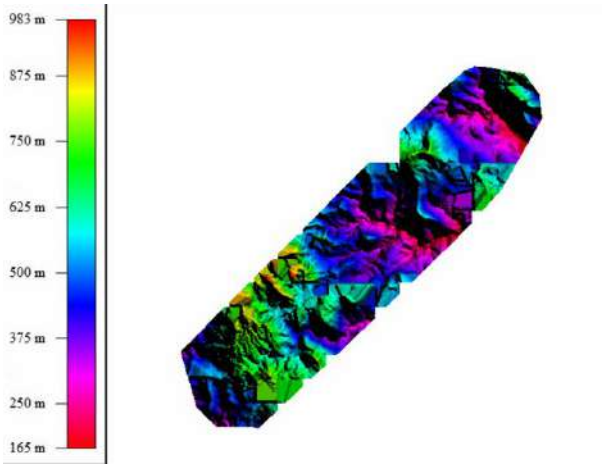
Aerial Mapping of the 2019 Central Luzon Earthquake

Flight area location and suspected location of the fault line



Digital Terrain Model of the mapped area

3D model showing effects of the earthquake

OVERVIEW	
Flying Labs	Philippines Flying Labs
Geographic area	Pampanga and Zambales, Philippines
Date	October 2019
Sector program	AidRobotics
Main SDG	Goal 9: Industry, Innovation and Infrastructure

SCOPE	
Stakeholders (clients)	University of the Philippines Resilience Institute (UPRI)
Challenge	On April 22, 2019, a magnitude 6.1 earthquake shook the provinces of Zambales and Pampanga, with the epicenter located on a mountainous area in Zambales. The University of the Philippines Resilience Institute, which is a research institute focused on reducing and managing disaster risks in the Philippines, has deemed it useful for their research to have an updated aerial map of the fault line area of the earthquake, however considering the mountainous terrain and the size of the area, UPRI currently does not have the capacity to acquire the data that they need - the earthquake caused dangerous rockfalls and landslides on the mountain range and it would be very dangerous for the personnel to be physically present at the mapping site.
Scope	To further investigate the 2019 Central Luzon Earthquake, UPRI has delineated a 32 sq km area in the mountain ranges of Zambales and Pampanga where aerial data would be collected. The desired data products included an orthomosaic, a Digital Terrain Model (DTM) and a 3D model, which were later used by UPRI to conduct additional processing and analysis such as visual analysis of landslide scarps and potential fault traces delineated on the imagery.
Outcome	Taking into account the size of the area and the mountainous terrain, as well the rainy season during the data collection period, it was decided to use a manned aircraft based mapping system to acquire the data. The system was designed for areas of these characteristics and has been previously used in similar projects. The rainy season in this period made it difficult to find a weather window to collect aerial imagery, but the aircraft was able to cover the project area in less than half a day in a single flight in favourable weather. Collected images were processed in Pix4Dmapper the same way drone photos are processed. The methodology of this activity was divided into 4 parts: 1. Project Planning and Preparation 2. Data Acquisition 3. Data Processing 4. Data Analysis Project Planning and Preparation included delineation of the flight area, making arrangements with the pilot, securing necessary permits and flight planning. Based on initial studies, UPRI has located the fault line area and added sufficient buffer to produce the final mapping area.

	In the Data Collection phase, all equipment parts of the system were properly installed and secured to the aircraft. To prepare for weather changes, flight plans with several flying heights were made for different weather conditions. Pix4Dmapper was used to process the images. The outputs included an orthophoto map, DSM and DTM. A 3D model of the mapping area was processed using TerraExplorer Pro. The data allowed for detailed spatial analysis of landslide trends and distribution as a result of the 2019 Central Luzon Earthquake. The outputs showed the damage to the mountains caused by the earthquake. Landslides and rockfalls were clearly visible on the orthophoto map and on the 3D map. The DTM was useful for further elevation change analysis of the damaged areas.
Next steps	With no clear source fault for the earthquake and multiple theories existing, the data can help to understand where the earthquake may have originated. The aerial data outputs and the damage that will be seen in the aerial images acquired right after the earthquake will help UPRI to ascertain the geologic effects and mechanisms related to the earthquake. The data can also be used to produce updated hazard maps which will help determine the vulnerability of the people living nearby, as well as the neighbouring towns and cities.

DATA ACQUISITION	
Size of area	3200 ha (32 sq km)
Aircraft	Cessna (manned aircraft)
Sensor(s)	WaldoAir XCAM B Camera (RGB)
Flight plan software	WaldoAir KML reader
Flight height	6000 ft (1829 m) above ground
Spatial resolution (GSD)	15.9 cm/pix
Number of images acquired	780
Number of flights	1
Time invested in data acquisition	4 hrs (1 day)
Georeferencing	Onboard GPS

DATA PROCESSING & ANALYSIS	
Processing software	Pix4Dmapper, Skyline Photomesh
Processing time	1hr for Pix4Dmapper, 2 days for Skyline Photomesh
Data products	Orthophoto, DSM, DTM, 3D model
Analysis tools	Pix4Dmapper, TerraExplorer Pro
Analysis outputs	3D model
Final outputs shared with stakeholders	Raw images, orthophoto, DSM, DTM, 3D model
Data sharing	Hard drive