CHAPTER 1 INTRODUCTION

1.1 Problem Statement

The coastline of Malaysia consists of two widely different physical formations: the mangrove and nipah fringed mud flat, and the sandy beaches. Malaysia is experiencing increased erosion rates along the coastline. The National Coastal Erosion Study (EPU 1985) reveals that of the 4809km of coastline in Malaysia, about 1300km (27%) are presently subjected to erosion and the economic values of the human activities have been threatened. Coastal erosion sites have been classified into the following three categories (Table 1.1) -

a. 145km of critical erosion areas where the facilities are expected to be endangered (Category 1),

b. 246km of significant erosion areas where the facilities are expected to be endangered within 5 to 10 years, if no remedial action is taken (Category 2),

c. 975km of acceptable erosion areas that are generally undeveloped with consequent minor economic loss if coastal erosion continues unabated (Category 3).

Table 1.1. Spatial distribution of eroding coastline of Malaysia

Area	Total length of coastline (km)	Category I	Category II	Category III	Total length of eroding coastline (km)	(%)
Peninsula Malaysia	1972	131 (41)	213 (57)	651 (58)	995 (156)	73.0
Sabah	1802	6 (3)	10 (7)	310 (14)	326 (24)	24.0
Sarawak	1035	8 (3)	23 (11)	14 (7)	45 (21)	3.0
Total	4809	145 (47)	246 (75)	975 (79)	1366 (201)	100.0

Note: The figures in parenthesis refer to the number of sites.

Source: EPU 1985

The spatial distribution of the eroding areas is shown in Table 1.2. Of the 47 critically eroding sites, agriculture features by far as the most dominant human activity (in 19 of the sites), followed by housing (15), transportation (8) and recreation (5) in decreasing number of critically eroding sites.

Since 1985, at least six of Category 2 has been reclassified as Category 1 and partly due to a worsening eroding condition (Zamali and Lee 1989). At present, there are altogether 72 critical erosion areas with a total length of 226km (Cho 1996). The length of individual areas ranges from 0.2km up to 3.5km. There are currently 65 areas with a total length of 228km in significant erosion category. Although important economic and social activities are carried out in this area, such activities are presently not threatened by coastal erosion but may be so within the next 5 to 10 years.

A total of 77 areas are in the acceptable erosion category. Erosion in these areas, which aggregate more than 940km in length has no serious consequences because these areas are generally undeveloped (Table 1.2).

Table 1.2. Distribution of coastal erosion areas in Malaysia

State	Length of coastline (km)	Category 1 (km)	Category 11 (km)	Category 111 (km)	Total length of eroding coastline (km)	(%)
Perlis	20.0	4.4 (3)	3.5 (1)	6.4 (4)	14.3 (8)	71.5
Kedah	148.0	22.6 (13)	2.6 (2)	12.4 (6)	37.6 (21)	25.4
Pulau Pinang	152.0	36.7 (8)	19.1 (5)	1.1 (1)	56.9 (14)	37.4
Perak	230.0	20.8 (3)	26.3 (2)	93.1 (4)	140.2 (9)	61.0
Selangor	213.0	55.3 (9)	32.9 (8)	66.1 (3)	154.3 (20)	72.4
Negeri Sembilan	58.0	2.0 (1)	9.6 (5)	12.9 (1)	24.5 (7)	42.2
Melaka	73.0	9.2 (3)	22.1 (3)	3.0 (1)	34.3 (7)	47.0
Johor	492.0	18.8 (7)	53.2 (9)	165.7 (13)	237.7 (29)	48.3
Pahang	271.0	9.6 (8)	2.8 (2)	107.8 (8)	120.2 (18)	44.4
Terengganu	244.0	20.0 (6)	12.8 (5)	122.4 (10)	155.2 (21)	63.6
Kelantan	71.0	5.0 (3)	10.9 (6)	37.6 (3)	53.5 (14)	75.4
W.P. Labuan	59.0	0.0	5.5 (4)	25.1 (22)	30.6 (6)	51.9
Sarawak	1035.0	9.0 (3)	22.8 (11)	13.7 (7)	45.5 (21)	4.4
Sabah	1743.0	12.8 (5)	3.5 (2)	279.2 (12)	295.5 (19)	17.0
Total	4809.0	226.2 (72)	227.6 (65)	946.5 (77)	1400.3 (214)	29.1

Source: JPS 1996

According to the data compiled by Teh and Lim (1993) from the 1985 study, more than half of the mangrove coast of Peninsula Malaysia is eroding, with the states of Perak and Selangor having the most extensive erosion (Table 1.3).

Table 1.3. Conditions of mangrove coasts in Peninsula Malaysia

State	Retreating (km)	Stable (km)	Advancing (km)	Total (km)
Perlis	5.6	0	3.4	9
Kedah	21.9	17.6	30.9	70.4
P.Pinang	27.2	10.7	21.4	59.3
Perak	134.8	0	52.6	187.4
Selangor	148.7	5.1	47.3	201.1
N.Sembilan	12.7	7.9	9.5	30.1
Melaka	5.1	0	18.2	23.3
Johor (west)	80.1	24.6	58.1	162.8
Johor (east)	32.0	18.0	0	50.0
Pahang	40.0	53.0	0	93.0
Terengganu	10.0	25.0	0	35.0
Kelantan	0	0	0	0
Total	518.1	161.9	241.4	921.4
%	56.23	17.57	26.20	100.0

Source: Teh and Lim 1993

Of the eroding mangrove fringe, 53% are retreating at up to 8m per year, 11% at more than 8m per year and the remaining retreating at an undetermined rate (Table 1.4). Mangrove erosion is widespread in Balik Pulau on the west coast of Penang, where recession up to 100m per year has been recorded. Other areas of erosion of more than 8m per year include Kuala Kedah, Sungai (Sg.) Pandiang, Bagan Sg. Tiang, Bagan Sg. Belukang, Bagan Sg. Burung, Bagan Sg. Besar, Sg. Limau, Sg. Senggarang, Parit Hylam, Sg. Rambah dan Sg. Buntu (Teh & Lim 1993).

Table 1.4. Rate of mangrove retreat in Peninsula Malaysia

State	Rate of Retreat (m/yr)						
	<2	2-3.9	4-5.9	6-7.9	>8	unknown	Total (km)
Perlis	0	0.3	5.3	0	0	0	5.6
Kedah	13.6	0.6	1.0	6.7	0	0	21.9
P.Pinang	9.4	0	4.2	3.7	9.9	0	27.2
Perak	60.9	21.1	25.7	5.3	21.8	0	134.8
Selangor	17.1	16.4	35.9	14.2	23.7	41.4	148.7
N.Sembilan	12.7	0	0	0	0	0	12.7
Melaka	0	0	0	0	0	5.1	5.1
Johor (west)	0	0	0	0	1.7	78.4	80.1
Johor (east)	0	0	0	0	0	32.0	32.0
Pahang	13.5	0	0	0	0	26.5	40.0
Trengganu	0	8	0	0	0	2.0	10.0
Kelantan	0	0	0	0	0	0	0
Total	127.2	46.4	72.1	29.9	57.1	185.4	518.1
%	24.55	8.96	13.92	5.77	11.02	35.78	100.0

Source: Teh and Lim 1993

Along the 241km of advancing mangroves, 38.3% are accreting at more than 5m per year with another 31% encroaching seaward at an unknown rate (Table 1.5). Areas of rapid advance include Kuala Sanglang in Perlis (more than 60m per year), Sg. Bakau, Sg. Kelumpang, Sg. Perak and Bagan Sg. Tiang in Perak, Bagan Beting Kepah, Sg. Tunggol and Sg. Terap in Selangor and Parit Burong in Melaka (Teh & Lim 1993).

Table 1.5. Rate of mangrove advance in Peninsula Malaysia

State	Rate of mangrove advance in Peninsula Malaysia					
	<5	5-10	11-15	>15	unknown	Total (km)
Perlis	0	0	0	3.4	0	3.4
Kedah	15.4	7.5	0	8.0	0	30.9
P.Pinang	0.8	0	0	3.0	17.6	21.4
Perak	6.5	0	7.6	38.5	0	52.6
Selangor	14.6	1.7	4.2	26.8	0	47.3
N.Sembilan	9.5	0	0	0	0	9.5
Melaka	0	5.4	0	12.8	0	18.2
Johor (west)	0	0	0	0	58.1	58.1
Johor (east)	0	0	0	0	0	0
Pahang	0	0	0	0	0	0
Terengganu	0	0	0	0	0	0
Kelantan	0	0	0	0	0	0
Total	46.8	14.6	11.8	92.5	75.7	241.4
%	19.39	6.05	4.89	38.32	31.36	100.0

Source: Teh and Lim 1993

Coastal erosion is a serious national problem with long term economic and social consequences. The economic and social consequences of coastal erosion and the concern generated have increased rapidly as the use of coastal lands intensifies.

Along the west coast, most of the agriculture land is seriously threatened. Bunds which protect seawater ingress have been breached by wave attack. The tidal flooding that follows bund breach can penetrate as far as 2km inland, thereby damaging the existing crops of coconut, cocoa, oil palm and paddy and reducing the soil fertility for future crops. Income from annual crops is completely eliminated and income from tree crops is substantially reduced.

Tidal-land conversion is one of the causes for the widespread of coastal erosion and bund failure along the west coast of Peninsula. Large tracts of the mangrove fringed coastline of the west coast of Peninsula have been reclaimed for agricultural development. Reclamation of the coastal plains was achieved through the construction of coastal bunds along the coasts to prevent tidal flooding. However, the protection afforded by narrow strip of mangrove as a natural buffer has been diminished or have vanished due to erosion. Consequently, wave run-up generated, overtops the bund. This condition has developed extensively along the west coast of Malaysia from the Prai-River in Province Wellesley to the Straits of Johore, which adversely affect large areas of existing agriculture land.

In other areas, coastal erosion has damaged coastal road, severing land communication links in extreme cases. Main roads or secondary roads connecting villages and scattered houses with main roads that are damaged result in delayed or interrupted travel and serious inconvenience. Quite often, traffic has to be rerouted to an alternative road and the severed road relocated further inland.

Therefore along the west coast, bund protection works have to be carried out in order to protect the investment on infrastructure and the livelihood of the farmers.

Today, typical mangroves exist only as a narrow fringe seaward of the outermost coastal bund and even there the mangroves are continuously diminishing as a result of erosion.

Bund breaching is becoming more common in Malaysia and former agriculture land has been partially or wholly reclaimed by mangroves. A recent breach took place in Bagan Datoh, when 60m of coastal bunds failed and the encroaching sea water damaged about 800ha of agricultural land (The Star 1995).

As the result, *mukim* Rungkup (Figure 3.2) was selected for this study because the conditions in this area is similar to other areas where mangrove swamps are under pressure to be converted into agricultural land and aquaculture. Agriculture land of about 800ha has been inundated due to coastal erosion and bund failure. This study discusses the causes of bund failure in Rungkup, and then proceeds to present the various protection measures adopted in the past and the present strategies in addressing the problem.

1.2 Objectives of the study

These are:

a. To describe the relationship between land conversion and land inundation,

b. To determine the causes of bund failure and their physical and socio-economic impacts,

c. To identify how coastal communities adjust to changing rates of inundation,

d. To evaluate the response options and policies for managing land vulnerable to inundation.

1.3 Scope

Literature review is discussed in Chapter 2. Chapter 3 gives an overview of the study area, biophysical characteristics, history of land utilisation and the underlying social processes. Three coastal study sites are selected, information on the household size is provided, and data gathering methods and techniques of analysis are described in Chapter 4. Results of questionnaire survey which includes past and present perception of the erosion hazard, range of adjustments and adjustment strategies adopted by the local community are contained in Chapter 5. A study on causes, impact assessments such as bund failure and an extended analysis of evaluation of response options are detailed in Chapter 6. Sustainable management and conclusion of this research is discussed in Chapter 7.