WORST-CASE SCENARIO

ISHVEENA SINGH LOOKS BACK AT HOW INDONESIA USED LIDAR UAVS FOR THE FIRST TIME TO CREATE MAPS FOR LAND PLANNING AND RECONSTRUCTION IN THE AFTERMATH OF THE 2018 EARTHQUAKE AND TSUNAMI

Located along the Pacific's Ring of Fire, which contains the most active volcanoes of all countries in the world, Indonesia is at constant risk of natural disasters such as earthquakes, tsunamis, floods and volcanic eruptions. According to the World Bank-managed Global Facility for Disaster Reduction and Recovery (GFDRR), the country has witnessed an average of 289 significant natural disasters per year over the past three decades.

Earthquakes are an everyday occurrence. But the one that shook Indonesia on 28 September 2018 was no ordinary tremor – the only way scientists could describe it was as the 'worst-case scenario'. A magnitude 7.5 earthquake struck the city of Palu on Sulawesi island and triggered a series of catastrophes. The powerful quake sent a 1.5m tsunami barrelling into the city. An estimated 4,400 people perished in the double disaster and more than 173,000 were displaced, and there was widespread soil liquefaction.

Housing relocation, restoring the damaged infrastructure and taking steps to prevent future disasters were high on the Indonesian government's priority list after the quake, especially with the tsunami wiping out coastal areas and liquefication turning entire neighbourhoods into rivers of sludge. The government earmarked around 1,100ha for which precise, updated maps were urgently required.

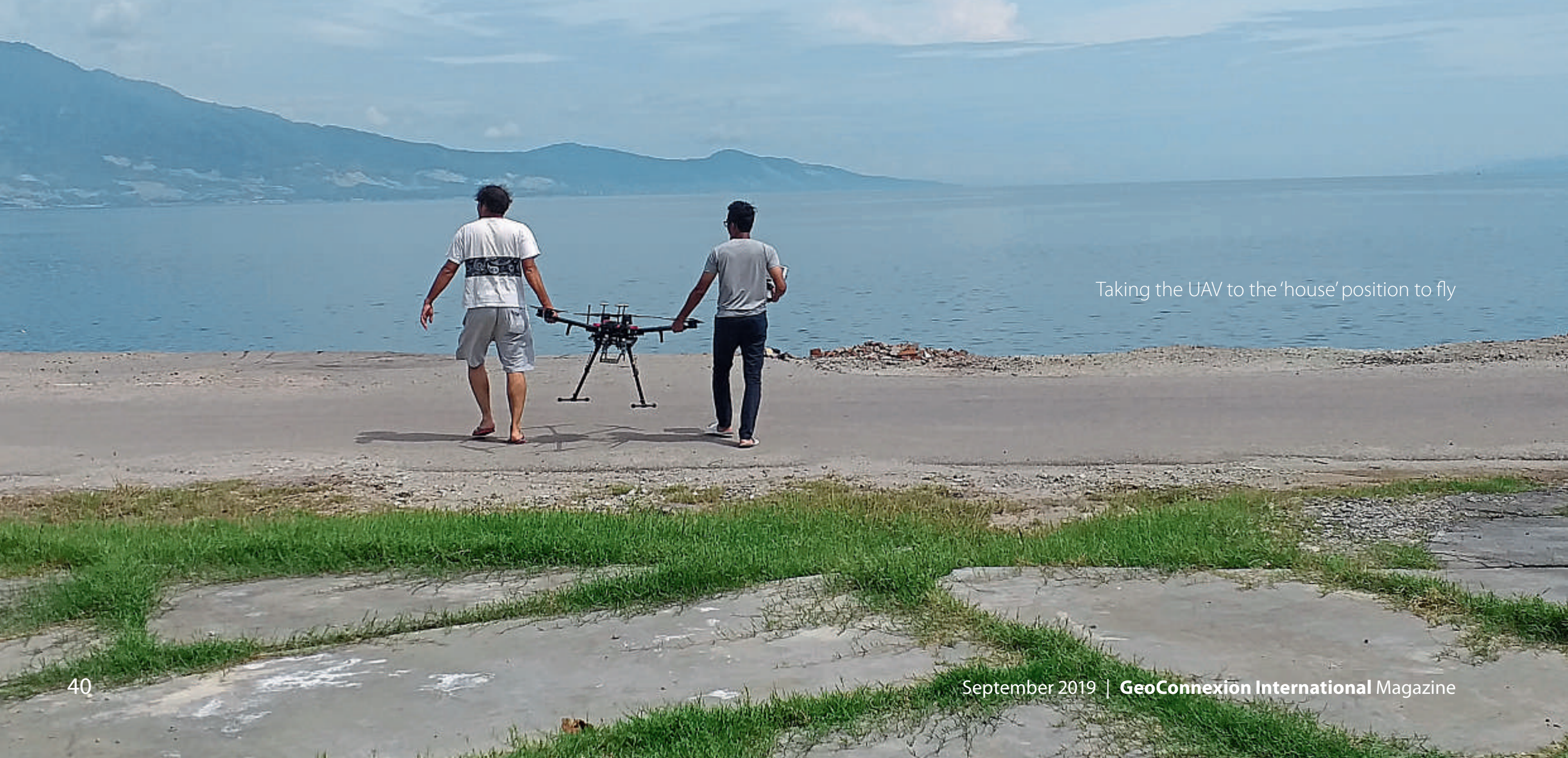
Traditionally, this activity would have been tasked to field surveyors who would have taken up to six months to provide the desired results. However, the tsunami had made large swathes of areas inaccessible and a dozen aftershocks hit the region every day. Undertaking a ground survey would therefore have been both difficult and risky for human surveyors. Furthermore, as more than half of the area selected was overflowing with thick vegetation, there was no telling what surprises the topography may hold.

The job clearly needed to be delegated to machines.

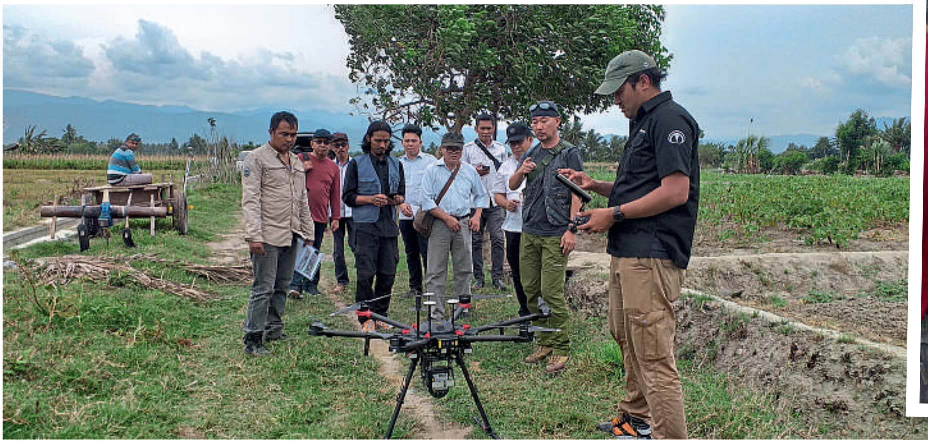
UAVs to the rescue

With help from the Japan International Cooperation Agency (JICA), Terra Drone Indonesia was recruited for the job. Armed with flight permissions from the local air navigation authorities, the UAV start-up first got down to map approximately 350ha of the coastal area using photogrammetry techniques.

To establish a precise control network, two GNSS receivers were set out to connect the baseline data with a national GPS continuously operating reference station, which was known to be stable in the aftermath of the disaster. A total of 10 ground control points (GCPs) were spread out using wooden pegs and tarpaulin panels to mark the surface. Collecting measurements every 30 to 90 minutes depending on the baseline length, the team measured the centre points of the



Taking the UAV to the 'house' position to fly



Preparing for the LiDAR flight

Charging the batteries in between activities

GCPs to obtain a post-processing accuracy of less than 2cm for the base network.

Braving high winds at the coast, a DJI Phantom 4 Pro flew at an altitude of 85m and an average speed of 8m/s. The team covered the entire coastal area in 13 flight paths. The images captured had an 80% frontal lap and 75% lateral overlap between the flying segments.

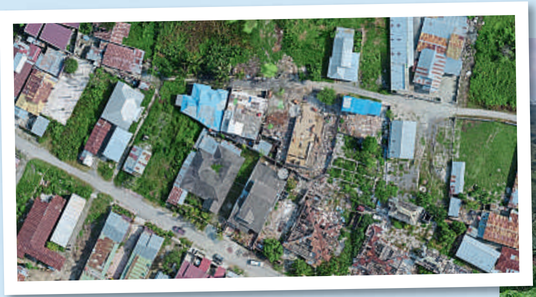
Agisoft PhotoScan software automatically triangulated the images using the GCP coordinate data, providing the delivery dataset a horizontal accuracy of better than 5cm and vertical accuracy of greater than 10cm. A 3cm/pixel GSD orthomosaic was produced along with an approximately 20cm/pixel GSD digital surface model (DSM). A digital terrain model was also produced using the DSM using a stereoplotting method wherein the breakline was generated manually from the ortho-DSM to filter the non-ground objects.

First tryst with LiDAR tech

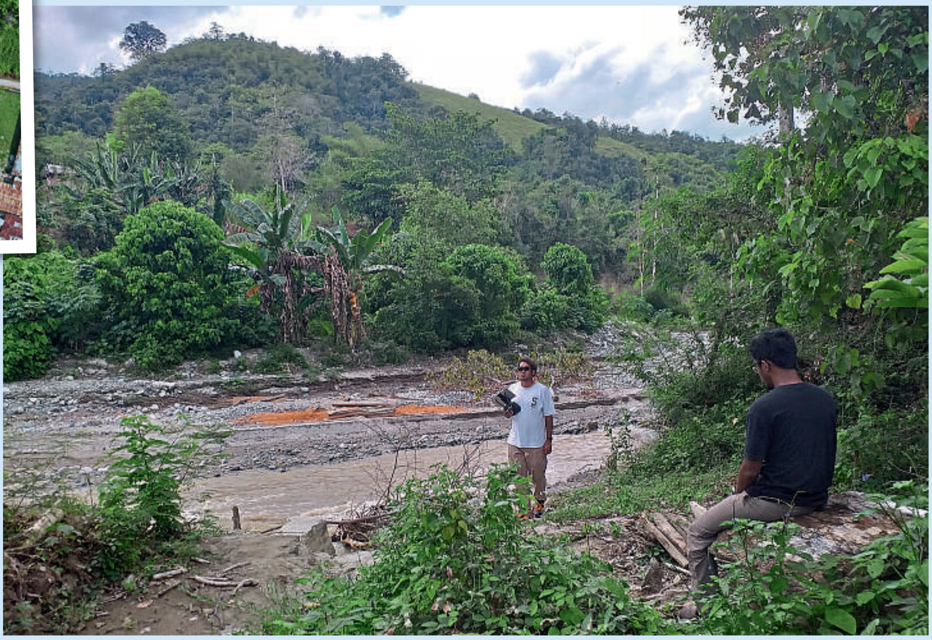
But the subsequent aerial LiDAR data collection mission was not that simple. Around 750ha of hilly, forested area – with slopes as steep as 30° in places – needed to be mapped. This area was not only earthquake-affected, it had also witnessed massive landslides resulting from the collapse of a dam. Thousands were feared to be still buried under the mud.

To reach the survey area located in the rural region, the team first needed to undertake a two-hour car journey and then walk for 2km to the base station. Travelling every day was mandatory because the remote area lacked sufficient electricity for the team to camp out there. One time, an unexpected downpour led to the team almost getting trapped in a house that was quickly filling up with floodwaters.

The physical strain, however, seemed trivial when compared to the emotional toll the project took. Adi Poetra Pratama, data manager at Terra Drone Indonesia and a core member of the Palu project, says: "We interacted with several locals during the course of the mission. They would look at our equipment, not understanding what it was, and ask if we could predict when the next big tremor would hit. Many of them are still afraid to sleep inside the houses that had survived the impact. Almost everyone we talked to had



Aerial orthomosaic of an area damaged by the earthquake



The team takes a break in a severely damaged area

been looking for the remains of a loved one. It was heart-breaking to listen to those stories."

Those stories, nonetheless, made the area's revival even more important for the Terra Drone team. Indonesia had never used LiDAR technology before to create maps for post-disaster recovery efforts and the team was also familiarising itself with the new equipment: a DJI M600 equipped with YellowScan Surveyor.

"The technology is different, not only in terms of data acquisition but also in terms of processing the data. We ended up sending datasets to the headquarters in Japan and processing team in India for quality checking on a daily basis," Adi explains.

The DJI M600 was flown at an altitude of 50m and speed of 4m/s. The team collected around 150-200 points/square metre with a total of 35 flight paths covering the planned area. Using Terrasolid software for baseline adjustment, correction, filtering and accuracy assessment, the elevation models and contour maps were generated.

Both photogrammetry and LiDAR surveys, as well as post-processing of the data captured, were completed within three weeks.

Using the data

The photogrammetry data is now being used by the Indonesian government to design and build a levee along the coast for future flood mitigation. The LiDAR data is intended for the reconstruction of the dam, as well as to plan a new irrigation system and restore housing in the region.

The success of this project has led to Terra Drone Indonesia receiving interest from other sectors that stand to benefit from high-accuracy LiDAR data, sucbh as the construction industry. Today, the company also has access to the proprietary Terra LiDAR system which promises to significantly slash the costs of LiDAR data acquisition, making the technology much more affordable for use in Indonesia.

The team, however, is convinced that no other project will come close to this one in terms of the satisfaction they have received from doing something for the betterment of the community. As Adi sums up, "This project is not only a technical achievement for us, but also an emotional high.".

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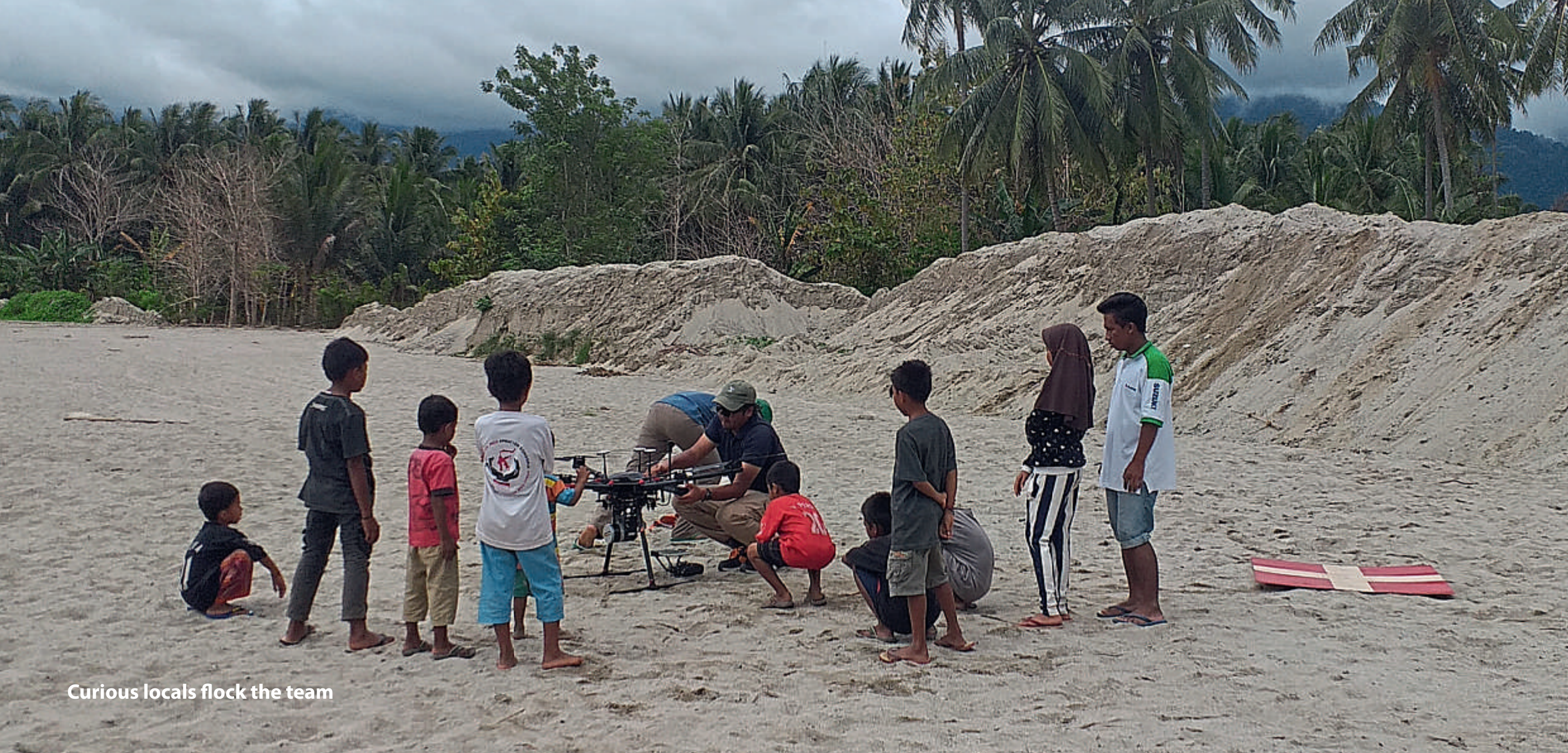

Curious locals flock the team