
# Analyzing Archaeological Sites Using Drones

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## Introduction

Drones are recent additions to many scientific fields. Drones accurately and efficiently collect photo and spatial data, creating data paths, and gaining unique perspectives. Reconstruction during the dig process gives insight to changes in the stages of an area over the small multi-period settlement that has several building phases. I traveled to the archaeological site at Saint Clement Island, Croatia to participate in the Soline Project 2018 excavation to understand the sequence of archaeological layers and the phases of built features. The site on Saint Clement Island is a small-scale excavation of a Roman maritime villa. There is evidence that this settlement was used from Early Imperial to Late Antiquity, with changes and additions to the architecture over time[1]. The mix of structures from salt works, residential, warehouse and production give evidence to what the area was used for over time. I performed flights over two weeks at the site with a DJI Phantom to acquire data then processed it in ESRI's ArcGIS Pro/Scene software. Sequential recording of the site over time is an invaluable tool for sharing the excavation process. Still photography and day books of the excavation can never give a full picture of the excavation process. Most archaeological sites are never fully excavated, but excavations may be resumed at a later point in time, making this type of excavation record invaluable since it recreates the direct participation at the site.

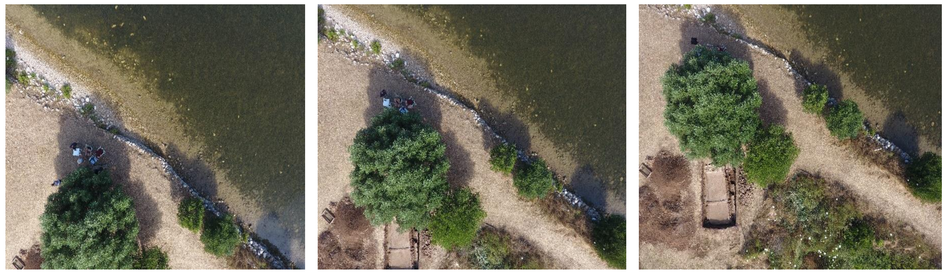
**My research questions**:

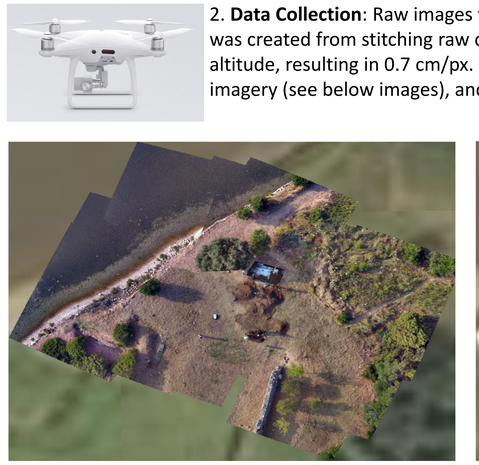
How practical is it to use a drone to collect high quality data in the field?

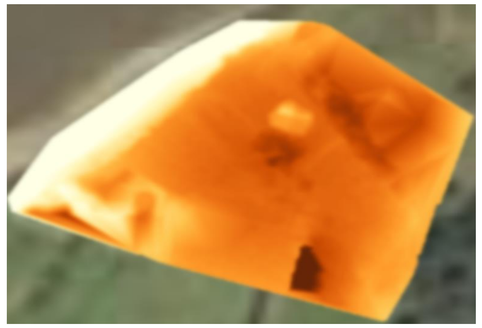
Can a 3D models of the site be created from drone acquired imagery and used to estimate volume?

1. **Study Area Design**: The flight Path remained constant throughout the flying process and took an approximate 80 pictures per flight. Initial flights were used to decide on this flight pattern, based on efficiency and overlap of photographic data. Flights use this pattern to ensure that the study area in each model is consistent.


## Methods

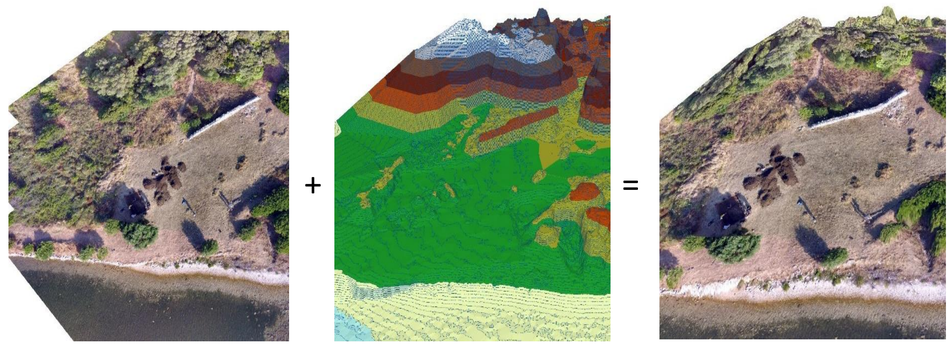






2. **Data Collection**: Raw images from a DJI Phantom 4 drone (above). An orthomosaic was created from stitching raw drone images together. The drone flew at 15 meters altitude, resulting in 0.7 cm/px. Drone imaging is considerably clearer than satellite imagery (see below images), and cheaper than helicopter acquired imagery.

3. **Data Processing and Analysis**.: Volume was estimated to be 2.578 cubic meters based on the amount of soil removed from the archaeological site. In comparison, volume was measured of the dig hole itself, to 3.081 cubic meters. (That calculation is larger than the soil calculation since rocks were also removed in the dig.) Comparisons were made to a Cross Section Survey[2] which estimated volume to be 3.608 cubic meters. This means drone imagery volume calculations were 85.3% accurate.




4. **3D Imaging**: The process of combining an orthomosaic (left) and TIN file (center), to create a 3D orthomosaic (right). The result is a highly detailed 3D representation of the archaeological site. 3D imaging allows volume to be calculated of excavation sites and historical features. 3D imaging gives perspective that 2D imaging cannot.

## Conclusions

Based on my findings, using a drone to collect data at a small excavation site is cost effective and efficient in collecting imagery and data compared to traditional ways of data collection.

- Orthomosaics created from drone imagery are far more detailed that satellite images.
- Additional data can be collected by the drone simultaneously and used for making future decisions in archaeology.
- Software used by the drone is easy to use and allows future excavations exact flight patterns to keep a consistent record of data over time.
- Volume measurements give insight into extent of yearly excavation.
- Volume calculations were 85.3% accurate. Image resolution was high, so image correctness was not the problem, but a software accuracy issue.
- 3D imaging gives a extensive view of the dig site that 2D pictures wouldn't achieve.

Limitations and Future Research:

- Volume measurements have to be on relatively flat land.
- Proximity to other features (ex. tree near a wall) can alter 3D imaging and DEM.
- Tree cover can reduce overlap of the ground under and around them.

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Bibliography

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