

GIS Challenges Exposed by FEMA Appeals Period

By:

Brandon T. Grimm
Grounds Anderson, LLC

Jacob P. Spenn, P.E., CFM
Harris County Flood Control District

John S. Grounds III, Ph.D., P.E., CFM, D. WRE
Grounds Anderson, LLC

Elle L. Anderson, P.E., CFM
Grounds Anderson, LLC

After Tropical Storm Allison ravaged Harris County, Texas in June of 2001, Federal disaster funds were used for a county-wide re-study resulting in the most technologically advanced Flood Insurance Study in United States history. Harris County, Texas encompasses over 1,700 square miles and is home to 35 communities and almost 4 million people. Harris County used this project as a platform to educate its residents of their flood risks utilizing all media outlets including public service announcements on television and radio stations and in newspapers. All residents were made aware of this project and were eager to see the new products. Throughout the entire project, as data was developed, it was made available to the public including community officials, planners, engineers and local residents for their review and use. The big question became, could anyone use the GIS data developed or had technology passed them by?

New products created during this project include accurate topography from LiDAR data; stream cross section survey data; new and re-leveled county-wide benchmarks; updated and advanced hydrologic and hydraulic computer models; detailed

information for previously unstudied channels; increased knowledge of past floods; and up to date land use information. The items listed above and their supporting data were available in a digital GIS formats.

During the Appeals and Protest period, community officials, engineers and the public were charged with reviewing the final product and submitting comments and concerns. Technical Appeal and Protest Check-list Forms were prepared by Harris County Flood Control District (HCFCD) in order to assist in the review and comment period of the data. Directions for submitting these forms were outlined on the project web-site. These check-lists requested that GIS files be created and submitted in support of Technical Appeals and Protests. At the end of the Public Appeal and Protest Period, 259 Appeals or Protests were received. Based on the large area and population of the County, only 1 Appeal/Protest was submitted for every 7 square miles of County and only 0.004% of the population submitted an Appeal or Protest.

The format of the 259 Appeals and Protests varied significantly and posed great challenges for the integration of data into a seamless geodatabase. The data types ranged from hand-annotated notes to detailed hydraulic (HEC-RAS) models. The data was edited using functions in the ArcGIS environment maintaining the ability of the geodatabase to be modified and seamlessly integrated back into the master dataset.

The first GIS based challenge encountered when dealing with the appeals and protests involved compiling all the submitted information and developing a management system. The ESRI geodatabase was the backbone of the management system and

contained all submitted data, including a hand annotated maps that were converted electronic format through the process of optical scanning. This information along with the required electronic files, were cataloged as metadata-like information. This metadata-like information was comprised of word documents describing the grounds on which each appeal was submitted. Because this information was submitted with evidence supporting the appeals, some information was quite extensive and large. For instance appeals involving the modification of the floodway required detailed study (HEC-RAS) information to be submitted. Because this detailed information was created by a certified hydraulic engineer on behalf of the land owner, information was submitted by many different private firms and under many dissimilar formats. After cataloging all information, the exact location was determined by creating a point feature dataset that described the appeal location with a FEMA created number and a local HCFCID identification number so that pre-appeal/protest related data can be linked to existing tabular information. Upon detecting the spatial location of the appeal, the review process was enabled. This process of review began with creating an ArcGIS project for each appeal. Each .MXD project contained a raster background made up of aerial photos in differing resolutions. The most detailed photography available in Harris County was 6-inch resolution but it only covered a limited number of appeal sites, therefore most appeals relied on 1-foot imagery. The actual FIRM panel, roadway centerline, FIRM channel centerlines, preliminary floodplains, preliminary base flood elevations, and FEMA cross-sections were imported to visually compare against submitted data. Each appeal or protest had its own .MXD document and each document contained the same basemap information. Additional sources of data were sometimes used to verify

elevations and, moreover, appeals involving fill relied on the use of the LiDAR and the by-products produced as a result of the data collection; 2ft. contours, full feature mass point data (ASCII), and modified survey integrated elevation data sets.

The easiest of the protests submitted involved changes to the existing base map information. These types of protests included, but were not limited to, the incorrect spatial locations of the street centerlines, annotated street names, and designations as public or privately owned. These centerlines were extracted from the original FEMA Appendix L of the Study Contractors Manual dictated S_TRANSPORT_LN file. These extracted streets were corrected and shipped to FEMA's contractor (MCC) for final incorporation into the map. Within each appeal/protest that was reviewed and sent back to FEMA via the MCC, we incorporated a letter of findings, detailed editing procedures conducted, data dictionary, metadata, map detailing changes (See fig 1.), and the edited feature dataset.

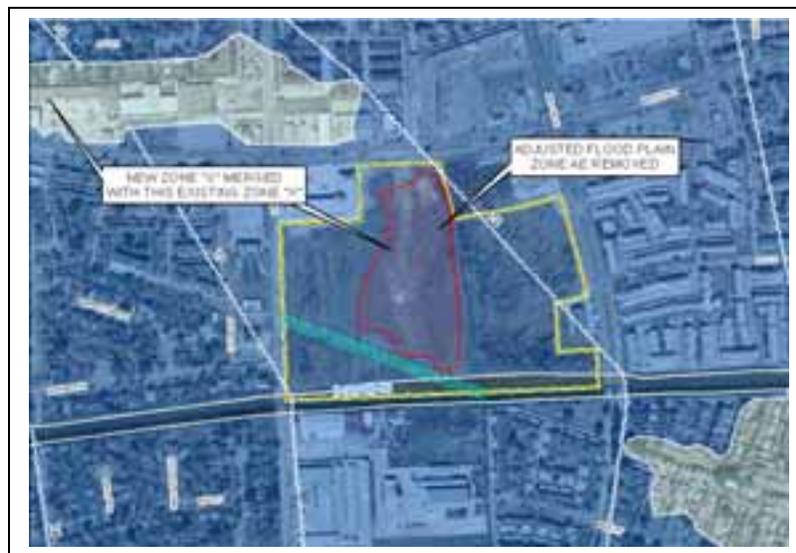


Fig 1.

Consistency in the submittals allowed for flawless incorporation into the existing preliminary FIRM data. Another appeal/protest type commonly submitted involved the incorrect mapping of a property in the floodplain. Some land owners who had previously not been mapped in the floodplain had under this new Flood Insurance Study (FIS) become mapped inside the floodplain. Because these property owners in the pervious FIS were mapped in a zone of risk and under NFIP directorates, these properties did not have to submit a Hydrologic and Hydraulic studies when obtaining a permit. Therefore there were multiple landowners who had to submit a protest to be removed from the floodplain simply because their privately conducted study was not submitted to be incorporated into the new FIS study. The existence of these studies was not determined until the appeals/protest periods began. Other mapping inconsistencies noticed by the community during the 90-day period involved the correction of misaligned channel centerlines. Some channel centerlines for the FEMA map panels were generated from existing data. These datasets, although accurate, did not conform to the surveyed cross-sections collected during the data collection period of the project. These inconsistencies were observed when the channel centerline was overlaid on the aerial imagery. In cases where the area was obscured by trees, it was impossible to determine if the centerline matched the actual channel geometry. These special cases involved taking the survey data and converting this survey data to a grid based dataset so that it could be imported into the ArcGIS environment. This conversion from surface based coordinates to grid was done with an implied conversion number which sometimes differed for each appeal. Again the errant channel centerline was extracted from the Appendix L dictated S_WTR_LN file and corrected to match the survey data (See Fig 2.).



Fig 2.

The editing process involved snapping the line feature to the surveyed channel centerline. The appeals/protests involving communities where non-electronic data was submitted proved to be the most interesting to decipher. One particular protest involved a community that submitted for a map change, which was incorrectly mapped on the preliminary FIRM. The information was submitted by fax machine wherein the paper was so dark it was almost impossible to decipher. After brightness was increased during scanning the document and adjusting brightness levels it was imported into ArcGIS. Again because each appeal/protest has a unique MXD with all the pertinent information it was easy to georeference this scanned document and digitize the area that was considered to be errant. Without the georeferencing toolbar and included applications within, it would have been nearly impossible to digitize the areas correctly. Overall these types of appeals and protest only involved the basic functions of ArcGIS and depended less on the complex mathematical functions found when dealing with continuous raster elevation data or LiDAR.

The complex appeals and protests involving fill allowed for the implementation of complex analysis using spatial analyst and in one case using the functions found within 3D analyst. The appeals involving fill usually involved comparing the supplied survey data against the existing LiDAR data that preliminary maps were created with. Most survey data was supplied in a suitable or electronic format. Most electronic data had to be converted from a surface coordinate to a grid coordinate system and the hard copy survey information was digitized into a shapefile containing elevation. These shapefiles were created by hand after georeferencing the hardcopy into the correct spatial location and, if required, were converted into Point ZM or 3D points. This 3D point conversion allowed for complex integration with a floating point grid dataset. Occasionally it was necessary to compare the elevations created by the surveyor as referenced therefore we used an extraction method against the LiDAR data to compare elevations quickly. Because we allowed for extrapolated data elevations to be interpolated, we sometime had to create entire surfaces from the survey data so that a more correct and accurate comparison of the fill could be made with the proposed water surface elevation for that area. Some areas involved requesting more detailed survey information. Some of the supplied survey information was so spatially separated that the interpolation methods were inaccurate. For instance one protest involved a subdivision that was delineated within Special Flood Hazard Area Zone AE and the provided survey data was not complete enough to determine if the adjacent landowners across a roadway were releasing floodwater over the roadway in the subdivision. As a result an additional request for a detailed survey along the roadway was needed. Once this detailed

information was re-submitted we took this information and created a profile in ArcGIS to determine the lowest point in the roadway (See Fig. 3). This low point in the roadway was compared to the depth of flow on the roadway which was modeled as a hydraulic weir. This modeling was done to determine an inundation volume within the subdivision. This additional information was only requested when all other sources of information were exhausted. The above protests are some examples of some of the individual process and methodologies developed for this appeal and protest period. Because each of the 259 appeals and protests posed a different issue and required a unique solution, this project will be used as a model for future Map Modernization efforts.

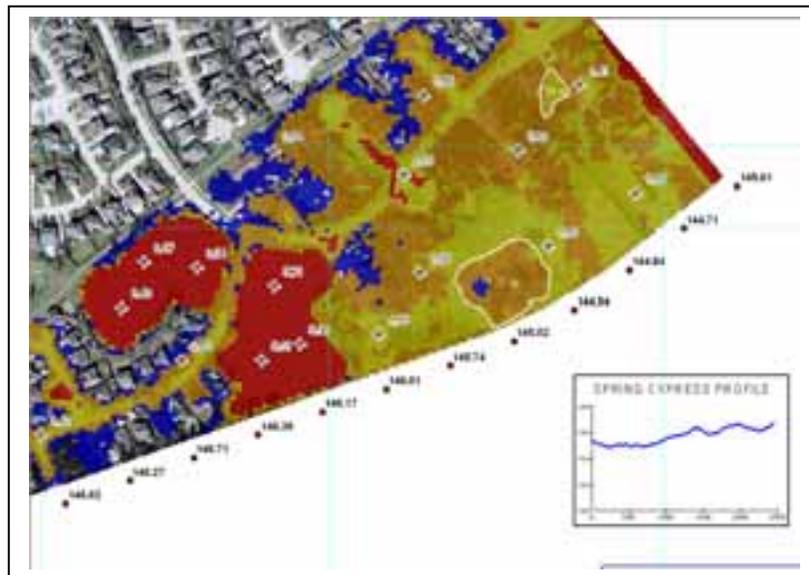


Fig 3.

As an addition to the geodatabase based management system, we incorporated all the formal directives and memos written by the governing powers into an MXD project with hyperlinks (See Fig. 4).

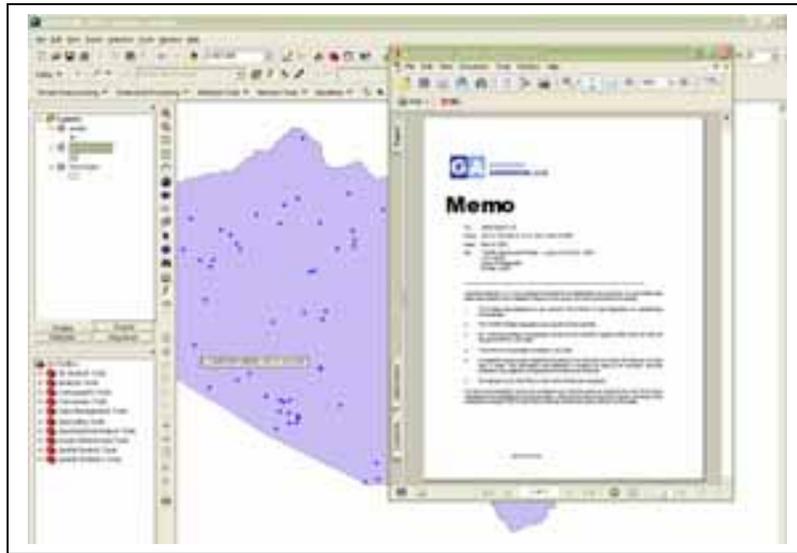


Fig 4.

These hyperlinked documents helped management juggle personal inquiries and well as private firms requesting the status of the there appeal. This additional map document also helped to identify those appeals that were either rejected or appeals wherein additional information was still being sought. The Appeals Period was completed in an unprecedented manner and the GIS processes will be used as a model for future FEMA Map Modernization efforts.