BEACH NOURISHMENT AS A MEANS OF COASTAL EROSION CONTROL: THE MALAYSIAN EXPERIENCE

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Beach Nourishment as a Means of Coastal Erosion Control: The Malaysian Experience

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ABSTRACT: *The first concerted effort toward addressing coastal erosion on a nation-wide basis was initiated when the Department of Irrigation and Drainage, Malaysia (DID) was entrusted with the additional function of tackling coastal engineering problems upon the recommendation of the Phase I of the National Coastal Erosion Study conducted in 1985. Commencing with the setting up of the Coastal Engineering Technical Center in DID in 1987, more than 30 projects on erosion control at a cost of more than RM100 million have been implemented by DID. These projects mainly involve the construction of revetments, groynes, offshore breakwaters, and beach nourishment. Of late there has been a conscious shift toward the use of beach nourishment, which is the placement of suitable beach fill material from an external source to replace sand that has been lost plus advanced requirements, as the preferred means of coastal erosion control. Appropriately designed and well-executed, beach nourishment has shown to be a sound and cost-effective way to protect upland economic activities and boost the nation's flourishing tourism industry. The paper briefly reviews the concept of beach nourishment and documents the implementation of the various beach nourishment projects in Malaysia with a view to distilling valuable lessons that can be used to improve the planning and design of similar projects in the future. Technological advances and experience accumulated in other countries are also summarised in an effort to augment our knowledge base on beach nourishment methodology. While beach nourishment projects have a relatively short history of implementation in Malaysia, which implies that their field performance has not been monitored sufficiently long enough for a rational assessment to be made, preliminary observations do indicate that they perform as intended and would continue to feature prominently in the national coastal erosion control strategy, especially in view of the projected rise in global sea level resulting from global warming.*

1. Introduction

The shoreline of Malaysia is about 4,800 km in length, and consists primarily of sandy beaches and mangrove-fringed mud coast in roughly equal proportions. A national coastal erosion study completed in 1985 (EPU, 1985) revealed that about 30% of the shoreline suffer from varying degrees of coastal erosion. Of the eroding shoreline, about 300 km has been

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classified as Category I (Critical) where the rate of erosion considered in conjuction with threatened economic activity justifies immediate mitigation action.

Since the establishment of Coastal Engineering Technical Center (presently Coastal Engineering Division) in the Department of Irrigation and Drainage in 1987, various methods of mitigation measures against coastal erosion have been implemented. They range from hard engineering solutions such as seawalls and groin fields, soft engineering approaches such as beach nourishment, to non-engineering controls such as setback lines and buffer zones. The focus of this paper is on the use of beach nourishment as an effective means of mitigating shoreline erosion in Malaysia.

2. Classification of Erosion Control Measures

As mentioned above, various engineering solutions for the control of coastal erosion are available. These can be conveniently grouped into the following categories (Parker, 1980):

a) *Rigid sea defense lines*, which include seawalls and revetment that oppose/reflect the wave energy and are hence, inflexible.

b) *Sand retention structures* such as groins, which are obstructions to longshore sediment transport.

c) *Wave attenuators* such as breakwaters and jetties that still the waves and are usually used to provide sheltered waters for navigation. They block sediments, define harbour entrance and fix entrance channel.

d) *Shore/beach stabilization/protection measures* that approximate natural processes such as beach nourishment, or the longer version of it, beach stabilization by sand replenishment. They are not designed to arrest erosion but dissipate wave energy. While beach nourishment is a short-term measure that does not fix the cause of erosion, it is the only method that adds sand to the littoral system.

Representative structures under each category are depicted in Fig. 1. Based on an analysis of the technical designs of 30 contracts for coastal erosion control implemented since 1989 till Oct 1994 by DID (Hiew and Lim, 1994), the number of projects employing each category of control measures and their average unit costs are given in Table 1. Many factors affect the cost of a coastal protection project, which include the system adopted, length of the shoreline to be protected, and the proximity of the material source (haulage distance and handling frequency). Therefore, it is more instructive to compare the unit costs in terms of three ranges: low, median, and high.

As evident from Table 1, beach nourishment projects generally cost higher. However, the project cost is sensitive to the length of shoreline protected as the high but fixed cost of mobilising and demobilising of dredges can be spread out over a longer project shoreline. Another point to note is that the unit cost for beach nourishment projects has not taken into

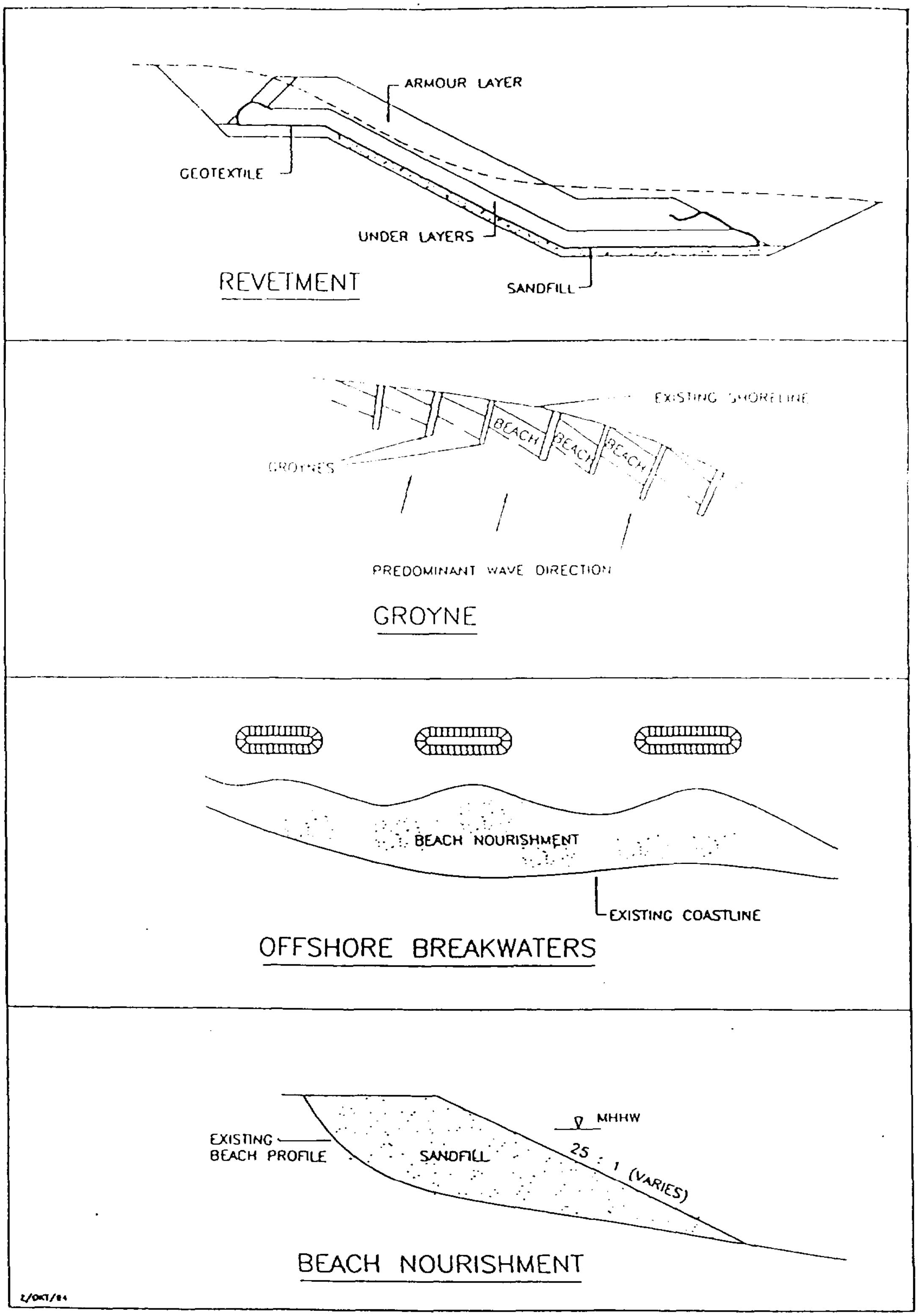

Fig. 1: Typical types of coastal erosion control works in use in Malaysia (After, Hiew and Lim, 1994).

account the additional expenses for periodic replenishment requirements, which is a unique feature of beach nourishment projects not seen in other control systems where the structures are designed for a project life of 30 years with allowance for perhaps 5 - 10 percent of the initial project cost as an annual maintenance cost.

Table 1: Comparison of Unit Cost of Coastal Erosion Control Measures

Coastal Erosion Control Measure	No. Of Projects	Cost per m run of shore protection (RM)		
		Low	Median	High
Revetment - rock	25	1,400	2,500	5,400
Revetment - articulated blocks		3,800	4,150	4,350
Groins	3	1,000	2,300	4,500
Beach Nourishment	4	2,600	5,000	7,500

Note: Some of the systems above are used in combination.

3. Overseas Experience on the Use of Beach Nourishment

Beach nourishment has a long tradition of use in overseas countries, especially the U.S. As can be seen from a short review presented below, the "art" of beach nourishment planning and design has gradually progressed to one amenable to rigorous analysis, even though detractors still describe the present "state-of-the-art" of beach nourishment methodology as over-simplification of reality due to the use of a deterministic approach (Young *et al.*, 1995). However, efforts toward improving beachfill design are on-going (*e.g.*, Milbradt and Holz, 1996), which would in time further buttress the theoretical foundation of beachfill design methodology.

3.1 United States of America

In the U.S., the use of beach nourishment has been on the rise due in part to the recognition of the need for environmentally sound practice. Beach nourishment was first used in 1922 at Coney Island, New York. Since then many more such projects have been implemented, the most notable one being perhaps the project at Miami, Florida. This project involved placing 14 million yd^3 of sand along 10.4 miles of ocean beach and was completed in 1980 at a cost of US$64 million (Wiegel, 1987). Presently, another mammoth beach nourishment project is underway at south of Sandy Hook, New Jersey, which involves 17.7 million yd^3 of beachfill to create a 100 foot wide dry beach (Nickens, 1995).

In the U.S., beach nourishment has been criticized as "little more than building sand castles that will be wiped away by the next storm and as a public subsidy of shorefront property owners". To these people, the regression of beachline is part of the natural process of beach migration rather than beach erosion. They advocate damage avoidance over damage repair.

Amidst this debate between proponents, led by U.S. Army Corps of Engineers, and opponents of beach nourishment spearheaded by a group of concerned coastal geologists, a recent report from National Research Council (NRC, 1995) has been prepared in clear support of beach nourishment as a viable method for protecting the shoreline from erosion and for restoring lost beaches. The report concludes that to be effective, beach nourishment projects must be carried out:

a) at sites where the erosion processes are understood;
b) where uncertainties about design and performance are accounted for realistically; and
c) where state-of-the-art engineering standards of planning and design are used.

The performance of beach nourishment has been mixed, the amount of fill material lost from the initial fill area range from a lowly 12% to total loss over a period of two years after project completion. Some of the reasons cited for poor field performance include:

* winnowing of fines and consequent displacement beyond the active beach zone;
* sediment deficit; and
* high tidal range and storm events.

One other concern raised in the U.S. in connection with the use of beach nourishment is the inducement of shore development resulting from a beach nourishment project. This is an important policy issue as regards the siting of immobile high density development. Relevant questions include how long will financing for project maintenance and sand sources last and the degree of involvement of federal government vis-a-vis state and local/private funding. More recently, there has been a call to incorporate new imperatives in evaluating the economic viability of beach nourishment projects. These include recognising the erosional cost impacts of placing sand dredged from navigation inlets/channels offshore on adjacent shorelines and considering the potential of damage reduction and enhanced recreation on adjacent shorelines outside the project confines (Dean, 1988).

3.2 Europe

Most of the European experience in beach nourishment, at least prior to 1987, has been documented in the works of Pilarczyk and Overeem (1987). The following features of beach nourishment have been generally cited as being the reasons for their preference over hard engineering solutions:

Flexibility
As opposed to hard engineering structures that may engender deleterious impacts outside the protected area such as the classical downdrift erosion, any such effect from beach nourishment is likely to be temporary. In most cases, the adjacent beaches actually benefit due to lateral spreading of the initial beach fill.

Harmony with Nature
An artificial beach fill does not disturb the natural character of the coast where it is placed, unlike hard engineering structures that introduce visual interference. On the contrary, the amenity value of the beach is enhanced. Beach nourishment is aesthetically pleasing and hence, more desirable, and provides added beach space for recreation. It remedies, rather than causes problems by providing a supply of sand.

Spreading the Cost
Beach nourishment is not an one-time panacea, but requires periodic maintenance fill operations to replace fill that has been lost in the interim. It is a conscious design effort based on well-tested methodology. Hence, a beachfill option can better spread the cost compared to a hard engineering solution that concentrates most investment in the initial phase of project implementation.

Hazard Free
It is not hazardous to beach users and does not sponsor disruptive phenomena such as rip currents in a groin field.

4. Malaysian Experience

4.1 Projects

In Malaysia, at least five (5) large beach nourishment projects, including those in combination with fill retention structures, have been completed as listed in Table 2. In addition, one beach nourishment project is currently underway and another one in the detailed design stage. Fig. 2 shows the locations of these projects.

As evident from Table 2, the scale of the projects in Malaysia is about one order of magnitude smaller than their American counterparts. Nevertheless, the costs of beach nourishment projects do represent a significant portion of the budget allocation for coastal erosion control works because the fill quantity per linear meter of shoreline is large (about 300 m^3/m of fill compared to about 60 m^3/m for U.S. beaches). The source of fill material is varied. The majority of the borrow areas is either located offshore or within the rivermouth. The use of sand from the latter site is perhaps premised on the considerations that the rivermouth is known to be a significant sink of both littoral and fluvial sediments that have accumulated as relict deposits. On the other hand, sand is taken from the seabed at a considerable distance offshore to ensure that the imported sand represents new addition to the sediment in the active profile area, and not mere redistribution of the available sand within the active zone. Placement is usually through hydraulic filling using a floating hydraulic dredge or hopper dredge located offshore through pipelines.

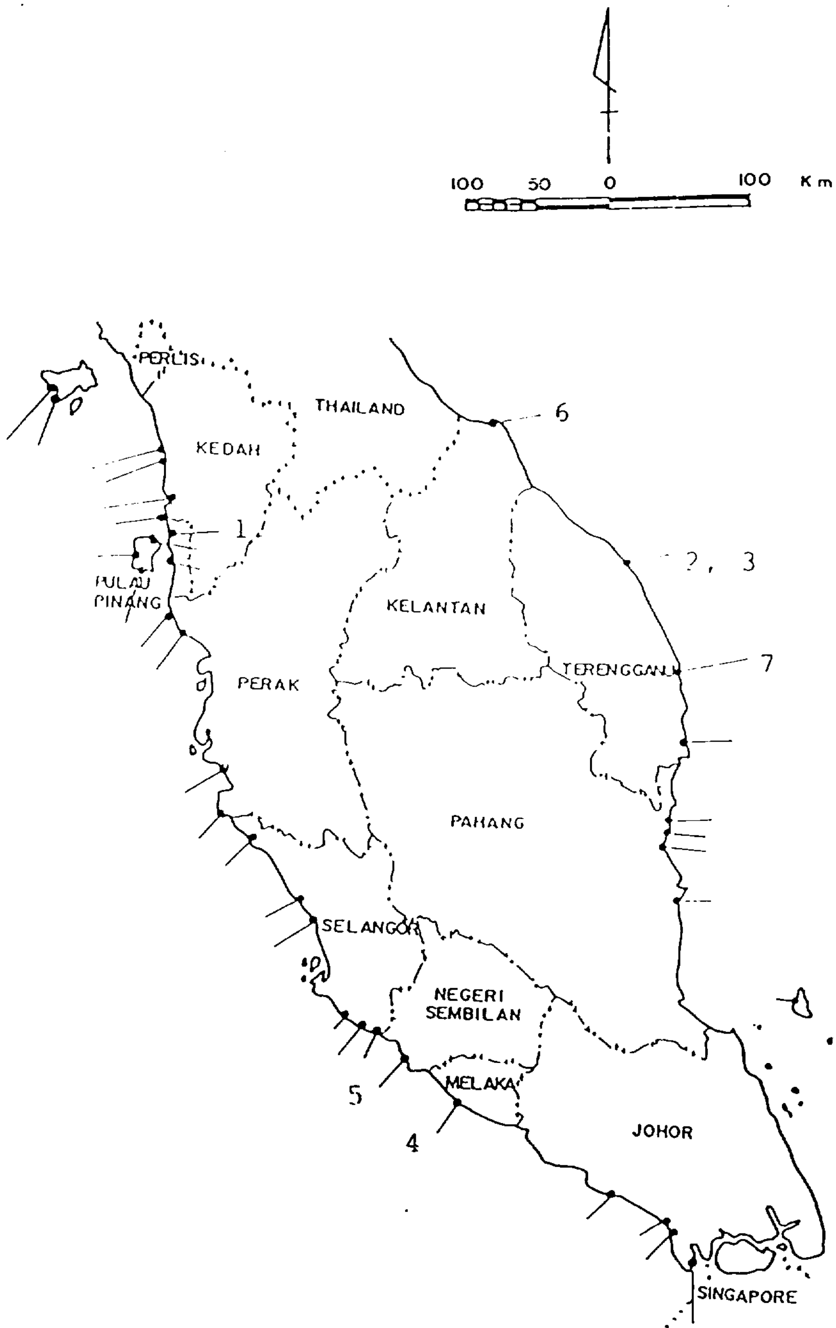

Fig. 2: Locations of beach nourishment projects in Malaysia as listed in Table 2.

Table 2: Beach Nourishment Projects in Malaysia

Project Site	Dimension of Beach Fill		Construction Summary			
	Length (m)	Average Width (m)	Fill Quantity (million m^3)	Source of Fill	Period	Cost (RM million)[1]
1. Butterworth Phase 1, Seberang Perai	3,400	50	0.8	offshore	04/91-12/94	11.2
2. Seberang Takir, Terengganu	3,000	56	2.5	Rivermouth	02/92-11/92	18.8
3. K. Terengganu-K. Ibai, Terengganu	5,500	70	1.8	offshore	03/93-10/93	13.0
4. Pantai Kundor, Melaka	2,850	30	0.3	offshore	03/95-12/95	4.0
5. Port Dickson 4th Mile, N. Sembilan	2,000	20	0.2	Land and offshore	05/95-10/96	4.3
6. Pantai Sabak, Kelantan	3,500	40-70	1.2	offshore	04/96-10/96	14.5
7. Dungun, Terengganu	2,000	50	0.5	Rivermouth	-	-
Total	22,250	-	7.3	-	-	65.8

Note: [1]Cost shown is for beach nourishment component only if used in combination with other systems.

4.2 Design Methodology

The design of beach nourishment follows the American practice as recommended in the Shore Protection Manual (Coastal Engineering Research Center, 1984). The manual details procedures for estimating the overfill factor, which is used to compute the amount of overfill required to satisfy project dimensions due to the difference in size between the native and borrow materials, and the renourishment factor, which is used to estimate the frequency of periodic renourishment for long-term maintenance of a beach nourishment project. The textural properties of the native sediments and fill material from potential borrow sites are established via a sediment sampling campaign and the subsequent size gradation analysis. The suitability of the borrow site is examined from the locational viewpoint of beyond the active profile zone for sediment transport and the standpoint of sediment budget (sediment sink).

Noting that the dry or visible beach is but a portion of the active profile area, the offshore bottom is also to be filled. The offshore slope of the placed fill depends on the size of the sand used and will be shaped by the incident wave regime during the post-construction period. The initial slope is steeper and the dry beach wider than the final condition. In addition to restoring the volume of sand lost, the placement quantity needed to reestablish the natural state of littoral transport over a number of years is also taken into account. Hence, the project dry beach width is the sum of the width of restored beach and several years of advanced requirements based on the renourishment schedule.

Construction aspects are also considered in terms of equipment and plants to be used and the availability of construction windows in estimating the length of construction period. Due to the presence of inclement weather during the monsoon season, especially along the east coast of Peninsular Malaysia, the nourishment work is usually planned during the calmer periods and such that the work could be completed within one season by resorting to the use of dredges with larger capacity. It is also expedient to schedule construction during the time when the beach normally starts to recover from the monsoon erosion when low steepness waves tend to promote onshore sediment movement.

One aspect of beachfill design methodology that has been lacking in earlier efforts is the prediction of the longevity of the beach fill. This inadequacy has been addressed in recent attempts, albeit at the post-construction rather than at the pre-construction stage (Hiew *et al.*, 1995), in an attempt to effect a more rational design basis for beach nourishment. However, as discussed in Section 4.4, this effort is presently hampered by a post-construction monitoring program that has been found wanting.

4.3 Shoreline Evolution Modelling

Beach nourishment is the placement of large quantities of sand in the nearshore area to advance the shoreline seaward. Hence, it represents a shoreline perturbation to an otherwise uninterrupted shoreline, which tends to be smoothed out by wave action over time. The wave-induced alongshore sediment transport moves the sediment from both ends of the placed fill laterally into the adjacent areas and beyond. Methods have been proposed by several investigators to predict the field performance of nourishment projects (*e.g.*, Pilarczyk and Overeem, 1987).

The bases for predicting the performance of beach nourishment projects are the equations of continuity and sediment transport. These two governing equations are used to develop a one-line model in which only one contour, usually the mean water line, is simulated (*e.g.*, LeMehaute and Soldate, 1977; Hanson and Kraus, 1989; Dean and Grant, 1989). Extension to two-line (*e.g.*, Bakker, 1968) and multiple-line cases have also been developed.

Briefly and referring to the definition sketch shown in Fig. 3, the one-dimensional equation of sand conservation can be written as:

$$\frac{\partial y}{\partial t} + \frac{1}{(h_* + B)}\frac{\partial Q}{\partial x} = 0 \qquad (1)$$

where y is the offshore coordinate, x is the longshore coordinate, t is the time, Q is the total longshore sediment transport, h_* is the depth of limiting sediment motion, and B is the berm elevation. In Eq. (1), it has been implicitly assumed that accretion and erosion of a profile is associated with a seaward and landward translation, respectively, of the profile without change of form where the denominator, $(h_* + B)$, represents the total vertical extent of profile change.

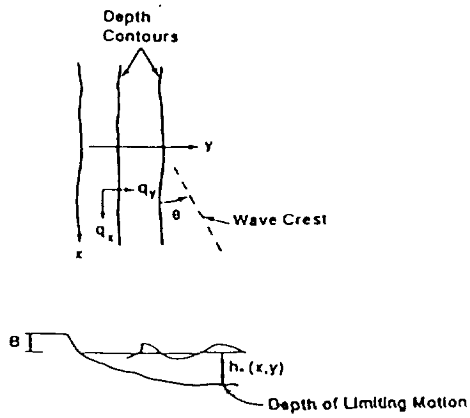

Fig. 3: Definition sketch.

The corresponding one-dimensional equation for alongshore sediment transport can be expressed as (Komar and Inman, 1970):

$$I = K P_{ls} \qquad (2)$$

where I is the immersed weight alongshore sediment-transport rate, K is a non-dimensional sediment transport proportionality factor, and P_{ls} is the longshore energy flux factor. In turn, I and P_{ls} can be written as:

$$I = Q\rho g(s - 1)(1 - p) \qquad (3)$$

$$P_{ls} = E_b C_{Gb} \sin\theta_b \cos\theta_b \qquad (4)$$

where ρ is the density of water, g is the acceleration due to gravity, s is the ratio of mass densities of sediment to water, p is the *in-situ* sediment porosity, E is the wave energy density, C_G is the wave group velocity, θ is the angle between the wave crests and the bottom contours, and the subsript b denotes that the subscripted variable is to be evaluated at the breaking location. Using linear shallow water wave theory and the spilling breaker assumption, $H_b = \kappa h_b$ where κ is the spilling breaker index:

$$E_b = \frac{1}{8}\rho g H_b^2 \qquad (5)$$

$$C_{Gb} = C_b = \sqrt{g h_b} = \sqrt{\frac{g H_b}{\kappa}} \qquad (6)$$

where C_b is wave celerity at breaking. By substituting Eqs. (3) to (6) into Eq. (2), the following equation results:

$$Q = \frac{K H_b^{5/2} (g/\kappa)^{1/2} \sin\theta_b \cos\theta_b}{8(s-1)(1-p)} \tag{7}$$

Pelnard-Considere (1956), by linearising Eq. (7) with respect to perturbations in the predominant shoreline alignment and combining the result with Eq. (1), has obtained the second-order diffusion equation:

$$\frac{\partial y}{\partial t} = G \frac{\partial^2 y}{\partial x^2} \tag{8}$$

where G is defined as the longshore diffusivity given by

$$G = \frac{K H_b^{5/2} \sqrt{g/\kappa}}{8(s-1)(1-p)(h_* + B)} \tag{9}$$

The assumptions inherent in the linearisation approach include that the breaking wave angle relative to the shoreline normal and the shoreline orientation are small and that the amplitude of the longshore sediment transport rate (Q) and the incident breaking wave angle (θ_b) are constant in x and in time.

Eq. (8) is recognised to be the one-dimensional heat conduction equation. Thus, many analytical solutions can be found by applying the proper analogies between initial and boundary conditions for shoreline evolution and the processes of heat conduction and diffusion (Larson *et al.*, 1987). Since Eq. (8) is also linear, superposition of solutions to take into account more complicated planform geometries is an added advantage.

An alternative formulation in terms of deepwater wave characteristics developed by Dean and Grant (1989) can also be used. The bathymetry is considered as straight and parallel bottom contours and the wave refraction and shoaling is represented by a simple one-step procedure. In this approach, the azimuth of the outward normal within the depth limit affected by nourishment (h_*), β_s, is related to the azimuth of the outward normal outside the project limit, β_0, by

$$\beta_s(x) = \beta_0 + \Delta\beta \tag{10}$$

where $\Delta\beta$ is the shore planform direction anomaly as shown in Fig. 4 and is considered small.

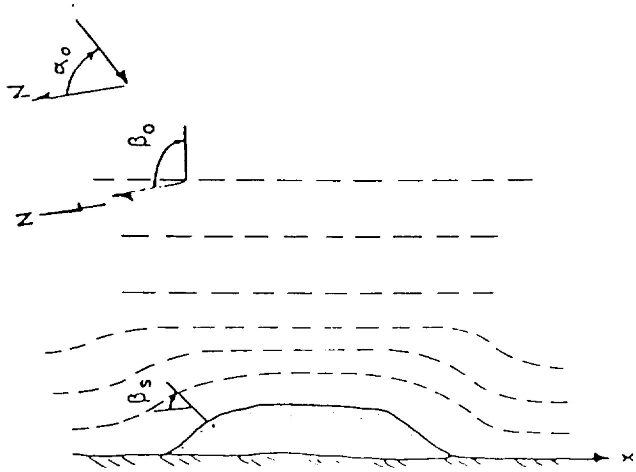

Fig. 4: Shore planform direction anomaly.

From geomtery, it can be seen that $\beta_s - \alpha_b = \theta_b$ in Eq. (4) and Eq. (7) and

$$\Delta\beta = 90° - \tan^{-1}\left(\frac{dy}{dx}\right) \approx 90° - \frac{dy}{dx} \tag{11}$$

since $\Delta\beta$ is small.

Briefly, by using conservation of energy $[EC_g\cos(\beta_0 - \alpha_0) = \text{constant}]$, Snell's law $[\sin(\beta_0 - \alpha_0)/C_0 = \text{constant}]$, and trigonometric identities that result from the smallness of $\Delta\beta$, the longshore sediment transport rate can be shown to consist of a linear sum of the transport without the project present (Q_B) and the transport induced by placement of the project beachfill, Q_p. Linearising Q_P using the smallness assumption of $\Delta\beta$ and substituting into Eq. (1) leads to Eq. (8) as before where the longshore diffusivity is here given by:

$$G = \frac{K H_0^{2.4} C_{G0}^{1.2} g^{0.4} \cos^{1.2}(\beta_0 - \alpha_0)\cos 2(\beta_0 - \alpha_*)}{8(s-1)(1-p)C_* \kappa^{0.4}(h_* + B)\cos(\beta_0 - \alpha_*)} \tag{12}$$

where $C_* = C_0\tanh(2\pi h_*/L)$ and $\alpha_* = \beta_0 - \sin^{-1}[(C_*/C_0)\sin(\beta_0 - \alpha_0)]$.

The usefulness of the simple method of representing wave refraction and shoaling in the vicinity of a beach-nourishment project has been shown by Dean and Yoo (1992) to yield results in good agreement with a more detailed grid-based refraction and shoaling algorithm. The analytical solutions given in Larson *et al.* (1987) appropriate for the planform geometry of the nourishment project are then used together with Eq. (12) to simulate the evolution of the nourishment planform. Specifically, the relevant analytical solutions are that for a finite rectangular beach fill:

$$y(x,t) = \frac{Y_0}{2}\left[\operatorname{erf}\left(\frac{a - x}{2\sqrt{Gt}}\right) + \operatorname{erf}\left(\frac{a + x}{2\sqrt{Gt}}\right)\right] \tag{13}$$

and for a triangular-shaped transition end section:

$$y(x,t) = \frac{Y_0}{2a}\left\{(a - x)\operatorname{erf}\left(\frac{a - x}{2\sqrt{Gt}}\right) + (a + x)\operatorname{erf}\left(\frac{a + x}{2\sqrt{Gt}}\right) - 2x\operatorname{erf}\left(\frac{x}{2\sqrt{Gt}}\right)\right\}$$

$$+ \frac{y_0}{2a}\left\{2\sqrt{\frac{Gt}{\pi}}\left[e^{-(x-a)^2/4Gt} + e^{-(x+a)^2/4Gt} - 2e^{-x^2/4Gt}\right]\right\} \tag{14}$$

where y_0 is the beach width and 2a the total length of the initial beach fill, respectively. The component of backgound erosion losses (Q_B) are computed by multiplying the estimated long-term erosion rate by the time interval and added to the component of spreading out losses (Q_P) to yield the total shoreline changes.

Fig. 5 shows a result of applying Eq. (14) to simulate planform evolution of beachfill at Seberang Takir, Terengganu (refer to Table 2 for project details). Only one half of the beachfill is shown in Fig. 5 where the origin coincides with the center of the initial beachfill planform. As indicated, there is lateral spreading of the fill into adjacent areas. However, the rapid landward regression of the mean water line over one monsoon (10/1992 to 03/1993) is due largely to profile equilibration in the cross-shore direction which occurs over a relatively short time scale. This loss of the visible beach width does not amount to actual coastal erosion as the "lost" material may still be contained in the subaqueous profile that stretches to the point of closure depth. Its presence there is still capable of dissipating waves that would otherwise attack the shoreline. Such a scenario further underscores the need for looking at profile changes, as discussed in the next section, lest the conclusion be made that the project has failed.

4.4 Beachfill Monitoring

The completed beachfill is surveyed to document the cross-sectional changes of the fill. This profile change information is used to assess volumetric change and longevity of the beachfill. Usually the monitoring survey consists of just wading survey using a level and a survey rod. The profile survey extends seaward from a baseline, which is already established on land, along a line normal to the shoreline orientation till a point where the rod holder can

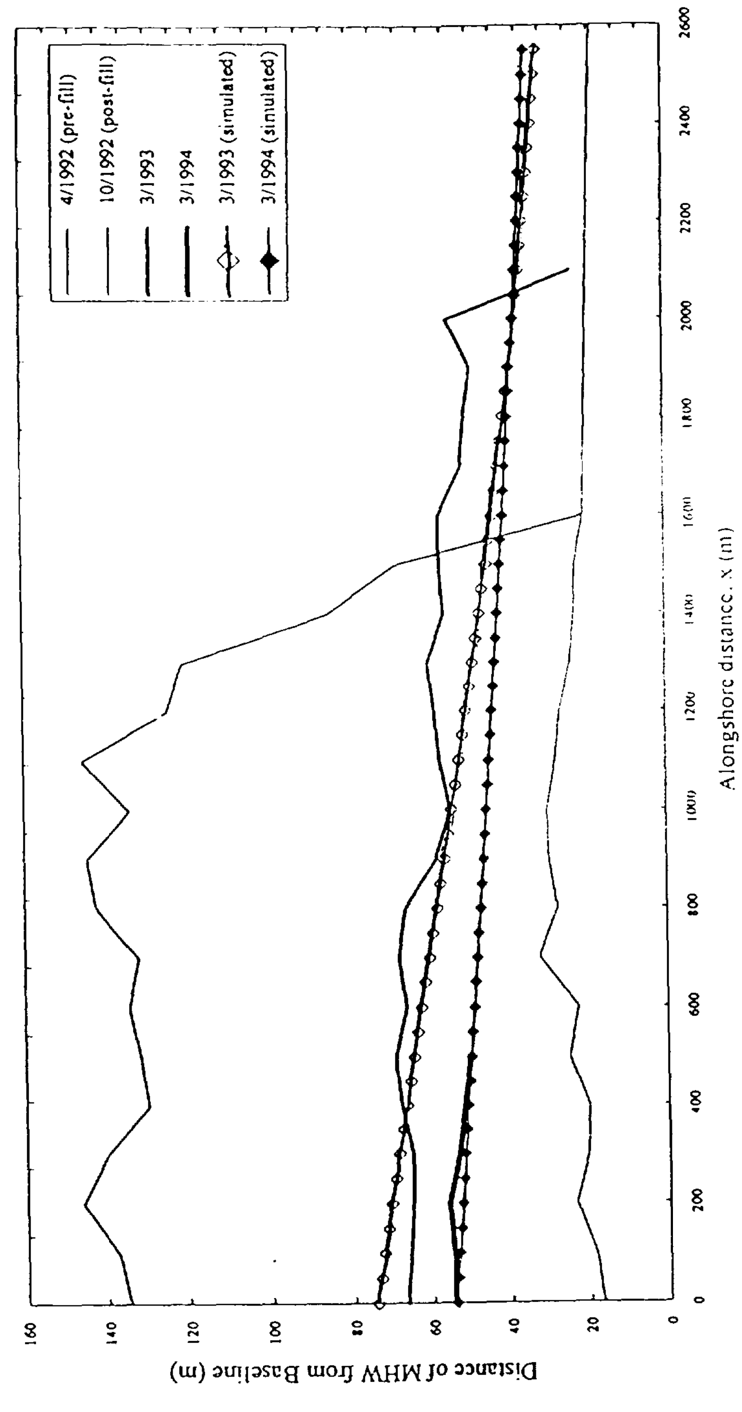

Fig. 5: Simulation of beachfill planform evolution at Seberang Takir, Terengganu.

no longer stand steady in water. The survey is conducted during low tide to maximise the seaward extent of the profile survey.

Ideally, the wading survey should be complemented by offshore survey using a boat-mounted echo sounder. In this way, the profile survey can be extended beyond the depth of profile closure shoreward of which coastal sediment movement due to waves, nearshore currents, and changes in water levels is concentrated. However, this is often times not done due to a variety of reason, chief among which is budgetary constraints as the deployment of a sea-based survey is more elaborate and demanding than a land-based one. On the other hand, the location of the shoreline, defined as the line of interception of the beachfill slope by the horizontal plane of mean water level, is always furnished by the results of periodic land-based monitoring survey. The temporal variation of this line is sometimes used as a surrogate to assess the planform evolution of the fill configuration as discussed in the previous section.

Fig. 6 shows a typical comparison of profile change subsequent to the completion of the beach nourishment project at Seberang Takir, Terengganu. It is evident that the plots are the results of wading survey and do not cover the entire active profile zone. Hence, an accurate assessment of the beachfill performance is unlikely to result from this comparison. An examination of Fig. 6 reveals an interesting trend in that the profile movement after 09/1993 is one of profile advance, even during the 1993/1994 monsoon period. A plausible explanation is that the 1993/1994 monsoon was an exceptionally mild one.

5. Concluding Remarks

While the Government is intent on protecting the coastline against shoreline erosion by the use of beach nourishment where appropriate, the available beachfill design methodology has not been fully embraced by the designers of beach nourishment in Malaysia, at least presently. Since local capability in beachfill design has been considerably augmented by the acquisition of state-of-the-art numerical packages for sediment transport computation by several government agencies and private consultants, this state of affair can be largely attributed to one dominant factor, the lack of relevant data. This lack includes instrumented wave information during the design stage and inadequate extent of beach profile survey during the post-construction monitoring stage. This perceived inadequacy is being addressed by one of the components of the ADB-financed project on Institutional Strengthening for Shoreline Management under the management of Department of Irrigation and Drainage, Malaysia.

Compared to overseas practices, especially that in the U.S., Malaysia can be considered to be in the infancy stage of implementing beach nourishment, not only in the realm of design methodology, but also in policy discussion. Ideally, beach nourishment projects, and for that matter, shoreline protection, should take into consideration real-world factors such as public interest, private property ownership rights, political factors and impacts, and existing customs and policies. Most of these issues are already routine discussion topics in U.S. and the crystallised thoughts that surface would be useful as guides for Malaysia on her own way toward developing her brand of shoreline management. In fact, these are relevant issues to be

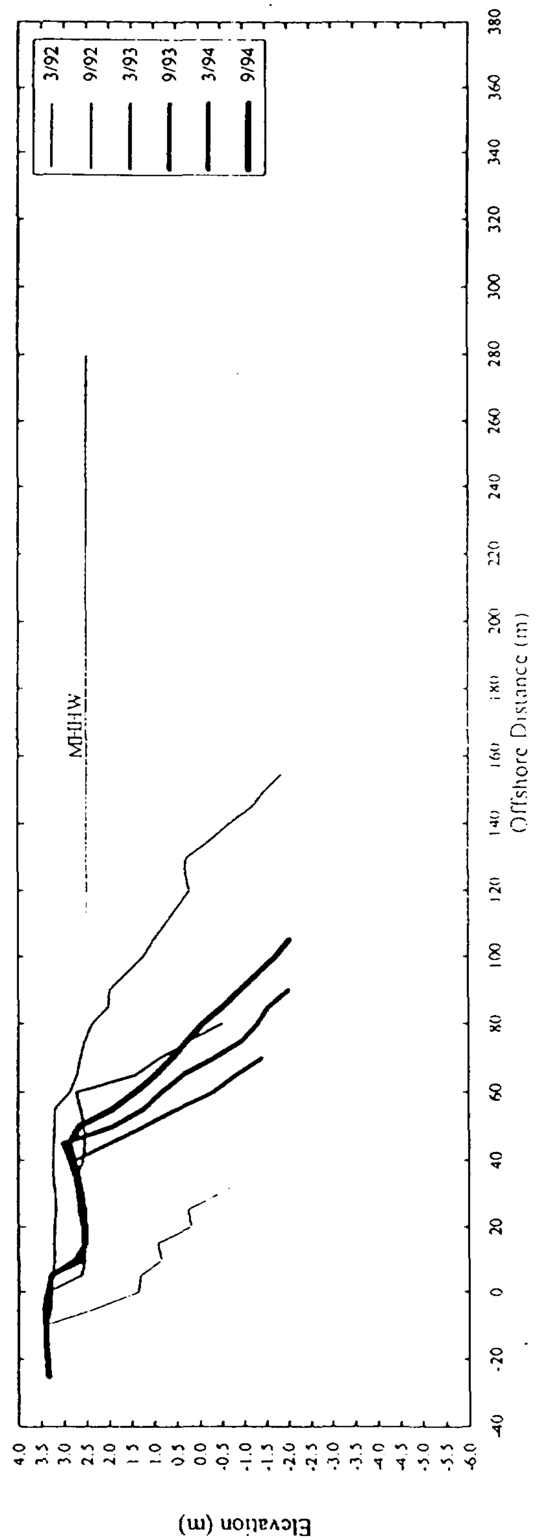

Fig. 6: Comparison of beach profile change at Seberang Takir, Terengganu.

considered under the overall context of coastal resources management plan as is being formulated in Malaysia.

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