Deploying UAV technology to assess typhoon impacts in vulnerable communities in Guam

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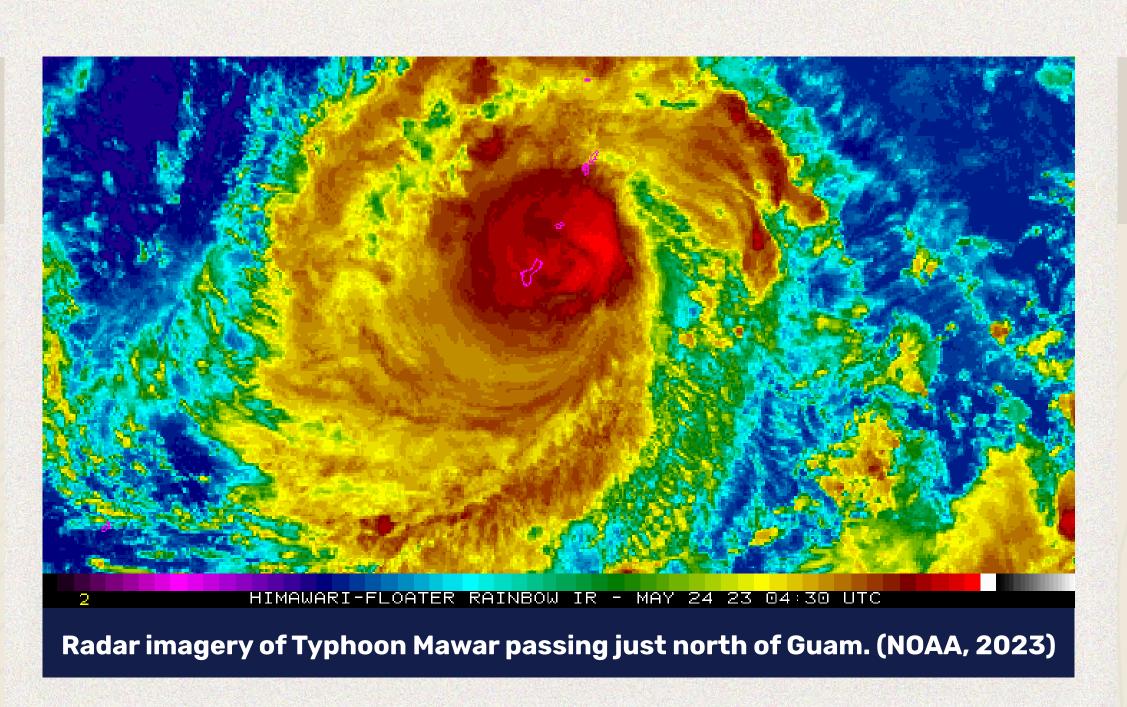
DRONE CORPS — UNIVERSITY OF GUAM — **MAGIC LAB** MICRONESIAN AREA GEOSPATIAL INFORMATION CENTER

INTRODUCTION

The U.S. territory of Guam is threatened annually by high-intensity storms and typhoons due to its location in the western Pacific Ocean[1]. The island's infrastructure bears the brunt of typhoon damage, which in turn affects the public health, economy, and natural resources. Due to their efficiency and costs, drones have emerged as powerful tools for surveying damage following the events of natural disasters such as storms or earthquakes[2]. The University of Guam (UOG) Drone Corps is a program that trains university students to become Federal Aviation Administration (FAA) Part 107b-licensed drone pilots so they can support local resource managers and researchers with high-resolution imagery of the island.

On 24 May, 2023, Typhoon Mawar made its closest approach to Guam as a 225kph Category 4 typhoon. The storm, which was the strongest typhoon Guam had endured in 20 years, left nearly all of the island without power, water, and cellular service. Following the storm's passage, the National Weather Service (NWS) Guam Forecast Office contacted the UOG Drone Corps to request assistance in capturing aerial imagery of priority sites across the island. From 27 May to 08 June, 2023, a coordinated campaign was conducted to collect aerial data using drones. This project showcases how a collaborative drone mapping effort led by UOG Drone Corps remote pilots and the NWS meteorological team can effectively capture the spatial extent and severity of typhoon damage across diverse environments, including urban neighborhoods, coastlines, forests, and other community infrastructure.

1 Spennemann, Dirk. (2004). Typhoons in Micronesia. A history of tropical cyclones and their effects until 1914. 10.13140/RG.2.1.3940.6249/1.

2 Yucesoy, E., Balcik, B. and Coban, E. (2024), The role of drones in disaster response: A literature review of operations research applications. Intl. Trans. in Op. Res., 32: 545–589. https://doi.org/10.1111/itor.13484

Radar imagery of Typhoon Mawar passing just north of Guam. (NOAA, 2023)

UOG Drone Corps pilot Kaya Taitano observes a drone mid-flight during a post-Mawar mapping mission in Hagåtña, Guam.

NASA Guam Space Grant Associate Director Dr. Romina King and NASA Guam EPSCoR Research Associate Jonelle Sayama view an airspace map.
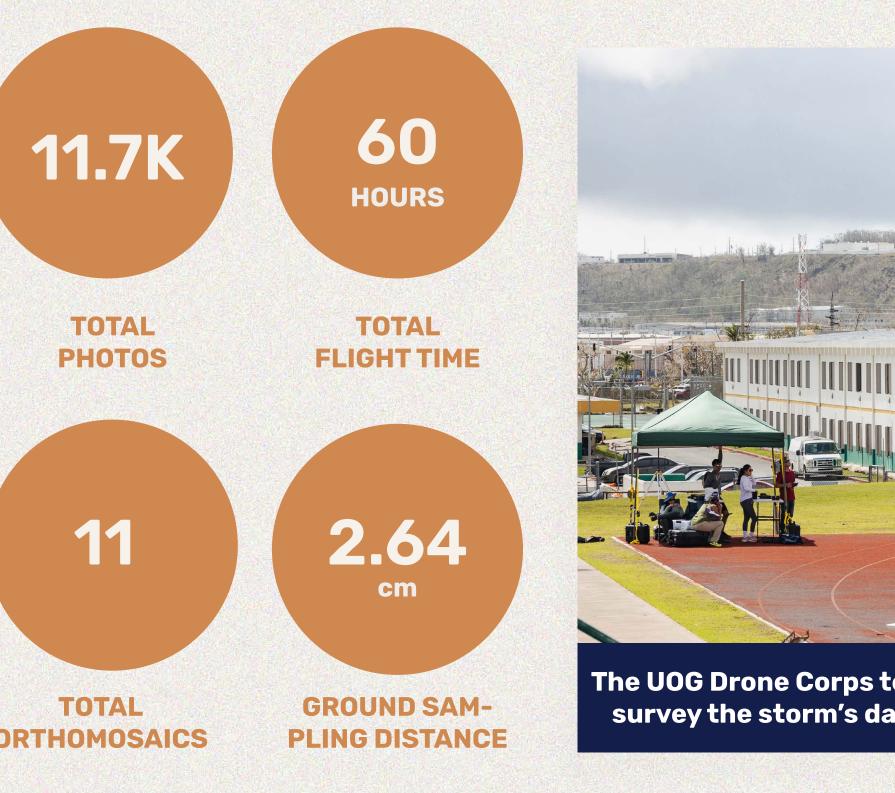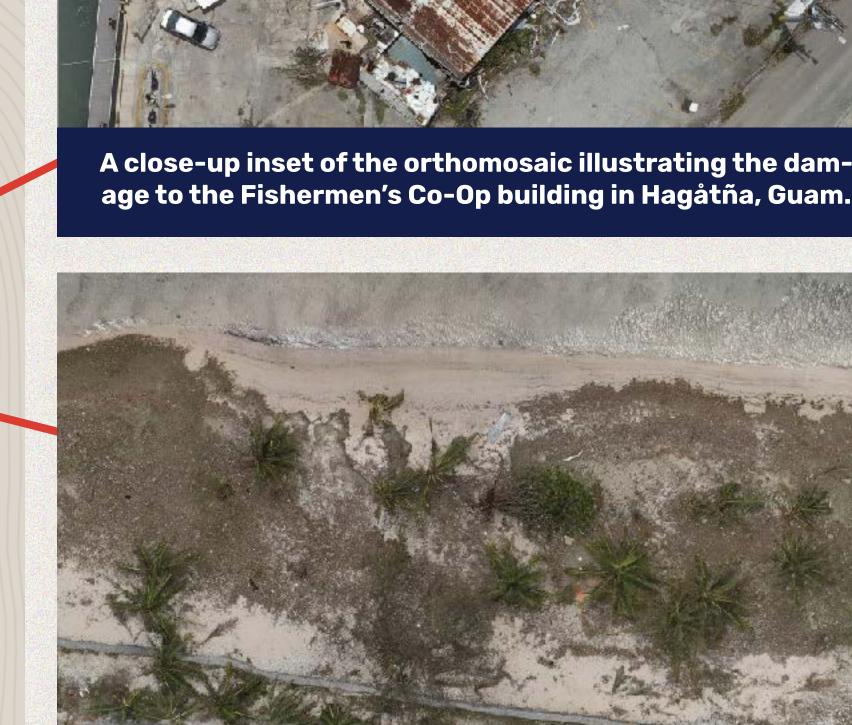
RESULTS

Spanning a two-week period of 60 hours of drone flight, the post-Mawar drone mapping campaign produced a rich set of geospatial data capturing Typhoon Mawar's impact across priority sites on Guam. In total, eleven high-resolution orthomosaic maps consisting of 11,758 total photos were created, corresponding to the surveyed sites. The image resolution of each map contained a ground sampling distance (GSD) of 2.64cm.

11.7K TOTAL PHOTOS
60 HOURS TOTAL FLIGHT TIME
11 TOTAL ORTHOMOSAICS
2.64 cm GROUND SAMPLING DISTANCE

The UOG Drone Corps team launches a drone to survey the storm's damage in Tumon, Guam.

UOG Drone Corps member Kaya Taitano views a drone near a fallen tree in Hagåtña, Guam.

REQUEST ACCESS TO ORTHOMOSAICS AT **bit.ly/uogdronedata**

An orthomosaic map of Hagåtña, Guam following the passage of Typhoon Mawar. This orthomosaic was created from 1974 images taken on 27 May 2023, at 121.92m AGL, with a DJI P1 Sensor mounted to a DJI Matrice 300 UAV.

0   0.25   0.5   1 km   N

Sayama, J., Lee, D. W., King, R., Fausto, K., Taitano, K., & Lujan, F. (2023). Post-Typhoon Mawar Orthomosaic – Hagatna, Guam [Data set]. Zenodo. https://doi.org/10.5281/zenodo.8181218

A close-up inset of the orthomosaic illustrating the damage to the Fishermen's Co-Op building in Hagåtña, Guam.

A close-up inset of the orthomosaic illustrating how Typhoon Mawar affected the shoreline in Hagåtña, Guam.

STUDY SITES MAP

0 2.5 5   10km

LIST OF SURVEYED SITES

1. Ritidian
2. Astumbo
3. Okkodo
4. Dededo (2D)
5. Dededo (2A)
6. Tumon
7. Hagåtña
8. Piti
9. Mangilao (UOG)
10. Pago Bay
11. Hågat

METHODOLOGY

From 27 May to 08 June, 2023, a coordinated campaign between the UOG Drone Corps and NWS Guam Forecast Office was conducted to collect drone aerial data. Eleven sites were selected to be surveyed, which took factors such as airspace, storm path, social vulnerability, and accessibility into consideration. As outlined in the workflow process below, the aerial campaign was conducted in three phases: pre-flight, data capturing, and post-processing:
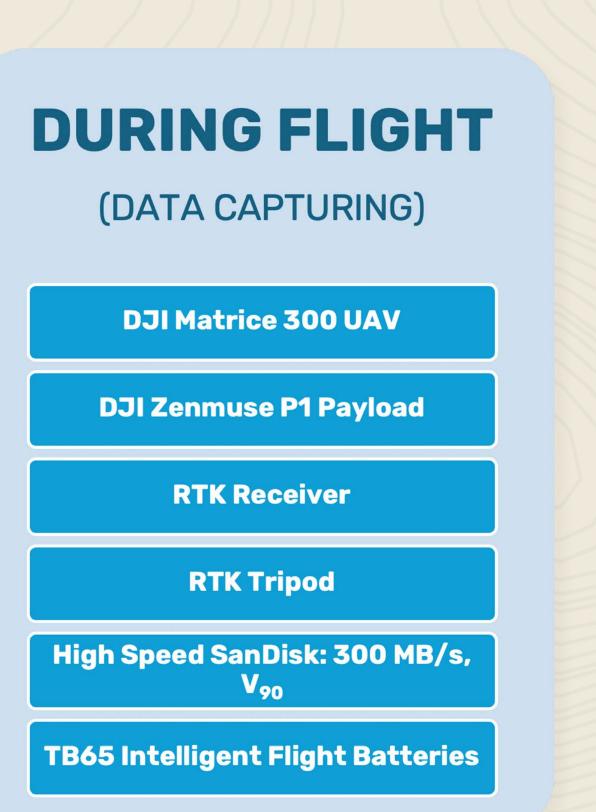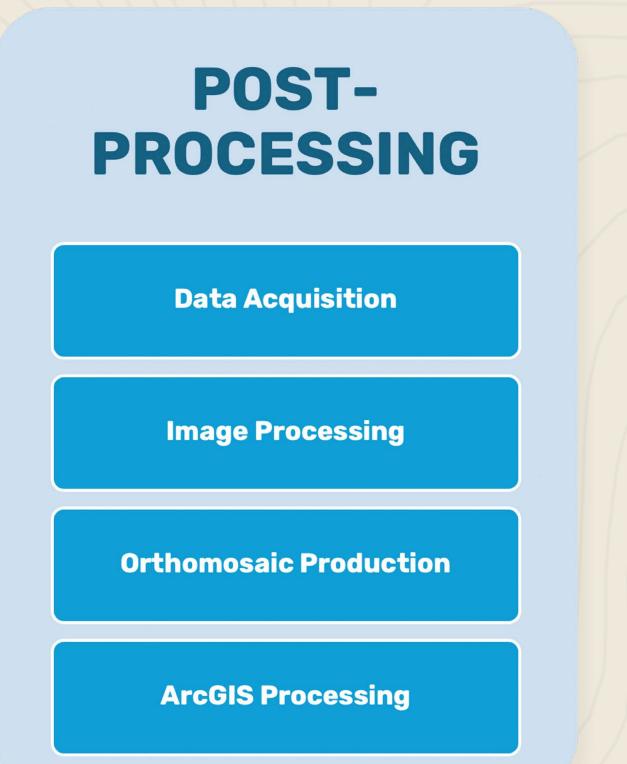
PRE-FLIGHT
- Define Area of Interest
- Flight Planning
- Site Selection
- UAV Maintenance
- Weather and Airspace Check

DURING FLIGHT (DATA CAPTURING)
- DJI Matrice 300 UAV
- DJI Zenmuse P1 Payload
- RTK Receiver
- RTK Tripod
- High Speed SanDisk: 300 MB/s, V90
- TB65 Intelligent Flight Batteries

POST-PROCESSING
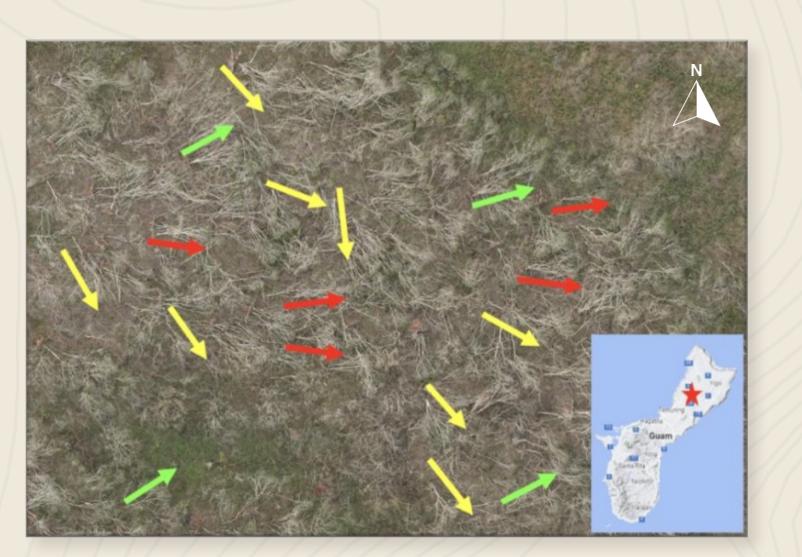- Data Acquisition
- Image Processing
- Orthomosaic Production
- ArcGIS Processing

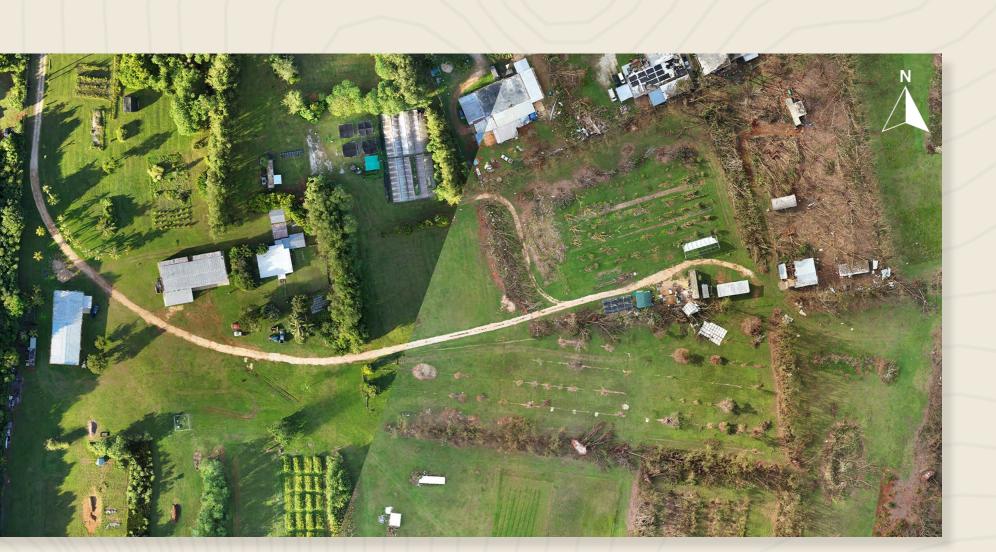## DISCUSSION: COMMUNITY APPLICATIONS

To ensure the collected images from the post-Mawar drone mapping campaign were disseminated to the appropriate end users, orthomosaics were uploaded onto Zenodo. Since uploading the data, the orthomosaics have helped natural resource managers and public officials in developing damage assessments across a number of observations. Below are some examples of image analyses that led to significant post-disaster assessment and recovery efforts.

WIND DIRECTION & TREE DAMAGE

The National Weather Service Guam Forecast Office used imagery of snapped and uprooted trees in north-central Guam to determine wind direction. From the aerial imagery, NWS was able to see that stronger trees were taken down by west and southwest winds.

National Weather Service Guam. Meteorological Report on the Effects of Super Typhoon Mawar (02W) in Micronesia and the Marianas 20-28 May 2023. NOAA.

VEGETATION DAMAGE

The UOG Drone Corps conducted surveys over affected farms, like the UOG Yigo Triton Farm. With the imagery, the team could identify and quantify the percentage of damaged fruit trees. The figure above displays orthomosaics of the farm before and after the storm.

Taitano, K., Velasquez, A., and King, R. (2025). Poster: Optimizing Micronesian Farms with Drone Technology. 2025 Mariana Islands Conservation Conference.

CONCLUSION & FUTURE RESEARCH

The UAV-based damage assessment of Typhoon Mawar was a successful collaboration that illustrated how innovative technology, local capacity-building models, and accessible data sharing strategies can enhance emergency response plans for the island. The project resulted in detailed orthomosaic maps of key areas, leading to actionable insights for community partners.

Moving forward, the workflow can be refined to address challenges of airspace and resources (e.g. electricity loss, long gas station lines). The team can propose plans with agencies to develop collaborative protocols for capturing imagery. The UOG Drone Corps will continue to provide training opportunities for students to become FAA-certified remote pilots so they can assist local government with natural resource monitoring.

ACKNOWLEDGMENTS

UNIVERSITY OF GUAM WESTERN PACIFIC TROPICAL RESEARCH CENTER — NASA — Partner

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