Food and Agriculture Organization of the United Nations

RESILIENCE GOOD PRACTICES

Natural hazards and climate-related disasters

Using unmanned aerial vehicles to improve post-disaster assessment and validation of agricultural damages in the Philippines

Enhancing monitoring for disaster resilience, preparedness and response in a context prone to hydro-meteorological hazards

Context

The Philippines ranks fourth among the world's most disaster-prone countries. The archipelago's over 7 000 islands lie in the path of the most active typhoon generator in the world, as well as in perilous proximity to the Pacific Ocean's volcano-filled, earthquake-plagued pathway known as the Ring of Fire. Around twenty typhoons hit the country on average each year, producing devastating storm surges and enacting heavy losses to the communities and industries in their wake.

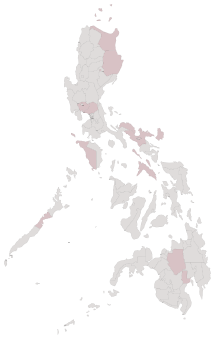
The agriculture and fisheries sector, which contributes about a tenth of the Philippines' gross domestic product, bears among the highest damages due to disasters, averaging USD 477 million annually from 2006 to 2013. From 1990 to 2006, climate-related disasters were responsible for the majority of the damages and losses incurred by the agriculture sector – 70 percent from typhoons, 18 percent from drought, and 5 percent from floods. Agriculture also faces additional risks associated with rapid urbanization, migration and socio-economic changes.

The Philippines withstands these climate-related natural disaster shocks on a regular basis. Over twenty percent of the Filipino labor force works in the agriculture and fisheries sector, and its farming and fishing communities need immediate interventions to recover and build more resilient livelihoods. Crucial to these efforts are reliable information and datasets that can be used as a baseline for developing recovery and rehabilitation plans. As of 2014, the conventional process employed by the Department of Agriculture (DA) in assessing agriculture damages has been to rely on actual site inspection by local agricultural extension workers in the affected municipalities, followed by reports submitted to the DA- Regional Field Offices (RFOs) and then aggregated at the DA central office.

Key facts

Geographic coverage

Bicol and Davao Regions (pilot sites), Cagayan Valley, Central Luzon, MIMAROPA and Northern Mindanao Regions (EPRiMA Pilot Sites).



Conforms to the UN World map, February 2019

Actors and stakeholders

The Department of Agriculture (DA), its Regional Field Offices (RFOs) and FAO.

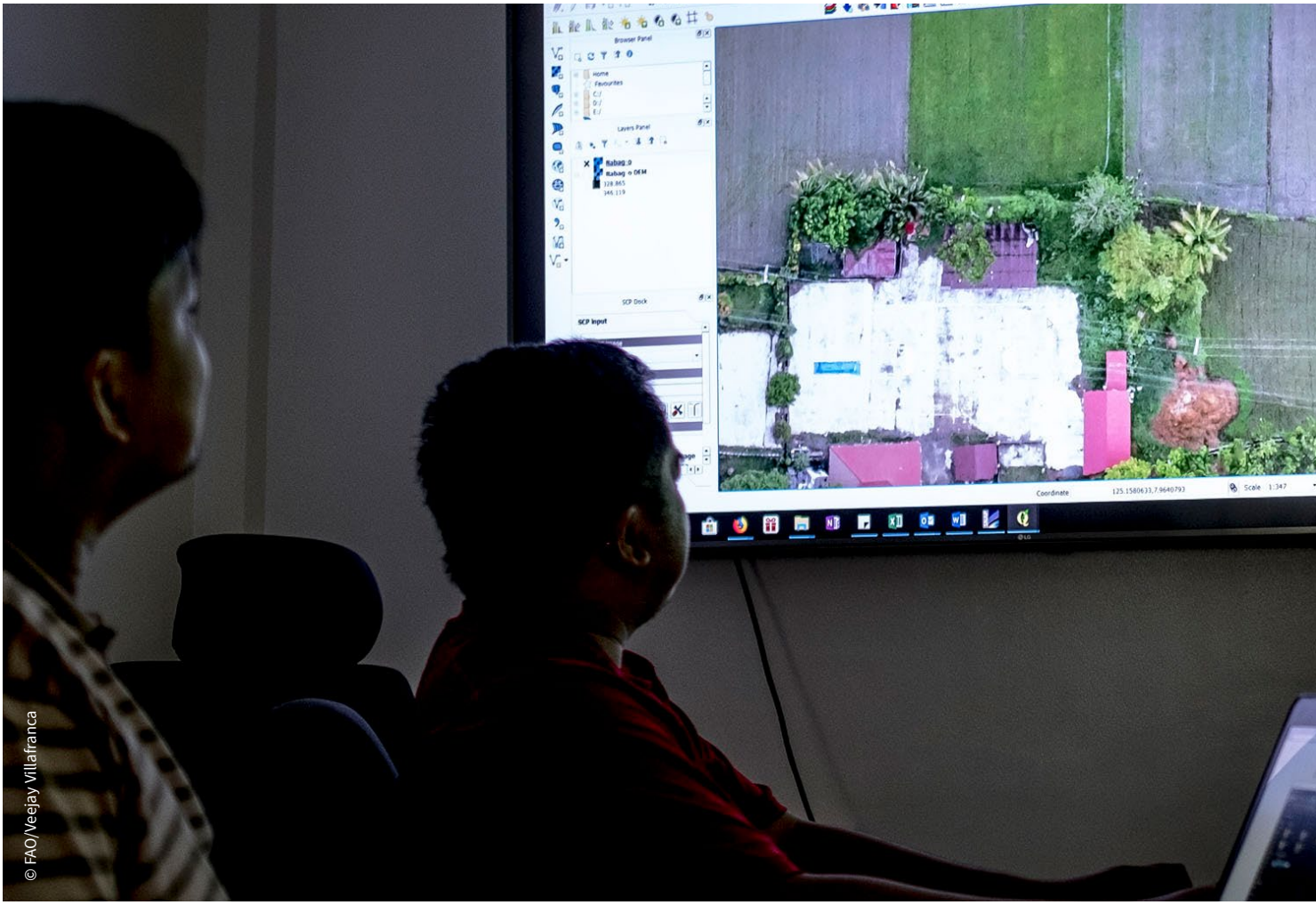
Information and Communication Technology in agriculture

Since the introduction of unmanned aerial vehicles (UAVs) to the Department of Agriculture (DA) in 2015, various emergencies were supported conducting data gathering and validation. UAVs have proven useful in post-disaster assessments, enabling a faster, more convenient and more efficient operation compared with previous RFO manual practices. Now, the DA management is able to get reliable data to support decision making for response and rehabilitation activities.

Challenges

While the assessment of agricultural damages is vital and necessary, the conventional method involving manual validation can often take months, and also suffers from inaccuracies and subjective influence. This lengthy process results in delays and the misdirection of timely recovery support to the affected farmers wanting to resume their livelihoods quickly. When reports are delivered late, farming communities may be forced to forego potential income until the next planting season, making prolonged responses even more detrimental when implemented outside the usual seasonal cropping cycles.

In 2015, the DA and the Food and Agriculture Organization of the United Nations (FAO) collaborated to pilot an unmanned aerial vehicles (UAV)-based methodology for pre- and post-disaster assessment in the Bicol and Davao Regions in order to mainstream innovative ways to enhance Disaster Risk Reduction (DRR) in the agriculture sector. As of 2019, all RFOs are equipped and capable of operating fixed-wing or multi-rotor UAVs, which have been used in numerous areas affected by disasters. This good practice fact sheet looks at how UAVs contribute to strengthening disaster resilience in the Philippines.



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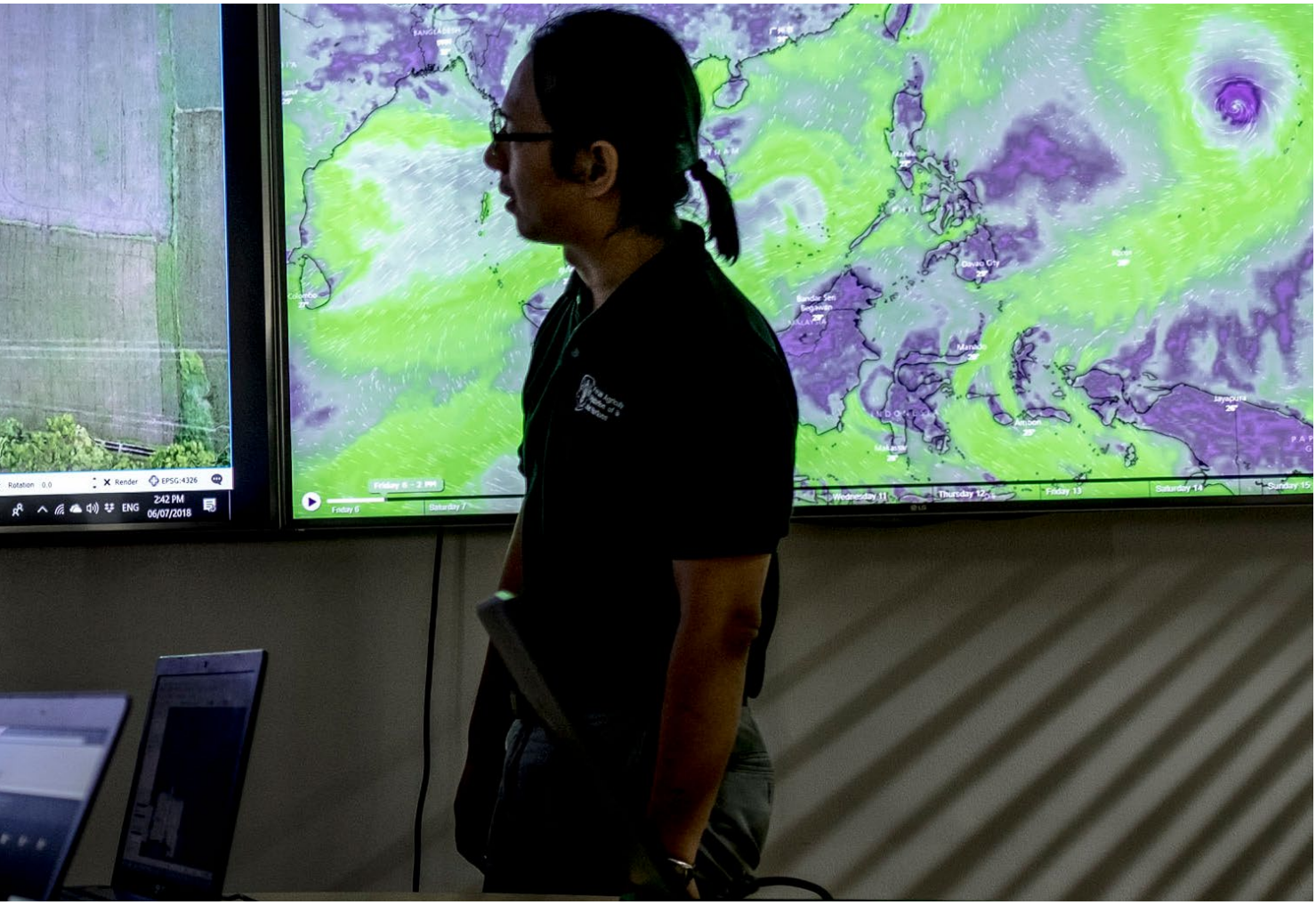
How does the use of unmanned aerial vehicles (UAVs) strengthen resilience of the agriculture sector?

Unmanned aerial vehicles (UAVs) are remotely piloted aerial vehicles. Their use aims to increase efficiency and accuracy in validating damages in the agriculture sector after a hydro-meteorological event such as typhoons, floods and droughts, among others. UAVs thereby expedite the process of collecting and using data needed in creating data-driven and informed recovery and rehabilitation plans for affected farming and fishing communities. They also provide visualization that can support decision-makers in the Department of Agriculture (DA) and in the local government units (LGU) to direct targeted post-disaster activities and investments. Interventions can be implemented faster compared with traditional post-disaster assessments and validation processes. UAVs can also be used in the monitoring of agricultural land and facilities on a regular basis, supporting the management of resources and guiding preparedness action before a disaster strikes. UAVs are an important tool contributing to the overall goal of strengthening the resilience of the agriculture sector. Technical capacity development and empowerment of government responders, as well as increased preparedness of different stakeholders, are critical for disaster resilience.



Methodological approach

In using UAVs to enhance disaster resilience, preparedness, and response in the agriculture sector, it is important to consider a systematic approach to their operationalization. Since 2015, the joint FAO-DA drone initiative has been employing the following approach:

1. **Procurement of UAVs:** The procurement of UAVs underwent several considerations, namely **(a) procurement scheduling and evaluation of technical specifications**, and (b) **the climate of the country.** FAO ensures that the UAVs arrive before the onset of the rainy and typhoon season and crafts specific requirements for each UAV unit, including design customization, fail-safe mechanisms, and inclusion of the latest and top-of-the-line UAV components. This ensures that the UAVs are able to operate at optimal conditions within the target geography and with minimal ensuing costs on repair and maintenance. FAO also includes a training package and assists in the processing of pilot certification when procuring the UAVs. To ensure quality and accessibility, FAO enlisted local UAV suppliers certified by the national civil aviation agency.

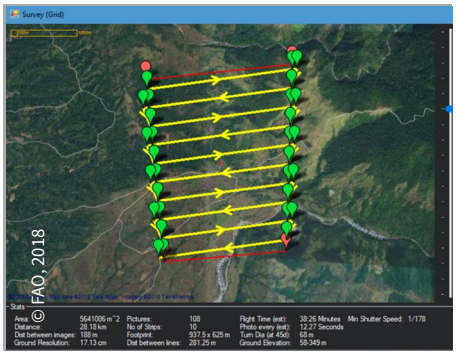
2. **Protocols for field damage validation:** The DA, along with FAO, develops protocols for field damage validation processes using UAVs. The protocols include site selection and base point selection, pre- and post- deployment procedures, sampling methods, and post-flight processing.

3. **Capacity development of UAV operators:** The UAV supplier, duly certified by the Civil Aviation Authority of the Philippines, conducts one-week Ground School and Flight School Training for UAV operators both in the DA central office and in RFOs. The Ground School Training includes basic flight theories, flight planning and flight simulation, while the Flight School training includes actual flying exercises and the post-processing of UAV images.

   Both trainings are held outside of the typhoon and tropical cyclone season. To ensure UAV suitability, test flights are conducted at different topographies in the country as well as a simulation of deployment protocols. Trained personnel are assisted in obtaining their licenses for the operation of remotely piloted aircrafts.

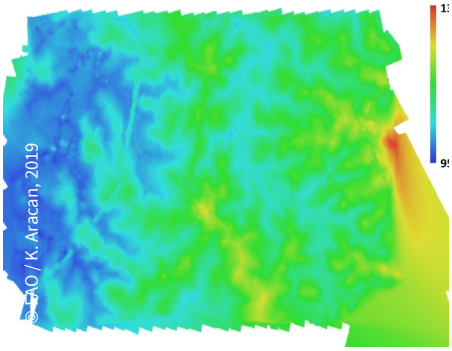
4. **Actual operation:** Trained DA staff are deployed to areas severely affected by hazards, and are able to produce orthorectified mosaic images, videos, digital elevation models, and shape files of damaged areas to facilitate post-disaster validation. The outputs produced by the UAVs include:

   - **Orthorectified mosaic maps:** Individual images captured throughout the flight undergo color correction and are then stitched into one big map. This raster dataset is used in geographic information system (GIS) software to facilitate post-processing, such as area digitization and area computation. The maps are helpful in evidence-based planning and decision-making.



Sample output of the mission planning exercise during Ground School Training.

Orthorectified map of rice area in Barangay Calancuasan Sur, Cuyapo, Neuva Ecija after the onslaught of Typhoon Mankhtu.



Digital elevation model of rice areas in Echague, Isabela.

- **Corridor runs:** Multiple images stitched into a single image are then used to calibrate remotely-sensed images captured after a disaster. Corridor runs help compute the changes in the landscape before and after a disaster has occurred.

- **Quadcopter videos:** Videos of the damaged areas provide a bird's eye-view of the extent of damage. This presents decision makers and officials with a clear visualization of the actual conditions of the affected areas remotely and guides them in their reporting and planning.

- **Digital elevation models:** Visual models show the topography of the area under survey, enabling the planners and validation team to visualize the terrain and use elevation data for other purposes.

- **Damage validation reports: Damage reports are generated for field missions after a disaster assessment. They include outputs of the UAV and on-the-spot interviews with local government agriculture experts and farmers.**

5. **Follow-up training:** To further refine the operators' skills and techniques during deployment, routine UAV operations are conducted. This helps to ensure that the acquired units for deployment are ready and have no technical or mechanical issues. Through regular flight operations, FAO and the DA are able to sustain the continuity of UAV operations and facilitate necessary knowledge transfers to the DA. FAO encourages the implementing partner to be an active counterpart in most of these activities to ensure ownership of the capacity development initiative.

Testimony

Lowell D. Rebillaco is an agriculturist in the Department of Agriculture (DA) Regional Field Office (Central Luzon) and is championing the use of Unmanned Aerial Vehicles (UAVs).

Prior to the use of drones, his office usually conducted days of ocular validation and field interviews to assess the extent of agricultural damage brought by hydro-meteorological calamities, pests and diseases. Things changed in 2017 when the DA started to use UAVs. He says:

> *Utilization of UAVs reduces our time in validation activities since it can cover large areas compared to ocular inspection. This provides us with ample time to validate more affected areas based on the figures and location reported by our Local Government Units (LGUs) counterparts. At the moment, we are utilizing UAVs not just in the validation of affected areas but also for the monitoring of other programmes and projects of the department. The footage and images captured by UAVs provide easy explaining of the actual situation in the field as well as the tangible status of the project on the screen later.*

Impacts

Since the introduction of UAVs in post-disaster assessment and validation in 2015, the maps and images produced, data and subsequent assessment reports documented, and actions taken by decision makers highlight the improved capacities and approaches of disaster resilience in the Philippines. The two main impacts include:

1. **Institutionalization of UAV usage and sustained capacity development:** The UAV-based approach has been incorporated into the regular functions of the DA through the establishment of the Disaster and Climate Information Office. UAV operation teams have also been formed at the national and subnational office levels.

   UAVs are further being used to validate the outputs of the National Drought Monitor implemented by the DA. Before the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) officially declared a mild El Niño event in the country in early 2019, the DA had already identified areas experiencing dry spells in Mindanao. The RFO deployed UAVs and was able to confirm the presence of water stress-affected crops. Through the use of UAVs, the government saved time and resources by not sending personnel from the central office to assess the situation in person. The exchange of information between field personnel and technical staff in Manila meant that analysis and resilience action plans could be formulated at a much faster pace.

2. **Enhanced resource allocation:** UAVs in the Philippines have proven useful in post-disaster assessments, enabling faster, more convenient, and efficient operations compared with the previous RFO manual practices.

   - With UAVs, government agencies such as the DA and LGUs can conduct disaster-related work in a more agile, objective and prudent manner. Before the introduction of UAVs for DRR operations in the agricultural sector, a team of manual inspectors was only able to validate about 100 hectares per day. With the use of UAVs, post-disaster validation can now cover a total of more than 2 000 hectares per day without sending personnel to hard-to-reach sites.

   - The training of personnel and direct procurement of UAVs are more economical than relying on the professional services of UAV operators and engineers on a per-need basis. As per the 2019 service rates of the Geodetic Engineers of the Philippines, a single flight of a UAV covering up to 800 hectares would cost twice the amount of the FAO-procured package, consisting of the UAV twin-engine unit, training and after sales support.

   - With less effort needed for validation, more time can now be devoted to planning for response and rehabilitation action. This means that farmers can receive support from the government and stakeholders faster, enabling affected populations to bounce back quickly and smoothly. This has been observed in post-disaster operations in Cagayan Valley, which was affected by Typhoon Mangkhut and Yutu

in the latter part of 2018. With the help of UAVs, rehabilitation plans were already formulated a week after the super typhoons hit, whereas during Super Typhoon Haiyan in 2013 it took about a year to complete damage data collection, resulting in a much-delayed rehabilitation plan for affected communities.

Sustainability

Key to the sustainability of UAV-based approaches to post-disaster assessments and validation is the gradual process of institutionalization within the DA, starting with the interest and willingness of the government to adapt and invest in this technology despite the relatively high cost of investment capital. The government can then reduce significant costs and time spent on traditional methodologies through the utilization of its annual development fund and the Disaster Risk Reduction and Management (DRRM) Fund for UAVs.

Strengthening coordination between the DA Central Office, RFOs and LGUs is thus important for effective piloting and implementation. As of 2019, both central and regional offices have undertaken initiatives to institutionalize the use of UAVs into the regular operations of the DA. UAV and GIS focal units were established in the RFOs, specifically to aid capacity development and sustainability. Both private and public Filipino entities are working on the research and development of UAV technologies, providing opportunities for support and innovation.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Replicability and upscaling

The success of the UAV-based approach to post-disaster assessment and validation can be attributed to the commitment of the DA to scale up and expand the results of the 2015 pilot project funded by the European Commission Humanitarian Aid department's Disaster Preparedness Programme (DIPECHO) in partnership with FAO. With the scaled up efforts to develop the Enhanced Production and Risk Management in Agriculture Integrated Decision Support System (EPRiMA) project, the DA has continued to acquire more UAVs and conducted trainings on UAV operations and mapping technology.

By 2020, the DA plans to create a UAV technology center that can build its own UAVs. This will enhance the capacity of the DA personnel and attached bureaus and agencies in the application of UAVs and related geo-spatial technologies in the agriculture and fisheries sector. FAO is also planning to revise all training modules (currently all in English), including those focusing on the UAV operation, by the end of 2019. This will include regular training activities where UAV teams can practice flight operations, refine their skills, and share information.

Local suppliers able to manufacture or assemble UAVs are critical to replicating the practice in other areas or contexts.

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