GIS Approach to Shoreline Management
Using MapObjects and MS Access

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Abstract

In efforts to streamline and standardize the current business process of managing shoreline permits within the Mobile District of the US Army Corps of Engineers, a relational database, utilizing MapObjects technology was created. In the past, the USACE did not release any standards to ensure area resource offices were collecting accurate and complete permitting information. The paper presents the process used by the Spatial Data Branch to design and distribute a user-friendly, Microsoft Access database that enables non-GIS users to quickly retrieve data through both spatial and attribute queries, without requiring a license to high-end ArcGIS software.

The ultimate goal of the centralized database is to allow any authorized user to access, create and modify database information and view a geographical representation of permitting datasets, such as permit location, imagery, and shoreline allocation polygons, all within an attached simple GIS interface. Once synchronization of the satellite databases is achieved, a more enterprise approach can be applied to this project. Using web technology, in coordination with ArcIMS map services, the Shoreline Management Application can be a distributed in a web-based format. This creates a single point of data entry, with the public applying for permits online, and allows District employees to manage the permits without software accessibility constraints.

Introduction

Since the Rivers & Harbors Act of 1899, the Corps has been involved in regulating activities by others in navigable waterways through the granting of permits. At first, this program was meant to prevent obstructions to navigation, although an early 20th century law gave us regulatory authority over the dumping of trash and sewage. Passage of the Clean Water Act in 1972 greatly broadened this role by giving the Corps authority over dredging and filling in the "waters of the United States," including many wetlands. Using geospatial technology has been a means to assist the Corps of Engineers nationwide in maintaining its role with the waters of the United States.

The new direction of the US Army Corps of Engineers is to promote the integration of geospatial technology infrastructure to deliver spatial information products, services and standard datasets to all business elements and processes in the organization. The application of the Shoreline Management Plan (SMP) is a corporate information system that stores information on the management, protection, and preservation of the lake's environment while monitoring the balanced use of the Shoreline. However, the guidelines of the SMP primarily address the private use of "Limited Development Areas" (LDA). The plan also considers means of restoration of the shoreline where excessive use, misuse or degradation may have occurred (1130-2-40, 1990).

In making decisions on whether to grant, deny or set conditions on permits, District commanders are required to consider "all factors in the public interest," including economic development and environmental protection. It is the policy of the U.S. Army Corps of Engineers to manage and protect lakeshore and navigation projects in a manner which promotes the safe and healthful use of the shoreline by the public while maintaining environmental safeguards to ensure a quality resource for future generations. Public access and use of the Mobile Districts' project shoreline

will be preserved. Regulatory guidance requires that the U.S. Army Corps of Engineers seek reasonable measures to minimize private exclusive use of public property and to maximize general public uses.

Each record, or application permit, maintained in SMP information system has a geographical or spatial component. Therefore, the objective of the GIS-enabled Shoreline Management application is to provide the required tools and opportunity for users to synthesize and visualize this data to ultimately improve the decision making process. In the past the importance of spatial visualization has been disregarded, or maintained and accessed by a select few with access to GIS technology of their desktop.

Background

Not so long ago ODBC database connections and geospatial databases were unheard of in regards to shoreline permits. Prior to the days of FoxPro, permits were recorded by hand in hard copy files and stored in file cabinets until time for review. There were only hand drawn maps and photocopies of forms. Park Rangers would go out in the field with these hand drawn maps and base all decisions upon them. To make efforts more complicated, each permit is on a five year rotation. This complicated the process of decision making even more.

Early concepts for the Shoreline Management (SLM) GIS project began two and a half years ago upon discussions with management about the current status of the SLM program. The idea was to bring together new and existing technology with the SLM program. The SLM program at this time consisted of hard copy file system and an electronic database set up in Microsoft. The electronic database was the primary means of project administration with the file system as a backup. So the idea was to take existing program and integrate it with new technology to create a dynamic program that facilitated the needs of West Point Project.

Concepts of the SLM program would be an integrated data input methodology, a graphical interface for query and manipulation, a new management methodology, and a multiuse application for other programs. Once overall concepts were defined, discussion turned to types of data needed for fruition of SLM. Types of data needed included but was not limited to: GPS positions of permits on, digital photos of those permits, parcel/lot information, Access database of current SLM program, and base map information. Other information would also be added at a later time. An early problem that arose was how to integrate all this information in to one usable package. Information would have to be collected in several different formats from several different agencies. This would be an overall theme that would carry through the concept and design stages of this project.

An interface to a GIS environment was needed, that enabled all personnel the ability to view spatial information without the overhead expenses of ArcGIS software licenses and training. Also, all data stored in this system would be gathered through a standard database architecture used by all Project Offices. A standard structure would facilitate the development of future SLM applications.

GIS Approach

Ownership of private land near the lake or adjoining government property does not convey any exclusive rights to use of the lake or adjoining public lands. An application must be made to the Project Office for a permit prior to construction of boat mooring facilities, alteration of government land, or modification of vegetation on the lakeshore. In the past, these applications were processed in unique databases in each satellite Project Office. These databases, usually Microsoft Access driven, contained detailed information regarding the permit owner, authorized

structures, and location coordinates. These location coordinates prove to be a key component in authorizing the building or modification of structures on the adjacent property boundary.

Defining and analyzing spatial relationships between permit locations and lakeshore characteristics allow the Project Office to make informed and intelligence decisions on issuing permits. The tools inherent in a GIS allow the analyst to determine if the proposed permit is located in a limited development area, if the structure is in close proximity to developed parks, shallow areas, if areas subject to exposure to wind and currents, or if the structure negatively effects the ecological or aesthetic value of the area. Other data layers, such as parcel or road networks determine if applicants have ready access to the shoreline either by public road, ownership of adjoining property, or right-of-access across adjoining property. ArcView was initially selected as the tool to manage the spatial component of the Shoreline Management database. However, due to budget constraints, ArcView licenses are scarce in most Project Offices, and one ranger is generally appointed to perform any GIS related tasks. As the GIS technology becomes better integrated into the business process, more rangers are apt to perform data analysis, but lack the tools and license to do so.

In efforts to merge the spatial and business components of the Shoreline Management database, a standardized Microsoft Access database has been created the utilizes the functions available in MapObjects. This enables all users to access the business portion of the database, such as permit owner information, in coordination with available spatial information.

Centralization and standardization were the two main goals of creating this dynamic information system. This first step in the development process to was to create database architecture that addressed all of the needs and requirements of the area Project Offices. Though an official document exists on the SMP regulations, each Project Office maintained a separate database with varying applications, tables and queries.

Architecture

The overall design of the SLM program is loosely based off of the Access database used at West Point Project, in West Point, Georgia and Lake Sidney Lanier Project in Buford, GA. Querying information was facilitated by input one of a number of attributes, including a permit number or a permitee's name. This brought up information listed within the database. Using the same methodology, the SLM information in GIS would be queried and accessed. So the decision was made to use the permit number as the primary identifier for the project. The primary identifier is the item that GIS uses to link data from different sources together, and would be the main way of finding data spatially. All information would have to be based on the permit number system and would have to include this number somewhere in its information. This would later facilitate connection of all data together into one.
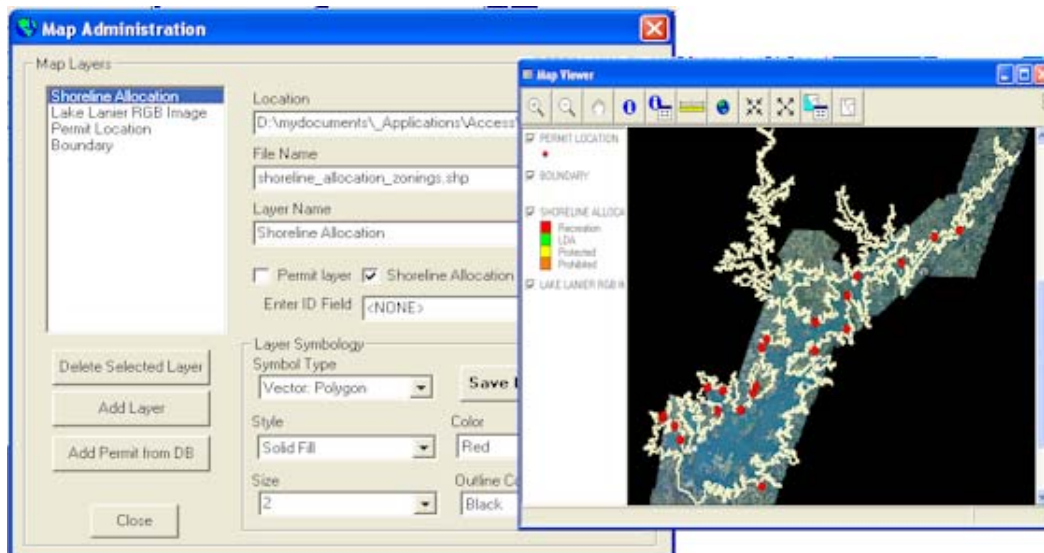
The most difficult step was to bring all the information gathered into a program that could be used by all. A standardized Microsoft Access relational database was created as a foundation for the GIS-enabled SMP. Spatial Data Standards (SDS) were incorporated into the table structures. It is a requirement in the USACE that any products or deliverables produced must comply with Spatial Data Standards. Therefore, any spatial function extraction from the database is produced with appropriate SDS attribution. For example, one function allows the user to export a point shapefile based on the coordinate information stored in the database. The shapefile contains the following standard columnar attribution: AGENCY_ID, COORD_ID, X_COORD, Y_COORD to represent the Project Office ID (AGENCY_ID), the Permit number (COORD_ID) and the locations coordinates (X_COORD, Y_COORD).

An enterprise function of the database allows the administrator to synchronize the individual Project Office database with the central database stored in the Mobile District Office. This data transmission automatically updates the each database record for the selected Project Office in the District Office. This allows decision makers on the District level to be aware of permitting actions of the Project Offices.

MapObjects Component and GIS Interface

ESRI's MapObjects 2.1 software is a significant addition to the Shoreline Management (SLM) database. Its assimilation allows maps and GIS components to be embedded in traditionally non-GIS applications such as Microsoft Access. MapObjects empowers users to view dynamic live maps with conventional GIS capabilities. To incorporate this functionality into the database, a Visual Basic 6.0 project was created that referenced the MapObjects component. All mapping tasks, such as building the map display, formatting feature layers, actions for map tools (zoom in/out, pan, identify, query, etc.), and layout generation were developed as a Class Module in the Visual Basic environment. An ActiveX DLL was compiled and referenced within the Visual Basic Editor console of the Microsoft Access database. Creating a DLL allows the developer to maintain and upgrade the GIS portion of the SLM database separately. As GIS technology continues to grow, the DLL can be updated to reflect recent advances without disrupting the associated database.

Most users of the SLM database are typically not trained in GIS. The GIS map viewer is simply used as an interface to view the geographic location of the permit in relation to other permitted structures or adjacent project shoreline properties. The choice was made to designate a GIS database administrator for each project location. The administrator's responsibilities include designing a project Basemap for all users at that Project Office. The Basemap can include imagery, property boundary, shoreline allocation areas, parcels, and permit locations. A map administration panel was created to administer this database transaction.

Database administrators have the option to view Permit Location by an existing shapefile, or generate a dynamic point layer based on the coordinate information entered within the database per each record. If this option is selected, each time the Map Viewer is referenced, the Permit Location layer is synchronized and the display is refreshed. The

administrator can add typical ESRI formatted shapefiles (points, lines, polygons) and raster images (TIFF, GeoTiff, MrSid). The Access database stores the symbology information. This data instructs the MapObjects code to symbolize the project layers based on the options selected by the database administrator. Below is the table structure for ADMIN_MAP which fuels the Map Display and a snippet of Visual Basic code that generates the display from the table. Values highlighted in **blue** denote values pulled from the database table.

ADMIN_MAP : Table

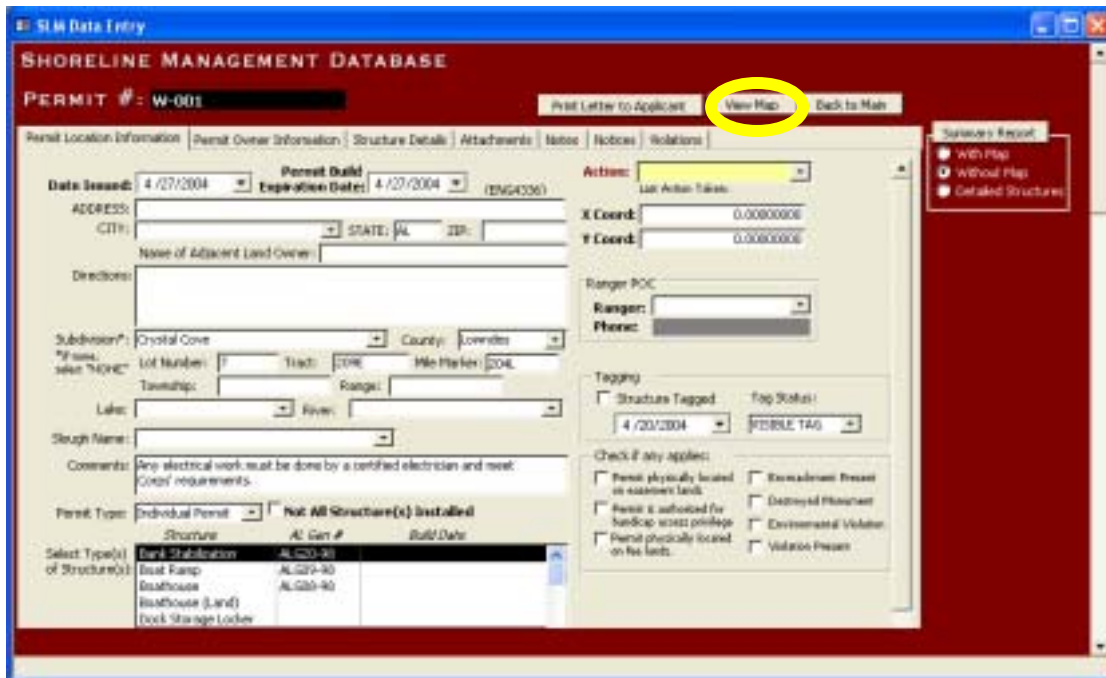| Field Name	Data Type	Description
LayerID	AutoNumber	Primary Key
SITEOFFICEID	Text	Project Office/Site Office Identifier
LayerName	Text	Common Name of Layer - As seen in Table of Contents
LayerPath	Text	Location of Shapefile
LayerFile	Text	Name of Shapefile
SymbolType	Number	Number representing Symbol Type (point, line, polygon)
SymbolStyle	Number	Number representing Symbol Style (dotted, dashed, solid, etc.)
SymbolSize	Number	Number representing Symbol Size
SymbolColor	Number	Number representing Symbol Color (red, blue, green, etc.)
SymbolOutlineColor	Number	Number representing Symbol Outline Color
PermitLayer	Text	Is this layer the Permit Location Layer?
SLALayer	Yes/No	Is this layer the Shoreline Allocation Layer
IdField	Text	Identifier field name for Permit Location Layer or Shoreline Allocation Layer
FromDatabase	Text	Should the Permit Location XY values be pulled from the database instead of using a shapefile?

```vb
…
   If pRecordset("FromDatabase") = "Y" Then
      'Create permit layer from coords in database
      pMapTools.ShowPermitXY pRecordset("LayerName"), moMapControl, CurrentDb

   Else
      Set pDataConnection = New DataConnection
      pDataConnection.Database = pRecordset("LayerPath")
      Set pGeoDataset = pDataConnection.FindGeoDataset(pRecordset("LayerFile"))
       If Right((pRecordset("LayerFile")), 3) = "shp" Then
         Set pMapLayer = New MapLayer
         pMapLayer.NAME = pRecordset("LayerName")
         Set pMapLayer.GeoDataset = pGeoDataset 'Rasters can not be GeoDatasets

            With pSymbol
                   .Color = pRecordset("SymbolColor")
                   .Outline = True
                   .OutlineColor = pRecordset("SymbolOutlineColor")
                   .Size = pRecordset("SymbolSize")
                   .Style = pRecordset("SymbolStyle")
                   .SymbolType = pRecordset("SymbolType")
            End With
       End If
      moMapControl.Layers.Add pMapLayer  Set pSymbol = pMapLayer.Symbol
   End If
…
```
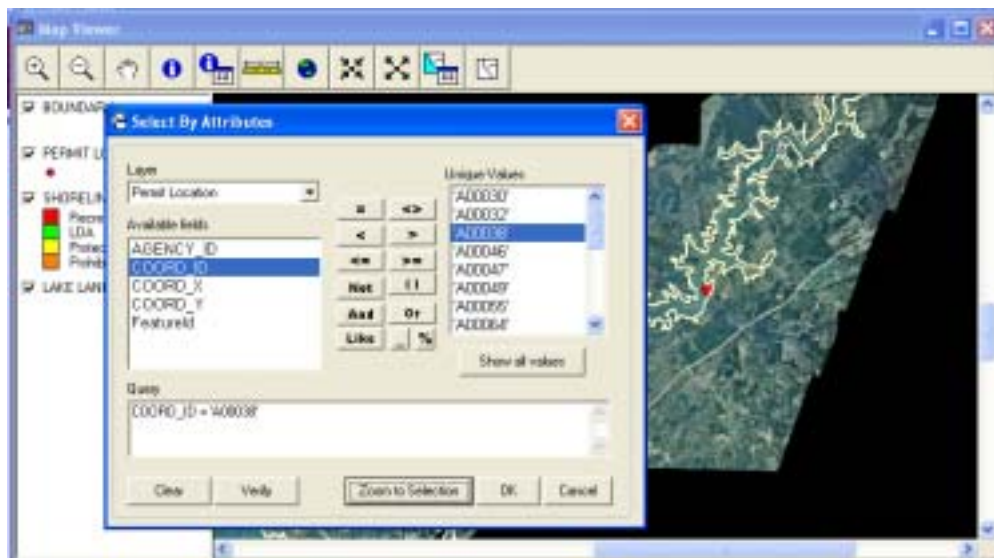
Users can access the Map Display from the data entry screen. Once the "View Map" button is selected, the Map Display zooms to the location of the permit. Once the Map Display is open, a number of tools are available to perform simple analysis. These tools include, zoom in/out, pan, identify feature attributes, identify with detailed database information, measure, query, and select.
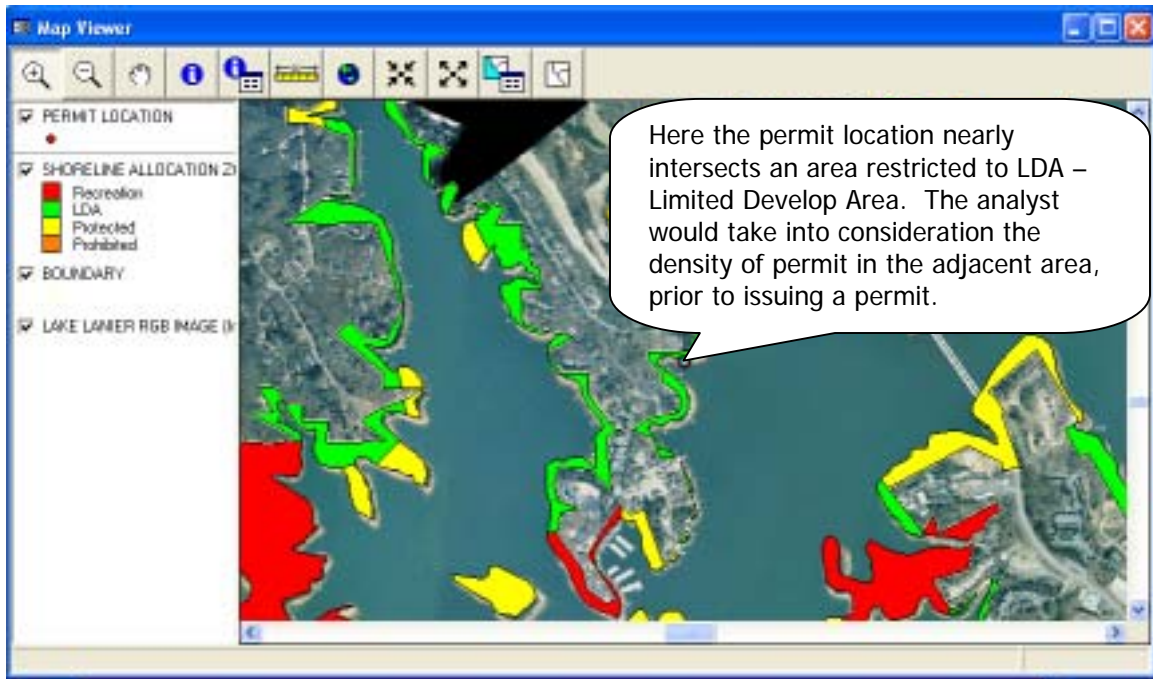
Data entry interface for Permit.

Once in the Map Viewer, users can locate feature with the Select by Attribute tool.

Using GIS overlay techniques, users can visualize shoreline allocation zone restrictions in synchronization with the permit location. This overlay comparison procedure in one of the foundations in shoreline management. Shoreline allocation zones are categorized by *Limited Development*, *Protected Shoreline*, *Public Recreation* or *Prohibited Access*. Intersection of permit locations with one of these designated areas, flag a potential violation. An analyst can also approve or deny a permit based on density of development, navigation, environment, safety, or site conditions. Below is a representation of shoreline allocation polygons overlain with permit location.

This interface provides a set of tools for the users of the Shoreline Management database, without the need for an individual license of a high-end GIS software package. Any user now has the option to launch a map display without assistance from the GIS Coordinator at the Project Office.

The Future of Shoreline Management

Phase 2 of this implementation plan to upgrade the entire geographic and corporate information system into a Web environment. ArcIMS will be used as the engine that generates the maps and coordinates the business information through a number of .NET applications. Applicants would then be able view the desired location of the permit, in relation to shoreline allocation zones or other currently permitted facilities, prior to applying for a permitted structure. Educating the public creates informed customers for the USACE. These customers guide the success of the Shoreline Management Plan by promoting safe and healthful public use. Management must continue to strive to sustain quality natural resources for both present and future generations while accommodating general public access to all project lands and waters with the assistance of a GIS.

Conclusions

Management of all public lands, throughout Mobile District, is necessary to provide an opportunity for optimum recreational experiences for the maximum number of people, while at the same time assuring compatibility among permitted private uses, general public use, and protection of project resources. Objectives of the plan are to achieve a balance between public use and permitted private use, while assuring long term resource protection for the enjoyment of project benefits by all.

The GIS-enabled Shoreline Management application is a prime example of how a GIS can be used as a powerful tool in spatial data analysis, and aid in the organization and preservation of institutional knowledge. More than just a simple data viewer, this decision support GIS

empowers all users to analyze numerous datasets in coordination with standard requirements of the shoreline permitting process and make well-informed decisions on future management practices. The GIS is designed as an archive system, ready to store and retrieve an array of information from varying years and a variety of spatial and non-spatial data types. The infrastructure for the data repository has been centralized; therefore allowing users from across the district to query and view permitted structures information, regardless of geographic location. This network of information promotes the sharing and distribution of data, while advocating prompt data maintenance and database upgrades.

The shoreline management application requires the capability for stakeholders in management positions to explore the broad spatial and temporal impacts of potential directive actions. Enabling park rangers or project managers direct access to all spatial datasets, allows each stakeholder to make educated decisions regarding the rules and regulations of the shoreline management plan.

Acknowledgements

References

Engineering Regulation (ER) 1130-2-406 of the US Army Corps of Engineers, *Project Operation - Shoreline Management at Civil Works Projects*. October 31, 1990, as per change 1 dated September 14, 1992, and change 2 dated May 28, 1999

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