American Society for Photogrammetry and Remote Sensing Meeting
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The Role of Airborne and Satellite Imagery in Disaster Response
"Lessons Learned" Workshop

President-elect Kari Craun welcomed attendees to the workshop, and described the goals of the day: 1) share information; 2) develop recommendations for improved imagery response to disasters to be published in the ASPRS journal, Photogrammetric Engineering and Remote Sensing (PE&RS). Additionally a follow up session is being scheduled for the ASPRS Annual Conference, May 1-5 in Reno. This follow-up session will welcome input from the broader geospatial community; today's workshop will focus on the Federal imagery providers and coordination of requirements being provided from users to providers.

IMAGERY USERS PANEL

Andrew MacInnes (Plaquemines Parish GIS Manager)
Powerpoint – "Airborne and Satellite Imagery Use for Hurricanes Katrina and Rita"

Coordination within the parish was facilitated by MacInnes, who was the only point of contact (POC) for geospatial data within the parish (small parish – 25,000 people).

Pan, Color, Infrared imagery is all useable, but needs to be georeferenced. Some unreferenced imagery (e.g. helicopter aerials) was shot but not as useful as it was not georeferenced.

National Oceanographic and Atmospheric Administration (NOAA) color imagery was not originally geo-referenced.

Non-geo-referenced imagery was useful for initial evaluation of damage extent and what was on the ground.

Federal response chain of command was somewhat muddled, Federal Emergency Management Agency (FEMA) agreed to supply imagery to the National Geospatial-Intelligence Agency (NGA). However, the fact that imagery was being provided from FEMA to NGA was not widely known and the distribution of imagery beyond NGA to state and local users did not seemed to be planned in advance.

Use of classified imagery in the field limited interaction with locals, as many locals did not have a clearance.

NGA emphasis seemed to be more on New Orleans, instead of Plaquemines Parish or the Mississippi coast.

NOAA imagery was the first imagery, and was made available (to MacInnes) ten days after the event.

NGA files were in National Imagery Transmission Format (NITF), not directly useable by locals; they needed geographically referenced Tagged Image File Format (GeoTIFF) and Multi-resolution Seamless Image Database (MrSid) formatted files.

Satellite multi-spectral (4 meter) is generally too coarse of a resolution.

All satellite imagery was provided by NGA.

Lots of satellite imagery was acquired but it didn't get full coverage of the parish.

The best imagery set (quality and coverage) was flown and donated by a private company; they got coverage of all livable areas in all formats within three days, and delivered within three weeks.

The biggest problem for the Parish was formatting/mosaicing/post processing of data to make it useable for first responders and local government users. There was plenty of data but it was not easy to ingest or use.

Post Katrina imagery of all damaged areas was not delivered before Hurricane Rita arrived (this has impact on insurance and FEMA claims – which storm caused the damage).

High turnover rate of FEMA, National Guard, etc. personnel and support meant multiple requests were made to get the message through, sometimes locals would go to temporary facility to check on availability of data to find that facility had been pulled out and moved to another area (temporary tent based Federal GIS facilities).

Some support was pulled out just before Hurricane Rita hit.

In summary, the two biggest problems for the Parish was the delay in obtaining complete, geo-referenced image coverage for damage assessment, and lack of one central point of contact for Federal response.

Mike Liotta (GIS Manager, Louisiana National Guard (LNG), Camp Beauregard)
Powerpoint – "Louisiana National Guard Geographic Information Center"

Jackson Barracks – Primary LNG facility affected by Katrina/Rita.

LNG needs more elevation data for planning passable routes and dry support locations.

Joint Operations Center was at Jackson Barracks – entire first floor was inundated, communications were lost.

Active units were able to get data from NGA without a lot of difficulty.

Main format for end user data was Portable Document Format (PDF) files that would be emailed and plotted out for use by large format plotters.

Raw data was generally not requested, PDF's came from NGA and FEMA.

For Rita, operations were shifted to the new Joint Operations Center in Baton Rouge.

Water level and water depths were the main data categories that were needed.
US Geological Survey (USGS) gauges were used, but some went down.

Pat O'Neil (U.S. Geological Survey Geospatial Liaison for Louisiana)
Powerpoint - "Lessons Learned Workshop"

Communications in Lafayette were impacted by Katrina/Rita (a lot of communications links were routed through New Orleans).

US Army Corps of Engineers (USCOE) New Orleans District staff was dislocated by Katrina (building was ok but staff members were scattered by events; damage to property, commuting routes impassable, etc.).

One meter 2004 National Aerial Photography Program (NAPP) derived imagery was very valuable for pre-damage assessment.

Building outline coverage was not available for Orleans Parish (proprietary licensed?).

Two foot contours/elevation data derived from Light Detection and Ranging (LIDAR) was the main source of elevation data.

Landsat Thematic Mapper (TM) was used for area inundation determination and shoreline loss detection.

Security issues between NGA/LNG/Department of Homeland Security (DHS), etc. needed to be resolved to transfer datasets (secure File Transfer Protocol (FTP), Firewalls, etc.).

Shipping of Firewire drives was the preferred method of data transfer.

Extension of area of coverage for Katrina damage was requested, process to approve/disapprove these requests is unclear – guidelines for expansion of coverage areas and purposes of overflights are needed.

70 Counties in MS and LA experienced hurricane force winds, not just urban areas or coastal areas were affected.

National Wetlands Research Center (NWRC) in Lafayette was an imagery distributor for FEMA/USCOE. There were possibly too many distributors of imagery data resulting in duplication of effort.

Basic metadata is very important – especially for reflight information (e.g. cloud cover or subsequent imagery update missions).

Karen Schuckman – Geospatial Technology Leader URS Corporation
(*No Powerpoint*)

Requirements were not well defined – one paragraph scope of work from FEMA.

Personal and industry contacts were used to determine and focus response approach and requirements.

Better distribution system is needed than just sending around Firewire drives.

URS – contracted by FEMA for various post disaster mapping and support functions (high water marks, residential damage assessment, water vs. wind damage lines, Public facilities inspections, flood recovery mapping, flood map revision).

Use of imagery and remote sensing was not fully exploited by URS until recently.

Imagery gaps were problematic but inevitable.

USCOE ADS/40 imagery was the primary dataset used.

Data management issues were a major problem (all those firewire drives).

Seamless one foot data was really required for the damage assessment done by URS.

EDI/URS produced orthos from NOAA data, using USGS Digital Elevation Models (DEM) within a few days of acquisition, distribution was problematic; USGS's Earth Resources Observation and Science (EROS) center was used as a FTP node.

Commercial satellite imagery was too difficult to use; too hard to access and index. It was not used by URS for FEMA work.

3001/ADS imagery – no ground control, spatial mismatches between strips, no DEM used for orthorectification, no radiometric balancing, useful for near term work but is not a high quality product.

This data (ADS/40 USCOE) should really be properly rectified and balanced as a final record of the post hurricane damage. This could be done for about $800,000, not much interest (and/or funding) in doing this to date.

Distribution – Data was processed and placed on a SANZ type server (seamless, full resolution, etc.) at URS, and is available from the web. FTP transfer of large datasets is too cumbersome, Firewire drives are not as effective either.

Recommendation (audience) – Set up USER Sites and PUBLIC Sites as separate sites, general public downloads can clog up data pipelines.

Karen – Remote access (via a Web Mapping Service) to imagery, vs. data downloads are a better approach for most users.

Jim Plasker – establishment of mirror sites would be a good approach to data distribution; this would free up bandwidth at primary sites.

URS has the same task response to hurricane Wilma support – not enough coverage was obtained from FEMA (West coast not covered as well as the East coast).

John Perry – Department of Homeland Security
(FEMA/National Response Coordination Center - Emergency Mission Presentation)

NTM Datasets are sometimes used for National Response Events – NGA is FEMA's broker (executive agency) for NTM data.

12 Agencies that are signatories of the National Response Plan can access NTM data.

Internal assets for DHS – border patrol P3 Orion aircraft (live/recorded/still digital video).

Wind field databases are used to determine area of impact for aerial imagery collection.

USGS EROS is FEMA's "executive agent" for non-classified data; NGA is the executive agent for classified data.

USDA/FSA provided a large amount of pre-event imagery (NAIP?).

Private imagery donations – EarthSat NaturalVue, General Electric, Pictometry, Google.

FEMA spec for blue roof program is 15% or less of the roof damaged.

Housing damage (Karen Shuckman -URS) – two assessment tasks – salvageable houses for blue roof program vs. condemned housing for housing inspection….these tasks should be linked to use the same imagery source.

Comments to the presentation by **John Perry – Department of Homeland Security**

Jim Plasker (ASPRS) – Pull together examples of applications used for disaster response and provide to FEMA to influence future requirements.

Larry Handley (USGS) – No central repository/central library of "value added" products from disaster response efforts. This results in duplication of effort and delays. EROS provided a central point for acquired data, but there needs to be a central place for value added vector and raster products.

Karen Shuckman (URS)– Variable accuracy and quality of value added products can be a problem, need for these products to be associated with their imagery source ...good metadata is a very valuable for this (concurrence by US Army rep – "metadata is critical").

FEMA – is developing pre-scripted mission assignments based on key triggers (loss estimation) for different types of disasters, different types of products, different products at staggered intervals.

Glen Bethel – U.S. Department of Agriculture (USDA)/Farm Service Agency
Powerpoint - "USDA Disaster Response Acquisition, Integration, Packaging, Delivery, and Uses"

USDA has two mirrored data sites (Ft. Worth TX and Salt Lake City, UT).

440 7.5' Image tiles were created and mosaiced from post Katrina/Rita ADS/40 imagery for East TX and LA/MS.

Kari Craun/ASPRS (question) – is USDA providing imagery requirements to FEMA? Glenn Bethel (response) – yes but not always effective in directing imagery acquisition footprints.

EarthWhere – Sanz Corporation software/hardware used to track, store and manipulate imagery, make mosaics, and perform data management on large raster datasets.

Inaccurate wind speed charts/maps are a problem for USDA applications, they are used as an indicator of damage to trees and crops, and there is a need for accuracy and consistency in wind speed data maps.

Inland areas (agricultural mainly) are not covered as well as coastal/urban areas – multiple flights/coverage for those areas but many inland areas got no imagery at all.

GIS ready imagery (not just raw and not georeferenced) needs to be a deliverable.

Commercial imagery needs to be packaged/labeled, etc., you shouldn't need to open a DVD or a hard drive to see what is on the media.

Chemical contamination was an EPA responsibility, in terms of environmental impacts USDA was looking mainly at salt water contamination of agricultural lands.

Jeff Seehase / NGA (Booz, Allen, Hamilton)

No Powerpoint

Shipping of hard drives worked well for Tsunami effort, but could not be delivered (via FedEx) to hurricane areas.

They recommend more wide use of NITF format, so it does not have to be reprocessed…this costs time and $$$$.

NGA will be moving to a pull service, not a push service (e.g. Skymedia is a push service) for distribution of commercial/non-classified imagery.

Bill Pichel – Department of Commerce, NOAA
No Powerpoint

Radarsat imagery of Gulf acquired for Rita (after Katrina experience) for oil spill detection from offshore platforms.

Karen Shuckman (comment) – There was a lot of difficulty in knowing paths/footprints/schedule of systems like Radarsat, this forced users to use airborne assets instead.

Mike Aslaksen – Department of Commerce NOAA
Powerpoint – "NOAA Remote Sensing and GIS Support"

Imagery was acquired by NOAA for coastal areas, for use in damage assessment, search and rescue, salvage operations.

Thermal sensor imagery was flown for levee breach assessment.

Data (aerial imagery) was usually made available within 24 hours of acquisition.

Improvements – there is a need to develop a flight plan database, and a concept of operations for multiple platforms and staging areas. Identify sources and prioritize pre-imagery acquisitions.

Develop separate websites for government "official use only" and public use.

Need for better communication between field and office on collection priorities.

DSS sensor (from Emerge/Applanix) is the system NOAA is using – two improvement phases planned for the sensor and processing (June 2006/June 2007) to include real time IMU/ABGPS processing onboard, near real time processing of imagery mosaics.

Brenda Jones – USGS National Center for EROS
Powerpoint - "ASPRS Hurricane Katrina – Lessons Learned"

Criticism (noted by Brenda) – FTP site at EROS is huge and unorganized…mainly because it is prepared in disaster response mode just prior to the event.

Normal EROS disaster response team is composed of two FTE, members from other parts of EROS are added as needed.

Pool of money for data access and distribution from disaster response agencies would improve response for data collection.

EROS is looking at re-engineering the emergency response system – should tasks be distributed? How much can vendors supply. USER Requirements are needed!

There is a need to provide tiered web access based on connection type and speed, especially in post disaster situations, not every end user has high-speed internet.

What are key delivery format specifications that meet most requirements?

Browse image specs and compression formats/types/ratios need to be defined.
On the fly compression can be accommodated but would use time.

EROS proposing a unique identifier that would be used to reference the data type, location, format, etc. for every image.

Larry Handley (USGS) - what about archive of this data?

Response from EROS/Brenda - Original format would likely be the archive format.

Ability to pull data by event, not just location or data type is needed…

Need for media will always be there, web delivery needs to be enhanced but option of media delivery should be maintained.

Data Archive – data is moved from disc cache to 9840 tape (on silo). After 60 days, data is moved from silo to long term archive (tape based, but not online – near line?).

Users currently have problems downloading data from EROS…they need input on problems and possible solutions.

Jim Plasker (comment) – How about getting a FEMA disaster waiver for EROS imagery data, or to get a waiver from DOI security requirements? OR, contract out a mirror site that hosts all the data from the EROS server (not full time, but as needed – e.g. under presidential disaster declaration).

Monthly telecons still being held with disaster response agency members.

BREAKOUT SESSIONS (Technical Issues and Logistics Issues)

LOGISTIC ISSUES/PROBLEMS/SUGGESTIONS/SOLUTIONS

Need a single Federal POC (point of contact).

Consistency of POC – rotations of personnel in the field is disruptive, there was infighting among agencies where there was no communication.

Need an "Incident Command" system, make sure everyone knows who is in charge of geospatial response operations.

Computer connectivity (LAN-LAN), sharing data access networks an issue, also classified and unclassified networks make it much more difficult to share data.

There is a great need for a pre-established connection between NGA, other Federal, State and local government responders.

Difficult to differentiate among Federal agencies and their responsibilities; "mission creep" sometimes occurs.

Requirements coordination, who is responsible?, what is the process?, a mechanism for coordination and prioritization of requirements is needed.

> There is a need to prioritize requests. Only requests focused on were the "Blue Roof" over flights, need input into the process for other ESFs.

There is a need to "pre-identify" or stage pre-disaster source imagery, don't wait until just before the event

Need a phased acquisition of missions
- quick reconnaissance missions at first, to support rescue and safety needs
- need contract, mechanisms to facilitate rapid response
- funding needs to be in place for pre-staging of assets and personnel
- longer term missions for recovery, infrastructure assessment

Need practice, training, and execution of exercises including ALL players.

Need to safeguard/backup geospatial data

Need to preserve and provide access in the future to this data for historical purposes

There is a need to "finish" or cleanup (e.g. add metadata, geo-referencing, etc.) datasets after the event while information about the acquisition is still available

TECHNICAL ISSUES/PROBLEMS/SUGGESTIONS/SOLUTIONS

The group outlined some lessons learned during Katrina / Rita response:

Rooney/FEMA – per Bethel's suggestions, data needs to be provided in a useable format

NGA – Users don't want to wait, but packaging data and formatting it to their requirements takes time

Incomplete metadata is nearly as bad as no data

No prioritization of flights…existing pre event data was initially quite useful, but then new flights commenced without prioritization, scheduling, needs assessment, or requirements definition.

The group outlined the types of imagery requirements that need to be defined by end users: spatial, spectral, temporal, and radiometric. Format is another requirement needing definition, but can be determined in advance.

Need to think about the value of acquisition of hyperspectral data or LIDAR.

Prioritization should be by area of interest, accuracy, temporal, and need for geo-referencing.

Kimmet/NRCS – Media is needed for field use for damage assessment when there is no internet access

Hard copy is still needed for difficult environments (raining, windy, remote) and field use

Emergency operations center have a difficult time depending on web server access, cannot use WMS only, they have a need for data on local servers

Hard Copy maps – grid systems were a big problem – helicopters wanted lat/long, others wanted UTM. Dual grid maps were printed but not preferred. No one wanted to use the National Grid.

USGS - Albers projection preferred for work across state boundaries, UTM is used for local area work

MEDIA TYPES – Hard drives are generally preferred, too many errors, corrupted data with DVD's, most computers can now easily interface with external drives

EASE OF USE – There is a need for indices of data available and browse images

FORMAT – GeoTIFFs vs. NITF (overwhelming preference from users is for GeoTIFF); need a user evaluation and validate software available for processing

COORDINATE SYSTEMS

A grid system such as the National Grid has use in search and rescue, but is not a true map projection, which is needed for GIS applications.

1. Additional discussion needed on coordinate systems – no firm recommendation at this time

2. Metadata – Need minimal FGDC metadata

3. Data Formats – NITF is standard NGA delivery format from commercial vendors, but very few end users want to deal with NITF. EROS suggested that it would be easy to store in NITF and convert to GeoTiff on the fly.

4. Additional discussion is needed regarding preferred compression schemes: SID, JP2.