Drone Mapping Technology, a game changer in construction Project communication during COVID-19 pandemic – A case study at Asanko Gold Mine – Tetrem Full Resettlement Project, Ghana

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SUMMARY

Tetrem full resettlement project was a key milestone to Asanko Gold mines during the High peak of the Covid-19 pandemic. At the highest peak of the pandemic Tetrem resettlement project had to continue for safety and humanitarian grounds. The project hoisted over one thousand (>1000) employees and 45 contractors and involved both nationals and expatriates. In order to ensure project continuity covid-19 protocols were in placed and employees or workers contained at the site. Subsequently, construction communication methods at the time were suspended. Moreover, there were multiple stakeholders and consultants in different geographical locations and continents who were all eager to know how things are progressing on-site in the midst of the pandemic. Drone technology became a game changer when finally engaged by survey team. The aerial photos, orthomosaic maps, videos and 3D Models maps created from drone survey and data weekly and shared with project team and key stakeholders helped and made several improvements and successes in the Tetrem Resettlement construction from design optimization; to construction optimization; to effective communication, to accurate reporting, to costs cutting, to safety improvements and efficiency.

Key Words: Covid-19, Drone Mapping, Resettlement Project, Aerial Photos, Tetrem

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INTRODUCTION

Tetrem full resettlement project was a key milestone to Asanko Gold mines during the High peak of the Covid-19 pandemic. For humanitarians' grounds, urgency of the project, legal requirement, and safety concerns of the affected mining community a full resettlement project of Tetrem Community had to commence during Covid-19 pandemic by Asanko Gold Mine. The coronavirus known as COVID-19 disease, is the biggest global pandemic in history that impacted the economy and disrupted the lives of many people, financial markets and supply chains. Unlike other pandemics, COVID -19 triggered a near-total shut down of socio-economic activities and plunged the global economy into a severe contraction. According to World Bank forecasts (2020), the global economy would shrink by 5.2% in the followed year, 2021; that would represent the deepest recession since the Second World War, with the largest fraction of economies experiencing declines in per capita output since 1870. During the total shutdown of global economy by COVID-19 pandemic, construction industry was one of the few industries that managed to maintain production to some extent. Engineering and construction companies are used to cyclical downturns, but the speed and strength with which COVID-19 struck is unprecedented. The pandemic squeezed supply chains and created difficulties including late or cancellation of deliveries, and price escalation from suppliers. The consequence is that many construction sites have been shut down for an indefinite period of time. Construction projects were suspended, delayed or cancelled. The well and health beings of employees or labours became a concern or top priority with practical challenges around social distancing on construction sites.

Unfortunately, the impact of coronavirus pandemic on Asanko Gold mine - Tetrem Resettlement project was not different from overall COVID -19 pandemic on the construction industry. The project hoisted over one thousand (>1000) employees and 45 contractors and evolved both nationals and expatriates. The main project consultant was DRA Global, an EPCM Consulting Firm from South Africa, managing the project on behalf of Asanko Gold Mine. Moreover, there were multiple stakeholders in different geographical locations and continents who were all eager to know how things are progressing on-site in the midst of the pandemic. Besides, investors and key stakeholders were kept out of the loop making it difficult for them to visually appreciate the progress and monitor the project unlike their usual visit to such project site. At the same time, construction supervisors and safety team were finding it difficult to interact with workers. The construction management systems at the time became labor-intensive and slow and it did not allow project executives to respond quickly to changes on the ground and contribute to project planning, scheduling, executing, monitoring and controlling budgets. In order to ensure business or project continuity and involve key stakeholders at their comfort zones and ensure effective project planning, scheduling and costs reduction; visual technological tool was scouting for and this called for the need for this research and the introduction of drone mapping technology in such construction project in the midst of global pandemic. The use of drones in construction industry has already led to many changes in the way buildings are put up. In the last few years, drones have helped make several

improvements in construction industry; thus, from increased accuracy in reporting, to improving safety conditions, to cutting costs and increasing efficiency.

STUDY AREA

Tetrem Bontefufuo is the official name of the study area. Tetrem is a small town or village and is in the Amansie West District of Ghana, specifically Ashanti Region. The geographical location of Tetrem Bontefufuo falls on **6.5615° Latitude and -1.908280° Longitude.** The closest major towns near Tetrem include Mpatuom, Tetekaso and Esaase and the closest major city is Kumasi. The occupation of the people in the area are mainly cocoa farmers with few doing artisanal mining which dated from the colonial time. Despite of economic gains accrue from farming businesses, recent surface mining activities have destroyed large hectares of land and have deprived them of their lands, income and job opportunities. The extensive mining activities have turned large section of the arable lands into degradation, thus creating habitat conditions unsuitable for agricultural purposes. Tetrem township falls within the mining operations of Asanko Gold Mine, which in fact, have direct impacts to the operations of the mine. The red circle color in the Fig. 1 shows the Tetrem township or community and the cyan color in the same Fig. 1 shows the mining facilities. The operations of the mine really had direct and severe impacts on the life of the Tetrem Community and per the mining regulations the mine had to resettle them hence the reason for this project. The proposed site for the Tetrem resettlement project is shown in black square color in Fig.1 and is adjacent to Tetekaso township.

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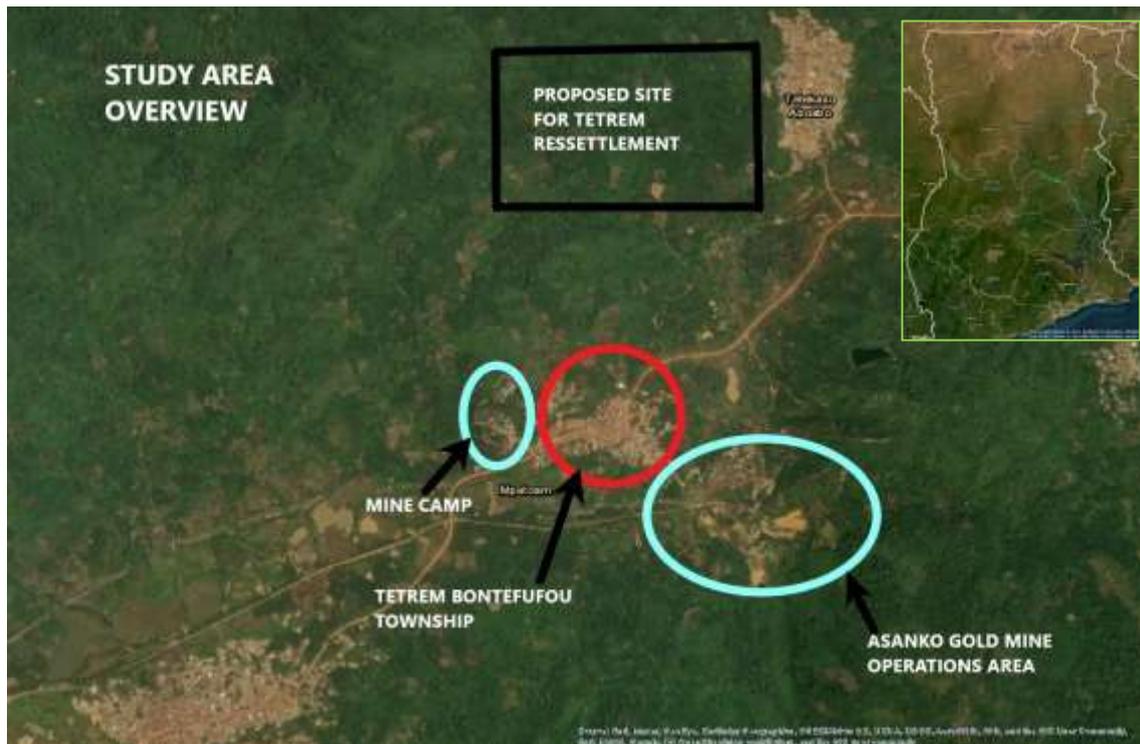
Fig. 1: The Satellite View of the Study Area

METHODS AND MATERIALS

Generally, your ability to collect quality data begins with proper planning, so we planned our mission by understanding the job location, timing, data needed and equipment to use. Weather conditions such us good light and good weather and amount of time required for data capture were carefully considered during drone survey as they are keys to a safe and successful flight. The drone equipment and tools engaged for this project include Mavic pro series, phantom 4 series and DJI App. An advanced image processing software, thus, Agisoft Metaphase Pro was also used for the image and data processing.

Because we had a good understanding of the site and data requirement, flight path was normally created when collecting drone data for mapping and generating points cloud. Ground control points (GCPs) were also marked out on the ground to reference the positions of drone images with geographical coordinates anytime and any day drone had to fly for accurate reporting. In this case, automated flight path was often chosen to ensure that images are captured in a consistent manner and with adequate overlap. The

flight area and camera settings were 75 % sidelap, 75 % frontlap, 1.4 in/pix resolution and 200 ft – 300 ft altitude with speed of 12 mph.

Drone data Collected for the project progress update was scheduled end of every week, thus, Friday and also end of every month till the project duration. Drone datasets and images that were collected were also processed and corrected for image distortion and stitching together during post-processing to create a high-accurate resolution points cloud and orthomosaic map. Each pixel contains 2D geo-information (X,Y) and one can directly compute accurate measurements such as horizontal distances and areas.

The general workflow for Drone Data collection and image processing is demonstrated in the Fig.2 and general workflow for data and image processing using Agisoft metashape software is shown below.

- ➢ Loading photos into Metashape
- ➢ Inspecting loaded images, removing unnecessary images
- ➢ Aligning photos
- ➢ Building dense point cloud
- ➢ Building mesh (3D polygonal model)
- ➢ Generating texture
- ➢ Building tiled model
- ➢ Building digital elevation model
- ➢ Building orthomosaic map and,
- ➢ Exporting results

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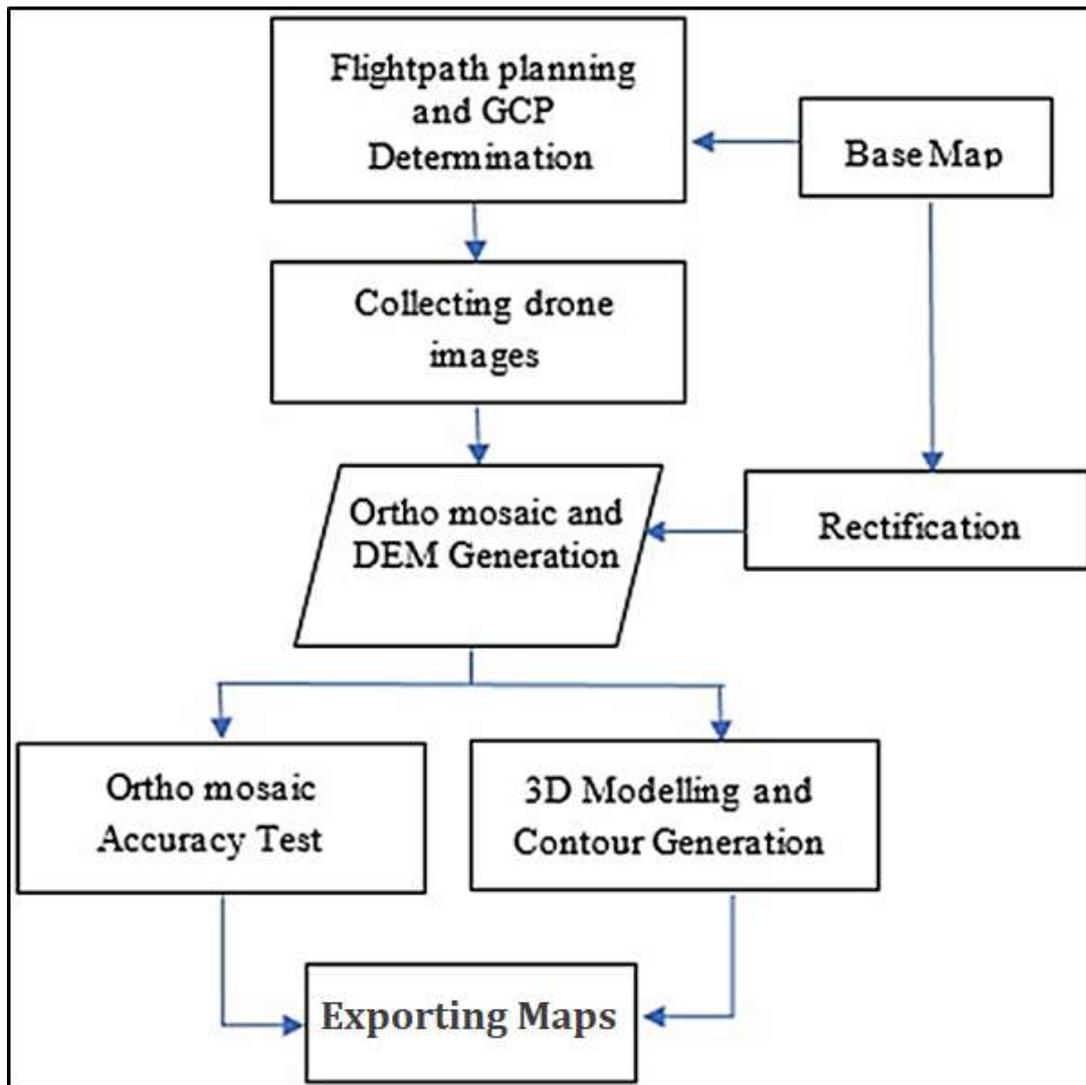
Fig.2: Work flow diagram for Drone data Collection and image processing

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RESULTS AND DISCCUSSION

The results of engaging drone mapping and surveillance technologies in the construction of Tetrem Resettlement project during the peak of COVID-19 Pandemic produced aerial photos, points cloud, orthomosaic maps, videos and digital elevation models, which directly and indirectly helped the project in data collection, ground modelling, design optimization, construction optimization, and facilitated effective communication amongst engineers and stakeholders around the globe. Applications of drone data and images are so versatile, that it helped the entire project lifecycle in the following ways as demonstrated in the results and discussion.

1. Farms Baseline Mapping and Compensation Program Enhancement:

The first application of drone mapping regarding this project was site baseline mapping to identify ground conditions of the proposed site for the resettlement, identify active farming areas, evaluate farm assets and properties that may affect the project and monitor speculative activities prior to the project to enhance transparency in the compensation programme. The Speculative activities prior to projects within mining communities have been noted to be a canker and a liability to all mining companies in Ghana. The typical example is Newmont – Ahafo North Project which have held the project for over five (5) good years till now. Thus, engaging drone mapping to provide a base map to serve as a baseline for compensation program for the mine was a laudable one. With the aerial drone photos and desktop analysis, the mine was able to determine accurately initial building structures as shown on the Fig. 3. The drone image also helped surveyors and valuers to identity active farming areas, the type of crops and the number of crops within a farm as shown in Fig. 4 and Fig.5. This simple and single drone image captured and shared amongst the stakeholders brought transparency in the compensation program, reduced corruption, minimized expenditure, saved time and energy and finally saved cost of millions of dollars and cedis to be misappropriated.

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Fig. 3: Site Aerial view of Proposed Tetrem Resettlement Site from Drone Mapping

Fig. 4: Active farming areas identified from drone mapping to enhance compensation program.

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Fig. 5: Offsite crops counting enabled by drone mapping which enhanced transparency in crop valuation and compensation program.

2. Time and Cost Savings for Survey Data Collection:

The ability to collect fast and accurate survey data prior to construction tells the healthy and wealthy of the project as project designs and planning largely rely on initial ground information. These survey datasets help project owners and consultants to get a good understanding of the project location, the environment and the topography. The total land coverage earmarked for the construction of full ressettlement project was about 150 Hactares and looking at the timelines, the size of the land and the nature of the vegetation; conventional land survey methods such as tachymetric(Total Station) and global navigation satellite system (GNSS RTK) were not appropriate at that time. Here, drone survey became a game changer by a twinkle of an eye by completing the aerial survey and mapping with drone technology at the shortest possible time which would have taken conventional survey methods two months to finish. With the help of drone technology, surveyors were able to collect ground information and levels without hustle, and avoided the risk of being injured or bite by snakes. The Digital Elevation Modelling (DEM) of the site (Fig. 6) generated from drone data largely showed possible drainage and river channels, changes in elevation and other factors that assisted in

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selecting the best locations for building pads, equipment and resources. From the same drone data, contour surface (Fig. 7) was generated and superimposed on the drone image for other ground surface analysis.

Fig. 6: Digital Elevation Modelling (DEM) generated from Drone Images

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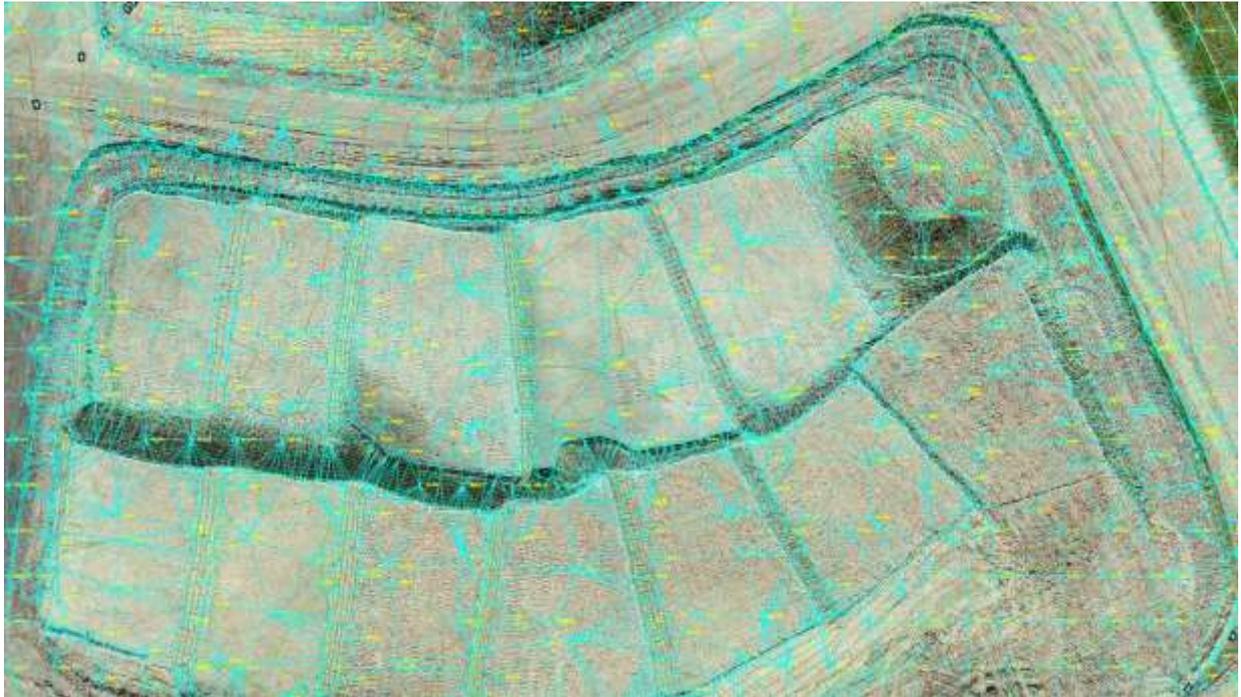
Fig. 7: Contour surface generated and superimposed on drone images.

3. Resource allocation and planning:

Allocating, prioritizing and positioning of resources such as heavy equipment, 45 contractors' laydowns, block manufacturing plant, batching plant, water storage tanks prior to construction within a confined space was a difficult one and it needed broad consultation with key engineers and managements at South Africa and Canada whose movements were restricted by Covid-19. At this point aerial photo was taken by drone and shared among key managements at their comfort zones where decisions were finally made. With the help of aerial photos from the drone images engineers sitting at the Johannesburg office, South Africa were able to designate area for Block manufacturing plant (Fig. 8 and Fig. 9) situated 500 metres from the construction site (Fig. 8); the batching plant (Fig. 10) placed adjacent to the main site access road; the contractors' laydowns (Fig. 10 and Fig, 11) sited close to the contractors' allocated plots and material storage area (Fig. 10) was also located at plots earmarked for school buildings.

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Fig. 8: The Site for Resettlement project and Block Manufacturing Area

Fig. 9: The overview of Block Manufacturing Area from Drone image

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Fig. 10: The Designated areas for Concrete Batching Area, Materials Storage Area and Contractors' Laydown.

Fig. 11: The designated Contractors' Laydown from the Drone image

4. Tracking, Reporting and Monitoring site progress:

The project progress reports are requirement in contracts and the only means to track progress of work; and have been part of contraction process for decades now. Often key stakeholders had to travels around the globe to project site and visually inspect and confirm what progress reports talk about. At the peak of covid-19 pandemic, there were several key project team and stakeholders in different locations (thus, countries and continents) whose movements were restricted by covid-19 pandemic and were also eager to know and appreciate how site activities are progressing. Surprisingly, with the help of our aerial photos by drone mapping; stakeholders from within, far and near Ghana were able to track progress, appreciate quality of work, and kept them in the loop till the completion of the project. The weekly site updates (Fig. 12, Fig. 13, Fig. 14, Fig. 15, Fig.16, Fig.17, Fig. 18 and Fig. 19 showed various construction stages with the aerial photos which helped engineers at Johannesburg, South Africa to plan, communicate and keep the project on schedule. The stages of project construction life cycle

from weekly aerial photos or drone shots can be observed as follows which also helped stakeholders across the globe to have detailed understanding of site progress.

Fig. 12: The site update – Earthworks operations from Drone image

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Fig. 13: The Site update – Foundation and Block Laying Stage

Fig. 14: The site update – Buiding Lintel Stage from Drone image

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Fig. 15: The site update – Roofing Stage from Drone image

Fig. 16: The site update – Biogas Digester Toilet Construction from Drone image

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Fig. 17: The site update – Project Completion Stage from Drone image

Fig. 18: The site update – Project Completion Stage from Drone image

Fig. 19: The site update – Project Completion Stage from Drone image

5. Enhancing and Improving Occupational health and safety on site:

The safety and security of workers, resources and properties at site were very paramount to the client, thus, Asanko Gold Mine during the construction period and the hike of the covid-19 pandemic. At the peak of the pandemic, safety of the workers at the site was priority meanwhile social gathering was cancelled and technology was needed to track and monitor potential hazards on site and unsafe acts of workers. Drone surveillance was initiated or mounted every day to monitor operational activities on site. Drone shots were also made to assess and check occupational safety standards and compliances on site as can be observed on the drone images (Fig. 20 and Fig. 21). The involvement of drone surveillance in this regard helped the safety team to identify hazards, assess the hazards and identify control risks and review the health and safety protocols in their offices throughout the project life cycle. Also, hard-to-reach places that posed danger or risks to workers were also identified in drone shots and corrective actions taken. Notwithstanding, the drone surveillance and drone shots really assisted the safety team and management to stay on top of changing ground conditions that may have great impacts on workers' safety. Thus, making all the difference in preventing incidents and accidents on site throughout the construction period.

OCCUPATIONAL HEALTH AND SAFETY COMPLIANCE MONITORING

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Fig. 20: The site update – Project Completion Stage from Drone Surveillance

Fig. 21: The site update – Project Completion Stage from Drone Surveillance

6. Comparing As-built to as-design

One of the most striking advantages of accurate site visualization is the ability to overlay the CAD on the orthophoto map. This allows you to compare what was built with the plan and make sure that they fit together. Typical example is Fig. 22 where the whole design was overlayed on the drone digital elevation model (DEM) to check if the earthworks platform is accurately done according to design and also analyze if it has a sufficient coverage to accommodate all the housing units. With this, site managers and engineers can easily identify differences between planned and real-time progress and steer projects accordingly.

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Fig. 22: CAD Design Overlayed on Drone DEM to Check Compatibility

7. Better documentation and faster reconciliation with subcontractors:
The frequent construction site surveying and mapping means that the site would have more complete documentation throughout its life cycle. Drone datasets (i.e.. Points cloud, orthomosaic maps, photos, DEM and videos) provided clear, accurate and retrievable documentations for the resettlement project at frequent points in the construction process. This will allow the key stakeholders to review and pinpoint where mistakes occurred and settle disputes out of court when the need arises because there is construction data backups as evidence. Another benefit of this better documentation is that the data collected can be analysed now and future to draw lessons from it and compare it for benchmarking purposes.

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CONCLUSION

The introduction of drone technology and mapping in the construction of Tetrem Ressettlement project brought huge changes and benefits in the way we communicated to our key stakeholders whose movements were restricted by covid-19 pandemic and were eager to know day-to-day activities of the project. The results of aerial photos by the drone mapping during the construction period, in the midst of covid-19 pandemic allowed our managers and engineers whose movements were restricted by the pandemic to do accurate measurements of distances, surfaces, elevations and volume with a click of mouse at their comfort zones across the globe or continent.

Aside that, the aerial photos, orthomosaic maps and videos created from drone data and shared among project manager and project engineer at their comfort zones helped them to plan and monitor progress, coordinate with site managers, appreciate day-to-day activities, and control budget. The captured images and recorded videos taken weekly at the site and shared among key project stakeholders significantly and equally kept them in the loop and boosted their confidents and enthusiasm about the project. Importantly, the aerial photos and videos from drone data also served the project owners and managers better documentation for future references and ligation, cost savings, and faster reconciliation with contractors.

The introduction of drone technology in this project really benefited surveyors in time reduction and cost savings for repetitive survey and associated labour costs for collecting intensive ground data in the field and updating ground surfaces from the continuous changing of ground conditions. The point clouds generated from drone images, which contains geospatial coordinates (x,y,z) helped surveyors to provide accurate ground modeling for distance, area and volume measurement. The drone mapping and surveillance mounted daily also helped safety team to identify occupational hazards and enhanced safety throughout the project duration.

In a whole, drone mapping and surveillance technology brought huge changes and improvements in our resettlement project communication, safety, and operations when covid-19 pandemic restricted the movement and visit of our key project consultants, stakeholders, project owners and investors scattered across the globe to site for 12 months duration. This tells us that a single drone photo or image speaks volume, contains rich datasets and worths millions of dollars. Therefore, I highly recommend the usage of Drone mapping technology for all construction projects, particularly multi-dollar projects, projects hoisting hundreds and

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thousands of workers, global pandemic such as covid-19 and rugged grounds where human accessibility is restricted.

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