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A Methods Note on Remote Sensing Platforms and Large-Scale Archeological Impact Assessments (AIA) in the Philippines

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Abstract

This research note attempts to present to Philippine-based archeological impact assessments (AIA) archeologists "how to" possibly approach spread-out or large-scale project sites through the integration of various aerial remote sensing platforms in the work process. Cascading remote sensing platforms providing multiscalar (macro, meso, and micro) perspectives are presented in conjunction with the complimentary method of stratified random sampling (SRS). The SRS is informed by a predictive model of where to find archeological sites in the Philippine setting, even in areas where there are no positive archeological features. This methods note offers the AIA archeologist efficient and targeted utilization of limited time and resources following a streamlined workflow process using remote sensing and geographic informations systems (RS-GIS) as a force multiplier. After carrying out the AIA, further mitigating arrangements can also be undertaken including possible side-by-side monitoring of earthmoving activities by archeologists, and possible recommendation for further revalidations of the initial AIA results.

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Background

It would be good to provide a succinct account of the unique historical context of AIA in the Philippines because it has a direct implication to why practice of AIA in the Philippines is gaining momentum just recently. This is due to the convergence of various factors but arguably a major stimulus to the demand for AIA is the so called *golden age of infrastructure* in the Philippines ushered in by the *Build Build Build* (BBB) policies of the Philippine Government starting in 2016 up to the present. The BBB has resulted to the undertaking of large-scale infrastructure projects (i.e., the construction of highways, expressways, hydroelectric dams, land reclamation, railway systems). These BBB projects attempt to comply with the requirement for an AIA. While BBB is in the public sector, there is also growing stimulus coming from the private sector (i.e., residential and commercial businesses, private public partnerships [PPP]).

It is important to note the changes in AIA legislation. Since 2019 the regulation of *stand-alone* AIA undertakings has become a function of the National Commission on Culture and the Arts (NCCA). While there has been Philippine legislation since 1977 that mandates AIA as part of the Philippine Environmental Policy (Presidential Decree 1151), AIA then was not a *stand-alone* and was a subcomponent of the Environmental Impact Statement (EIS) under the purview of the Department of Environment and Natural Resources (DENR). By 1998 this function was transferred to the National Museum of the Philippines (NMP) through Republic Act 8492 and further strengthened by Republic Act 10066 in 2012. RA 8492 was then repealed in 2019 by Republic Act 11333 “An Act Strengthening The National Museum Of The Philippines, Repealing For The Purpose Republic Act No. 8492, Otherwise Known As The “National Museum Act Of 1998”, And Appropriating Funds Therefor.” The implementation of RA 11333 by 2020 transferred the AIA regulatory functions to the National Commission of Culture and the Arts (NCCA) as the NMP expanded its educational, cultural, and scientific functions.

As shown above there is growing demand for AIA in the Philippines to assess project sites. The footprint of some of the recent earth moving projects go beyond our typical site sizes in research archeology. An efficient and targeted approach is therefore needed to address such long-span, large-scale projects. Below is a recommendation that capitalizes on the use of remote sensing and geographic information systems (RS-GIS) tradecraft in tandem with stratified random sampling (SRS).

Method

Cascading Multiscalar Platforms

Remote sensing and geographic information systems (RS-GIS) platforms in conjunction with stratified random sampling (SRS) are force multipliers in an AIA due to their ability to access and ability to navigate various spatial scales of data or multiscalar data including the macroscale, mesoscale and microscale data (Figure 1). The macroscale-level data involves the whole project, or the segment/section identified for AIA, and may involve more than one political unit boundary (barangay/municipality/province/county/state). The mesoscale-level data will involve specific sections of the project such as a road segment or railway segment. The microscale will involve the targeted area for test pit excavation, or even a positive feature such as a historical feature within the vicinity of the project.

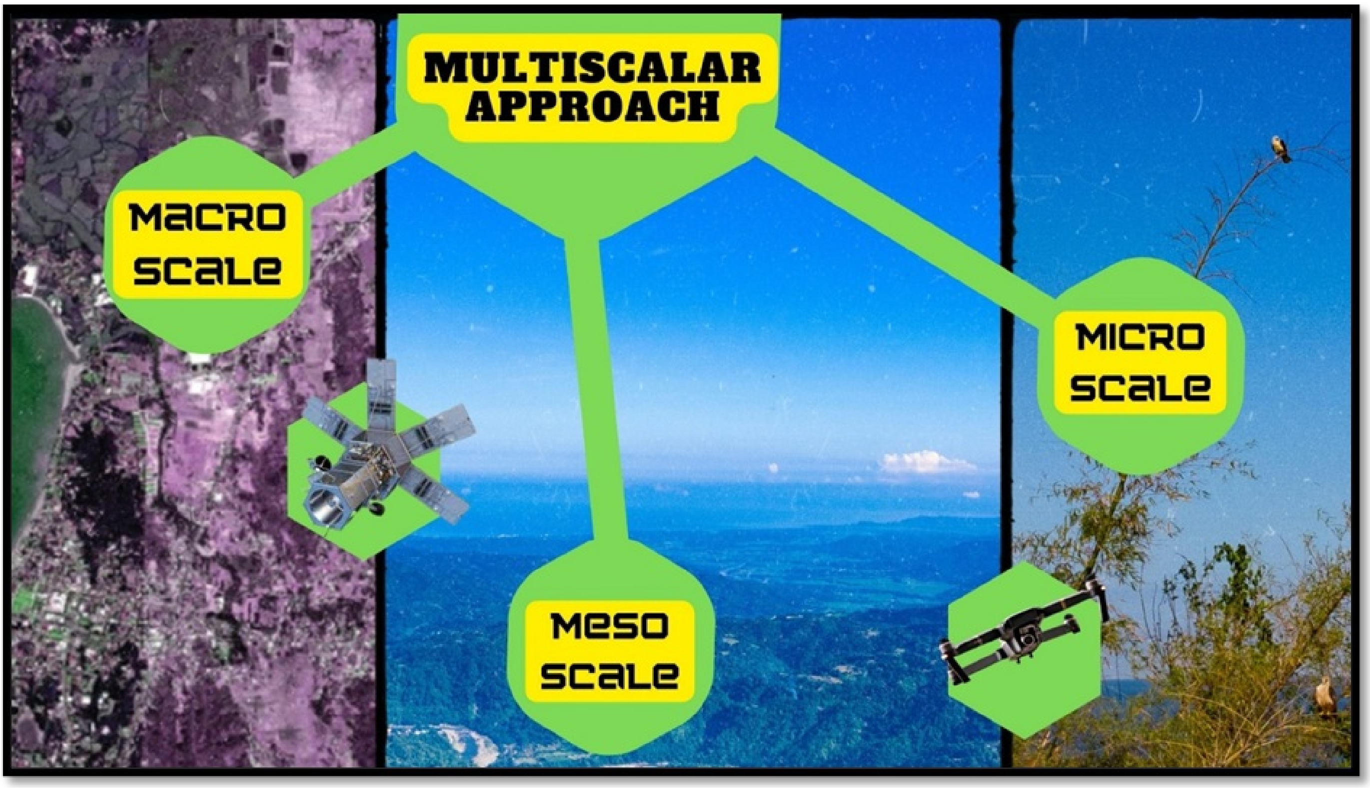

Figure 1. Multiscalar approach integrating aerial platforms including high-resolution multispectral satellites and remotely piloted aircraft systems (RPAS).

The targeting of areas for test pit excavation will be based on the output of a stratified random sampling that is based on a predictive model for archeological sites. Archeological materials that may be recovered from these targeted locations may then be subject to further analysis. The full work process is illustrated in Figure 2. Working parallel to the RS GIS approach is a historical approach that will identify sites that will be subjected to positive feature-informed excavation or test pit excavation.

The use of archived and tasked high-resolution imagery satellite data is recommended in order to fill in the requirement for macroscale data. The minimum spatial resolution that allows for the remote sensing of features is a < 2-meter resolution. A sub-meter spatial resolution; however, is highly recommended since this may provide a complementary perspective of the microscale level data that can then be easily compared with remotely piloted aircraft systems (RPAS) data. The mesoscale level data will rely heavily on real-time, immersive use of RPAS. The **best-case scenario** (author's emphasis) is to utilize a suite of RPAS payloads including multispectral sensors, infrared sensors, thermal imaging, and light detection and ranging (LiDAR). If unavailable, the minimum requirement can be easily filled in by a high-resolution, imaging consumer off-the-shelf RPAS (COTS-RPAS). The COTS-RPAS can also provide multiple perspectives at the microscale level depending on flight conditions during AIA operations. In fact, the COTS-RPAS is to be used extensively since this provides higher vantage points that help inform a decision on whether to employ test pit excavations in some localities. The COTS-RPAS serves as the archeologists' putative eyes in carrying out the archeological reconnaissance of the area.

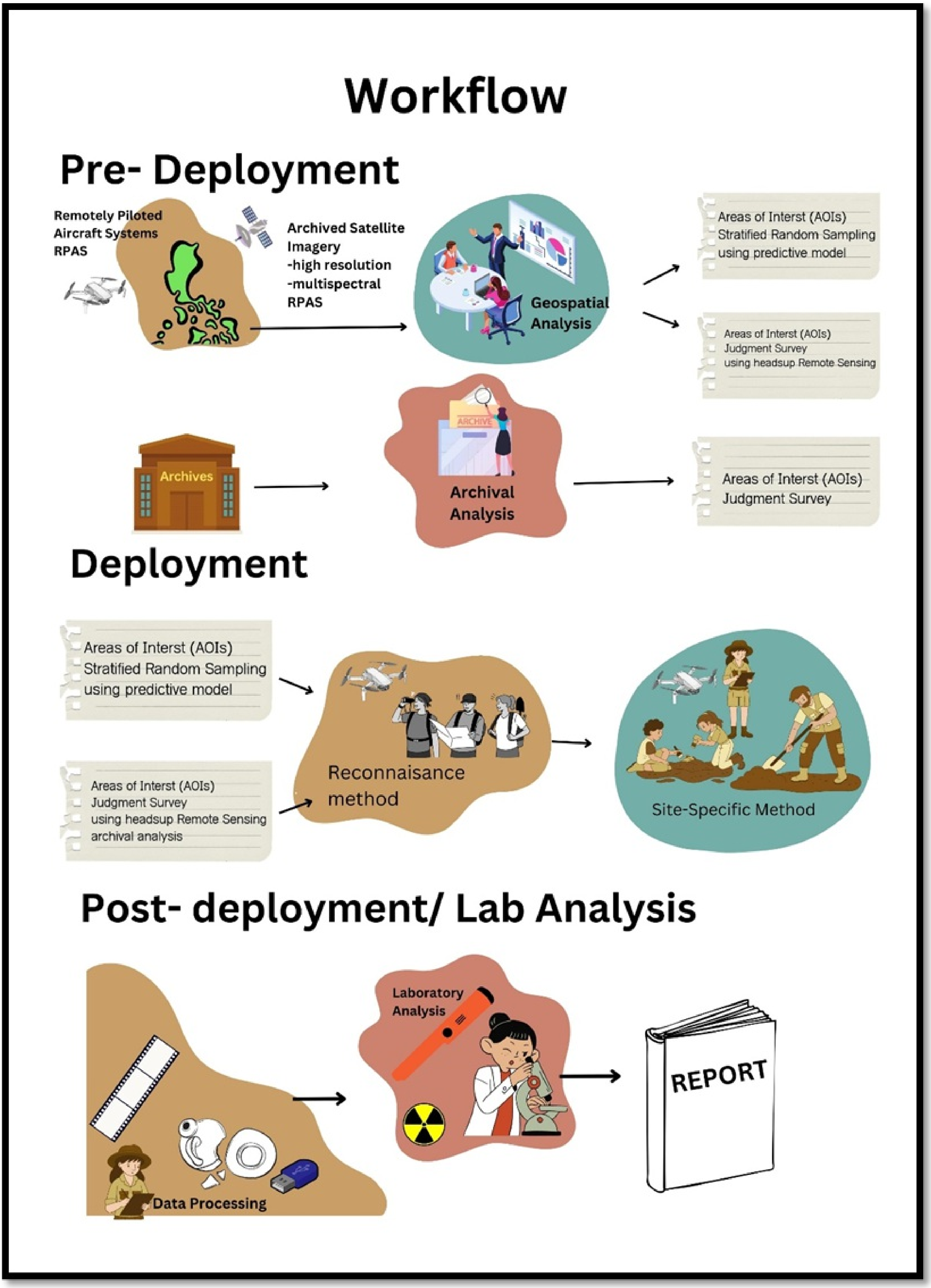

Figure 2. Proposed overall workflow.

Stratified Random Sampling the Predictive Model

The AIA operation should aim to sample the whole universe of archeological sites within the project's spread-out footprint, including known and unknown sites both in the historical and the prehistoric period (see Figure 3). There is also the possibility that known sites are composite sites that must be further investigated. Unknown sites that exist as composite sites can benefit from revalidation AIA to re-assess the period of occupancy of the site. Here I propose to use as a predictive model for archeological sites the generalized model proposed by Bronson (1977) (Figure 4). The model was further elaborated by Junker (2013, 1999) in her work at Tanjay, Negros Oriental. The model can also be supplemented by archeological remote sensing works in the Philippines (see Canilao Sarmiento Hilario Rufino 2021, Canilao 2020, Canilao 2018).

In setting up the variables for the predictive model, the first step is to process a digital elevation model (DEM) of the area to delineate the major rivers and their corresponding drainage basins. The next step is to identify the probability zones for archeological sites within the river dendritic structure, following Bronson (1977). The high probability zone is the river delta estuarine area, the medium probability zone will be slightly upriver, and the low probability zone will coincide with branches further upriver of the river. A shapefile delineating the project footprint is then overlaid on the predictive model, and the resultant intersectional predictive model map (IPMM) is then subjected to a systematic random sampling (SRS) procedure. Constraints in time and resources behoove the AIA archeologist to set a percentage of SRS to be undertaken in the IPMM.

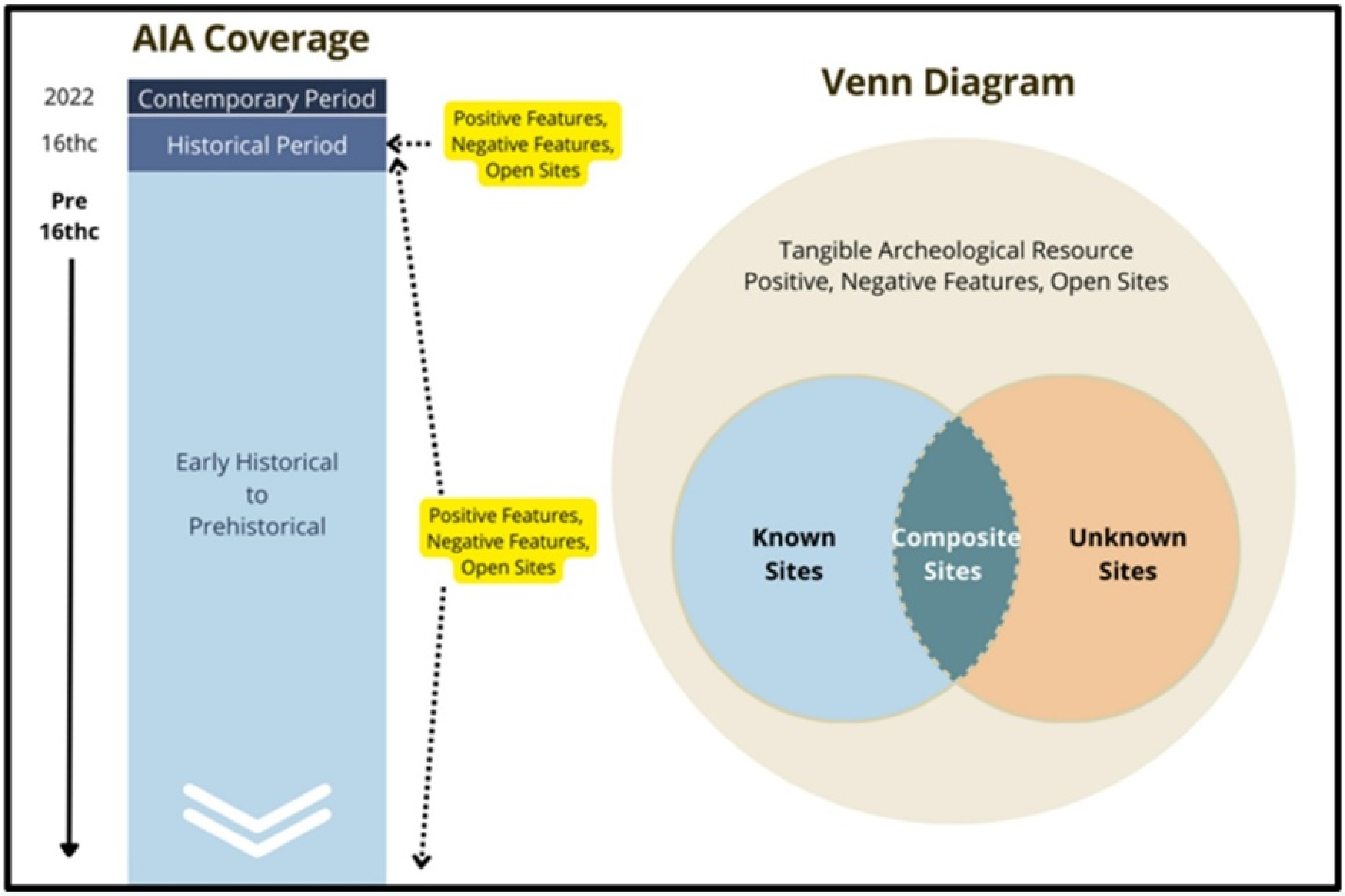

Figure 3. the purported universe of archeological materials in the Philippines.

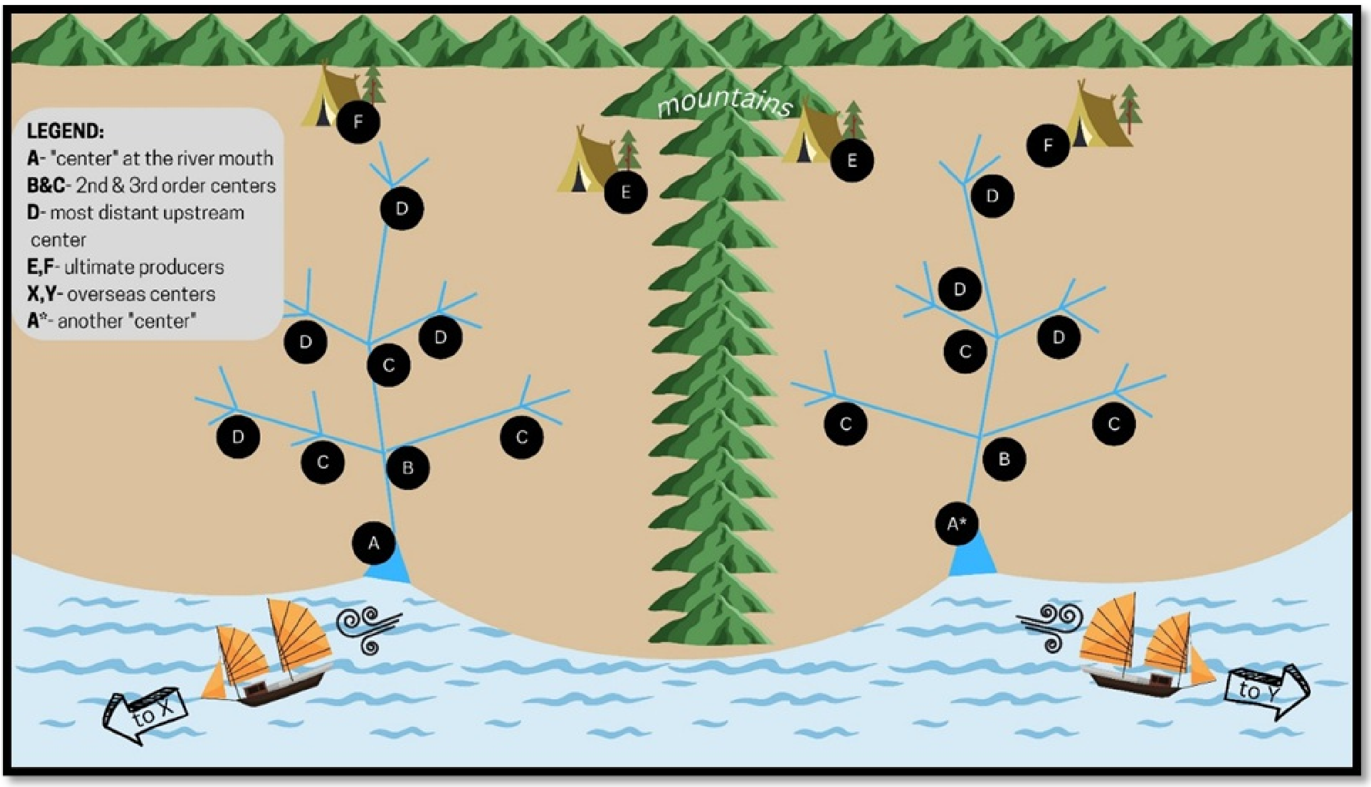

Figure 4. After Bronson's (1977) model of settlement sites. The proposed core model to be used in the AIA predictive modeling.

The IPMM final output is principally a map of target locations that will then be the guide to undertaking the archeological aerial survey which then informs possible test pit excavation. Depending on the scope of work of the AIA contract, site discoveries may be subjected to subsequent focused excavations or earmarked for follow-up salvage archeology at a later time.

Heads-up Remote Sensing of the High-Resolution Maps

The high-resolution satellite imagery available in the AIA project will also be analyzed using heads-up remote sensing. In such a procedure, possible archeological features are identified based on some of the remote sensing indicators seen in previous works (see Canilao, Sarmiento, Hilario, and Rufino 2021; Canilao 2020; Canilao 2018). These works are specific to remote sensing of *ijang* (fort) locations and archeological trails in smaller island contexts.

Systematic Archeological Aerial Survey

It should be stated at the outset that formal training in RPAS operation with corresponding accumulated flight hours is required in implementing this method. Local RPAS laws should also be consulted by the AIA archeologist. The objective of the systematic archaeological aerial survey (SAAS) is documentation of the meso- and micro-scale context of the target location. The RPAS will undertake both orthogonal documentation (Figure 5) and side-looking documentation with perspectives following the different cardinal directions (Figure 6). The imaging drone will be used to take not only aerial photographs but also aerial videos of the site. The latter will involve two additional flight patterns: the expanding spiral/helix flight pattern (Figure 7); as well as the full-length/full coverage flight over the target location (Figure 8).

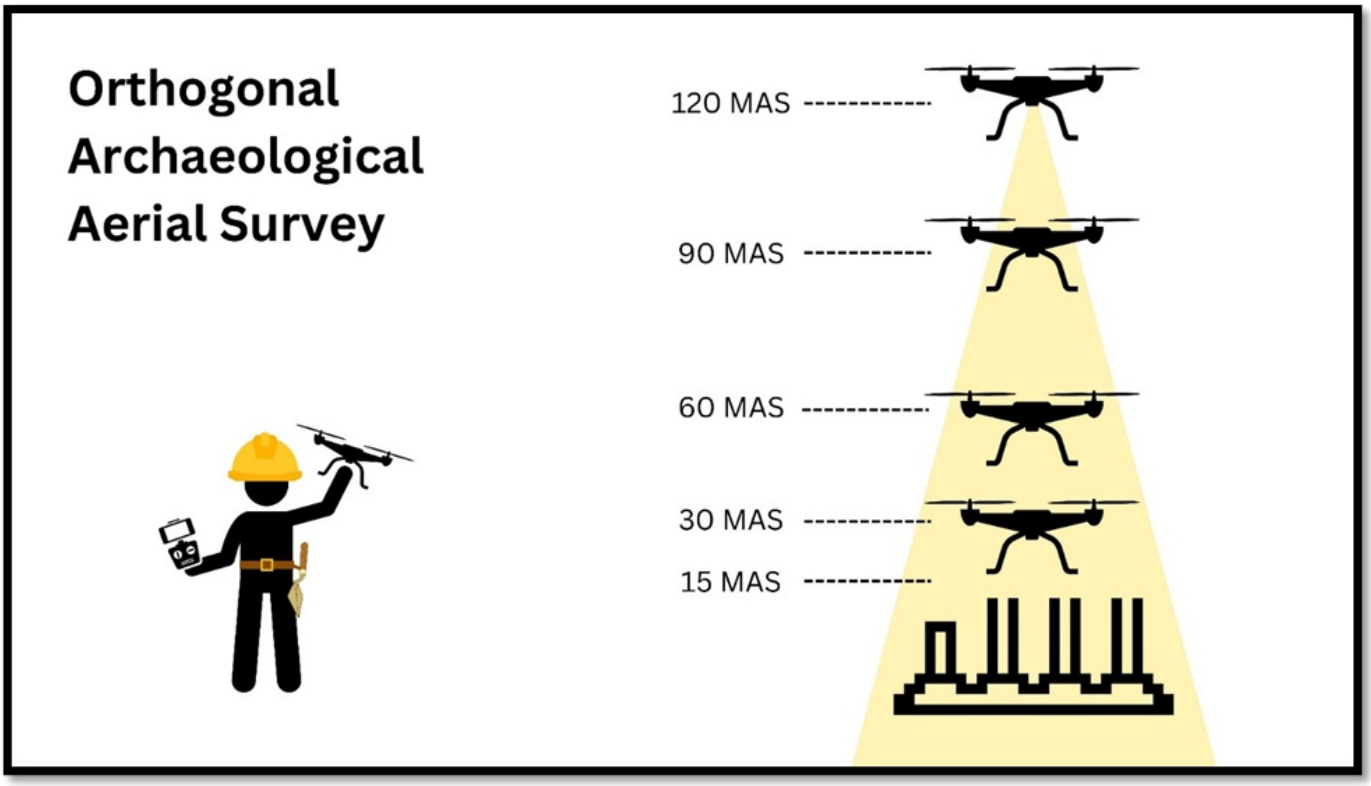

Figure 5. Orthogonal documentation at decreasing altitudes in meters above surface (MAS).

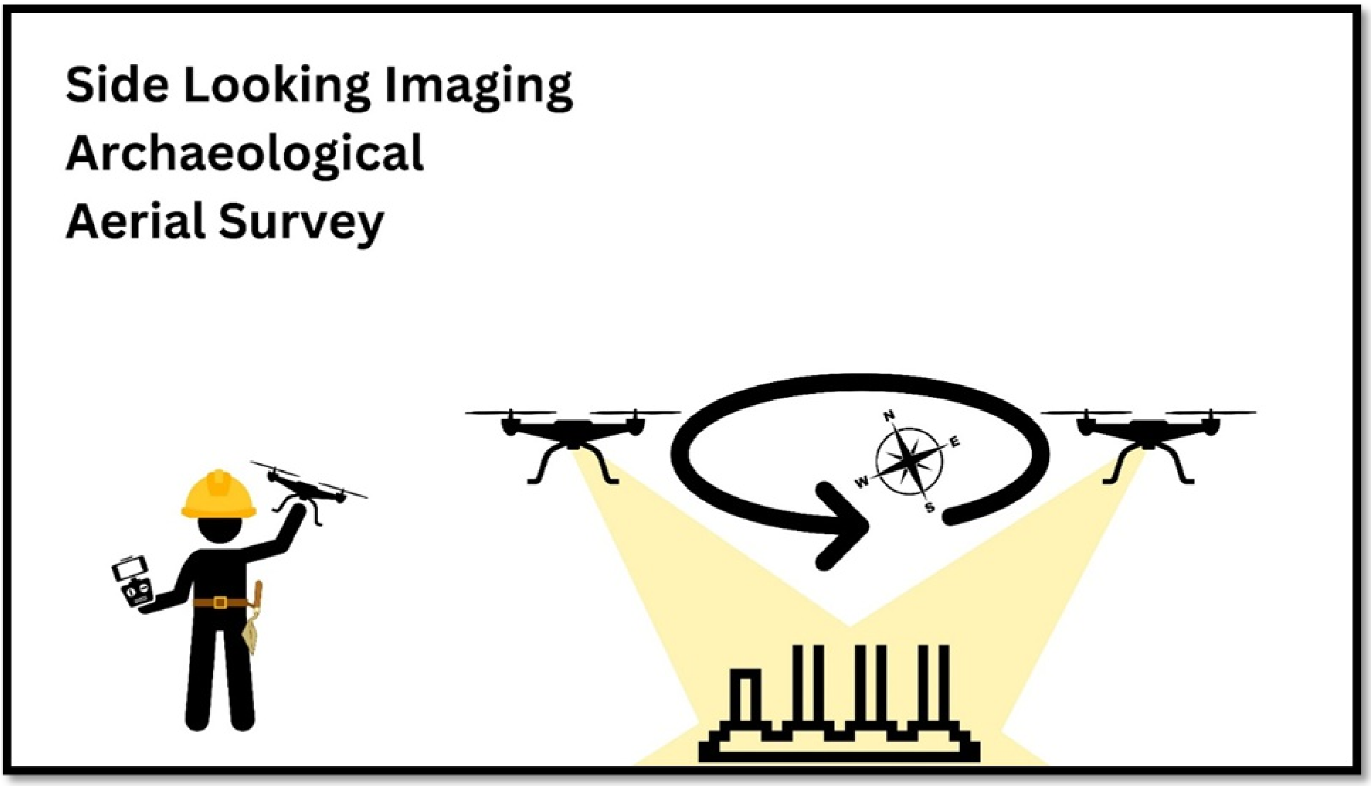

Figure 6. Side-looking imaging following cardinal directions.

Depending on the project footprint, there may also be a need to fly the entire length of the project segment or even close-up documentation of features located in inaccessible areas.

The RPAS display size may allow on-the-spot analysis or there may be a need to immediately export data to be viewed on a good-sized monitor to analyze the aerial photos and videos. This data will then be used to inform decisions on where to carry out a test pit. Archeological plan and if possible archeological profile drafting of sites can already be undertaken with the RPAS. The use of control points (See Figure 9) is recommended to be able to carry out geo-referencing of the resulting RPAS plates and overlay them on the macroscale satellite imageries.

Discussion

The method outlined above has presented a possible approach for undertaking AIA on spread-out, large-scale infrastructure projects in the Philippine setting. The unique AIA historical context was also presented to show why there is a surge in its demand in the Philippines. The method, or “how to,” presented above is a bare minimum, although the scope of work in the contract may be negotiated to include further sampling runs, revalidations, or even on-the-spot monitoring of the actual earth-moving activities. At the very least, this method would guarantee a dipstick into the plethora of unique Philippine archeological sites that may be impacted by the project (the known and the unknown; pre-contact and contact sites). Total excavation, which entails completely peeling off the stratigraphic layers that may contain archeological materials up to the putative bedrock is a utopian endeavor. Instead, we should aim for a sound sampling procedure that is guided by a predictive model and further supplemented by RS-GIS methods.

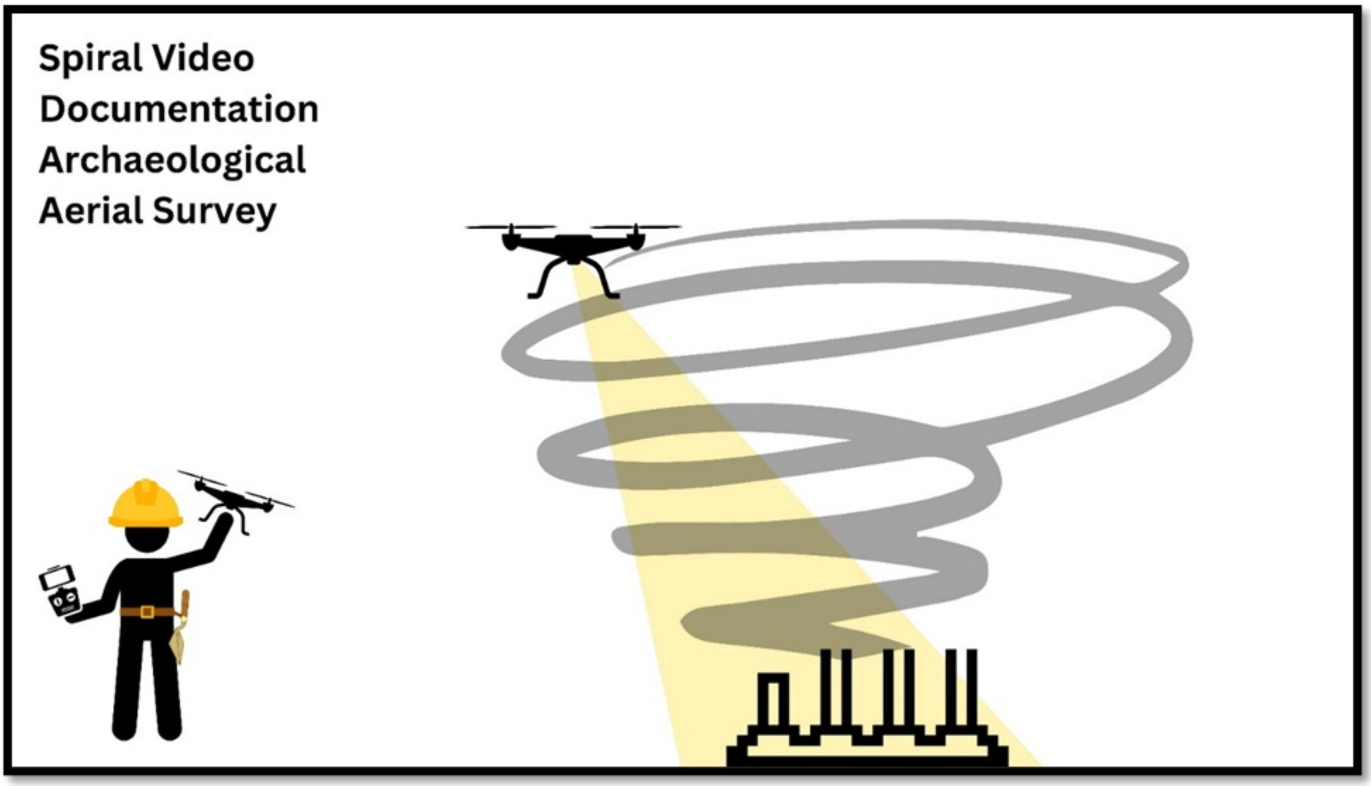

Figure 7. Expanding spiral/helix flight pattern in video documentation.

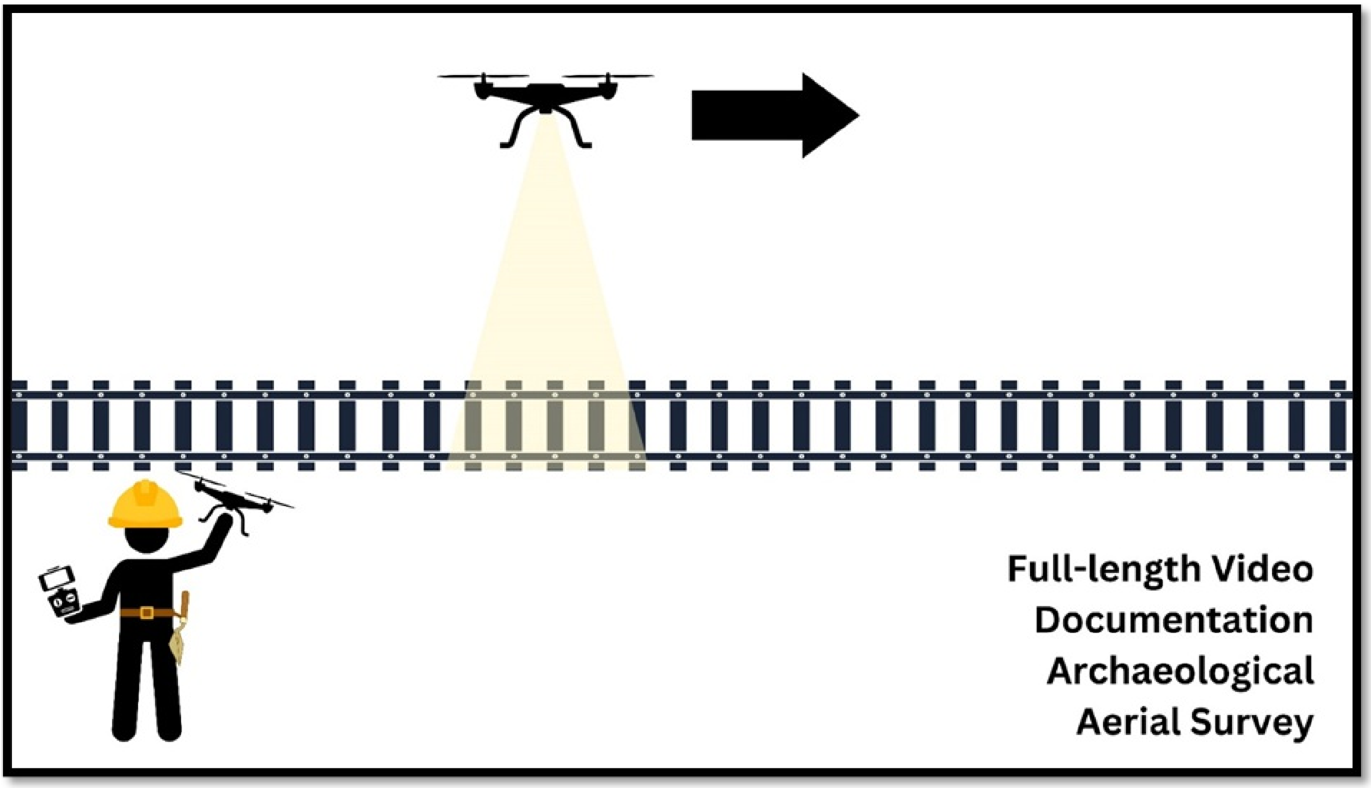

Figure 8. Side-looking imaging following cardinal directions.

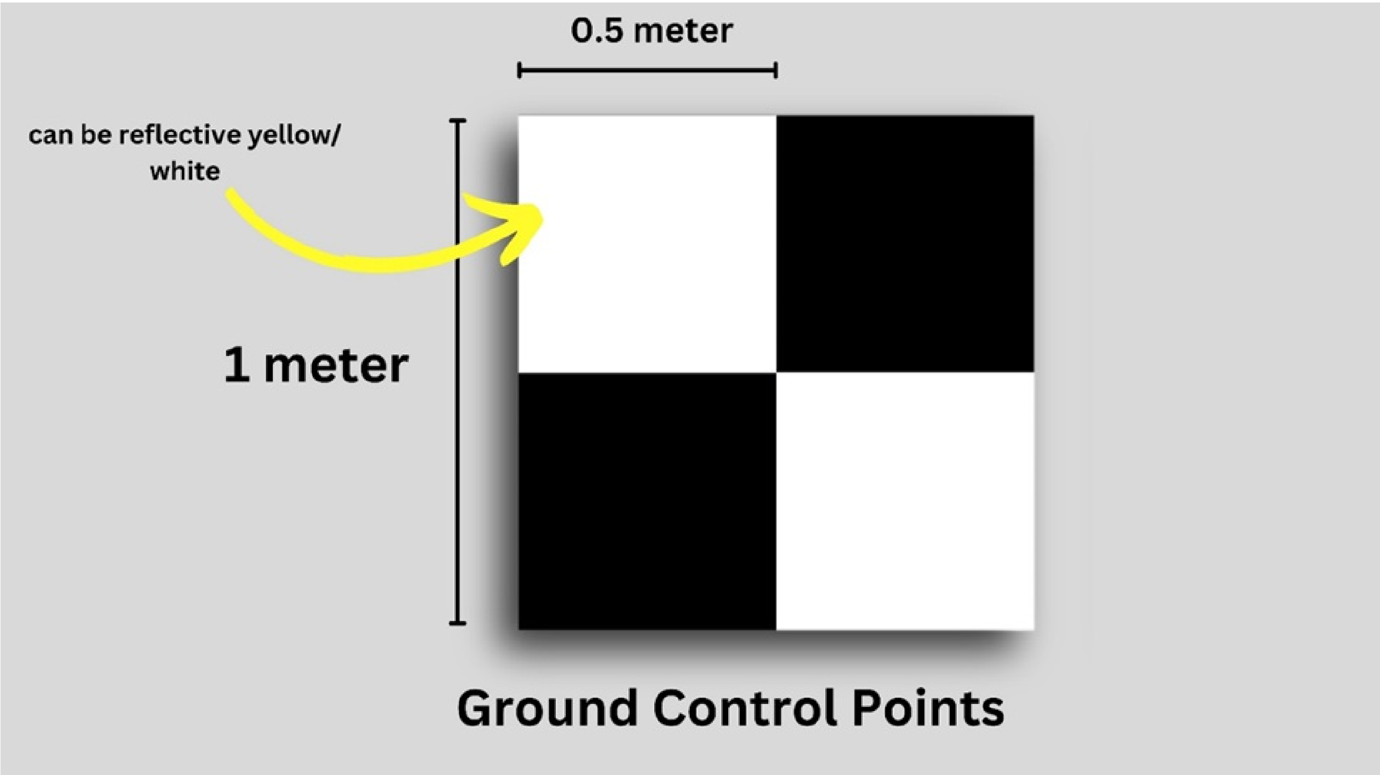

Figure 9. Example of a ground control point (GCP) to use in an archaeological plan and, if possible, profile drafting.

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