

Hancock County EOC Support: Mapping the Hardest-Hit County Post Katrina

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I. Introduction

NVision Solutions Inc. began volunteering in the Hancock County Emergency Operations Center Geographic Information Systems (GIS) Lab a week following Hurricane Katrina putting maps in the hands of local responders as well as federal and state agencies deployed to the area. The local officials led by Emergency Management Agency Director Brian Adam, used the maps to help transfer knowledge that could only be gleaned through years of firefighting, police work, and emergency management. As such, GIS served as a common thread in the coordination of Hancock County first responders with outside assistance. Months later, with the recovery process now well underway; Adam often asserts he cannot imagine having worked the disaster without GIS. Even the simplest of GIS solutions proved vital in the post-Katrina recovery effort.



Fig. 1: Hancock County Location and Katrina Landfall

A. Hancock County

Hancock County, located on the Mississippi Gulf Coast, is approximately 485 square miles in size and supported a pre-Katrina population of 46,902¹ people. The county encompasses two incorporated cities: Bay St. Louis and Waveland, and the

unincorporated areas of Diamondhead, Kiln and Pearlinton. The NASA Stennis Space Center and accompanying buffer zone make up about one-third of the county and is home to many high technology companies with a GIS or spatial focus. In spite of this proximal technology pocket, the county had yet to adopt a wide spread GIS program. A limited capability was in existence at the county tax assessor office with the chief appraiser partially dedicated to creating maps and analysis for the tax assessor, the building inspector's office and other county and city offices.

B. Ground Zero

On August 29th, 2005, Hurricane Katrina made landfall at the mouth of the Pearl River along the Mississippi-Louisiana border. This positioned Hancock County in the storm's perilous front-right quadrant sealing its fate as ground zero. Structures between the railroad tracks and the beach were predominantly obliterated. Even Mr. Adam, who has lived in Hancock County all his life and has served as EMA director for 5 years, sometimes lost his bearings in heavily damaged areas. Street routing and post disaster imagery became critical to any disaster relief worker finding their way.

II. Logistics

A. Map Requests

To ease the process of tracking and recording the influx of map requests at the EOC, the GIS Lab developed a form on which the customer could indicate the type of map needed, size, quantity, as well as their organization and justification. This enabled the lab to maximize accuracy in filling these requests as well as keep an archive of maps created and distributed. Users could choose the paper size to best display their map including letter, tabloid, ANSI C, D, or E. The lab further created ArcMap templates to be quickly applied to

¹ United States Bureau of the Census 2004 Update

any size map to include title, date created, a scale bar, and north arrow.

B. Maps2Go

The lab also preprinted commonly requested maps referred to as "Maps2Go" and posted numbered examples on the wall outside the office. A relief worker could quickly receive their desired maps and continue their disaster recovery function.

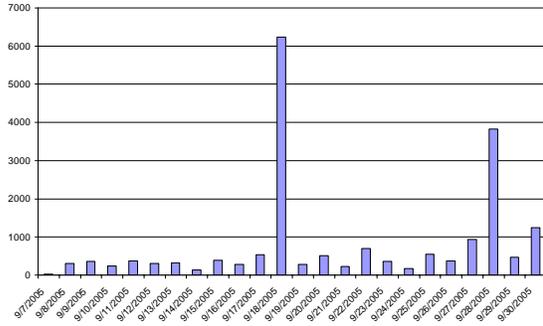


Table 1: Distributed maps for September 2005

C. Power

Following the storm, commercial power at the EOC was incapacitated for an entire month. As the entire EOC was running on a single generator, power failures were frequent, sometimes lasting as long as two hours. This was particularly problematic when printing large format maps on the plotter. The power outage would wipe the plotter memory preventing it from continuing the current job. Also, the computers would shutdown and unsaved work would be lost. Though uninterrupted power supplies (UPS) protected all hardware in the GIS Lab these devices were repeatedly destroyed by the rapid successions of power outages from attempts to bring the generator back online.

D. Internet Access

Commercial Internet was also unavailable forcing the GIS lab to work on military or FEMA satellite Internets that used DHCP. Internet would generally be interrupted each day between the hours of 2:00 and 3:00 pm due to satellite positions. Upon restoration, the entire DHCP connection required reconfiguration. This especially slowed the process of gathering data in the initial days following the storm.

E. Supply Lines

Following Hurricane Katrina, mail and parcel delivery was severely limited. This proved challenging when ordering supplies such as plotter paper, ink, and battery back ups. Runners frequently had to be dispatched 200 miles to Jackson, MS to retrieve these supplies as commercial carriers refused to deliver to the impact zone.

IV. Base Maps and Points of Interest

Paper was the only reliable medium during this time when the infrastructure was fragile and power outages frequent. Without an established GIS program, the county had few paper maps, of which some were destroyed in the storm. Thus the first task involved gathering any data sets to help characterize the area including streets, municipal boundaries, hydrography, critical facilities, parcels, building footprints, and aerial imagery. Armed with these layers, the lab could develop maps to orient the many agencies and individuals deployed to Hancock County with little familiarity of the area. This was especially important given the lack of street signs in the affected region.

A. Map Books

Map books or street atlases are crucial to any disaster relief effort. They allow the user to view map information intended for large scale mapping on small and manageable printouts. Non-local Law enforcement, fire fighters, and FEMA employees had to be able to locate any street in the county quickly day or night. Large format maps were hard to use in vehicles. Street atlases were especially useful on smaller rural routes. A street index could direct the user to the appropriate section of the indicated page where they could find the street they were seeking. An overview map of the entire county would indicate which page would show the area they needed. In addition, a latitude and longitude grid enabled the map to be used with GPS technology. Each East Hancock County Fire Fighter is now issued a map book for use in the field. Beyond simple street navigation customized mapbooks proved useful for specific tasks. Map books with EPA-identified hazmat locations such as hospitals and industrial sites helped health and hazmat teams search sensitive areas

for harmful materials such as chemicals or medical wastes. FEMA inspectors relied heavily on map books overlaid with parcel information for property damage inspections and FEMA trailer site inspections.

B. Facilities and Points of Interest

Hurricane Katrina severely devastated the infrastructure in Hancock County. For several days following the storm, emergency crews were only in communication by Ham radio. All three 911 towers were destroyed. Many common offices and services were relocated to temporary sites. Points of distribution and temporary medical facilities opened in parking lots while emergency housing sites were established. All of these new locations needed to be mapped so emergency personnel could dispatch to these locations with greater ease. County, Federal Emergency Management Agency (FEMA), and Mississippi Emergency Management Agency (MEMA) officials often provided GPS coordinates of these and other points of interest, which were plotted in the lab using the *Add XY Data...* tool in ArcGIS.

C. Street Data Update

Locating accurate and complete street data for Hancock County proved challenging following the storm. ESRI StreetMap USA data while useful in making smaller scale street maps were incomplete. Also, the data set is of a 1:100,000 scale and therefore unsuitable for large scale mapping especially when used with parcels and aerial imagery. After several weeks, the lab was able to obtain local data sets from Environmental Protection Agency (EPA) and Gulf Regional Planning Commission (GRPC). These data sets, however, were also incomplete as many rural roads were excluded from the geometry. Thus the GIS Lab took on the task of digitizing missing roads and updating others with the correct name to create a comprehensive street data set suitable for large scale mapping.

D. Streams, Waterways, and Bridges

Streams and bayous run through the whole of Hancock County. Lacking detailed local data, the GIS Lab used nationally collected hydrography data sets which generally exclude stream names. With the help of Mr. Adam, the lab attributed each known stream

and water body with the correct name and located isolated bridges. Showing these named streams, water bodies, and bridges on a map helped county officials to better locate their desired destinations in rural areas. The bridges dataset was later supplemented with a shapefile from the National Bridge Inventory provided by the U.S. Department of Transportation.

III. Raster Analysis

Raster data played several important roles at the EOC. They were used in the form of elevation, wind, and rainfall surfaces; as derived analyses in the form of flow direction mapping; while the large part of raster data holdings included a variety of pre and post Katrina imagery critical to visualizing the terrain for relief workers deployed to the disaster area.

A. Debris Mapping

The United States Army Corps of Engineers (USACE) provided GPS point locations of 15 major debris fields within Hancock County. While removal of these debris fields generally falls on the Corps, the county needed to clear each pile with a search and rescue team prior to clean up. The GIS Lab created maps of each debris area using 6-inch resolution orthogonal imagery taken on September 19th, 2005 to be used to plan search and rescue missions to each location.

B. Elevation

In planning for future events, determining the elevation of structures and roads is critical. In addition to readily available digital elevation models available from Mississippi Automated Resource Information System (MARIS), the GIS lab harvested pre-Katrina Light Detection and Ranging (LIDAR) data from the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center². The lab downloaded, converted, and mosaicked the data for use in county mapping. A recent application of these data included determining the elevations along the road outward from the current Hancock County EOC building to identify low points in the road where flooding may occur impeding the potential evacuation routes. Also,

² Topographic Change Mapping:
<http://www.csc.noaa.gov/crs/tcm/>

county officials often inquired to the elevation of specific buildings and site locations.

C. Hydrological Flow Vector Mapping

Hurricane Katrina claimed the lives of 56 people living in Hancock County. Although Search and Rescue (SAR) teams worked diligently to locate missing persons, some bodies were more difficult find due to the movement of water. The GIS Lab applied flow direction analyses to show the recession path of Katrina's floodwaters. Upon running the *Flow Direction* tool in ArcGIS Extension Spatial Analyst, the resultant grid values represent the direction of its most extreme downhill neighbor.³ Converting the grid to a shapefile using the *Raster to Polygon* tool enables the symbolization of the resulting polygons as arrows showing the appropriate direction of water flow. The lab coupled the directional surface with 6-inch resolution imagery to provide a realistic context to SAR teams. Because the flow vectors were produced countywide engineering teams later used them when rebuilding the culverts for the county drainage network.

IV. Building Zone Mapping

A. Zoning Maps

Months ago, Hancock County Zoning information existed exclusively as a set of tattered hard copy maps housed in building inspector office with no digital backup. The GIS Lab scanned each hardcopy in the effort to archive digital versions of the existing maps. The lab further digitized a comprehensive zoning data set using the original hard copies as well as the official legal descriptions as reference. Parcels, streets, and water bodies were combined with the zoning areas to create new maps. The new zoning data proved useful as representatives from the EPA were required to visit each commercial property within the county. The lab created a map series showing detailed maps of each commercially zoned area within the county as well as an overview map showing where each area of this zoning type was regionally located.

³ "Flow Direction" *ArcGIS Desktop Help*

B. Zoning Application

In addition to zoning maps, the Building Inspector Office required an approach to determine Advisory Base Flood Elevation (ABFE), flood zones, Board of Supervisor District, and elevation for each parcel within Hancock County. This information was difficult to quickly ascertain and required the use of several different maps. As a solution, the GIS Lab developed a MapObjects application that would allow the Building Inspector to either enter an address or parcel ID or click on a parcel to find the corresponding ABFEs, flood zone, board of supervisor district, as well as the elevation of the parcel centroid. This information was also used to create a map book for reference in the event of a power outage.

V. Tax Assessor Mapping

Following Hurricane Katrina, the Hancock County Tax Assessor's Office needed to reassess damaged properties. This required the addition of post-Katrina imagery to the official tax assessor maps. The GIS Lab added the USACE/3001 Inc.⁴ 1-foot resolution imagery flown during the month of September to each of the 177 tax assessor maps. The resultant maps were printed, laminated, and converted to pdf format for easy reprinting.

VI. Damage Assessment

The GIS Lab facilitated damage assessment mapping for a representative with FEMA. The project encompassed rapid assessment data collected by FEMA, MEMA, and the Hancock County Building Inspector's Office. The county rapid assessment was record on hardcopy data sheets and digitized into database form in the GIS Lab. All three data sets were combined into a single shapefile and mapped by joining tabular data to the corresponding property by parcel ID. Further, as FEMA was specifically interested in damaged primary residences, the GIS Lab limited the assessment to damaged homes qualifying for the homestead exemption. The lab further calculated the number of structures within Hancock County and the incorporated cities of Bay St. Louis and Waveland as well as structures in and

⁴ US Army Corps of Engineers (USACE) Photography flown by 3001 Inc.

outside the FEMA Special Flood Hazard Area (flood zone). To protect resident privacy in mapping the information yet retain the ability to widely distribute the maps, a parcel centroid was generated running the *Feature to Point* tool on the parcels at which point the points were converted to a surface using *Inverse Distance Weighted...* interpolation.

VII. Site Selection for New EOC

The Hancock County Emergency Operations Center (EOC) was relocated due to flooding following the storm. Funding is currently sought to secure resource for a county campus to include the new EOC facility. As the county government deliberates potential locations, Mr. Adam requested maps to help determine optimal locations for relocation while ruling out low-lying areas. This process involves viewing parcel ownership information to locate public land, determining the elevation of these areas and whether they are in the Special Flood Hazard Area, further determining if they either flooded during Katrina or were close to an area that flooded, and determining if the Sea, Lake and Overland Surges from Hurricanes (SLOSH) model indicates potential flooding for a potential storm of any severity. Figure 2 shows a parcel under consideration that resides almost entirely in the 100-year flood zone (Zone A).



Fig. 2: EOC Site Selection

VIII. Business and Infrastructure Mapping

In the effort to inform the public of businesses reopening, the GIS Lab acquired business records registered on the *Coast Back to Business*⁵ web site and mirrored

them on the Hancock County EOC web site. The interactive database interface included a "View Business on Map" link that passed the business address to an ArcIMS Geocoding Service and displayed the location on a map. The lab also incorporated donated InfoUSA data, a nationwide directory of businesses classified by the North American Industry Classification System (NAICS), for the Mississippi Gulf Coast. This data was useful in locating crucial infrastructure such as fueling stations and grocery stores. However, as the data was created through address matching, the accuracy required editing to move business to the correct parcel.

IX. Online Mapping

The GIS Lab assisted in developing a web site for the Hancock County EOC where residents could seek emergency-related information. The GIS Lab included on the site frequently used maps in interactive form served using ArcIMS and ArcMap Server. Users could access street maps, topographic mapping for entire county, digital elevation modeling with contours, FEMA flood zones, fire susceptibility, Katrina inundation and high water marks, and an address matching service allowing officials and citizens alike to determine Advisory Base Flood Elevations (ABFEs).

X. Volunteer Assistance

A steady stream of volunteers moved through the EOC. Many of them needed to orient themselves to the area with the street maps and map books provided by the GIS Lab. Among other notable volunteer groups, Americorps National Civilian Community Corps (NCCC), helped coordinate the volunteer effort in Hancock County. Their responsibilities entailed traveling the county to determine need and coordinate work locations. With their help, the GIS Lab created a comprehensive data set of faith-based and disaster relief organizations address matching and imagery verification. We further incorporated these locations into ArcGIS Extension Network Analyst to create routes and driving directions the volunteers could use to organize their visits. Incorporating Network Analyst barriers prevented these routes from incorporating

⁵ Coast Back to Business: <http://mscoastbiz.com/>

impeded bridges and roadways. (See Fig. 3)



Fig. 3 Volunteer Routing in Network Analyst

XI. Hurricane Season 2006

The GIS lab was tasked to create new and updated products in preparation for the 2006 season.

A. South Mississippi Hurricane Preparedness and Evacuation Brochure

NVision Solutions Inc. designed a hurricane preparedness and evacuation brochure.

This vital public education tool was coordinated jointly by the southern six counties in Mississippi. The brochure includes regional and state evacuation route maps, potential storm surge zones as well as pertinent information to help citizens prepare for hurricanes and tropical storms. Over 300,000 brochures were distributed to the residents of South Mississippi to help prepare the region for the 2006 hurricane season.

B. Hancock County Hurricane Preparation

In emergency planning at the EMA level, Mr. Adam requested maps detailing county hurricane preparedness information such as the location of the American Red Cross approved shelter, primary and secondary evacuation routes, and intended locations of points of distribution (POD) where residents can seek ice, hot meals, and other resources following storms affecting the area. Citizen evacuation pick up locations are a new feature this season. The GIS Lab coordinated with Mr. Adam and the city fire chiefs to evenly space bus stops throughout populated areas using buffer/proximity analysis. These maps will be used as justification to the Hancock County Board of Supervisors that at least one bus stop would

be accessible to all residents within the county.

XII. Lessons Learned

A. Flat and Database File Standard Operating Procedure

- Concern: GIS Lab employees constantly saved new map documents and created data sets. In the fast paced environment, employees often saved files or data in places where it would be difficult for others to locate as well as duplicated maps they had difficulty finding.
- Solution: A standard operating procedure will be written detailing the organization of data and map documents to include:
 - A procedure for organizing data in a file server environment as well as ArcSDE.
 - All ArcMap document file names will have a descriptive title and the in the file name.
 - Files will be saved in a central place and recorded in a common log to be quickly reference and avoid duplication of effort.

B. ArcSDE

- Concern: ArcSDE crashed due to a compression error on the server and data sets exclusive to the database were lost.
- Solution: ArcSDE will be backed up to ensure all data are readily available to be reloaded into the database.

C. Maps on Hand

- Concern: The County had few maps on hand to aid in disaster response.
- Solution: Street maps and map books are stockpiled and ready for the next event. Without the added responsibility to secure maps, which can be time consuming to print, first responders can save precious time during the initial hours and days of a response.

D. Power and Internet Usage

- Concern: Power and internet outages interrupted work and hampered abilities to distribute maps in a timely manner.
- Solution: Heavy duty battery backups larger than required for a normal office desktop were connected to the equipment with priority to the printers. This would see the lab through the outage until generator power returned.

XIII. Conclusion

These lessons learned will enable NVision Solutions Inc. to fine-tune our emergency and hurricane GIS support approach streamlining techniques and minimizing the interval between customer request and delivery. The company will further continue to join in the effort to reduce the number of localities functioning without GIS support in Mississippi and other areas.