THE ADDED VALUE OF INTEGRATING UAVS INTO THE HMA TOOLKIT

by Shathel Fahs and Greg Crowther [MAG (Mines Advisory Group)]

The rapid and ongoing development of lightweight, powerful, and relatively cheap unmanned aircraft vehicles (UAV)—still commonly referred to as drones—has demonstrated their use in increasingly diverse and imaginative ways across a large number of industries and sectors. They have also captured the public imagination with the prospect of revolutionizing many aspects of how we live and work. Humanitarian mine action (HMA) has not been immune to this process, and a number of organizations have conducted research, trials, and field tests into how they can support and improve the landmine and explosive remnants of war (ERW) survey and clearance process.

MAG (Mines Advisory Group) has trialed and employed UAVs across a number of programs and has now started to integrate them fully into the operational toolkit in a number of contexts. This article outlines MAG's experience with UAV operations, indicating where they appear to currently add the most value and where the technology may be headed. MAG's experience is that while UAVs can make a substantial and beneficial contribution to the mine action sector, like any technology, they are better suited to some tasks than others. They add the most value when integrated into the survey and clearance process, particularly when linked to effective information management (IM) systems and used with clear standard operating procedures that complement other activities. Their use is also dependent on national level regulations surrounding the use of UAVs, which often lie outside of the HMA coordination body itself.

Figure 1. The same sites shown with UAV maps displaying updated high resolution images of the site where locals are using the land for farming and housing.
All figures courtesy of MAG.

Overview of the Technology

MAG has generally favored the use of small, relatively cheap UAVs, such as the DJI Magic Pro or the DJI Phantom, in contrast to some of the UAV research projects we have been invited to review and comment on. With support from the U.S. Department of Defense Humanitarian Demining Research and Development Program (HD R&D), MAG conducted field evaluations of these UAVs for more than four years in Cambodia. In addition, MAG has also used the DJI Mavic Pro in Syria, Lebanon, and Iraq. These UAVs have the advantage of being widely available, relatively robust, easy to use, and simple to maintain. Demining operations typically take place in challenging environments, and these qualities are essential for the effective integration of new tools. Many of these criteria of course apply to any form of technology when being integrated into demining operations in challenging contexts. These particular UAVs also have the capabilities and technical specifications that MAG requires to undertake the tasks that UAVs are currently most suited: survey.

Pre- and Post-clearance Survey

A UAV is only a vehicle for undertaking an existing mine action process. In terms of UAVs, these can be broken down into two main areas: survey and detection. Based on trials to date, UAVs' primary added value to the HMA process is improving the speed, precision, and quality of pre- and post-clearance survey in suspected (SHA) or confirmed hazardous areas (CHA), allowing for better planning, operational management, and monitoring. The UAV allows access to otherwise inaccessible areas and high-resolution images to be gathered, whether inside or around a collapsed building in Syria or over a heavily vegetated forest in Cambodia.

Understanding the hazardous area is a key element in task planning. Improving knowledge about terrain, vegetation, and obstacles can greatly improve a task manager's ability to plan how to approach the technical survey and clearance process. Without UAVs, information about a task site is based on community interviews, historical knowledge, and an assessment from known safe areas. Often times, only

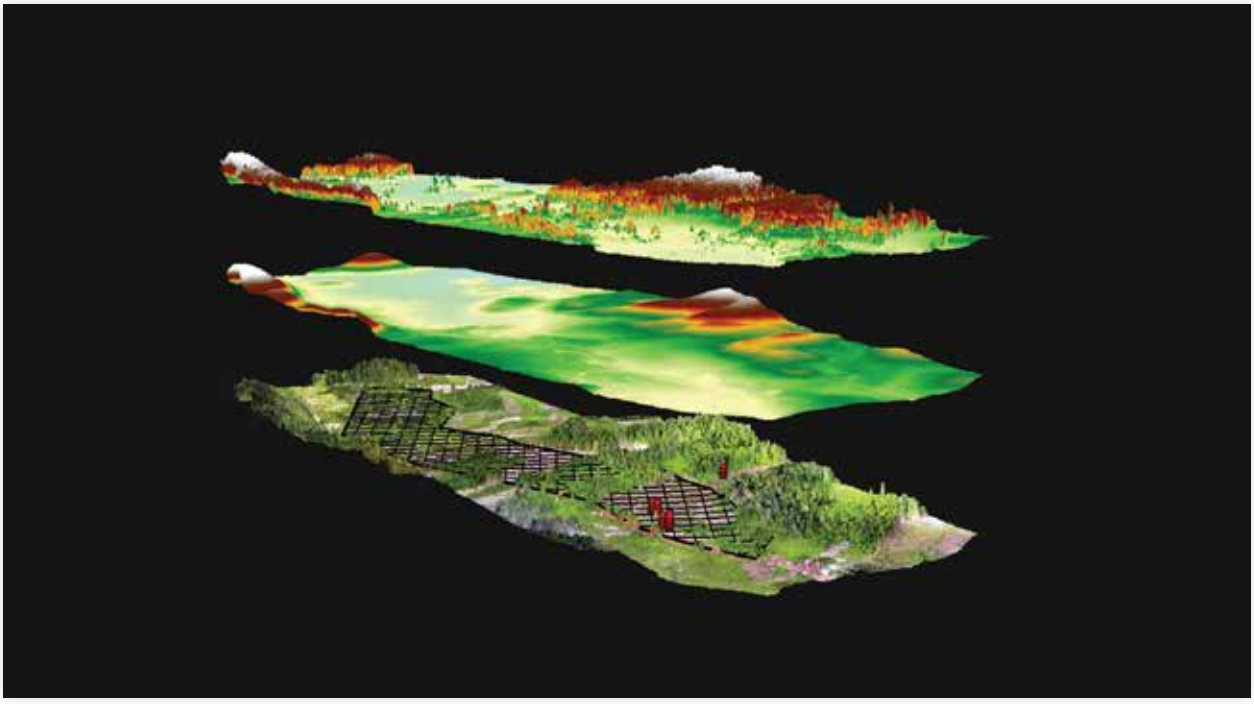

Figure 2. A 3D module of a battle area clearance site in Northeast Cambodia produced from drone images using Drone2Map and ArcGIS Pro. The Polygon, clearance boxes, and cluster munition symbols were overlaid on the 3D layer of the site along with spatial analyses of DTM and DSM.

limited amounts of the suspect land can be physically accessed or even seen. Initially, the use of UAV images can improve interviews with key informants and beneficiaries, as showing them the pictures captured by the UAV allows them to offer a more detailed explanation regarding both the threat and the impact of the contamination. In some contexts, such as Iraq, MAG is anticipating that UAV-based survey will provide initial information about the location and extent of minefields laid with surface-lying or shallow-buried improvised devices.

Beyond simply improving human level information gathering as part of non-technical survey, UAVs allow for greater detail about task sites through spatial imaging (see Figure 1), all of which can be made even more powerful through the adoption of an integrated information management approach.

Spatial imaging works by placing an imaging sensor on the underside of the UAV and, in most cases, establishing a pre-entered flight path that allows the UAV to autonomously map the required area without direct operator control. This imaging can then be transferred and processed by an on-site computer, which provides detailed information on terrain and vegetation density as well as high-resolution imagery. This allows vegetation density to be categorized into light or heavy, which then allows task managers to decide if manual string trimmers or mechanical assets would be preferable for ground preparation prior to clearance (see Figure 2). Terrain analysis can identify otherwise hidden obstacles, like ditches or mounds, and allow for better planning in terms of access lanes and angles of approach for machines in areas that would be difficult to identify for someone operating remotely.

UAVs are made even more powerful when effectively integrated with IM systems such as ArcGIS. MAG has built an integrated suite of tools around the ESRI ArcGIS system. This allows UAV captured imagery to be integrated into the broader GIS and IM systems used by MAG, through a combination of Drone2Map for data processing and ArcGIS for spatial analyses, where all UAV-captured maps can be made available online. The Collector for ArcGIS mobile app can also be used to view the UAV imagery offline when used in the field. When integrated into the full Esri ArcGIS application suite, information such as polygons, evidence from historical tasks, casualty data, etc., can be overlaid over both the high-resolution drone and low-resolution satellite imagery, again improving planning, presentations, and operational briefings (see Figure 4).

Potential Usage: Enhanced Detection

Several research projects have appeared to focus on detection, aiming to develop sensors that can be fitted and carried

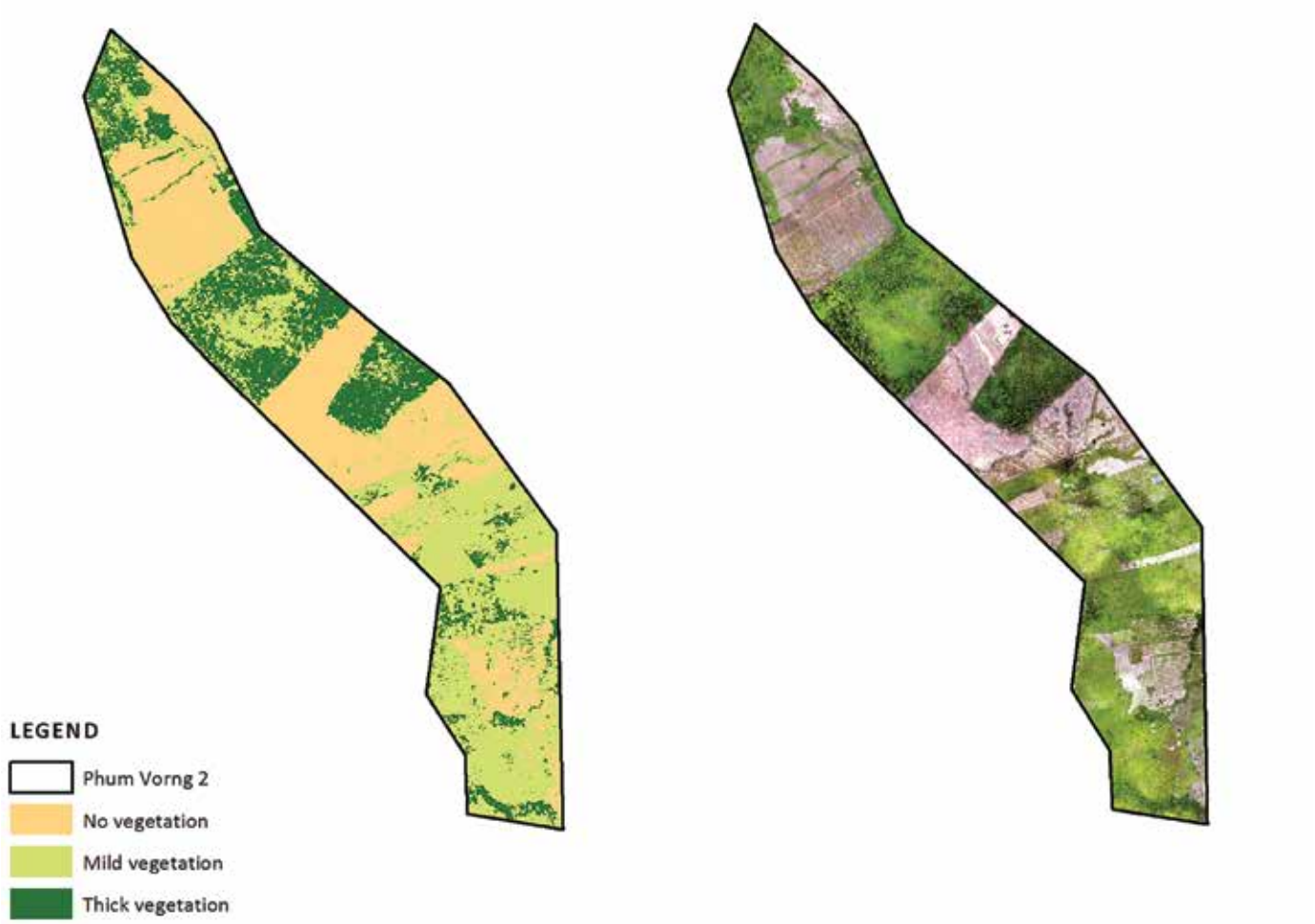

Figure 3. Sample drone images of a battle area clearance site in Northeast Cambodia where the UAV maps replaced the satellite base map and vegetation analyses, divided into three categories.

by UAVs. While feasible and a potentially useful development, this only really adds value if the specific detection capability itself is equal to or an improvement on existing manual, mechanical or animal-based detection systems from the perspective of safety, quality or efficiency.

It may be that in some environments, particularly those with limited vegetation and flat terrain, that a form of UAV-mounted detector may be able to undertake technical survey and clearance as quickly and safely as existing methods, and add some specific value to the process in terms of either speed, access, or cost-effectiveness. MAG will shortly be trialing one such UAV-mounted detection system, again in Cambodia, that combines ground-penetrating radar (GPR), light detection and ranging (LiDR), millimeter wave, computer vision, and artificial intelligence technologies that may enable reliable detection of anti-vehicle and anti-personnel mines as well as subsurface ERW.

Capturing and Quantifying Impact

As a humanitarian non-profit organization, MAG is always looking for ways to measure and demonstrate impact. Conducting pre- and post-clearance flyovers with UAVs allows for changes in land use to be captured in high levels of detail. For unused land that is turned into a mix of residential and agricultural plots, MAG can accurately determine how each type of land is used. For more detailed studies, different crop types can be identified through pattern recognition analysis, allowing specific and quantifiable benefits to be measured based on the type of crop and amount of released land being used to farm it. As with the pre-clearance non-technical survey process, images can be shown to beneficiaries to better identify how they have used particular parts of the land. The change in the way land is used—before clearance, during clearance, and after clearance—allows MAG to demonstrate the dynamic impact of clearance to the donor community and other stakeholders.

Conclusion

UAVs are proving to be integral to the survey and clearance process by improving planning, management, and monitoring capabilities as well as increasing operational safety. They undoubtedly add significant value while reducing costs

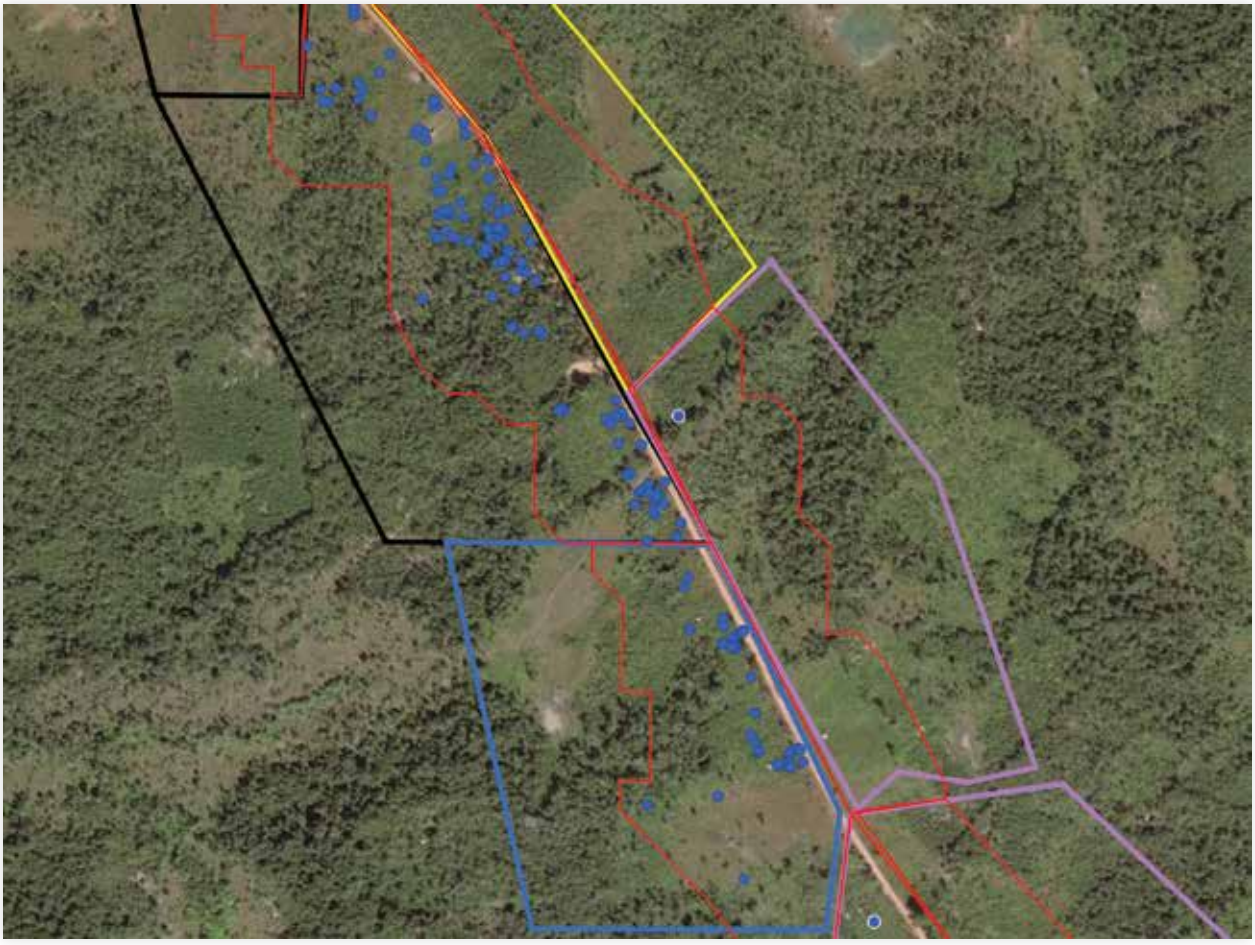

Figure 4. Satellite photos displaying outdated images of the sites, in which only forest can be seen.

by demonstrating value-for-money through better post-clearance assessment and are likely to become a standard part of most operational toolkits. Wherever allowed, MAG will continue to test, trial, and use UAVs for a range of purposes. Where permissions for the use of UAVs are difficult to obtain, we would strongly encourage national mine action authorities to lobby for their use as part of the drive toward improved management of mine action processes.

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