Rapid Damage Assessments of **Tabarre and Surrounding Communities in Haiti** following Hurricane Sandy

The timely availability of aerial imagery of the damage caused by Hurricane Sandy, combined with existing open source imagery and census data, allowed analysts to determine with precision where assistance was needed. The ability of drones to acquire the imagery depended on pilots gaining access to the affected areas, but did not require the clear skies necessary for the effective use of satellite imagery, and the drones accomplished the task seven days before the satellites.

Background

On October 24, 2012, while the country was still recovering from the 2010 earthquake and cholera outbreak, heavy rains associated with Hurricane Sandy struck Haiti. The country was hit hard by three days of continuous rains: the Grey river in Port-au-Prince, among others burst its banks, houses were destroyed and at least 54 people died during the storm[1].

Readily operational, the International Organization for Migration (IOM) and the OpenStreetMap Community of Haiti (COSMHA) reacted promptly to the disaster. Both had a local response capacity in place: IOM to support the ongoing relief work following the earthquake, COSMHA because it is a locally based community of Haitian volunteers. One of the first actions was to assess the extent of damage. As soon as the area was accessible (on Sunday, 28 October, four days after the beginning of the emergency), the teams deployed an IOM drone for a damage assessment over two communes along the Grey River[2]. Applying a before-and-after comparison methodology, they precisely evaluated the damages in the flood zone[3].

Figure 1 Imagery taken of the Grey River in Port au Prince is overlaid on a street map. © MapBox, OpenStreetMap

1 Caroit, J.-M., 2012. État d'urgence à Haïti, durement touchée par l'ouragan Sandy. Available at: http://www.lemonde.fr/ameriques/article/2012/11/02/etat-d-urgence-a-haiti-durement-touchee-par-l-ouragan-sandy_1784854_3222.html [Accessed 20 11 2015].

2 IOM, 2012. UAV (Unmanned Aerial Vehicle) as Aerial Mapping & GIS platform. Available at: https://docs.google.com/file/d/0B23KlWXOmZhJTkRlN2h5dmEtdWc/edit?pref=2&pli=1 [Accessed 07 01 2016].

3 Moine, Frédéric. Head of GIS management for IOM and IHSI between 2010-2012. Interviewed by Audrey Lessard-Fontaine. 10. November 2015.

Although IOM Haiti did not foresee using drones for damage assessment prior to this emergency, drones were regularly used for their relief operations in Haiti, and the technical capacity was in place to deploy drones for this purpose. The damage assessment using pre- and post-storm imagery is regularly done with satellite imagery and was adapted for drone imagery instead. The results allowed precise assessment of which houses had been damaged or destroyed and analysis of how to best protect the zone from future disasters.

Implementation

Drone Flights and Data Collection

Having received the information from locals that the river was destroying houses during the storm, OSM members and IOM staff visited the commune of Tabarre along the Grey River to confirm the damages visually. Subsequently, the team delimited a zone along the Grey River to be assessed with drone imagery, and COSMHA members designed the flight plans.

When the winds and rain calmed down the next day, the teams returned to Tabarre to acquire aerial imagery. The drone used was a Swinglet from Sensefly: a fixed wing drone (eBee predecessor) owned and operated by IOM (see Figure 2). The team collected imagery of an area of about 2 km^2 with a resolution of 4 cm in two hours of flights[4].

The post-disaster imagery was processed using Terra 3D to obtain an ortho-mosaic of optical imagery. This imagery would then be compared against the baseline imagery and database that showed the commune before the floods.

For the pre-Sandy (baseline) mapping, IOM accessed two data sources – freely available Bing imagery and previous censuses done in collaboration with the municipality and the national statistics office. The censuses included data on buildings and the individuals living in each building. A dozen COSMHA volunteers helped digitize footprints of the buildings on this pre-disaster imagery.

On Monday October 29th, the teams from COSMHA and IOM started working on the before-and-after analysis using change detection techniques in ArcGIS for Desktop. Inspecting a 3D surface model generated with the imagery they used the nadir view (from above) to determine which rooftops were completely destroyed and rotated the imagery making best use of oblique view (the side angle) to analyse the facades and determine which buildings had been damaged.

The complete analysis specifying which houses had been destroyed and damaged was available four days after the flooding event, on November 1st. In comparison, satellite imagery requested at the same time from the United Nations Institute for Training and Research (UNITAR) Operational Satellite Applications Programme (UNOSAT) was not available until one week after the drone analysis. Several days of cloud cover over Haiti prevented the satellites from acquiring imagery, but the drones are able to fly and take imagery below the cloud cover.

4 Ancavil, Sebastian. GIS Officer at IOM. Interviewed by Audrey Lessard-Fontaine. 21.October 2015.

Figure 2 The Swinglet by SenseFly is the predecessor version of the eBee

Damage Assessment of Infrastructure

The first and main product of this deployment was the damage analysis of the houses around the Grey River area. Thanks to the quality of the data gathered, the IOM/COSMHA teams were able to determine the precise number of houses damaged or destroyed in different communes (see Figure 4). The teams used existing census data to determine the number of people affected.

Having a precise figure for the number people affected was the first step in finding a solution and compensation for the affected population[5]. In addition updating the data directly in OpenStreetMap made it widely available to all actors in the region, including the affected population.

West of the zone shown in Figure 5 is camp St-Étienne where IOM had built shelters. During Hurricane Sandy, the river rose up to the camp boundary (in blue in Figure 5). Using historic satellite imagery, IOM was able to assess the regular level of the river (yellow) and using precisely timed drone imagery the flooding line (red). This assessment was then used to plan a protection wall to limit the risks in case of future flooding events. Obtaining imagery at the time of the maximum flood extent enables analysts to make this kind of assessment.

5 Moine, Frédéric. Interview. 10. November 2015.

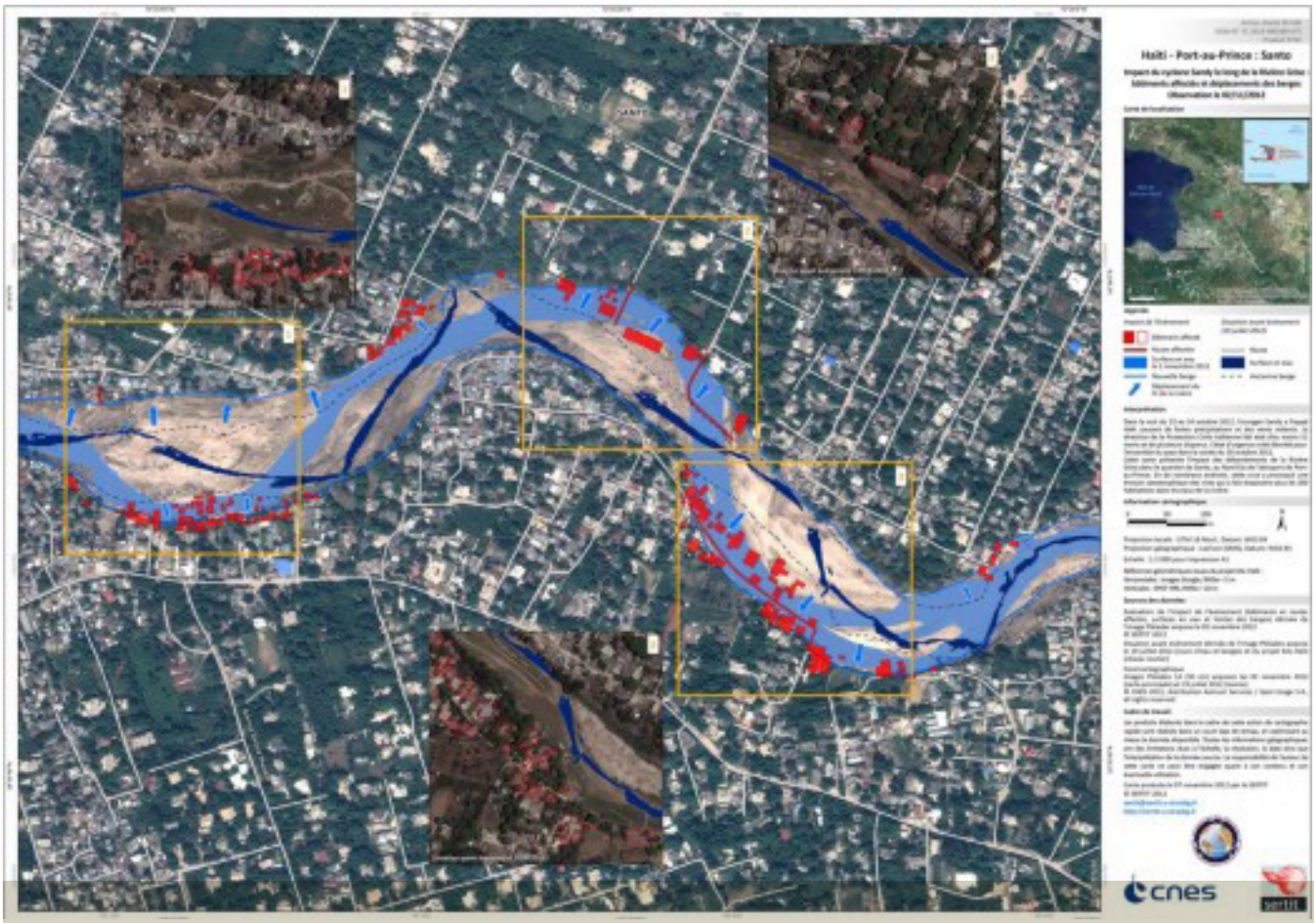

Figure 3 Grey River analysis by the CNES

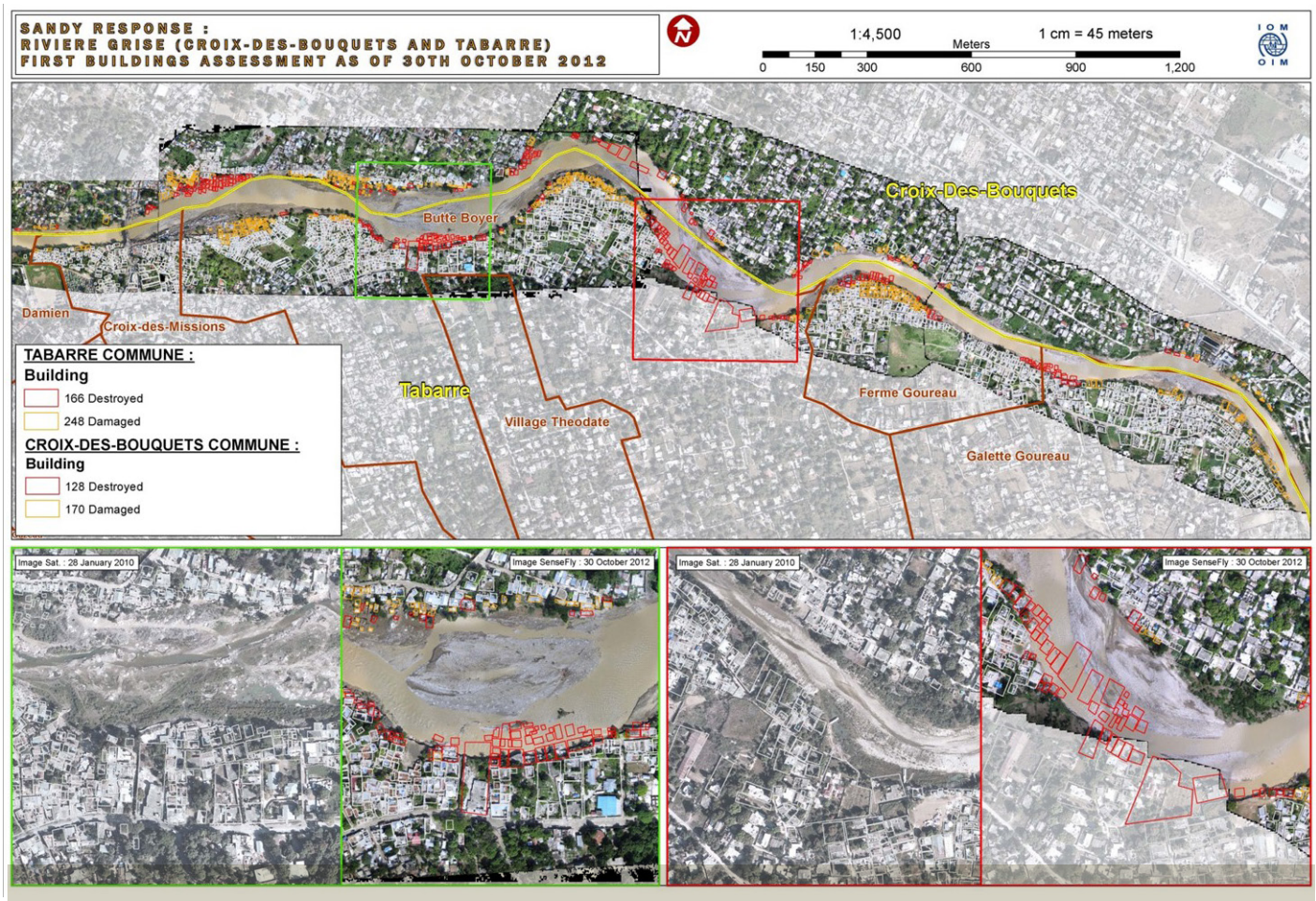

Figure 4 Damage assessment along the Grey River. Analysis conducted by OSM community/IOM

Evaluation

The main benefit of the high-resolution imagery in this case was the precision in the damage analysis and speed at which the local community as well as local authorities and humanitarian community had access to the analysis. This allowed for a swifter and more targeted response as it was possible to know precisely who required compensation.

Choice of Method

As IOM and the local OSM community (mostly COSMHA) had been using drones for some time, the teams naturally decided to use the drone to assess the post-Sandy situation on the ground. In addition to the drone, however, properly trained staff was also a key element in the operation's success[6], and the team needed at least one staff member trained in emergency response, in this case the team leader.

The ability to quickly deploy drones to obtain imagery at the moment of the maximum extent of the flooding is crucial, and the same degree of timing would be very difficult to obtain with satellites.

In terms of time, one IOM pilot flew the drone for two hours to obtain the imagery, which required a few hours of processing to be exploitable. In contrast, under the International Charter on Space and Major Disasters, there are no costs for UNOSAT imagery, but the acquisition required a few days in this case. In terms of coverage, the drone was flown over 2 km^2 along the river, whereas the satellite imagery would be covering a minimum of 25 km^2. To achieve such rapid deployments, drones were required to already be on-site and the affected towns had to remain physically accessible to a drone pilot.

6 Moine, Frédéric.Interview. 23. January 2016.

Figure 5 The Grey River around IDP camp St-Étienne. The blue line is the camp boundary, orange is the riverbank before Sandy, in red the riverbank immediately after Sandy, in black is the projected wall to be built by IOM to protect the camp from future floods. © IOM

Community Engagement and Social Acceptance

The drone deployment was a joint IOM/COSMHA project that also involved the local community and authorities. Moreover, the OSM members are part of the local community themselves. The zone where the drone was flown was not easily accessible to humanitarians and having a team comprising local COSMHA members helped gain the trust of the residents to obtain their permission to access the sites[7].

Plans for Adaptation

There is resilience component involved. COSMHA contributors, and IOM staff members Frédéric Moine[8] and Presler Jean envision using OpenStreetMap data[9] for baseline data to inform for hurricane season response efforts. During an alert, OpenStreetMap members and/or an IOM GIS team would assess damage through fieldwork and discussion with the locals. Then they would conduct drone assessments and a before-after methodology to assess damages as was done after Sandy.

Both the local OSM team and IOM would be operational in case of future events. In addition, the OSM team now has an eBee drone, thanks to Drone Adventures, and they have sought expertise from scientists and specialized non-governmental organizations (NGOs) to develop advanced hydrologic analysis using drone imagery and to build their internal capacity. Late in 2015, COSMHA created the NGO, Potentiel 3-0[10], with the objective to better understanding hydrological risks and to prepare for future hydrological events with the help of digital social innovation, including drone imagery.

For replicating the methodology in other regions or zones, IOM staff member Sebastián Ancavil emphasizes that already being on the ground and operational when Sandy happened enabled the team to deploy the drone and have results ready after only four days[11].

7 Moine, Frédéric. Interview. 10. November 2015.
8 Frédéric Moine was a staff member at the time of the deployment
9 Partially based on high resolution drone imagery
10 See resources section
11 Ancavil, Sebastian. Interview. 21. October 2015.

Resources

OpenStreetMap (OSM) – www.openstreetmap.org OpenStreetMap is often referred to as the “Wikipedia of Maps” as anybody can make changes to the maps online. OSM data are maintained by volunteers and released under an open source licence. In many developing countries, OSM maps are more detailed than Google maps because Google has no commercial incentive to improve its maps in these countries.

COSMHA www.cosmha.wordpress.com is the local OSM community in Haiti

Potentiel 3-0 http://potentiel3-0.net

Acronyms

CNES	Centre National D’études Spatiales (French government space agency)
COSMHA	OpenStreetMap Community of Haiti (Comunite OpenStreetMap de Haiti)
GIS	Geographic Information System
IOM	International Organization for Migration
NGO	Non-Governmental Organizations
OSM	OpenStreetMap
UNOSAT	United Nations Institute for Training and Research (UNITAR) Operational Satellite Applications Programme

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Technical Specifications & Credits

Type of system: Swinglet Fixed Wing Mapping Microdrone
Deploying Agency: IOM and Comunite OpenStreetMap de Haiti (COSMHA)
Piloting Agency: IOM
Dates of Deployment: October 28 to November 1, 2012
Author: Audrey Lessard-Fontaine, Friederike Alschner, Denise Soesilo, ed.

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