

Using ArcGIS “on-the-fly” for Coastal Disaster Response Following Hurricane Katrina

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Following Hurricane Katrina’s impact on the heavily petroleum-industrialized coastlines of Louisiana, Mississippi, and Alabama, the resources of the NOAA Office of Response and Restoration (OR&R) were quickly deployed to that region at the request of the US Coast Guard. OR&R is the primary federal agency that supplies technical and scientific support for oil spills to the US Coast Guard. A true unified command arose in Mobile, Alabama to deal with pollution response activities. This organization was uniquely successful because it held data management and presentation as a critical objective to ensure effective command, control, and status management of the situation. GIS played a pivotal role in that success. Multiple federal agencies (USEPA, USCG, NOAA) with different ways of managing information worked together to merge their information onto a single constantly updated map. This presentation will focus on lessons learned.

Hurricane Katrina made landfall as a Category 4 hurricane at 7 am on Monday, August 29th, 2005. Katrina was an unprecedented event in recent American history. With the extensive and dramatic media coverage, many people are only familiar with what the cameras were able to capture and the controversies raised by the federal response. Behind the scenes and beyond the politics, GIS played a pivotal role in the process of cleaning up the unhealthy mess left behind by the storm. Following Katrina’s impact on the heavily petroleum-industrialized coastlines of Louisiana, Mississippi, and Alabama, the resources of the NOAA Office of Response and Restoration (OR&R) were quickly deployed to that region at the request of the US Coast Guard. OR&R is the primary federal agency that supplies scientific and technical support for oil spills to the US Coast Guard. Given the impacts to the petroleum infrastructure in the region and the overall extent of damages, it quickly became apparent that more staff would be needed and the request was sent out for help from other parts of the country. Substantial resources were diverted to Baton Rouge, Louisiana to assist with oil and hazardous material spills in New Orleans and along the coast. This is where damages were the greatest, but not the only region affected by hazardous material debris left in the wake of the storm. In Mobile, Alabama, an Incident Command System (ICS) center was set up at the US Coast Guard Aviation Training Center (ATC). The primary Federal Agencies on scene were the US Coast Guard (USCG), the National Oceanic and Atmospheric Administration (NOAA), the US Environmental Protection Agency (EPA), the US Fish and Wildlife Service (USFWS), numerous federal contractors, and local agencies. Each agency had a somewhat different mission, but through the ICS Emergency Support Function 10 (ESF-10, Environmental) coordinated hazardous material cleanup response efforts from the Louisiana-Mississippi border east to the Florida Panhandle.

The quickly improvised ICS Command Center initially had no phones, no Internet service, no computer network, and no GIS support. It quickly became apparent that all of the above were going to be needed for the ICS to perform its mission effectively. This is when the Fish and Wildlife Research Institute became involved. On September 2nd, 2005, five days after the storm had hit, the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWC/FWRI) was requested by the NOAA Office of Response and Restoration (OR&R) to help provide IT/Information management support for the Katrina response. FWRI has a long standing program of GIS based oil spill response called the Florida Marine Spill Analysis System which essentially consists of a workstation computer, a laptop computer, a local area network, cables, and WI-FI router, a large format (42' wide) plotter, a mobile printer for standard size documents, highly customized GIS and data management software tools, and an eight passenger cargo van to transport it all anywhere in the state within 24 hours. Our skills and equipment were in need, so we packed up, made some last minute equipment purchases, and headed to Mobile. Two of the most helpful purchases were a handful of USB thumb drives and a four function color printer, a few other purchases not IT related, but needed were four 5-gallon jerry cans of gasoline, and a trailer-hitch mounted carrying rack.



The Response Vehicle

We departed Saint Petersburg early in the morning on September 4th. We had no map data for Alabama and Mississippi. I made this point to NOAA and they were able to FedEx three disks of Environmental Sensitivity Index (ESI) data. ESI is a national standard data set on the sensitivity of coastal environments and wildlife to spilled oil. Within the data set is detailed shoreline with a classification scheme of sensitivity to spilled oil (roughly 1 thru 10, based on substrate, geomorphology, wave energy and difficulty of cleanup), plus a relational spatial database of species present, their relative concentration, their activity based on season, and their threatened or endangered status. NOAA had flown several post storm survey missions and georeferenced imagery from these flights was available as was QuickBird™ and Ikonos imagery. We just had to get

it, somehow without an Internet connection. This would prove to be an issue throughout the first weeks of response. Imagery has large file sizes and even zipped, can be time consuming to download. Throughout the first hours of our drive to Mobile, I was able to connect to the Internet through a Wireless Wide Area Network (WWAN) connection, but maximum speeds were only 128 Kbps. Not bad for traveling at 60 miles per hour, but not good enough to pull down the kind of data we were being asked to provide. The Internet connection did keep the email streaming though and that was helpful in staying abreast of the evolving situation...namely, that the command center still did not have a connection and that we could not rely on that by any means. We stopped in Tallahassee to pick up the third member of our away team, a network administrator from headquarters. His help would prove invaluable later.

On the drive up, we were all troubled by the fact that we had no base map data for anywhere but Florida. Fortunately, we had the foresight to pack an ESRI Data and Maps CD/DVD set into the response cases. This ended up being our saving grace. We loaded 2.5 GB of data to one of the laptops to serve as our basemap data for all of the map making we expected to be doing. The StreetMap USA data and ArcMap project was a perfect place to start, given we had nothing else to choose from. This was truly response "on-the-fly".

We arrived on scene in Mobile the evening of September 4th, seven days after the storm hit. There were still no Internet connections available, wireless or otherwise. We were given a tour of the command center and a spot to set up our equipment. We unpacked the truck and began the setup. A local area network was assembled between four computers, the plotter, and the 4-in-1 color printer and each of the drives were mapped to each other so we could easily share data among the computers. The ESRI data and projects were copied to each machine so we could work independently and directory structures were agreed upon and built to manage the projects and other data coming in and going out. Once the equipment was set up, we left for the hotel where four of us were sharing one room. Everything else was sold out. The hotel had a wireless internet connection, so I took advantage of this and set up my Tablet computer to download imagery from NOAA's FTP site overnight while we slept. We were all asleep by midnight or so and were out the door back to the command center by 6:30 am. My computer was still downloading when we woke up, so I left it behind to finish its job. Problem was...no one told me that we weren't coming BACK to the hotel that night. A problem we dealt with later that day by sending someone back to pick it up.

The command center still didn't have an Internet connection, but we were able to hit the ground running by getting a briefing of the situation. The EPA was focusing on mapping and removing hazardous materials that could be found on the land and inspecting documented hazardous material facility locations for damages. The Coast Guard was dealing with vessels that were sunken or washed ashore, but were particularly concerned with vessels that were either leaking fuel or were threats in other ways, such as vessels that contained hazardous materials. Aerial surveys had already determined that there were hundreds littering the waterways from the Mississippi/Louisiana border East to Mobile Bay. There had been a few smaller oil spills reported as well. Another primary

responsibility of the Coast Guard was to evaluate shoreside petroleum facilities for damages.

Our first full day of work was focused on producing base maps for planning groups to work with and reference. The EPA contractors had a developed system for field data collection from other previous work. The system consisted of GPS enabled PDAs and data collection software deployed with groups across the coast. Each group would collect data via PDA and upload to a central server in the evenings, whereby another EPA contractor in the command center would download each daily record set for use in the center. This was a very effective system but for one small glitch. There were two companies under contract to the EPA to do this work and each used a different database, one named RAID and the other FAST. The data could not be merged when converted to GIS data, so thus had to be put on the maps as different data layers with different symbology. The databases collected similar information, but in different fields and at that point in the response, a field mapping utility had not been developed.

The primary objective of all of the groups in the command center was to keep track of all these activities and be able to report on a daily basis on progress and objectives for the following operational period. Maps and data management was crucial to these objectives and became a daily objective in itself, “Use effective data management practices to provide timely and accurate information for the response.”

The EPA contractors were well prepared to provide data suitable for conversion to GIS and placement on a wall sized map. Each record had an associated Latitude and Longitude in Decimal Degrees and was quite easy to convert. We were simply handed a USB thumb drive with the daily data on it as an Excel spreadsheet. This was not the first time that the infinite utility of USB drives had become clear. We had purchased four 1-GB drives prior to leaving just for this reason. We were on a Local Area Network and could share data easily and quickly between each of our computers, but every other computer in the room was a standalone. To share data, we would copy to the drives, get up out of our chairs and WALK over to who we needed to share with and hand them the drive. We nicknamed this “sneaker-net” and we did a LOT of walking for the two weeks we were deployed. NOAA Hazmat used Macs at the time and the cross platform USB drive was a great asset.

The Command Center (at right)

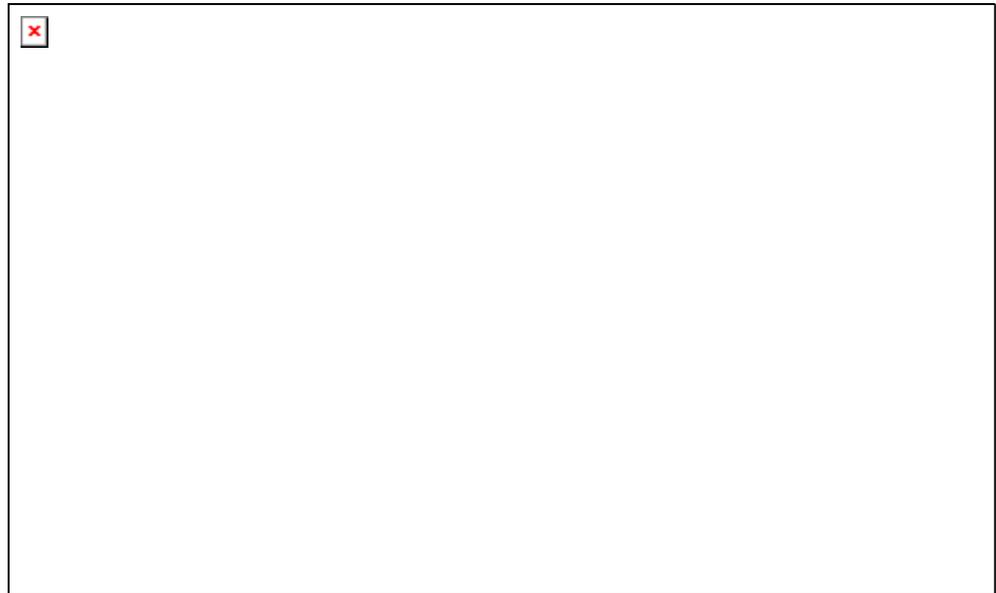
The Coast Guard was not quite as GIS-savvy. They had contracted with a local marine salvage company to assist in the field surveys of damaged vessels. A paper form was quickly drawn up to record specifics of each vessel,



including lat/long, which was recorded in Degrees, Minutes, and Seconds. Photocopies were made of each days surveys and sent back to the command center. In the beginning, there was no database. It became my job to create one so we could produce daily status maps. No one Coast Guard or NOAA person working in the command center was familiar with Access, so we opted for Excel. After several hours of data entry, we had our first database. With conversion from Degrees, Minutes, and Seconds to Decimal Degrees and conversion from Excel to DBF, we had our first shapefile of vessel surveys to put on the map. Each vessel was symbolized based on condition and wether or not it was actively leaking. This gave the command a useful “big-picture” product from which to brief the ICS and to make plans for operations in subsequent operational periods.

Several initial wall maps were produced, some for EPA data, some for administration zones, some with just Coast Guard and NOAA data, and some combined with all of the above. As is usually typical, at least in drills, we quickly became inundated with map requests and were having a tough time keeping up. Fifteen to sixteen hour days were typical until a Coast Guard Master Chief was assigned the additional duty of becoming our map “gate keeper”. All requests from then on had to go through him and were assigned a priority and a schedule.

A wall map depicting vessel surveys, damaged vessels, aerial survey data for oil spills and obstructions, and priority areas for response action. No logos were used on any maps we produced, there were already enough egos involved, plus if we didn't have all of them to use, then we weren't going to use any of them.



There was a constant pressure to “feed the beast”, meaning, produce products to provide updates to agencies and organizations outside of the immediate ICS. For these products we exported to Adobe PDF. On about the 6th day that we were there, the US Coast Guard Gulf Strike Team had successfully installed a T1 data connection and we were able to plug in the WI-FI router to throw a signal to everyone in the room and to our own machines. This was a glorious occasion in our opinion. I wish I had some champagne to celebrate, but at that point we really had to go to work. Numerous FTP sites had been set up to post data and maps and my (Richard) new job became porting much of what we had

done to these sites as PDFs. Our email connections had been restored through web mail and things were starting to feel more normal and settled into a routine.

With the new routine of producing daily wall maps and letter sized field maps settled in and reinforcements starting to roll in, we could focus on some other technologies to rapidly assess the changing situation and provide better information to outside staffers. One of these was a software package that works with a digital camera and a GPS to spatially reference pictures. This was deployed on a helicopter overflight and did help to locate a large above ground storage tank that had been swept into an extensive marshland. The grasses were so tall that no one would have been able to find it from the ground.

Other cool technology that evolved once we had an Internet connection was Google Earth and the KML dynamic link. NOAA had flown numerous swaths of overhead and oblique imagery that was spatially referenced but these files were much too large to download in the coverage that was needed in a typical GIS. NOAA provided the imagery to Google and it was housed on a server. A dynamically linked KML file was distributed for official government use only that allowed users to zoom into a location and if an image was available at that location, it would load dynamically. This proved useful in a few instances where data records came in with no lat/long reference, but could easily be seen in the imagery. It was also a nice tool for getting a better idea of how things looked ‘out there’.

We relied heavily on ArcGIS and the MapLogic extension for nearly all of our map production efforts though. We were forced to keep it simple, but by keeping it simple, we could get what we needed to get done in a reasonable time. I feel that many eyes were opened to the value of GIS in a difficult extensive situation like Katrina. Those of us who do this on a regular basis already know, a picture can be worth a thousand words, and a big picture even more.

As our time in Mobile began to run down, we were asked to get new people coming in up to speed on what we had put in place. The EPA had brought another contractor in to do GIS and NOAA had brokered a deal with the City of Mobile’s GIS department to assist the Coast Guard with damaged vessels GIS data management. The event had outgrown the small command offices, so mobile trailer office were brought in and set up with electricity and Internet connections and these groups moved in. Several high capacity external hard drives were purchased and we moved all that we had done, products, data, email strings, and all, were copied to these drives in preparation for the handoff. The new teams were briefed and set up and we began to look forward to going back to our lives and families. The City of Mobile’s talented staff were able to set up an Internet Map Service that allowed vessel owners to search for and locate their boats and the data base that we created continued to grow and evolve into a database that was used for managing the whole process of damaged vessel management. The response continued for many many months after Katrina struck and many talented, dedicated people have put a great deal of time and effort into making the process run as smoothly and efficiently as

possible. They should all be applauded for their efforts in this difficult job. We simply feel fortunate that we were able to help.

Some key lessons learned should be summarized here. Stay prepared, carry lots of data storage, bring an IT expert with you to iron out the network kinks, establish an Internet connection at the earliest possible time, bring lots of extra supplies (remember the stay prepared part), carry the ESRI Data and Maps set with you, hoard data because you never know when you are going to need it, work closely with the GIS professionals you may end up working with in a disaster response, those relationships can be very helpful (drills are good for this), stay on top of emerging technology, and finally, stay proficient with ArcGIS, getting things done quickly is what it's all about.