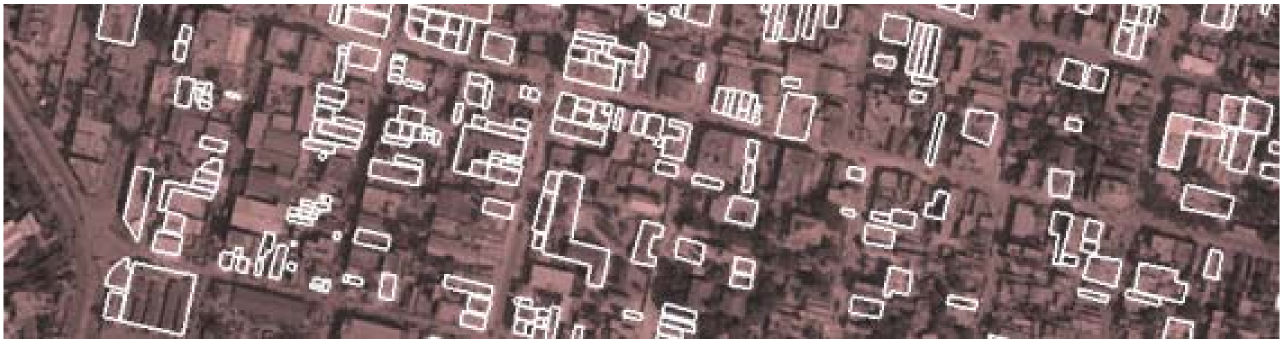
HAITI EARTHQUAKE AND CROWD-SOURCING: HOW AN INTERNATIONAL CROWD OF MOTIVATED EARTHQUAKE SPECIALISTS HELPED IN RAPID DATA ANALYSIS TO HELP HAITI

John Bevington, Senior Project Scientist, ImageCat UK, jb@imagecatinc.com
Ron Eguchi, President and CEO, ImageCat, rte@imagecatinc.com
Beverley Adams, Managing Director, ImageCat UK, bja@imagecatinc.com
Shubharoop Ghosh, Vice President, ImageCat, sg@imagecatinc.com



In the hours following the 12 January 2010 Haiti earthquake, it quickly became evident that this was no ordinary disaster. Multi-lateral organizations were clamoring to discover the true picture of damage to the area and its effect on the people of Haiti, to guide relief and expedite aid. Within 48 hours of the event, the World Bank working with ImageCat and the Earthquake Engineering Research Institute (EERI) launched the Global Earth Observation Catastrophe Assessment Network (GEO-CAN) - a worldwide network of scientists to map the devastation in Haiti. The first maps showing collapsed buildings were being developed almost immediately. This was only the beginning of a unique response effort from an international community of earthquake and remote sensing specialists.

The crowd-sourcing process and the key role it played in Post-Disaster Damage Assessment

After the Haiti earthquake, impact assessment from remote sensing was the most viable option, due to the spatial scale and magnitude of the humanitarian emergency. This was compounded by access limitations to the country and a lack of central administration due to damaged and destroyed critical infrastructure leading to a lack of immediate security. The World Bank (WB), through the Global Facility for Disaster Reduction and Recovery (GFDRR), based in Washington D.C., moved quickly to utilize ImageCat's experience in multi-hazard damage assessment (previous experience has ranged from the World Trade Center to Hurricanes Charley , Katrina , Gustav , tornados , wildfires , tsunamis and earthquakes). At once, a wider team was coordinated to include the Rochester Institute of Technology (RIT), New York, who facilitated an aerial survey of Haiti using their aerial reconnaissance system - the Wildfire Airborne Sensor Platform (WASP). In tandem, a multi-phase damage assessment using image interpretation was implemented, firstly from satellite, then aerial imagery.

For the Phase 1 of the Haiti damage assessment, ImageCat quickly mobilized a consortium of volunteers that responded to the 2008 Sichuan China earthquake and customized the online Virtual Disaster Viewer or VDV (a web-GIS that allows pre- and post-event very high spatial resolution imagery to be used for damage assessment, see www.virtualdisasterviewer.com/) allowing 500 × 500 meter grid cells of the Port-au-Prince area to be assigned to each volunteer. Phase 1 used 50 cm GeoEye-1 imagery, collected the day after the earthquake, and made publicly available by Google. Within 48 hours, a team of over fifty remote sensing scientists identified more than 5,000 completely collapsed buildings (equating to level 5 on the EMS-98 damage scale) across an area of 133 km2. These data were delivered to WB/GFDRR, and used for response efforts and identification of the neediest areas for aid delivery. These data also acted as a precursor for a more in-depth forensic analysis using aerial imagery collected by partner institution RIT. The WB-GFDRR-ImageCat-RIT team flew an area of 650 km2 using the airborne WASP system - a unique and diverse combination of very high spatial resolution (as fine as 15 cm) visible and infra-red sensors, and 3-dimensional LiDAR data.

Anticipating a prolonged effort, the core team of remote sensing volunteers from Phase 1 was swiftly expanded for the second phase damage assessment and formally recognized as the Global Earth Observation Catastrophe Assessment Network (GEO-CAN). The network of volunteers grew to over 600 participants representing 131 private and academic institutions in 23 different countries, from Sudan to China and Germany to Costa Rica. Several strategic organizations were approached to participate in the Phase 2 damage assessment, each with their own established expertise in engineering or remote sensing. Previous partners and users of VDV volunteered, including the Earthquake Engineering Research Institute (EERI), the UK-based Earthquake Engineering Field Investigation Team (EEFIT), MCEER and LESAM at the State University of New York at Buffalo, Georgia Tech, Cambridge University, UK, and University College London, UK, to name but a few. Each participant member of GEO-CAN was an established professional in their field, and was personally coordinated by ImageCat through VDV.

With initial focus of Phase 1 on Haiti's capital, Port-au-Prince, the study area was expanded for Phase 2 to include both collapsed and heavily damaged (grades 4 and 5, EMS-98) areas of Carrefour, Delmas, Léogâne, Jacmel, Grand Goave and Petit Goave, a greater than four-fold increase in the area targeted in Phase 1. Analysis of these areas was also more in-depth, with each heavily damaged and completely collapsed building identified and its image footprint digitized into a GIS database of nearly 30,000 polygons. The distributed damage assessment so effective in Phase 1 was repeated, with each volunteer accessing a restricted area of VDV to check-out one grid cell at a time for analysis. Post-event imagery consisted of the 15 cm optical aerial imagery collected by the WB-ImageCat-RIT Remote Sensing Mission and Google aerial mission, and these were compared with pre-event satellite imagery made available by Google. Once a volunteer had completed each assignment, each 2,500 m2 cell would be checked-in via the VDV system and a GIS file of collapsed and heavily damaged building footprints submitted to a central repository. Each building was also assigned a confidence level and descriptive comments, based on the user's assurance of the damage state for each building.

Data from the expanded Phase 2 was delivered in stages to WB/GFDRR following a rigorous quality assessment by ImageCat. Over a third of the main affected areas around Port-au-Prince and the city's suburbs were delivered within 96 hours of commencement of Phase 2, and in less than three weeks, close to 30,000 buildings had been identified as heavily damaged or collapsed across the study area, solely using remotely-sensed imagery as a data source. The data from this phase was also independently verified using field ground surveys by multi-lateral bodies including The United Nations Institute for Training and Research (UNITAR)/Operational Satellite Applications Programme (UNOSAT), the European Commission (EC)/Joint Research Centre (JRC), the Centre National d'Information Géo-Spatial (CNIGS) representing the government of Haiti, and other U.S. teams (Stanford University and Betero-Fierro-Perry, Inc.). An additional engineering team, led by Cambridge University, UK, conducted more detailed QA evaluations using very high spatial resolution oblique imagery, provided by Pictometry, which was invaluable in determining whether significant structural damage had occurred that did not result in the complete collapse of a structure (e.g., soft-storey collapse). These efforts helped to validate that the assessments produced from the GEO-CAN initiative were accurate in identifying the total number of collapsed structures and that, statistically, the aerial results could be used as an index for estimating damage at all lower levels (i.e., below 'collapsed' and 'very heavy damage' – grades 1-3, EMS-98).

Conclusions and Recommendations

The immense value and usefulness of crowd-sourcing as a mechanism for performing remote sensing based damage assessments was clearly demonstrated in the Haiti event. The use of crowd-sourcing for engineering and scientific objectives, with a very quick call for volunteers and a short turn-around period for the analysis, is particularly unique. The success of the Haiti initiative suggests that the hazards community may be on the cusp of using remote sensing in new and innovative ways. However, the engineering and scientific community would benefit immensely from a) more pre-event training to more effectively recognize earthquake damage from both satellite and aerial imagery, b) a more formal structure for participating, i.e., formalizing the GEO-CAN initiative, and c) extending the protocols to address other natural hazards. A key recommendation from this Haiti effort was to create a formal business plan to ensure that the GEO-CAN community lives on for future events. It was also recommended that a broader involvement be pursued that expands the GEO-CAN community to other relief organizations such as the UNOSAT group and JRC. EERI played a central role in this process and should remain actively involved in order to provide the technical support needed to respond to future earthquakes.