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MAKING VILLAGES OUT OF ADOBE HILLS: MICRO-TOPOGRAPHIC MAPPING OF ANCESTRAL TEWA SITES IN THE TEWA BASIN, NEW MEXICO

INTRODUCTION

In some of the earliest archaeological investigations to take place in the American Southwest, Adolph Bandelier (1892) recognized the ruins of prehispanic villages in the northern Rio Grande as some of the largest in the region. However, the majority of these large pueblos were built primarily with adobe, not stone. Over 600 years of erosion, deflation, and grazing have reduced these grand, sometimes three-story, structures to a collection of earthen mounds. A common visitor reaction when standing on top of the three story roomblock in the middle of the pueblo Pose'uinge (LA 632) is, "where's the site?"

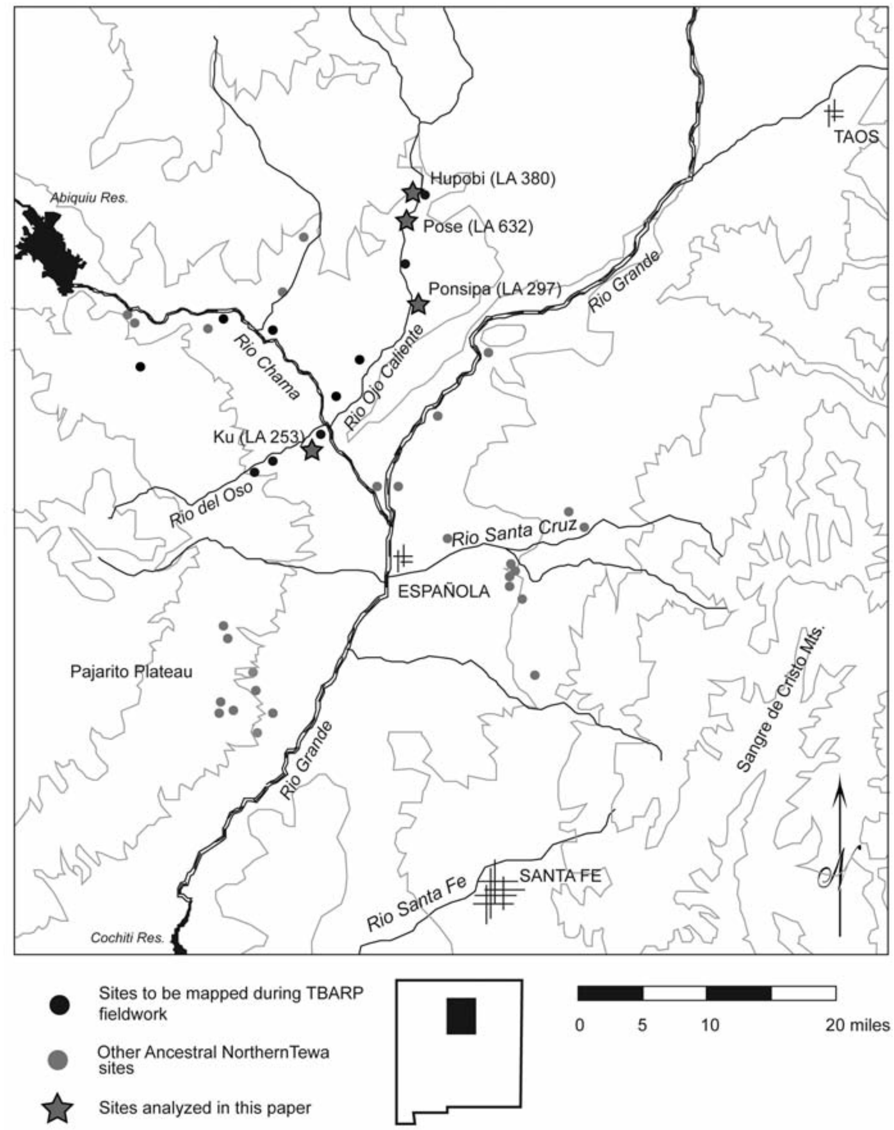
Archaeologists have had a difficult time interpreting these large sites as well. Due to a dearth of modern excavation data delineating wall boundaries, in many cases researchers have had to make general outline maps of the melted adobe mounds, kiva depressions, and midden deposits. Even the work of H. P. Mera (Daw 1990; Fugate 1995), whose maps of these surface features are strikingly accurate and precise (Duwe and Duwe 2008), is plagued by the subjectivity of defining melted and eroded architecture.

An alternative to subjectively mapping the boundaries of room mounds and kiva depressions, which is the concern of this paper, is to use modern survey equipment to create micro-topographic maps of pueblo architecture. Creating three-dimensional maps allows for the construction of objective representations of architectural remains, and also aids in drawing two-dimensional plan maps. Although this is not a novel method in Southwestern archaeology, I argue that its use can provide archaeologists with more accurate spatial representation of sites without the use of excavation. Wide-scale use of site-level micro-topographic analysis over a large study region is imperative for understanding residential mobility in the past, and also for examining detailed questions such as social change.

The Tewa Basin Archaeological Research Project (TBARP), of the Department of Anthropology, University of Arizona, has sought to understand the social and cosmological implications of village coalescence (or population aggregation) for ancestral Northern Tewa populations in the northern Rio Grande region during the Coalition (A.D. 1250–1325) and Classic (A.D. 1235–1600) periods. To understand the social effects of coalescence it is necessary to first understand how and when coalescence occurred. This requires both mapping of sites to see patterns of growth and depopulation and ceramic analysis to gain chronological control of residential mobility.

This paper outlines the methods used and preliminary results achieved in mapping Classic and Coalition Period Tewa sites in the Tewa Basin of northern New Mexico, particularly in the Rio Chama drainage. I evaluate and compare the utility of instrumental survey mapping and global positioning system (GPS) technology in mapping large adobe sites and also offer suggestions for future research.

Figure 1.
Map of study area and archaeological sites of interest within northern New Mexico.



THE RESEARCH AREA

The Tewa Basin is positioned along the Rio Grande, running north to south from the upper tributary reaches of the lower Rio Chama to the northern Pajarito Plateau. The area is bounded by the Sangre de Cristo Mountains to the east, the Jemez Mountains to the west and south, and the Pajarito Plateau to the south. The primary rivers, the Rio Chama and Rio Grande, are the lifeblood of the region, and the majority of the 40 ancestral villages and countless archaeological remains are located on the benches above these rivers and their tributaries (Figure 1).

Like many pueblo sites in northern New Mexico, the majority of ancestral villages in the Tewa Basin were built with coursed adobe and were very large, the biggest averaging over 1,000 rooms (Beal 1987). Some of the largest sites in the Tewa Basin, Ponsipa'akeri (LA 297) and Pose'uinge (LA 632), measure 6 and 12 ha, respectively. However, without regular maintenance adobe architecture will begin to decompose and erode (melt) within only a few years. Through the pressures of time, erosion, and grazing these sites have been reduced to collections of mounds and depressions (buildings and kivas, respectively).

The resulting eroded architecture was described by Bandelier when performing the earliest archaeological reconnaissance in the region. His observations of site layout, occupation sequences, and residential mobility in the Tewa Basin were perceptive and anticipated future research. Of Howiri'uinge (LA 71, a pueblo neighboring Hupobi'uinge [LA 380]) he stated, "The pueblo was probably built of adobe, and the condition of the mounds indicated that its decay antedates that of the most southerly pueblo in the valley, the one which the Tehuas call Pose-uingge" (1892:39).

The first comprehensive research that involved accurate site mapping was conducted by H. P. Mera in the 1920s through the 1940s (Daw 1990). Mera, who possessed a keen eye for archaeology that was honed over nearly 30 years of fieldwork as well as a background in graphic design (Fugate 1995), used both compass-and-pacing and a plane table to map hundreds of sites in the American Southwest (Daw 1990). These maps, while seemingly incredibly accurate and precise (Duwe and Duwe 2008), were based on Mera's subjective eye. His maps, and those made by others who followed him, provide excellent interpretations of site layout but do not offer additional data for the spatial reanalysis.

The TBARP is primarily interested in understanding how and why Ancestral Tewa populations in the Tewa Basin coalesced in the Coalition and Classic periods. In order to understand changes in village size through time, data recovery consists of mapping and remapping large (>50 room) sites to create accurate maps that record not only the location of architectural features but also their height and volume. As of the summer of 2008, the TBARP has intensively mapped eight sites using both total station and global positioning systems (GPS) technology.

METHODS

Three-dimensional site mapping is not new to archaeology, and established methods have been constructed worldwide to address increasingly complex theoretical questions (see Lock and Harris 2000 for an overview). Micro-topography has been used in contexts as varied as ancient hominin landscapes in Olduvai Gorge (Kamau 1977) to European cities dating to Late Antiquity (Keay et al. 2007). Researchers in the American Southwest have also successfully made use of micro-topographic site maps to interpret architectural building sequences and pueblo population estimates (Liebmann 2006). The increasing amount of non-invasive or "surface archaeology" (Sullivan 1998) in the American Southwest is directly related to a changing archaeological and political climate that deemphasizes excavation in favor of other methods of data collection (survey, mapping, and the analysis of existing collections and reports).

Micro-topographic mapping, or the ability to visualize in three dimensions ground relief at a high resolution, is especially applicable to the sprawling adobe villages in northern New Mexico based on two factors: elevation and subjectivity. The ground elevation, which is loosely related to original wall height or kiva depth, is often difficult to measure due to vegetation growth and disorientation. Subjectivity is an unavoidable artifact of archaeological fieldwork (especially mapping) where the researcher is forced to make interpretations in the field. Both instrument mapping and GPS record space in three dimensions; this information can be measured and analyzed more accurately out of the field and in the laboratory. These data can also be shared with others who may make different interpretations.

Both survey instrument mapping and GPS were employed to 1) test the efficacy of using these technologies to create three-dimensional micro-topographic mapping on large adobe sites; 2) aid in drawing accurate two-dimensional plan maps of the sites; and 3) evaluate the relative strengths and weaknesses of the two technologies in creating micro-topographic maps.

Instrument Mapping

The TBARP carried out high-resolution micro-topographic instrument mapping on eight Coalition and Classic Period sites in the Rio Chama valley during the 2007 and 2008 field seasons (Figure 1). Mapping was performed using a Leica Total Station TC 307 (supplied by the Integrative Graduate Education and Research Traineeship [IGERT] archaeological science program at the University of Arizona) which is accurate to approximately 3 mm in favorable conditions. Two people are required to map a site (one operating the station and the other holding the stadia rod and prism). In most cases a single arbitrary datum (Pose'uinge required a secondary datum due to its large size) was established at the highest point on the landscape. The UTM coordinates of the datum were subsequently recorded by a Trimble GPS, and all points shot with the total station were georeferenced into a fixed, global coordinate system.

To record visible architecture and interpret site layout (the subjective in-field observations), features such as roomblocks, kivas, plazas, and rock alignments were first identified by walking the site and setting pin flags (mapping using in-field observation is important because not all architecture and site features will be resolved in the micro-topographic analysis). Multiple points were shot using a total station to define the features' outlines. These points were imported into ArcGIS 9.2 and drawn to reflect my initial impression of the site layout.

The creation of micro-topographic surface maps required recording many points across a site that captured changes in elevation across space. Each site was gridded into 5 x 10-m units and points were shot at the corner of each unit, providing on average 800-1500 points devoted to capturing subtle relief. Mapping in the field generally took two to three full days.

All three-dimensional data points recorded with the total station (both from feature mapping and the topographic grid) were converted into three-coordinate points (easting, northing, elevation) and georeferenced into real space as UTMs. These coordinates were imported into Surfer 8.0 mapping software to generate surface maps of the sites.

Both shaded relief and contour maps generated with the Surfer software were imported into ArcGIS and compared to my in-field interpretations of surface architecture. When there were discrepancies, the roomblock or kiva outlines on my two-dimensional plan map of a site were adjusted to concur with this topographic data.

GPS Mapping

A Trimble GeoXH GPS was used throughout the mapping process to record features outside the range of the total station (approximately 150 m) including shrines and material remains of agricultural activity. The Trimble GPS was chosen because of its sub-meter accuracy that averaged a standard error of 20 cm. Due to the relatively time-consuming nature of using the total station to record micro-topography, and the ability of the GPS to record three-coordinate points in quick succession, I tested whether a GPS alone was capable of observing high resolution micro-topographic variability.

The Trimble was set to record a line with individual spatial points recording every second. By setting the antenna height to the distance the GPS was held above the ground, it was possible to walk 10-m transects across a site and collect 3,000–4,000 topographic points. This process took two hours to complete.

In the laboratory these GPS points were corrected using Trimble Pathfinder software to a standard error of 20 cm. The individual points that comprised the line were exported as three-dimensional UTM coordinates (easting, northing, and elevation) and imported into Surfer 8.0 software where surface maps were created.

RESULTS

For the sake of brevity, four sites were selected to illustrate the results of the analyses: Ponsipa'akeri, Pose'uinge, Ku'uinge (LA 253), and Hupobi'uinge. These sites are located on Bureau of Land Management land. The first three sites demonstrate the use of micro-topographic mapping and the last site, Hupobi'uinge, provides an example of the potential data quality of GPS applications.

Instrument mapping

It was immediately apparent that the data generated by the total station were sufficient in resolving micro-topographic variation at the site level. At Ponsipa'akeri (Figure 2), Ku'uinge (Figure 3), and Pose'uinge (Figure 4) house mounds and kiva depressions are clearly outlined in relation to the natural topography of the ground surface. Plaza areas are also clearly defined, which is best seen in the small plaza roomblock in the northwestern portion of Ponsipa'akeri.

Micro-topographic mapping also made it possible to distinguish ephemeral architectural features that appeared amorphous during field observation. This includes the small roomblocks in the southwest portion of Ponsipa'akeri (Figure 2) that appeared to be midden area, but were resolved as small mounds on the contour and surface maps. These likely represent a Coalition Period habitation at the site that predates the larger Classic Period architecture based on associated Santa Fe Black-on-white and Wiyo Block-on-white ceramics (author's personal observation).

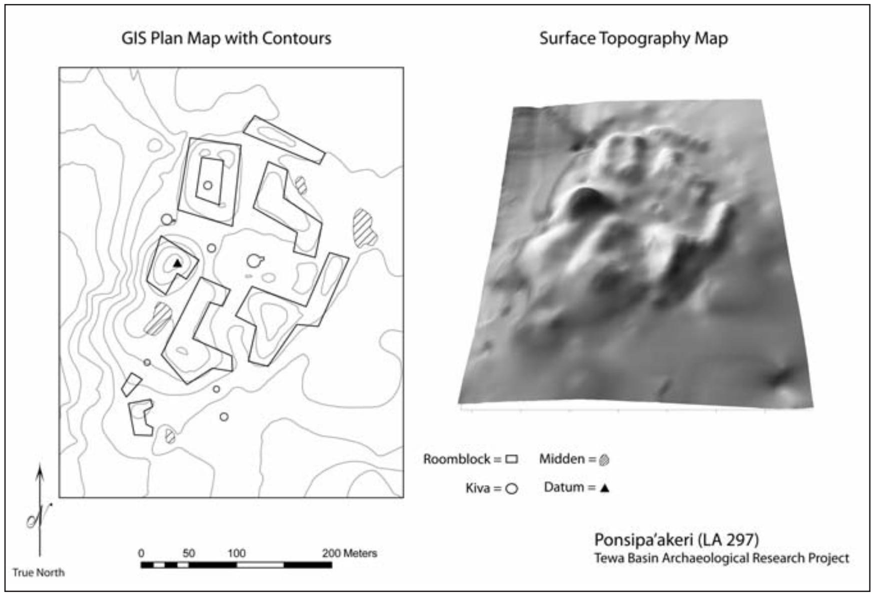


Figure 2.
GIS plan map and surface topography map (at 50 degrees tilt) of Ponsipa'akeri (LA 297). Contours on plan map are 1-m intervals.

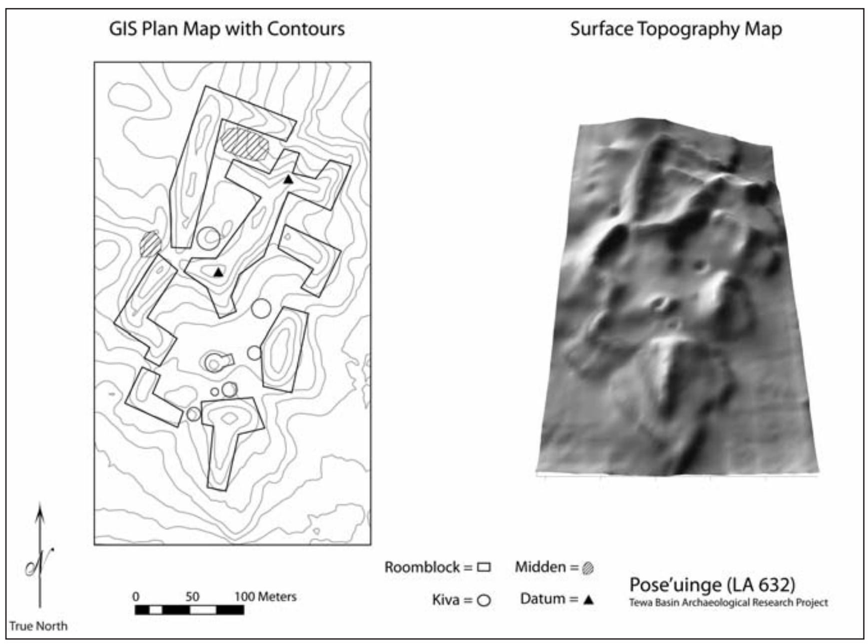


Figure 3.
GIS plan map and surface topography map (at 50 degrees tilt) of Pose'uinge (LA 632). Contours on plan map are 1-m intervals.

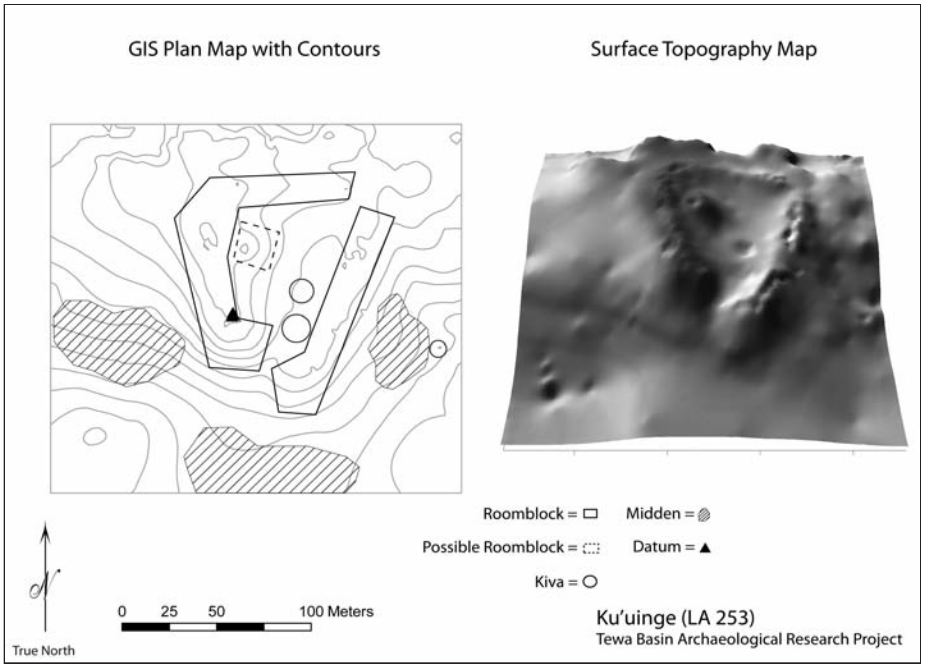


Figure 4.
GIS plan map and surface topography map (at 50 degrees tilt) of Ku'uinge (LA 253). Contours on plan map are 1-m intervals.

As stated in the previous section, a site map is a subjective representation of an ancient village. Archaeologists will interpret the layout of a site based on personal experience and in-field judgment (i.e., how the edge of a mound is defined based on elevation above the perceived natural ground surface). For this project, I used this contour data to redraw my subjective two-dimensional plan maps to better fit the objective data. This was particularly useful at Ku'uinge (Figure 4) where areas of heavy erosion had distorted the house mound boundaries and their definition was only possible after examining the topographic data. Of course, the identification of midden areas, shallow kiva depressions, and eroded house mounds that are not resolved on the micro-topographic maps require field observation. The combination of in-field observation and objective micro-topographic data allow archaeologists to make a "best-fit" decision on the spatial layout of a site without putting a shovel in the ground.

I argue that the most important aspect of creating (and publishing) micro-topographic data of hard-to-define pueblos is that it keeps us honest. When combined with two-dimensional plan maps archaeologists can make interpretations about site layout, but at the same time leave room for future interpretation from researchers who possess better data or approaches. An example is at the site of Ku'uinge (Figure 4) where an extension of the western roomblock continues to confuse me. I have labeled this extension as "possible roomblock," and its identity can be tested by future excavation or remote sensing activities.

GPS mapping

Due to the preliminary nature of this project, only the micro-topography of Hupobi'uinge was mapped using the GPS. The results, however, are striking. When the surface maps generated from the total station and the GPS are compared side by side (Figure 5) it is apparent that the GPS resolved the same melted house mounds and kiva depressions as the total station data. The GPS map somewhat appears rougher, which is likely due to the greater error inherent in GPS technology (20–50 cm vs. 3 mm accuracy). Points recorded using even a GPS with sub-meter accuracy can vary within tens of centimeters while the error inherent in data recorded with a total station is much smaller and more standardized. This lack of standardization with a very large quantity of data creates maps with areas of high resolution (such as the large kiva in the southwest portion of the site where the eastern entrance is clearly visible) and areas of lower resolution (the eastern plaza is poorly defined). Because the total station and GPS provide sometimes different spatial data, the use of both may be desirable to create accurate site maps. However, if a researcher is in need of low-cost and efficient maps, using only a GPS to collect data is a viable option especially when the number of person- hours is weighed against the differences in spatial resolution and standardization. Approximately 40 person-hours can be saved using just the GPS method. The topographic data created by a GPS can be used to create two-dimensional plan maps and can be subjected to the same types of analysis as the data generated by the total station.

DISCUSSION AND CONCLUSIONS

The results of this research have demonstrated that micro-topographic mapping is an efficient means of creating detailed site maps of large sites composed of melted adobe. This method can objectively capture subtle changes in elevation that are indicative of the boundaries of large-scale architecture and the location of ephemeral features. When combined with in-field observations these data are also useful in constructing accurate and precise two-dimensional plan maps for reports and publication. It also allows for archaeologists to test the accuracy of their field observations, and provides raw data for future researchers to make different interpretations based on additional (or better) data and more advanced field and theoretical perspectives.

A second, unexpected, conclusion is that while the total station can generate fine-resolution topographic data, a Trimble GPS unit will also produce good results in only a fraction of the time. This is useful to researchers who want to perform regional analysis over many sites, and also to land and cultural resource managers whose time and budgets are limited.

This research is still in its preliminary stages but the possible scope of data manipulation for the TBARP is already apparent. Due to the limited time required to thoroughly map a site, many sites can be mapped in a relatively short period of time. This is useful for large-scale regional architectural analysis including determining village growth patterns. Additionally, in conjunction with excavated data, this three-dimensional information will be useful in interpreting original pueblo wall height and the number of roomblock stories. By measuring the size of a pueblo in three dimen-

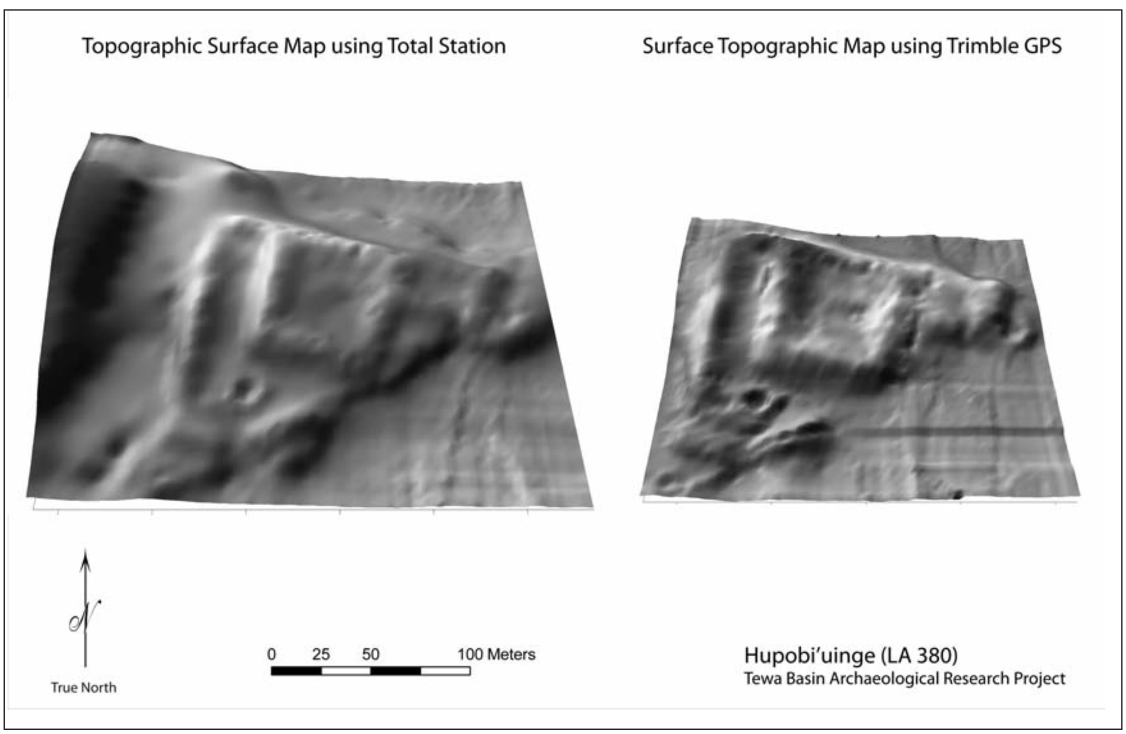


Figure 5.
Comparison of surface topography maps from Hupobi'uinge (LA 380) generated by the total station and GPS.

sions room count can be estimated, allowing for the interpretation of population size, growth, and decline: fundamental information for answering how populations coalesced in the Classic Period.

This method can also be applied to non-research based questions. By occasionally mapping a site, land managers can monitor erosional changes and pot-hunting activity. These maps can also be used for disseminating archaeological information to the public.

It is important to state that no amount of technological innovation can substitute for time spent in the field. Sets of human eyes and archaeological knowledge and experience will always result in the most accurate interpretation of a site. However, with micro-topographic mapping the amount of time and energy spent in the field is greatly reduced, and the amount and quality of data is greatly increased.

ACKNOWLEDGMENTS

Paul Williams of the Bureau of Land Management, Taos Field Office, has been both supportive of this research and fundamental to its fruition. Monetary support was provided by a National Science Foundation Dissertation Improvement Grant (#0741708). The total station and Trimble were provided by the University of Arizona IGERT program of archaeological science. Michael and Janis Duwe and Kelly Swarts assisted with mapping in the field. Kelly Swarts and the editors of this volume provided helpful comments on earlier drafts of this paper.

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