CHAPTER 3 THE STUDY AREA

Bagan Datoh is situated on the west coast of Peninsula Malaysia in the state of Perak. It is bounded by Sg. Perak in the north, Sg. Bernam in the south and to the west by Straits of Melaka, into which both rivers empty (Figure 3.1). Bagan Datoh is further divided into three *mukims*, Hutan Melintang, Rungkup and Bagan Datoh. *Mukim* Rungkup is shown in Figure 3.2.

3.1 The Physical Environment

3.1.1 Relief and Drainage

The study area is a low-lying area. The entire Rungkup Peninsula can be categorised as a flood prone area as the highest level of the Peninsula is 2.3m (7.7ft) based on the bench mark (Figure 3.3). The area is generally covered by mangrove and subject to tidal flooding. The coastline is fronted by an extensive tidal mudflat of near horizontal or very gently sloping towards the Straits of Melaka.

Seven streams drain the study area namely Sg. Burung, Sg. Rungkup, Sg. Tiang, Sg. Belukang, Sg. Parit Batang, Sg. Bagan Lipas dan Sg. Bagan Pasir Laut. The entire Rungkup coastal zone has been colonized for agricultural production since 1910s. Reclamation for cultivation and settlement has been through the construction of a series of lateral canals extending inland to drain the swamps and other low-lying areas. Many of these canals or *parit* bear the name of the settlers who had pioneered development in the area.

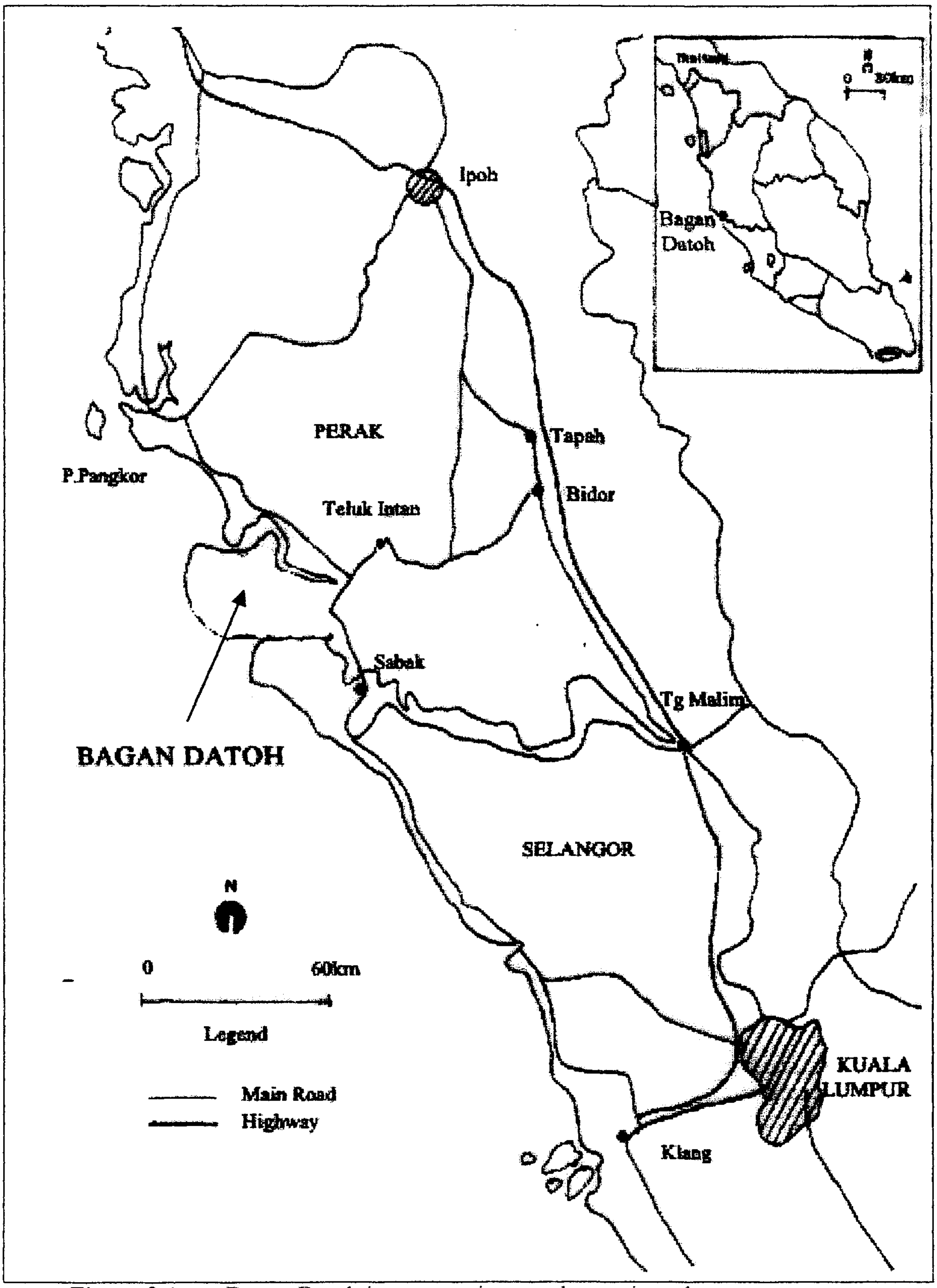


Figure 3.1. Bagan Datoh in perspective to other major urban centres

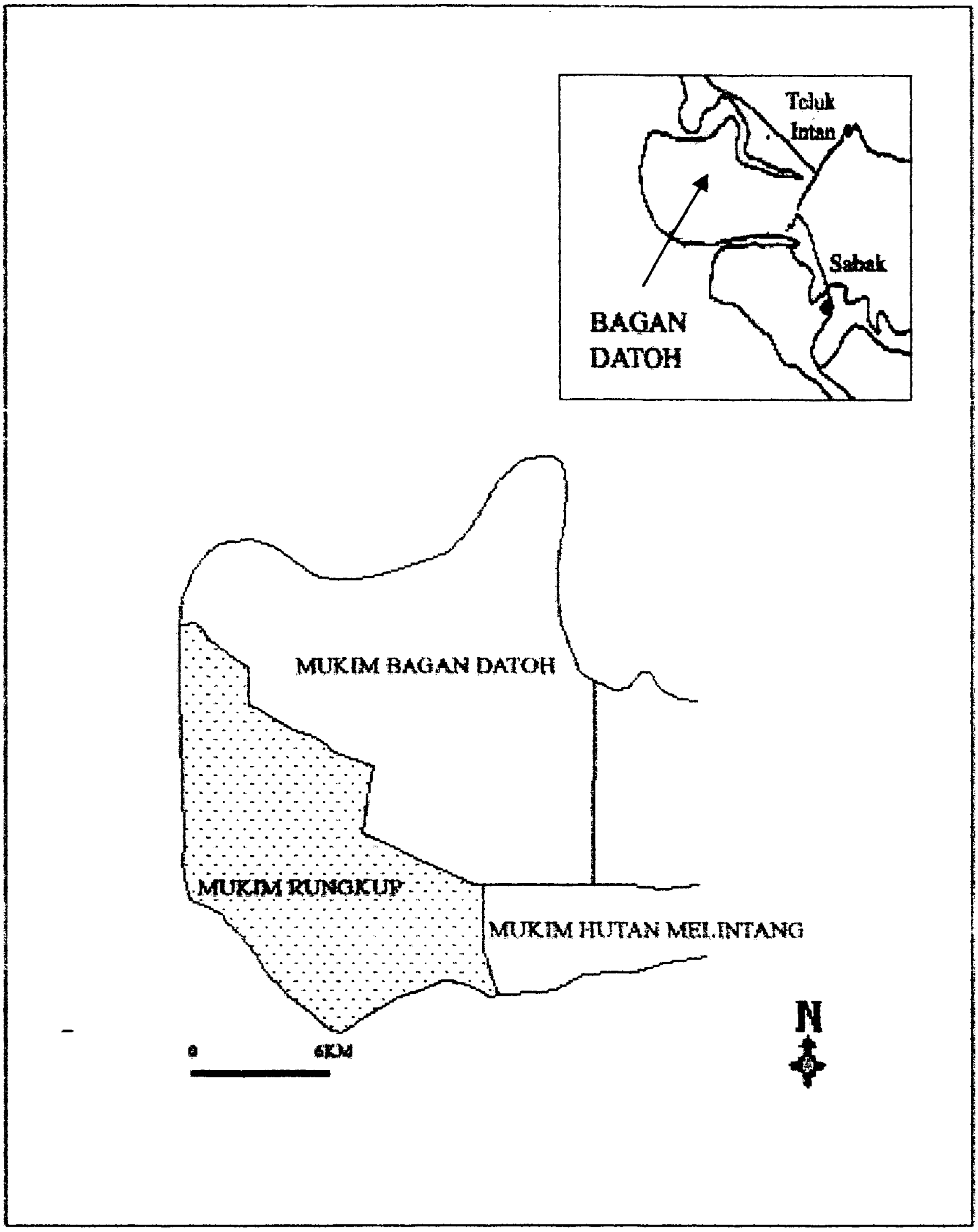


Figure 3.2. Division of *Mukims* in Bagan Datoh

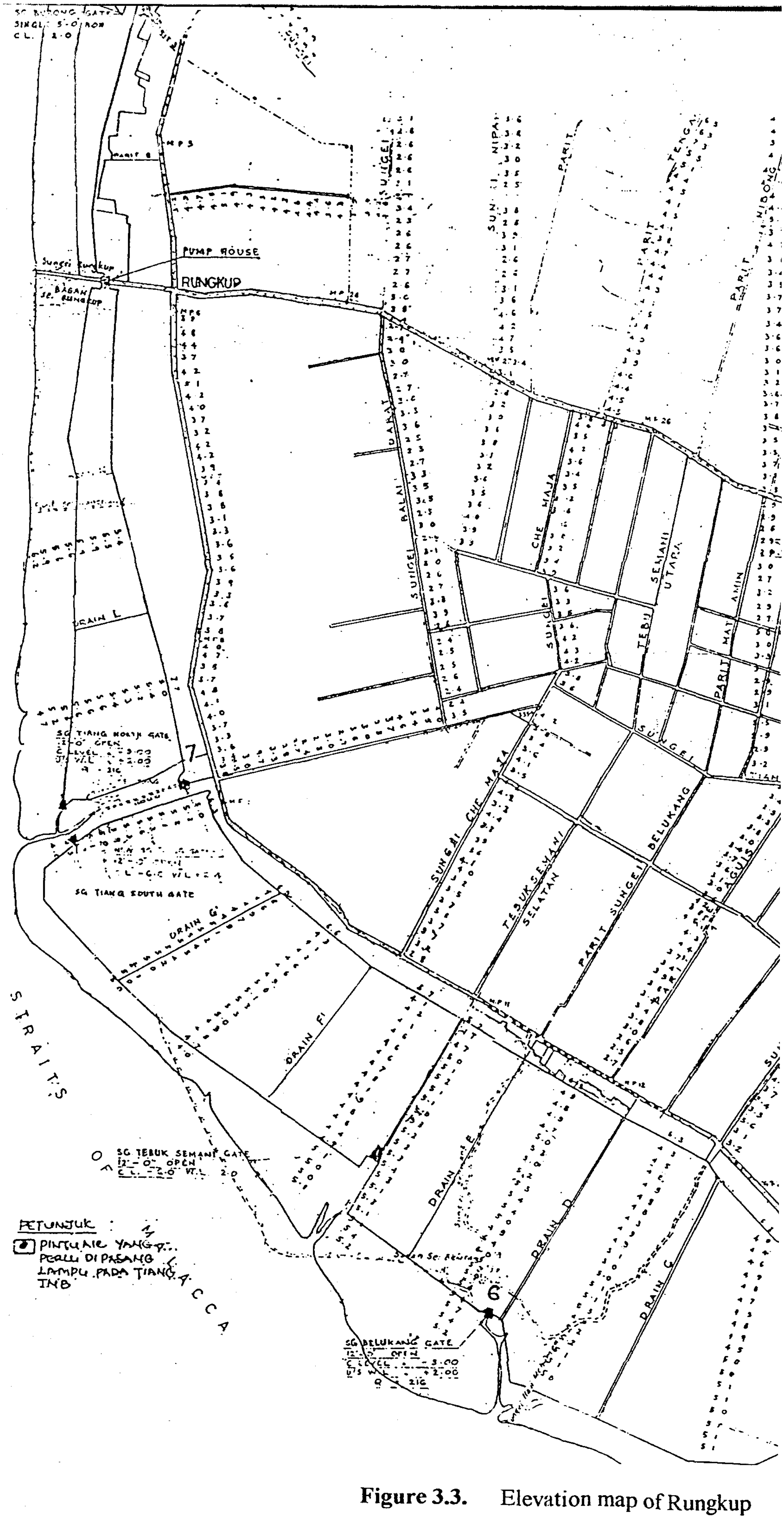
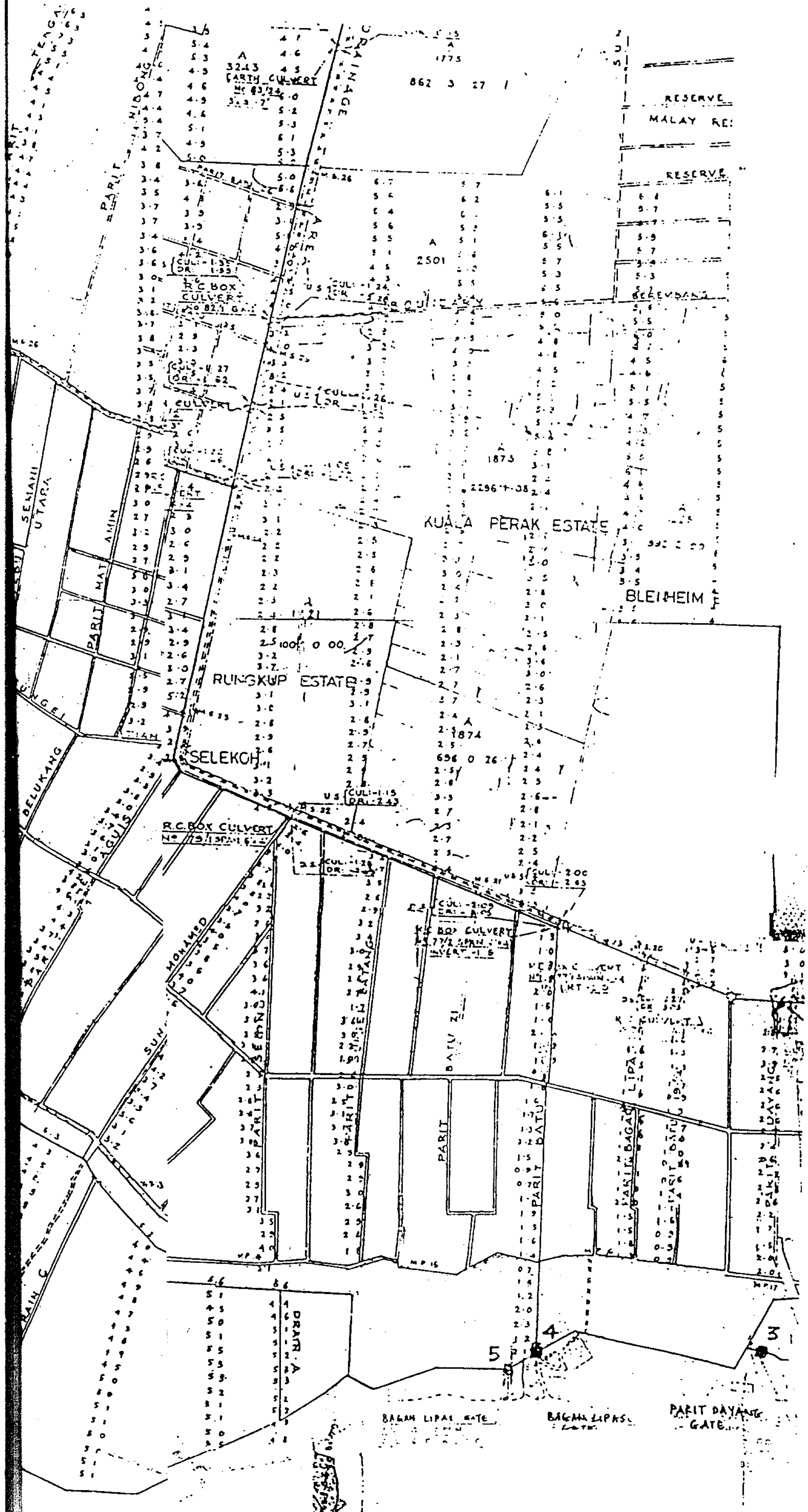


Figure 3.3. Elevation map of Rungkup


KUALA PERAK ESTATE
RUNGKUP ESTATE
BLENHEIM
SELEKOH
MALAY RESERVE
RESERVE
R.C. BOX CULVERT
DRAINAGE
PARIT BATU
DRAIN A
BAGAN LIPAS GATE
BAGAN LIPAS GATE
PARIT DAYANG GATE
3
4
5

of Rungkup

The Department of Irrigation and Drainage has since the 1930s added coastal as well as many lateral drains in an attempt to improve drainage conditions. Bunds were constructed from the estuary of Sg. Perak down to the estuary of Sg. Bernam. These structural control measures protect the Rungkup Peninsula from tidal flooding and also from coastline erosion. Tidal gates ensure that there is no sea water intrusion up stream. When water level in the stream is higher than at sea (especially during rainy season), these tidal gates are opened to allow the stream water to drain into the sea. At present, discharges from Sg. Rungkup, Sg. Tiang, Sg. Belukang, Bagan Lipas, Bagan Pasir Laut and Parit Dayang is controlled by the tidal gates.

One pump house is located at Sg. Rungkup. The pump house consists of three pumps with a capacity of 50 cusec each (total capacity of $150ft^3$/second). During the rainy season, stream water is pumped into the sea even during high tide. However, the exceedingly gentle gradient impedes drainage, and many areas are periodically waterlogged.

3.1.2 Geology

Geologically the area is covered by quaternary deposits of The Gula Formation consisting of recent alluvium of marine facies (JPT 1985). The map of Quaternary geology of the southern Perak region is shown in Figure 3.4. The Quaternary sediments in the Bagan Datoh area are Holocene marine deposits, which consist of clay and plant remains deposited in a mangrove environment.

The Gula formation is described as being made up of clay, silt and sand with subordinate amount of shell fragments.

In the study area, two soil types are encountered. The physical and chemical properties of the soils are shown in Table 3.1 and their limitation and suitability in Table 3.2.

Table 3.1. Physical and chemical properties of soils

Soil series	Great soil groups	% clay	% silt	% fine sand	% coarse sand	pH	Total P (p.p.m)	Total K Meq %
Selangor	Low humic gley	60	30	5	5	5.5	80	3.0
Kranji	humic gley	50	35	10	5	4.4	240	12.0

Source: Soo 1968

Table 3.2. Soil limitations and suitability

Soil Series	Class	Limitations	Crop Suitability
Selangor	I	Imperfectly drained, fine textured, weak structured	Coconuts, rubber and cocoa, medium for oil palm
Kranji	IV	Very poor drainage, fine textured, strongly saline	Unsuitable for most crops except possibly coconuts.

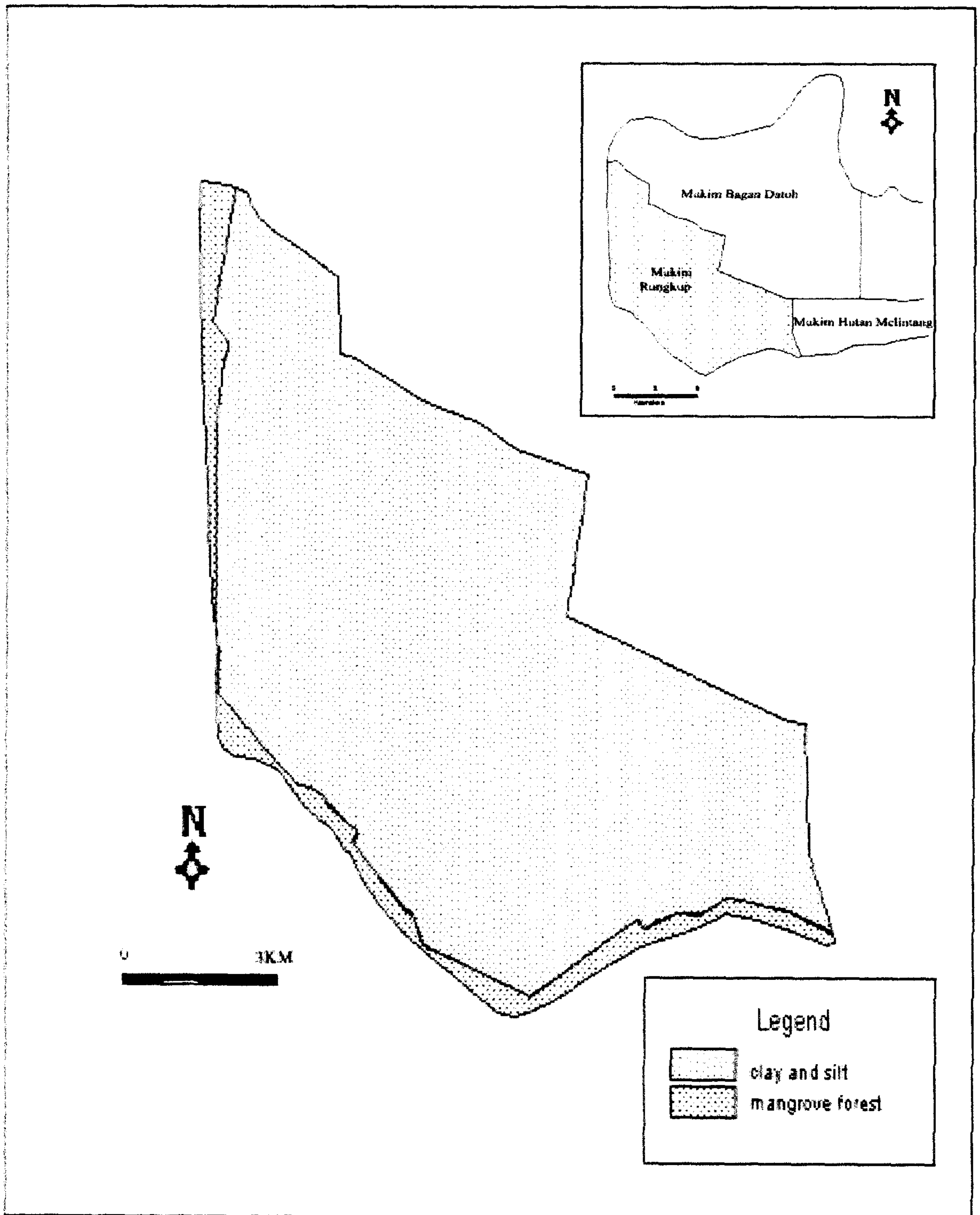
Source: Soo 1968

The Selangor series is the dominant soil in this area. Kranji series occupies the remaining area (Soo 1968) (Figure 3.5). Kranji series is a very recent marine alluvial soil developed on very flat coastal areas and in the vicinity of tidal river mouth. It is subject to frequent tidal flooding and supports mangrove swamps. In its undisturbed state, it has a neutral to alkaline reaction due to the high proportion of dissolved salts present. However when drained and oxidised, its soil reaction tends to increase in acidity as a result of the removal of the dissolved salts and the oxidation of sulphur compounds to sulphates and sulphuric acid. The relatively high salinity and very poor drainage status render this soil unsuitable for agriculture. With improved drainage and the construction of coastal bunds and tidal gates to prevent sea water ingression this soil can be successfully utilised to grow coconuts. Apart from the Kranji, the Selangor soil is generally productive to very productive and is suitable for most crops if properly drained.

The soil in Rungkup has been classified under Class I and Class IV (Table 3.2). Soil in class I with no limitations or only minor limitations to crop growth whereas soil under class IV has more than one serious soil limitation to crop growth (Soo 1968).

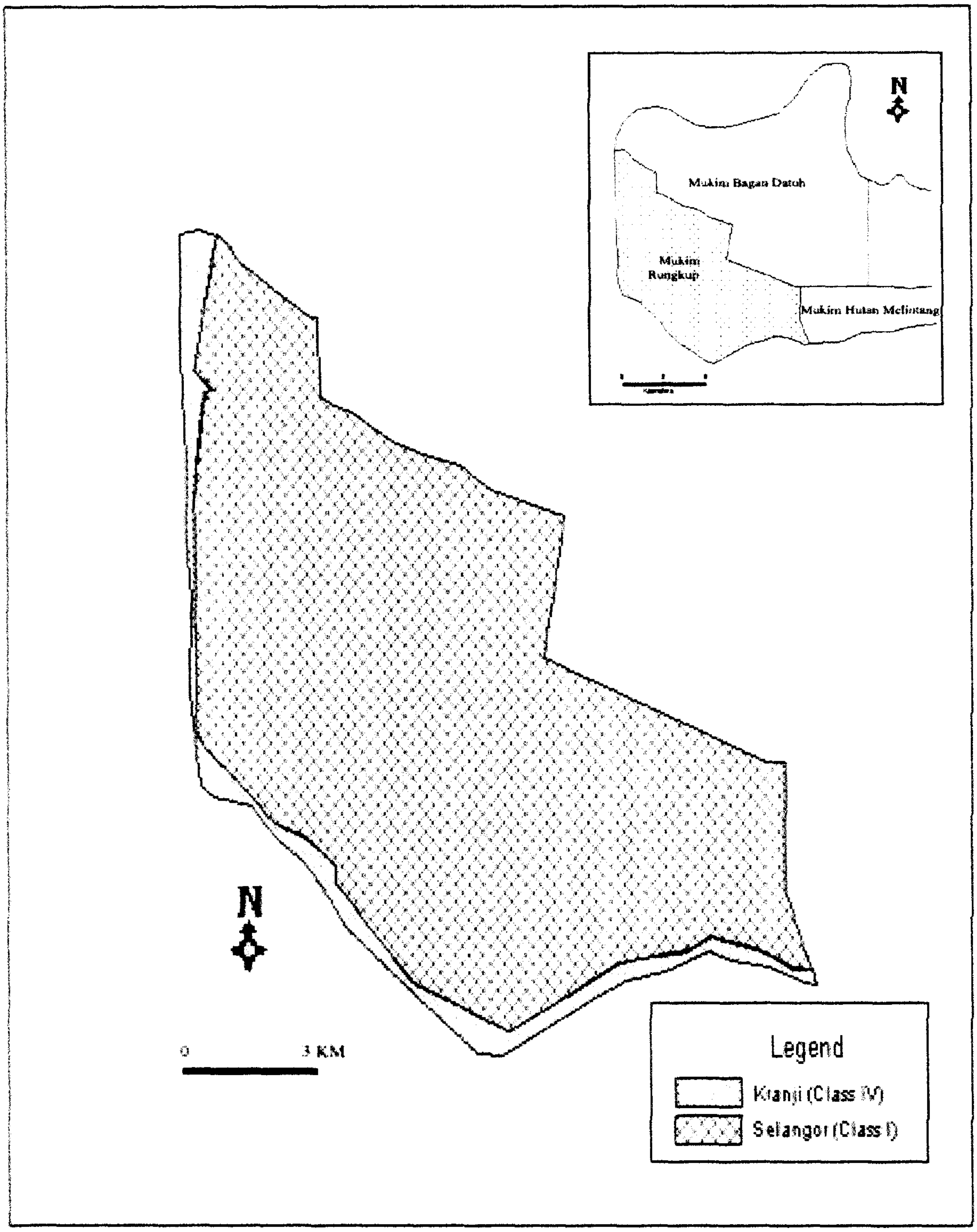
As mentioned earlier the entire area is underlain by very soft marine clay. Mudflat exposed during low tide along the coast. Site investigation carried out in Bagan Datoh in 1985 by Stanley Consultant show that the top 20m of the subsoils are composed of grey and greenish grey compressible very soft to soft silty clay with traces of fine sand and sea-shell. Pockets of decaying vegetation were also encountered in the upper 5m soil layer.

The undrained shear strength of the clayey silt ranged from 0.67 to $12.1 kN/m^2$. Sensitivity of the silty clay generally varied between 2 and 4 indicating that the clay is moderately sensitive (JPT 1985). In general, the natural moisture content of the clay exceeds the liquid limit. Liquidity limit greater than 1 indicates that the soil is unconsolidated sediment and highly compressible. The liquid limit ranged from 38 per cent to 73 per cent, the plastic limit varied from 20 per cent to 37 per cent, the moisture content ranged between 37 per cent to 99 per cent and the unit weights varied from 1.34 to 1.63mg/m^3. The average sulphate content of the subsoil is about 0.33 per cent. The presence of soft clay deposits will significantly have several implications for the proposed protection works and any associated infrastructure to be built on it.



Source: Soo 1968

Figure 3.4. Quarternary geology map of Rungkup



Source: Soo 1968

Figure 3.5. Major soil series in Rungkup

3.1.3 Tides

Tides are the alternating rise and fall of sea level with respect to land, as influenced by the gravitational attraction of the moon and sun. Other factors such as coastline configuration, local water depth, sea floor topography, winds and weather alter the arrival time of tides, their range and the interval between high and low water.

The Straits of Melaka is generally influenced by semi-diurnal tides. The Highest Astronomical Tide (HAT) is 1.7m, while Mean High Water Spring (MHWS) is 1.2m (Hydrographic Directorate 2001). The rest of the tidal level is shown in Table 3.3.

The tidal streams in the Melaka Straits generally flow in the Northwest (NW) and Southeast (SE) directions. The maximum current speed for SE-going and NW-going stream is generally less than 1m/s (JPS 1999).

Table 3.3. Tidal levels of Bagan Datoh

Tide Categories	Tidal level (m)
Lowest Astronomical Tide (LAT)	-1.7
Mean Low Water Spring (MLWS)	-1.3
Mean Sea Level (MSL)	0
Mean High Water Neap (MHWN)	0.4
Mean High Water Spring (MHWS)	1.2
Highest Astronomical tide (HAT)	1.7

Source: Hydrographic Directorate 2001

Table 3.4 shows the reoccurrence interval of storm surge condition in Bagan Datoh, which is higher during southwest monsoon.

Table 3.4. Storm surge condition at Bagan Datoh

Recurrence Interval (Year)	Southwest Monsoon Period (m)	Northeast Monsoon Period (m)
10	2.9	2.4
25	3.5	3.0
50	4.0	3.3
100	4.4	3.7

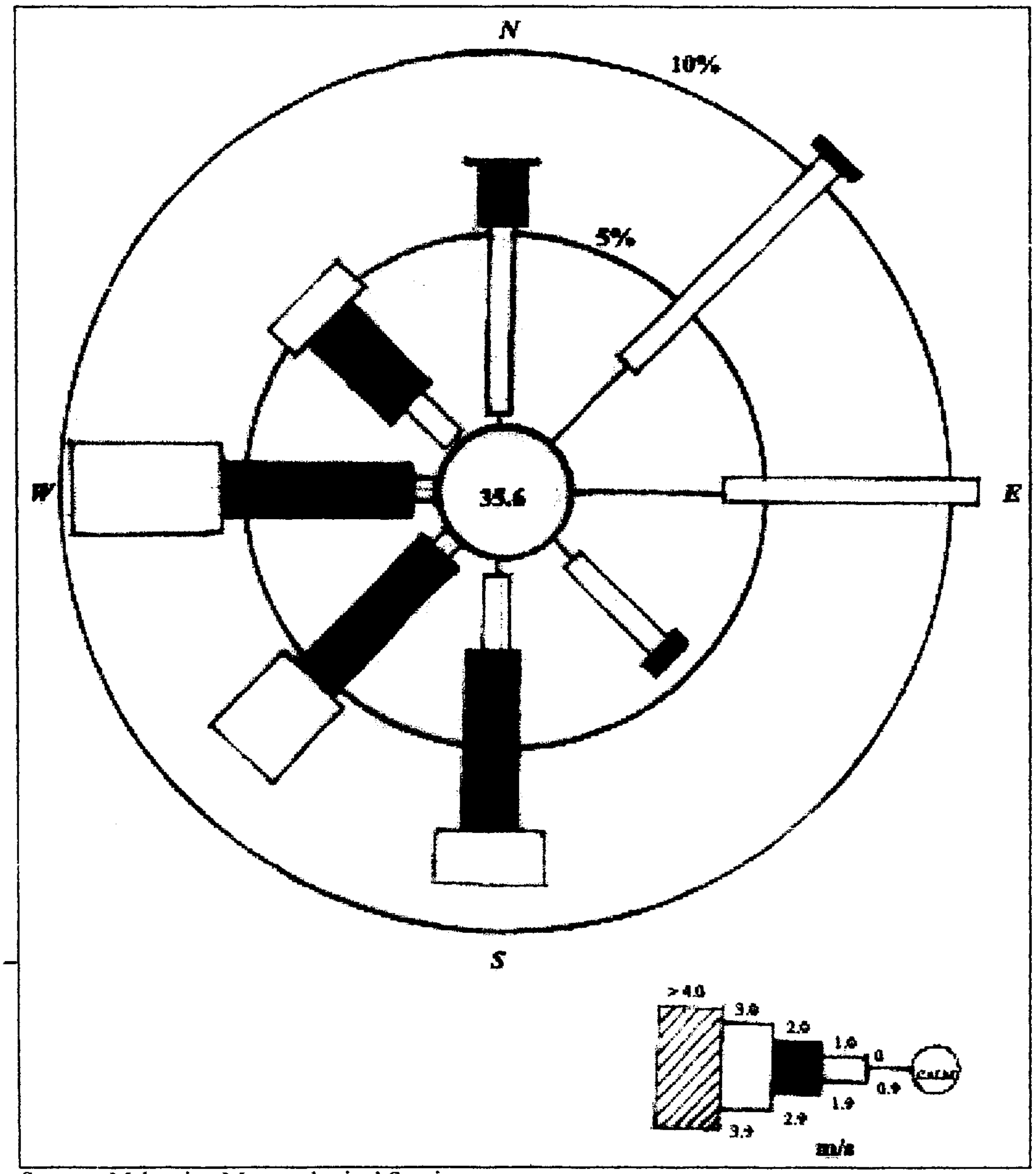
* wave period are 6 to 9 seconds

Source: JPT 1985

3.1.4 Wind

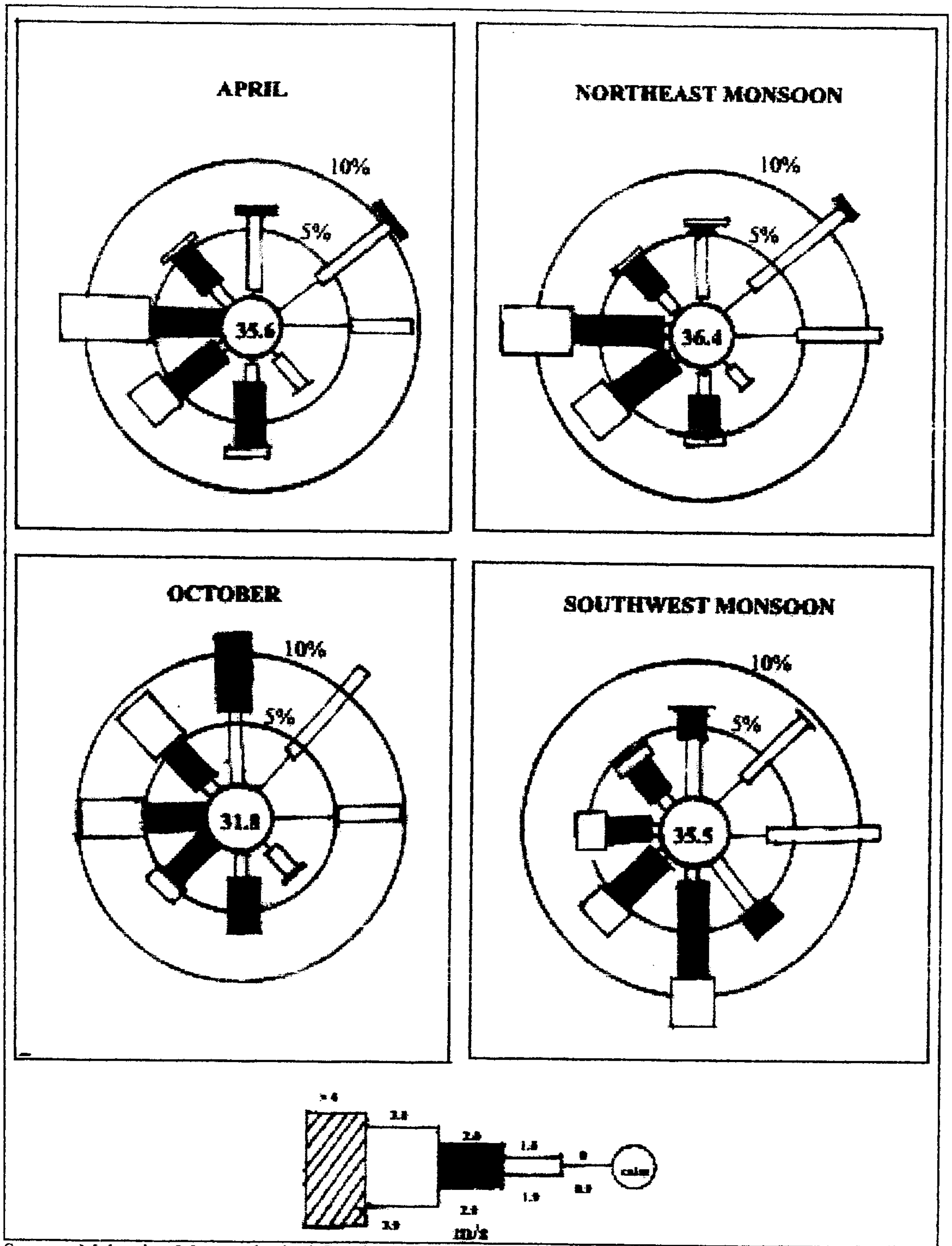
The study area has no station, which keeps climate records. The nearest available climate station is in Sitiawan. Figure 3.6 and 3.7 show the annual and monthly wind rose for the 1974-1997 periods. Wind in the study area is influenced by two monsoon periods. During Northeast monsoon, between the months of November and March, the predominant wind blow from the west and southwest directions. Although the study area is situated on the west coast of Peninsula Malaysia and in the lee side of wind attacks during the Northeast monsoon, waves can still be generated in the west and southwest direction during this period. The maximum wind speed occurring during the Northeast monsoon is about 8m/s.

During the southwest monsoon, between May and September, winds blow mainly from the south and southwest directions. Winds from these directions hardly exceed 8m/s.



Source: Malaysian Meteorological Services

Figure 3.6. Annual wind rose at Sitiawan (1974-1997)



Source: Malaysian Meteorological Services

Figure 3.7. Seasonal wind rose at Sitiawan (1974-1997)

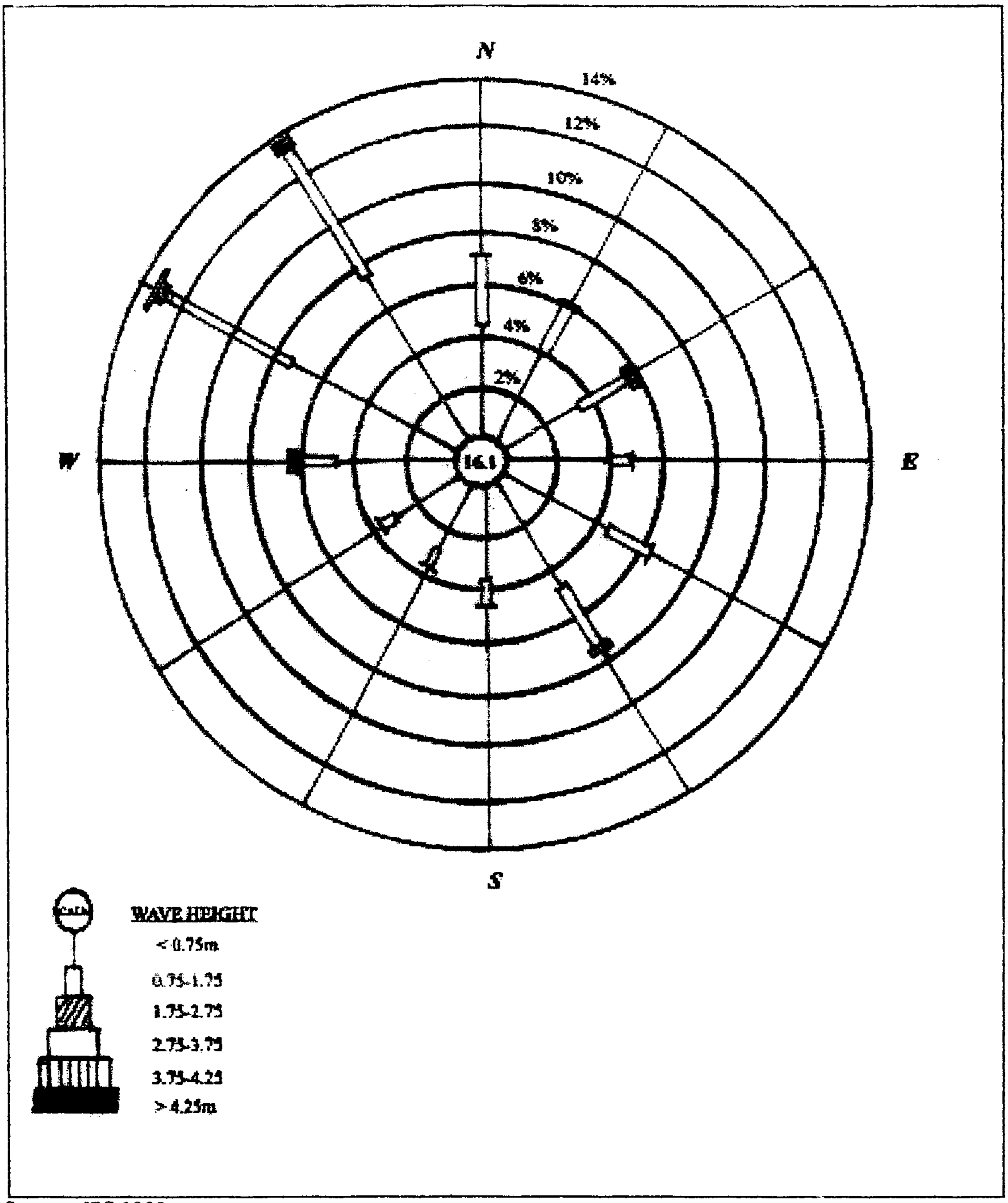
3.1.5 Waves

Wave conditions are influenced by the limited fetch in the Melaka Straits. Effective fetch length varies from 110km to the southeast and 280km to the NW, with much longer fetches along the North Northwest (NNW). The fetch in the NNW direction exceeds 1000km right up to Andaman Sea, however waves from the NNW are more likely to be duration limited. Figure 3.8 shows the wave rose for the Melaka Straits based on Visually Observed Shipboard observations (JPS 1999). About 32 per cent of the waves approached from the West (W) to NNW sector, 15 per cent from the SE sector and about 16 per cent of calm conditions. It is clear that the NW wave conditions dominate in the area. Although the study area is in the lee of wind attacks during the NE monsoon, significant waves can be generated in the NNW direction. This is due to the relatively longer fetch in this direction.

3.1.6 Rainfall

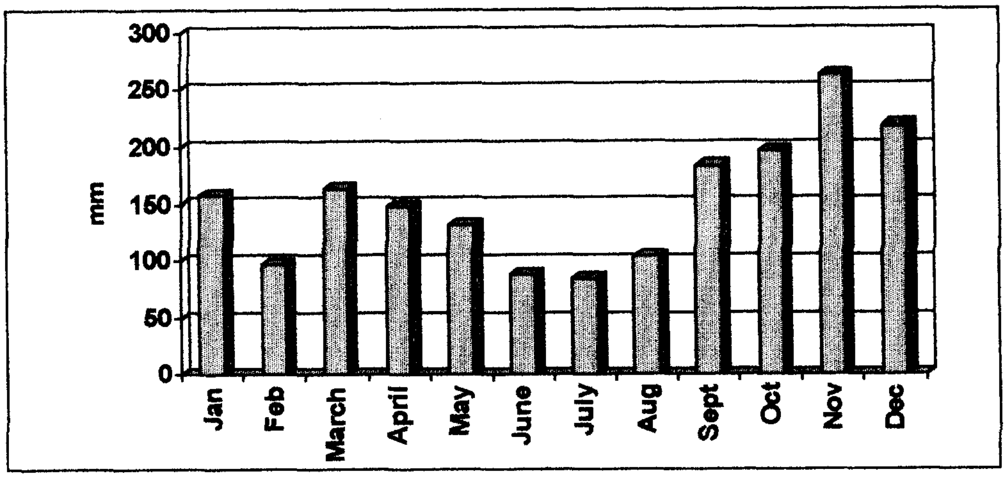
Figure 3.9 shows that the year to year variation as reflected by the coefficient of variation values among the months for the period 1985-1994 ranges from 27.1 per cent in November to 81.5 per cent in June. The annual total of rainfall, however, shows less variation, in the order of 9.3 per cent for the period.

On the basis of mean monthly rainfall, the dry months are February, June, July and August with total mean rainfall of 97.25mm, 87.53mm and 104.38mm respectively. The wet months are October, November and December with total mean rainfall figures of 195.73mm, 261.81mm and 217.5mm respectively.



Source: JPS 1999

Figure 3.8. Annual wave rose for Bagan Datoh (1949-1983)

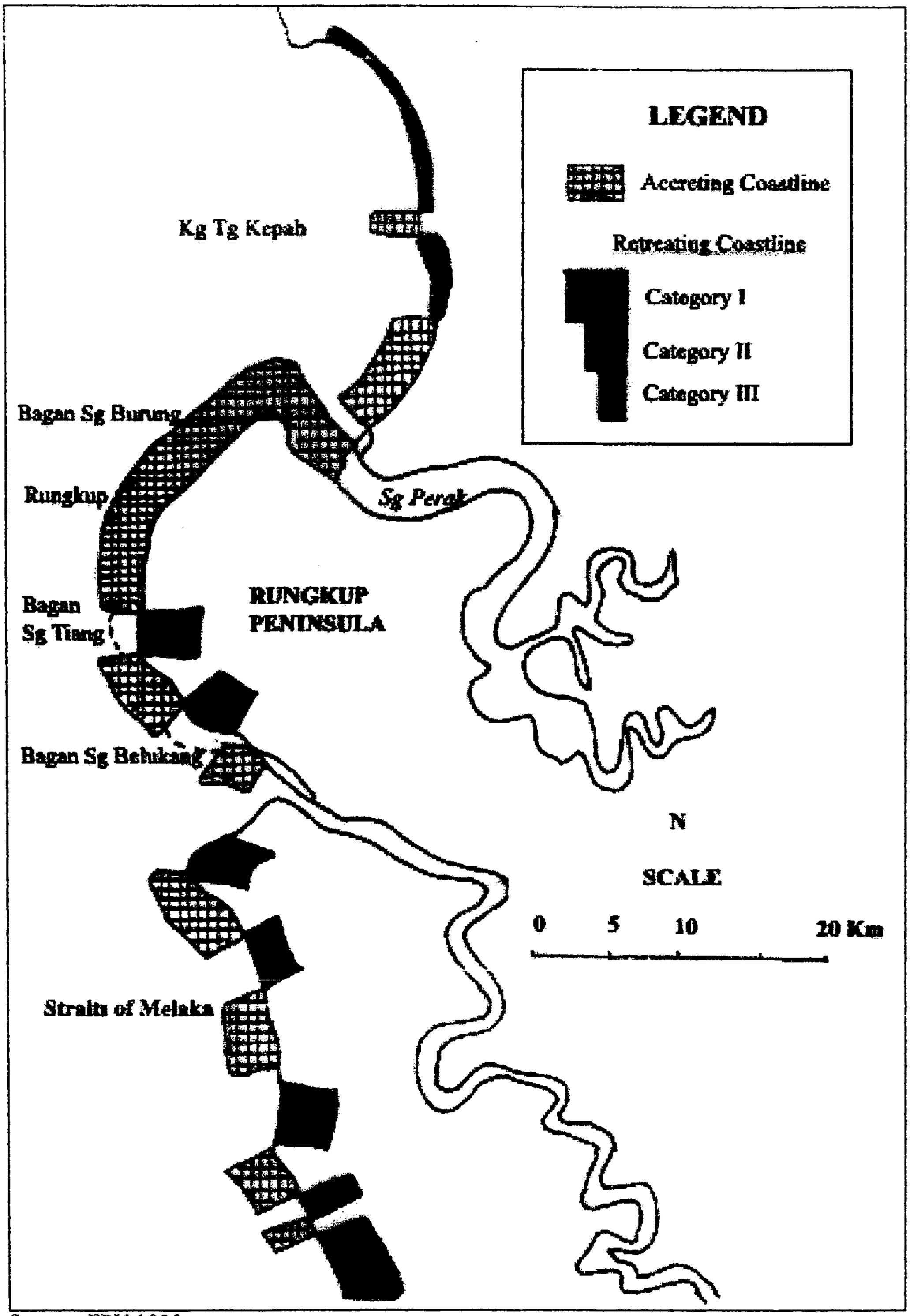


Source: Malaysian Meteorological Services

Figure 3.9. Mean monthly rainfall in Sitiawan (1985-1994)

3.1.7 Rungkup Coastline

Most of the Bagan Datoh coastline has experienced significant erosion since the earliest available records in 1930s. The National Coastal Erosion Study (EPU 1985) has identified the accreting and retreating coastlines along the Rungkup Peninsula and these are shown in Figure 3.10 and Table 3.5.



Source: EPU 1985

Figure 3.10. Conditions of Rungkup coastline

On the whole, the Rungkup Peninsula possesses the characteristics of an advancing coastline with the exception of areas around Bagan Sg. Tiang and Bagan Sg. Belukang. These two areas were severely eroded and classified under Category 1 (critical erosion). At Bagan Sg. Tiang, a large portion of mangrove trees have been killed, as evidenced by dead trunk and uprooted trees (Consumer 1991). Here the coastline has retreated by several hundred metres. DID had constructed new rock revetment to protect the coastline from further retreating. At Bagan Sg. Belukang, the coastal erosion had damaged the bund, resulting in saline water flooding about 800ha of land. A new revetted bund has been constructed by DID to stop erosion (New Straits Times 1995).

Table 3.5. Coastline classification of Rungkup Peninsula

Location	Coastal Processes	Coastal Material	Coastline Condition (m/yr)	Coastal Protection
Sg. Perak – Bagan Sg. Burung	P,N	C_{mf}	Accreting, +35	-
Bagan Sg. Burung – Bagan Sg. Rungkup	P,N	C_{mf}, S_t	Accreting, +12	-
Kg Sg. Lanchang – Bagan Sg. Tiang	P,N	C_{mf}, S_t	Retreating, -25	R_r – a S_t – p
Bagan Sg. Tiang	N,P	C_{mf}, S_t	Retreating, -28	-
Bagan Sg. Tiang (south)	N,P	C_{mf}	Retreating, -30	R_r – p
Bagan Sg. Tiang (south) – Sg. Tebuk Semani	N,P	C_{mf}	Accreting , +40	-
Sg. Tebuk Semani	N,P	C_{mf}, S_t	Accreting , +30	R_r – a

Bagan Sg. Belukang	N,P	C_{mf}, S_t	Retreating, -48	R_r – f S_t – f
Bagan Sg. Belukang – Sg. Bernam	N,P	C_{mf}, S_t	Accreting, +20	-

Source: EPU 1985

Note:

P – shore parallel movement

N – shore normal movement

C_m – marine clay strata

C_f – fine littoral sediments

S_t – sand trace

R_r. a – revetment or rip rap (rock, adequate condition)

R_r - p – revetment or rip rap (rock), poor condition

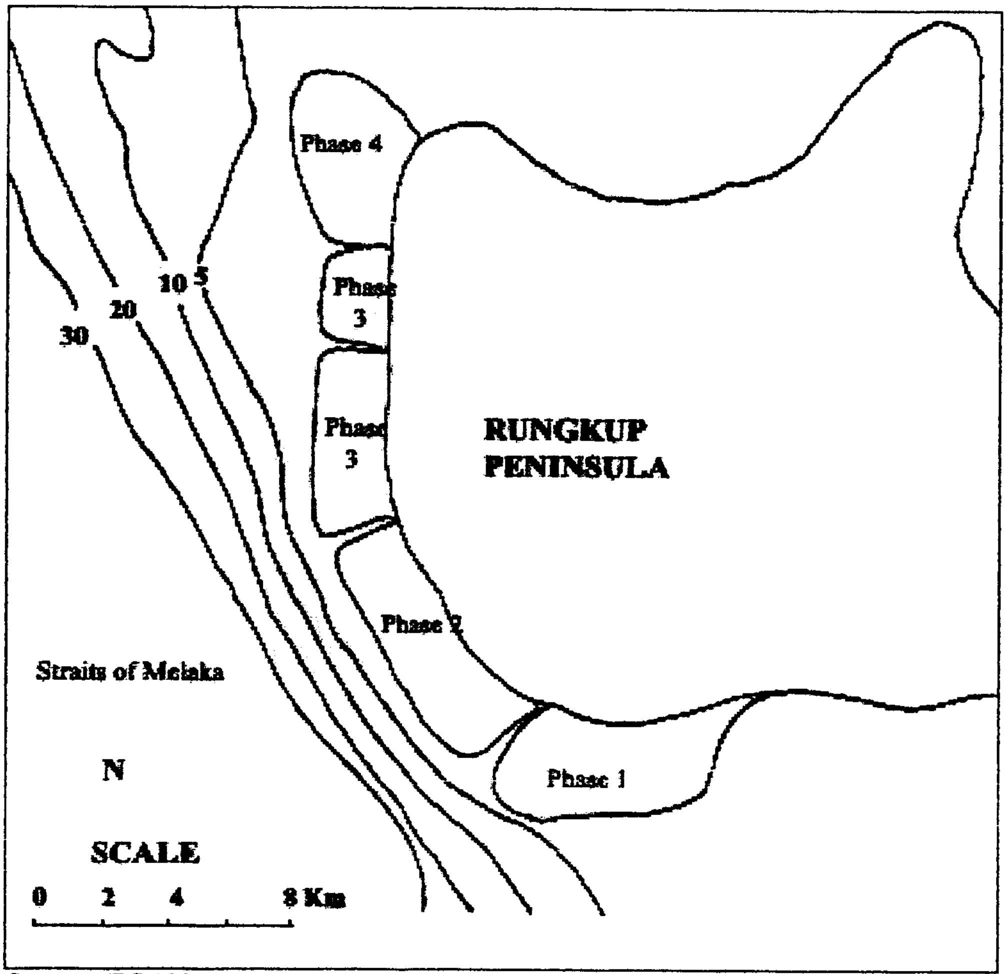
R_r. f – revetment or rip rap (rock), but failed

S_t - p – seawalls (timber). Poor condition

S_t - f – seawalls but failed

3.1.8 Offshore Conditions

Fetch distances in the Straits of Melaka range between approximately 110km to the southeast and 280km to the northwest. Water depths in the straits average about 40m (JPS 1999). The water of the Straits of Melaka influenced wave conditions of waves approaching from the northwest and south directions. Waves rising in the northwest quarter are generated in the Andaman Sea. The fetch in the direction exceeds 1000km. The Andaman Sea has water depths up to 3100m although the effective depth from the northwest is in the order of 100m. Offshore bottom contours generally are parallel to the coastline up to a depth of 30m. From these contours seawards, contours appear independent of the coastline and landforms (JPS 1999). Figure 3.11 shows the offshore bathymetric condition of the study area.



Source: JPS 1999

Figure 3.11. Offshore bathymetry of Rungkup Peninsula

3.1.9 Coastal Vegetation

The mangrove forest in Rungkup which was previously a Forest Reserve had been reclaimed. The Rungkup Forest Reserve gazetted in 1913 was degazetted in 1967 (Jabatan Perhutanan Negeri Perak 1986-1995) and converted for agriculture. Conversion of mangroves for agriculture has drastically diminished the mangrove areas. As the result most of the coastline is eroding and at some points the bunds are under direct attack by waves.

3.2 Socio-Economic

3.2.1 Population

The *mukim* of Rungkup is sub divided into 11 *kampung* (Kg.) and 4 *bagan*, or fishing village, supporting a population of about 21198 people and covering a total area of over 9400ha (Table 3.6).

The ethnic composition of Mukim Rungkup is well represented with Malays (69%), Chinese (30%) and Indians (1%). Majority of the Chinese are full time fishermen living along the coast, while the Malays are predominantly coconut small holders residing slightly further inland from the coast.

Table 3.6. Profile of *Mukim* Rungkup

Kampung / Bagan	Area (ha)	Population
Kg. Batu 20	786.5	2333
Kg. Sg. Batang	941.6	1490
Kg. Sg. Hj. Muhamad	1,654.0	1429
Kg. Selekoh	461.7	1100
Kg. Sg. Belukang	722.5	715
Kg. Sg. Tiang Darat	1,226.7	2215
Kg. Sg. Tiang Baroh	830.6	1193
Kg. Sg. Lancang	1,150.6	1386
Kg. Rungkup Kecil	648.4	1220
Kg. Sg. Nipah Darat	407.4	1621
Kg. Simpang Tiga	379.8	1670
Kg. Bagan Pasir Laut	105.3	1371
Kg. Bagan Lipas	75.3	308
Kg. Bagan Sg. Tiang	32.4	2304
Kg. Bagan Sg. Belukang	31.9	843

Source: 1. UPEN 1984
2. Department of Statistic
3. Penghulu's Office, *Mukim* Rungkup 1999

3.2.2 Economy

A brief review of the peninsula's agriculture history will help the understanding of the Rungkup's existing land use patterns, and as to why certain areas are facing critical erosion. The agriculture development of Rungkup started with the conversion of swampland by small holders around 1870s.

The peninsula first known contact with the British was during 1893, when copra was intruduced as one of the highly valued products by the Perak British Resident, F. A. Swettenham (Khusarie 1996). In March 1897, in the *mukims* of Bagan Datoh and Rungkup, smallholders were reported to have produced between 50,000 to 60,000 coconuts at RM20.00 per 1000 nuts.

In 1896 British owned plantations were developed and in 1900s, the crop spread throughout the Peninsula, which became the major producer of copra in Perak.

The development of coconut plantation from 1900s onwards resulted in the clearing of vast areas of virgin forest. Accelerated development of the hinterland led to rapid coastal accretion. In 1962 some 2630ha of accreted areas on the south and west coast of the Peninsula were converted under the Second Five Year Development Plan (1961-65) (1st MP).

The converted land was developed under different land schemes as shown in Table 3.7 and Figure 3.12.

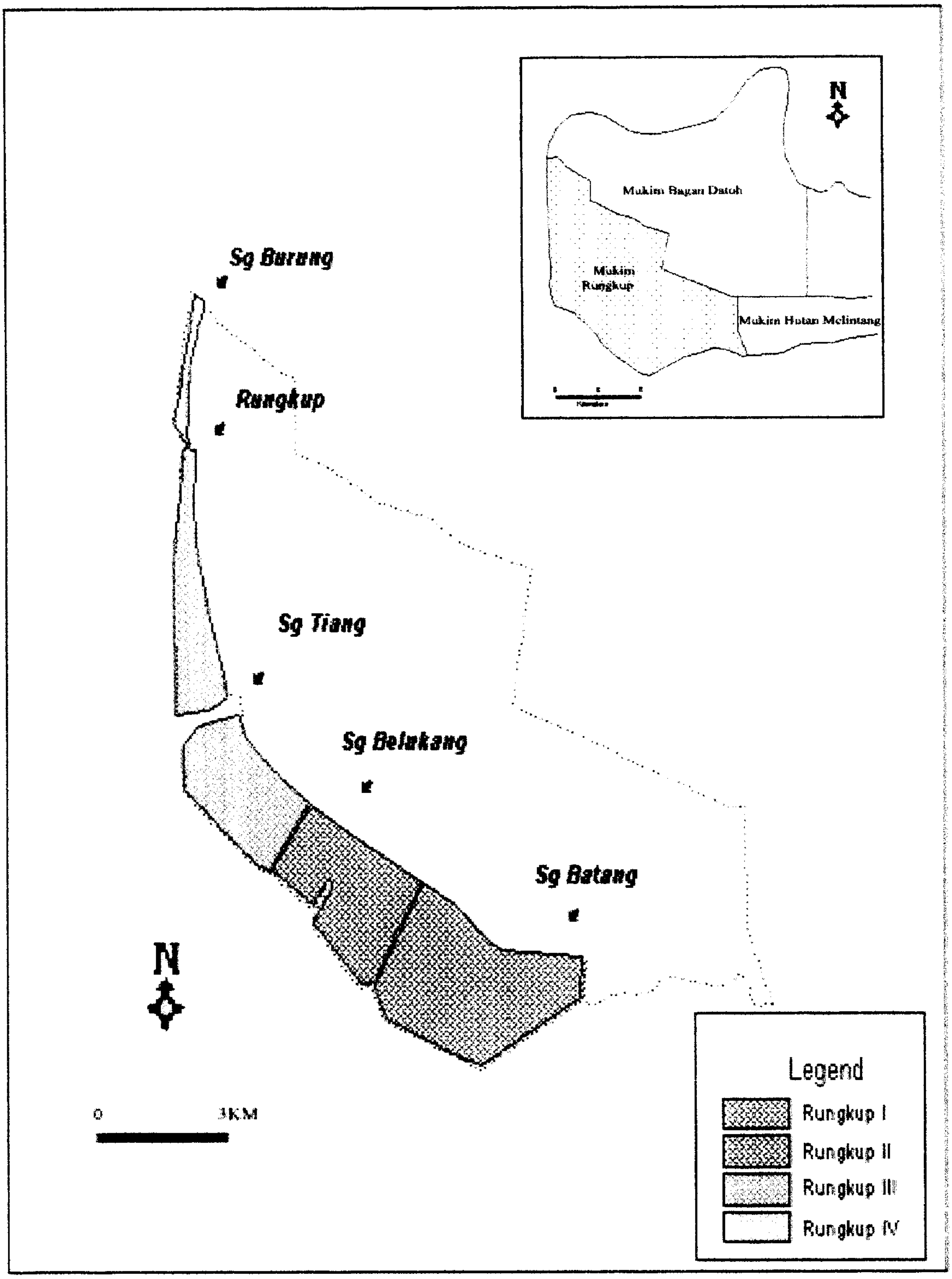
Table 3.7. Agricultural land scheme of *Mukim* Rungkup

Class	Area (ha)	Year Developed	Crops
Rungkup I	874	1973	Coconut
Rungkup II	706	1973	Coconut
Rungkup III	1083	n/a	Coconut
Rungkup IV	311	1988	Oil palm

Source: District Office Teluk Intan

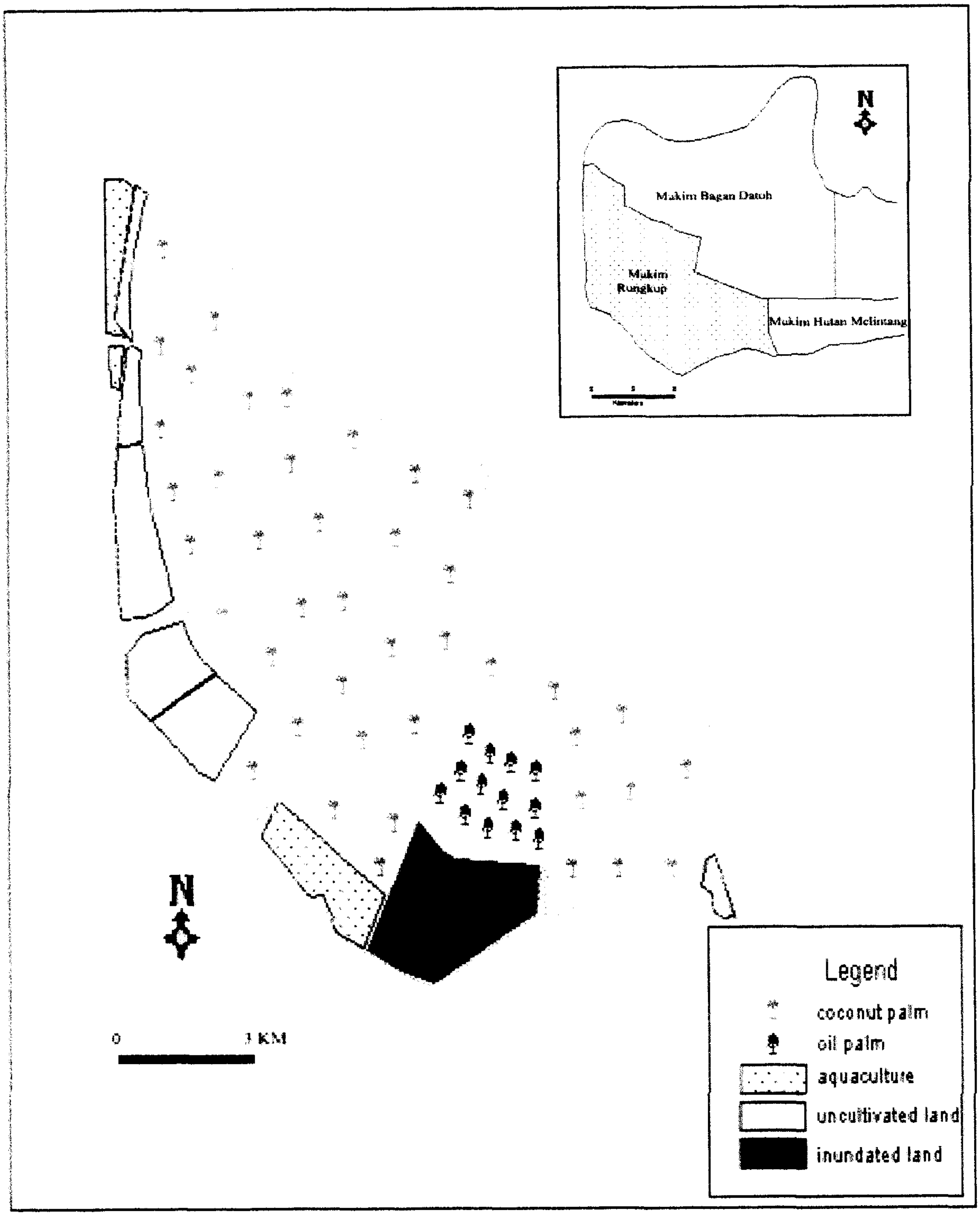
The converted land is protected from saline intrusion by coastal earth bund. This area is under small holdings and planted with coconut. Intercropping was widely practiced in the early 1970s, with vegetables, bananas, pineapples and cocoa planted.

Figure 3.13 shows the present land use pattern of Rungkup and Figure 3.14 shows the economic sectors of *Mukim* Rungkup. Fishing is focused in 4 fishing villages. Most of the catch (80%) is for domestic market. The annual catch were estimated at 35,262.28 metric tons with a value of RM75.5million (UPEN 1996). There are about 115 aquaculture ponds in *Mukim* Rungkup. According to the Department of Fishery, Teluk Intan, tiger prawns and cockles breeding in *Mukim* Rungkup totalling 66.5ha and 34.8ha respectively.



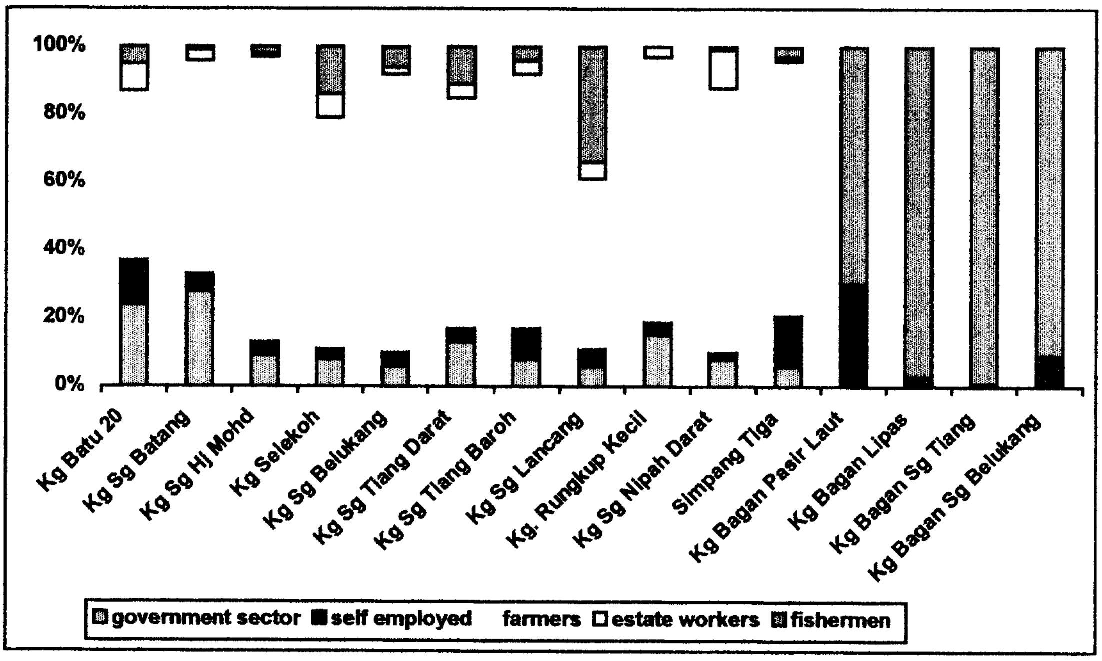
Source: District Office, Teluk Intan

Figure 3.12. Land scheme development in Rungkup



Source: Personal Study 2001

Figure 3.13. Present landuse in Rungkup



Source: District Office Teluk Intan

Figure 3.14. Economic sectors of *Mukim* Rungkup

3.2.3 Amenities

According to the information provided by the District Office, Rungkup is well provided with adequate basic facilities and amenities and at par with similar rural areas in other parts of the country. Almost all houses (99.84%) are supplied with piped water and electricity. There are several small towns and a dense network of linear settlements. They are served by schools, clinics, mosques, cemeteries and other amenities (Table 3.8).

Table 3.8. Social amenities in *Mukim* Rungkup

Facilities and Amenities	Number
Flush pour toilet	3179 (84.9%)
Electricity	3705 (98.9%)
Piped water	3686 (98.3%)
Tarred road (km)	42.1
Crushrun road (km)	32.65
Mosque	11
Surau	50
Temple	15
Post office	1
Police station	3
Hall	17
Multi-purpose hall	1
Rural clinic	7
Children playground	2
Football field	8
Badminton/Sepak Takraw court	37
Basketball court	7
Volleyball court	8
Public Library	1
Public telephone	46
National school	20
National (type) school	4

Source: UPEN 1996
DOE 1997

A similar level of basic facilities can also be found in the fishing villages (Table 3.9). The access roads leading to most of the fishing villages are paved

Table 3.9. Basic facilities in the fishing village

Facilities	Bagan Sg. Tiang	Bagan Sg. Belukang	Bagan Lipas	Bagan Pasir Laut
Houses	392	91	39	157
Public telephone	1	1	1	1
School	1	1	-	1
Temple	4	2	2	5
Hall	0	0	0	1
Rural clinic	0	1	0	1
Badminton court	1	0	0	0
Basketball court	1	0	0	1
Volleyball court	1	0	0	0
Piped water (%)	100.0	100.0	100.0	100.0
Electricity (%)	100.0	100.0	100.0	100.0
Sanitary toilet (%)	43.9	82.4	64.1	80.9
Tarred road (km)	3.2	1.6	3.2	2.4
Crushrun road (km)	1.6	2.4	0	0

Source: Penghulu's Office 1999

3.2.4 Land Development

Ownership of agricultural lands is mainly by smallholders, while the main parts of the mangroves and mudflats belong to the Perak State Government and a small parcel of land in Bagan Belukang belongs to FELCRA.

A recent proposed development project to reclaim an area of approximately 10,500 acres (4,250ha) has been initiated by the Perak State Government (JPS 1997) (Figure 3.11). The proposed project will be carried in 4 phases and is conceived with the main objective of combating coastal erosion and land inundation besides upgrading the socio-economic status of the area. This land reclamation project will provide a form of protection to the existing coastline. The land will dissipate the wave energy thus solving the erosion problem. The proposed project will span over a distance of about 30km hugging the present coastline (JPS 1997).

Unfortunately, the reclamation project initiated by Innovest Sdn Bhd did not materialize. DID had to decide a new strategy in planning for a permanent coastal protection bund. The permanent protection bund is planned to be implemented within the 8th Malaysia Plan and it is hoped that this coastal protection project will be a successful measure against coastal erosion thus resolving the problem of coastal flooding.