An ArcObjects Software-based 3D Cross Section Tool for REALM

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Abstract

A new model, REALM (River, Estuary, and Land Model) is under development at the State of California Department of Water Resources. This effort is driven by the need to improve upon the functionality and performance of existing simulation models from a traditional water resources modeling standpoint. REALM will also incorporate management tools from other disciplines needed to solve the Department's and California's increasingly complex and difficult water issues in the Delta, tributaries, and bays. One component of this strategy is the implementation of a 3D cross section editing and analysis tool. When viewed in 3D, the bathymetric data are represented by a cloud of points. Using this cloud for reference, the analyst can digitize a cross section into geo-referenced 3D space, resulting in a more representative cross section at any given reach interval. A summary of the methods and ArcObjects programming techniques employed in this ArcHydro implementation will be presented.

Introduction

In March 2004, the State of California Department of Water Resources contracted with the Michael Thomas Group to develop software to support their REALM project. The software requirements included a GIS-based user portal to access various 1D and 2D hydraulic model areas. This paper will focus on development of the user portal specific to the 1D model.

The general strategy was to develop custom ArcObject-based tools that could be accessed from within the ArcMap framework. The functionality of these tools includes the ability to zoom by reach name, place and analyze cross sections in 2D and 3D, place Manning coefficients at various locations throughout the model (which are subsequently interpolated along the reaches), and generate a model output file. These data are housed within an ArcHydro-compliant geodatabase.

Methodology

REALM Portal

Figure 1 illustrates the REALM user portal. The Model View window contains a Microsoft TreeView control which has been programmed to read the ArcHydro database and load the rivers as folders. Since both the TreeView control and the GIS data are built on an object-oriented architecture that is accessible from the Microsoft VisualStudio platform, these objects can communicate with one another. For example, a click on a folder in the TreeView control can trigger events on the GIS objects.

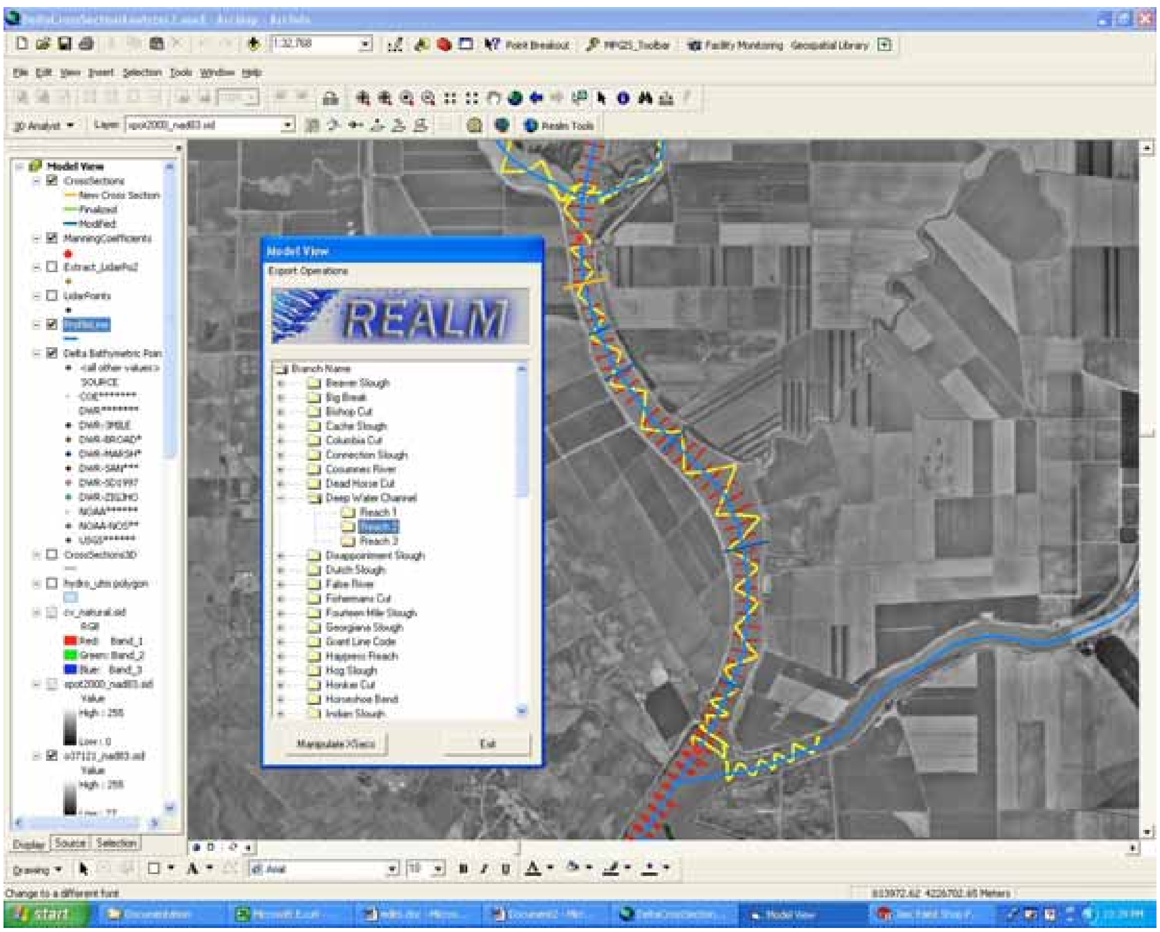

Figure 1. REALM portal view running within an ArcMap session.

In this particular application, a right-click on a river folder presents a context menu (Figure 2a) that allows the user to zoom to the extent of the selected river or out to an overview of the entire project area. Double-clicking on a selected river folder presents the reaches associated with the river. A right-click on a selected reach (Figure 2b) presents a context menu that allows the user to zoom to the extent of the reach, turn on the bathymetric data points associated with the reach or view the branch profile.

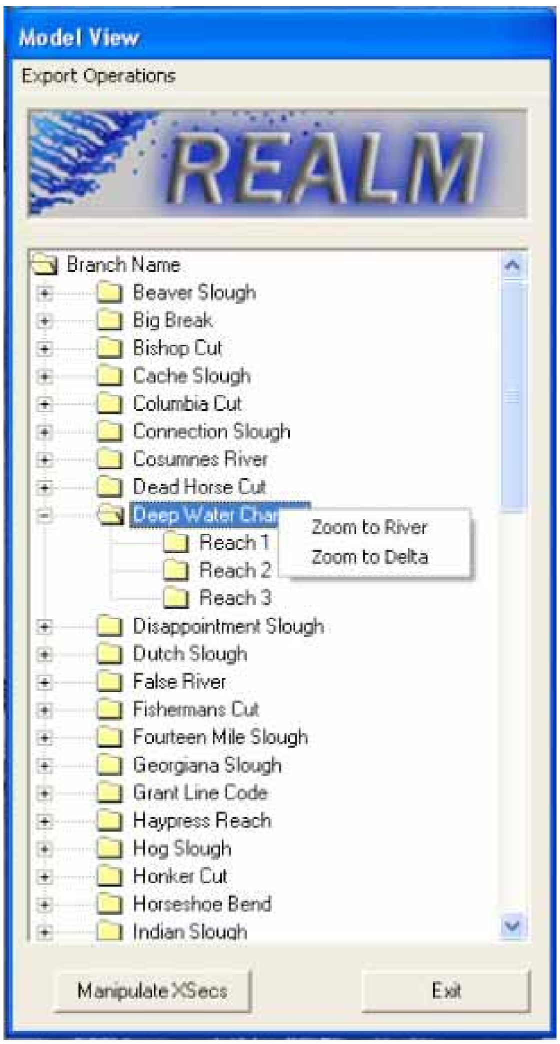

Figure 2a. Context menu for Rivers

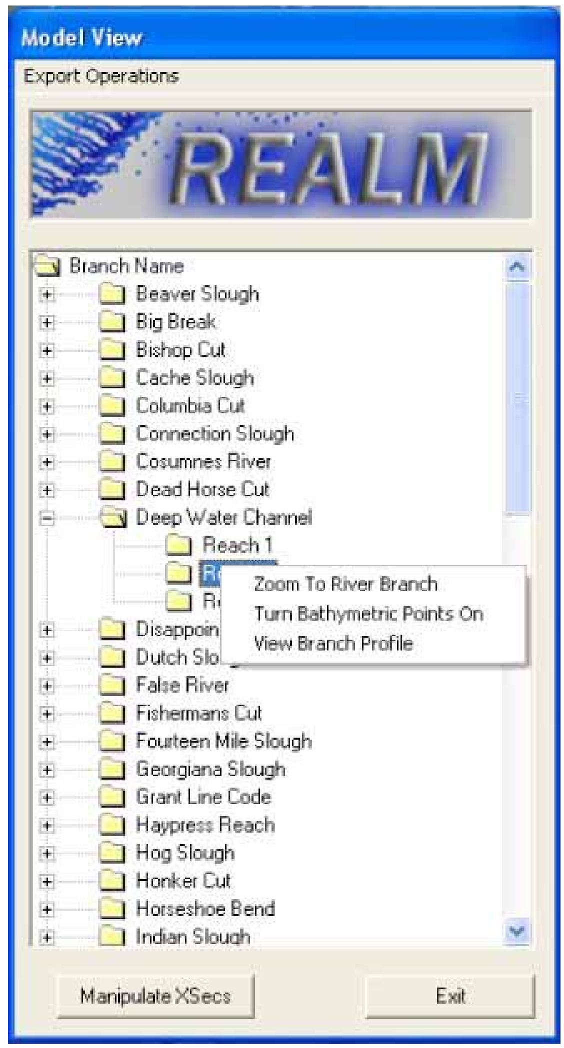

Figure 2b. Context menu for Reaches

Transect Placement
After the interface has zoomed to the selected reach, tools are enabled which facilitate the placement of transects (cross section locations as planimetric line features) on the map. The idea is to extract a subset of bathymetric points in user-definable proximity to the transect. When viewed in 3D space, these extracted points form a point cloud, which is used to guide the development of a representative cross section for the area.

In Figure 3, the GIS presents a reach centerline (blue), along with bathymetric points from various sounding studies (red and yellow, color-coded by source), with a digital orthophoto as a backdrop. The green line is a transect that has been placed with the standard ArcGIS editing tools.

Bathymetric Point Selector
Subsequent to the transect placement, a form appears with a slider bar that allows the user to 'rubberband' a box centered about the newly placed transect. This box serves as a selection geometry for the bathymetric points that fall within it. For performance reasons, these points are written out to a feature class that will be used in the 2D and 3D visualization of the point cloud.

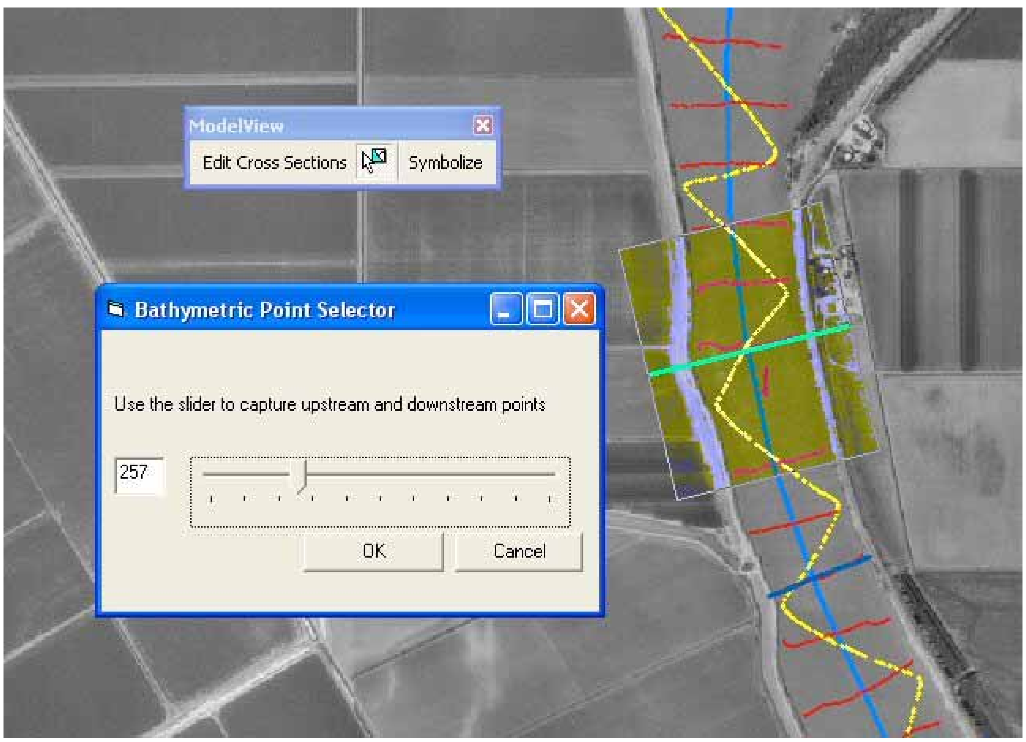

Figure 3. Bathymetric Point Selector form. The slider bar allows the user to select which bathymetric points to include in the point cloud. The point cloud is used to determine the cross section geometry.

The 3D Editing Environment

Upon entering the 3D editor, an ArcScene session is initiated. The point cloud formed by the selected bathymetric points is presented. Reference planes are rendered to visually orient the user. Standard zoom and navigational tools are available on a custom toolbar.

This software allows for the digitizing of the cross section directly in 3D. This is accomplished by the creation of a custom tool that uses the scenegraph's locatemultiple method which is restricted to finding hits on the vertical plane extruded below the transect. As the user 'draws' the cross section, the mousedown events string together these hits to form a 3D graphical element which is converted to a 3D polyline feature and placed in the ArcHydro cross section table.

In Figure 4a, the 3D viewer contains bathymetric points with a cross section already drawn in. Viewing the data in 3D allows the user to study the spatial relationships between the point cloud and the cross section.

Figure 4b shows a specially oriented, flattened view with perspective removed. The effect is as follows. Pick a bathymetric point. Construct a perpendicular bisector through the point to the plane. Transport the point along the bisector until it hits the plane. Repeat for all of the points. In GIS terminology we might say, "Snap all of the points to the closest location on the vertical plane."

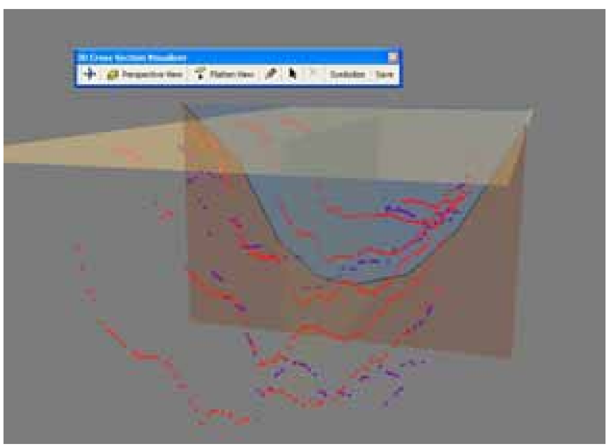

Figure 4a. 3D perspective view

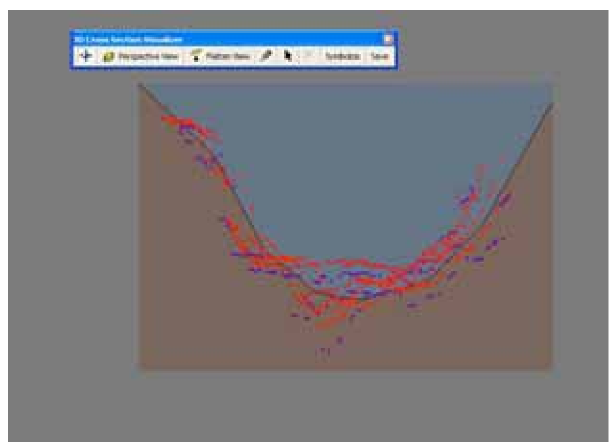

Figure 4b. 3D flattened view

Summary

A GIS Interface was developed for the California Department of Water Resources REALM model using ESRI ArcObjects technology. This interface serves as a portal to their 1D hydraulic modeling engine (there are 2D and 3D components also). This paper covers some fundamental aspects of the 1D model interface, most notably the ability to manage river reaches using TreeView controls and digitize cross sections in a 3D environment.

This is a work in progress. Software is the property of the California Department of Water Resources. All software was designed by the Michael Thomas Group Inc., a GIS corporation.

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