COASTAL ZONE MANAGEMENT FOR COASTAL ENGINEERING - MALAYSIA

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Coastal Zone Management for Coastal Engineering — Malaysia

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SUMMARY Most Malaysian coasts are erodible mud and fine sand, and inhabited. The Coastal Engineering Division (CED), of the Department of Irrigation and Drainage, Ministry of Agriculture of Malaysia, has a mandate for erosion protection of coastal agricultural land. In practice this includes all coastal land, through CED's examining applications for coastal development and providing design data. CED have set up, with AGRA Earth & Environmental Ltd through the Asian Development Bank, a coastal engineering Geographical Information System (GIS) to help fulfil this mandate.

1. MALAYSIAN COAST

Malaysia is made up of the Peninsula [Figure 1], the states Sabah and Sarawak on the island of Borneo, and several islands, the best known being Pulau Pinang off the northwest coast of the Peninsula.

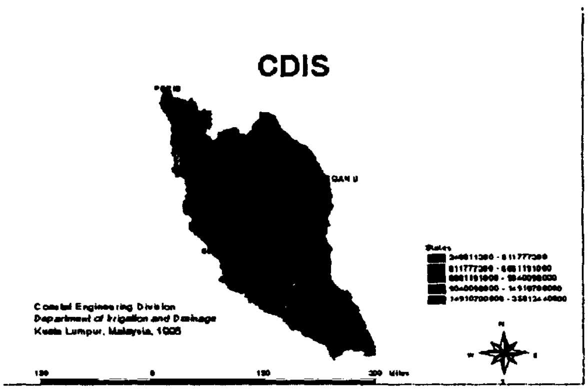

Figure 1: Peninsular Malaysia

The following Malaysian coastal data was taken from the National Coastal Erosion Study (NCES, Stanley Consultants Inc 1985) —

Length of Coastline	—	4800 km
Erodible Alluvium	—	4300 km or 90%
Beautiful Sand Beach	—	East and some West Peninsular Malaysia, and Sarawak
Silt, Clay, Mud	—	Most of West Peninsular Malaysia and Sabah
Eroding Coastline	—	1300 km or 25%
Erosion Rate	—	1 to 100 m/a
Facilities Threatened	—	400 km or 10%

2. COASTAL ZONE MANAGEMENT (CZM)

The Coastal Engineering Division (CED), of the Department of Irrigation and Drainage (DID), Ministry of Agriculture of Malaysia (MoA), was set up to carry out the recommendation of the NCES for management of at least the agricultural lands threatened by coastal erosion. In practice, Coastal Engineering Division acts in an advisory capacity for all Malaysian coastal erosion, not just agricultural, and is responsible for supplying design data for shore protection and river mouth works.

Despite its name, Coastal Engineering Division is responsible for only the sedimentary aspects — shoreline erosion (90% of CED's budget) and related deposition in river mouths (10%) — of coastal zone management in Malaysia. Port and harbour engineering is carried out by the Malaysian Ministry of Public Works; and coastal data collection by several other agencies.

2.1 CZM Data Requirements

CED has begun archiving the following data, necessary to fulfil its mandate for coastal zone management (Willis 1996a) —

Topography and Bathymetry — To define erosion and deposition rates, volumes of sediment, and nearshore wave and current transformations

Geology — To define sub-bottom sediment properties and availability

Waves — The principle driving force for coastal erosion, alongshore currents, and deposition. Longterm statistics and return periods are needed for design, but regular measurements and hindcasts are required to build up those statistics around the Malaysian coast

Tides and Waterlevels — Although prediction of astronomical tides is excellent, regular measurements are still required to build up longterm statistics of wind and wave set-up (storm surge) and the effects of global warming, needed for shore protection design *e Currents* — The second most important force in coastal erosion and deposition, but too in both time and space for regular measurement iving. Current measurements and model results are d when available

— Longterm wind data is more readily available in 990s than wave data, and can be used to predict wave stics from hindcast models. It is also important in ating storm surge waterlevels

ver — Rivers supply sediment to the coastal zone, and low maintains navigable depths. Hydrographs, including sediment loads, are needed for rivers that flow into the coastal zone.

3. GEOGRAPHICAL INFORMATION SYSTEM (GIS)

The Geographical Information System (G I S) is Coastal Engineering Division's main tool in managing Malaysia's coastal zone (Li 1996). In addition to standard maps of land use and shoreline type; the G I S accesses airphoto and satellite imagery, and points to coastal engineering databases.

Geographic Information System is made up of three parts —

1. Hardware — A dedicated network of 5 Hewlett-Packard Pentium PCs and peripherals: one as network server; two to manage data collection and analysis; and two for G I S applications like digitizing
2. Software — The CED G I S is based on ArcInfo™, ArcView™, and specifically ArcCAD™ for compatibility with CED's existing archives of AutoCAD™ engineering drawings
3. Databases — In addition to the shoreline history [Section 3.1] and timeseries [Sections 3.2 and 3.3], these include: hydrographic charts; topographic maps; and attribute maps, such as shoreline type, geology and land use.

3.1 Aerial Photographs

C tal aerial photographs [Figure 2]have been acquired for decades to support shoreline related applications. In general, the shoreline of Peninsular Malaysia is well covered — 4038 hardcopies since 1964. Sabah and Sarawak are less well covered by 354 photographs. CED will add one complete coverage every 5 years, and have taken steps to acquire historical photographs obtained by other government departments.

All aerial photographs have been digitized so that they can be called up from the G I S, for a visual assessment in 2-dimensions of the coast. They have also been photogrammetrically processed to extract the historical shoreline, or contour of Mean Sea Level, for comparison with maps, charts and other photographs.

Satellite images fall into the same category as 2-dimensional aerial photographs, and are digitized into the same database.

Figure 2: Aerial Photograph of George Town, Pulau Pinang

3.2 Timeseries Databases

The G I S points to timeseries coastal engineering databases (Kjerfve 1996) where data is available. The following databases are available in dBase™ 5.0 for Windows —

Surface Ship Meteorological Observations (SSMO)

Surface Ship Meteorological Observations (SSMO) include wave and meteorological observations. The data are observed by commercial vessels according to a set of agreed upon international procedures. CED have purchased 1949-'93 SSMO data for Marsden Squares 24-27, to form the core of their offshore wave database.

SSMO is not strictly *time*series data, although the time of each observation is recorded. The primary dimensions of the SSMO database are spatial, defined by the 10° x 10° Marsden squares. The database is therefore geared to the statistical manipulation of all observations within a defined area of the ocean surface.

Offshore Waves

Defined as far enough offshore to be unaffected by nearshore wave transformation processes such as refraction, diffraction, reflection and attenuation. The SSMO data is a specific example of offshore wave data. Another is wave data hindcast from wind or isobar records.

The offshore wave database is temporarily filled with hindcast waves. These are being replaced by measured offshore directional wave data, as it becomes available.

Nearshore Waves

The nearshore wave database contains the 'design' wave statistics, for shore protection for example. These are the offshore waves after they have been modified through the processes of refraction, diffraction, reflection and attenuation, passing through the nearshore zone. Because of spatial variations in nearshore bathymetry, the spatial variations in nearshore waves are much greater than those in offshore waves.

hore wave database contains, for the most part, ts from numerical wave transformation models o offshore wave statistics. These are of course ed with nearshore wave measurements as they are .

stal wind database contains hourly wind speed and n recorded near the Malaysian coast, at most for example. In most cases, enough wind data for statistical and return period analysis, and for the sting of statistically significant waves and evels.

s the astronomical tidal constituents around the ysian coasts, as well as timeseries and statistical data fferences between measured and predicted waterlevels t-up or storm surge.

rents
isurements or model results of current velocity and ction, with depth of measurement, and water depth, at tion and time

vers
drographs of mean daily water and sediment discharge rivers flowing into the nearshore zone.

he G I S locates each database by latitude, longitude, and ater body. Timeseries data is defined by day, month, year, nd time to the 24 hour clock. Directions are by azimuth to he 16 point compass.

3.3 Littoral Environmental Observation (LEO)

CED has neither the budget nor the staff to undertake the comprehensive coastal measurements required to fill these databases. The emphasis is on acquiring existing data, and on encouraging other government departments to collect data in a way which will be useful to CED.

Nevertheless, CED have equipped and trained (""llis 1996b) regional officers of the Department of I...gation and Drainage to observe daily data at some 20 typical coastal sites around Malaysia. Each team received:

- a hand-held anemometer and compass
- a clinometer for measuring beach slopes
- a tethered 15 cm fishing float, ballasted to float low in the water; and
- a stopwatch.

Changes from U S standard (Schneider and Weggel 1986) include —

- Use of the tethered drogue, instead of dye, for observing alongshore currents
- Observation of erosion scarp height
- Estimation of waterlevel for storm surge statistics
- Where access to a mud beach is prohibited, observations near High Water only

The Malaysian LEO program has been augmented with a regular profile survey at each site — from the dune crest, or similar shoreward limit, to a suitable offshore limit, such as a depth of twice the maximum annual wave height. Each profile is surveyed at least quarterly, with additional surveys as soon as possible after major storms.

LEO and profile data are submitted every month to CED, in spreadsheet form, from which they are automatically entered into timeseries databases.

3.4 Pilot Study — Pulau Pinang

Pulau Pinang is Bahasa Malaysia for 'Penang Island' [Figure 3], lying off the west coast of Peninsular Malaysia, just south of its northern border with Thailand

Pulau Pinang was chosen for a pilot study, because the State of Penang had already established a GIS of the island and agreed to make some of their digital maps available to CED. The island boasts some magnificent beaches along its north shore, a major coastal urban centre in George Town, and the worst coastal erosion in Malaysia — up to 100 m/a lost from agricultural land along the west coast

Figure 3: Shore Type, Pulau Pinang

Figures 3 also gives an example of G I S shore type output for Pulau Pinang.

3.5 Hydronumerical Modelling

CED have a suite of Danish Hydraulic Institute coastal hydronumerical models: MIKE21™ for tides and currents; and LITPAK™ for nearshore sediment processes These are used for specific projects and for simulation of G I S data, such as the wave hindcasting and nearshore wave transformation referred to in Section 3.2.

Coastal Engineering Division is studying the feasibility of incorporating a shoreline evolution model, perhaps part of LITPAK™, in their Geographic Information System, to predict changes in geomorphology due to proposed coastal works.

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