Toy or tactical tool? The value of drones in incident management and situational awareness.

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On 23 January 2022 the Stuart Highway, a major transport corridor through the centre of South Australia was severed at Glendambo. Glendambo is a small town 600km north of Adelaide, consisting of two roadhouses, a hotel-motel and caravan park. Glendambo is the last source of fuel before the 254km journey north to Coober Pedy.

The Highway was submerged beneath more than 450mm of water and the road condition was unknown for over 8 days. Road freight from north to south of Australia ceased. Concurrently, significant railway line damage was reported, halting rail transport east-west across the country. Repairs to railway lines were estimated to take weeks and so the timely restoration of the road corridor was of critical importance. Movement of critical food and supplies to Coober Pedy and the Northern Territory ceased. Travellers were isolated, unable to cross the water to Glendambo and unable to complete the 254km drive back to Coober Pedy without access to fuel.

SASES activated the SES State Control Centre and Regional Coordination Centres on Friday 21 January in anticipation of the forecast severe weather event. Heavy and persistent rain over the next few days caused the significant infrastructure damage. A Major Emergency Declaration was signed by the State Coordinator on 28 January, from which time SES personnel were supplemented with Liaison Officers from several agencies and Functional Support Groups. This declaration remained in place until 8 February.

The National Heavy Vehicle Regulator investigated alternative Type II Network Routes (for B-triple trucks) through Queensland. However, this new route became compromised by floodwaters on the Queensland/ Northern Territory border. Additional road routes were investigated through Woomera Department of Defence property but not feasible due to floodwater.

Understanding the volume and footprint of water covering the Stuart Highway was of critical importance in order to plan to resolve the situation.

SES Swiftwater Rescue Technicians were passengers in fixed wing flights (Air Observer missions) and captured photos of the affected area. The photographs provided an overview of the area of impact and revealed that the depth of the water meant relying on evaporation alone was not an option. Further intelligence was needed to inform an engineering solution; this was difficult to obtain from high elevation, oblique angle images.
The Air Observer photos provided a static reference of the water level and topographic challenges of the surrounding terrain. The images lacked detail and depth from a distance and photos taken closer did not provide an appreciation of the whole incident scene.

In an attempt to obtain up-to-date imagery of the flooded Stuart Highway and other isolated roads, satellite imagery was utilised. The Copernicus Satellite Emergency Management Service was activated to provide high level imagery of multiple flooded regional roads across South Australia. Unfortunately, the image quality was hampered by cloud cover.

Remotely Piloted Aircraft (RPAs, commonly known as drones) were deployed to Glendambo to provide targeted, detailed, low altitude imagery. Four RPAs of different size and capability and SES' Chief Remote Pilot were deployed via road from Adelaide to Glendambo.

The objective was to conduct Remotely Piloted Aircraft operations in order to capture imagery to produce orthomosaic and panoramic products for briefings, situational awareness and planning. Videos and photos were also used for public awareness and social media distribution.

Four RPAs were utilised for this mission:

- DJI Inspire 2
- DJI Phantom 4 Pro+
- DJI Mavic 2 Enterprise (Dual) - vision camera and thermal camera
- DJI Mavic Mini

The RPAs are of varying size and specification and allow the capturing of imagery in a variety of environments and conditions.

SES had been undertaking a project with ESRI using Drone2Map to develop orthomosaics, 3-dimensional, elevation and volumetric models of a flood retention dam, north of Gawler.

This mission would see the first operational use of another ESRI product, SiteScan. At the time of the event, SES had only just received login details for the application. As this was new territory, we requested assistance from Esri Disaster Response Program to use SiteScan successfully. The response from Esri was fantastic, with approval granted quickly and the support received was critical to our success.

Multiple RPA flights were conducted and imagery from the RPAs was uploaded to SiteScan and created several 360-degree panoramas and orthomosaics of the flooded highway and surrounding area. All products were shared with local and national agency stakeholders via an interactive dashboard. The quality of products produced by RPAs surpassed the static imagery from Air Observers and provided a detailed view of the road condition and the status of a road train that had become immobilised after driving through floodwater.

Public sentiment from social media commentary suggested the road conditions could be drivable and the water wasn't that deep. Video footage captured from the Remotely Piloted Aircraft showing the road quickly disappearing beneath the muddy water for several hundred meters with a truck immobilised, started to change public perception of the risk.

Several challenges were encountered during the mission. Producing orthomosaics and panoramic products in SiteScan requires an internet connection to upload the photos. Glendambo is in a relatively remote part of South Australia so limited internet access was available from the field. Whilst a large number of photos are required to produce a detailed orthomosaic, one of the significant advantages of the panoramas is that a relatively small number of photos (30) are required to create them in SiteScan, making upload via a mobile phone hotspot from the field a realistic option.

The RPA connected to SiteScan had intermittent issues warning of GPS signal loss. This did not cause any loss of control to the RPA but forced it into manual flight mode.

SiteScan controls the RPA with an automated flight path and predetermined camera settings to get the optimal angle for imagery. The issue with the RPA prevented it from completing a mission as it was planned and had to be flown manually with the transmitter (remote controller). The mission flight path, altitude and camera angle was reproduced and flown manually by ensuring the images captured overlapped to ensure they could be 'stitched' together in SiteScan. 360-degree panoramas of the incident scene were produced through this manual method with minimal defects. Although this was a deviation from the automated system, it showed that any person skilled in flying an RPA could be instructed to manually reproduce the process to capture sufficient quality imagery to create orthomosaics and 360-degree panoramas.

The process to produce the orthomosaics and panoramas was quite straight forward: upload the photos and process. The processing time is commensurate to the number of photos. A panorama consisting of a maximum of 30 images can be processed in 20 minutes. An orthomosaic over a large area with 1000+ photos could take 4 hours or longer to process.

The orthomosaics were exported out of SiteScan and in to our GeoHub (Enterprise Portal). This was not a straightforward process and therefore took time. Panoramas were easy to share with internal and external stakeholders via a link generated in SiteScan. The only downside is that this is a link back into SiteScan. The use of third-party panorama viewers could be worth investigating if this is a problem for other users.

The dashboard was shared widely as it was already in existence to serve a land based Survey123 Reconnaissance app. This was initially used to display Air Observer photography and then further enhanced to provide links to RPA videos and panoramas. One orthomosaic of an immobilised road train was also added. It was used to brief the SASES State Control Centre, the State Emergency Centre and access was provided to all supporting agencies' liaison officers. Access was also provided to the federal Department of Home Affairs National Situation Room, Department of Defence and the National Recovery and Resilience Agency.

The panoramas confirmed that evaporation was not going to be enough to open the road in a timely manner. Consideration was already being given to construct a drainage channel in order to reduce the water level and this was the solution ultimately adopted.

This mission provided many learnings. Orthomosaics are created by programs "stitching" together multiple photos with common identifiable elements such as (roads, trees or buildings) and the data embedded in each image (altitude and GPS location). Creating an orthomosaic of a large building is easy due to the number of unique details that can assist the program to stitch the photos together in to align correctly without distortion. However, where many photos are of still water with no other uniquely defining features, it is difficult to create an orthomosaic free of distortion.

Selecting the correct settings for optimal panoramas and orthomosaics will take time. An issue was encountered during processing with separating water versus horizon. This was rectified in SiteScan by identifying the individual image causing the issue and excluding it from processing. This significantly improved the panorama.

Air observer photos are not helpful for mapping as they have too oblique an angle and are also some distance from area of interest. RPA imagery is more targeted; however, Air Observer flights can cover a much larger area and can be used to identify areas of concern worthy of sending RPA capability to gather targeted intelligence.

This event had an impact nationally and so multiple jurisdictions were trying to activate the Copernicus Satellite Emergency Management Service simultaneously. Geoscience Australia had to prioritise requests from multiple stakeholders creating delays. Satellite imagery is not instantaneous and can take several days to receive. The downloaded images are very high resolution and require significant storage and processing capacity. It is not the same as downloading a .jpeg photo to your laptop. Given this was a storm event, cloud cover hampers obtaining clear satellite imagery.

Future opportunities to integrate assets to achieve high quality imagery, panorama and orthomosaic products. Air Observer missions do not provide the quality of imagery required for mapping, creating orthomosaics or panoramas. They do however, cover a larger area compared to an RPA that is limited by regulations to maintain visual line of sight of the RPA when flying. A Remote Pilot with an RPA as a passenger in an Air Observer helicopter flight would be able to cover larger expanses of land/ flooded area. The helicopter may be able to land near certain points of interest, allowing the Remote Pilot to disembark and capture imagery for orthomosaics and panoramas. Multiple stops could be made in a single round trip. This would extend the reach and quality of intelligence gathering products, which inform incident management decision making.

Remotely Piloted Aircraft have many applications are not just a child's toy or an amateur photographer's flying camera. Orthomosaics, panoramas and 3-dimensional maps can be used post-incident in After Action Reviews or future training scenarios. The high level of detail and accuracy obtained from the products can give viewers an accurate view of the situation. A flooded highway, road crash or collapsed structure could be captured using RPAs and SiteScan. The products produced are more valuable than a person recalling the incident from memory or sharing their anecdotes in a training session.

A panorama can be produced within 30 minutes from initial take off, which provides a rapid and high quality 360-degree view of the incident.

RPAs are an incredibly powerful tool that can provide an Incident Management Team with greater oversight of the incident scene and contribute to informed decision making. RPAs need to become a mainstream intelligence gathering tactical tool available to Incident Management Teams and deployed early to incidents.