

Decision Support System for Oil Spill Financial Responsibility

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Abstract

Understanding the condition of our nation's water resources, identifying what causes problems, and determining how to solve these problems are essential but difficult undertakings. These undertakings can be simplified with the use of Geographic Information Systems as a decision support system.

While working for the Minerals Management Service (MMS) of the United States Department of the Interior, an assignment was handed down to determine the feasibility of creating a decision support system that would allow minimally trained government workers to not only locate/plot the location of an offshore oil facility, but to determine if an offshore facility is covered by Oil Spill Financial Responsibility (OSFR) regulations. If it was determined to be feasible to create such a tool after analysis, the next step was to create such a tool using Environmental Systems Research Institute's (ESRI) ArcView software. Digital Raster Graphics (DRG's) and a GIS were used as a decision support system tool to determine whether offshore oil facilities were required to have a Certificate of Financial Responsibility (COFR) in the United States Gulf of Mexico coastal waters.

Introduction

Our waters are one of our most valuable resources. They support animal, human, and plant life and the natural environment, promote economic opportunity, and provide beauty and enjoyment to all. Because water is such a precious resource in a limited supply and is vital for all life to survive, water management is a huge issue and is strongly influenced by the decisions made from the city all the way up to the federal government level. Inevitably, traditional methods of water

management are changing in response to an evolving economic, political, and ecological environment. Offshore water management attempts to maintain the integrity of natural systems while continuing to provide for multiple uses, including oil production (Jensen et al. 1996). In order to achieve this goal, future oil production must be integrated into existing offshore habitats in ways that minimize detrimental impacts on other offshore uses and natural processes.

Federal Outer Continental Shelf (OCS) leases exist off all coasts in the United States. Of all leases in existence, 83 percent were in the Gulf of Mexico. As of 1997, about one-eighth of the Nation's domestic oil production comes from Federal waters. Because of the long lead times involved from leasing to exploration to production, it is essential that sound leasing policies exist (MMS Handbook, 1987).

There are approximately 18,000 oil discharges that are reported in a year. Most of these are minor, but each spill has a drastic effect on the environment. Recognition of these detrimental impacts to the environment led to the passing of the Oil Pollution Act (OPA) of 1990. OPA streamlined and strengthened the Environmental Protection Agency's (EPA) ability to prevent and respond to catastrophic oil spills. A trust fund financed by a tax on oil is available to clean up spills when the responsible party is incapable or unwilling to do so. Since the passage of the OPA in the United States, the number of oil spills has dramatically decreased because of the prevention, preparedness and response activities utilized by the U.S. EPA Oil Program in the United States. Modern conveniences, it seems, come paved with environmental messes, such as the oil spilled from the Exxon Valdez (May, 1997). We have not had a spill of the Exxon Valdez magnitude in Alaska in 1989 (coastal or marine) since then, but we have had smaller inland or freshwater spills. These are closer to populated areas and drinking water sources.

The beauty of GIS is that it does not discriminate against any fields of work or any level of expertise. GIS can be designed to solve complex problems, or it can be designed to make simple

tasks even easier. Through the use of visuals and maps, decisions can be made without hesitation and with the utmost confidence.

This assignment for the MMS was to be designed for novice GIS users with little experience using ArcView software. So before this tool was to be built, one stipulation had to be met. The decision support system would have to allow government users to easily locate particular locations in the Gulf of Mexico Region (GOMR). The assignment was broken into four different parts:

1. Through the analysis of available software and databases, determine the feasibility of creating a decision support system for determining location of offshore facilities.
2. If a system can be designed for easy use, design the system using ArcView software.
3. Once created, test the system and analyze its effectiveness.
4. Train government users how to use the system.

Several software packages and other databases were analyzed. After analysis of the most popular Current Off the Shelf (COF) products, it was determined that the Geographic Names Information System (GNIS) database was the most robust option and would be a great addition to the decision support system. The GNIS database was developed by the United States Geological Survey (USGS) in cooperation with the United States Board on Geographic Names which contains the federally recognized geographic names for all places, features, and areas in the United States that are identified by a proper name.

Each feature is located by state, county, and geographic coordinates and is referenced to the appropriate 1:24,000 or 1:63,360 scale USGS topographic map. This database will allow for easy identification of locations that are on the landward side of the 3-mile federal/state line. The 3-mile federal/state line is an imaginary line that separates jurisdiction from federal to state government. OSFR regulations are not limited to only federal waters, so the database will allow easy reference to state waters. Facilities that are on the federal side of the 3-mile line have different regulations than those on the state side. This is due to the fact that the cost of clean up after an oil spill rises exponentially as you travel a greater distance from shore. Table 1 displays the difference in required levels of insurance coverage between state and federal facilities

Table 1. Levels of insurance coverage for state and federal facilities

	State	Federal
3-Mile Line	Landward	Seaward
Min. Coverage	\$10,000,000	\$33,000,000
Max. Coverage	\$150,000,000	\$150,000,000

The purpose of OSFR regulations is to ensure that a person who is responsible for an offshore facility can demonstrate the ability to pay for cleanup and damages resulting from an oil spill. Oil spills have a dramatic effect on the environment, probably in more ways than we will ever understand. Walker and Steffen (1997) point out that global changes, such as biodiversity loss, land use/land cover change, hydrological modification, and the alteration of global biogeochemical cycles will interact with climate change to alter ecosystems in complex ways across a broad range of scales. What OSFR does is ensure that

cleanup will take place, hopefully before too much environmental damage takes place. To demonstrate the ability to pay for clean-up after an oil spill, a facility must obtain a COFR. Only certain facilities must obtain a COFR. The regulations state that a facility is any structure and its components, equipment, or device used for exploring for, drilling for, or producing oil or for transporting oil from such facilities. The facility must also be located seaward of the coastline, or in any portion of a bay that is connected to the sea, either directly or through one or more bays. The final requirement is that the facility must have a worst case oil spill discharge potential of more than 1,000 barrels of oil, or a lesser volume if the risk justifies the requirement to demonstrate OSFR (MMS Handbook, 1987).

The decision support system would allow scientists to determine where insurance coverage is needed, and how much coverage is needed per facility. It also would allow scientists to notify future explorers of the requirements for their planned facilities. Using this decision support tool will allow the MMS to keep accurate, up to date records for all regions in the U.S., and provide a visual tool for easy use. The purpose of this tool is to provide visible results that can be accessed by any scientist within the MMS organization (Coats, 1998). Current methods within the MMS involve using hard-copy maps pinned to tag board, and using rulers to determine where the estimated location of a facility might be.

Methods

Data Collection

Data sources were obtained from the

USGS. The data obtained provided the MMS with an accurate background using the USGS DRG's of 1:100,000 topographic maps, and the Geographic Names Information System (GNIS) to provide a comprehensive name database. The USGS DRG's were in a BMP image format, which is compatible with ArcView. The GNIS data set was retrieved from the USGS Anonymous FTP site. The native coordinates in the database were stored in degrees, minutes, seconds. Other shape files were property of the MMS, including a coastline, the Gulf of Mexico including all bays, and the 3-mile federal/state line.

Data Creation

Once the GNIS data set was downloaded, a C++ program was written to read the flat ASCII GNIS file to produce an ARC/INFO file of the GNIS point coverage. The ARC/INFO GENERATE command was used to create the coverage, which was built in decimal degrees, double precision. The GNIS coverage was then 'cropped' to

include only the Gulf of Mexico Region using the CLIP command in ARC/INFO. The ArcView shapefile was then created using the ARCSHAPE command.

A cell grid shape file was created within ArcView that corresponded to the locations of the DRG's. The purpose of the Cell Grid shapefile was to represent the areas that were covered by the USGS DRG topographic maps. Planning for future use of this tool, an Avenue program was written within ArcView that would output a shapefile, based on the coordinates and how many break points a user entered. The resulting grid could be overlaid on a standard U.S. states coverage to display where there were USGS DRG's. A COFR (3-mile) line was also developed by the MMS to determine how much insurance coverage would be needed. The 3-mile line was developed in ARC/INFO and exported into a shapefile to be used with ArcView. This collection of data would be sufficient to allow the creation of a user-friendly system.

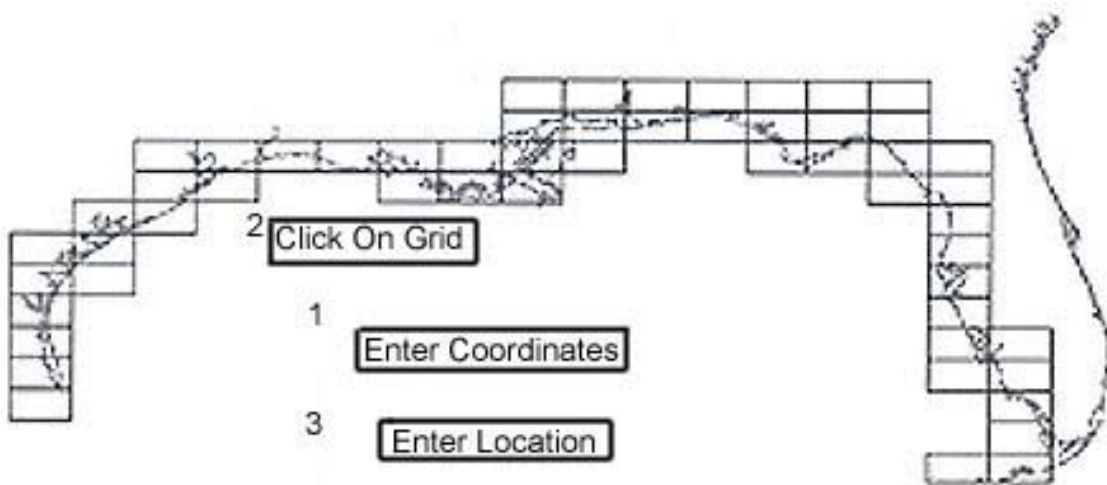


Figure 1. Methods for zooming to a facility including entering coordinates, entering a location, or clicking on a grid.

Results

For the whole project to even be considered by MMS authorities, proof had to be shown that a system could be built which would allow a government user with little training to determine where a facility was located and whether that facility would need to obtain a COFR. The MMS had adopted ArcView as the main software packages that scientists would use for mapping, so all facets of the project had to be compatible with ArcView.

After analyzing several different software packages which allowed for easy name recognition and had to be geographically referenced, it was determined that the GNIS was by far the most comprehensive and would be easy to integrate into the project. Once the point coverage was created, code was written to allow the user to type a name of any location; a list would then appear of all matching names. The user would then select one of the names and the program would zoom to the marked location and display the surrounding area. This was the first method to find a location (Figure 1).

The second method was the most interactive, allowing the user to click on a cell in the grid shapefile. The display would then zoom to the corresponding DRG. Once the user visually located the facility using ArcView's coordinate display, a tool was created to allow a user to mark the facility location (Figure 1).

The final and most accurate method of zooming to a location was to allow the user to enter a longitude/latitude coordinate pair and a radius in miles. The program would mark the location of the existing or planned facility and would zoom to the

radius that was entered (Figure 1). No matter which method was used to determine the location of a facility, the final product would always be the same (Figure 2). The background would be the DRG image, the facility would be marked with a ●, the 3-mile line would be displayed, and of course the coastline and Gulf of Mexico would be shown. The final theme that was displayed and labeled was any GNIS features that were in the area. Figure 2 displays three possible locations of an oil facility.

Testing the Project

Upon completion of this phase of the project, it was tested and analyzed for ease of use. Three different government users, all of different ranging GIS capabilities, were selected and briefly shown how to use the program. Once the users were briefed, they were asked to plot the locations of three different facilities, using each method once. The three scientists were able to plot each location and had only minor suggestions. It was determined that the GNIS method of zooming to an area was too broad of a query and could sometimes last up to 60 seconds. A user would type in the name of a location and would often get over 100 location names in return to choose from. After analyzing the GNIS query, a user-friendly method was created that would allow for a more precise search of the GNIS database. The data from the USGS also included a type of location for each record. These locations ranged from cities, towns, airports, bays, schools, etc. The new method would allow the user to select a type of location and then type in a location name. This narrowed the return results to ten different choices

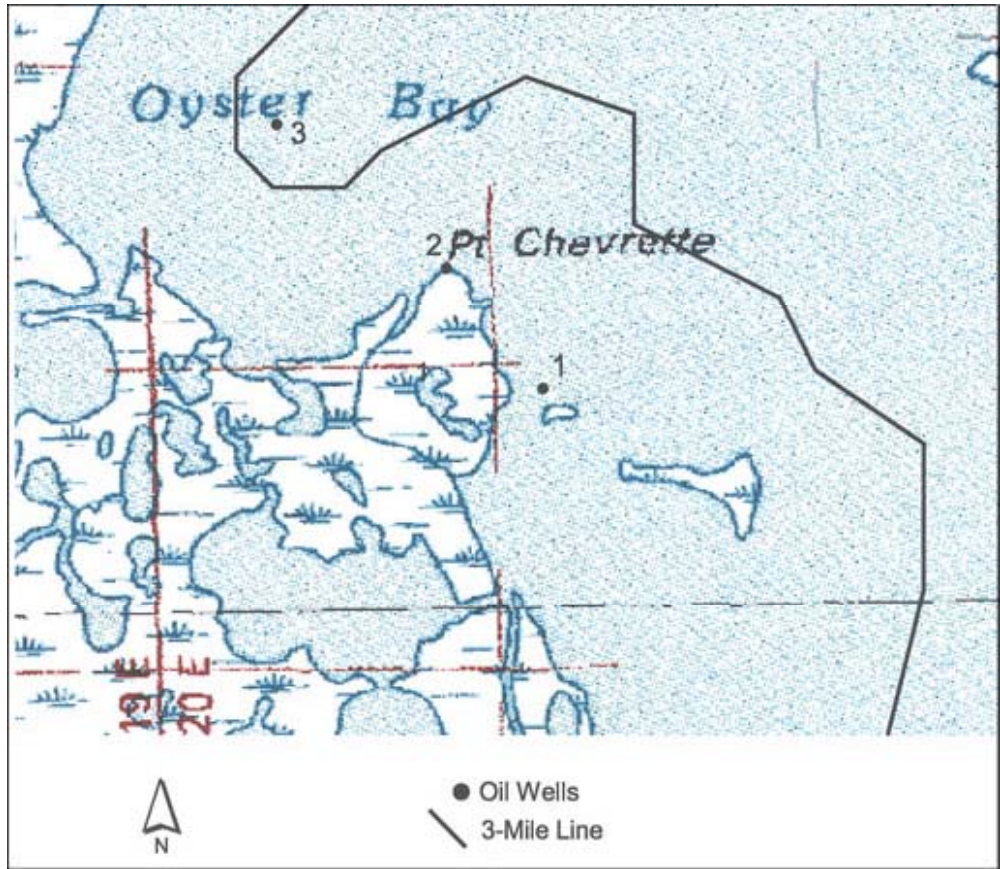


Figure 2. Final product displaying facility, DRG, 3-mile line, Gulf Coast, and GNIS features.

at the most. Once the study was completed it was determined that the project was easy to learn, and greatly improved upon the existing methods of plotting facility locations, and more importantly, was extremely accurate.

Discussion

With GIS technology and the software industry growing at an exponential rate, the easy tasks are sometimes left behind. But with the limited time and the high cost of personnel, making the easy tasks easier can save a potentially large amount of both time and money. And with a good decision support system, tasks can be completed with 100% confidence and accuracy.

Working in a government agency makes one realize the potential for saved dollars and time, at the same time increasing efficiency and accuracy. Most users will support an efficient and user-friendly system. More decision support systems need to be put into place. A good system will allow a wide group of users to come to the same conclusion, and there will be no dispute about the results. Decision support systems could be utilized through every level of government, not to mention corporate America and the whole world for that matter.

With the rising cost of fossil fuels, there will no doubt be a greater demand for more production. This in turn means that more oil facilities will be built, with the chance of oil spills

increasing dramatically. The most important problem facing our species in the next century is how to reconcile our insatiable drive for development with the limited resources of our planet (O'Neil et al. 1998).

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