INSTITUTIONAL STRENGTHENING FOR SHORELINE MANAGEMENT
Approaches, Strategies and Results of a Technical Assistance project

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1. INTRODUCTION

This paper describes the results and achievements of the Advisory and Operational Technical Assistance (AOTA) project "Institutional Strengthening for Shoreline Management" (ADB TA 1604 - MAL) which was implemented at the Coastal Engineering Division (CED) of the Department of Irrigation and Drainage (DID) from July 1994 to July 1996. Beginning with the National Coastal Erosion Study (NCES) which was completed in 1985, the paper provides details of the TA project, emphasizes the approach to project implementation, describes some administrative and human resource activities, and summarizes the technical results. Contextually, therefore, the paper provides a framework for subsequent presentations by the technical specialists who will provide details of the individual components.

The TA was funded by the Asian Development Bank (ADB) and piggy-backed to a sectoral loan (National Coastal Erosion Control Sector) for shoreline protection by the Bank to the Government of Malaysia (GOM).

a. Background

The NCES, a program to describe the Malaysian shoreline identified several reaches which were eroding at unprecedented rates and which threatened existing socio-cultural and economic infrastructure. To address the concerns which were identified, GOM established the Coastal Engineering Technical Centre (CETC), forerunner of CED, in the DID, and authorised the following mandate:

- protection of public property from coastal erosion;
- improvement of river-mouths for navigation; and
- supporting and promoting better coastal zone management.

To implement this mandate, CED identified several key activities including;

- conducting feasibility studies;
- preparing designs for coastal protection works;
- providing technical services to other agencies and the public;
- reviewing EIA's for coastal development projects; and
- functioning as a technical information centre.

Simultaneously, CED embarked on a nation-wide construction program to alleviate and remediate erosion at priority sites. During the loan evaluation, ADB, knowing the importance of a coastal management program to Malaysia, recommended a TA program to strengthen CED's institutional capacity to allow the Division to introduce shoreline management as an outcome of the present shoreline protection program. ADB recommended that the TA focus on the following core elements:

- a data collection and monitoring program;
- a framework for shoreline management;
- numerical modelling for coastal hydrodynamics, processes and engineering design; and
- integration of physical modelling in the design process.

ADB also recommended that the TA be implemented by engineering/computer science specialists with expertise in following areas:

- Data Collection and Management
- Shoreline Management/GIS Applications
- Shoreline Management/Coastal Engineering
- Coastal Engineering/Physical Modelling

b. Goals and Objectives

The TA's goal is "to assist the government to implement, successfully, the National Coastal Erosion Control Sector Project by enhancing the implementing agency's (DID) capability, and to assist the government in moving towards a longer term goal of full coastal zone and coastal resource usage and management to maintain the project's sustainability". The objectives are:

- procure computer hardware and software to support time-series and spatial data management;
- configure the software to store and retrieve data and provide suitable analysis and display;
- design and document a data model for implementation on the GIS;
- review training needs, and develop and implement training programs for data collection, analysis, and management, and numerical modelling; and
- prepare the "Terms of Reference" for a "Data Capture Contract".

Taken together, these components comprise the basis of a comprehensive electronic data management system for shoreline management.

c. Specialists, Time Contributions and Schedules

Five technical specialists, with expertise in the following disciplines, were recruited: oceanography/data collection and management/computer science; Engineering/GIS Applications; coastal engineering; hydronumerical modelling; and physical modelling. To facilitate easier implementation of the technical work, the Canadian government, through the Canadian International Development Agency (CIDA), provided one specialist in project planning and coastal zone management to work with the ADB's specialists. ADB also provided project

management support, and later in the project, funded the project planning and management specialist as Team Leader. CED provided three engineers and one engineering technician to be counterparts to the specialists.

In all, the TA provided 17.025 months of international consulting services. Another 5.0 months were provided by CIDA. The distribution was as follows:

Professor Bjorn Kjerfve, Data Collection and Management	4.225 months
Professor Rongxing Li, GIS Applications	5.250 months
Dr. Craig Everts, Shoreline Management	0.750 months
Mr. David Willis P. Eng., Physical Modelling	3.000 months
Mr. Norman Crookshank, P. Eng., Numerical Modelling	1.000 months
Mr. Les Sawatsky P. Eng., Project Director	0.750 months
Dr. Eugene Ramcharan, Team Leader/Project Planning	7.050 months

Project implementation occurred in three distinct periods between July 1, 1994 and July 31, 1996, with continuous project planning, management and administrative support by the Team Leader and CED providing the linkages. This extended timing was necessary because of the time required to evaluate the needs of CED and of shoreline management in Malaysia, in general, the time taken for procurement, configuration of the hardware and software, training, and troubleshooting the data system to ensure full functionality.

2. PROJECT IMPLEMENTATION

a. Approach

The TA was implemented through close collaboration between the specialists and CED. Technical recommendations were presented to CED and agreement on project direction was reached through discussion. Regular meetings were held with CED to discuss project needs, current progress, and possible variations. Variations were important since, with continuous assessment, there were opportunities to improve the TA through the addition and re-assignment of various components. Meetings were also held with the Project Technical Committee which was comprised of representatives of several government departments and agencies and the private sector. Through these meetings, inter-agency collaboration was facilitated and CED was able to develop further linkages which would improve the operational aspects of shoreline management. This openness with CED and the Technical Committee facilitated the transfer of project understanding, as well as technology, to the Division, and ensured, that during the specialists' absence from Malaysia, CED-directed work continued on the project. This approach to implementation allowed CED to conduct "continuous assessment" of the project's status as well as the Division's technical needs and performance.

In introducing data management and GIS technology to CED, the specialists focused on the concept of "appropriate technology". As applied on this project, the concept elaborated the following premises:

- that computer and data management technology already resided at CED;
- that staff were knowledgeable in the use of resident technology;

- plans to introduce new technology should make full use of existing skills and technology;
- new work should be integrated into existing workloads seamlessly;
- future work generated by new technology should build on existing capability and make use of existing datasets; and
- further development of data management technology at CED should be self-directed.

Following these principles, it was important for the TA project to assess correctly, CED's current skills and technology base, identify appropriate work loads to current workflows, identify training needs and develop a program for training, identify appropriate levels of technology which could be integrated into the Division's programs seamlessly, and assist CED to facilitate self-assessment in program development.

Summary

b. Inception Study/Report

An Inception Study was conducted to finalize the work plan, assign specialists' responsibilities, and establish milestones for performance assessment. The resulting Inception Report was presented to ADB as the "operating manual" for project implementation. The Inception Study confirmed ADB's project definition as well as CED's needs and contributions. The study also recognized that some other aspects of coastal data management such as data analysis and coastal processes modelling were outside the scope of the TA. In addition, in the interval between ADB's project review mission and the present TA implementation, GOM installed physical modelling facilities for education and coastal infrastructure works. Since expertise in physical modelling was present in Malaysia, CED and the Technical Committee recommended that this component of the TA could be provided by Malaysian specialists using local funds, and that ADB's specialist could be re-assigned to provide services in coastal processes/sediment modelling and engineering data applications to CED. CED also requested ADB to provide a specialist in numerical modelling who was experienced in using the Danish Hydraulic Institute's (DHI) software "Mike 21".

c. Technical Committee

A Technical Committee to provide guidance to the specialists was formed with the following membership:

- Implementation and Coordination Unit, Prime Minister's Department
- Malaysian Centre for Remote Sensing (MACRES)
- Royal Malaysian Navy (RMN)
- Department of Surveys and Mapping (DSM)
- Department of Fisheries
- Department of Environment (DOE)
- PETRONAS
- Ministry of Land and Cooperative Development
- Department of Public Works (JKR)
- Universiti Sains Malaysia
- Universiti Teknologi Malaysia
- Universiti Pertanian Malaysia

- Universiti Kebangsan Malaysia
- Universiti Malaya
- Institut Teknologi MARA
- Maritime Department of Peninsula Malaysia
- Department of Meteorological Services

The committee provided advice on the scope and focus of the project, and identified opportunities for inter-agency collaboration.

d. Project Components and Specialist Assignments

As finally implemented, the TA comprised five technical components as well as administrative, procurement and training activities. The following section describes the scope of work for each component.

- Data Collection and Management

The Data Collection and Management component of the TA was to establish an integrated collection and management program for acquiring, storing, and analyzing non-spatial, site specific, data from coastal and marine areas. Five major tasks were identified:

- review the existing data collection program and development suitable management protocols;
- document data collection procedures and identify crucial measurements and data sets required by CED;
- document data requirements and data format for data which is collected by other agencies;
- identify and configure computer hardware and software required for data management; and
- prepare reports, including a user manual explaining the configuration and operation of the database.

The key responsibility of the Data Collection and Management Specialist (DCMS) was to identify parameters and datasets which are important for coastal engineering applications, and to develop structured database in which these materials could be housed. Supplemental responsibilities would include identifying analytical procedures which could be used to reduce the data or improve its usefulness for applications. To improve functionality, metadata files and linkages between metadata, non-spatial and spatial datasets, were required.

- GIS Applications

Completing this assignment required the GIS Applications Specialist (GISAS) to develop a GIS data model which is suitable for spatial and non-spatial data collection, shoreline management, coastal engineering and physical and numerical modelling. Four specific assignments were identified:

- development of a conceptual model for GIS applications;
- detailed application design for implementation;

- design of the functional prototype; and
- system implementation and testing.

Developing the data model required knowledge of the full range of data required for coastal engineering and shoreline management, as well as the needs of physical modelling. Achieving this required close collaboration between the individual specialists and CED.

- Coastal Engineering/Shoreline Management

Successful integration of data management principles and practices into engineering applications is one key objective of the TA. To support this effort, the Coastal Engineer/Shoreline Management Specialist (CESMS) provided an evaluation of coastal/marine data which is both traditionally used and important for engineering projects. Two key assignments were identified in this component:

- assessment of the data needs for engineering applications; and
- assessment of the data needs for coastal processes and hydro-numerical modelling.

Since CED has an on-going data collection program under its 'Littoral Environmental Observations" initiative, the specialists were required to pay particular attention to the utility of the data gathered thus far, and recommend areas for strengthening.

- Physical Model Laboratory Training

This component of the TA comprised two assignments:

- set up a series of physical model demonstrations to illustrate model applications; and
- prepare and deliver 2 to 4 courses over a four-week period to explain the use of physical models in the design process.

This program is targeted mainly to engineers in the Malaysian Public Service and local Universities, and the training and demonstrations are to show the techniques used for design, as well as alternatives which might provide equally acceptable results.

- Training in Coastal Sediment/Processes Modelling

The modelling of coastal processes and the movement of sediments is important to engineering since it provides further information on the potential occurrence/re-occurrence of coastal phenomena, and could emphasize the effects of specific remedial and/or mitigative action. Modelling of sediments is especially important in cases where the "theoretical considerations" are weak, and where some parameters are ill-defined. The key assignment in this component was to be a 5-day, hands-on, training course in coastal sediment modelling using proven technology, in the form of several software packages, to demonstrate boundary conditions, shoreline evolution, wave propagation, nearshore currents and beach dynamics.

- Training in Hydro-numerical Modelling

Training in hydro-numerical modelling was included in the TA and envisaged to be supplementary to the training program in coastal processes and sediment modelling. This component focussed on developing capability to understand and apply the DHI software package "Mike 21" to engineering applications. The course, comprising both lectures and "hands on" exercises, was targeted at CED's engineering staff.

e. Milestones

Following definition of the project into constituent components, it was necessary to identify key assignments, called milestones, which could be used to assess TA performance and determine priorities. Ten milestones drawn from all components of the TA were identified:

- assessment of data needs for shoreline management;
- assessment of computer hardware and software needs;
- procurement of computer hardware and software;
- tender call for data capture contract;
- configuration of non-spatial database software;
- assessment of GIS needs of CED;
- design and document spatial database model;
- customize GIS to suit CED;
- implement modelling training program; and
- assess further training needs and develop suitable programs.

3. RESULTS AND ACHIEVEMENTS

The achievements of this TA are varied reflecting the diverse assignments and technical skills which were used. In summary, however, a state of the art computer system with relevant software was installed in the Division, models for spatial and non-spatial data were developed and installed, Divisional staff, and others, received training in numerical modelling, coastal engineering and the collection of littoral data, and data capture contracts for selected items of spatial data were issued. These developments resulted in a re-definition of CED's organizational structure and the creation of a "Data Management and Information" section within CED, a unit which is comparable to current units for "Rivermouth Engineering" and "Coastal Zone Management".

a. Data Collection and Management

Using data held by CED, the DCMS constructed and configured a relational database for non-spatial time series and metadata for Peninsula Malaysia, Sabah and Sarawak in dBase 5.0 for Windows in the PC environment. Database construction resulted from an interactive/consultative approach by the specialist and CED counterpart staff. This approach further benefits CED through the dedicated "hands-on" training which is provided. Consensus decisions allowed the counterparts to evaluate datasets for suitability, specific parameters for relevance and utility, preferred formats, and units of measure. These ensure that the final product is acceptable for use

in shoreline management, and provide the added benefit of training CED staff to conduct similar exercises after the specialist support is ended.

The database, which contains a series of data tables, queries, and forms, is organized into the following four computer sub-directories:

- Littoral environmental observation (LEO) data for the 19 extant stations (16 in Peninsula Malaysia and three in Sabah and Sarawak) for the period 1988 to present.

- NOAA National Climatic Data Centre (NODC) Surface Marine Data, also known as the Surface Ship Meteorological Observations (SSMO) for Marsden squares 24 - 27, available on CCT 9-track tapes separately for 1949 - 1983 and 1984 - 1993.

- Time series of existing tidal water level data (1992 - 1993) from installations near Marang, Terengganu, and Tanjung Piandang, Perak, by consultants from the Japan International Cooperation Agency (JICA).

- Time series of existing wave data (1992 - 1993) from installations near Marang, Terengganu, and Tanjung Piandang, Perak, by consultants from JICA.

The DCMS and the CESMS collaborated on the development and delivery of a lecture/field training course to upgrade the skills of personnel who are collecting data for the LEO program. A new computer-based format for storing, retrieving and transmitting data from the collection points to the data centre at CED was introduced. Key recommendations from the DCMS include the coordinated implementation of a national wave data collection program, improvements to the LEO program, and the development of coordination mechanisms for inter-agency data exchange.

b. GIS Applications

GIS can support various stages of shoreline management where the data required incudes spatial data, time-series oceanographic variables, social and economic information and multimedia information. For the GIS at CED, the GISAS recommended the development of databases to characterize shoreline history, bathymetry, topography, attribute data (demography, land use, environmental quality, etc.), multimedia (e.g aerial photographs), and time-series data (LEO, wave data, SSMO, etc.).

Work flows at CED, as well as GIS operations at several Government of Malaysia (GOM) departments and agencies, were reviewed before recommending a computer hardware and software combination emphasizing Pentium (TM) desktop computers and the software ARCVIEW and AVENUE. To make full use of current technical expertise and existing databases, the system also included ARC CAD, a software which creates a GIS file from AutoCAD documents. Functionally, the system was designed to accept and analyze spatial and time-series data in digital format. The ANSI SPARC design database standard was adopted. This standard outlines the following four phases of database development: external design, conceptual design, logical design, and internal design.

Following development of system and function design, the TA developed a pilot project at Pulau Pinang to implement and test the data model. Spatial data from the Department of Agriculture (DOA), as well as time-series data from LEO sites at Tanjung Bunga and Bagan Tambang, were used. Further, Terms of Reference for two data capture projects to provide shoreline maps were prepared and contracts issued, and the specialist delivered a lecture/demonstration training course in GIS to counterparts and other staff at CED.

c. Coastal Engineering/Sediment Modelling

The CESMS evaluated CED's data needs and identified several parameters which are essential to the Division. Working with the DCMS, these were incorporated in the final non-spatial time series database. The current LEO program was strengthened by the delivery of a training course and improvements to data management practices. Finally, a 5-day, hands-on, training course in coastal sediment modelling using proven software packages, was given to demonstrate boundary conditions, shoreline evolution, wave propagation, nearshore currents and beach dynamics.

d. Numerical Modelling

A lecture/computer demonstration course in "Hydronumerical Modelling" was given to complement the course in "Sediment Modelling/Coastal Processes". As such, the only references made to sediment modelling was to illustrate the close integration required by different hydronumerical models and sediment models to solve sedimentation problems which are typical to Malaysia's coasts. The lectures were delivered in the morning sessions and were illustrated with case-studies recently completed at the Canadian Hydraulics Centre, National Research Council of Canada. Afternoon sessions focussed on developing the concepts and principles presented in the morning lectures through working with the "Mike 21" suite of models developed by the Danish Hydraulics Institute (DHI).

Presented as an overview of hydronumerical modelling, the lectures presented the history of modelling, the need for numerical modelling, the basis equations involved, the solution schemes available, the types of models available, an modelling application areas. A review of models followed an in-depth evaluation of the "Mike 21" series of models, with extra attention paid to the Hydrodynamic Module and the Boussinesq Wave Module. The lectures concluded with an overview of the future of computer and information technology, integrated systems and hydro-informatics.

In the afternoon sessions, CED's staff worked directly with "Mike 21" by modifying and running "Mike 21-supplied" examples. In addition, a Malaysian coastal site was selected to illustrate how to integrate several "Mike 21" models to determine shoreline currents resulting from the combined effects of waves and tides. The course concluded with a series of recommendations designed to aid CED in strengthening shoreline management in Malaysia.

e. Procurement

The computer hardware and software to implement data management activities in the TA and for on-going work at CED was a key element of the project. Considering the rapid development in computer technology, as well as the large databases which will be managed by CED, the specialists considered it appropriate that current, state-of-the-art technology would provide the

best system for present work as well as for future development. It was also important that the system be upgradeable to allow CED to make improvements.

The system procured comprised 5 Pentium 90 desktop personal computers with 17" monitors, 2 NEC Versa 50C notebooks, one NEC 4050 notebook for portable GIS applications, various peripherals including printers, digitizers, storage devices and other equipment networked under Windows NT. Software included productivity packages, non-spatial database items and design/drafting programs. For the spatial database, the specialists recommended the GIS software ARCVIEW which, together with AVENUE allows CED access to datafiles held in ARC INFO format.

f. Training

Training programs were delivered in two formats. First, there was the "hands on" training in database management given by the specialists through the active participation of the counterpart staff. Key items which were emphasized during these programs were assessment of data needs, selection of appropriate technology, data utility and functionality, and applications. All CED staff assigned to the project received this training which served to increase the level of awareness and understanding of the importance of high quality data management and its role in decision-making.

Also, several formal training courses were given by the specialists. These courses comprised both laboratory and lecture presentations, and some, included "hand on" training. The GISAS delivered a 5-day course in GIS Development and Applications to the counterpart and other CED staff. A total of 8 engineers attended. As structured components of the TA, both the Coastal Engineer/Sediment Modelling Specialist and the Hydro-numerical Modelling Specialist delivered training courses in coastal processes/sediment modelling and hydro-numerical modelling. The course in coastal processes was attended by 20 DID engineers from offices throughout Malaysia, while the hydro-numerical modelling course was delivered to 10 engineers from CED's offices.

To strengthen the current data collection activities implemented under the "Littoral Environmental Observations" program, the CESMS and the DCMS delivered a 3-day training program. Supported by improved data collection and reporting methods, the new program allows for efficient reporting through the use of a standard format for data recording and electronic reporting.

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