AIRBORNE REMOTE SENSING AND HURRICANE KATRINA

Rapid Post-disaster Mapping

Nearly a week before Hurricane Katrina slammed into Louisiana and Mississippi the Federal Emergency Management Agency (FEMA) was making plans to map the damage that was sure to come. The importance of rapid image acquisition called for an entire digital-processing stream. The author reports on how airborne remote sensing was of great help in mapping areas heavily damaged by Katrina.

Mapping firm 3001 Inc was well positioned to handle the post-disaster mission, not only due to its proximity but because it operated airborne digital sensors with sub-foot resolution and supported by an all-digital processing system. With Katrina still days from landfall, 3001 got the call to prepare for the mission. Speed was the top priority. In the days to come, FEMA and related agencies pulled together several other key geospatial companies and technologies into what would, according to those who participated, become one of the fastest large-area mapping projects ever conducted. The quick turnaround cut weeks off the time it otherwise would have taken FEMA to assess damage and put relief cheques into the hands of Gulf Coast residents who had lost nearly everything.

Kit and Products

3001 LandAir owns two ADS40 Airborne Digital Scanners developed by Leica Geosystems AG of Heerbrugg, Switzerland, and two more were made available by Digital Aerial Solutions, LLC, of Tampa, Fla. In addition to its all-digital workflow, the ADS-40 scanner has the ability to acquire imagery with sub-foot spatial resolution over a large area. This level of detail would allow for assessing damage with a high degree of accuracy. The multispectral sensor also collects panchromatic, colour infrared and natural colour imagery simultaneously, which would satisfy multiple end users and applications. Project specifications called for mapping 11,800 square miles of the most heavily hit parts of Mississippi and Louisiana, including New Orleans and Mobile, at one-foot resolution. In the interests of time, no tonal and colour balancing was carried out. For the same reason and because there is very little topography over most of the affected area, only planar rectification rather than orthorectification was performed. The sensor platforms included two Learjet 24s and a Cessna 401, temporarily operating out of Houma airport, La. To achieve the specifications and maintain continuity among datasets, aircraft altitudes and speeds had to be synchronised. The Learjets were flown at a speed of 300 knots at an altitude of 10,000 feet Above Ground Level (AGL), while the Cessna moved at 250 knots and 9,000 feet AGL. The swath width was 12,000 feet, or about two miles.

Processing Data

Hurricane Katrina made landfall on the Louisiana and Mississippi coastlines on 29th August and next day the Army Corps contacted 3001 to finalise project specifications and plan flight lines. Headquartered in Fairfax, Va., the firm operates four facilities in the Gulf region, including an office in New Orleans, which suffered heavy damage. The post-disaster mapping was overseen from its Gainesville, Fla., office. Flights began on 3rd September and each day the aircraft flew flight lines from early morning until about 4 p.m. After return to Houma airport the hard-drives were removed and loaded onto one of the jets, for immediate delivery to the 3001 facility in Gainesville. The datasets were processed using the Leica LPS system developed for rapid production of large ADS40 image files. With all ground control points underwater and with no ability to put any in place, solely the onboard GPS was used for photo control. Processing activities continued through each night until about 11a.m next day, when six identical imagery products representing flights from the previous day were loaded onto 200-Gigabyte FireWire hard-drives. Two of the hard-drives were flown to Washington, D.C., where they were hand-delivered to FEMA and the Army Corpsâ€™ Topographic Engineering Center. The other four imagery products went to designated state agencies in Louisiana and Mississippi. The acquisition and processing cycle continued non-stop for sixteen days, until the project area was covered. On the slowest day, around 360 square miles were captured in 24 hours, and on the fastest day 2,520 square miles. The mapping phase of the project was completed five days ahead of schedule and ultimately delivered 3,433 rectified images.

Damage Assessment

The images were applied in a variety of projects aimed at assessing damage, prioritising relief efforts and planning the recovery. Two of the projects, both conducted through FEMA, made immediate use of the imagery in rapidly deployed programmes that directly benefited residents impacted by Katrina. URS Corp. of Washington, D.C. has a standing contract to provide the federal government with rapid support during or after a major disaster. In the case of a hurricane or flood, URS is tasked with establishing high-water marks and delineating the wind/water damage-line throughout the inundation area. (Damage caused by wind is covered by homeowners insurance, damage caused by water is covered by the National Flood Insurance Program.) While reviewing satellite and aerial imagery for this purpose URS was informed that 3001 had just initiated its mapping programme with the ADS40. The ADS40 dataset fulfilled URS needs in terms of timeliness, resolution and information content. Together with NOAA aerial imagery, processing of the dataset was carried out by URS subcontractor EarthData International of Frederick, Md. for the high-water line and wind/water delineation project. The work was complemented by URS field-crew observations of on-site debris lines and damage conditions, entering details into GPS-equipped mobile GIS units.

Washington Post

Within a week of Katrina striking, FEMA came under considerable pressure to begin delivering much-needed financial assistance to each

property owner whose home had been rendered uninhabitable. In the past, FEMA handled these damage assessments primarily by housing inspectors personally visiting each property. With hundreds of thousands of homes feared lost, it was suggested supplementing this time-consuming field-inspection method with remote sensing technology. FEMA awarded this damage-assessment project to Michael Baker Corp. of Moon Township, Pa. The firm subcontracted tahrough URS EarthData, which used the same ADS40 imagery. Working in ArcView, polygons were drawn around those blocks where damage to residential buildings appeared to be total. The resulting shapefiles were correlated with zip codes and street addresses by Baker and the information provided to FEMA to assist the agency in identifying neighbourhoods most likely to be eligible for government assistance. FEMA verified the damage assessments with spot-checking by field surveyors. High-water mark and wind/water-line vectors were compiled using the same technique and delivered to URS along with the image mosaics. Within twenty days of Hurricane Katrina hitting Louisiana and Mississippi, FEMA and related agencies had received mosaicked imagery and damage vectors for more than 11,000 square miles of hurricane destruction. The Washington Post confirmed that the use of remote-sensing techniques had helped speed the delivery of relief cheques to residents on the Gulf Coast.

Web Distribution

URS was also responsible for assisting in the distribution of its imagery and derived information within FEMA and to other participant organisations. In the early stages of imagery delivery URS realised the file sizes were too large to be easily served to other offices over the Web. The company contacted Pixia Corp. of Sterling, Va. to convert the rasters into a more manageable file structure. Pixia is the developer of the â€˜.nuiâ€™ file format and encoding technique, which stores extremely large raster datasets in a non-compressed structure that makes them much faster and easier to archive and access. As EarthData mosaicked a group of flight lines into a contiguous image, URS shipped these image blocks, about ten in all, to Pixia, where they were encoded into the .nui format. The converted images were served via ArcIMS and by Web server very quickly to other offices, where they could be opened in about any geospatial software application.

Concluding Remarks

The demand for this high-resolution imagery was enormous. URS essentially built an entire Information Technology (IT) infrastructure, including internet connectivity, just to distribute the imagery and the analysis information derived from it. Fortunately, much of the image acquisition, processing and distribution infrastructure was still in place when Hurricane Rita entered the Gulf just a few weeks later. By the time the next hurricane season comes the IT infrastructure will be more robust. Based on the lessons learnt from Katrina, aerial imagery will be used to an even greater extent the next time around.
