US Army Corps of Engineers®

SBAS-A: SBAS for ArcView© Application

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PURPOSE: The Coastal and Hydraulics Engineering Technical Note (CHETN) herein describes a version of the Sediment Budget Analysis System (SBAS) that has been modified for application within the ArcView 8.x® platform. A stand-alone version of SBAS is also available for PC application. Both versions of SBAS facilitate calculating and displaying local and regional sediment budgets including single and multiple inlets, estuaries, bays, adjacent beaches, and through the watershed. This CHETN serves as a user's guide for Sediment Budget Analysis System for ArcView (SBAS-A).

BACKGROUND: U.S. Army Corps of Engineers projects must be designed and managed within a regional context to ensure compatibility of the project within the region as a whole. The regional view encompasses both the local, project-specific aspects as well as how the project affects, and is affected by broader coastal, estuarine, riverine, and watershed processes. Regional Sediment Management (RSM) refers to the effective utilization of littoral, estuarine, and riverine sediment resources in an environmentally effective and economical manner considering both the local and regional context. RSM procedures are directed at maintaining or enhancing the natural exchange of sediment within the boundaries of a physical system. Implementation of RSM recognizes that the physical system and embedded ecosystems are modified and respond beyond the formal dimensions and time frames of individual projects.

The sediment budget is a fundamental planning and design tool for projects concerned with sediment transport, deposition, and erosion. A sediment budget is a tally of sediment gains and losses, or sources and sinks, within a specified control volume (or cell), or in a series of connecting cells, over a given time. There are numerous ways of formulating a sediment budget (e.g., *Shore Protection Manual* 1984; Jarrett 1991; Bodge 1999; Mann 1999). The algebraic difference between the sediment sources and the sinks in each cell, hence for the entire sediment budget, must equal the rate of change in sediment volume occurring within that region, accounting for possible engineering activities. Expressed in terms of variables consistent as volume or as volumetric rate of change, the sediment budget equation is:

$$\sum Q_{source} - \sum Q_{sink} - \Delta V + P - R = Residual \qquad (1)$$

where Q_{source} and Q_{sink} are the sources and sinks to the control volume, respectively, ΔV is the net change in volume within the cell, P and R are the amounts of material placed in and removed from the cell, respectively, and *Residual* represents the degree to which the cell is balanced. For a balanced cell, the residual is zero. For a region consisting of many contiguous cells, the budgets for individual cells must balance in achieving a balanced budget for the entire regional system.

As noted in Figure 1, sources in the sediment budget include longshore sediment transport, erosion of the riverbank, and dredged material placement (placement indicated by P) as from navigation

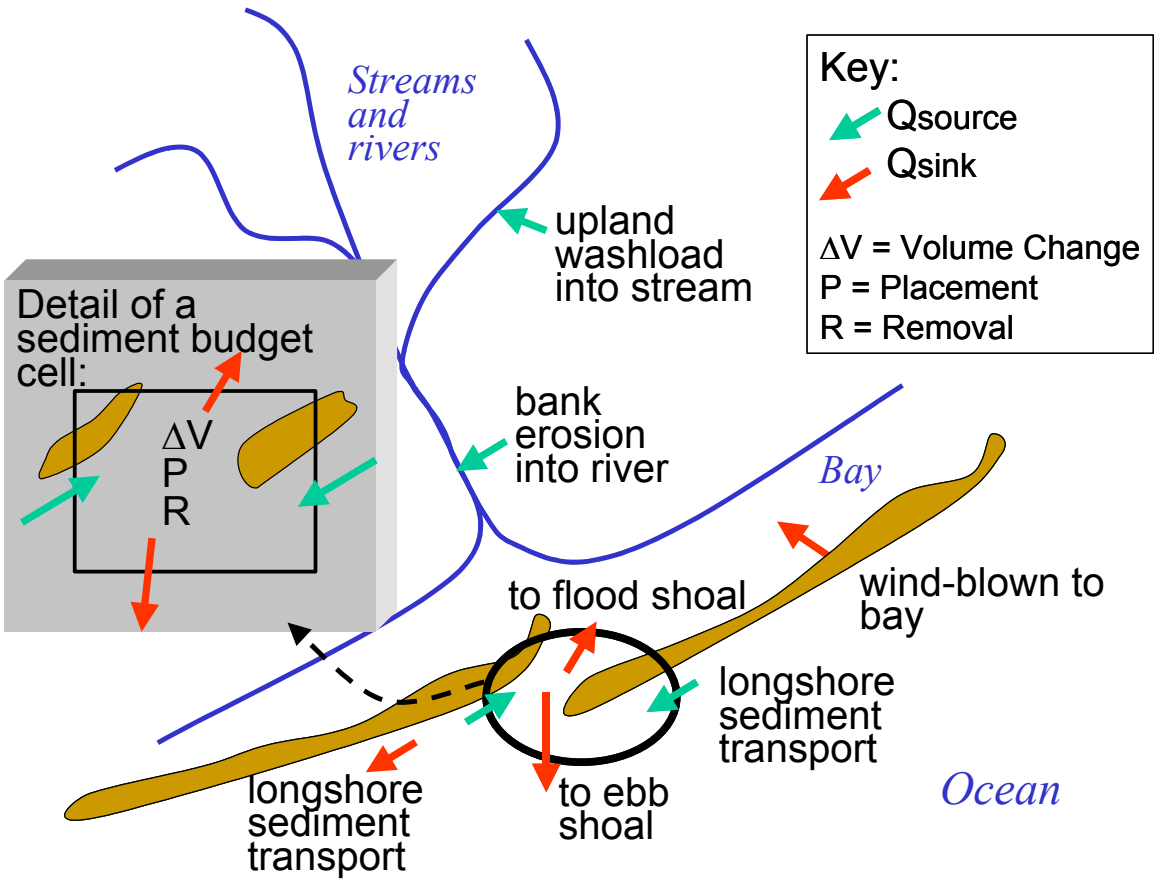


Figure 1. Sediment budget parameters as may enter Equation 1

channel maintenance. Examples of sediment budget sinks are longshore sediment transport, dredging and mining, and losses to shoals. Note that a source to one cell can represent a sink from another cell.

The SBAS is a tool that allows many local (project-level) sediment budgets to be characterized within one or more regional sediment budgets. Features of SBAS have been designed to facilitate creation and display of both the local and regional sediment budgets (Rosati and Kraus 1999, 2001). SBAS was initially designed as a stand-alone PC product that has an option for non-georeferenced images to be used as a background for local (zoom-in) and regional sediment budgets (zoom-out). Along with sediment budgets, a Geographic Information System (GIS) database is another highly useful (perhaps essential) tool for understanding regional processes. To provide the sediment budget capability within a GIS, SBAS-A has been developed. The stand-alone version of SBAS and SBAS-A have been designed so they can share files. The following sections discuss use of SBAS-A. For more information about sediment budgets, or about the stand-alone version of SBAS, the user is directed to Rosati and Kraus (1999, 2001) and Rosati (in preparation).

GETTING STARTED: SBAS-A has been designed exclusively for use in ESRI's ArcMap© environment of ArcView 8. It is integrated directly into the ArcGIS desktop via a customized toolbar. This custom application is available for download from the U.S. Army Engineer Research

and Development Center (ERDC), Coastal and Hydraulics Laboratory (CHL) Web site, *http://chl.wes.army.mil*.

Installation Instructions:

1. Download the SBAS-A setup file (setup.exe) from the CHL's Web site.

2. Double-click on setup.exe and follow the on-screen instructions for installation of SBAS-A into the ArcMap environment.

3. Open the ArcMap application. The SBAS-A toolbar (Figure 2) will appear as a floating toolbar in the display. This toolbar can be mounted by dragging and dropping it on any existing toolbar. If at any time after installation this toolbar is not visible, it can be activated by selecting the *SBAS-A Toolbar* option in the *Toolbars* item in the *View* menu (Figure 3).

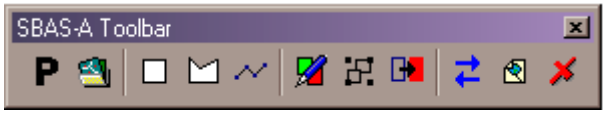


Figure 2. SBAS-A Toolbar

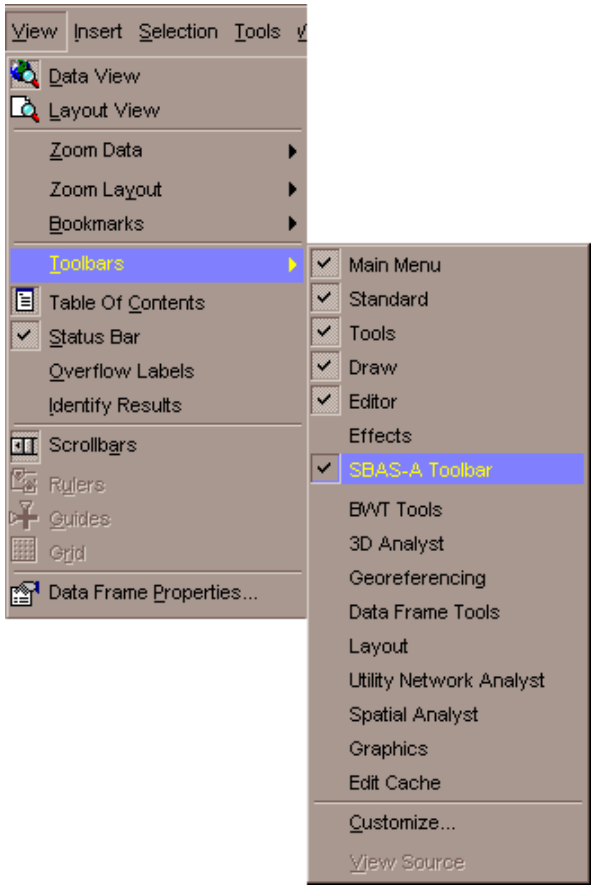


Figure 3. Accessing the *SBAS-A Toolbar*

If *SBAS-A Toolbar* is not visible in the list, the SBAS-A installation files have not been set up correctly. Table 1 describes the toolbar.

Table 1
Toolbar Description

	SBAS-A preferences	Use this tool to set *Working Directory, Projected Coordinate System, Measurement Units, Uncertainty Method,* and *default labeling options*.
	Alternative tools	This tool allows the user to save and load alternative files (*.sbd). Users must load the alternative file associated with the sediment budget shapefiles before editing an existing sediment budget.
	Draw rectangle	Use this tool to draw a rectangle that represents a littoral cell.
	Draw polygon	Use this tool to draw a polygon that represents a littoral cell.
	Draw line	Use this tool to draw lines that represent flux arrows.
	Create sediment budget	This tool allows the user to create a new alternative and convert graphics in the display into littoral cells or flux arrows data layers.
	Macro budget	A macro budget can be created as a new layer, when a user draws a polygon (with *Draw Rectangle* or *Draw Polygon* tool) around a micro budget. This tool automatically calculates a total residual for all cells residing in the macro budget polygon.
	Add graphic to layer	Users can add additional cells or fluxes to existing sediment budget layers. Using the selected graphic(s) in the display, this tool converts the graphic(s) into the selected layer.
	Change direction of flux arrow	This tool changes the direction of the selected flux arrow.
	Edit cell or flux values	Using the selected feature of the active layer in the table of contents, this tool provides an interface to enter cell and flux values.
	Delete selected features	This tool deletes the selected feature of the active layer in the table of contents.

Definition of Terms.

Alternative. An alternative represents one set of assumed conditions for a particular sediment budget. Each alternative has its own set of fluxes, cells, placements, and removals.

Attribute table. A table used to store attribute information for a specific coverage feature class. Each row represents a feature and each column denotes a field. To view a layer's attribute table, right-click on the layer in the table of contents and select the *Open Attribute Table* option.

Feature. A point, line, or polygon in a coverage, shapefile, or geodatabase feature class.

Layer. A collection of similar geographic features—such as rivers, lakes, counties, or cities—in a particular area or place referenced together for display on a map. A layer references geographic data stored in a data source, such as a shapefile, and defines how to display it. You can create and manage layers as you would any other type of data in your database.

Projected coordinate system. A reference system used to measure horizontal and vertical distances on a planimetric map. A coordinate system is usually defined by a map projection, a spheroid of reference, a datum, one or more standard parallels, a central meridian, and possible shifts in the x- and y-directions to locate x,y positions of point, line, and area features.

A reference system consisting of a set of points, lines, and/or surfaces, and set of rules used to define the positions of points in space either in two or three dimensions.

Shapefile. A vector data storage format for storing the location, shape, and attributes of geographic features. A shapefile is stored in a set of related files and contains one feature class.

Table of contents. In ArcMap, the table of contents lists all the data frames and layers on the map, and shows what features the symbols in each layer represents.

Working directory. The directory where all shapefiles created with SBAS-A are stored.

APPLYING SBAS-A: The SBAS-A application allows users to take advantage of the standard spatial tools inherent in the ArcView environment. Before beginning the development of a sediment budget, users should add pertinent data sets into the data frame to assist in the analysis and design of the budget. Vector, raster, and tabular data can all be added using the *Add Data* tool.

Many types of data will be used in the creation of a sediment budget and can be easily stored in the GIS environment. Fluxes into and out of sediment budget cells may be in the form of numerical model output, or of actual data collected during field studies. The change in volume for cells can be derived from varying types of data and GIS tools. For example, volume change between successive SHOALS or other bathymetric data sets may be computed directly in the GIS environment. Volume change may also be derived from comparisons of successive beach profiles or shoreline change data.

Once the initial basemap data has been added into the view, users can begin to use the tools available in SBAS-A. First, preferences should be set to determine some basic elements of the sediment budget. Clicking the *Preferences* button P can access the dialog box as shown in Figure 4.

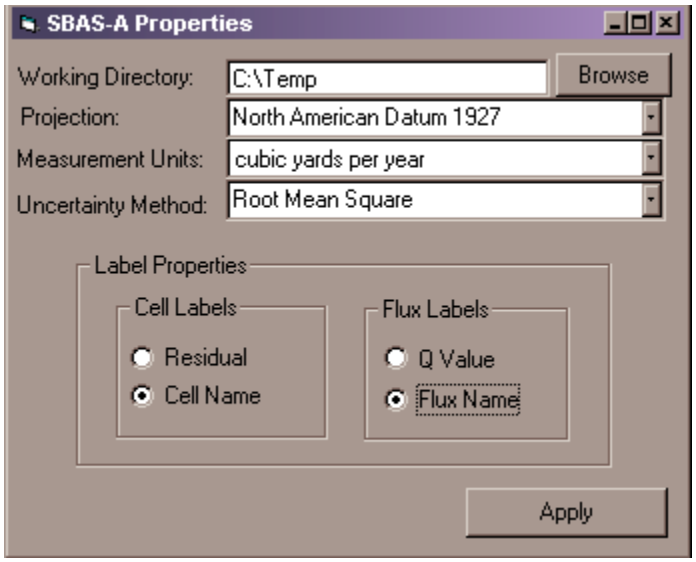


Figure 4. Setting SBAS-A default properties

The value of the *working directory* is the default location for all layers created through SBAS-A. These layers are given the projection system selected in the *Projection* combination box. All SBAS-A related calculations use the *Measurement Units* and *Uncertainty Method* chosen on this dialog. Users can also choose the default labeling options. These preferences can be changed at any point during a SBAS-A session. Once the *Apply* button is clicked, the changes will take effect.

Creating Cell and Flux Layers. The structure of the sediment budget is now ready to be created. Using the *Draw Rectangle* and *Draw Polygon* tools, littoral cells can be placed in data frame. To draw simple, rectangular cells, select the *Draw Rectangle* tool and click where the upper right boundary of the littoral cell should reside; then drag to the lower right boundary. When the mouse button is released, a rectangle will be displayed in the frame. To draw irregular shaped cells, select the *Draw Polygon* tool and click to represent each vertices of the polygon. Double-click to finish drawing the cell. Once all cells are drawn for the budget, a sediment budget layer can be created. If cells need to be added at a later point, they can be done so with the *Add Graphic to Layer* tool.

Sediment budget layers can be created from graphics using the *Create Sediment Budget* tool. To convert a littoral cell graphic into a layer, select *Cell* for the type of layer. If no alternatives are loaded or no alternatives exist, the dialog will appear as in Figure 5.

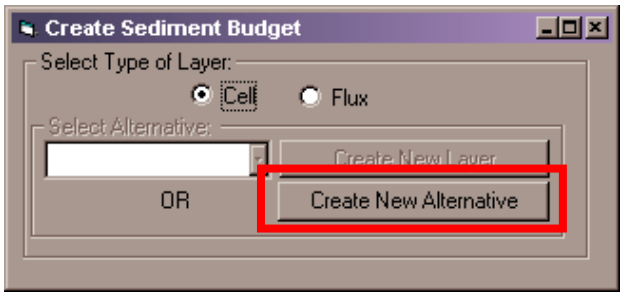
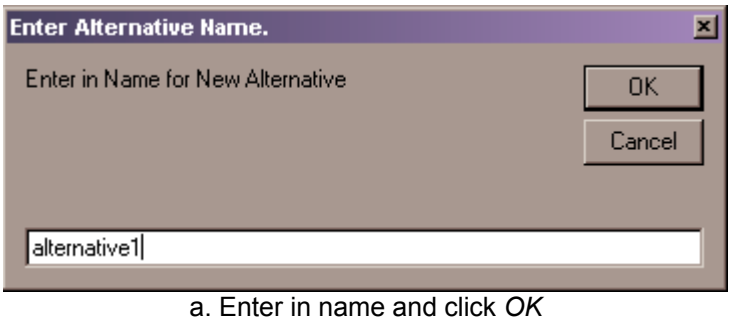


Figure 5. *Create Sediment Budget* tool

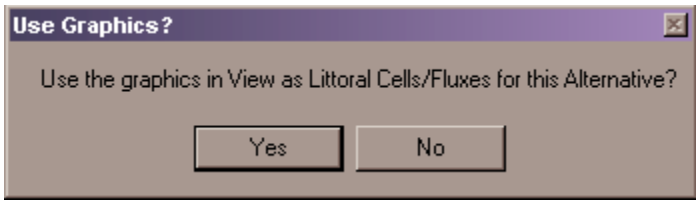
Click the *Create New Alternative* button to name the new alternative. Each alternative created should only consist of one littoral cell and one flux layer. The steps in this process are shown in Figure 6.

This layer will be stored in the working directory location set in *SBAS-A Preferences*.

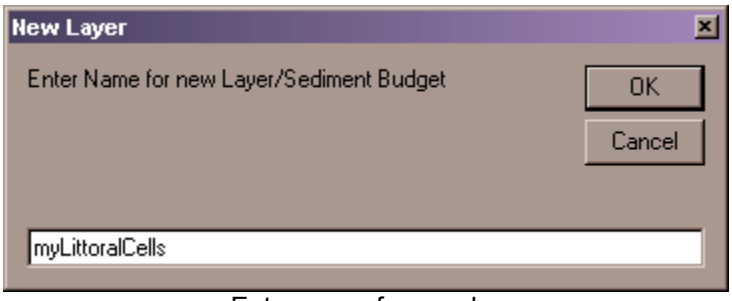
All graphics in the view are now converted into a layer in the table of contents. Setting the color and label options can be done by editing the properties of the layer. To edit these values, right-click on the layer name and select *Properties*. By default, when a littoral cell layer is created all residual values are set to zero. Therefore, all the cell colors remain the same until cell or flux values are edited. Also, the littoral cells have an opaque fill and any data layer beneath the cells cannot be seen. To change the fill of the layer, transparency can be set. To change the transparency for a layer in the table of contents, first turn on the *Effects* toolbar. This can be activated by selecting the *Effect* option in the *Toolbars* item of the *View* menu (Figure 7).



a. Enter in name and click *OK*



b. Select *Yes* to convert the graphics in the view into a layer



c. Enter name for new layer

Figure 6. Creating a new alternative

Figure 7. *Effects* toolbar. Select littoral cell layer from combination box

Flux layers are created in a similar fashion as littoral cells. To create a flux layer, the *Draw Line* tool is used . To connect two cells with a flux, using the *Draw Line* tool, click on the sink cell first and drag to the source cell. Double-click to end the line. Flux arrows can also be drawn as polylines. Polylines allow a line to have multiple vertices to curve around structures. When all flux lines are drawn for the sediment budget, convert them to a layer using the same steps previously outlined for converting littoral cells. However, the flux option needs to be selected in order to convert the layer properly (Figure 8).

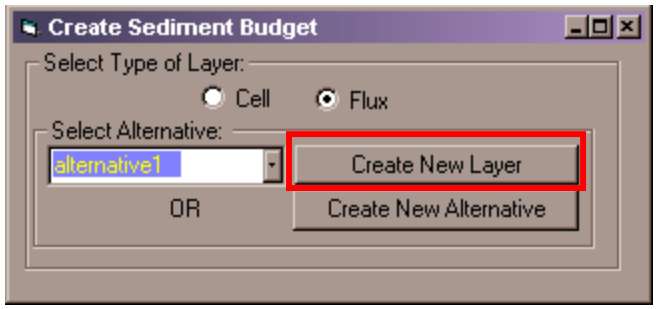


Figure 8. Creating a new flux layer within an existing alternative

To add the flux lines to the current alternative, select the alternative name from the combination box on the *Create Sediment Budget* dialog; then select the *Create New Layer* button to convert the graphic lines and name the flux layer. Once the layer is added into the table of contents, the lines are transformed into arrows denoting sink and source values. The direction of an arrow can be changed at any time by selecting the flux layer in the table of contents, selecting a flux arrow, and clicking *Change Direction* of *Flux Arrow* tool.

Editing Cell and Flux Values. The selected layer in the table of contents and the feature selection of this layer determine the values to be edited when the SBAS-A *Edit Tool* is selected. To select a feature for editing, use ArcMap's *Selection Tool*.

If a cell layer is selected in the table of contents and has a littoral cell selection the following data sheet will display when the *Edit Tool* is clicked (Figure 9):

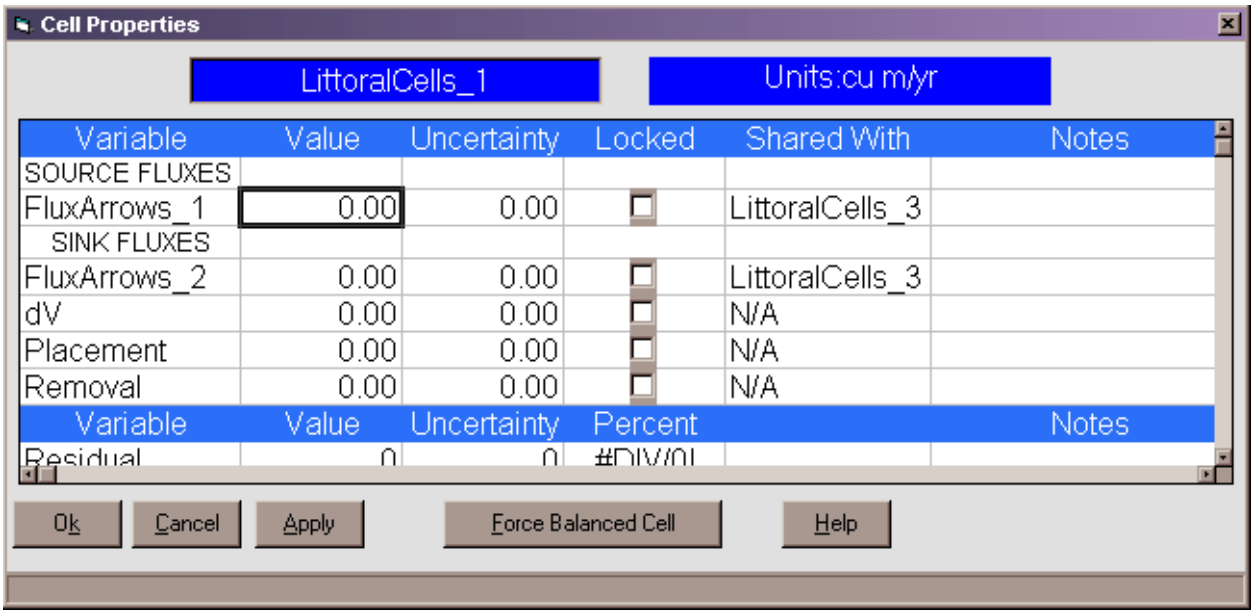


Figure 9. Data sheet for entering littoral cell values

Click *Apply* to save value changes. When values are entered into this spreadsheet and the *Apply* button is clicked, the residual value is posted in the layer's attribute table in the *Residual* field.

If a flux layer is selected in the table of contents and has a flux arrow selection, the following tabbed form will display when the *Edit Tool* is clicked (Figure 10):

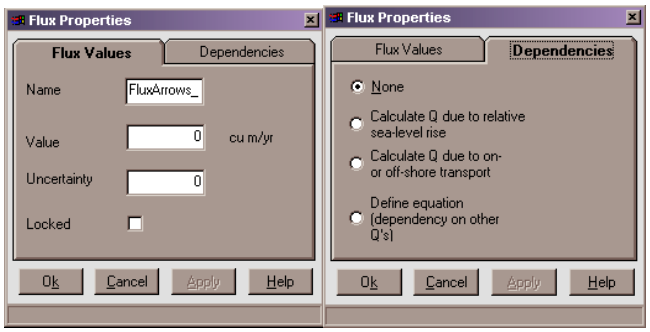


Figure 10. Data entry forms for editing flux values

Click *Apply* to save value changes. When values are entered and the *Apply* button is clicked, the value per flux is posted in the layer's attribute table in the Q value field. Figure 11 shows the data frame once graphics have been converted into a spatial layer and transparency has been set for the littoral cell layer.

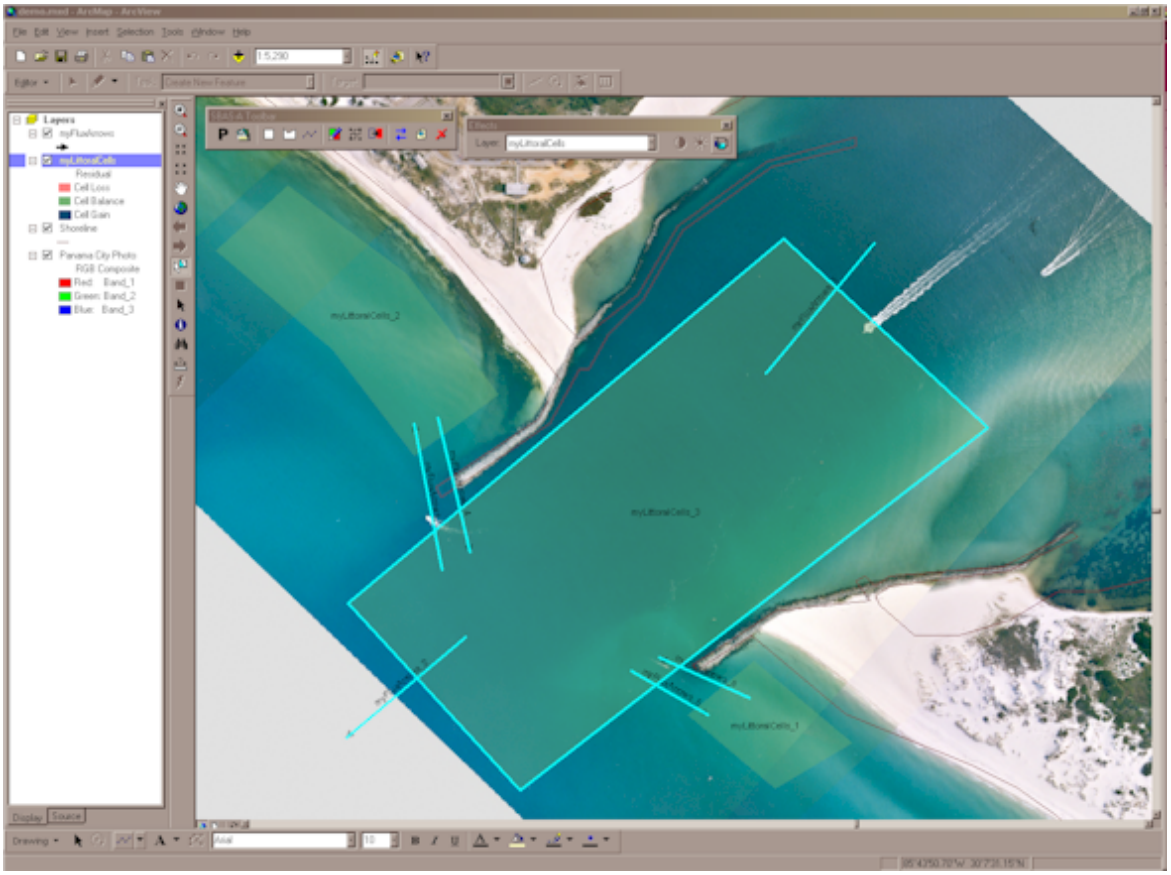


Figure 11. Example data frame

Editing Feature Layer. When editing the sediment budget, additional cells and fluxes may need to be added to the schematic. To add these items to an existing layer, either draw graphic polygons (for littoral cells) or polylines (for flux arrows) with the drawing toolset. Select the graphics, using the *SHIFT* key to select more than one graphic. Then, using the *Add Graphics to Layer* tool, select the type of graphic and then the target layer (Figure 12).

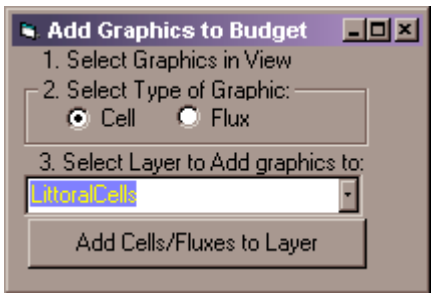


Figure 12. Add graphics to budget menu

Once the button is selected, the graphics will be added to the target layer.

The design process of the sediment budget may also require reshaping existing littoral cells. If a user needs to resize or move a littoral cell, that already has been converted into a layer, the *Editor* toolbar must be visible and an *Edit Session* must be started. To begin an *Edit Session*, select the *Editor* menu for the *Editor* toolbar and choose *Start Editing*. A sample of the dialog appears in Figure 13. Select your working directory from the list and click *OK*.

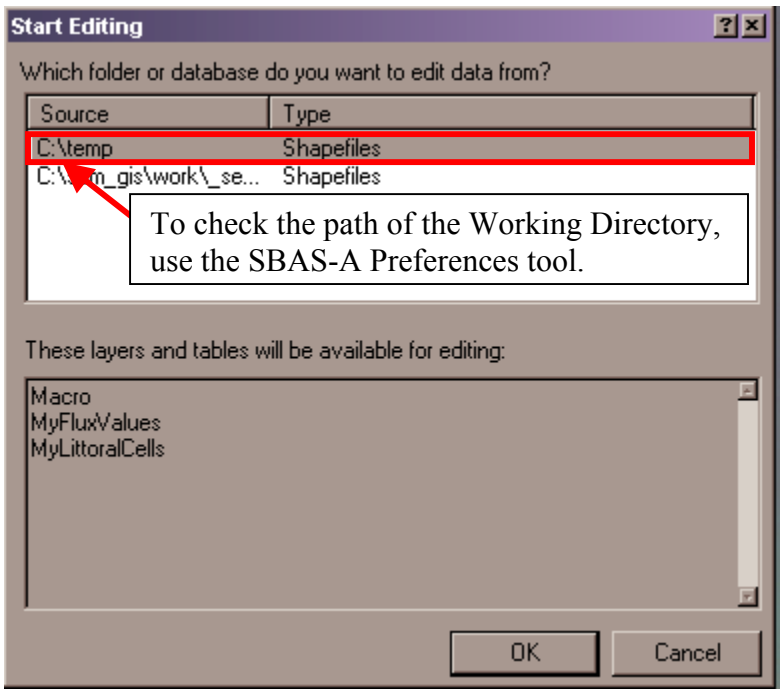


Figure 13. Example edit session

From the *Editor* toolbar, change the task to *Extend/Trim Features* and set your target layer to the layer in need of reshaping (Figure 14). Once these settings are in place, use the *Edit* tool from the *Editor* toolbar to move or resize the dimensions of the target layer. To save changes to the layer, select the *Stop Editing* option from the *Editor* menu. When prompted, select *Yes* to save the changes.

Figure 14. Editor toolbar with edit tool highlighted

To completely remove a selected flux or cell from a sediment budget layer, select the layer in the table of contents and click the *Delete Selected Features* tool from the SBAS-A toolbar.

Creating a Macro Budget. Now that the sediment budget has been represented by littoral cells and fluxes, a macro budget can be created to represent this budget on a large scale. Using the drawing tools, draw a polygon around the sediment budget area to be included in the macro budget.

When the *Macro Budget* tool is selected, the dialog appears as shown in Figure 15. Select the layer that contains the littoral cells used in the macro budget. When the button is clicked, a new layer is created in the table of contents.

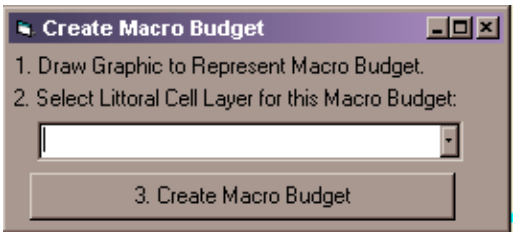


Figure 15. Create macro budget menu

The *Collapsed Cell Properties* data sheet (Figure 16) represents a summary of the macro budget. This datasheet can be accessed by selecting a macro budget layer in the table of contents that contains a macro budget cell selection; then selecting the *Edit Tool* .

Saving SBAS-A Alternative. Saving sediment budget in the ArcMap environment requires three steps:

1. Create cell and flux layers to represent the sediment budget with the *Create Sediment Budget* tool.

2. Save the ArcMap project, *.mxd, file.
   File – Save/Save As…

3. Save the alternative. The alternative file (*.sbd) holds all values for the sediment budget. To save the alternative, select the *Alternative Tools* button from the SBAS-A toolbar.

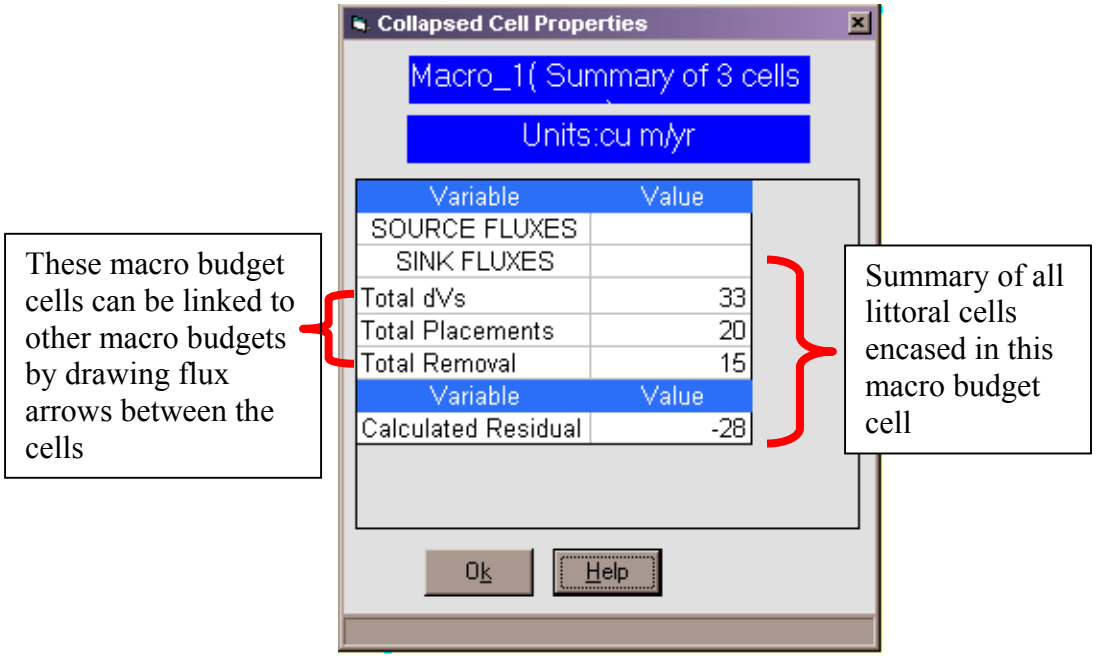


Figure 16. *Collapsed cell properties* data sheet

Use the drop-down menu to select which alternative to save, and click the *Save SBAS Alternative* button (Figure 17).

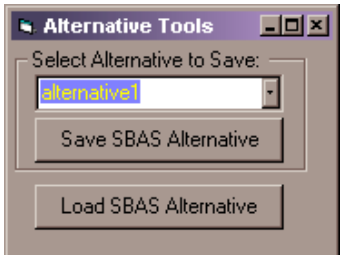


Figure 17. *Alternative Tools* menu

Browse to location and type in the name for the SBAS-A alternative file and click *OK* (Figure 18).

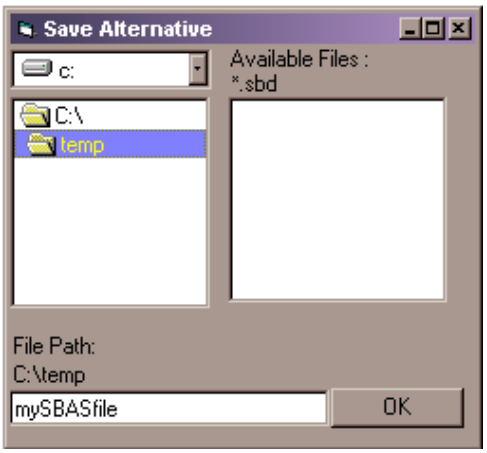


Figure 18. Saving an alternative

The sediment budget is now complete. To access this sediment budget during another session of ArcMap, the user must load particular files in order to see all values correctly. First, the saved ArcMap project file (*.mxd) must be opened. Once opened, all sediment budget littoral cell and flux arrows should be visible. Before a user can view or edit cell or flux values, it is imperative that the associated SBAS-A alternative file is loaded. To load the alternative file, select the *Alternative Tools* button from the SBAS-A toolbar. From the *Alternative Tools* dialog, select the *Load Alternative* button (Figure 19).

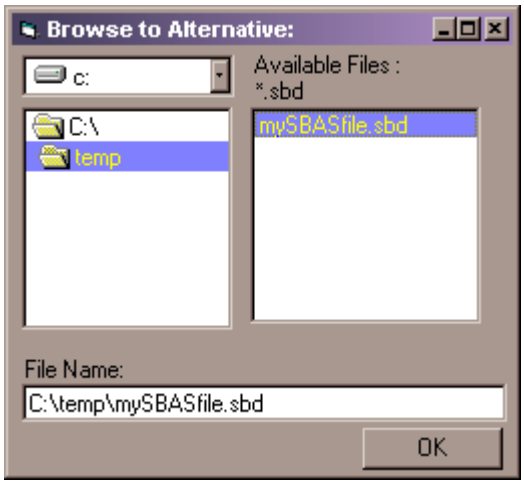


Figure 19. Loading alternative file

Next, browse to location of the existing SBAS-A alternative file that is associated with the sediment budget layers. Click *OK* to load the alternative. If the user is does not remember the associated file name, the file path and name are tagged in the layer's attribute table in the SBAS_file field (Figure 20).

Name	Residual	SBAS_File
MyLittoralCell_1	24	C:\temp\mySBASfile.sbd

Figure 20. Portion of a layer's attribute displaying alternative information in SBAS_file field

The user is now ready to begin editing an existing sediment budget in the SBAS-A environment. It is vital to continue to save the ArcMap project file, and SBAS-A alternative after each session.

EXCHANGING FILES BETWEEN SBAS-A AND SBAS-STAND-ALONE: SBAS-A has been designed for users that have access to existing geospatial data sets that assist them in building sediment budgets. Some of these data sets can include georeferenced aerial photography, beach profile surveys, shoreline position data, dredging history, coastal process, bathymetry surveys, etc. Provided these data sets are in a formats that ArcMap can translate (*.tif, *.sid, *.shp, *.lyr, etc.), all pertinent information can be added to the data frame for analysis. Users can view the data spatially in the data frame or view its attributes in its associated database file.

SBAS-A has been created exclusively for use in ESRI's ArcMap environment of ArcView 8. It is integrated directly into the ArcGIS desktop via a customized toolbar. Users of SBAS-A are encouraged to take advantage of the basic spatial tools inherent in ArcView.

Users who have the basic need for creating a sediment budget, but do not have access to ArcMap or a variety of geospatial data sets, can use the stand-alone version of SBAS to create budgets. If at any point a user upgrades to the ArcGIS/ArcMap platform, alternatives in the SBAS-stand-alone can be exported as ArcMap ready shapefiles (Figure 21). Whenever the user saves an SBAS file (.sbs), the (.sbd) file is automatically saved using the same file name. Once in ArcMap©, users can add the shapefiles as layers in the table of contents (using the *Add Data* tool) and load the Alternative, *. sbd file (using the *alternative tool* from the SBAS-A toolbar).

Sediment budgets created with SBAS-A can also be displayed in SBAS-stand-alone. Sediment budget layers (fluxes and littoral cells) created in SBAS-A can be imported in SBAS-stand-alone with the *Load ESRI Shapefile* tool. Also, whenever the user loads an *.sbs file, SBAS automatically loads the corresponding *.sbd file. The saved alternative (*.sbd file) must also be loaded into SBAS-stand-alone before cell and flux values can be viewed or edited for the imported shapefile layers.

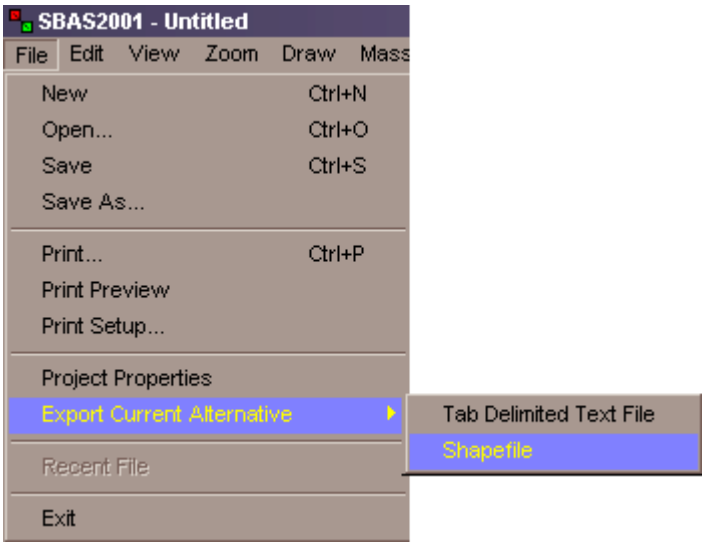


Figure 21. Exporting alternatives from SBAS-stand-alone (as shapefiles)

ADDITIONAL INFORMATION: This technical note was produced under the Navigation Systems Research Program Work Unit "Regional-Scale Modeling Sediment Transport and Morphology Change" by Rose Dopsovic, Lynn Hardegree, and Julie D. Rosati. Ms. Julie D. Rosati at the U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, is the work unit Principal Investigator. Questions can be addressed to Ms. Dopsovic at *Rose.Dopsovic@sam02.usace. army.mil* or to Ms. Rosati at *Julie.D.Rosati@erdc.usace.army.mil*. This CHETN should be cited as follows:

> Dopsovic, R., Hardegree, L., and Rosati, J.D. (2002). "SBAS-A: SBAS for ArcView Application." ERDC/CHL CHETN-XIV-7, U.S. Army Engineer Research and Development Center, Vicksburg, MS. *http://chl.wes.army.mil/library/publications/chetn*.

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