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# LiDAR

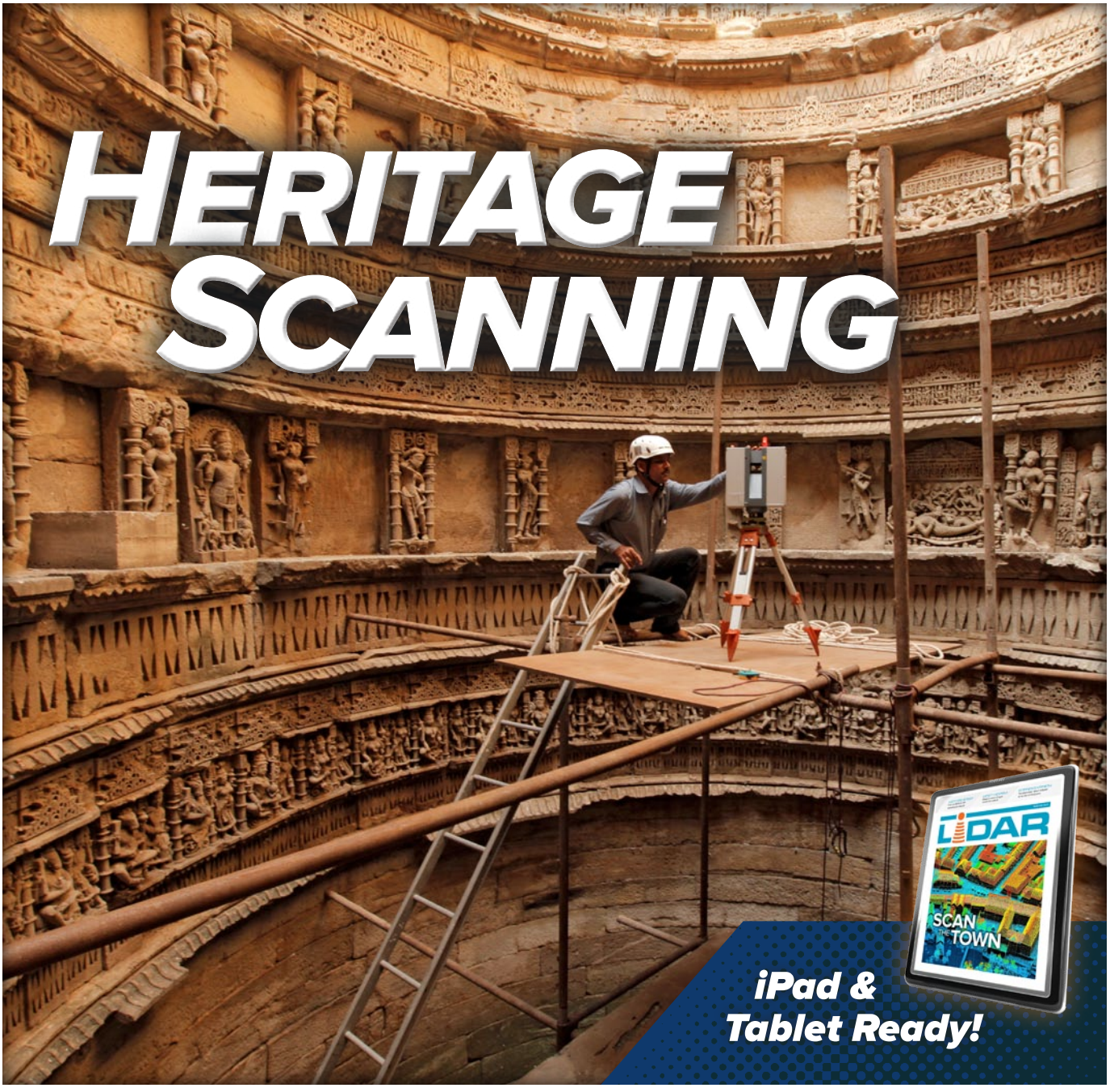

**Figure 1. Examples of the data collected after the 2010 Haiti earthquake:**

**Figure 1A** High spatial resolution imagery, showing the damage to the Presidential Palace.

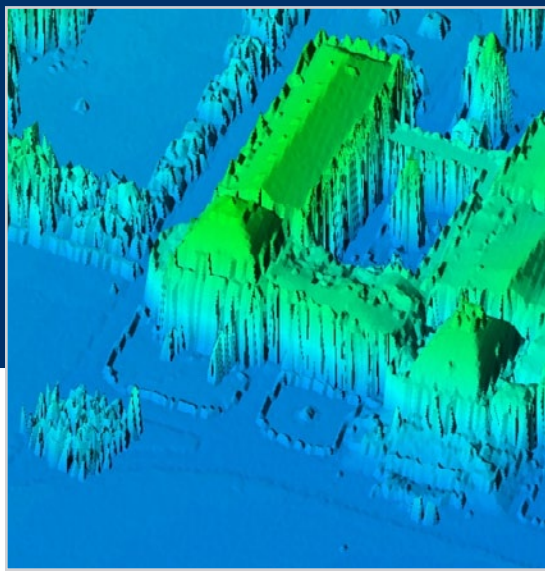

**Figure 1B** Coincident LiDAR-derived grid, the damage is again evident, but in this case, in a structurally quantifiable manner.

# An Inside Look at IPLER

## Developing Remote Sensing Information Products for Earthquake and Flood Mapping

The Information Products Laboratory for Emergency Response (IPLER) is a major activity housed within the Rochester Institute of Technology's (RIT) Chester F. Carlson Center for Imaging Science that seeks to cultivate the application of remote sensing technology and data products within the disaster response community. IPLER was established in 2009 through a grant from the National Science Foundation's (NSF) Partnerships for Innovation program with a focus on bridging the knowledge gap between remote sensing technology and service providers and information product end-users; in essence educating technologists on the needs and constraints of users and educating users on the capabilities of remote sensing technology.

IPLER researchers are actively engaged in the development of new information tools and processes that

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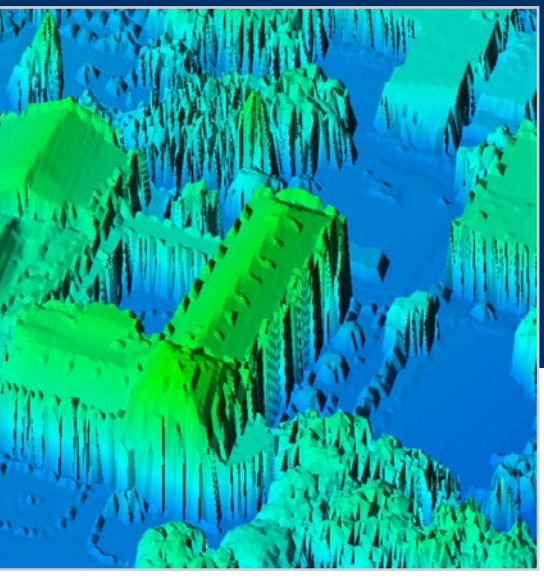


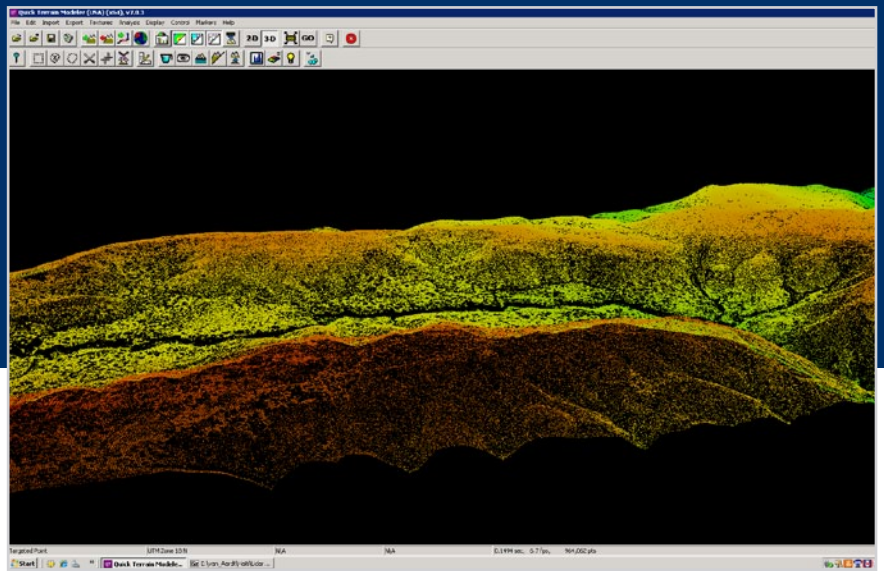


**Figure 1C** A LiDAR point cloud collected over the fault tine.

use remotely sensed imagery as a major ingredient. Some of these include;

- Automated detection and mapping of temporary shelters (blue tarps; multispectral imagery)
- Automated building damage assessment (lidar data)
- Automated wildfire mapping (thermal imagery)
- Delivery of georeferenced multispectral airborne imagery in realtime
- Integrated watershed modeling, spring runoff flooding analysis, and post-wildfire erosion assessment

RIT, through IPLER, has established partnerships with, among others, the University at Buffalo (UB) as academic partner, ImageCat Inc., Kucera International, and Wacom as active commercial partners, and the Monroe County (NY) Office of Emergency Management and New York State Office of Emergency Management (NYS OEM) as local and state-level collaborators. These partnerships in particular have been the bridge allowing IPLER to provide support to actual disaster scenarios.

The IPLER support to the World Bank after the Haiti earthquake disaster in 2010 deserves special mention. High spatial resolution imagery and the only publicly available lidar data were collected over 250 mi2 and rapidly disseminated worldwide via the internet; this effort was cited in an April 2011 UN Foundation/ Vodaphone Foundation report as having "transformed the response". An example of the color imagery and lidar height model is shown in **Figure 1** (Haiti Presidential Palace). Not only was building damage assessed by a global network of engineers using RIT and Google imagery (Global Earth Observation- Catastrophe Assessment Network; GEO-CAN via partner ImageCat Inc.), but the lidar data were used to developed a building damage assessment tool, sponsored by Google.

MS student, Rick Labiak, developed a graphical user interface that could ingest lidar data, apply algorithms to detect buildings, assess their damage levels, and export a damage assessment GIS layer. Rick applied a combination of established and novel approaches to address the challenge: (i) He first extracted building footprints based on lidar intensity values, return number characteristics, and the variability of lidar heights; (ii) next he calculated normal vectors from lidar data for building rooftops and used these to assess damage (**Figure 2**). The results were encouraging in terms of building extraction and damage assessment,

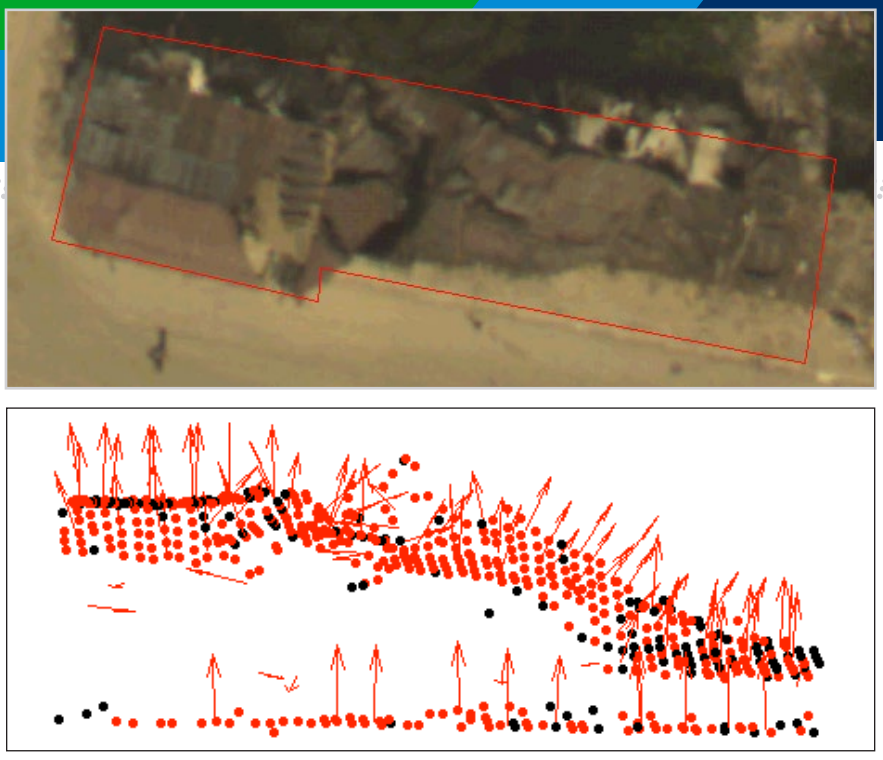


**Figure 2.** Collapsed Grade 5 (demolished) building near the Haitian Presidential Palace that was calculated to be 100% damaged. The red arrows show the normal vectors to the roof plane/s – note that variability in the angle.

although he concluded that the latter could benefit from fusion with imagery.

Following on the success of the Haiti disaster response for the World Bank in 2010, the IPLER team has been very active in 2011 in various exercises and in international- and state level emergencies, thereby highlighting the utility of remote sensing-based information to users and providing valuable insight into user needs to technology/service providers.

When the Tugoku earthquake and resulting tsunami struck Japan on March 11, 2011 the International Charter was activated. Working with the US Geological Survey (USGS) Natural Hazards group, IPLER joined with ImageCat Inc. and a team of other academic institutions to provide map products derived from commercial satellite imagery to emergency managers in Japan. Specifically, IPLER produced maps for the hard hit areas of Kessenuma, Hachinohe, and the Fukushima nuclear power station. **Figure 3** shows an image map created by IPLER showing the Fukushima plant before and after the explosions there.

Finally, as hurricane Irene moved up the east coast in August, IPLER offered to support NYS OEM with imaging of communities along the Schoharie Creek watershed, which experienced a 500 year flood as a result of the storm. The offer was accepted and on 28 August, 48 hours after passage of the hurricane/tropical storm, RIT working with Kucera, collected imagery and lidar data over 28 mi2 and began delivery of data via FTP server to the NYS OEM within 4 hours after collection. Imagery was used to plan recovery efforts and to re-evaluate crucial flood models for the area.

Then, a mere week after the Irene flood, the remnants of tropical storm Lee pounded PA and the southern tier of NY with up to 10 inches of rain. The resulting flood greatly exceeded previous records and forced the evacuation of an estimated 10,000 persons in NY an PA. 20,000 were evacuated in the city of Binghamton, NY alone. Again IPLER responded, and with support from NYS OEM and FEMA, executed a

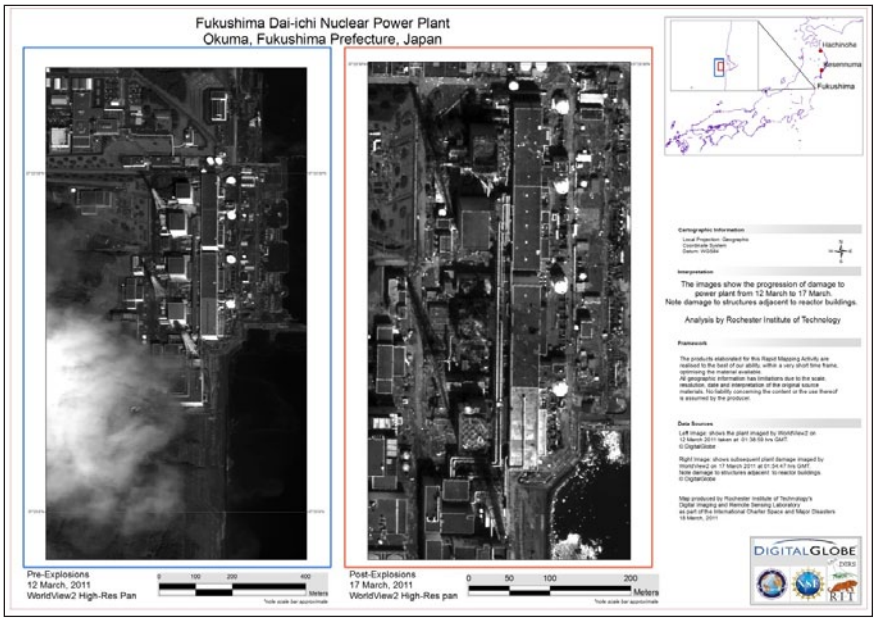
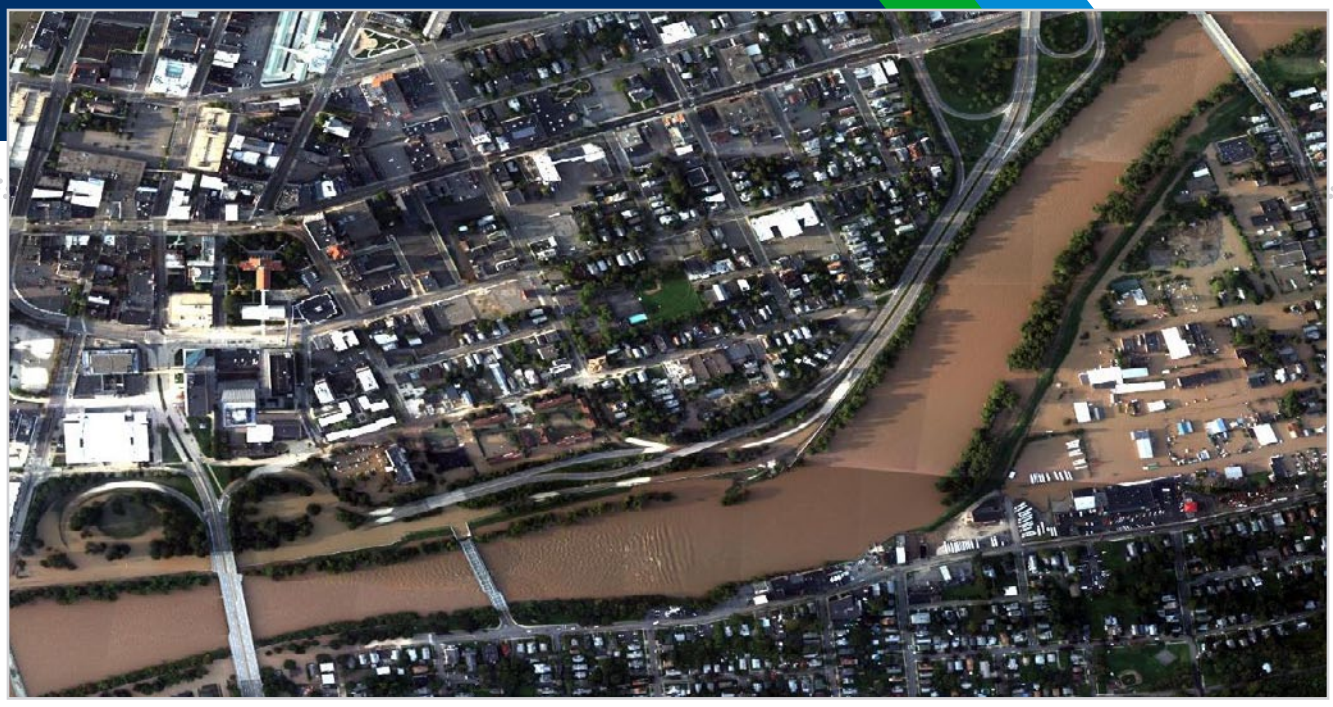



**Figure 3:** IPLER map product showing Fukushima nuclear plant



**Above:** flooded neighborhood in Johnson City, NY. Imagery rapidly collected approximately 8 hours after flood crest.

**Right:** Flood waters pour over the Gilboa Dam on Schoharie Creek following rains from Irene. Imagery provided to NYS by IPLER with 4 hours after collection.

rapid aerial mapping of 23 square miles of the hard hit cities of Binghamton and Johnson City on September 9 approximately eight hours after flood crest. Imagery was available for download 4 hours after collection and a mere 12 hrs after authorization was given to proceed. Flying low, below the cloud layer impervious to satellite imagers, the RIT sensor on the Kucera aircraft collected very high resolution images of the flood in progress. The imagery has been shared with NYS OEM, FEMA, Broome County, and with Energy East, the gas/electric utility responsible for the Binghamton area. Exploitation of the imagery is underway at this time.

The common thread by which the IPLER PFI succeeds is through the relationships and trust built up between providers like ImageCat Inc. and Kucera International, and users such as the USGS, FEMA, and NYS OEM. In a disaster, managers turn to those they trust to understand what they need and who can provide what they want. IPLER and its partners are continually growing in their understanding of the promise and challenge associated with the use of remote sensing derived information in emergency response.

**Jan van Aardt:** Jan van Aardt is an associate professor (PhD Forestry; Virginia Tech) in the Digital Imaging and Remote Sensing (DIRS) group, Chester F. Carlson Center for Imaging Science at RIT, since 2008. He worked at South Africa's Council for Scientific and Industrial research (CSIR) prior to his current appointment. He specializes in LiDAR and imaging spectroscopy applications in forestry and agricultural environments.

**Don McKeown:** Mr. McKeown has a BS in aerospace engineering from the University of Buffalo with 29 years experience as a system engineer project manager developing and operating satellite and airborne remote sensing systems. He currently provides project management and system engineering support for remote sensing research in the Digital Imaging and Remote Sensing laboratory at the Rochester Institute of Technology in Rochester, NY.