Harris County Risk Assessment Using HAZUS-MH

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Project Overview

CivilTech Engineering, Inc. (CivilTech) worked with Harris County during the last half of 2005 to develop a Risk Assessment Program for the County which utilized the latest methods and tools provided by the Federal Emergency Management Agency (FEMA). Historically, risk assessment has been accomplished at the local level using a variety of tools to predict damage losses and economic impacts, with varying degrees of success. To satisfy the need for a better risk assessment tool that could be used by local communities, counties, and state agencies, FEMA released a nationally applicable software program and standardized methodology for estimating potential losses.

The software program is called HAZUS-MH, which is an acronym coined by FEMA to represent "Hazards U.S. – Multi-Hazard". The software program uses state-of-the-art geographic information system (GIS) software to map and categorize hazard data and the results of damage and economic loss estimates. The program can predict loss estimates based on current scientific knowledge of the effects of hurricane winds, floods, and earthquakes, and was intentionally designed to be flexible by allowing the user to select the level of analysis based on available resources, manpower expertise, and analysis needs. For this project, a Level 1 Analysis, which utilizes default data provided by the program, was run for the entire county, while a Level 2 Analysis, which improves the results of Level 1 by considering user-supplied data such as building inventories and flood elevation data, was run for a pilot watershed.

Harris County has a population approaching four million, encompasses 1,746 square miles, and is frequently subjected to damaging winds and flooding. Harris County was in a unique position to initiate a Risk Assessment Program using HAZUS-MH in 2005. The Tropical Storm Alison Recovery Project (TSARP) provided up-to-date hydrologic and hydraulic data and new mapping tools. In addition, the County's unique relationship with the U.S. Army Corps of Engineers provided extensive economic and risk assessment data from multiple completed and ongoing federal flood reduction projects. In summary, the County already paid for extensive data collection and data generation for other projects which it now was able to utilize in applying HAZUS-MH to a Risk Assessment Program. CivilTech worked with the County to develop a Phase 1 project which would test the capabilities of HAZUS-MH.

In Phase 1 of the Harris County Risk Assessment Project, a basic HAZUS-MH Level 1 analysis using the Hurricane Wind and Flood modules was run for the entire county to familiarize personnel with the program and provide an immediate useful product. This

was the largest application to date of the HAZUS-MH program. In order to evaluate the program for a Level 2 analysis, a pilot watershed was selected and the software program was populated with high-quality data specific to the watershed. During the project, the project team was also able to apply the software program to test case – Hurricane Rita.

Hurricane Rita

The project team was presented the opportunity to apply HAZUS-MH to a real-time scenario when Hurricane Rita impacted the Gulf Coast in late September 2005. Hurricane Rita entered the Gulf of Mexico as a Category 5 hurricane in late September and by the week of Monday, September 19, 2005, appeared to be heading for landfall on the Texas Coast. The hurricane approached on an erratic path, first threatening landfall far to the west, then changing its approach so that its track was closer to Harris County. Local government officials, who were still assisting neighboring states and evacuees with the recovery from Hurricane Katrina, activated emergency preparedness protocols. By Wednesday, predictions placed Galveston and Houston directly in the path of the hurricane.

The counties and cities along the Gulf Coast issued evacuation warnings and thousands of residents clogged major freeways and evacuation routes in an effort to travel to the north and west. Traffic impacts in Harris County from both evacuees moving north from the coast and from county residents leaving their homes were extraordinarily severe for several days preceding landfall of the hurricane. Although Hurricane Rita moved to the east and primarily impacted counties and parishes in eastern Texas and western Louisiana as a Category 4 hurricane, shortages of gasoline and other supplies in Harris County aggravated the transportation problems and made a rapid recovery of the evacuation event difficult.

Fortunately, Harris County was spared a direct hit from Hurricane Rita and sustained only minor wind damage and power outages (in addition to the transportation issues resulting from the evacuation). The storm did, however, give county personnel the opportunity to test their hurricane preparedness protocols and to evaluate planning and implementation of emergency response activities. CivilTech assisted the Harris County Office of Emergency Management (OEM) in applying HAZUS-MH predictive tools to the event.

HAZUS-MH in Real Time

In early September 2005, CivilTech initiated the *Harris County Risk Assessment Using HAZUS-MH Phase 1 Project* with Harris County. Just a few weeks into the project, Hurricane Rita presented the opportunity to test the software using a real event. CivilTech was prepared to start the Phase 1 project immediately upon receiving a contract and had the HAZUS-MH software packages already loaded with Harris County data in the first few weeks of September. On September 21, 2005, CivilTech was requested to provide support for planning for Hurricane Rita by OEM.

CivilTech engineers and GIS technicians were mobilized in the CivilTech offices and at the offices of the OEM at Transtar. At irregular intervals during each day of the weeklong event, hurricane advisory information from the National Weather Service was processed using HAZUS-MH to provide anticipated hurricane conditions (wind speeds) and quantities of debris. This information was provided to the OEM for distribution to the Harris County precinct staff and County Commissioners. Since the majority of the rainfall associated with the hurricane did not fall in Harris County, the flood module was not used during this event.

Results and Conclusions

Level 1 Analysis - To verify the precision of the modules, the predicted flood elevations from the HAZUS-MH Level 1 Analysis were compared to the new floodplain boundaries generated by TSARP and were found to be a good approximation. The results of the Level 1 Analysis using the hurricane wind and flood modules were provided in automated reports for estimating damages:

- HAZUS-MH Building Inventory for Harris County (the Building Stock)
- Expected Building Damage by Occupancy and by Building Type
- Expected Damage to Essential Facilities
- Building Related Losses

The primary conclusion drawn from the results of the Level 1 analysis is that the HAZUS-MH software package can be successfully applied to Harris County. In addition, the analysis also showed that supplementing the default topographic data with an improved Digital Elevation Model allowed flood results to more closely match the current County geography.

Level 2 Analysis - The goal of the HAZUS-MH Level-2 project was to incorporate local data in the HAZUS-MH model in order to produce a more accurate prediction of damage losses. For the pilot study area of White Oak Bayou, approximately 180,000 building records from the Harris County Appraisal District (HCAD) were incorporated into the HAZUS-MH building inventory, thereby improving the default, census-based HAZUS-MH inventory information. Similarly, approximately 1,000 flood level cross sections were input into the HAZUS-MH flood model to improve the local flood model. The results of the Level 2 analysis appear to more favorably correlate with previously developed U. S. Army Corps of Engineers FDA damage models (for flood) and the observed HCAD damage results from Hurricane Rita. The primary conclusions from the Level 2 analysis are that using local data to supplement the default national data does improve the results of the analysis, and that a Level 2 analysis is possible using current data developed for Harris County in previous projects.

Hurricane Rita Test Case - Generally, HAZUS-MH worked well during this emergency. The performance of HAZUS-MH during the Hurricane Rita event yielded the following conclusions:

- Near real-time reporting of hurricane events is possible with the HAZUS-MH hurricane module by using NWS advisory bulletins.

- HAZUS-MH provided much greater detail regarding wind speed distribution throughout the County than was available through the normal news and information services. Final recorded wind data closely matched the predictions of HAZUS-MH.
- The observed results of the hurricane damage predicted by HAZUS-MH did not correlate well with damages observed by the Harris County Appraisal District (HCAD). Damage data for Level-1 compared with HCAD damages indicated HAZUS-MH residential was too high and commercial damages too low.
- Analysis of the effectiveness of HAZUS-MH debris reporting was not possible because actual debris numbers were not available.
- Additional CivilTech analyses of the HAZUS-MH results for Hurricane Rita indicated that adjustments to the HAZUS parameters can be made to provide more accurate predictions.
- Problems related to the use of the computer network at Transtar were not anticipated, as Transtar had never supported outside consultants at the level required by Hurricane Rita. Since that time, CivilTech and Transtar personnel have worked to ensure that the Transtar computer and communication networks meet or exceed the requirements to support HAZUS-MH during the next disaster.

Recommendations

The Phase 1 Harris County Risk Assessment Project using HAZUS-MH demonstrated many of the capabilities of the HAZUS-MH program. Many of these capabilities could only be utilized after resolving significant issues with data input, data manipulation, and reporting. The Level-2 analysis on the pilot watershed uncovered similar technical issues, but the results of the incorporation of local data appears to be a more accurate model that better reflects the conditions in Harris County.

The future of HAZUS-MH in Harris County as a planning and mitigation tool appears to be promising. Although the Phase 1 project was completed in less than three months, expanding the Level 2 analysis to more watersheds, and eventually to the entire county, will take considerable longer. However, this Level of analysis will be necessary to provide a complete, accurate Risk Assessment for the county. Several issues identified during the Phase 1 project can be addressed during subsequent phases:

- The data processing problems with HAZUS-MH which prevented some reporting from accurately completing in this program must be addressed and resolved. For this Phase 1 project, custom reports were used to produce accurate results.
- Further data compilation and evaluation may allow for more refinement of the flood model.
- The depth-damage curves may be refined for more of the specific structures within the County.
- To date, modeling flood information has required substantial processing time (days). Additional customization of the analysis tools may be able to reduce this time for real-time events.
- Incorporation of data detailing newer construction processes or refinement of the

tree inventory may improve the hurricane model damage predictions for Harris County.

- Additional analyses and reporting information may be customized for county precincts and departments.
- Data from storm events compiled by various agencies could be enhanced to allow for calibration of the HAZUS-MH model.