

Use of GIS Technologies for Environmental Litigation in Coastal Louisiana

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ABSTRACT

Coastal Environments, Inc. employed numerous aspects of GIS technology for a field investigation to be utilized in a multi-million dollar litigation. GIS was used to specifically document historic and present field conditions on an 18,000-acre property traditionally used for petroleum production. ArcMap was used to create a field atlas and examine historic images of the property to establish baseline conditions. ArcPad was then used to navigate to selected field locations and collect sample data. A management plan was subsequently created using ArcMap. This paper will discuss the use of GIS technologies in litigation of historic petroleum lands in coastal Louisiana.

INTRODUCTION

The past decade has seen rapid advances in the availability, application, and functionality of GIS, GPS, and remote sensing technologies. This increase in geographic-based sciences, data collection, and management resources, coupled with an ever-expanding environmental awareness by the general public, has resulted in a unique synthesis of these two fields. Due to the size and scope of many environmental issues, the use of a GIS in planning, sampling, processing, and in subsequent litigation has become a popular alternative to more traditional forensic practices.

Coastal Louisiana, with its heavy concentration of oil and gas industry is no stranger to this trend, and has seen a substantial rise in the number of damage claims by landowners whose property has been adversely impacted by oil and gas production and exploration. These properties are not typically damaged by a single catastrophic event, which garners much media and political attention. The adverse environmental conditions on these properties can be directly attributed to years of negligent oil and gas exploration and production activities.

One such site, located in Cameron Parish, Louisiana (Figure 1), has seen more than 18,000 acres of natural freshwater and brackish marshes degrade over the past 70 years into an environment with considerable hazards, both to its indigenous flora and fauna and most importantly, its human population. This site has been home to various oil and gas production since its mineral rights were originally leased in 1928. Through time this area has seen a number of owners as well as multiple petroleum operators. The current owner purchased the land in 1996 for personal recreation as well as mineral royalties, and later discovered the extent of damage as a result of severe neglect by the petroleum operators working on it for the past 70 years.

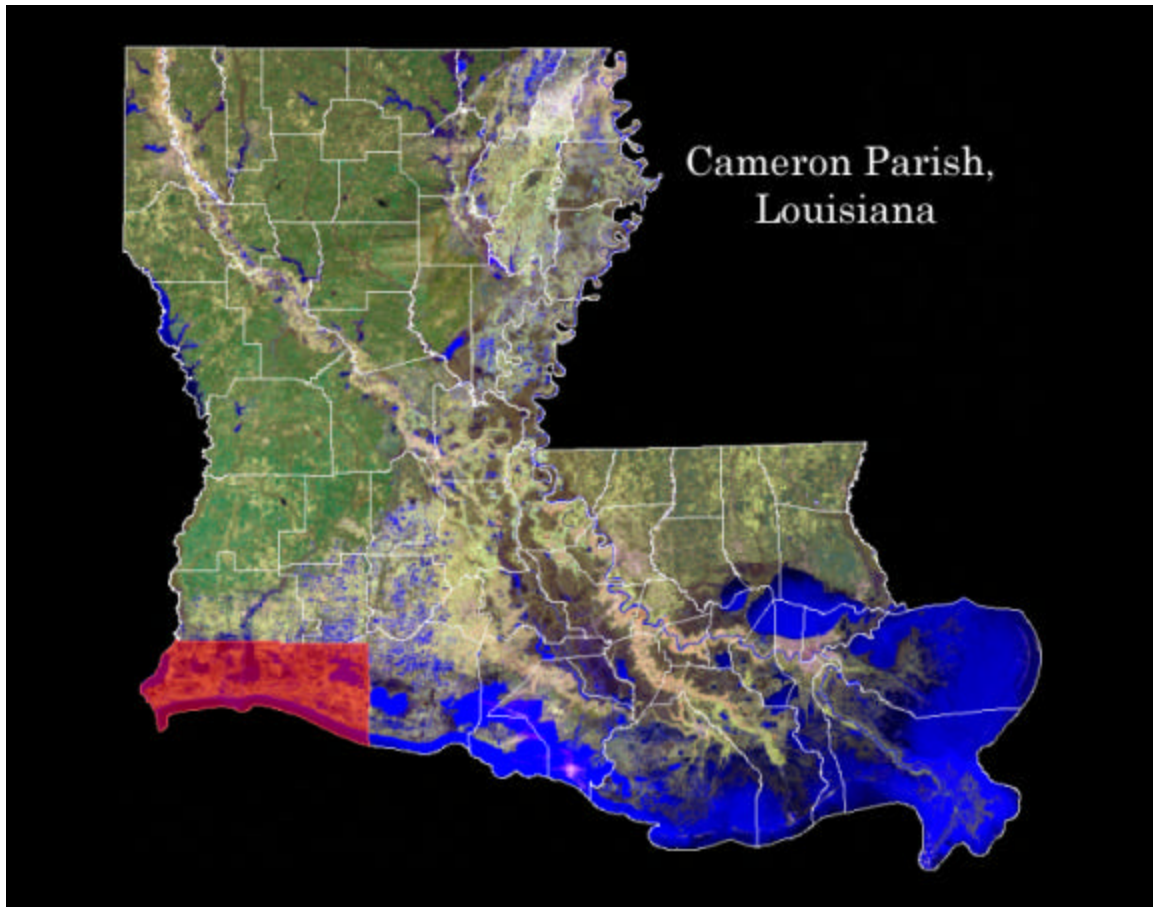


Figure 1. 2002 TM Satellite Image of Louisiana with Cameron Parish highlighted in southwest corner.

Coastal Environments, Inc. was hired to assess environmental damage, estimate remediation, restoration, and monitoring costs, and help recover costs from those entities responsible. With such a large undertaking CEI determined that GIS, GPS, and remote sensing technologies could be used to aid in field navigation, sampling, mapping, data processing, and litigation support.

Initial field studies indicated three main areas of concern; debris (physical hazards), chemical contamination, and land loss. Each of these situations had to be assessed

separately. Initial sampling of impact sites indicated elevated levels of heavy metals including; lead, selenium, zinc, barium; benzene; and chlorides from brines associated with production and exploration activities. Repeated dredging and expansion of a complex canal system has led to vegetative loss and soil erosion. Debris included abandoned wells and storage sites, abandoned pipelines, and abandoned equipment. Abandoned pipelines were of particular interest because of the difficulty associated with removal.

With multiple owners and operators throughout the history of the site, and poor record – keeping practices, it was a challenge to allocate liability. A combination of determining well ownership history and costs associated with remediation and restoration has resulted in the naming of approximately twenty responsible parties in a multi-million dollar lawsuit. The following paper will discuss how Coastal Environments, Inc. has utilized GIS, GPS, and remote sensing technologies to support the litigation process involved in addressing environmental damages to this property.

SAMPLE COLLECTION AND PROCESSING

Atlas:

To assist the field crews in the location of the different areas of interest, and give them a general layout of the study area, a field atlas was created. The background image of the atlas was made up of 1998 digital orthophoto quarter quadrangles obtained from the USGS. Figure 2 shows the overview index map of the study area. This map was broken down into 20 smaller scale maps. Each of these individual maps displayed detailed information about the oil wells in that area and the boundaries of the property. Both well type and the date range of well completion were used to classify the oil well data. Each well type was assigned a unique symbol and each date range was assigned a unique color. Thus field crews could tell at a glance the approximate age and last known status of individual wells. Each detail map also displayed information about the township, sections, and ranges in which the wells were located.

ArcPad:

There were two major deployments into the field. The first was to visit each of the oil wells and collect general data such as salinity and soil core samples, as well as determine the general condition of the site. This included a vegetative investigation, debris and pipeline analysis, and surface water assessment (i.e. was there a sheen from the presence of oil attributed to leaking drums, wellheads, containment units, etc.).

A second deployment was used to take more detailed samples at some of the heavily impacted areas, as well as control samples from areas within the property boundaries, believed not to have been impacted by oil and gas activities. Soil, water, and biological (fish & crabs) samples were sent to an independent laboratory for analysis.



Figure 2: Overview map of the study area and detail map used in field atlas.

Each of the 265 oil wells on the property was visited. To facilitate navigation and to create digital field notes, an ArcPad project was created. The ArcPad project contained a wells shapefile for navigation, a sampling shapefile for data collection, and aerial photos for background images. Navigating in the marsh can be difficult even with the use of a conventional GPS, but using a Compaq Ipaq Pocket PC along with ArcPad software made this job much easier. A Trimble ProXR differential GPS receiver was used in the field to navigate to each of the wells, sample locations, and various brine pits.

When a well was found, a point was collected as close to the site as possible. An ArcPad data input form was created to record relevant information about each site. A sample of the form can be seen in Figure 3. This process was conducted on each of the two field deployments. After the field activities were completed, the data was imported into ArcMap for analysis and mapping, and the field notes were archived.

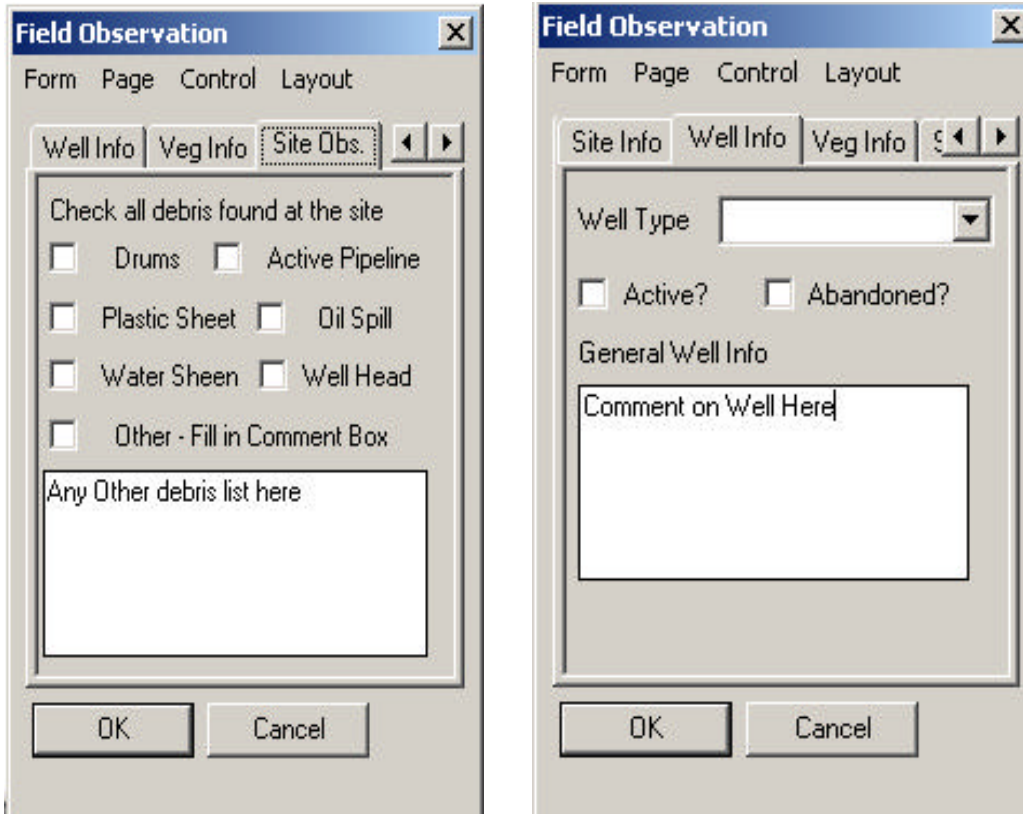


Figure 3: ArcPad forms used in the field data collection.

MAPPING

Historic Images:

In order to demonstrate that the marsh had been damaged by oil and gas activity over the last 70 years, CEI compiled a comprehensive set of historic and modern images of the study area. Historic images from the 1930's to 1998 were used in conjunction with an oil and gas well database to quantify marsh damage and to determine the responsible party. Figure 4 shows one of the ways the historic images were used to compare areas that were impacted by oil and gas activity within the study area.

Digitize 1998 Open Water

Coastal Environments determined that knowing the total area of open water in the study area was important in determining the cost of the remediation. This was done using the 1998 USGS digital orthophoto quarter quadrangles.

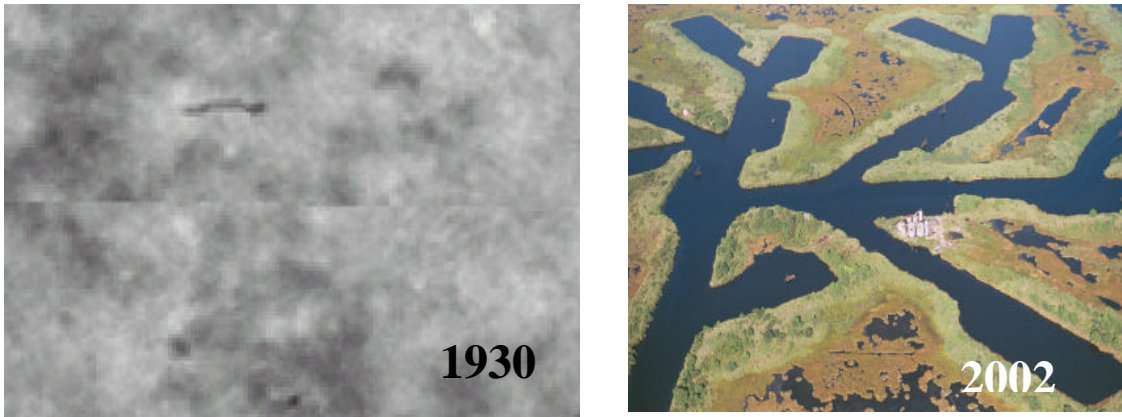


Figure 4. Historic and modern images of the study area show solid marsh in the 1930's as compared to the open water, canals, and slips presently intersecting the site.

All digitizing was completed at a scale of 1:12000 in ArcMap. The outline of the open water was traced using polylines. The polylines were then cleaned and built into a polygon coverage using ArcInfo workstation. This coverage was added to ArcMap and total acres of open water were calculated for each. This process was repeated for each year of historic imagery obtained for the property. Using this process CEI determined that over 20% of the 18,611 acres of the study area was open water, compared to 0.5% open water in 1930.

Study Zone Map

The main goal of the site investigation was to identify the adversely impacted marsh and return it to a more natural condition. The study area is over 18,600 acres, much too large to look at as a single unit. The study area was broken down into 17 units based on the hydrology of the property. This would allow for remediation estimates to be made on a unit-by-unit basis. These units can be seen in Figure 5 below.

Estimate Pipeline Lengths

Another major issue on the property was the miles of abandoned pipeline that traverse the property. In the marshes of southern Louisiana these pipes have a limited lifetime before they need to be replaced. During the site investigation, CEI discovered that many of the oil and gas operators installed new pipe on top of the abandoned lines without removing the deteriorated line. Marsh subsidence, environmental changes over time, and poor pipeline mapping made it difficult for field crews to determine where all of the pipelines were located. Every well, that had ever been active, had at least one pipeline associated with it. To estimate the amount of abandoned pipeline that had to be removed, the production facility associated with the wells pipelines was determined. ArcMap was then used to calculate the straight-line distance from the well to the production facility. The straight-line distance did not take into account the bends in the pipelines that had to be taken to follow the edges of the canals or to avoid known obstacles the pipeline would encounter.

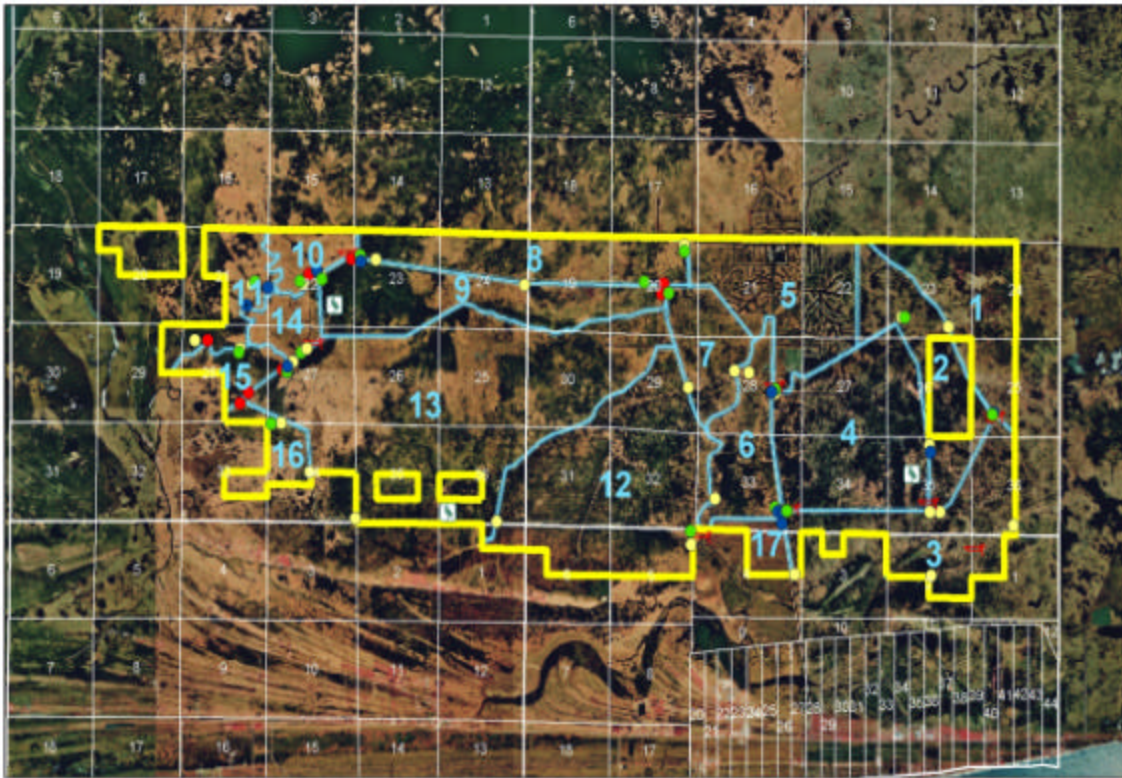


Figure 5. Study unit map based on hydrology of the property.

Based on expert advice CEI estimated that a pipeline in a marsh would have to be replaced approximately every 10 years. The total length of abandoned pipeline was calculated by multiplying the length of pipeline from well to production facility by the number of years the well was active, divided by ten. Final calculations estimated approximately 536,000 feet or 100 miles of potentially abandoned pipeline in the project area.

CONCLUSION

Upon completion of the fieldwork, CEI continued to use ArcMap to create figures and displays for presentation to the legal professionals involved in the case. There is also potential for further development and processing of data with 3D Analyst software. By interfacing ESRI products with soil and geologic profiling software, increasingly detailed figures and displays were created and continue to be created, to aid in the litigation proceedings. Final maps and diagrams were incorporated into digital presentations and used for presentation of the site conditions to the responsible parties.

Throughout the course of the fieldwork, it was discovered that with more initial planning, GIS could have been further integrated into data collection, data processing, and litigation support. Subsequent projects are benefiting from what was learned in Cameron Parish. Coastal Environments, Inc. is continuing to use GIS technologies in other lawsuits

throughout coastal Louisiana and to date is actively involved in approximately 15 to 20 similar projects. GIS and GPS technologies have proved extremely beneficial in these cases due to their ability to present data and issues for all parties involved. Providing spatial orientation to the data also helps to emphasize the seriousness of the situation, as well as the need for remediation and monitoring. This case is still pending and will be involved in court proceedings for sometime. The size and factors involved in this case will set a precedent for all future cases and proper land management by petroleum operators in coastal Louisiana.

AUTHOR INFORMATION

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