have been washed away by the recent tsunami. A clear width of beach is available as can be seen in **photo 4.13.** The river Vellayar (**photo 4.14)** joins the sea adjacent to this stretch of the coast and is shown in the above photo. **It is recommended to dredge the mouth of river Vellayar and nourish the beach on its Northern side as well as to construct a sand dune. Plantations backed up with sand dunes and masonry buffer blocks are recommended for this stretch of the coast as shown in the fig. 4.6**. Both plan and sectional elevation of the proposed are shown in the above figure. The buffer blocks may also serve as a relaxing facility for the pilgrims and locals. After monitoring the shoreline for a period of about 2 years, a decision can be taken up on the necessity of a hard measure.

4.3 Vellapallam (N 10°31′20.7″ E 79°51′37″)

This location in **Stretch 'B'** is near the confluence point of the Nallar Straight cut**.** This area can be taken up for dense plantations as hutments are away from the shoreline at

a distance of about 200 m. The shoreline is found to be stable and the beach south of this stretch is as shown in **photo 4.15**. Two long training walls for the improvement of the mouth of Nallar Straight cut should be taken up as shown in **fig 4.7**.

4.4 Tharangampadi (Tranquebar) (N 11°01′32.4″ E 79°51′23.1″)

This stretch of the coast (**Stretch 'C'**) at Tharangampadi comes under the protection of monuments and places of National heritage. The Tranquebar fort, seawall, temple and the Governor's Bungalow / hotel along with the groins (constructed long back for which no details are available with PWD) are presented in **photo 4.16.** A figure showing the location of the existing groins and the seawall is presented in **fig 4.8**. The length of the groins and the spacing between them has made the scheme totally ineffective in trapping the sediments. A view of the fort and the existing seawall and groins taken from A-A on its southern side is shown in **photo 4.17**. A view on the northern side from A-A (**photo 4.18**), show the erosion along the Tharangampadi village. **It is recommended to rehabilitate the groin A-A with a proper head with a top elevation of +3.35 m. Also, an extra groin of length 70 m at a distance of 50 m South of A-A is recommended. The existing two groins on the South of A-A should be rehabilitated and the length should protrude to a distance of 50 – 60 m from shoreline with a top level of +3.35 m. Plantations on the leeside of the existing seawall is recommended as a long-term measure.** The proposed scheme is shown in **fig 4.9.**

The village Sathankudi (N 11°01′52.7″ E 79°51′19.6″), located North of the fort has suffered huge loss of life and dwelling units. The water has penetrated about a distance of about 750 m from the shoreline. The watermark due to tsunami on the compound wall is shown in **photo 4. 19.** A view of the damaged village of Sathankudi after having been leveled to some extent is shown in **photo 4.20**. The PWD has a proposal for construction of a seawall for a distance of about 850 m from the existing seawall. While, the construction of the seawall is recommended, the crest level has to be at + 4.35 m. In addition to the seawall, **a groin field consisting of 5 transition groins of average length of 100 m, with one or two groins to be bent to be formed as 'Thoondilvalivu'.** The above mentioned scheme is as shown in **fig. 4.10**. This will help the fishing community as there are number of boats. The Rubble mound seawall may be considered after construction of the groins and monitoring the shoreline changes. **In the barren land due to the damaged houses, plantations are recommended.**

4.5 Poombuhar (N 11°08′37.8″ E 79°51′27.8″)

The beach south side of the above location protected by an existing seawall is shown in **photo 4.21**. The North side of this stretch is shown in **photo 4.22**. The tsunami has penetrated to a distance of about 75 m from shoreline with a run-up of about 1.5 m. The performance of the existing seawall is good as beach has formed. However, the seawall has to be rehabilitated with a crest elevation of + 4.3 m. The North of this village has to be protected by a seawall for a distance of about 650 m as shown in **fig. 4.11**. The large extent of barren land is to be developed with plantations.

4.6 Vaanagirikuppam (N 11°07′50.4″ E 79°51′28″)

This stretch of the coast is South of Poombuhar and South of Cauvery infall point. This is a location, where, a number of casualties and damages to houses have taken place. The damages on the Southern side of the location (**photo 4.23**) show the land has been cleared. The damages on the Northern side of this stretch are shown in **photo 4.24**. **This area has again been cleared of the debris and barren land is an ideal location for plantations. The government should take immediate steps for plantations. The beach can be protected by groin field and rubble mound seawall with cross-section similar to Tharangambadi.**

4.7 Pudukuppam (N 11°10′07.4″ E 79°51′18.2″)

The entire village has been washed out and the people have totally abandoned their houses. Only plantations are recommended in this stretch of the coast shown in **photo 4.25.**

4.8 Palayur (N 11°21′14.6″ E 79°49′44.5″)

A number of casualties and damages to the property have taken place in this stretch of coast. Typical damages are shown in **photo 4.26.** As the village is right on the banks of river Coleroon, **one suggestion is to retain the dunes already constructed by the local people** (**photo 4.27**) and the top level of the dune may be further raised. The ditch in front of the dune should be shifted to rear side of the dune. The dune should take the shape as shown in **fig. 4.12** for a distance of about 1 Km. Plantations on the seaside and on the dune are recommended. **No further construction of houses should be allowed along this stretch. As a long term measure, the dunes can be converted to revetments or with**

Geo-tubes with its top level of + 6.0 m above MSL. For this purpose, the shallow regions can be dredged and the dredged spoil can be used for the creation of the dune. The wide mouth of the river Cooleron is shown in **photo 4.28**. A portion of the bank can also be planned for landing jetty in future after the protection of the river bank with spurs. The details of the proposed scheme are shown in **fig. 4.13**.

4.9 Thirumalaivasal (N 11°14′31.5″ E 79°50′37.9″)

The local people report a number of casualties and damage to property. This stretch of the coast is at the confluence point of the river Vellapallam Uppanar as shown in **photo 4.29**. Entire stretch needs to be dredged and a bund has to be created using this dredged spoil for a distance of about 1 Km from the mouth. Two training walls, at the mouth of the river Vellapallm Uppanar as shown in **fig. 4.14**, are recommended. A few spurs along the banks of this river need to be provided in order to divert the flow into the ocean. Plantation along the banks of the river is recommended.

Photo 4.1 Damages to the property at Nagoor

Photo 4.2 The CPCL loading jetty at Nagoor

Photo 4.3 View showing beach South of Nagoor

Photo 4.4 Watermark on a compound wall 1 Km away from Shoreline at Nagoor

Photo 4.5 View showing the barren land North of Nagapattinam port

Photo 4.6 Presence of Vertical wall constructed at Nagapattianm port

Photo 4.7 Damages to the boats on rear side of the vertical wall at Nagapattinam port

Photo 4.8 View showing the damaged portion of the vertical wall at Nagapattinam port

Photo 4.9 The Coconut plantations planted post tsunami rear side of the sand dunes at Keechankuppam

Photo 4.10 View of the beach and artificial sand dunes North of Keechankuppam

Photo 4.11 a & b Views of the damaged bridge connecting Nagapattinam and Kallar

Photo 4.12. The damaged bridge connecting Nagapattinam and Kallar

Photo 4.13. The flat beach North of Velankanni

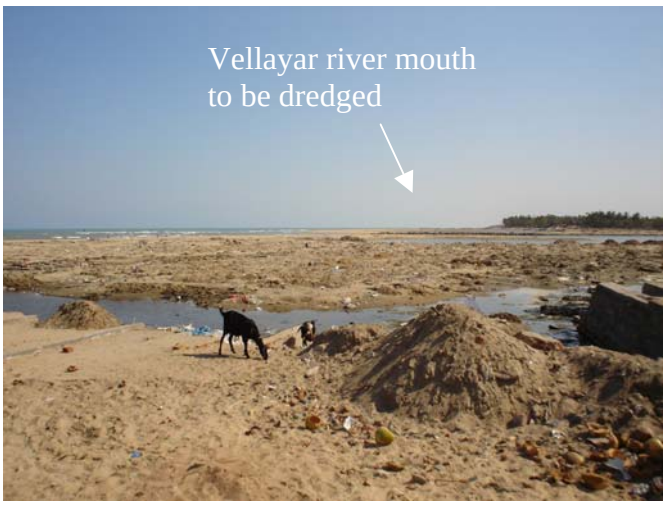


Photo 4.14. The confluence point of river Vellayar South of Velankanni

Photo 4.15. View showing beach South of Vellapallam

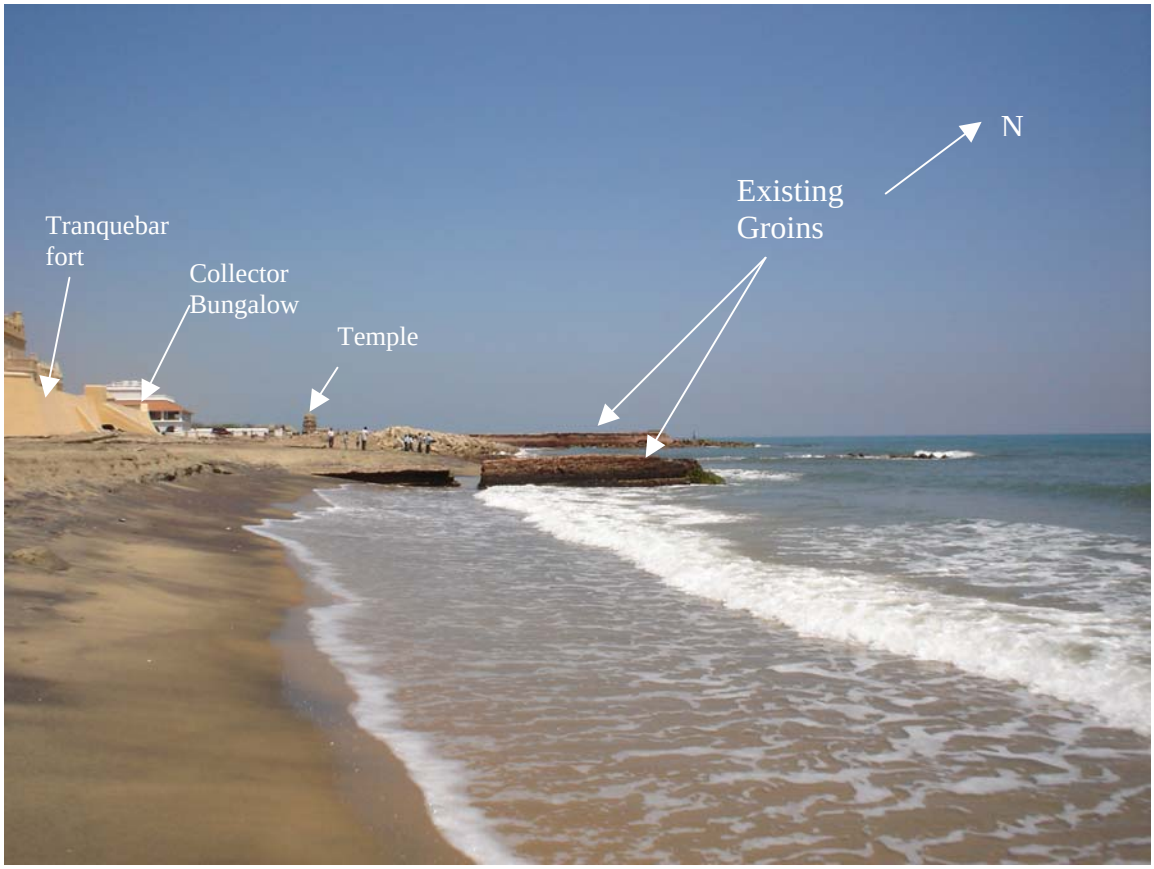


Photo 4.16. View showing the Tranquebar coast

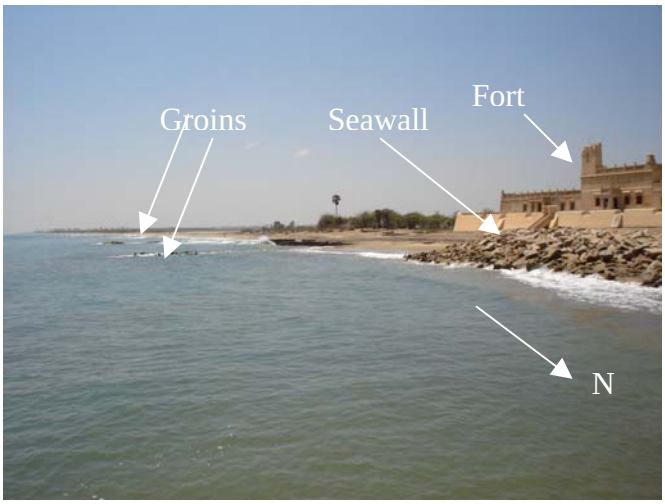


Photo 4.17. View showing beach South of section A-A

Photo 4.18. View showing erosion North of section A-A

Photo 4.19. The watermark on a compound wall at Sathankudi

Photo 4.20. View of damages at Sathankudi after partial leveling of the debris

Photo 4.21. View showing beach & seawall South of Poompuhar

Photo 4.22. View showing beach North of Poompuhar

Photo 4.23. The land cleared off debris South of Vaanagirikuppam

Photo 4.24. Damage to property North of Vaanagirikuppam

Photo 4.25. Abandoned houses at Pudukuppam

Photo 4.26. Typical damages to property due to tsunami at Palayur

Photo 4.27. Dunes constructed by local people of Palayur

Photo 4.28. View showing the wide mouth of river Coleroon

Photo 4.29. View showing the river Vellapallam Uppanar at Thirumalaivasal

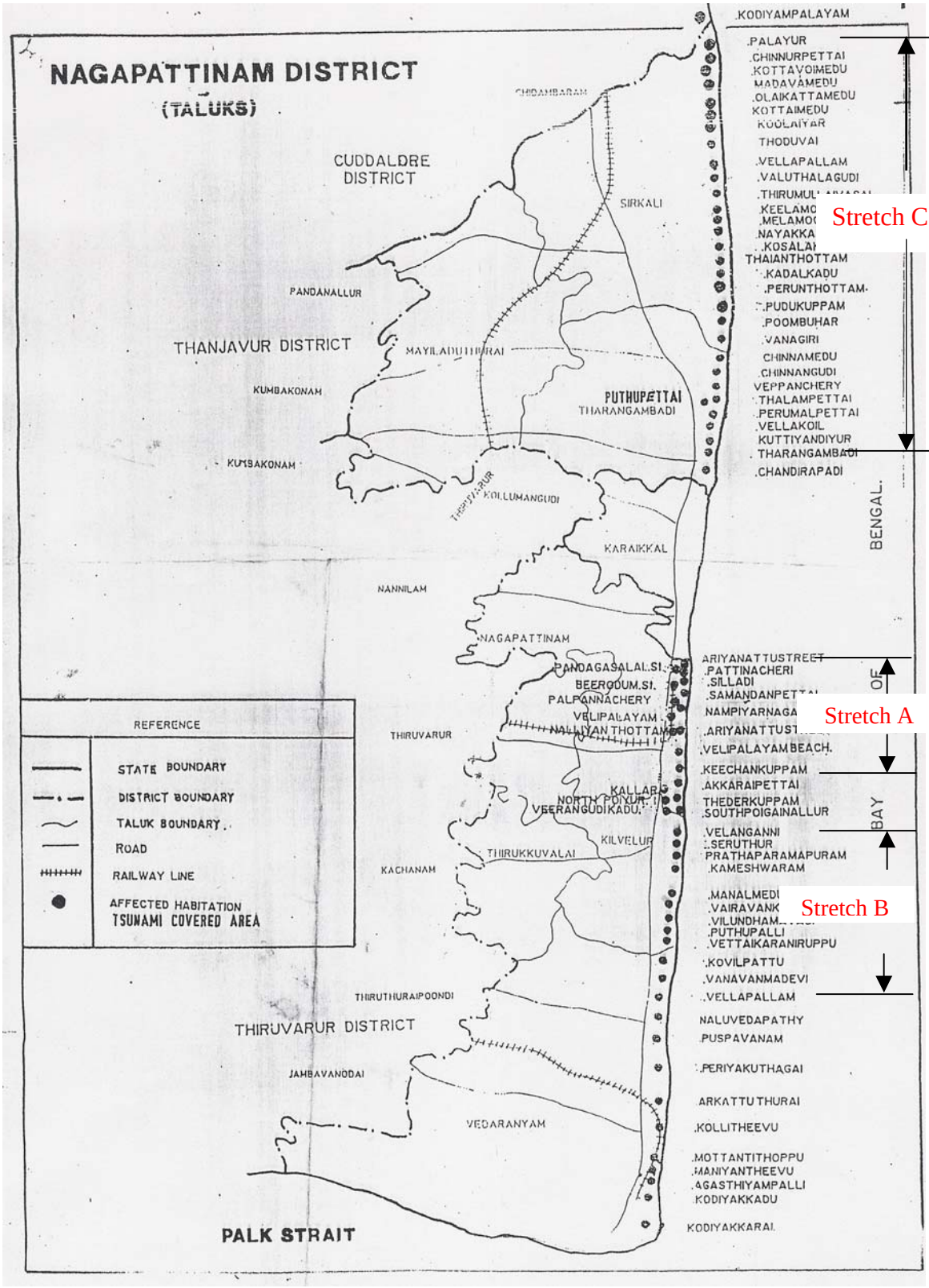


Fig. 4.1. The Nagapattinam coastal district map

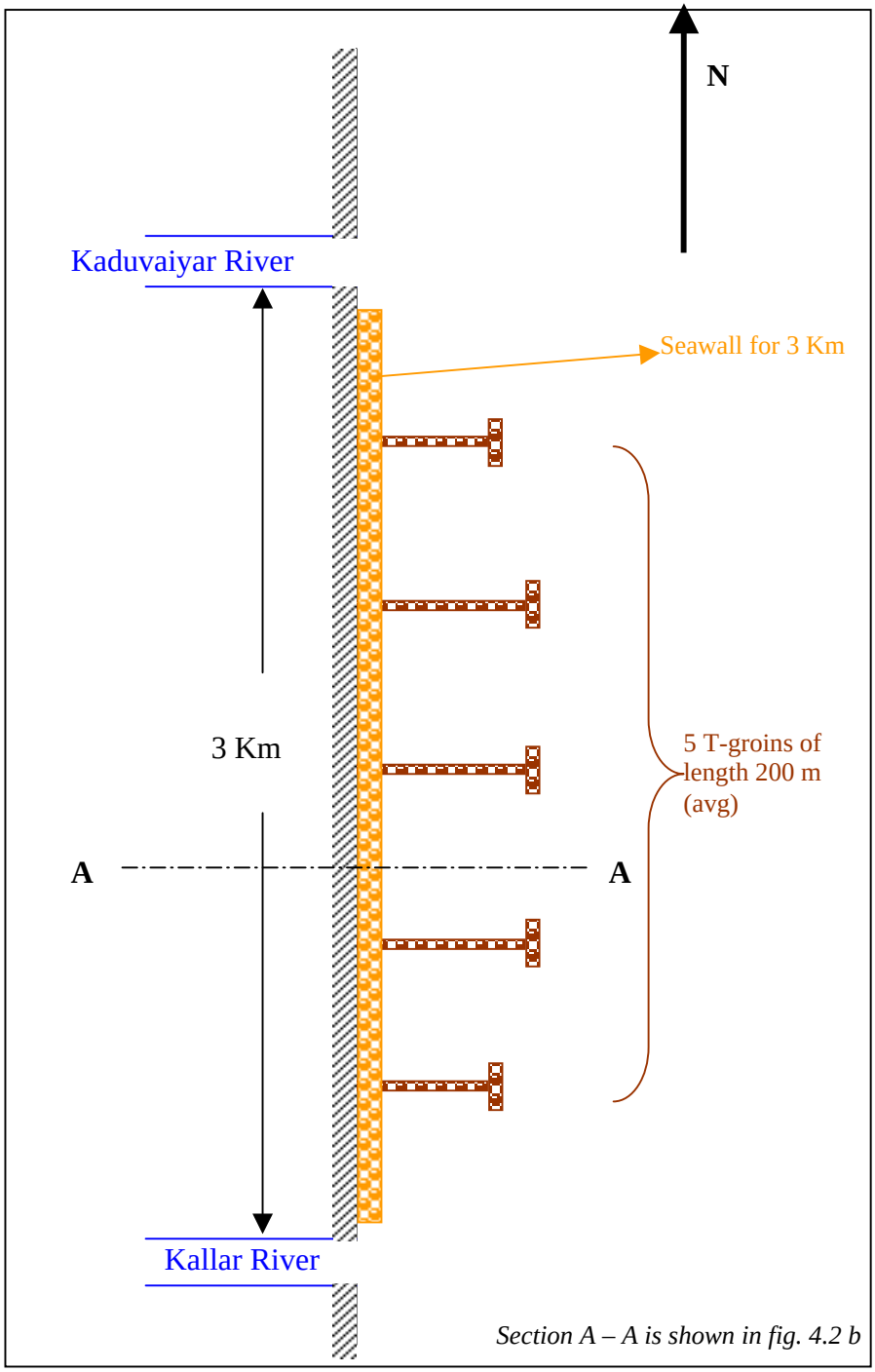


Fig. 4.2a. Proposed layout for the stretch of the coast from Nagoor to Keechankuppam

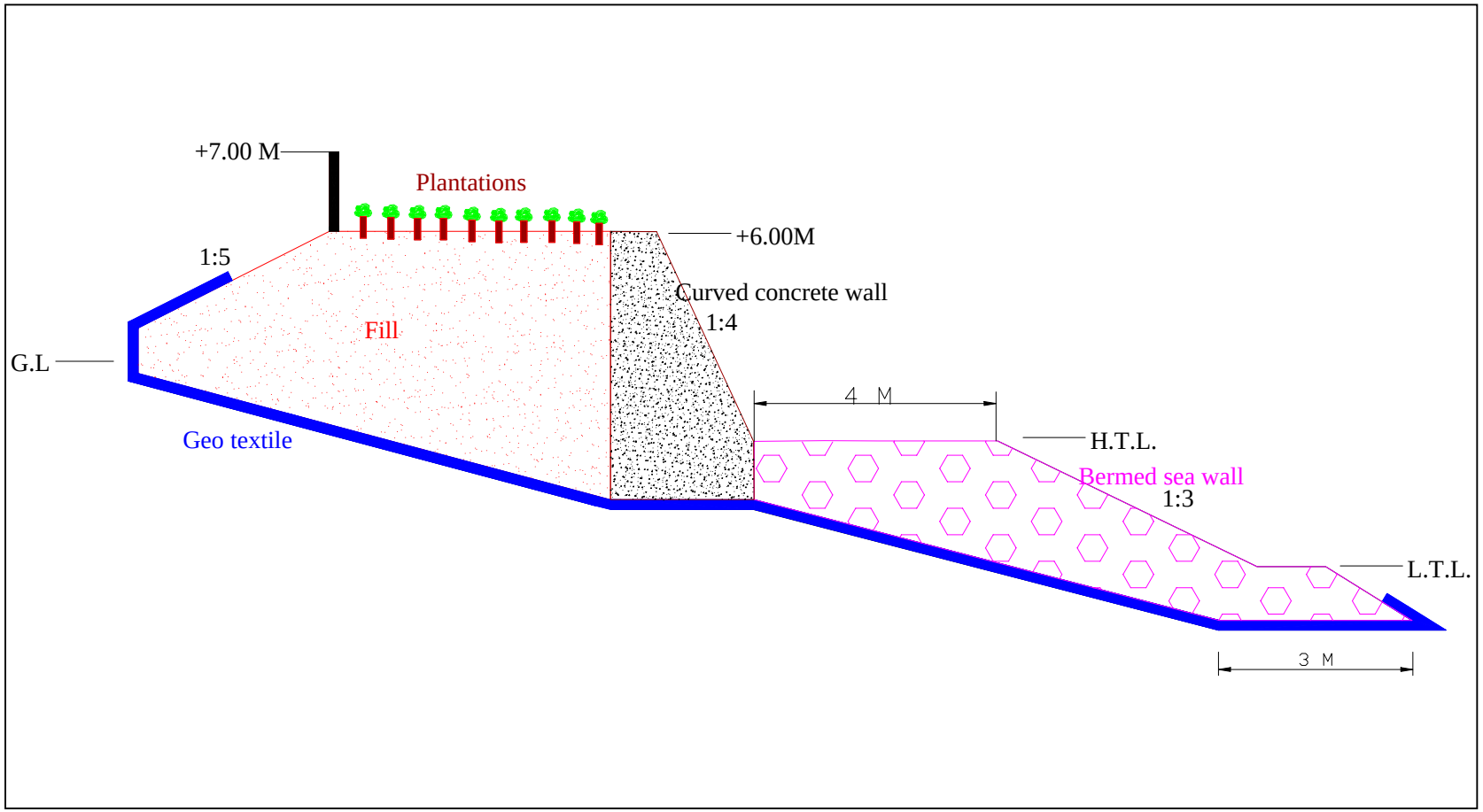


Fig. 4.2 b Cross-section of Seawall

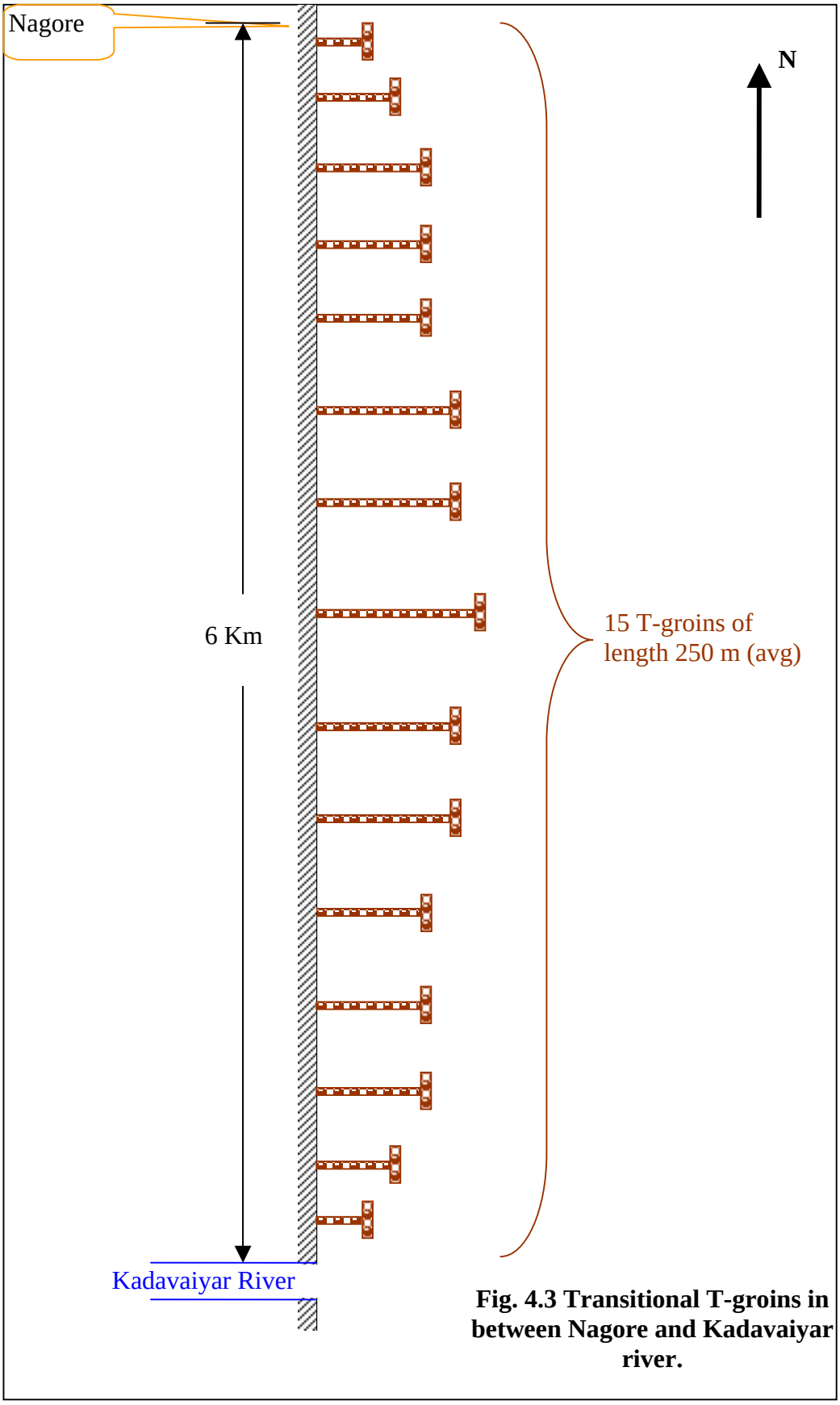


Fig. 4.3 Transitional T-groins in between Nagore and Kadavaiyar river.

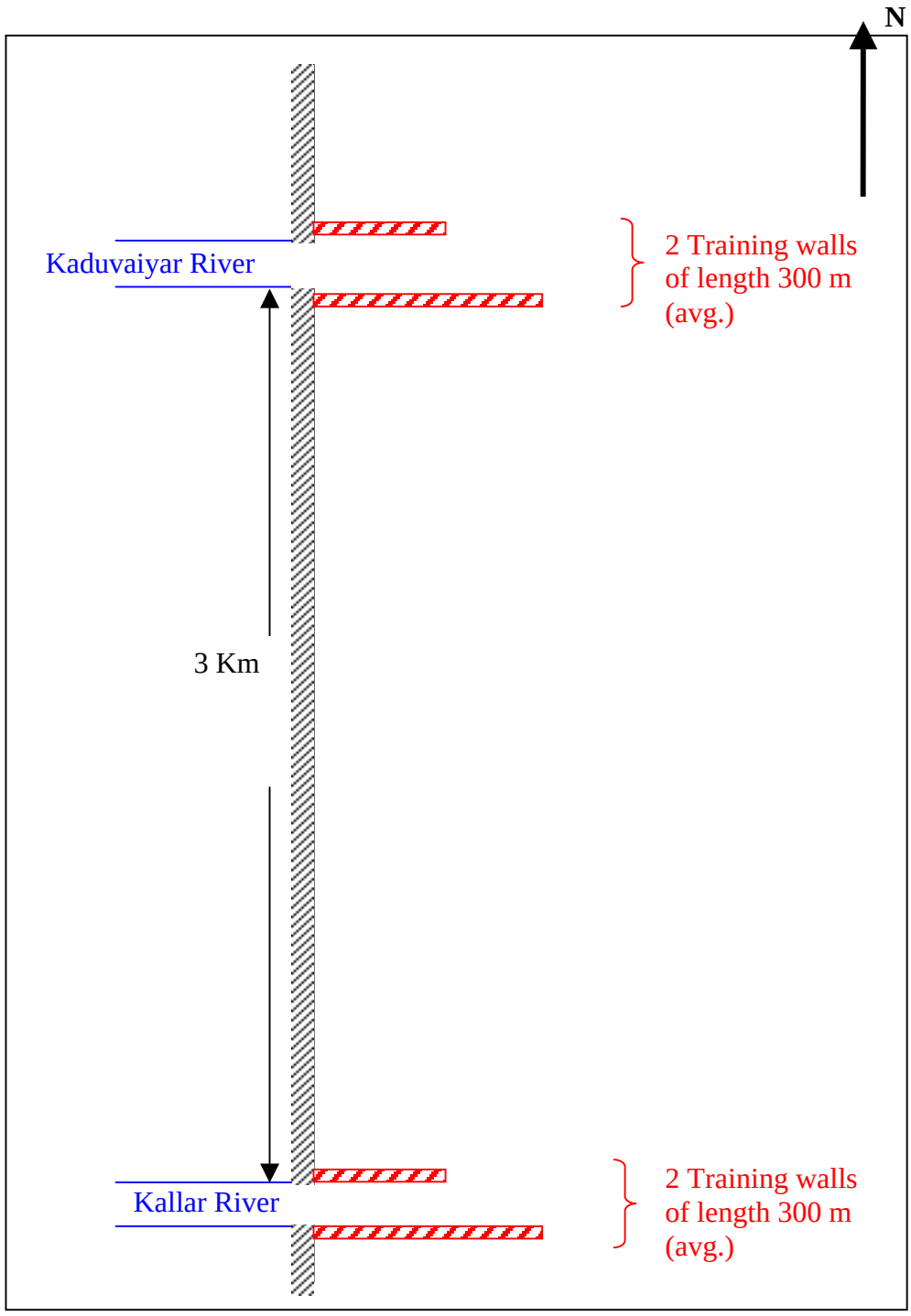


Fig. 4.4 Training walls at Kadavaiyar and Kallar river mouths.

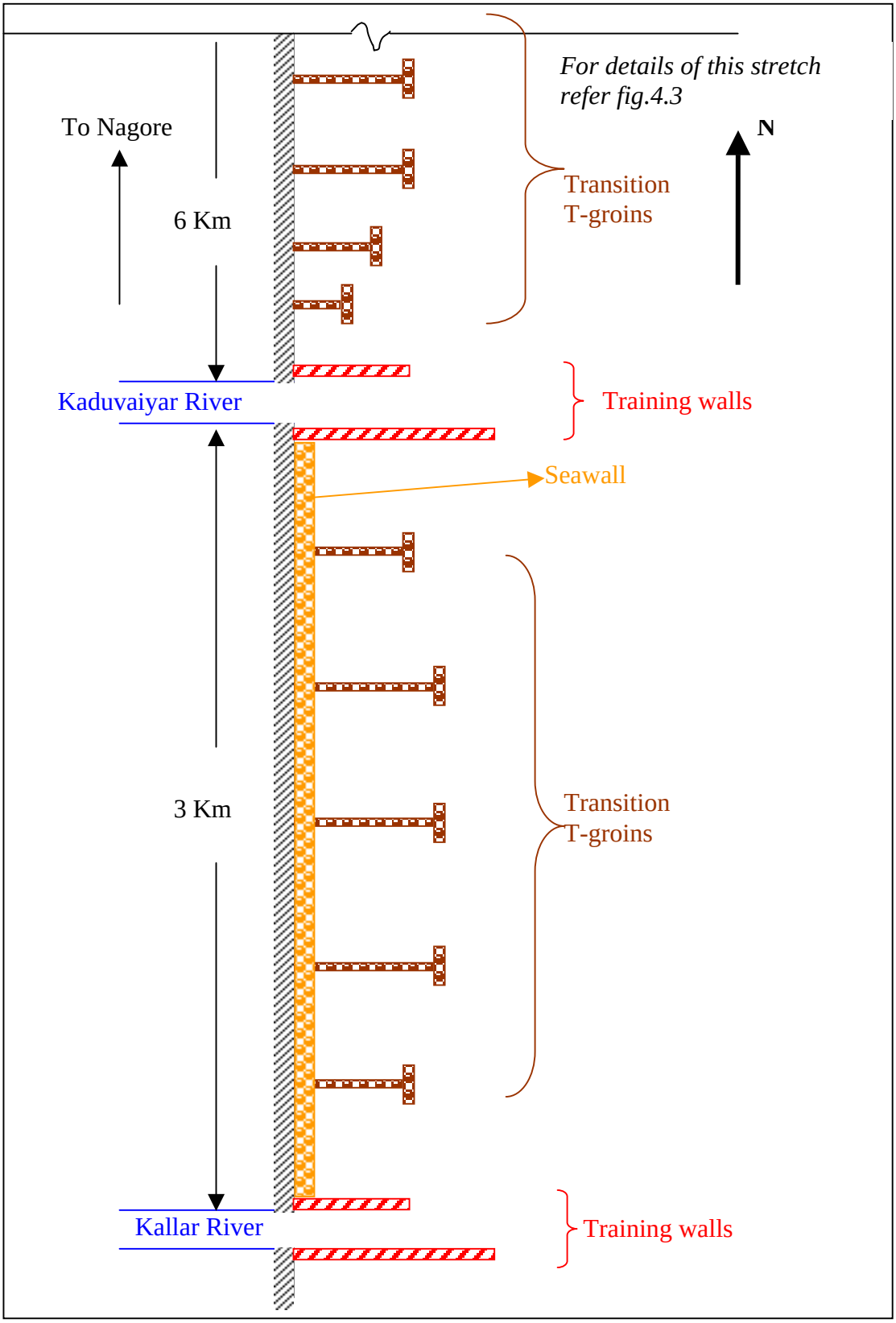


Fig. 4.5 The Complete protection measures for Stretch 'A'

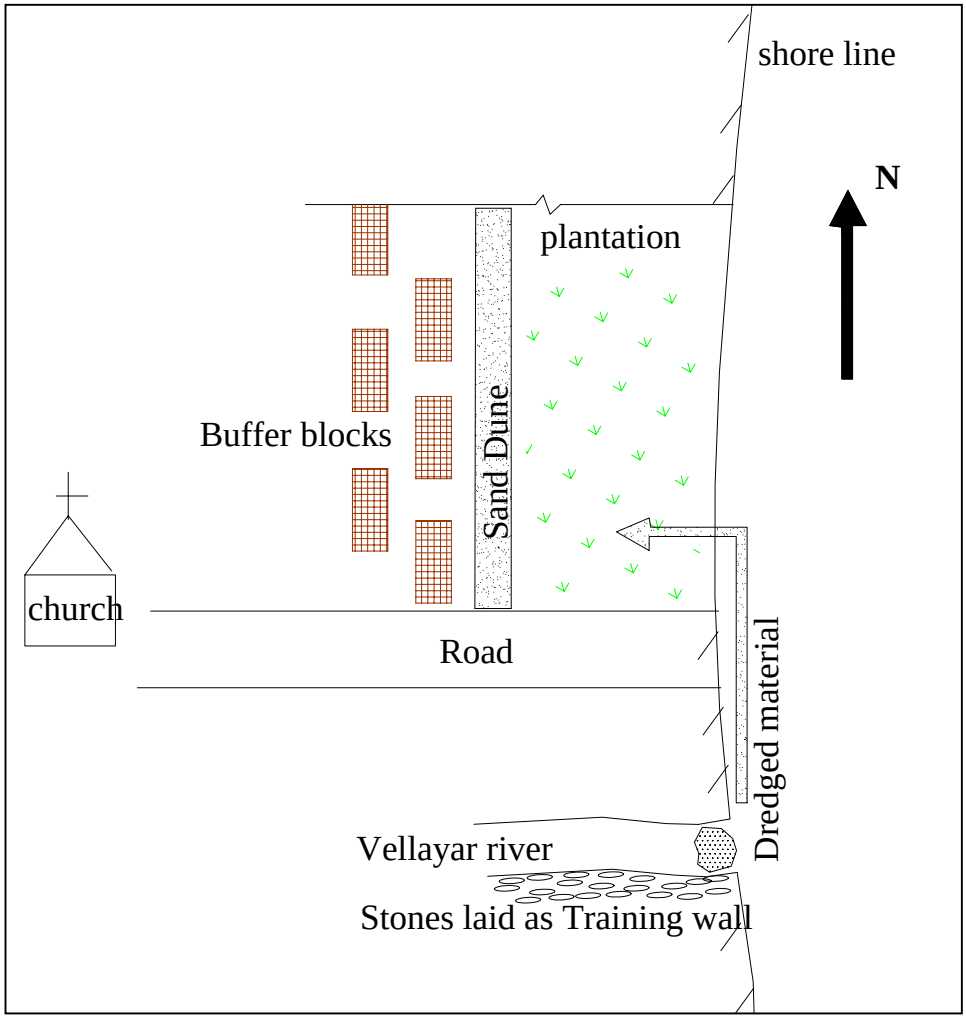


Fig. 4.6 The protection measures for Velankanni Stretch 'B'

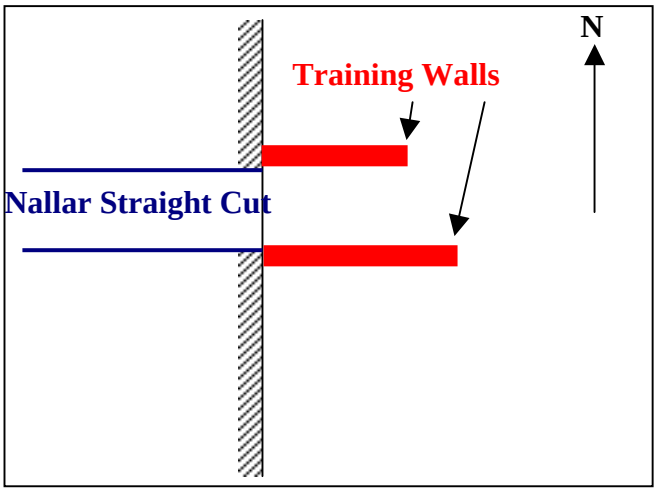


Fig.4.7. Training Walls at Nallar Straight Cut,Vellapallam

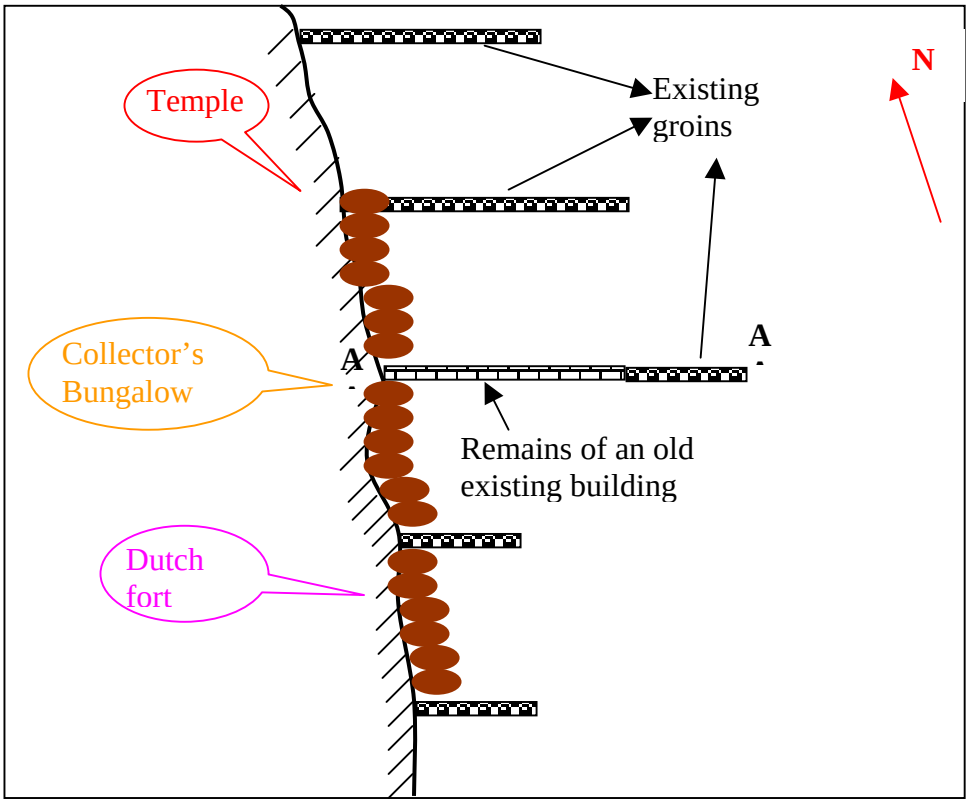


Fig.4.8 Existing Groins and Seawall at Tranquebar coast

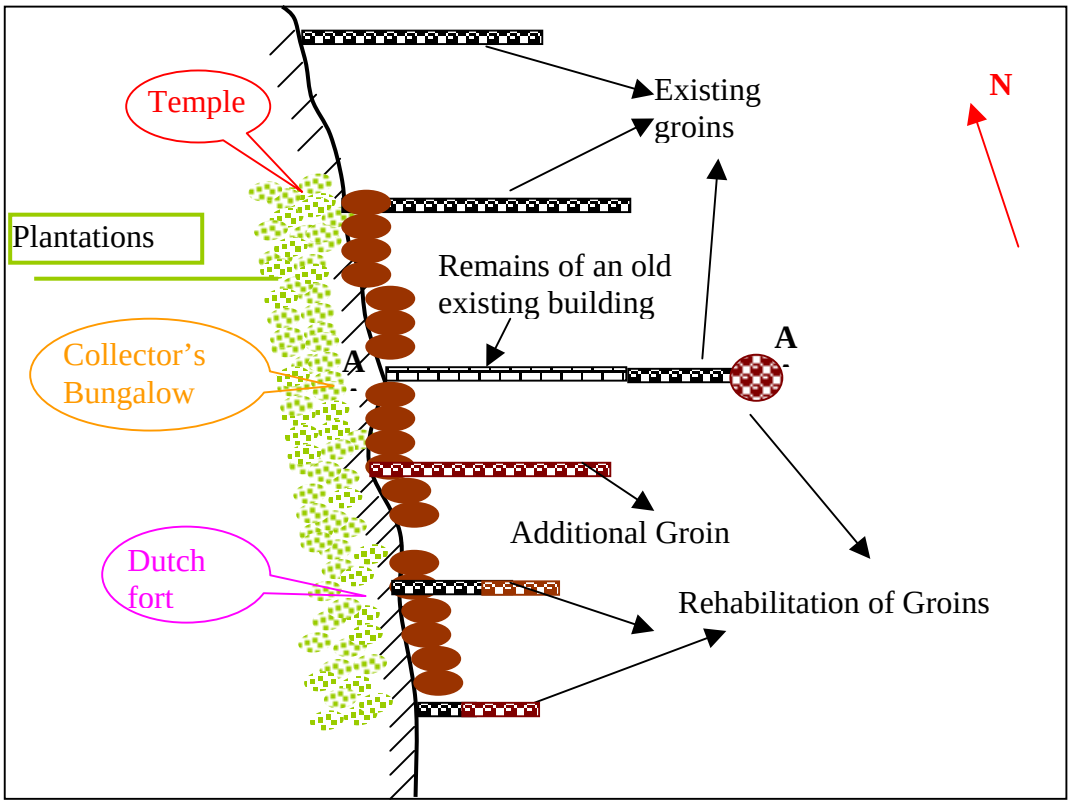


Fig.4.9 Rehabilitation of Existing Groins at Tranquebar coast

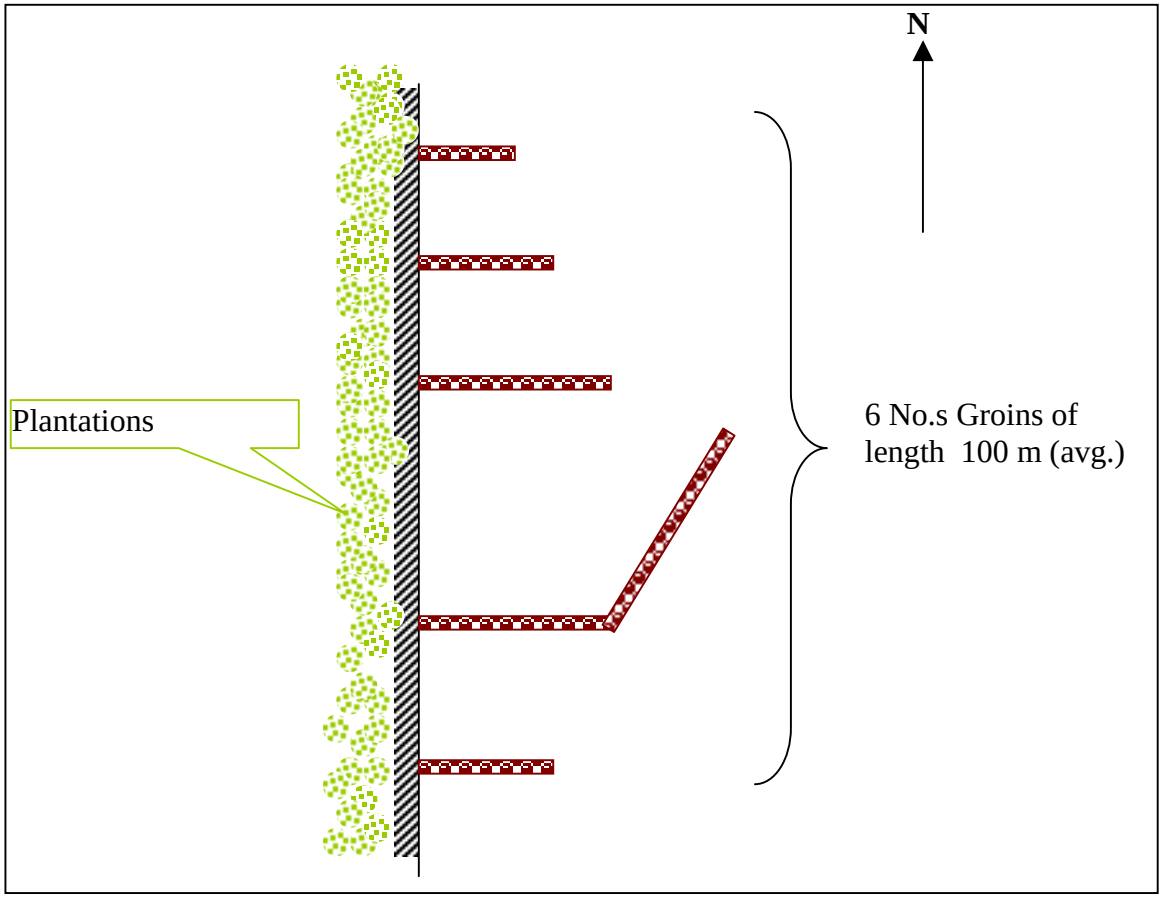


Fig.4.10 Transition Groins at Sathankudi, Tharangambadi coast

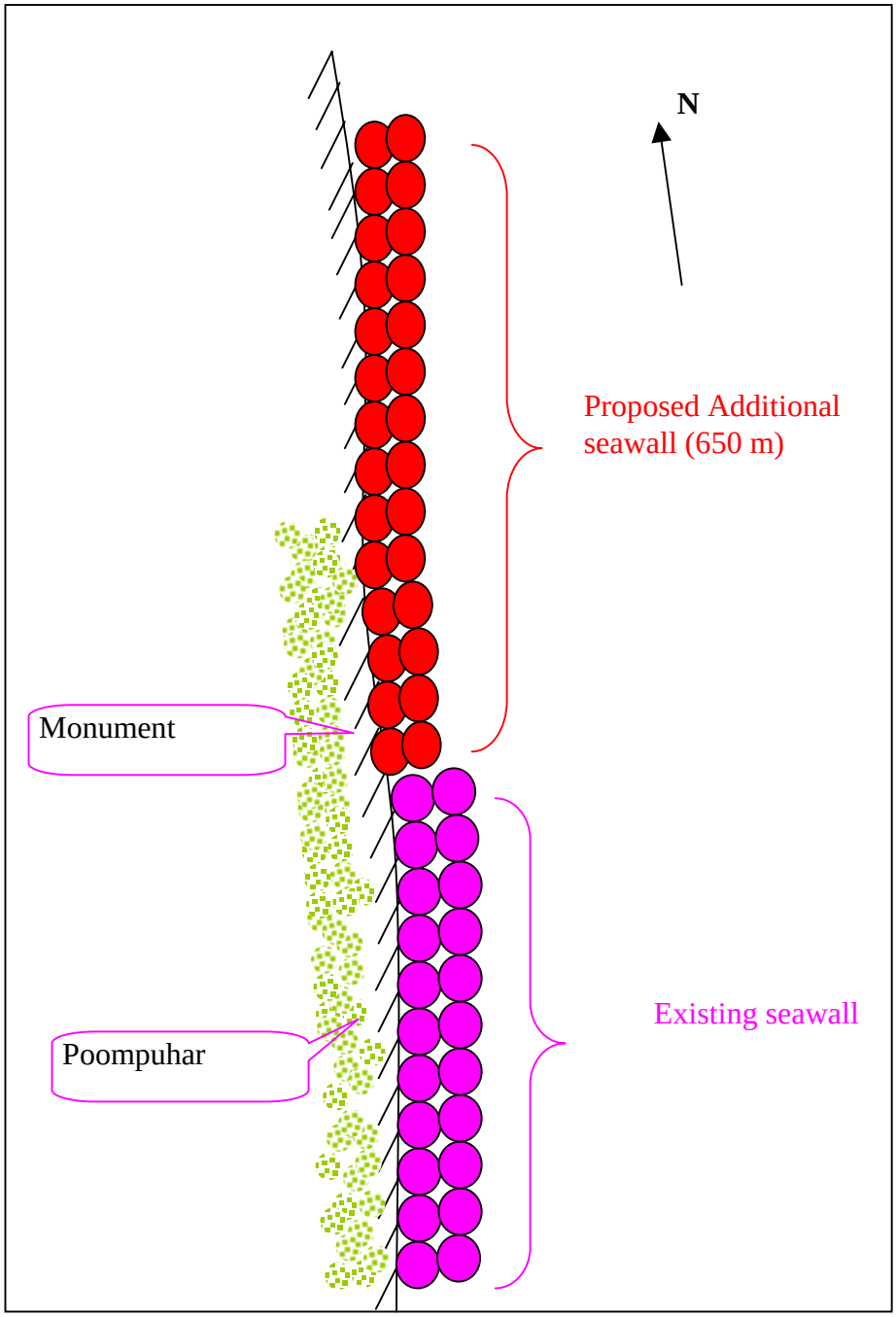


Fig. 4.11. Proposed additional seawall at Poompuhar

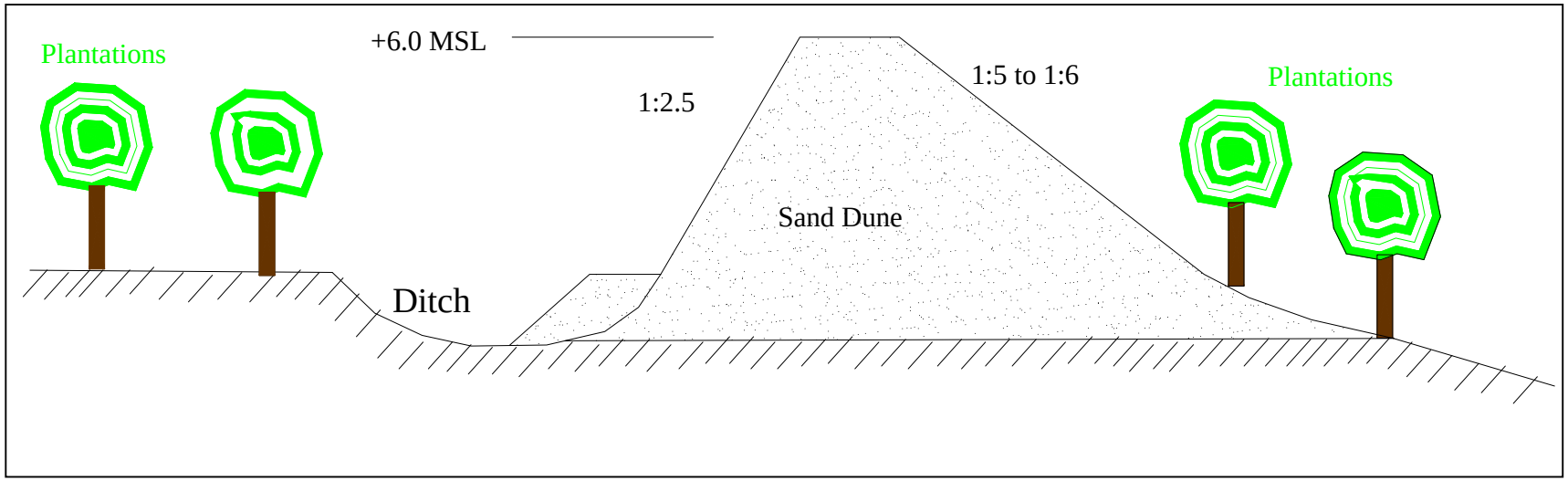


Fig. 4.12. Proposed shape of the sand dune at Palayur

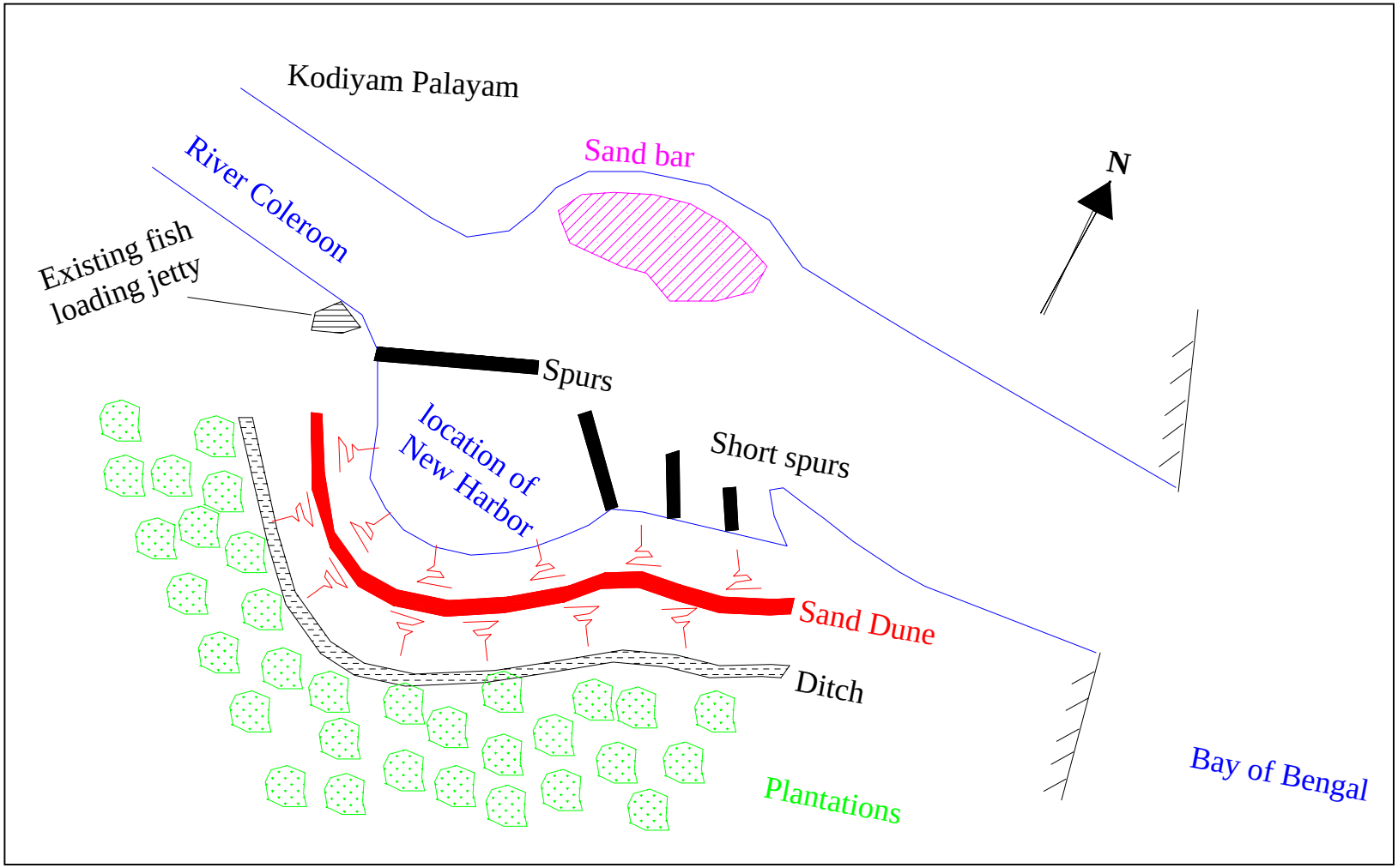


Fig. 4.13 Proposed Coastal protection measure at Palayur

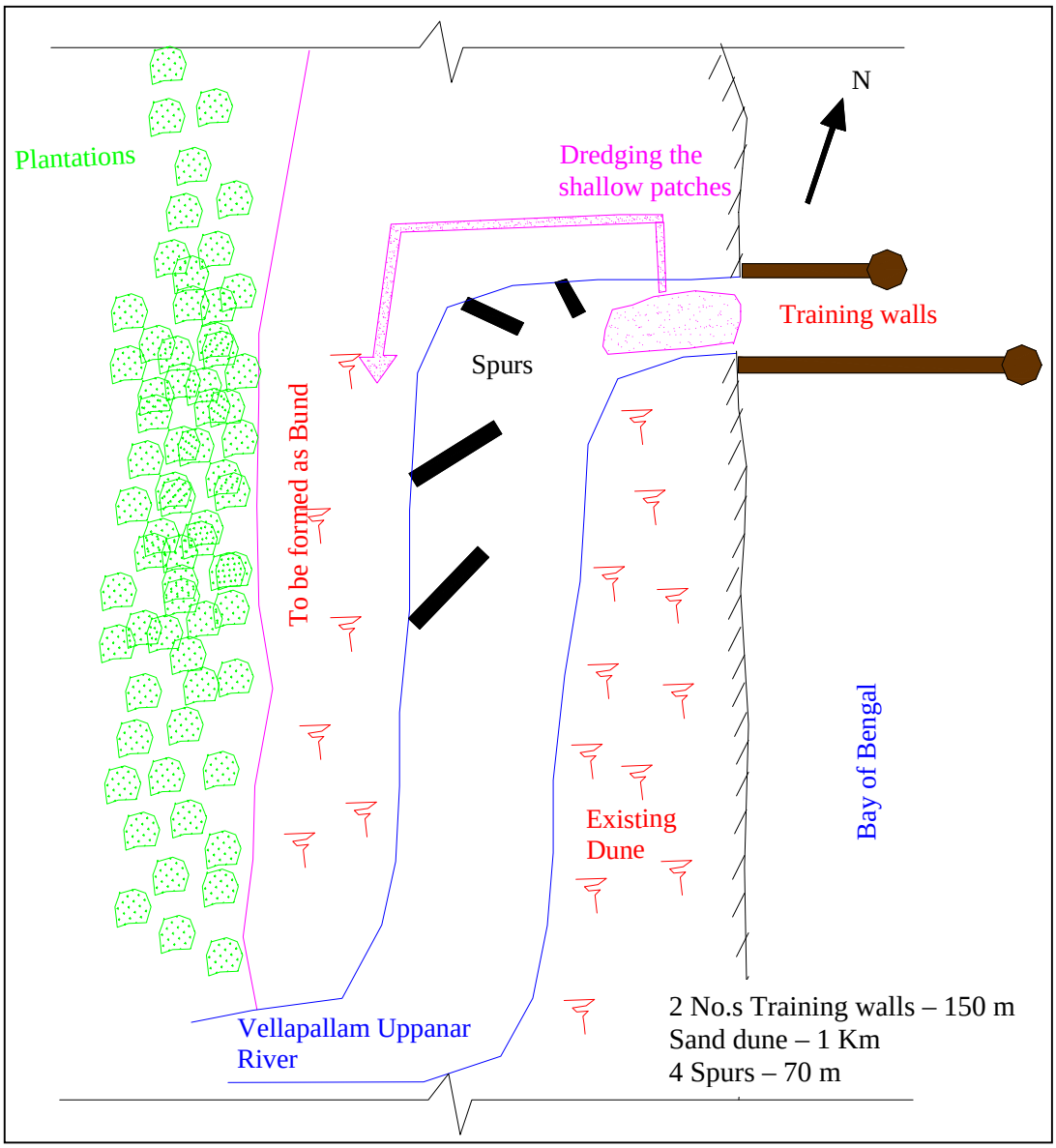


Fig. 4.14 a Proposed Coastal protection measure at Thirumullaivasal

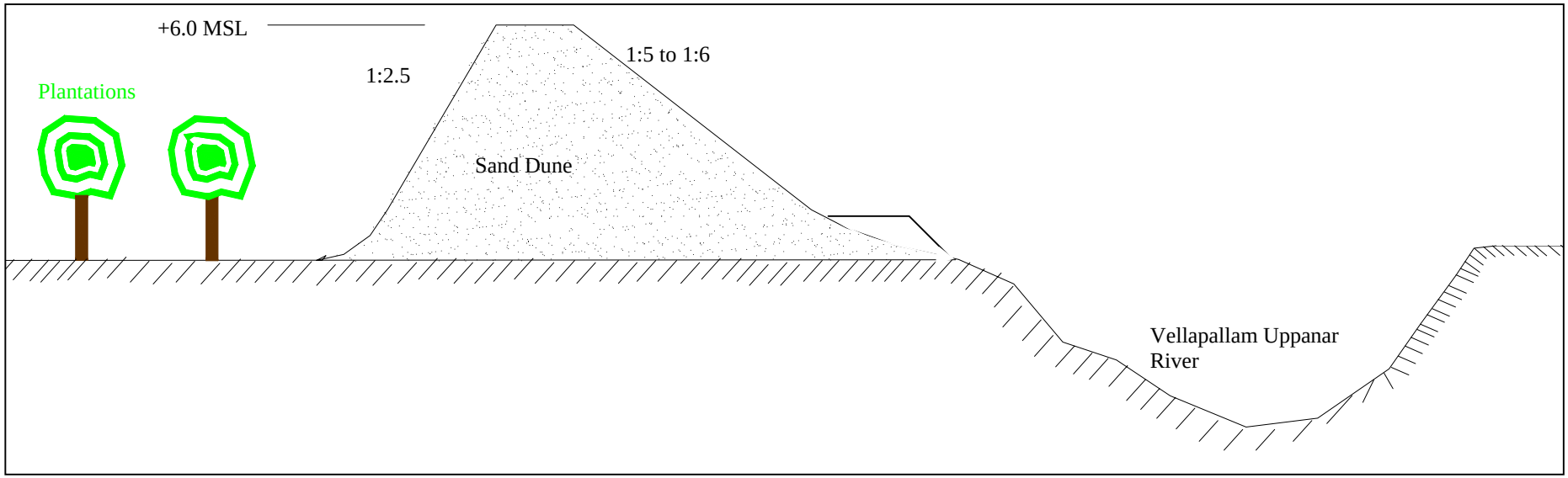


Fig. 4.14 b Cross-section of the sand dune at Thirumullaivasal

CHAPTER 5

SUMMARY AND CONCLUSIONS

The coast of Tamilnadu was visited and a general survey was carried out by Prof. V.Sundar, Department of Ocean engineering, I.I.T.Madras during Feb-March 2005 in order to assess the vulnerable areas being affected by the perennial problem of erosion. The effect of the recent tsunami was considered in the said exercise. As the state is divided into three coastal regions namely, Chennai, Madurai and Trichy, the chapters are accordingly organized. The suitable protection measures for each of the regions are discussed. Only the concepts are projected. The several protection measures in general consists of

- Seawall
- Groin field
- Combination of seawall and groins
- Training walls
- Plantations
- Buffer blocks
- Curved groins (Thoondil Valaivu)
- Geotubes

The protection measures are site specific and are dictated by the direction and magnitude of the littoral drift. As a detailed estimate of the host of parameters like the beach profile, bathymetry, shoreline changes over the past few years, behaviour of already existing protection measures, etc control the magnitude and quantity of Littoral drift has not been carried out; the contents of this report should serve only as a guideline for the preliminary planning and budgeting.

Only after a detailed analysis, numerical and physical model studies, and other associated studies, should the protection measures be finalized. The summary of the protection measures is provided in **Table. 5.1 a, b & c** as per priority. The section of the report containing the details the measures is also incorporated in the table.

Table. 5.1 a Summary of the protection measures for Chennai region

Section No.	Name of the location	Protection Measures				Priority / Ranking
		Groin field	Seawall	Training Wall	Others	
2.1	Kaatupallikuppam				Plantation & Nourishment	**
2.2	**Ennore Creek**	**2 No. (250m)**				****
2.3	**Ennore - Ernavoorkuppam**	**10 No. (150m)**				****
2.4	**Masthankoilkupam**		**2000 m**			****
2.5	**North of Royapuram fishing harbour**		**720 m**			****
2.6	Cooum River			2 No. (200m)		**
2.6	Adyar River				Dredging + Plantation	*
2.7	Besant Nagar				No intervention	
2.8	Kovalam				Plantation	**
2.9	**Devaneri**		**500m**			****
2.10	Mammalapuram				Plantation	*
2.11	**Meyyurkuppam**	**6 No. (200m)**	**1500m**			****
2.12	**Oyyalikuppam**	**6 No. (200m)**				****
2.13	Chinnakuppam			2 No. (200m)		**
2.14	Sodhanaikuppam	5 No. (50m)				**
2.15	Thanthiriyankuppam	10 No. (150m)			Plantation	**
2.16	Mudaliarkuppam				Plantation	*
2.17	**Thazhangauda to Devanampattinam**	**8 No. (150 m)**	**3000m**	**4 No. (250m)**		****
2.18	**Singarathoppu**				**Shifting of Dwelling units + Plantations**	****
2.19	Pudukuppam, Parangipettai				Buffer blocks + Plantation	**

Table. 5.1 b Summary of the protection measures for Madurai region

Section No.	Name of the location	Protection Measures				Priority / Ranking
		Groin field	Seawall	Training Wall	Others	
3.4	Neerodi to Erayumanthurai	15 No. (200m)	Rehabilitation of Seawall (8000 m)			*
3.5	Enayam to Muttam	6 No. (75m)				**
3.6	Vaniyakudi	1 No. (150 m)				*
3.7	**Colachel jetty**	**2 No. (600 m)**				***
3.8	**Kottilpadu**		**1000 m**		**Plantation**	***
3.9	Kadiyapattanam			2 No. (150)		*
3.10	Keezhamuttam		Rep. of Seawall (1000 m)			*
3.11	**Pozhikarai to MezhaManakudithurai**	**8 No. (200m)**	**Rep. of Seawall (1000m)**			***
3.12	**Keezhamanakudithurai**	**3 No. (200m)**	**Rep. of Seawall (500 m)**	**2 No. (300m)**		***
3.13	Ratchagar Street				Extension of existing groins	*
3.14	Vaavuthurai		Seawall (500 m)			*
3.15	Kootupuli				No intervention	-
3.16	Perumanal				No intervention	-
3.17	**Idinthakarai**	**3 No. (150)**				***
3.18	Koothankuli	2 No. (250m)				**
3.19	**Aalanthalai**	**6 No. (250m)**				***
3.20	Punnakayal			2 No. (300m)		**
3.21	**Threspuram**	**2 No. (400 m)**				***
3.22	Devipattanam to Nambuthalai				Plantation + monitoring of coastline	*

Table. 5.1 c Summary of the protection measures for Trichy region

Section No.	Name of the location	Protection Measures				Priority / Ranking
		Groin field	Seawall	Training Wall	Others	
4.1	**Nagoor to Keechankuppam**	**20 No.- T-groins (250m)**	**3000 m**	**4 No. (300m)**		***
4.2	**Velankanni**				**Dredging + Nourishment +Plantatuion +Buffer blocks**	***
4.3	Vellapallam			2 No. (150 m)		*
4.4	**Tharangampadi**	**6 No. (100m)**	**Seawall (850 m)**		**plantation**	***
4.5	**Poombuhar**		**Rebahilitation of exsiting seawall (500 m) + Additional seawall(650m)**		**plantation**	***
4.6	Vaanagirikuppam	5 No. (100m)	Seawall (500 m)		Plantation	**
4.7	Pudukuppam				Plantation	*
4.8	Palayur				Dunes with revetments or Geotubes (1km)	**
4.9	**Thirumullaivasal**	**Spurs – 4 No. (70 m)**		**2 No (150 m)**	**Dredging+ Nourishment**	***

*** High Priority
** Moderate Priority
* Least Priority

PROF. V. SUNDAR