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COASTAL EROSION: PROBLEMS  
AND SOLUTIONS

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PERPUSTAKAAN,  
PUSAT TEKNIKAL  
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JABATAN PENGAIRAN & SALIRAN  
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In recent years coastal erosion has resulted in damage and loss of agriculture land, mangrove forests, houses, roads and recreation beaches. In most cases erosion occurs due to natural causes but there are cases of erosion due to interference of nature by man. The recent National Coastal Erosion Study has found that 1,300 km out of 4,800 km of the Malaysian coastline is eroding. The eroding coasts can be divided into three categories i.e. critical erosion areas, significant erosion areas and acceptable erosion areas depending upon the economic value of the affected properties. In the critical erosion areas, the value of public facilities and private property exposed to imminent danger amounts to many millions of Ringgit, while facilities and property in some of the significant erosion areas may soon become endangered as a result of continuing erosion.

Control of coastal erosion has now become an important economic and social need. To this end, the Government is implementing a two-prong strategy. The immediate objective of the strategy is to protect existing facilities and property in the critical erosion areas. The long term objective is to give due consideration to the consequences of erosion when undertaking the development and planning of future facilities in coastal areas so as to obviate the need for expensive protective works. This paper will discuss coastal erosion problems in the country, the causes, consequences, mitigation plans and issues such as its relation to the EIA to be gazetted soon.

### Introduction

Malaysia has about 4800 km of coastline. Along 48% of this, agricultural development has taken place where 16% is taken up by housing, transportation and recreational facilities. As yet, no development has taken place on the remaining 36%. In recent years coastal erosion has resulted in damage or loss of agricultural land, mangrove forests, housing facilities, recreational

beaches and road communication links. Of the 4800 km of coastline, about 1300 km (27%) is at present subject to erosion of various degrees of severity. Based on the economic values of the activities that are being threatened, coastal erosion in Malaysia can be classified into 3 categories (Table 1):

- i) 140 km of critical erosion area where facilities are in immediate danger
- ii) 240 km of significant erosion area where facilities will become endangered in 5 to 10 years time
- iii) 900 km of acceptable erosion area which is generally undeveloped and has no facilities.

### Causes Of Coastal Erosion

Coastal erosion is a natural phenomenon resulting from the interactions between natural processes and the system. Man's actions sometimes interfere with these processes and alter the patterns of erosion and accretion. This is not a recently discovered phenomenon but has in fact been going on for a long time and will continue to occur in the passage of time.

Before we proceed, a clear distinction has to be made between sand and mud coasts. At present the transport mechanism of sand sediment under the influence of waves and currents is better understood than the transport of clay and silt sediments. This is due to the fact that research in coastal engineering has generally been concentrated on the problems in sandy shores. The clay-silt soil and sandy soil that make up most of the Malaysian coast respond differently to the actions of waves and current. Once mobilised, the clay and silt particles are suspended in the water column and are more easily transported (by longshore and other currents) as compared to the heavier sand particles. Deposition of clay-silt materials is not only influenced by waves and current but also by water salinity, temperature and density differences. Research on this type of coast is lacking and the transport mechanism is still not clearly understood.

The natural process primarily responsible for coastal erosion is driven by waves. As waves propagate towards the shore, and travel through increasingly shallow waters, they become more steep and increase in height (relative to depth). Consequently they lose stability and

break. Because the incoming waves vary in size they break at different depths and the band at which waves break, called the surf zone, changes in width as the height range of the waves change. During storms, the surf zone along the South China Sea can be several metres wide.

The surf zone is an area of violent movement. Breaking waves dissipate their energy by generating intense local currents which end in a final uprush onto the beach or shore. The turbulence lifts sediment off the sea bottom and the local current then transports it. Similarly, uprush mobilises sediment from the beach and the backrush then transports it back into the surf zone.

When the approach direction of the breaking waves is not perpendicular to the shore, a component of the wave energy is directed parallel to the shoreline and this generates a current in the same direction. This longshore current causes sediment, lifted by the breaking waves, to be moved along the shore. This process is called longshore sediment transport. The normal backrush current transports sediment seawards and often forms a bar which eventually grows large enough to cause the larger, incoming waves to break on it.

Sediment is almost always in motion in the surf zone. Some sediment is transported along the shore (longshore transport) while the rest is transported in the normal fashion (onshore-offshore transport). In most coastal areas in Malaysia, longshore transport is the more important activity. Longshore transport takes place in the direction of the wave-induced longshore current which in turn is determined by the direction in which the waves break. During the northeast monsoon, the waves break in a southerly direction whereas during the southwest monsoon, they break in a northerly direction.

Along the coast, sediment is continuously being moved. When the rate of sediment entering and leaving the coast is equal, the coast is said to be in dynamic equilibrium. Erosion occurs when, over a period of time, the volume of sediment transported out is greater than that transported into the coast. It follows that the reverse will result in accretion. The erosion process occurs continuously and as a result, the beach slowly retreats. This is normally indicated by the formation of beach scarp along the coast.

Erosion may be amplified during the monsoon period when high water levels, associated with this season, result in waves breaking directly against the scarp,

causing loss of material. Though some of this material might be returned to the shore by swells after the monsoon, the quantity returned is normally much less; hence the net result is erosion.

Erosion can also occur because of interference by man. Structures built by man can impede sediment transport and induce imbalances in the transport system. For example, seawalls and revetments immobilise sediment at its source thereby reducing the supply down the coast. Groins, piers and breakwaters that lie perpendicular to the coast and that project out to sea from the shore, physically block the movement of sediment along the shore, causing accretion on one side of the structure and erosion on the other. Breakwaters and other similar structures in the sea intercept and alter the direction of waves thus denying energy to the transport system. This causes accretion in nearby areas and erosion elsewhere. Seawalls and other similar structures concentrate and deflect wave energy to their base thereby accelerating erosion on the beach in front of them. Hence, the construction of structures without due consideration of their effects on the adjacent coast may result in adverse consequences.

### The Consequences Of Coastal Erosion

Concern about the economic and social consequences of coastal erosion has increased rapidly following the intensified use of coastal land. The activities most often affected are agriculture, housing and urbanisation, transportation and recreation.

Along the west coast of Peninsular Malaysia, most of the agricultural land is seriously threatened. Bunds, which serve to keep seawater out of the agricultural lands have been broken by the force of the waves. The resulting floods can penetrate as far as 2 km inland, damaging the existing crop of coconut, cocoa, oil palm or paddy and reducing soil fertility. Income from the sale of these crops is completely eliminated while that from tree crops is substantially reduced.

In some areas, residential and commercial structures have been or will soon be, damaged or destroyed due to coastal erosion. These include private houses, international class hotels, schools and other public structures. These structures were initially sited behind sandy beaches or tidal mud flats which provided protection from waves. As the beach or mud flats eroded, water depth in front of the structures increased thus allowing higher waves to break directly onto the beach scarp and

accelerating erosion. The foundations of the structures were slowly undermined and the structures themselves destroyed or endangered. The economic consequences of erosion on housing and urbanisation therefore is, loss of money from the damaged houses and the cost of procuring new sites and rebuilding the houses.

In other areas, erosion has damaged coastal roadways. Main or secondary roads which connect isolated villages with the trunk roads are damaged and this results in delayed or interrupted travel, and can cause serious inconvenience. Quite often, traffic has to be re-routed through an alternative route and the damaged road relocated further inland.

Erosion has nearly destroyed some beaches and drastically reduced the useable area of many others. Though presently these beaches may only be used by a handful of people, the demand for recreational facilities will increase in the near future as the standard of living of the society increases. With the destruction of beach area, people are less likely to visit beach resorts and this will result in lower occupancy rates in hotels and lodging houses as well as an overall decline in related business activities in the affected area.

#### **Erosion Control Plans And Strategies**

In the critical erosion areas, the value of public facilities and private properties which are exposed to imminent danger amounts to many millions of ringgit. Facilities and properties in some of the significant erosion areas may become exposed to the same danger as a result of continuous erosion.

Control of coastal erosion has now become an important economic and social need. To this end, the Government is implementing a two-stage strategy for the control of erosion. The immediate objective of the strategy is to protect the existing facilities and properties in the critical erosion areas, to the extent that it is economically feasible to do so. The long term objective involves taking into account the consequences of erosion when undertaking the development, planning and construction of facilities in the eroding areas, so as to minimise the need for expensive protective works in the future. The short term plan involves structural solutions such as the construction of seawalls, revetments, etc. whilst the long term plan involves the control of erosion by non-structural measures such as the control of land use.

At present there are 49 critical erosion areas with a total length of 140 km. The length of the individual areas ranges from 200 metres to 15.5 kilometres. The number, extent and type of protective work needed is determined by specific, detailed analysis of each site. In some of these areas, work has already been completed while in others it is being undertaken or has yet to be implemented. However, because of the limited financial allocation for protective works, work will have to be carried out in stages based on priority. In the critical areas, the coordination and review of plans for future development is required to ensure that the added facilities are compatible with the natural process. The new facilities must in no way adversely affect or interfere with the natural process.

There are 76 significant erosion areas with a total length of 240 km. There are important economic and social activities in the area which are presently not being threatened by erosion, but may well be in the next 5 to 10 years. It is not economically possible, as yet, to build any protective structures in these areas. Hence, the erosion control plan for these areas involves a periodic review of the situation to determine whether the area should be reclassified. The review will be carried out at 3 to 5 year intervals and will consist primarily of reconnaissance surveys. The plan also involves the development of non-structural measures to ensure due consideration of the consequences of erosion for any facility added to the area. The objectives of this erosion control plan are to provide protective works when and where needed for existing facilities and to minimise the need for protective works in future facilities.

Acceptable erosion areas total more than 900 km in length. Erosion in these areas has no serious consequences because the areas are undeveloped. If future developments in these areas properly anticipate the consequences of erosion, no protective works should be needed. The erosion control plan in these areas involves non-structural methods. These include educating developers in the causes and consequences of erosion and ensuring that planned facilities in acceptable erosion areas are compatible with the natural process. This will eliminate the need for protective works in the future as well as prevent interference with natural coastal processes.

As an initial step towards achieving the above objectives, the Government has issued a circular on the procedure to be followed in order to obtain approval for

development plans in coastal areas.

## Long Term Strategy Of Coastal Erosion Control

### 1. Surat Pekeliling Am Bil. 5/87

The Surat Pekeliling Am Bil. 5/87 dated 10 September 1987 was issued with the objective to reduce losses due to erosion and to eliminate the need to undertake expensive protection works in the future. It ensures that any future development in the coastal area will take into consideration the risk of erosion and the effects of the development on the coastal system. The construction of coastal structures such as jetties, groynes and ports, as well as offshore activities such as sand mining should be carefully planned so that it will not cause or aggravate erosion. To this end, all Government departments and agencies have been advised to refer all plans for development in coastal areas to the Coastal Engineering Technical Centre for consideration. The Coastal Engineering Technical Centre is not an approval authority but merely comments on the possible consequences of the planned development. The existing procedure for the submission of development plans still remains.

### 2. Perintah Kualiti Alam Sekeliling (Aktiviti Yang Ditetapkan) (Penilaian Kesan Kepada Alam Sekeliling) 1987

It is envisaged that the Perintah Kualiti Alam Sekeliling (Aktiviti Yang Ditetapkan) (Penilaian Kesan Kepada Alam Sekeliling) 1987 will be gazetted and enforced soon. With its enforcement, all developers involved in the activities listed in the schedule, will be required to carry out an Environmental Impact Assessment (EIA).

On the surface it appears that the Arahan EIA is a duplication of the Surat Pekeliling Am Bil. 5/87 where coastal development is concerned. However, on closer study, this is not the case. The Surat Pekeliling Am Bil. 5/87 complements the functions of the Arahan EIA in that it includes those activities not covered by the Arahan EIA such as the construction of sea-walls, breakwaters, groynes, etc. as well as for activities undertaken on a small scale.

For development activities in the coastal area, a report on the effects of the proposed development on the coastal system has to be included in the EIA. The EIA report prepared by the prospective developer will be evaluated by a panel which includes representatives of the

## Coastal Engineering Technical Centre.

### Conclusion

In some places, the dangers posed by erosion are imminent. Expensive investment in agriculture, housing, transportation and recreational facilities is being seriously threatened. The economic losses due to erosion are high. Indirectly, erosion retards economic growth in the area, and reduces the output of goods and services. It also creates social problems.

All of the problems mentioned above are a result of failure on the part of planners to anticipate the consequences of erosion on the planned facilities. Measures must be taken to rectify this problem at the planning stage to ensure that future developments are not similarly threatened. The Surat Pekeliling Am Bil. 5/87 and the Perintah Kualiti Alam Sekeliling (Aktiviti Yang Ditetapkan) (Penilaian Kesan Kepada Alam Sekeliling) 1987 are major steps towards achieving this objective.

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Table 1. Summary of eroding coastlines in Malaysia

Region	Total length of coast (km)	Category I	Category II	Category III	Total length of eroding coastline (km)	Percentage
Peninsular	1972	131 (41)	213 (57)	651 (58)	995 (156)	73%
Sabah	1802	6 (3)	10 (7)	310 (14)	326 (24)	24%
Sarawak	1035	8 (3)	23 (11)	14 (7)	45 (21)	3%
Total	4809	145 (47)	246 (75)	975 (79)	1366 (201)	100%

( ) Number of sites