EARTH AGAINST AIR

GROUND-BASED SURVEYING CAN PRESENT CHALLENGES WHEN MAPPING COMPLEX FARM TERRAIN. **RYAN MOORE** COMPARES A UAV SURVEY WITH A GPS GROUND SURVEY TO FIND OUT IF AERIAL APPROACHES COULD OFFER FARMERS AND AGRONOMISTS A NEW SOLUTION

Pre-season is a crucial time for many agriculture professionals. Activities, such as surveying fields and designing levees, are vital to ensure that the optimal level of water is delivered during the growing season. However, winter remains a challenging period for the agricultural sector – an increased volume of rain can make many fields inaccessible and difficult to monitor, and lead to increased wear and tear on equipment.

Greenway Equipment, which helps farmers improve operational efficiencies, collaborated with Travis Senter, assistant farm manager at Senter Farms in Osceola, Arkansas, in the US, to compare two surveying technologies: UAVs and terrestrial GPS. The aim was to help overcome some of the barriers agriculture professionals face conducting elevation surveys in the winter months.

Senter Farms provided the ideal opportunity to investigate elevation survey technologies. There are already many levees in place, as most crops grown are rice, where a controlled environment is essential. As 90% of the ground is irrigated, it is therefore crucial that water is supplied to the land as accurately and efficiently as possible, to reduce soil erosion and optimise the absorption of rain. Traditional ground-based methods can miss areas in a field and on-site vehicles' tyres can cause depressions in the soil, affecting the results of the survey and subsequent decision-making.

As such, aerial machines with large overlaps were selected to address these challenges and assess the most effective tools for pre-season irrigation activity.

Comparing tools

The comparative study, which took place in February last year, aimed to evaluate how closely matched the two different methods were across a 0.2km^2 rice field, which was graded on a single-plane slope at a 0° heading. With particularly level land, accuracy was an important measure of success, and the elevation survey needed to be as detailed as possible to meet these demands.

The aerial survey

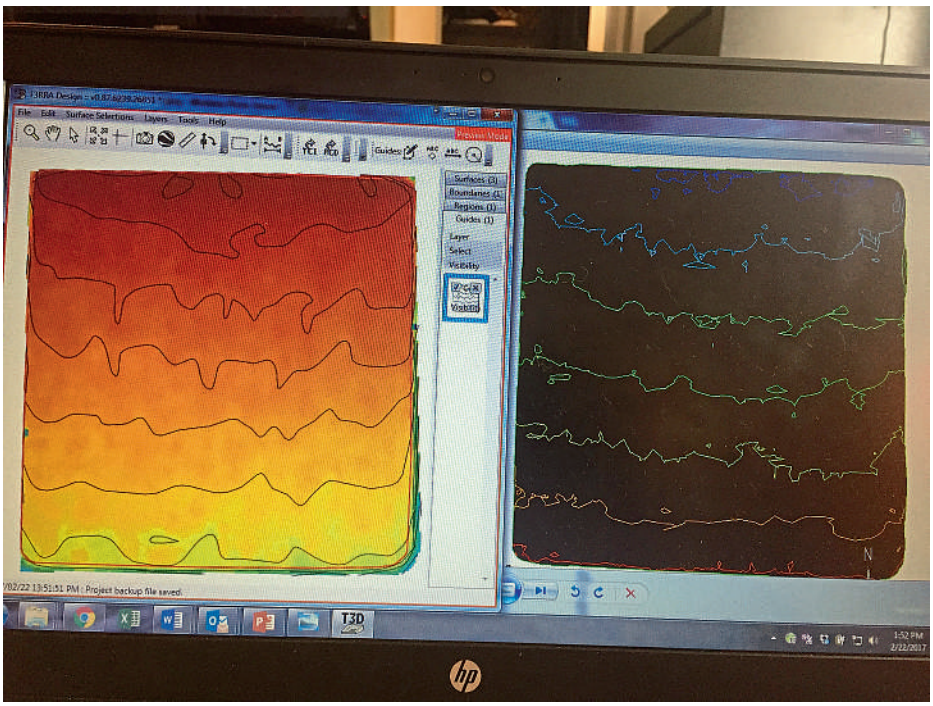
In the aerial survey, it was decided that a fixed wing UAV would be best as its efficient aerodynamics enable longer flights at higher speeds – a crucial requirement for mapping extensive land mass. The senseFly eBee Plus UAV was ultimately chosen, as it is capable of covering 2.2km^2 in a single automated flight and has wind resistance up to 45km/h.

The area was then surveyed with the UAV's RTK/PPK systems activated. The eBee Plus used the senseFly SODA camera, a 20MP resolution RGB sensor, to build a thorough picture of the farmland.

Conducted at 122m, the survey flight took approximately 20 minutes to complete, with 80% image overlap. To complement the aerial collation and offer an end-to-end analysis, Pix4Dmapper software was used, enabling the team to process and export the data into a functional digital surface model point cloud format.

However, the slow internet and processing speed on-site meant that

UAVS OVERALL ALLOW FOR MORE SURVEYS TO BE CONDUCTED THROUGHOUT THE YEAR AND WITHOUT DELAY



Elevation contours from the UAV survey are shown on the left and compared with data from the ground survey on the right, which uses the same contour intervals

it took approximately three hours to export point cloud data at 10m gridded resolution – much slower than typical processing times for UAV collected data.

The ground survey

For the ground survey, a popular terrestrial GPS with an integrated HD-GNSS processing engine and precision point positioning (PPP) system was chosen, as this would enable points to be measured quickly and easily. The receiver's range of GPS L1/L2/L5 and GLONASS L1/L2 signals allowed for fast RTK initialisation – particularly important in low-elevation tracking.

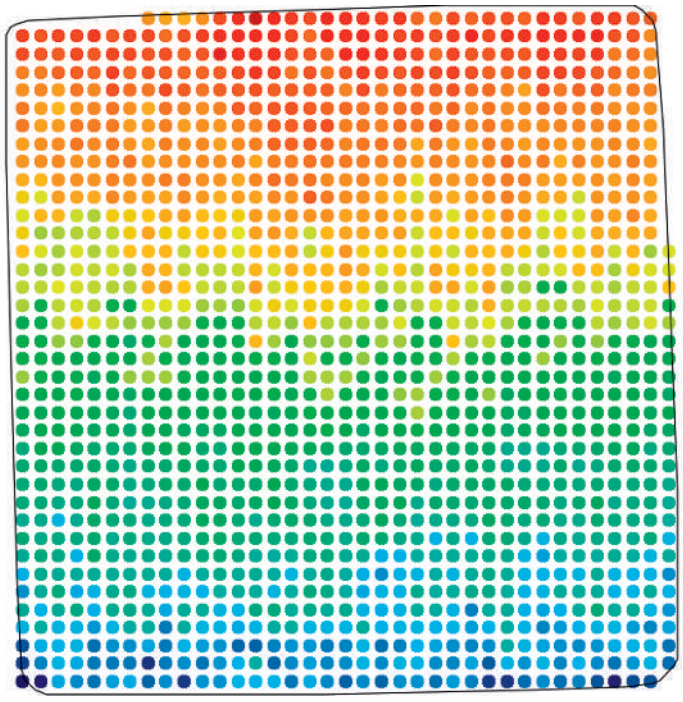
Following the aerial survey, wet field conditions delayed the ground survey by two days. However, once the site was viable, the ground-based approach was carried out on a 15m distance running north and south and then at around 30m on an east and west pattern. The survey took over one hour to complete. As with the aerial method, processing used T3RRA Design to import data from multiple sources, plan the surveys and export designs.

The results

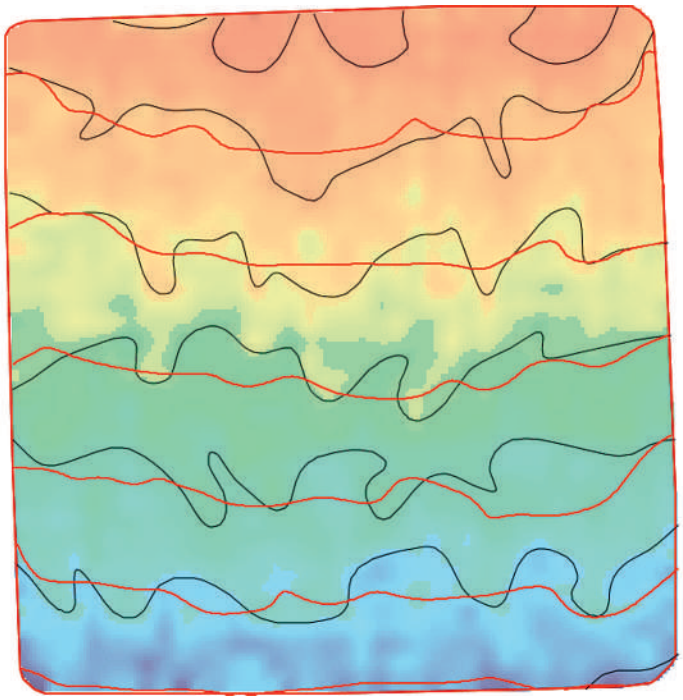
Overall, the ground survey consisted of 4,968 collected points, while the point cloud from the eBee Pix4D survey produced 28 million 3D densified points. To form a more accurate comparison of the two elevation survey methods, the team needed to surface the collected points and analyse both the elevation contours and earthwork dirt volumes.

Set to start at the 41m elevation mark at vertical intervals of 0.1m, elevation contours were examined to mimic the layout of levees for rice paddy flooding. The greater the elevation detail, the 'curvier' the contour, with the sheer density of collection points and coverage from the senseFly eBee Plus meaning differences between the two methods were inevitable. However, the contours in both surveys would typically be smoothed out once marked in the image processing software to create GPS guidance lines that machines can implement in the field for more efficient irrigation and consistent water depth.

The team also evaluated the earthwork dirt volume similarities between the two methods after levelling, to form a detailed second analysis. The ground survey measured at 61 cubic metres/hectare (cu.m/ha) five months after levelling, while the senseFly eBee Plus was at 75 cu.m/ha after the same period. Although there is a higher degree of variability between the two, this difference demonstrates that the aerial approach appeared to be more accurate on this occasion, due to the sharp increase in density of elevation points collected by the UAV.



The project's 10m UAV grid, exported from Pix4Dmapper, showing the elevation data



Elevation contours derived from the UAV survey

A different approach

While these closely matched results show how terrestrial equipment can support in pre-season planning, they also highlight the potential operational benefits of using end-to-end UAV solutions to conduct elevation surveys for levee line placement and earthwork designs. For instance, the flexibility they offer when weather conditions are difficult means UAVs overall allow for more surveys to be conducted throughout the year and without delay –demonstrating UAVs' significant time and logistical advantages.

Given that ground surveys have larger gaps between collection passes, software is often used after the readings have been taken to interpolate the data. As such, there can be greater margin for error, since they are not known elevation values. Meanwhile, the consistent readings in the UAV survey leave far fewer gaps for interpolation, increasing the accuracy of the data collected – a significant benefit when more detailed insights are required.

Changing landscapes

Pre-season provides an ideal opportunity for agriculture professionals to put processes in place for the year ahead. The Senter Farms study shows that, despite the time delays for image processing using UAV technology, it provided a greater level of data accuracy, as well as flexibility when accessibility is a challenge.

UAVs could therefore be used to complement more traditional terrestrial techniques, to provide a detailed analysis of complex farm terrain and help improve agricultural professionals' operational efficiencies.

The author on-site at Senter Farms, where both surveys were conducted

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Local operators prepare the eBee Plus UAVs for launch