Damage assessments and rebuilding of Minamisoma city one month after the Fukushima off-coast earthquake

Orthomosaic of Kashima ward of Minamisoma city

Project briefing

Orthomosaic showing damaged roofs are covered by blue sheet

3D point cloud of a damaged house

OVERVIEW	
Flying Labs	Japan Flying Labs
Geographic area	Kashima ward, Minamisoma city, Japan
Date range	April 11, 2022
Sector program	AidRobotics
Main SDGs	GOAL 3: Good Health and Well-being GOAL 11: Sustainable Cities and Communities

SCOPE	
Project stakeholders	The Nippon Foundation conducting various volunteer work in Japan
People impacted	Citizens of Kashima ward in Minamisoma city Minamisoma municipal office Minamisoma Council of Social Welfare (a center to recruit volunteers who help disaster-affected people) Volunteers
Number of people impacted	About 6500 citizens (part of the Kashima ward)
Challenge	Magnitude 7.4 earthquake hit the north-east side of Japan on March 16, 2022. The epicenter was located in waters off Fukushima coast at a depth of about 57 kilometers. The disaster killed 4 people and injured 225. Minamisoma city of Fukushima prefecture recorded that the earthquake had 6+ intensity on the Japanese seismic scale (the *shindo* scale, ranging from 0 to 7, is different from an earthquake's magnitude, which measures the size of the temblor at its source). Due to COVID-19, volunteer work in the disaster aftermath in the country has been restricted and scaled down. As a result, the disaster response progress was slow and many households were still using temporary roof covers even a month after the disaster.
Scope	Just after the disaster, the Nippon Foundation operated a multirotor drone to assess the damages from the sky. However, this small-sized drone was not best-suited for flying over large areas. Japan Flying Labs then used drones over a larger area of the Kashima ward of Minamisoma city to capture and document the current post-disaster situation. The main goal was to track the roof restoration progress by automatically extracting and locating the plastic sheets covering damaged roofs using drone orthomosaic. This exercise helped to demonstrate the usefulness and effectiveness of drones even months after the disaster.
Outcome	An orthomosaic, DSM, 3D mesh, and point cloud were published for anyone to view on various platforms including the website of Fukushima Oki quake 2022 in Disaster Cross View(BosaiXview). BosaiXview is run by the National Research Institute for Earth Science and Disaster Resilience (NIED) and provides comprehensive information for major disasters in Japan.

	The types of drones used in this project are suitable for flying long distances and mapping large areas. Thanks to this, the stakeholders obtained data on those disaster-affected areas that they could not assess before. This was a valuable source of information, as it allowed the stakeholders to compare the aerial images with the ones they captured just after the earthquake. We proved that the site must be revisited multiple times to correctly assess the roof restoration progress. The completion of roof repairs was confirmed by comparing drone images taken in different periods of time. We found that the number of houses that had previously had their roofs covered with blue sheets decreased over time, but the restoration work was slow, as there were still many houses with temporary roofs even one month after. We also concluded that using different types of drones is beneficial because they can provide different types of information. For example, small multi-copters allowed us to get high-resolution images of precise locations, while other drones were better at mapping a wider area.
Impact	The stakeholders confirmed the importance of using drones as one of the data sources and learned that drone mapping performed periodically is necessary to see the reconstruction progress.
Next steps	Create a method to detect damaged houses and features using artificial intelligence and deep learning. Regardless of the pandemic, the project proved that collecting aerial imagery using drones is useful not only before or immediately after a disaster, but also even months or years after the disaster. Japan Flying Labs will put efforts into emphasizing to relevant authorities the importance of planned recurring drone operations in their workflow.

COMMUNITY ENGAGEMENT AND STAKEHOLDER SUPPORT	
Consent for data acquisition	The Nippon Foundation handled receiving consent from the relevant bodies and community members for data acquisition
Activities to engage with the community	Email exchanges were the main method to communicate with The Nippon Foundation for the project. The briefing by the staff of the Nippon Foundation was held just before flying drones at a car park of the Kashima exchange center, which was a base for the operation and a nearby drone take-off & landing site.
Community groups engaged with	Community in general
Community attendance	Not applicable, as the Nippon Foundation engaged with the community for this project as representative of this project
Community feedback	They were impressed with the orthomosaic showing the “before” and “after” of the roof repairs process
Stakeholder support	The Nippon Foundation is knowledgeable in terms of drone technology and drone data, so minimum support was needed

DATA ACQUISITION	
Size of area	5.05km2 (505 ha)
Drone	VTOL (AS-VT01), Parrot ANAFI-AI, DJI Matrice 300 P1
Sensor(s)	RGB/UMC-R10C, RGB/Zenmuse P1
Flight plan software	PIX4Dcapture for Parrot ANAFI DJI pilot for DJI Matrice 300 P1 Dedicated flight planning software for AS-VT01
Flight height	140 meters above ground
GSD (Accuracy)	4 cm per pixel
Number of images acquired	2356 images
Number of flights	6 flights
Time invested in data acquisition	8.5 hours
Georeferencing	Onboard GPS

DATA PROCESSING & ANALYSIS	
Processing software	PIX4Dreact, PIX4Dcloud, Metashape
Processing time	~1500 images by PIX4Dreact: about 9 mins 2356 images by PIX4Dcloud: 17 hours
Data products	PIX4Dcloud: orthomosaic, DSM (Digital Surface Model), 3D mesh, point cloud
Analysis tools	CloudCompare
Analysis outputs	Extracted blue sheets which were put over damaged roofs from point cloud
Final outputs shared with stakeholders	Orthomosaic, DSM, 3D mesh, point cloud, raw images, XYZ tiles
Data sharing	OAM (OpenAerialMap), PIX4Dreact, PIX4Dcloud, Hinata GIS, Google Drive, Facebook, Google Earth, DisasterCrossView, (BosaiXview)