CHAPTER 2 LITERATURE REVIEW

A brief scenario on coastal erosion and inundation in Malaysia was discussed in Chapter 1. Numerous studies have been carried out locally and globally regarding the issue. However not much studies have been carried out on polder land.

2.1 Local Review

In the state of Perak, no study has ever been carried out in Bagan Datoh on individual basis. However, Department of Irrigation and Drainage (DID), has documented past and present condition of the coastal zone especially on the coastal bund, erosion and flooding problems in Perak and Malaysia on whole in its annual report since 1930.

Table 2.1 shows the annual, biennial and triennal reports of DID on Bagan Datoh. Almost all the reports published were on the conditions of coastal bund which included bund breaching or overtopping, location of vulnerable bund, cost of maintenance and others. Cost of maintenance includes cost of reconstruction, repair of coastal bund, improvement of drains, desilting, retirement of coastal bund etc.

Table 2.1. DID Annual Reports (1931-1999)

	Title	Content	Author	Source	Year
1	Bagan Datoh Delta Drainage Board	Conditions of coastal bund and cost of maintenance	n/a	DID	1931
2	Annual Report of the DID of the Federated Malay States and the Straits Settlements	Conditions of coastal bund and cost of maintenance	n/a	DID	1933
3	Annual Report of the DID of the Federated Malay States and the Straits Settlements	Conditions of coastal bund and cost of maintenance	n/a	DID	1935
4	Report of the DID	Conditions of coastal bund and cost of maintenance	n/a	DID	1935-1937
5	Annual Report of the DID, Perak	Conditions of coastal bund and cost of maintenance	n/a	DID	1936
6	Annual Report of the DID of the Federated Malay States and the Straits Settlements	Retirement of coastal bund	n/a	DID	1936
7	Annual Report of the DID, Perak	Conditions of coastal bund and cost of maintenance	n/a	DID	1937
8	Annual Report of the DID of the Federated Malay States and the Straits Settlements	Conditions of coastal bund and cost of maintenance	A.G.Robinson	DID	1938
9	Annual Report of the DID, Perak	Conditions of coastal bund and cost of maintenance	n/a	DID	1939
10	Annual Report of the DID of the Federated Malay States and the Straits Settlements	Reconstruction of coastal bund for Parit 9 to Parit 25, Bagan Datoh Drainage Board	A.G.Robinson	DID	1939
11	Maintenance of Bagan Datoh Delta Drainage Area	Cost of maintenance works	n/a	DID	1946
12	Annual Report of the DID of the Malayan Union	Conditions of coastal bund and cost of maintenance	W.Grantham	DID	1946
13	Annual Report of the DID	Conditions of coastal bund and cost of maintenance	W.Grantham	DID	1947

14	Annual Report of the DID of the Federated Malay States and the Straits Settlements	Conditions of coastal bund and cost of maintenance	W.Grantham	DID	1948
15	Annual Report of the DID	Conditions of coastal bund and cost of maintenance	W.Grantham	DID	1948
16	Annual Report of the DID, Perak	Conditions of coastal bund and cost of maintenance	M.P.Murphy	DID	1949
17	Annual Report of the DID	Conditions of coastal bund and cost of maintenance	P.McNee	DID	1951
18	DID	Conditions of coastal bund and cost of maintenance	n/a	DID	1952
19	Report of the DID	Conditions of coastal bund and cost of maintenance	P.McNee	DID	1952, 53,54
20	Report of the DID	Conditions of coastal bund and cost of maintenance	M.P.Murphy	DID	1955, 56,57
21	Report of the DID	Conditions of coastal bund and cost of maintenance	R.L.Akers	DID	1958, 59,60
22	Report of the DID of the Ministry of Agriculture and Co-operatives Malaysia	Conditions of coastal bund and cost of maintenance	Ow Yong Hong Chiew	JPT	1961, 62,63
23	Annual Report of the DID	Desilting works	n/a	DID	1963
24	Annual Report of the DID, Perak	Conditions of coastal bund, cost of maintenance and land reclamation	n/a	DID	1964
25	Annual Report of the DID, Perak	Conditions of coastal bund, cost of maintenance and land reclamation scheme	n/a	DID	1965
26	Annual Report of the DID, Perak –	Conditions of coastal bund , cost of maintenance and land reclamation scheme	n/a	DID	1966
27	Laporan Tahunan JPT Perak	Conditions of coastal bund , cost of maintenance and land reclamation scheme	n/a	JPT	1967
28	Bagan Datoh Delta Drainage Board	Conditions of coastal bund and cost of maintenance	n/a	JPT	1968
29	Laporan Tahunan JPT Perak	Conditions of coastal bund , cost of maintenance and land reclamation scheme	n/a	JPT	1968

30	Penyata Tiga Tahun Bahagian Parit dan Taliair Kementerian Pertanian dan Syarikat Kerjasama Malaysia	Conditions of coastal bund and cost of maintenance	n/a	JPT	1967, 68,69
31	Laporan Tahunan JPT Perak	Conditions of coastal bund and cost of maintenance	n/a	JPT	1970
32	Triennal Report of the DID	Conditions of coastal bund , cost of maintenance and land reclamation scheme	n/a	DID	1970, 71,72
33	Laporan Tahunan JPT Perak	Conditions of coastal bund and cost of maintenance	n/a	JPT	1971
34	Penyata Tahunan Bahagian Parit dan Taliair Kementerian Pertanian dan Perikanan Malaysia	Reconstruction of Bagan Datoh Scheme	n/a	JPT	1973
35	Penyata Tahunan Bahagian Parit dan Taliair Kementerian Pertanian dan Perikanan Malaysia	Reconstruction of Bagan Datoh Scheme	n/a	JPT	1974
36	2nd Malaysia Plan	Reconstruction and improvement of Bagan Datoh Drainage Delta	n/a	JPS	1971-75
37	Review of 2nd Malaysia Plan	Expenditure and flood damages	n/a	DID	1971-1975
38	Laporan Tiga Tahun Triennal Report	Reconstruction of Bagan Datoh Scheme	n/a	DID	1977-79
39	Laporan Tiga Tahun Triennal Report	Conditions of coastal bund and cost of maintenance	n/a	DID	1980-1982
40	Penyediaan peringkat pertama (Bhgn Persekutuan) Rancangan Malaysia ke 4	Agricultural programmes	n/a	JPS	1981-1985
41	Triennal Report of the DID	Conditions of coastal bund and cost of maintenance	n/a	DID	1983-1985
42	Penyata Kewangan Perak	Reconstruction and improvement of Bagan Datoh Drainage Delta	Dato Mohamad Noor Abdul Rahim	JPS	1989
43	Penyata Kewangan Perak	Reconstruction and improvement of Bagan Datoh Drainage Delta	Dato Dr Syed Jaafar bin Syed Azran	JPS	1991

44	Biennial Report	Coastal Erosion Control Projects	n/a	DID	1993-94
45	Cadangan Penyelesaian Isu Hakisan Pantai di Bagan Datoh dan Permohonan untuk 'Permanent Protection Works'	Conditions of coastal bund and erosion problems in Bagan Datoh	n/a	JPS	1997
46	Laporan Status Pelaksanaan Program Pengawalan Hakisan Pantai Negara	Conditions of coastal bund and erosion problem in Bagan Datoh	n/a	JPS	1997
47	Laporan Hakisan Pantai di Bagan Datoh	Conditions of coastal bund and erosion problem in Bagan Datoh	Hidzrami	JPS	1999

2.2 National Review

In Malaysia a complete study on the coastal zone condition was documented in National Coastal Erosion Study Volume 1 and 2 in 1985. The National Coastal Erosion Study (EPU 1985) carried out an evaluation of the existing coastal protection structures throughout the country including those erected in mud coast areas. The report concluded that the failure of most of the existing structures is due to inadequate strength of the designed structure and the use of less desirable materials, inadequate rock size, insufficient treatment of the foundation problem and frequent overtopping by waves.

These situations exist because of the protection methods used were of low cost technology such as timber piles, tyres breakwaters, rock dump and sandbags. They were erected as an emergency response to a crisis situation without proper understanding of the underlying problem and thus, lack proper planning. Though all these low cost technology approaches may have potential for emergency works, they are not suitable as permanent protection works.

An early documented Malaysia example of abandonment of polder land is Sg. Burung in Sabak Bernam, where repeated bund failure from 1978 to 1985 resulted in a new bund being constructed and built 60m inland. An earth escarpment was built for mangroves to regenerate and protect the new bund (Muhammad Akhir 1991).

The erosion problem at Sg. Burong was typical for the west coast of Malaysia. The width of the mangrove belt in front of the bund had been steadily decreasing until eventually the bund itself was threatened. Mangrove trees were planted in the open space between the escarpments. Observation of the performance of the escarpment protection shows that further improvement can be made where larger rocks must be used to amour the crest. Geotextile is used to prevent the crabs from making holes for shelter in the foundation of the structure. Planting of different species of mangrove can reduce the problem of pest and diseases.

The cost of construction of the Sg. Burong Escarpment Protection was inexpensive, around RM860 per metre. The cost of maintenance of the escarpment protection is very little too. The study shows that escarpment protection is a promising concept. It is an answer to the problem of protecting the coastal bund along the soft marine alluvial clay coast. The protection, if properly designed and constructed, is an inexpensive and safe method of protecting the bund. It also has the added advantage of providing a habitat for the fauna in the area through protecting the mangroves, an important natural resource.

The construction of the Sg. Burong Escarpment Protection was completed in August 1987. Mangroves were replanted behind the structure and more came in through natural regeneration. Since then, the escarpment protection has been performing effectively in protecting the soil underneath the mangroves. The mangroves are now established behind the structure and are dissipating the wave energy effectively (Muhammad Akhir 1991).

The escarpment protection proved to be a viable concept. After 4 years the mangroves are providing adequate protection to the bund.

The first comprehensive planning of the construction of rock revetments to protect coastal bunds in a major agriculture development area was initiated in the late seventies. This so-called rock bund was constructed in the Western Johor Agriculture Development Project and Muda Irrigation Scheme, Kedah. Most of the completed revetment works in these two areas are functioning well. However, foundation failure has occurred along certain stretches and rectification works were instituted during the maintenance phase of the projects.

Teh & Voon (1992) did a study along West Johor coasts cites nearly the whole length of the coastline of 82km in West Johor is protected by bunds, 14.5km of which have been raised and revetted. The coastal bund built of earth excavated from the adjacent ditch, is 3m wide on the crest that lies about 3m above mean sea level, or 0.5m above Highest Astronomical Tide (HAT). The buffer zone has become so narrow that bunds in Sg. Lurus and Sg. Rambah are facing the sea due to mangrove recession and other reasons. The mangrove belt on the entire west coast of Serkat where large areas of mangroves have been

ponds, the buffer zone is only 40m wide in 1986. This compares unfavourably with the recommended width for brackish water aquaculture of 100m (Working Group on Mangroves 1986).

The protective mangroves had further narrowed during a field visit to the area in 1990 and wooden structures had to be built in front of the retreating fringe (Teh & Voon 1992). Tidal gates control sea intrusion and drainage of the land, which is mainly below high tide level and can only be gravity drained for about 12 hours daily. Wave overtopping of tidal gates rarely occur, but bunds fail occasionally during exceptional storms, resulting in tidal inundation. Such an occurrence took place in Sg. Ayam recently and the bunds had yet to be properly repaired.

Another example of bund failure and an earlier example of managed retreat in Malaysia studied by Teh & Bird (1994) was in Sg. Lurus, Johor. The erosion problem had been noticed since the seventies. Breaches due to erosion and slip failure had been occurring along the bund. The bund protected an area of approximately 480ha. In 1978, the mangrove belt in front of the bund was thinned due to erosion. Bund retreat was carried out in 1985, as the bund breached in 1984 could not be repaired.

A project was initiated in 1984 to stabilize the eroding coastline. A breakwater was constructed using rubber tyres, timber piles, which was placed parallel to the coastline and at a distance of 120m away from it. Timber piles were used to keep the tyres in place and the tyres served as dampening elements for the incoming waves.

Based on observation, initially the coastline continued to erode considerably. The average receding rate of the coastline was about 0.85m per month. Rate of erosion decreased with time and it stabilized after 1986. Neighbouring coastlines were receding faster than that within the experimental site. Substantial increase in coastal profiles was observed in the beginning of 1989.

The tyre breakwater successfully causes deposition of suspended silt and clay materials behind it. The breakwater also served as a catalyst for coastal accretion in the downdrift direction of its current.

Since this was a full-scale experiment, it was felt that the general arrangement of the breakwater such as its length, distance offshore, orientation and crest elevation could be adopted for future project of similar conditions. The project provided insights for alternative protection methods of the muddy coast.

Within a period of about 15 years after abandonment (1970 to 1986) the mangroves have fully reoccupied the whole mud flat between the two lines of bunds near Parit Terus.

Lessons learned from Sg. Lurus show that where conditions are suitably created, mangroves can regenerate quickly on the abandoned land and serve as a habitat for shellfish, which can provide a sustainable livelihood for artisanal fishermen (Teh & Bird 1994).

West Johor comprises area, which are below high tide level and are thus physically analogous to the polders in the Netherlands. Thus considered, West

Johor may be regarded as one of the most important part of the country, which is characterized by a 'polder type' topography.

2.3 International Review

Over the centuries the Dutch have turned the low-lying marshy delta of the rivers Rhine, Meuse and Scheldt into a densely populated industrialized country. Before human habitation, the delta could fully interact with the sea to respond to changes in sea level and sediment supply and thus maintain a state of dynamic equilibrium. Drainage and dike construction were the first large scale human interferences with the Dutch coastal system. They enabled agriculture and provided safety. In order to protect the land various mitigation measures have been carried out.

Dynamic preservation policy introduced in Netherlands is primarily aimed at combining safety against floods with sustainable preservation of the values of the dunes and on the beaches (de Ruig 1998). The coastline will be maintained within certain margins, in order to preserve part of the natural dynamics of the coastal zone. For the implementation of 'dynamic preservation' the concept of 'basic coastline' has been developed. The basic coastline is in fact the 1990 coastline to be preserved. Each year, the actual location of the coastline is recorded at intervals of 250m and then compared with the location of the basic coastline. The results of the yearly assessments are presented on the 'coastline maps'. The maps allow a rapid insight into the changes of the coastline position

for each section of the coast (van Heuvel & Hillen 1994). The comparison is used to determine if and where it is necessary to build up the beach.

The Dutch do not stick to one coastline philosophy. Besides the 'dynamic preservation' strategy, there is room for land and sea reclamation. In this last option, polders, now protected by dikes, will be opened to the estuaries and Wadden Sea in order to restore ecologically valuable salt marshes and mudflats. An additional effect of this 'depoldering' is the increase in the buffering capacity during storm surges, thus this decreases the risk of flooding.

Growing with the sea is another policy introduced which refers to resilience and vulnerability. As a result of meticulous research on storm surges and river flooding in the Netherlands by Gottschalk (1971-1977) they are well-informed about damage done by the sea in the different parts of the Dutch coastal area (Borger & Ligtendag 1998).

Problems of erosion and inundation have led to a reassessment of the costs and benefits of maintaining areas that were reclaimed in the past, and in some places it has been decided that the cost is no longer justifiable. In Europe, European Community policy has encouraged 'setaside' the abandonment of less productive farms, which are commonly the low-lying, waterlogged areas of reclaimed land. Without maintenance, the enclosing bunds are soon breached by erosion, the sea flows in and the farmland reverts to inter-tidal marshland.

On the coast of England, several sites have recently been abandoned. Farmlands have reverted to salt marshes and inter-tidal mudflats, which represent alternative values such as nursery grounds for marine life together with scientific

interest and recreational opportunity. An example is Pagham Harbour on the south coast of England, which was drained and reclaimed in the 19th century. In 1910 a storm breached the enclosing bank and the sea flooded the reclaimed meadowland. No attempt was made to repair the breach, and soon the area reverted to a salt marsh and inter-tidal flats. The outcome was a revival of a rich habitat for fish and wild fowl, which has since become a major Nature Reserve, a wetland listed internationally by the RAMSAR Commission.

Managed retreat projects have also been initiated in Essex and Suffolk in England, where bank breaching has been followed by marine inundation of formerly reclaimed pastureland at Havergate Island, Suffolk. A series of brackish lagoons have been established to make an ornithological reserve on what was previously farmland and the flooding of a formerly embanked area on Brownsea Island, Dorset has formed a shallow tidal lagoon within which artificial islands have been shaped to complete a habitat for breeding waders, wildfowl etc (Teh & Bird 1994).

Ever since the problem of mangrove erosion surfaced in the sixties, various protection methods have been tried but with little success.

A detailed study on coastal erosion and inundation in mangrove areas is needed, to identify the real causes of the matter and ways to eliminate it. With the help of the past review and detailed study it is hoped that this study will be another source of help.