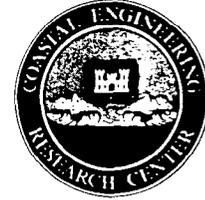




# Coastal Engineering Technical Note



## BEACH MORPHOLOGY ANALYSIS PACKAGE (BMAP) Version 1

**PURPOSE:** This note describes the Beach Morphology Analysis Package (BMAP). BMAP is an integrated set of beach profile analysis routines developed to automate and support mainframe and desktop studies of beach profile change, beach-fill design, and numerical simulation of storm-induced beach erosion.

**BACKGROUND:** Cross-shore modeling of storm-induced beach erosion is a central component of modern shore-protection planning. BMAP is an integrated set of computer analysis routines compiled at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center (CERC), to support mainframe and desk-top computer simulation studies of cross-shore modeling of storm-induced beach erosion and to aid in beach-fill design (Sommerfeld et al. 1993, 1994).

Originally, BMAP was conceived to simplify and automate the numerical modeling work flow and associated analyses of the input data and results of computations from CERC's Storm-induced BEACH CHANGE model (SBEACH) (Larson and Kraus 1989; Larson, Kraus, and Byrne's 1990). Because of the proven utility and convenience of the routines often used as a group, BMAP evolved as an integrated set of calculation, plotting, and input/output (I/O) procedures for analyzing beach profile morphology and its change (e.g., Larson and Kraus 1992).

The BMAP graphical interface produces on-screen plots of selected profiles and other calculation results which can be sent to a printer. The package allows storage of related data and parameters in files called "projects," allowing different users to access the package on the same computer system in analysis of the same or different projects. BMAP complements and is file-compatible with the Interactive Survey Reduction Program (ISRP) (Birkemeier 1984) used by the U.S. Army Corps of Engineers to clean, compare, and analyze beach profile survey data. However, BMAP is intended to be a stand-alone analysis package which can be used independently for a wide range of cross-shore modeling functions. Utilities are presently being developed to support beach-fill cross-section design.

In one compact and convenient software package, BMAP provides the coastal engineer and scientist with a multitude of capabilities in support of beach profile analysis, beach fill design, and cross-shore modeling of beach profile change and storm-induced beach erosion. The objective of this note is to provide an overview of the features of BMAP.

**MENU STRUCTURE:** BMAP operates through a series of self-explanatory menus. As an overview, Figure 1 shows the hierarchy of menus. Upon entering the command "BMAP" at the prompt, the **Project Options Menu** is displayed on the computer monitor. This menu allows

selection of a project and execution of associated file-and-operating system functions. After a project is selected, the **Main Menu** is displayed. The **Main Menu** is the control center through which I/O, analysis, and graphics functions are performed.

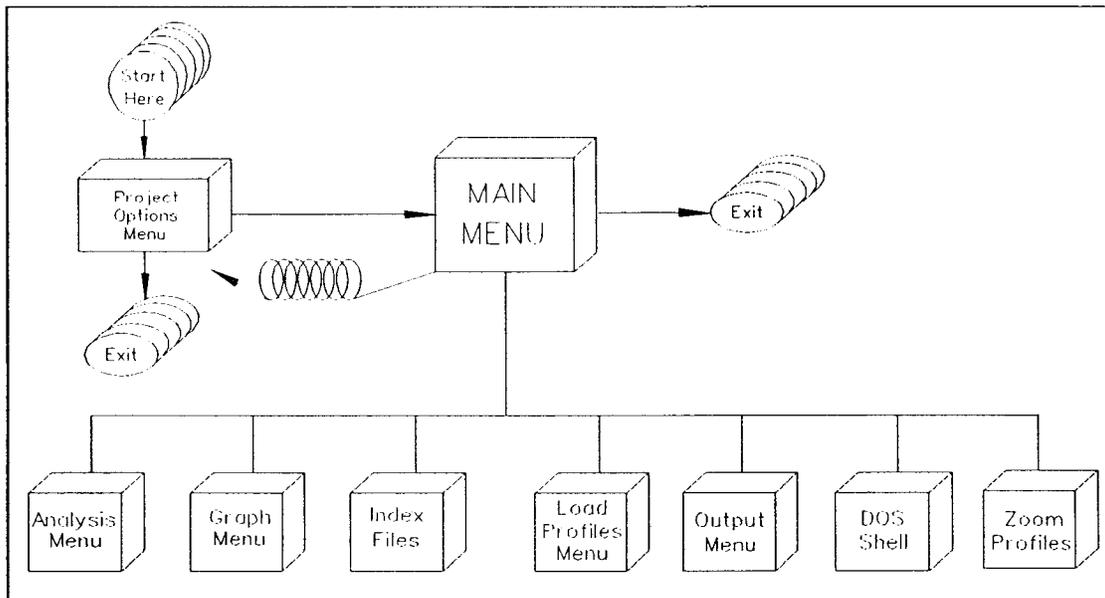


Figure 1. Menu Structure of BMAP

**Projects.** BMAP operates by cataloging I/O data and associated parameters in uniquely named files called “projects,” allowing different users to access BMAP on the same computer system in analysis of the same or a different project with a common or different subset of a profile survey database. In the case of field data, projects would usually contain profile survey data for a specific location at different times. In analysis of laboratory data, such as for SUPERTANK (Kraus, Smith, and Sollitt 1992), a project might correspond to a single test involving surveys of profiles generated under certain wave and water level conditions. The advantage of defining projects is that one may have a data file which contains a large amount of data with some profile surveys logically unrelated to other profiles within the same file; definition of projects readily gives accessibility to a subset of the large file, hence allowing the user to functionally separate the file and group of profiles for related locations, times, or tests.

Each project consists of a project file name, the data directory, the default input file name, the length unit (meters or feet), and multipliers related to the number of significant digits for the horizontal and vertical coordinates. Typically, the project consists of one or more profiles selected from the input data files. The project may also contain output profiles which have been generated from within the analysis routines of BMAP and saved to disk.

**Data Input, Manipulation, and Storage.** BMAP loads beach profile data into a project directly from input data files stored in ISRP format. A conversion utility is included in BMAP to convert free-format data to ISRP format. During a BMAP session, output profiles which are generated from analysis routines are stored in a project output file. Profile data stored in the project output file are specific to the project and can be accessed directly for further manipulation when

working on the project. Each output profile includes a date and time stamp indicating when the profile was generated. In addition, each output profile has a separate ID and description which can be edited by the user. These features allow the user to adopt a customized notation system to keep track of data manipulations and to document sources of generated output in the project. Because beach profile analyses can rapidly generate large amounts of data, the user is encouraged to utilize such data-tracking capabilities.

At the user's option, profiles contained in the project output file can be stored permanently to files on disk (external to the project) in either ISRP format or free format for access by other software packages or input to other BMAP projects. Whenever BMAP stores data to disk, the user is prompted for the name of the file in which to write the data. If the user specifies an existing file, BMAP will append the data to the end of the file to prevent overwriting existing input or output profile data.

**OVERVIEW OF CAPABILITIES:** BMAP will operate on 286/386/486-processor personal-computer (PC) systems with VGA monitors. Hard copy plots may be obtained on HP LaserJet II-compatible printers. BMAP's beach profile analysis capabilities are best summarized by reference to the menu system through which BMAP operates.

**Plotting.** BMAP provides for on-screen color plotting and black and white hard copies of multiple profile surveys from one or more input files and generated output profiles. The package allows the plotting of individual or multiple beach profiles for comparative purposes. Whenever a graph appears on the screen during a BMAP session, the user has the option of exporting that plot to an HP LaserJet II-compatible printer. Data displayed in BMAP-generated plots may also be exported and saved to a file in spreadsheet-compatible format for use in external graphics applications.

**Averaging.** BMAP uses linear interpolation to calculate an average profile of all input profiles. Included within this option is the capability to display the standard deviation and the envelope of profile change.

**Bar Properties.** This option calculates various properties related to a bar including minimum depth and location, maximum height and location, volume, and the position of the center of mass. These calculations may be performed with or without a reference profile. If an adequate equilibrium profile is not available for the corresponding profile containing the bar, or manual definition is desired, the user may specify starting and ending positions of a bar. This is done by visual estimation, and BMAP provides for easy adjustment of the entered coordinates.

**Cut and Fill.** The cut and fill option in BMAP is similar to that found in ISRP and calculates losses and gains, respectively, in volume. Cut and fill areas are determined with respect to distance across shore in cells defined by successive intersections of two profiles, or by the most landward and most seaward common points of survey data along the profiles for the first and last cells if there is no intersection at the beginning and end of the profiles.

**Profile Comparison.** This option calculates volume change and contour change between two profiles given specified contour elevations and starting and ending positions.

**Horizontal Alignment.** BMAP includes the option of horizontally aligning a group of profiles such that they cross on a user-specified elevation (if the chosen elevation occurs more than once on a given profile, the landward-most occurrence is used in aligning the profile). After selecting an alignment elevation, the user specifies the horizontal (distance) coordinate at which to align the profiles. BMAP then horizontally translates the group of profiles such that the alignment elevation on each profile is located at the specified horizontal coordinate. A natural elevation on which to align profiles would be zero elevation, i.e., the shoreline or datum plane.

**Least-Square Estimate.** This option generates a best-fit equilibrium profile with respect to a target profile. Also calculated and displayed are the  $A$ -parameter (shape parameter for the equilibrium profile), the corresponding effective grain size  $d_{50}$ , and the correlation coefficient squared  $R^2$ . The relation between  $A$  and  $d_{50}$  is calculated from data given by Moore (1982) as implemented by Hanson and Kraus (1989).

**Translation.** BMAP provides for shifting profiles vertically and horizontally a specified distance.

**Transport Rate.** This option computes the cross-shore transport rate from the starting point of two profiles to the ending point. The transport rate is calculated by integrating the equation for conservation of sand (Larson and Kraus 1989). The user is prompted to enter the horizontal increment at which to compute the transport rate. BMAP automatically calculates a default time difference based on the date and time recorded for both profiles. As an option, the user can manually specify an arbitrary time difference.

**Volume.** BMAP allows for the computation of volume within a user-specified section of the profile. It also has the option of computing volume above a user-specified contour. These options are illustrated schematically in Figure 2.

**Synthetic Profiles.** BMAP offers the option of generating four types of synthetic profiles: an equilibrium profile, a modified equilibrium profile, an interpolated profile, and a plane-sloping profile. The equilibrium profile, made popular by Dean (1977, 1991), is a concave monotonic profile given by the power-law relation

$$h = Ax^{\frac{2}{3}} \quad (1)$$

where  $h$  is water depth,  $A$  is the shape parameter, and  $x$  is the distance offshore from the shoreline. An equilibrium profile may be generated by specifying  $A$  directly or by specifying the median grain size  $d_{50}$  from which BMAP determines the required value of  $A$ . BMAP also offers the capability to generate a concave monotonic profile shape (modified equilibrium profile defined by Larson (1991)) describing beaches that have a decrease in grain size from coarser near the shoreline to finer in the

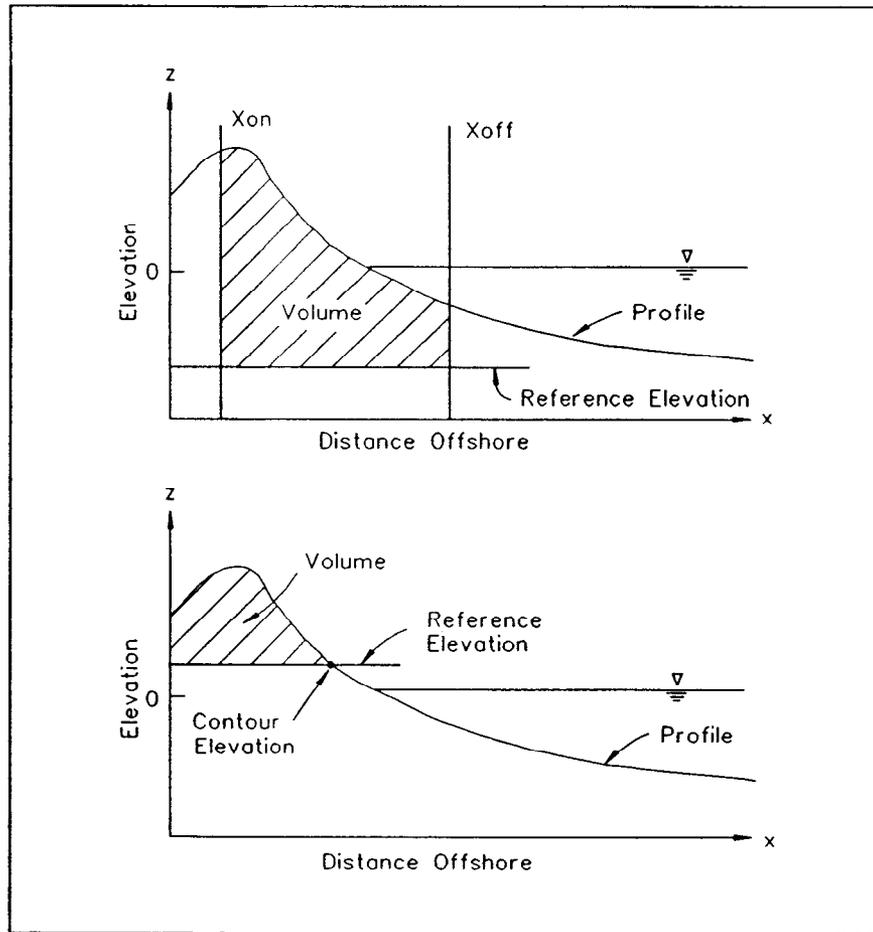


Figure 2. Definition sketch for the profile volume calculation

offshore. In addition to the  $A$ -parameter, the user specifies the energy dissipation ratio  $D_{ratio}$  (ratio of equilibrium energy dissipation at the shoreline over that in the offshore) and a parameter  $\lambda$  which controls the spatial rate of change in grain size from coarser to finer (nearshore to offshore). The modified equilibrium profile equation is

$$h = A \left[ x + \frac{1}{\lambda} (D_{ratio} - 1) (1 - \exp(-\lambda x)) \right]^{\frac{2}{3}} \quad (2)$$

BMAP includes the option to interpolate a selected profile already loaded into the BMAP session. This option interpolates and stores the input profile data at a user-specified constant horizontal grid spacing. The fourth type of synthetic profile included in BMAP is the plane-sloping profile defined by input of two distance-elevation ( $x, z$ ) pairs.

**SUPPORT:** Services and products provided to Corps users of BMAP include training workshops, consulting services, and user's manuals (Sommerfeld et al. 1994). Training Corps personnel on the usage of BMAP is accomplished via periodic workshops. Currently, CERC provides limited consulting services to Corps personnel performing model applications. More intensive training can be provided as part of joint field applications between CERC and Corps elements.

**AVAILABILITY:** Copies of BMAP and the user's guide may be obtained by calling or forwarding a request to:

U.S. Army Engineer Waterways Experiment Station  
ATTN: CEWES-CR-P (Mr. Randy A. Wise)  
3909 Halls Ferry Road  
Vicksburg, MS 39180-6199  
(601) 634-3085

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