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PRACTICE NOTE

Situational Assessment: Federal Emergency Management Agency Region VII's Use of Google Earth™ with Partner Agency Layers During the 2011 Missouri River Floods

PRACTICE
The Federal Emergency Management Agency (FEMA) Region VII Regional Response Coordination Center (RRCC) created a Google Earth™ product to provide situational awareness during the 2011 Missouri River flooding event. The product utilized data from various partners to provide a real-time view of the status of levees. As a result, RRCC and field personnel shared a common operating picture.

DESCRIPTION

The 2011 Missouri River Floods

The Upper Missouri River basin experienced unusual weather conditions throughout the winter and spring of 2011. Snow continued to accumulate in the region much later into the spring than had occurred in previous years. Temperatures stayed unseasonably cold from March through May, causing the snow at lower elevations to remain on the ground for a longer period of time. According to the National Oceanic and Atmospheric Administration (NOAA), areas around the Missouri River headwaters had more than 130% of the average snowpack on the ground compared to the period from 1971–2000.

Severe storms in May brought the equivalent of nearly a year's amount of rain to the upper Missouri River. The rainfall combined with heavy runoff from melting snow to cause reservoirs from Montana to South Dakota to reach their limits. NOAA reported, "On average, the Missouri River channels 24.8 million acre feet of water per year. This year, it carried 24.3 million acre feet in May and June alone." Beginning in early June, states bordering the Missouri River began preparing for and responding to severe flooding. Iowa, Kansas, Missouri, and Nebraska conducted response operations for extended periods of time. President Barack Obama issued emergency declarations for Kansas, Missouri, and Nebraska; he later issued major disaster declarations for these three states and for Iowa.

Levee failure in Hamburg, Iowa (Source: Iowa Department of Public Safety)

Establishing Situational Awareness During the Missouri River Floods

At the beginning of the Missouri River flooding, the FEMA Region VII RRCC found it difficult to maintain accurate and comprehensive situational awareness and analysis of the flooding over the large expanse of the river. The RRCC Planning Section utilized U.S. Army Corps of Engineers (USACE) Web pages that included daily levee status, levee overtopping projections, situation reports, and photos. The Planning Section also reviewed the USACE levee Map Book with the National Geospatial-Intelligence Agency (NGA) flood extent to determine risk.

The Region VII Geographic Information Systems (GIS) unit created a Portable Document Format (PDF) static product when a visual representation was needed for further analysis. However, these static products had several limitations. This format was not efficient for a large-scale ongoing disaster. "Static maps" took so much time to create that they often could not be produced quickly enough to support any useful analysis. Region VII's small GIS unit worked to produce map products for the RRCC and four different states to use in their reports and presentations.

Reporting Through the Regional Support Plan

During disaster responses, the RRCC will produce a Regional Support Plan (RSP) that provides information to incident personnel and to FEMA Headquarters officials on regional efforts in support of the incident. Typically, the RRCC produces the RSP as long as it is the primary Federal coordination entity for the incident; this ends once a Joint Field Office (JFO) assumes operational control from the RRCC.

During the Missouri River flooding event, the RRCC Planning Section reported events that had occurred in the previous operational period within the RSP during the first months of the flooding event. The RSP contained a situation report and identified resources available and gaps in critical assets. However, the Missouri River flooding response differed from most other disaster responses in that JFOs were established in four states: Iowa, Kansas, Nebraska, and Missouri. Consequently, the Planning Section of each JFO was attempting to provide analysis to each state's emergency operations center (EOC) and to estimate damage prior to damage assessment teams gaining access to the flooded areas of the state.

Given this situation, the Region VII RRCC Planning Section received a request that it continue to produce the RSP. It was also requested that the situation section provide additional analysis of what was happening on the river and what could happen in the next operations period. This would make the RSP a more "forward-looking" document. It quickly became apparent that a comprehensive, Web-based GIS viewer was needed. The RRCC Planning Section needed a tool that would allow it to view the levee system, see what was behind it, and do so quickly without waiting for a static map to be developed.

Deciding to Employ Google Earth for the Flooding Event

FEMA had adopted Situational Awareness Viewer for Emergency Response & Recovery (SAVER^2), the ESRI Web-based Viewer for Flex. However, SAVER^2 is not used widely and many of the primary users in the region do not know how to use it. Those who know how to use SAVER^2 experienced difficulties with the system and were unclear as to its capabilities. Further, the USACE and Civil Air Patrol (CAP) were already providing their data files in the Keyhole Markup Language (KML) format for Google Earth, a widely available, off-the-shelf product. The GIS unit and Planning Section decided that this product would be an easy solution for sharing GIS files and would not have the technical difficulties experienced by Viewer for Flex users. Google Earth offered several significant advantages as it has a widespread user knowledge base; it is a free, off-the-shelf technology; and it is easy to

learn for those not familiar with it. Google Earth has a fast refresh rate and makes it easy to add layers, mark locations, and share files.

Creating a Google Earth Product for the Flooding Event

The RRCC GIS unit employed several steps to create the Google Earth product for the flooding event. The GIS unit added layers found on various Web sites, including the USACE high and low river estimates and river miles, to the product. The GIS unit included NGA flood extents, which are geographical representations of where the flood waters are located at a given time. The unit updated the flood extents daily, thus showing the locations of water in near real-time. The GIS unit also uploaded CAP flight pictures in a format compatible with Google Earth. The KML files types being utilized were loaded onto a common server and updated daily. Eventually, the GIS unit developed a linked file that allowed the viewer to refresh automatically. (See Figure 1 for an image of the Google Earth Viewer.)

The Region VII GIS Unit Leader contacted the USACE's GIS representative and explained that FEMA Region VII needed to see what was behind the levees for analysis purposes. The unit coordinated with USACE Engineering Research and Design to gain access to the National Levee Database (NLD). The GIS unit requested access to the database and received the data after signing non-disclosure agreements. The NLD provided levee demarcation and levee protected area data. The GIS unit also received access to the USACE's Mobile Information Collection Application (MICA) database, a collection of photos taken by levee inspection crews and uploaded in real-time during inspections. The MICA database was added to the daily files showing ground photos taken by levee patrols. The unit did not have to sign non-disclosure agreements to gain access to the MICA database, which is currently in test phase. The Missouri River flooding event was the first time that these databases had been provided to FEMA to be utilized in this manner. FEMA Region VII personnel believe that "this data was vital to our response and analysis of the incident." The USACE representative deployed to the RRCC produced daily reports detailing levee system problems and a levee status spreadsheet providing freeboard and river level. At the same time, U.S. Department of Transportation data was incorporated into the product to display road closures and detours. These additional data layers enabled the RRCC Planning Section to gain a more comprehensive view of the issues facing the levees, such as seepage, sand boils, rodent holes, and systems with less than 2 feet of freeboard. This ability to "see behind the levee" allowed the Planning Section to analyze what impact flooding in that area would have. Prior to the addition of these layers, the Planning Section would have had to confer with the USACE representative in the RRCC to determine what was in an area behind a levee.

> The USACE's NLD is a geographical collection of all Federal and non-Federal levees in one database. It provides an illustration of where the levees are located, what area they protect, and what is located in the protected area.

> Freeboard is an additional levee height above the estimated water surface of a given flood used by the USACE when designing levees.

Photos from the MICA database and the CAP provided Region VII with air and ground perspectives of what was happening on and near levees. Critical infrastructure was added from Homeland Security Infrastructure Protection (HSIP) Gold to identify these structures in levee protected areas. Population and tribal land designations were also added. As levees failed, the breaks or overtoppings were geo-located and added to the daily files. The combination of the NLD, HSIP Gold, CAP photos, and the MICA photos produced a common operating picture.

Using and Refining the Google Earth Product During the Flooding Event

The Google Earth product was used both in the RRCC and in the field. Access to the Google Earth files was provided to the FEMA State Liaison Officers, the Planning Section Chief, and the GIS Unit Leader in each of the affected states. The RRCC GIS Unit Leader offered tutorials by phone for field staff members unfamiliar with the product.

After several iterations, the GIS Unit Leader worked with the NGA representative to build all layers into a single KML file that automatically refreshed daily. This made the product more user-friendly for partners in the field. Later in the flooding event, when the flood waters were receding, a Federal Coordinating Officer tasked the GIS Unit Leader to determine if the Google Earth viewer could provide a Preliminary Damage Assessment analysis of a flood-affected area. Using the NGA flood extent polygon and available post-event satellite imagery, the GIS unit quickly plotted all the affected homes. The unit tasked CAP to provide imagery of the impacted area; CAP provided geo-referenced, high-resolution aerial imagery of 90–95% of the affected homes. With set criteria of damage provided by the Recovery Division, each home was assessed for the level of damage. Each home was then color coded according to damage categories, and a completed damage assessment with a high level of accuracy was completed within 4 days.

Strengths and Limitations of the Google Earth Product

The Google Earth product proved successful because it allowed the RRCC Planning Section to view details for each levee system instantly and see what was behind it as well as available photos. The addition of the USACE databases made the product more complete and enhanced its utility for analysis. The product was used to make screen shots for morning FEMA briefings, which provided valuable visuals of the event. The instantaneous nature of the product allowed planners to see a "map" of the area without waiting for the GIS unit to produce a static map product. The product provided visual verification of different situations when the RRCC received reports from emergency support function partners and states.

The Google Earth product had several limitations. The viewer could not be shared with State GIS partners because it included HSIP information. The files used to refresh the product were located behind the FEMA firewall because some of the data was For Official Use Only. Finally, because the product was developed late in the flood response, it was not available during the peak of the incident when most of the levee systems were failing.

Concluding Observations

Ultimately, the Google Earth viewer provided close to real-time identification of Missouri River flooding events. It allowed FEMA Region VII planners and response personnel ground, aerial, and later satellite imagery over the situation. The viewer provided a better common operating picture for all who used it. The product improved over the course of the events as requests were made to the FEMA Region VII GIS Unit Leader. Region VII personnel noted that a geospatial understanding is vital to situational awareness and one of the greatest lessons learned from this event is to put greater value on GIS situational viewers.

FEMA Region VII personnel noted that it is vital that some type of GIS viewer system be adopted by individual FEMA Regions or by FEMA as a whole. This system needs to include the capability of sharing GIS data sources with Federal and state partners; to be easy for people to extract GIS products for presentations and briefings; and to have a friendly user interface. The most important factor to consider when developing a GIS viewer system is that the GIS specialists are not the end users. Rather, the field personnel and senior leaders

are the end users, with the GIS specialists modifying the viewer to provide the data they need.

CITATION

MacVie, Cory. GIS Unit Leader, FEMA Region VII. Robarge-Silkiner, Stacy. Planning Support Unit Leader, FEMA Region VII. Submission to *Lessons Learned Information Sharing*, 30 Dec 2011.

DISCLAIMER

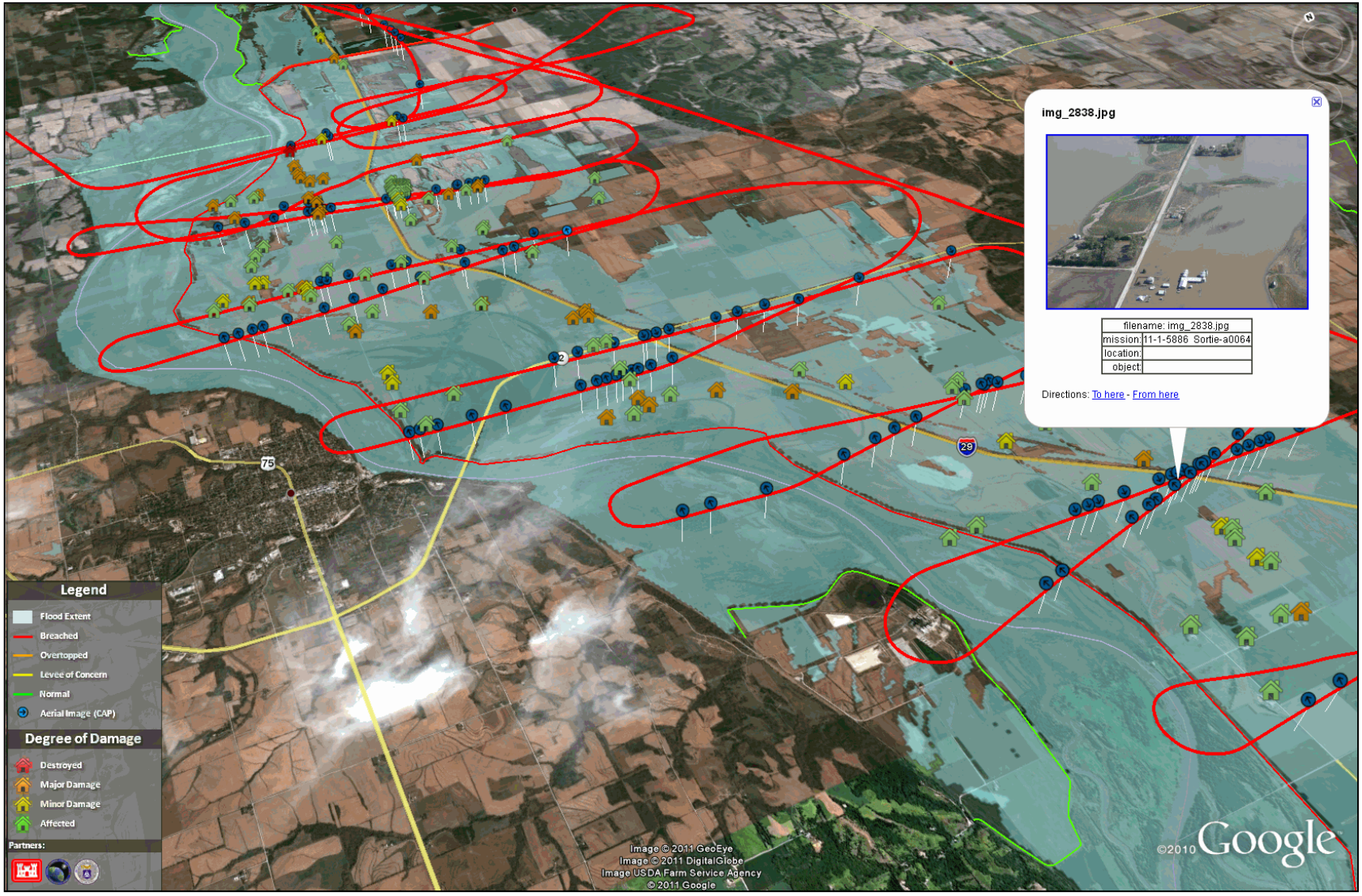

Figure 1: FEMA Region VII Google Earth Viewer (Source: FEMA Region VII)