

Using High-resolution Imagery to Support the Post-earthquake Census in **Port-au-Prince, Haiti**



The International Organization for Migration, in collaboration with the National Statistics Office of Haiti, conducted a census of areas and populations affected by the 2010 earthquake. Insufficiently precise GPS and out-dated reference imagery were inadequate to the task of clarifying land tenure status. IOM therefore conducted drone flights to obtain the high-resolution imagery essential to the preparation of assessments in Haiti's densely populated slums. The drone imagery enabled the preparation of precise maps of the enumeration areas, and the maps enabled the enumerators to pinpoint exactly which buildings to assess and to link individual buildings to their owners. Local support included volunteers from the Haiti OpenStreetMap community, who contributed directly to the project by digitizing buildings and roads.

Background

Two years after the 12 January 2010 earthquake, many recovery and reconstruction actors faced challenges in rebuilding housing and infrastructure because of unclear land tenure status in Haiti.¹

The GIS unit of the International Organization for Migration (IOM), in support of the National Statistics Office of Haiti (IHSI), conducted a census of earthquake-affected areas and populations with the objective of clarifying land tenure status. As part of this exercise, IOM was mandated to inventory all the buildings of the most affected metropolitan communes, which mainly included the densely populated slums around Port-au-Prince. They collected building information concerning position, type, usage and status before and after the earthquake, and then added supplemental information such as function and the number of inhabitants.

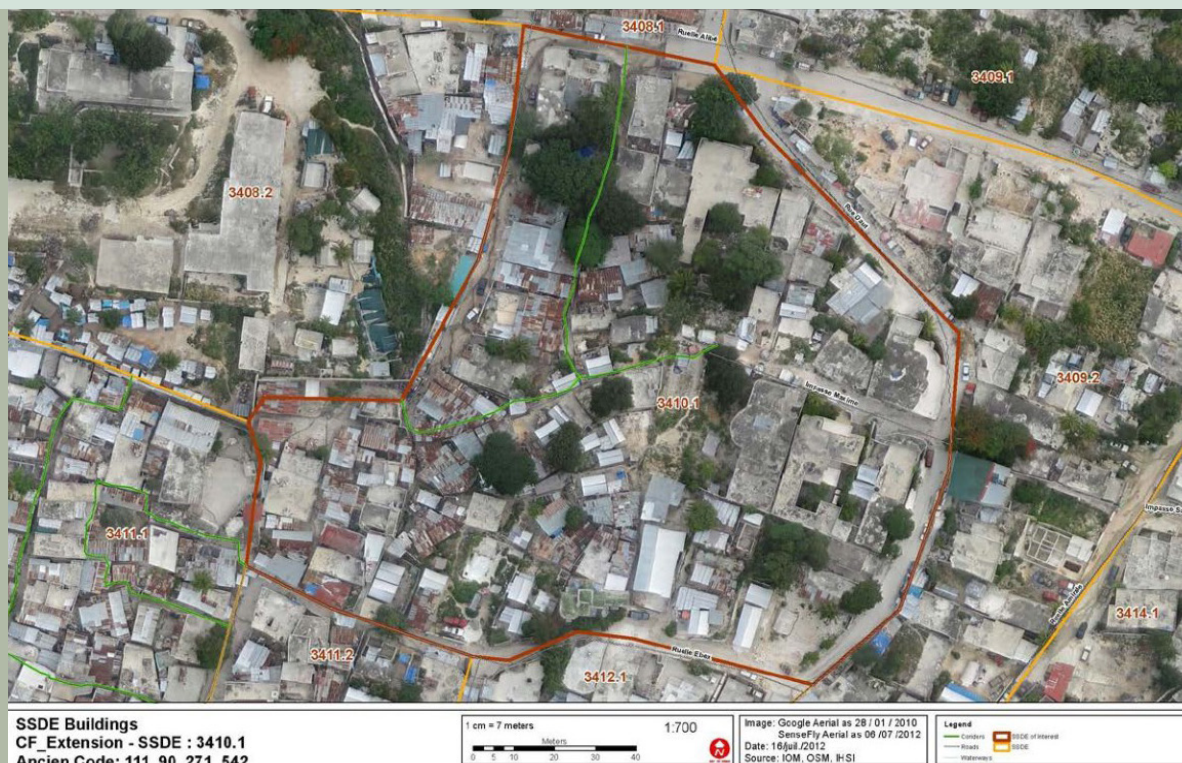


Figure 1 Enumeration area adapted to the ground reality thanks to high-resolution imagery

1 IOM, 2012. UAV (Unmanned Aerial Vehicle) as Aerial Mapping & GIS platform. [Available at: <https://docs.google.com/file/d/OB23KIWXOmZhJTkRIN2h5dmEtdWc/edit?pref=2&pli=1> [Accessed 07 01 2016].

The IOM work included delimiting the enumeration sections² for the census and mapping out roads and pathways within each section. They initially used satellite imagery and GPS, but the GPS was not sufficiently precise in densely populated urban areas, and the reference imagery available was a largely out-dated 28 January 2010 Google aerial photo that did not reflect the reality on the ground.³

To overcome these limitations, IOM considered the possibility of using drones to obtain the necessary aerial imagery, and partnered with the United Nations Institute for Training and Research (UNITAR) Operational Satellite Applications Programme (UNOSAT), who had drones available. Over a period of eight days, UNOSAT staff piloted drones to demonstrate the proof of concept by mapping an IDP camp.⁴

Following the demonstration, IOM acquired its first drone, a Sensefly Swinglet, predecessor of the eBee, and started using it for their operational needs, both for the land tenure/ census and camp management purposes.^{5, 6}

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- 2 The enumeration sections are the basic units of the census surveys, i.e., each enumerator is given a section.
 - 3 IOM, 2012. UAV (Unmanned Aerial Vehicle) as Aerial Mapping & GIS platform. Available at: <https://docs.google.com/file/d/0B23KIWXOmZhJTKRIN2h5dmEtdWc/edit?pref=2&pli=1> [Accessed 07 01 2016].
 - 4 UNOSAT, 2012. *UNOSAT carries out first UAV mission for IOM in Haiti*. Available at: <https://www.unitar.org/unosat-carries-out-first-uav-mission-iom-haiti> [Accessed 04 01 2016].
 - 5 Moine, Frédéric. Interviewed by Audrey Lessard-Fontaine. 10 November 2015.
 - 6 See case study No. 8

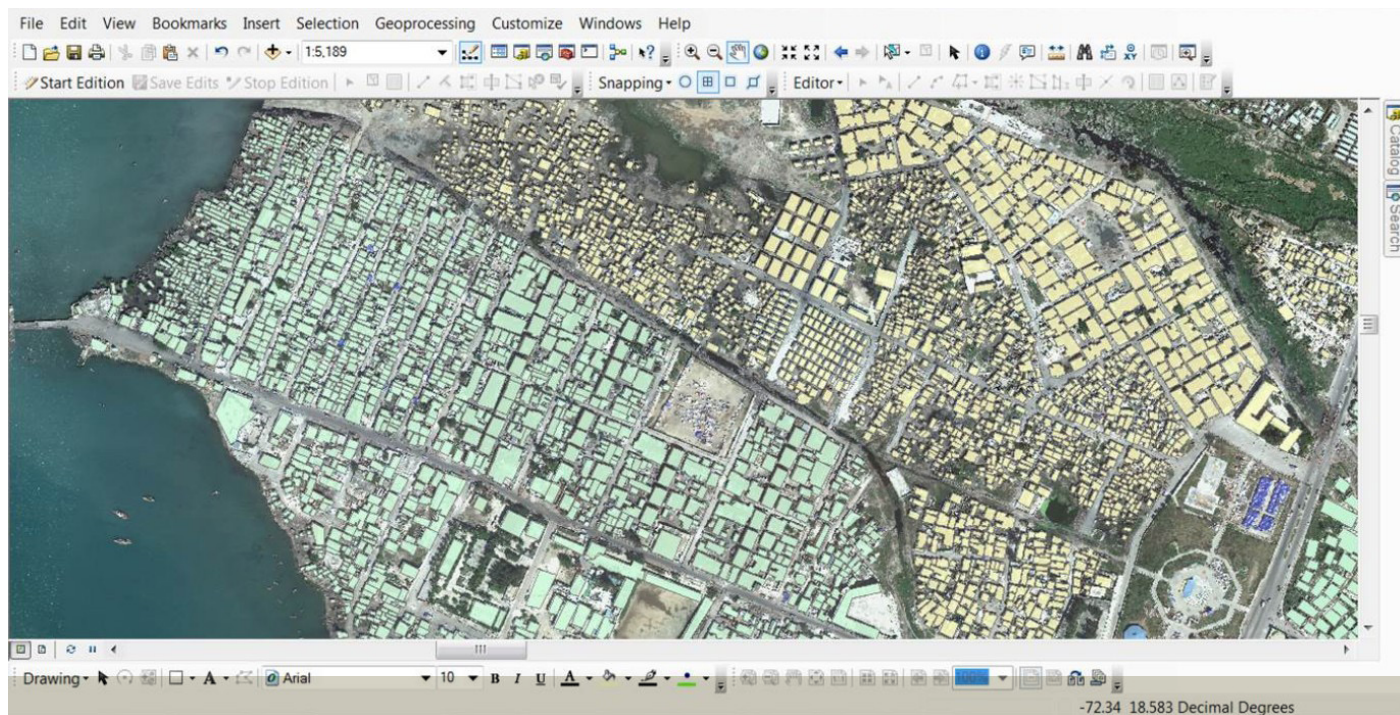


Figure 2 Digitized buildings over high-resolution drone imagery



Figure 2 Data available on OpenStreetMap where everyone can access it. Data digitized through OpenStreetMap are by default public. Therefore all geographic data linked to the project (such as building footprints, roads and pathways) are available to everyone and can be viewed, extracted, used and updated freely.

Implementation

Drone Flights and Data Collection

IOM conducted flights over parts of Port-au-Prince to obtain high-resolution imagery for the enumeration areas for the census. The census project flights ended when the project itself ended in September 2013, but continuing IOM interest in the use of drones for urban planning led to periodic monitoring of some of the neighbourhoods that were assessed for the census.

In April 2013, when the mapping effort was well underway, Drone Adventures joined the project for a 10-day mission to support the data collection as part of a joint project with IOM and the local OpenStreetMap community, COSMHA.⁷ For this mission, they utilized a newer version of the mapping drone, the Sensefly eBee. One controller can operate two of these models simultaneously, and the eBee has a longer flight time (45 minutes as opposed to 20 minutes) than its predecessor. This support mission boosted the data collection, and during these 10 days the majority of

the data for 2013 was collected. In Port-au-Prince, an area of 30 km² was covered in 10 days. In recognition of the advantages of the eBee over the Swinglet, IOM bought an eBee drone.

IOM used Terra3D to ortho-rectify the imagery collected during those flights, and in collaboration with COSMHA, used the imagery to digitize the roads and pathways for the census. These roads and pathways separated the IHSI-defined enumeration areas into clearly delimited sections. In a second step, they digitized and codified all buildings within the enumeration zones and carried out the field survey for the census. Using UAV imagery, IOM adjusted their logistics to take into consideration the reality observed on the ground, for example, by planning the staffing according to the number of buildings in the subsection of an enumeration area. The field teams had clean maps of their areas and were able to assess the full area without missing any buildings.

⁷ https://hotosm.org/updates/2011-01-14_introducing_cosmha
[Accessed 22 02 2016]

Evaluation

The need for highly detailed and up-to-date imagery of the area was the reason for the UAV deployment, and the acquisition and processing of the imagery produced the greatest benefits. The imagery was essential to the preparation of the assessments in densely populated slums where satellite imagery could not yield resolutions high enough to distinguish individual structures. The drone imagery enabled the preparation of precise maps of the enumeration areas, and the maps enabled the enumerators to pinpoint exactly which buildings to assess and to link individual buildings to their owners. The resulting census database was of higher accuracy and required less validation work than previously tested methodologies.

Choice of Method

After the earthquake, teams of experts from different statistics offices arrived to gather demographic information for their respective geographic areas of responsibility. Initially their methodology tested the use of satellite imagery, and did not involve drones. The need to assess the densely populated slums encouraged the development of new methodologies, and the insufficient resolution of the satellite imagery encouraged the team to consider the idea of using drones (Ancavil, 2015).⁸

The availability of this drone imagery resulted in a joint assessment procedure that ensured quality and comparability of the results. This approach helped define a general workflow for the use of drone imagery in censuses, and provided an overall methodology that can be adapted to different contexts.

The great advantage of drones was their ability to acquire aerial imagery whenever needed. The availability of the imagery does not depend on a stable Internet connection (in contrast to satellite imagery, which must be downloaded), and the use of drones might prove less expensive in the long run, since new aerial images are required at regular intervals to represent the fast-changing reality on the ground (Ancavil, 2015).⁹ In fact, the costs for the drone and its maintenance was about US \$25 000 excluding costs for repair. In contrast, one satellite image of a specific area at a certain date and with good resolution can cost up to US \$5 000.¹⁰

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

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

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

Community engagement and social acceptance

COSMHA volunteers from the local OpenStreetMap community digitized the buildings and roads and contributed directly to the project, which IOM conducted in collaboration with IHSI, another local partner.

In terms of social acceptance, UNOSAT, who conducted the first drone mission, states that an important part of their mission was the direct contact with the local community to explain and demonstrate the use of drones. They report that they were met with no animosity towards the drones in the field, but rather with a sense of excitement about the new technology.¹¹

The vision of COSMHA is that the drones help them to ensure that everyone sees the reality on the ground as it really is.^{12, 13}

Plans for adaptation

Haiti is probably the country that has done the most in terms of drone mapping to date. The local OSM community now has its own drone (donated by Drone Adventures), and has acquired the capacity for piloting and post-processing. IOM owns a Swinglet drone and an eBee, and in 2015, after testing a number of multicopter systems, IOM purchased an octo-copter from the German manufacturer MikroKopter. IOM has trained its national staff to fly drones and post-process the imagery, and uses its drones as regularly as 2-3 times a week in different projects. The census was the first IOM drone project, but new applications have come up.

Two other case studies related to IOM use of drones are also available¹⁴.

11 UNOSAT, 2012. *UNOSAT carries out first UAV mission for IOM in Haiti*. Available at: <https://www.unitar.org/unosat-carries-out-first-uav-mission-iom-haiti> [Accessed 04.01.2016].

12 Jean, Presler. GIS Project Assistant at IOM. Interviewed by Audrey Lessard-Fontaine. 08 January 2016.

13 CartONG, 2014. *Cartographie participative avec drone (UAV) en Haïti - COSMHA / CartONG / OSM*. available at: <https://www.youtube.com/watch?v=wQX5jhC2aAY> [Accessed 18.01.2016]

14 <http://drones.fsd.ch/2016/03/17/case-studies-mapping-drones-in-humanitarian-contexts/>

Resources

Port-au-Prince Imagery hosted on MapBox

https://a.tiles.mapbox.com/v4/uaviators.o86f153m/page.html?access_token=pk.eyJ1IjoidWF2aWF0b3JzliwiYSI6Ii-pqZEx2UzgifQ.o6vACHfsO6CTk2yluUZwUA#14/18.5633/-72.3347

Drone Videos from IOM:

Improving public urban space in La Savane, Les Cayes, Haiti https://youtu.be/EXImO_8UkP4

Réaménager Les Cayes (Haïti) autour d'un Boulevard de Mer <https://youtu.be/Vt8o1cnY2UE>

Block by Block: Minecraft Timelapse - Les Cayes, Haiti <https://youtu.be/7iNHESy5P8I>

COSMHA (Communauté d'OpenStreetMap Haïti) Blog <https://cosmha.wordpress.com/>

OpenStreetMap: <https://www.openstreetmap.org/#map=5/51.495/-0.088>

Acronyms

| | |
|---------------|--|
| COSMHA | OpenStreetMap Community of Haiti (Comunité OpenStreetMap de Haïti) |
| IDP | Internally displaced person |
| IHSI | National Statistics Office of Haiti (Institut Haïtien de Statistique et d'informatique) |
| OSM | OpenStreetMap |
| UAV | Unmanned aerial vehicle |
| UNOSAT | United Nations Institute for Training and Research (UNITAR) Operational Satellite Applications Programme |

The views expressed herein should not be taken, in any way, to reflect the official opinion of the European Union, and the European Commission is not responsible for any use that may be made of the information it contains.

Technical Specifications & Credits

Type of system: Singlet Fixed Wing Mapping Drone

Deploying Agency: IOM

Piloting Agency: IOM

Dates of Deployment: May 2012

Author: Audrey Lessard-Fontaine, Friederike Alschner, Denise Soesilo, ed.

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Swiss Foundation for Mine Action (FSD)

7bis, Avenue de la Paix - Floor 2

CH-1202 Geneva

Switzerland

drones.fsd.ch



cartong

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