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Conflict on the mesa: Assessing defensibility of plaza-oriented villages in the Salinas Pueblo Province, New Mexico

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Conflict on the Mesa: Assessing Defensibility of Plaza-Oriented Villages in the Salinas Pueblo Province, New Mexico

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Dedication

To my family whom I love very much: My mother, Susan; my sister, Sydney; my father, Mark; and my grandparents, Robert Stancil and Nancy Sumner. Your continued phone calls, emails, and text messages are the reason that I have was able to persevere in this arduous task. Without you continued support and encouragement I would not have been able to accomplish everything that I have and become the person that I am today.

Table of Contents

List of Figures

Figures

Tables

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Abstract

Previous archaeological investigations of plaza-oriented villages in the Salinas Pueblo Province investigated the reasons people may have aggregated in these larger towns. The threat of warfare and the need for defense is one possible explanation for the construction of plaza-oriented villages, whose layout is seemingly intended to limit access. This thesis further assesses the defensibility of these sites using Geographic Information Systems (GIS). The use of a GIS approach offers an opportunity to evaluate the potential for line-of-sight communications and inter-visibility between the plaza pueblo villages on Chupadera Mesa, factors which influenced their ability to signal allies and anticipate attack. GIS also offers an opportunity to determine the relative defensibility of the region's landforms, providing insight into the pueblo inhabitants' site selection process.

Chapter I.

The Natural and Cultural Setting of the Salinas Pueblo Province

Recently, there has been renewed interest by archaeologists in investigating the role and prevalence of warfare in the American Southwest. Several scholars have indicated that the Southwest is an ideal location to investigate the causes and effects of prehistoric warfare because of the quality of field research in the region, high-resolution dendrochronology, and the availability of quality climatic data (LeBlanc 1999; Lekson 2002; Haas & Creamer 1993; Wilcox and Haas1994). The focus of this thesis is to investigate the nature of warfare in one region, the Salinas Pueblo Province of central New Mexico.

Specifically, this thesis is concerned with seven plaza pueblo villages dating from the late Pueblo III and early Pueblo IV periods located on Chupadera Mesa and the Mesa Jumanes in the Salinas Pueblo Province. Movement into these villages marked the first time Salinas residents lived in contiguous buildings, though research indicates that dispersed communities made up of small houses immediately preceded occupation of the pueblos. Geographic Information Systems (GIS) analysis will be utilized to analyze decision-making strategies of the people living in the plaza pueblo villages on Chupadera Mesa and the Mesa Jumanes. The primary goal of the GIS analysis is to determine if the plaza pueblo villages were located to maximize their defensibility. Elements of a site's defensibility include proximity to steep slopes which hinders access by potential attackers, broad viewsheds allowing for the early detection of potential attackers, and inter-visibility between sites suggesting the ability to signal allies for help. The results of this

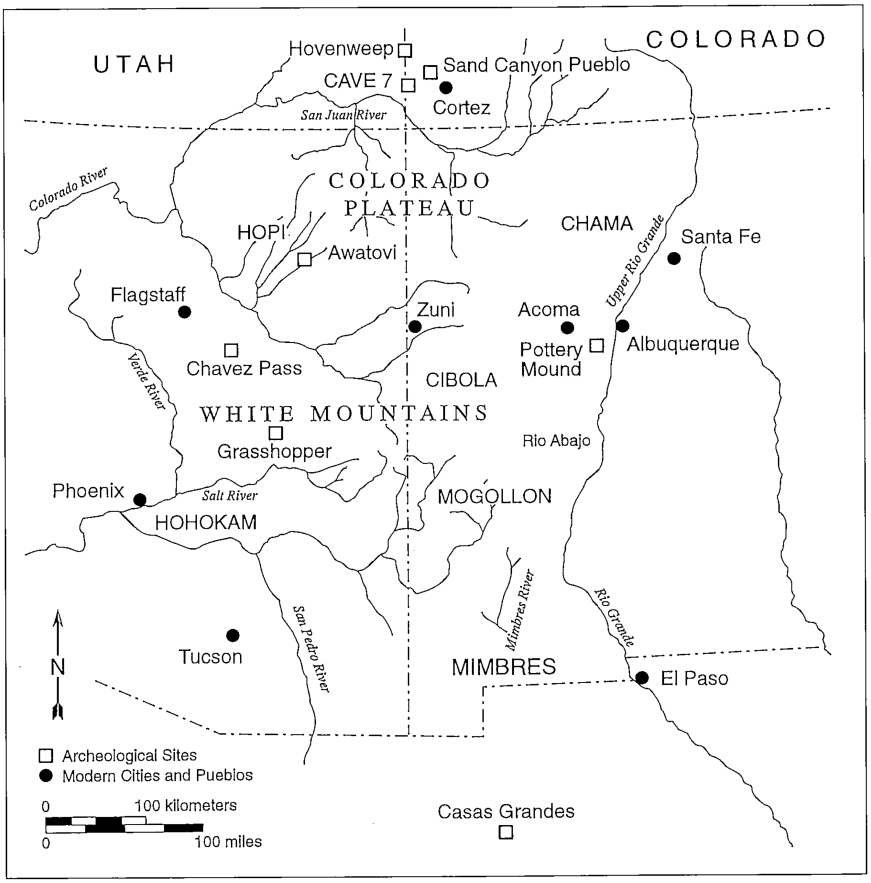
analysis will aid in assessing the role that conflict played in the aggregation of people into large masonry pueblo villages.

In the remainder of this chapter I provide a brief overview of Southwestern prehistory in order to introduce several important cultural developments which set the scene for the construction and occupation of the Salinas villages. I also review the environmental setting and culture history of the Salinas region, as well as introduce the history of archaeological research in the area.

Southwest Culture History: An Overview

To provide a broader context for this study, a brief overview of the prehistory of the American Southwest is presented here. The Pueblo people reside in approximately 30 towns and 19 tribal clusters across Arizona and New Mexico. However, at their maximal extent in the 10th and 13th centuries A.D., Ancestral Pueblo cultural groups could be found across the "Four Corners" area of southern Utah and Colorado, the majority of New Mexico and Arizona, and the northern portions of the Mexican states of Chihuahua and Sonora (Plog 1997). Figure 1.1 indicates the Southwest's major cities, present-day Pueblo communities, and several major archaeological sites.

Figure 1.1 Map of the Southwest



(LeBlanc 1999)

The Ancestral Puebloans can be divided into the Anasazi and Mogollon. The Anasazi cultural area consisted of the northern portions of the traditional Pueblo world, including the Colorado Plateau and the Upper Rio Grande Valley (LeBlanc 1999; Lekson 2002). Portions of southern New Mexico and the rest of the middle of the Pueblo world were occupied by people identified with the Mogollon cultural group (LeBlanc 1999: Lekson 2002; Plog 1997). A third cultural, group, the Hohokam, were found south of the Pueblo world, primarily in the southern half of Arizona and northern Mexico. It is believed that some portions of the ancient Hohokam people joined the Hopi and Zuni in

the late prehistoric period, while the majority remained, becoming the O'odham peoples of today (Plog 1997).

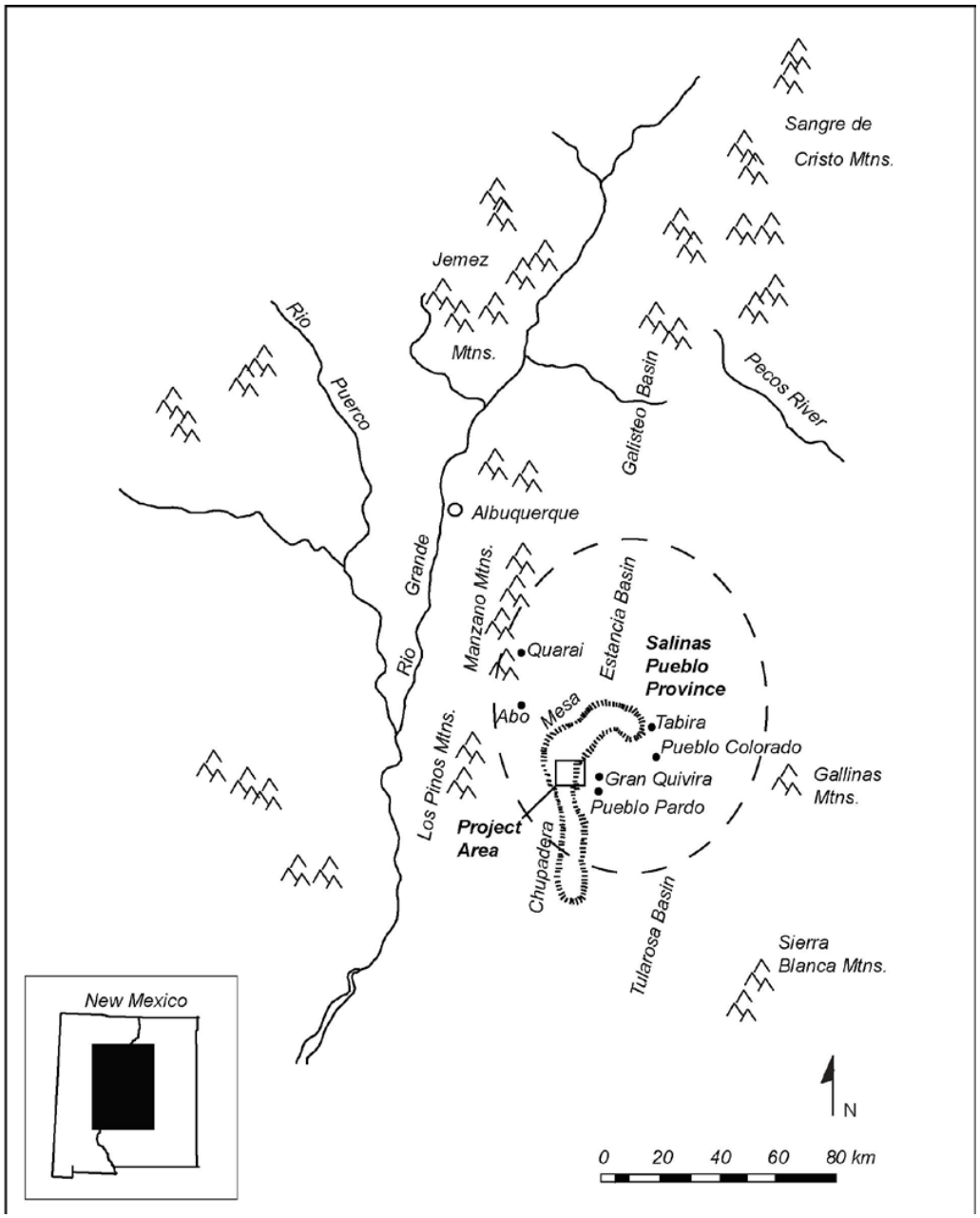
Several large-scale population movements or migrations characterize the cultural history of the Southwest. Chaco Canyon is almost certainly the most important location in the Southwest in the tenth and eleventh centuries A.D., with its monumental Great Houses, far reaching "road" network, and series of surrounding Chacoan 'outlier' communities (Lekson 2002). Many archaeologists appear to agree that a widespread religious ideology united much of the northern Southwest in this period (Plog 1997). Chacoan influence declined by the end of the twelfth century, and was followed by movement into cliff dwellings and other large villages in southwest Colorado and the rest of the Four Corners region in the twelfth and thirteenth centuries. Lekson (2002) notes that this period also saw the development and emergence of localized traditions within the Anasazi cultural group, including the "Kayenta" and "Mesa Verde." The abandonment of the Four Corners region at the end of the 13th century and beginning of the 14th century altered the social landscape as people moved south and east, ultimately establishing very large villages along and south of the Little Colorado River and the Rio Grande region. Many of these villages, like the Salinas villages studied here, were oriented around plazas, which are used as work and as ritual spaces in today's Pueblo communities. Sites in the fourteenth and fifteenth centuries reached very large sizes, with many of the pueblos in the northern portions of the Southwest flourishing until the arrival of the Spanish in the A.D. 1500s (Lekson 2002). The Spanish presence resulted in radical population movements and significant culture change; however, many Pueblo communities remain vital today (Dozier 1970). Pueblo people ultimately abandoned the

Salinas district, which was a site of Spanish colonization and mission building, in the 1670s A.D (Caperton 1981).

The Salinas Pueblo Province

The Salinas Pueblo Province is located southeast of the city of Albuquerque in central New Mexico. The region refers to the area of the Salinas Basin bordered by the Sandia, Manzanos, and Los Pinos mountains to the west and the Great Plains and the Gallinas mountains to the east (Chamberlin 2008). Located on the margins, away from traditional 'hubs' of the Pueblo world, in terms of archaeological cultures, Salinas is positioned at the northern extent of the Mogollon culture sphere and at the southeastern extent of the Anasazi culture group. The Salinas Pueblo Province has long been viewed as a recipient of cultural influences rather than as its own distinct cultural entity (Chamberlin 2008). Current research in the Salinas Pueblo Province has been directed towards addressing the issues of aggregation and nucleation in the Salinas Pueblo Province and understanding the scale and degree of connections between the plaza pueblo villages from the early Pueblo IV period. Specifically, the research investigated the role of the plaza in the formation of group identity (Chamberlin 2008; Rautman 2000) and the role of conflict in the aggregation of plaza pueblo villages (Chamberlin and Rautman 2009).

Figure 1.2 The Salinas Pueblo Province



(Chamberlin 2008)

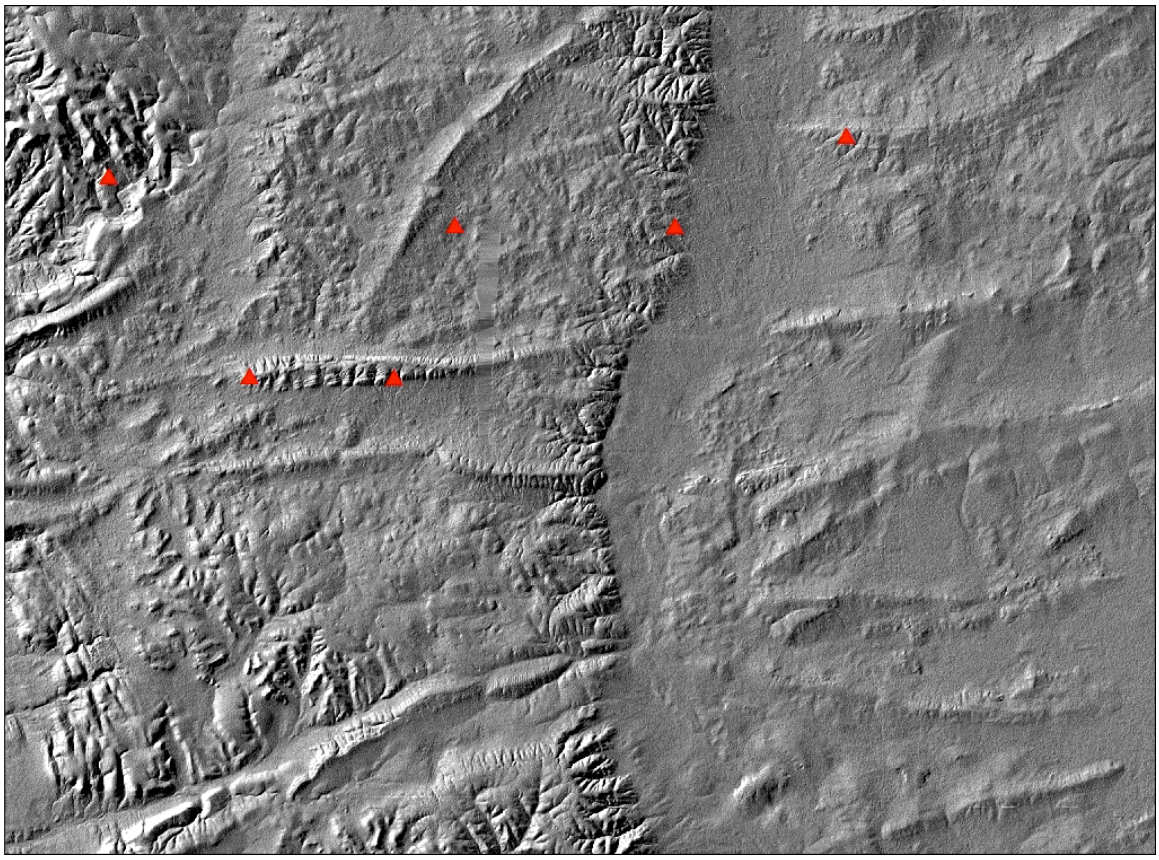
Two separate areas of cultural occupation define the region. Tiwa-speaking pueblos, including Quarai and Tajique, are located along the eastern edge of the Manzanos Mountains in the northern portion of the region (figure 1.2) (Chamberlin 2008; Spielmann 2011). The second major area of cultural occupation encompasses the

Tompiro-speaking pueblos, including Gran Quivira, Pueblo Pardo, and Pueblo Colorado, located on Chupadera Mesa and the Mesa Jumanes in the study area of this thesis (Figure 1.2) (Chamberlin 2008; Spielmann 2011). Chamberlin (2008) notes that differences in settlement patterns and artifact types separated the cultural groups of the Salinas Pueblo Province with sites from the Rio Abajo region to the west, the Galisteo Basin to the north, and Puebloan groups to the southeast near Roswell and in the Sierra Blanca.

Chupadera Mesa Environmental Landscape

The sites examined for this thesis are primarily located on Chupadera Mesa, which is the dominant physiographic feature in the southern area of occupation in the Salinas Pueblo Province. The mesa extends north to south and ranges in elevation from 6500-7000 ft. (Chamberlin 2008; Hill 1998). However, the geomorphology is complex, with multiple series of drainages dissecting the mesa into numerous valleys and ridges, which largely trend east to west (Figure 1.3). Some of these valleys drain to the southwest, forming the Chupadero Arroyo, while other valleys drain off Chupadera Mesa to the east towards the Medanos plain (Chamberlin 2008). Pinion and juniper forests dominate the semiarid environment of Chupadera Mesa, which receives approximately 335 mm of precipitation each year (Hill 1998).

Figure 1.3 Chupadera Mesa Topography



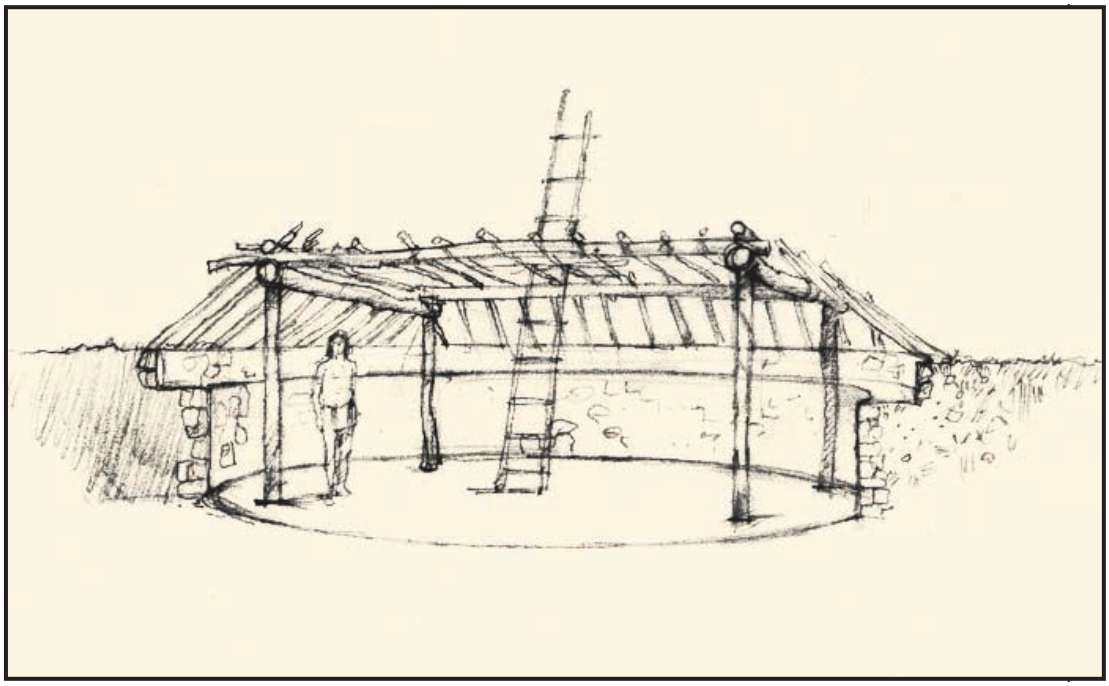
The location of plaza-oriented villages investigated in this thesis are marked with red triangles.

Occupational History on Chupadera Mesa

This study is focused on the southern area of the Salinas Pueblo Province, specifically the masonry villages located on and just east of Chupadera Mesa. Archaeological research in the area indicates that occupation on Chupadera Mesa extends from early pithouse villages to plaza-oriented, masonry pueblos (Chamberlin 2008). Sometime in the 14th century A.D., Chupadera Mesa's populations moved into larger towns such as nearby Gran Quivira. In this respect, the history of Chupadera Mesa and the Salinas region as a whole parallels the occupational history of the southwest as a whole.

Caperton's history of the Salinas region suggests that dispersed pithouse communities appear around the A.D. 700s. Pithouse sites were some of the earliest sites in the Southwest; some were likely seasonal camps , while others were more permanent villages. Rautman notes that two periods of pithouse occupation are documented on the eastern slopes of Chupadera Mesa (Rautman 2011). Structures from the early pithouse period were deep circular pit structures measuring 12-15 across with central hearths and wooden roofs (Rautman 2011). Figure 1.4 depicts an artists rendering of a large pithouse structure.

Figure 1.4: Artists Rendering of a Pithouse Structure



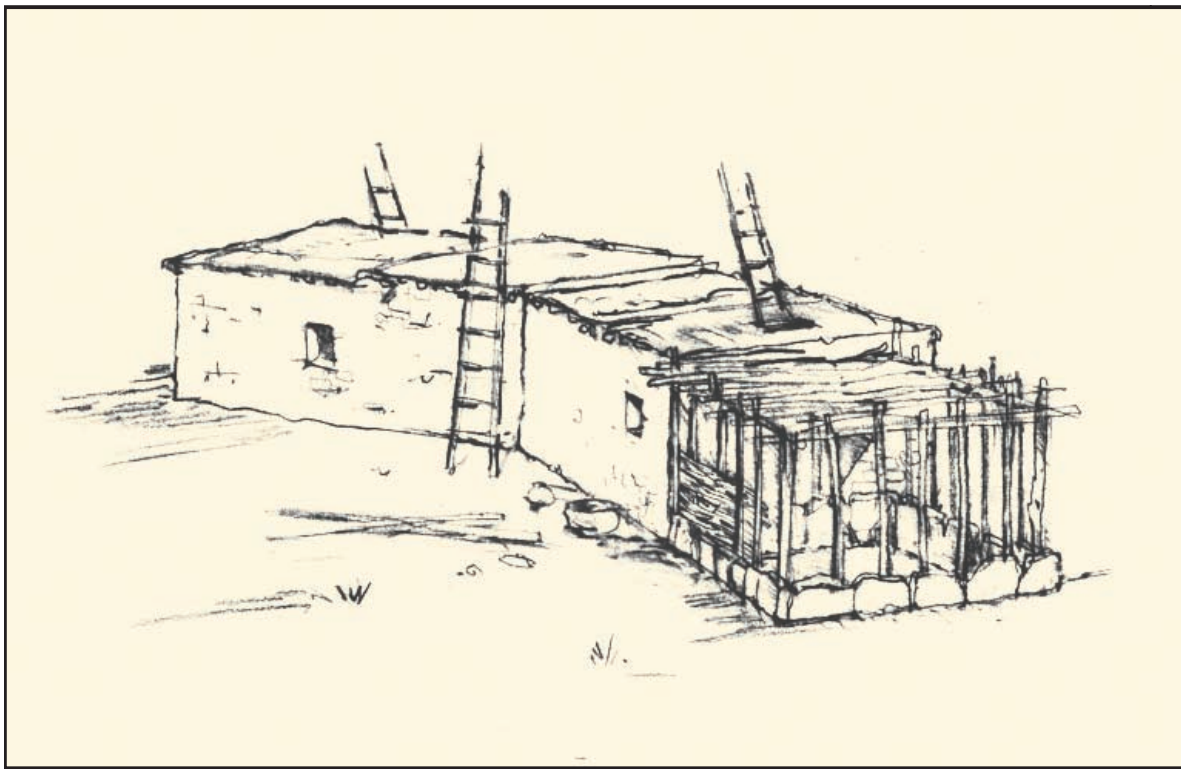
(Rautman 2011)

Ceramic assemblages indicate ties to groups beyond the Salinas region, including Jornada Brown ceramics and Alma Plain wares from Jornada Branch Mogollon communities (Chamberlin 2008). The later pithouse sites are smaller and shallower in structure. The Kite Site, excavated by Rautman, is representative of a later period pithouse sites.

Rautman's excavations suggest that the residents of the Kite Site had connections to groups to the southeast (Rautman 2011).

In the 900s and 1000s, dispersed pithouse communities were replaced by jacal villages. Jacal communities were characterized by twenty to fifty clustered dwellings, each constructed with wattle-and-daub superstructures atop masonry foundations (Rautman 2011). Chamberlin's survey of jacal communities on Chupadera Mesa indicated that the number of jacal rooms in the jacal communities ranged from 69 to 276 rooms with an average of 157 rooms per jacal community. Figure 1.5 depicts an artists rendering of a typical jacal structure.

Figure 1.5 Artists Rendering of a Typical Jacal Structure



(Rautman 2011)

The presence of White Mountain Redware from the Zuni area suggests early Jacal communities were connected with Western Pueblo groups (Chamberlin, Rauman, &

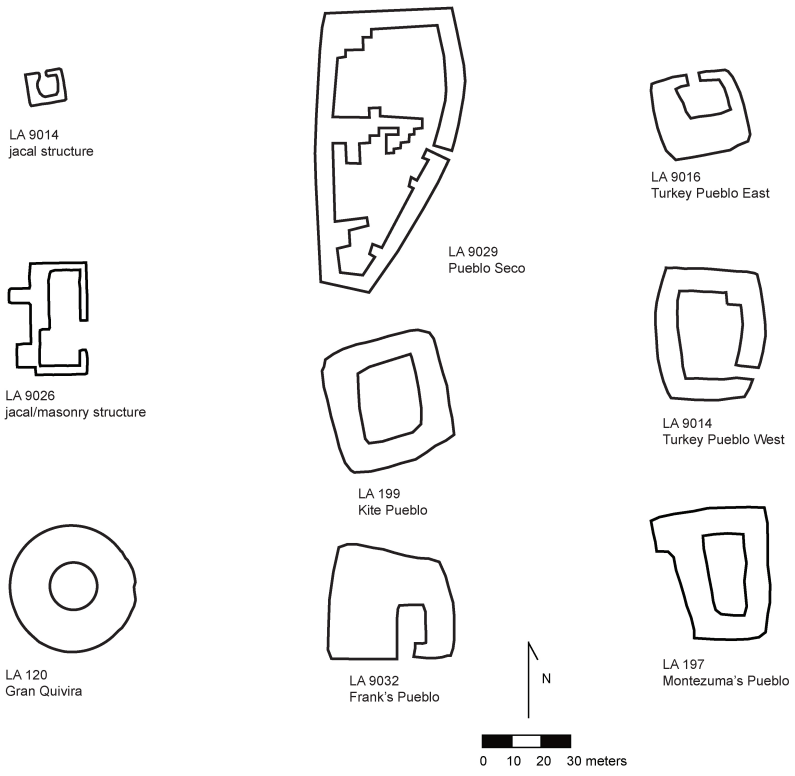
Solometo 2011). The largest jacal settlements appear during the A.D. 1000s and 1100s and consist of up to 50 rooms. These villages are scattered across the Salinas region on mesas, slopes, and hilltops (Chamberlin 2008). The later jacal villages had more total rooms, possessed greater quantities of masonry, and had greater numbers of contiguous rooms than earlier jacal villages. Chamberlin (2008) argues that these attributes indicate that the late jacals were a transitional phase in the move to full masonry, enclosed plaza pueblos.

The first contiguous, aggregated settlements on Chupadera Mesa and across the Salinas Province appear during the early Pueblo IV period (A.D. 1275-1350). These structures were generally consisted of 100 rooms organized in multiple roomblocks around one or more square or rectangular plazas. Excavations by Rautman (2000) and Rautman and Chamberlin (2009) have indicated that some pueblo structures were initially constructed with adobe, however, the shift to full masonry construction occurred quickly thereafter.

These later masonry pueblos have been identified on Chupadera Mesa, undernearth the later town of Gran Quivira, on the Jumanes Mesa, and in the Chupadero Arroyo region. The definition of the plaza was important in the construction of these masonry pueblos. The standardized plaza-oriented site layout is associated with the processes of abandonment, migration, and aggregation occurring across the Southwest during the Pueblo III period and early Pueblo IV period (LeBlanc 1999; Plog and Solometo 1997). Figure 1.6 depicts plaza-oriented sites from the Salinas Province, including LA 9029, LA 9016, LA 120, LA 197, LA 9032, and LA 9014, all of which are investigated in this thesis.

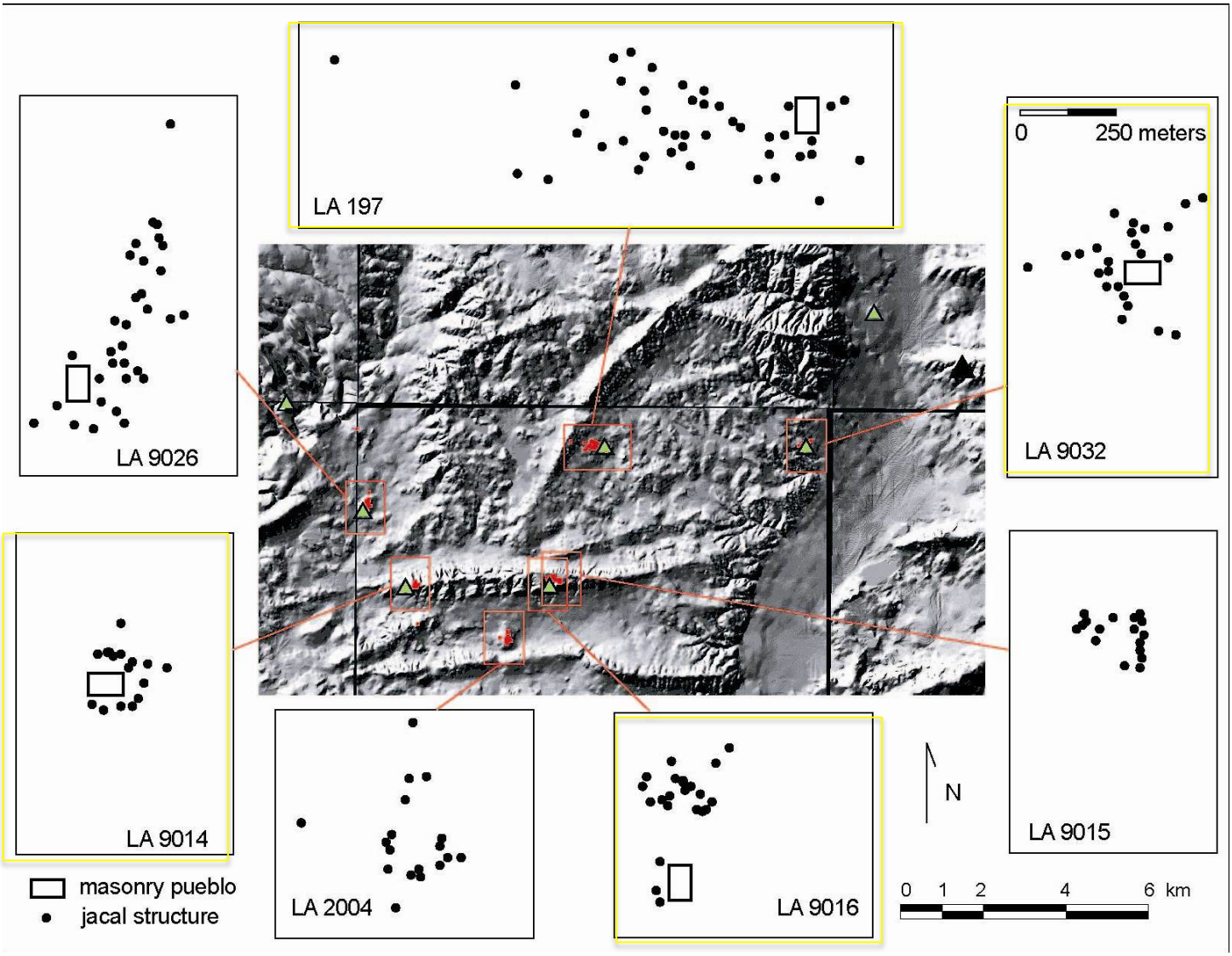
The majority of these plaza-oriented pueblos were erected in the midst of dispersed jacal communities (Figure 1.7), except for LA 9029 (Chamberlin 2008). A comparison between the number of jacal rooms and number of pueblo rooms at sites on Chupadera Mesa (Table 1.1) suggests that, unlike most areas of the Southwest at this time, in-migration was not a factor in the development and occupation of plaza-oriented pueblos on Chupadera Mesa. Rather, this evidence suggests that local extant populations in Salinas were responsible for the construction and occupation of the plaza-oriented pueblos on Chupadera Mesa.

Figure 1.6 Plaza-Oriented Sites in the Salinas Pueblo Province



(Rautman; Solometo; Chamberlin 2011)

Figure 1.7 Plaza Oriented Pueblos and Jacal Communities



This image depicts the locations of plaza-oriented pueblos on Chupdera Mesa and dispersed jacal communities. The locations of the pueblos are depicted by green triangles and the locations of the dispersed jacal communities are depicted by red triangles. Each identified site in this image has a corresponding inset map, which depicts the relationship between the plaza-oriented pueblo and the jacal communities associated with each plaza -oriented pueblos. Inset maps bordered in red indicate sites that were investigated in this thesis.

(Chamberlin and Solometo 2009)

Table 1.1 Jacal and Pueblo Room Count Estimates

LA no.	Jacal rooms	Pueblo rooms
2004	69	No pueblo
197	276	110
9014	97	110
9015	148	No pueblo
9016	180	100
9026	210	50
9032	121	150
9029	Pueblo only	250
120	No recorded jacals	150
199	No recorded jacals	100
Total	1101	990

(Chamberlin 2008)

Around A.D. 1400-1450, the people living in the plaza pueblo villages on Chupadera Mesa moved off the mesa and aggregated into nucleated pueblo towns located on lowland areas below Jumanes Mesa, including Gran Quivira. Pueblo Pardo, Pueblo Colorado, and Pueblo Blanco (Spielmann 2011). This process of nucleation was evident across the Salinas Pueblo Province with populations also aggregating into nucleated towns in the northern Salinas Pueblo Province area of occupation, including Abo and Tenabo in the Abo Pass area and the pueblos of Quarai and Tajique along the eastern flank of the Manzano's Mountains (Chamberlin 2008). These nucleated towns from the late Pueblo IV period were constructed with large, non-contiguous, multistory roomblocks which define multiple large plazas, some of which contain kivas (Chamberlin

2008). Excavations appear to demonstrate that these nucleated pueblo towns were not new settlements, but rather were built atop plaza-oriented pueblos originally constructed in the late Pueblo III and early Pueblo IV periods.

Previous Research on Chupadera Mesa

Previous archaeological investigations on Chupadera Mesa, including survey and excavations by Chamberlin and Rautman, have been primarily concerned with the transition period from dispersed jacal settlements to plaza-oriented, masonry pueblos. The location of these sites are known from Caperton's "fast moving and wide ranging reconnaissance", of the Salinas region (Caperton 1981; Chamberlin 2008; Rautman 2000). Current knowledge of these sites is derived from several archaeological excavations, including: Haye's (1981) work on LA 201, the circular pueblo beneath Mound 7 at Gran Quivira; Rautman's (2000) work on two plaza-oriented pueblos LA 199 and LA 2091; Rautman and Chamberlin's (2008) excavations at LA 9032, on Chupadera Mesa; Solometo and Chamberlin's (2009) excavations at LA 9016 and LA 9014; and Solometo and Chamberlin's (2010) excavations at LA 9029.

Research in the last fifteen years has been focused on issues pertaining to social identity, social interaction, and the role of conflict during this period of aggregation. The inferences resulting from previous investigations on Chupadera Mesa can be summarized into five key points: (1) communities from existing dispersed jacal communities erected the masonry pueblo plaza villages with an absence of significant population increase from migration; (2) aggregation of dispersed jacal communities into aggregated plaza pueblo villages was marked by increasingly insular connections between on mesa communities; (3) plaza pueblo ceramic assemblages suggest that stylistic expressions of

indemnity become more standardized; (4) the pueblo plaza villages on Chupadera Mesa (specifically LA 9032) indicate signs of planning with the specific definition of enclosed plaza spaces (Chamberlin and Solometo 2009). These key points offer suggestions about the development and abandonment of the early plaza-oriented pueblos on Chupadera Mesa. However, more research is needed to assess the degree to which the plaza-oriented pueblos on Chupadera Mesa operated as part of a larger group and possessed share aspects of social identity and cultural ideals. Specifically, this thesis is concerned with investigating the plaza-oriented pueblos on Chupadera Mesa and their collective and individual experiences of conflict and the degree to which they collectively or individually responded to conflict. The following chapter presents the current body of evidence concerning the presence and nature of warfare on Chupadera Mesa, which combined with the results of this thesis can aid in building better understandings of how the villages on Chupadera Mesa responded to conflict.

Chapter II.

Warfare and Conflict in the American Southwest: A Review Of Current Literature and Archaeological Expectations

In the opening lines of *War Before Civilization,* Lawrence Keeley (1996) indicates that the investigation of prehistoric warfare has been a sensational topic characterized by heated debate surrounding the role and nature of ancient conflict and the character of warfare in non-centralized societies. Solometo (2006) indicates that archaeologists, including LeBlanc and Keeley, have had to convince their colleagues of the complexity, extent, and nature of warfare and its role in broader cultural processes including abandonment, migration, and alliance. This review is focused on a discussion of war in non-centralized societies and how "war" is currently defined. In conjunction with this, the archaeological expectations of warfare are discussed as they indicate the presence or absence of warfare and provide an insight into the type, scale, and intensity of conflict that characterized prehistory.

The varied and numerous definitions of warfare have been the root of much of the debate concerning the presence and nature of warfare in prehistory. Keeley (1996) notes that several archaeological definitions define warfare as only occurring at the state level of sociopolitical organization, and thus ignore or dismiss evidence for the apparent incidence of violent conflict in prehistory. The effect of this, he argues, is to underestimate the potential impact that conflict had in prehistory. However, other anthropological definitions emphasize that war does not exist merely at the state level of sociopolitical organization. For instance, Ferguson defines war as "organized, purposeful group action, directed against another group involving the actual or potential application

of lethal force" (Solometo 2006: 25). Ferguson's definition includes "tribal" war and also highlights that warfare can come in several different forms, including formal battles, ambushes, surprise attacks, and massacres (LeBlanc 1999). It should also be noted that his "purposeful group action", is not simply confined to combat, rather this action also includes preparations for defense and the mobilization of people and resources.

Prehistoric Warfare/Conflict in the American Southwest:

Recent archaeological research in the American Southwest has become increasingly concerned with the role of warfare in the lives of ancestral Pueblo people. Building on regional and site-level studies by earlier scholars, LeBlanc (1999) and Lekson (2002) have attempted to identify spatial and temporal patterns in the incidence of warfare in the northern Southwest since the adoption of agriculture. Since publication of LeBlanc (1999), an increasing number of Southwestern archaeologists have recognized the broad relevance of conflict and warfare in addressing anthropological questions (see for instance papers in Rice and LeBlanc 2001). Despite this, several researchers continue to question the role of warfare as an important element of culture change and social integration (Solometo 2006).

LeBlanc (1999) reexamines the culture history of the Southwest, presented in Chapter 1, through the lens of warfare. LeBlanc emphasizes the element of warfare in an understanding of Southwest prehistory. He rejects the view that warfare in the Southwest was a minor and irrelevant factor. Rather he incorporates the causes, nature, and consequences of warfare in understanding significant events in Southwest prehistory, including the abandonment of the Four Corners region and the formation of large settlements along the Rio Grande River.

LeBlanc's Chronology of Warfare in the Southwest

In *Prehistoric Warfare in the American Southwest,* LeBlanc defined three broad temporal periods of Southwestern prehistory defined by changes in the intensity of warfare : Early (A.D. 0-900), Middle (A.D. 900-1150), and Late (A.D. 1250-Spanish Contact) (LeBlanc 1999). A fourth, less well defined period, the interim period A.D. 1150 -1250 is characterized by Lekson and LeBlanc as difficult to characterize in terms of the intensity and presence of warfare (Lekson 2002; LeBlanc 1999). Table 2.1 displays LeBlanc's chronology of warfare in the Southwest with Lekson's revisions. Lekson, clarifies the wide ranging behaviors in violence that LeBlanc characterizes as warfare in the Early and Late periods. Lekson (2002) suggests that "warfare" in the Early Period represented raiding and feuding operating on a small group scale and that "warfare in the Late Period consisted of large scale institutionalized combat at the village and inter-village scale.

Table 2.1 LeBlanc's Chronology of Warfare in the Southwest

A.D. 0 – Late 700s	early Early Period	Low-Level Raiding and Feuding
A.D. 700s – 900	late Early Period	Escalating Raiding and Feuding
A.D. 900 – 1250	Middle Period	Peace with EP Events
A.D. 1250 – 1600	Late Period	Village or Alliance Warfare

(Lekson 2002)

LeBlanc infers that warfare was endemic during this Early Period consisting of violent behavior, including raiding and feuding. However, LeBlanc indicates that there was a marked increase of warfare in the late 700s and 800s. Lekson (2002) adds that the

causes for this intensification of warfare are still unclear. Evidence for warfare during this period includes the location of sites, defensive construction of sites, presence of burning of sites, and unburied human remains showing signs of trauma (LeBlanc 1999).

LeBlanc's describes the Middle period, corresponding to the Pueblo II and early Pueblo II periods, as an era with unprecedented low levels of conflict and warfare. The beginning of the Middle Period sees an abrupt cession of the raiding and feuding activities of the Early Period (Lekson 2002). Settlement patterns during this period were characterized by small single-family or extended family residences scattered across the landscapes of the Southwest often in a loose cluster associated with Chaco "outliers" (Lekson 2002). Lekson and LeBlanc comment that this patterning coupled with sites not being placed on defensive landforms suggest that there was not a great concern for war and conflict during this period.

LeBlanc's emphasis on environmental explanations is evident in his discussion of the Middle Period. LeBlanc's Middle period coincided with a period of warming across the globe and climatic change thus allowing for greater access to arable lands and increases in population carrying capacity and population growth (LeBlanc 1999). Settlement patterns during this period were characterized by small single-family or extended family residences scattered across the landscapes of the Southwest often in a loose cluster associated with Chaco "outliers". (Lekson 2002). Lekson and LeBlanc comment that this patterning coupled with sites not being placed on defensive landforms suggests that there was not a great concern for war and conflict during this period.

In contrast to this period of remarkable period of peace LeBlanc (1998) and Lekson (2002) note the presence of some violent events during this period, though they

are limited in time and space. These violent evens represent a disturbing form of social violence that involved the "processing" and disposal of human remains as if they were food. Some have concluded that these individuals were cannibalized, while others avoid this term due to its potentially detrimental effects on modern Pueblo people; for instance Lekson (2002) prefers to refer to these as "extreme processing events. According to Turner and Turner (cited in LeBlanc 1999 and Lekson 2002), these events occur over much of the northern Pueblo region, at the northern edge of the Chacoan interaction area. These events occurred near the time of Chaco's decline in the early of mid 12th century A.D.

LeBlanc's final chronological period is the Late Period, which corresponds to the late Pueblo III and early Pueblo IV periods. LeBlanc defines this period as one of crises and catastrophe, during which large-scale warfare becoming prevalent. Archaeological evidence for warfare during this period includes defensive site configurations, such as the adoption of the enclosed plaza plan, and the opening up of no-man's lands between clusters of villages. While some of the clusters that emerged in this period were abandoned by the 1400s, others formed the basis of the distinct ethnic and linguistic communities (i.e. Hopi, Zuni, Acoma) recognized today. The enclosed plaza villages that are the subject of this study are adopted in the Salinas area during the Late Period, and by the time of their abandonment the Salinas cluster can be readily distinguished from its neighbors (Spielmann 1999).

Archaeological Expectations of Warfare

In *The Scream of the Butterfly Competition and Conflict in the Prehistoric Southwest*, Wilcox and Haas (1994) outline the data types that provide archaeologists

working in the Southwest and other regions an empirical basis to identify the presence of war in the ancient past. Similar classes of data have been identified by LeBlanc (1999). These data types include architectural data, artifacts, burned sites, skeletal evidence, rock art, and no-man's lands. Taken alone, each of these pieces of evidence might be interpreted differently, or seen as an isolated incident of violence. However, a stronger case for the presence of ancient war can be made when multiple indicators are found in a single area. In addition, these sources of evidence that indicate the presence of warfare in the Southwest can also be used to infer the nature, intensity, and scale of warfare in the Southwest.

Architectural Evidence: Wilcox and Haas (1994) and LeBlanc (1999) note that one of the major indicators of warfare is the defensive architectural layout. The purpose of a defensive layout was to limit access and make places very costly to attack. Wilcox and Haas (1994) review some of the defensive site types that have been documented in the Southwest, towers, palisades, forts, hill-slope retreats, and fortified villages and hamlets. A combination of architecture and topography can be used to further limit access to a site. Additionally, freestanding adobe or masonry walls could be constructed to further upgrade less defensible areas of sites.

Artifacts: Wilcox and Haas (1994) note that artifactual evidence for conflict could include an increase in the frequency of weapons such as atlatls and darts, bows and arrows, and axes (Wilcox and Haas 1994). However, these implements could have been used for other purposes and alone are not evidence for warfare. The presence of defensive armor or shields, however, are a strong indicator of war in the past. These items, typically made of perishable materials such as basketry or hide, are exceptionally

rare in the Southwest, but have been found in dry caves. Artistic depictions are far more numerous; Wilcox and Haas (1994: 223) describes a Mimbres bowl who holds a shield in one hand and a spear in the other

Burned Sites: Several factors may account for burned structures and widely burned sites. Wilcox and Haas (1994) and LeBlanc (1999) indicate that warfare-related burning ideally should be characterized by entire sites, or at least portions of a site, being burned with assemblages in place. Archaeologists have to be able to eliminate the possibility of accidental burning or intentional ritual "closure." Most of these stone and adobe buildings have been proven, through experiment to be difficult to ignite and fire rarely spreads throughout the buildings on its own (Julie Solometo, Personal Communication 2012). Patterns of burning offer evidence to understanding the scale, intensity, and goals of conflict. It is important to note that catastrophically burning a pueblo would be a difficult task, requiring that an attacker had gained nearly complete access to the pueblo. The extent and nature of burning at a site can suggest the nature and goals of an attacker.

Skeletal Evidence: The presence of burials of individuals who died from traumatic injuries associated with violence is another line of evidence for warfare. Several indicators of violent injury can be identified on skeletal remains. One of the clearest indicators is when arrow or dart points are embedded in the skeletons or the body cavity (Wilcox and Haas 1994; LeBlanc 1999). Southwestern archaeologists have also recovered crushed skulls, bodies without skulls or skulls without bodies, skulls bearing cut marks consistent with scalping, and bodies trapped in what appear to be intentionally burned buildings. However, such direct skeletal evidence of warfare is extremely rare;

according to LeBlanc (LeBlanc 1999: 84) skeletal evidence of warfare is only represented in one percent of all burials across the Southwest.

A less direct indicator of warfare comes from sex ratios from prehistoric burials. If a burial population has fewer males, particularly young males, than expected, it is possible that they lost their lives and were buried elsewhere. Observing unequal proportions of females in several adjacent regions of the northern Southwest, Kohler and Turner (2006) proposed that one region (enriched in females) was raiding the other region (which lacked females) and taking women captive. This evidence that the goals and the tactics of the attacking group were designed so as to facilitate the capture of women. The presence of female and child skeletons in contexts linked to warfare, found in catastrophically burned sites, can be used to construct inferences concerning the social distance between the groups. Solometo (2006) indicates that groups from communities possessing more shared ties would be more likely to avoid the deaths of non-combatants, women and children. However, such refrain would not be expected from a socially distant enemy where the maximization of death, with no restraint in targeting non-combatants, would have been sanctioned.

Rock Art: Evidence for warfare in the Southwest, includes the depiction of 'warfare' themes in rock art. The clearest evidence of warfare from rock art is seen in rock art from the Utina Basin region in northeastern Utah (Wilcox and Haas 1994). Depictions of warriors bearing shields are also found during the Pueblo IV period in the Rio Grande region, including in the vicinity of the large pueblos that immediately postdate the villages in this study (Schaafsma 2000).

No-man's lands: Archaeological evidence of settlement patterns offers archaeologists another line of evidence of warfare in the Southwest. The tendency for allied communities to cluster together and to withdraw from potential or actual enemies results in the opening up of empty buffer zones, or no-man's lands, between groups of villages. It should be noted that settlement clusters were not adaptive to the environmental conditions of the Southwest because they resulted in the abandonment of potentially productive land. Concentration into clusters also increased the potential to overexploit the available environmental resources.

Intervisiblity: Although not indicated by Wilcox and Haas (1994) as a major source of evidence of warfare, line-of-sight communication and inter-visibility are closely related to the presence of site clusters and mutual defense support networks. Signaling between sites would have been a prompt method of signaling an ally for aid. Haas and Creamer (1993) indicate that clusters of sites belonging to the same alliance would have contained sites that were intervisible. However, it was important that allied sites were not intervisible with enemy clusters. Intervisiblity between allied sites is in accordance with the development of no-man's lands, with the lack of intervisiblity probably defining alliance boundaries. In this regard evidence of intervisibllity and line-of-sight communication between sites can be used to understand the scale of warfare in the Southwest.

Assessing the Potential of Prehistoric Warfare in the Salinas Pueblo Province

As indicated earlier, the late Pueblo III and early Pueblo IV periods were defined by a transition from dispersed jacal communities to full masonry enclosed plaza pueblo villages. Several archaeologists, including Capteron 1981; Bernardini 1998; LeBlanc

1999 have argued that inter-group hostility increased during this period. However, establishing criteria of evidence for proving that conflict is a difficult task, since conflict involves hostile acts and the preparation to guard against such hostile acts. Solometo, Chamberlin, and Rautman have noted several sources of evidence for warfare during this transition period from dispersed jacal communities to aggregated plaza pueblo villages on Chupadera Mesa. Evidence for conflict and warfare on Chupadera Mesa is present in the placement of sites on defensive landforms, the defensive layout of sites, site remodeling evidence of defensive remodeling, and evidence for site burning.

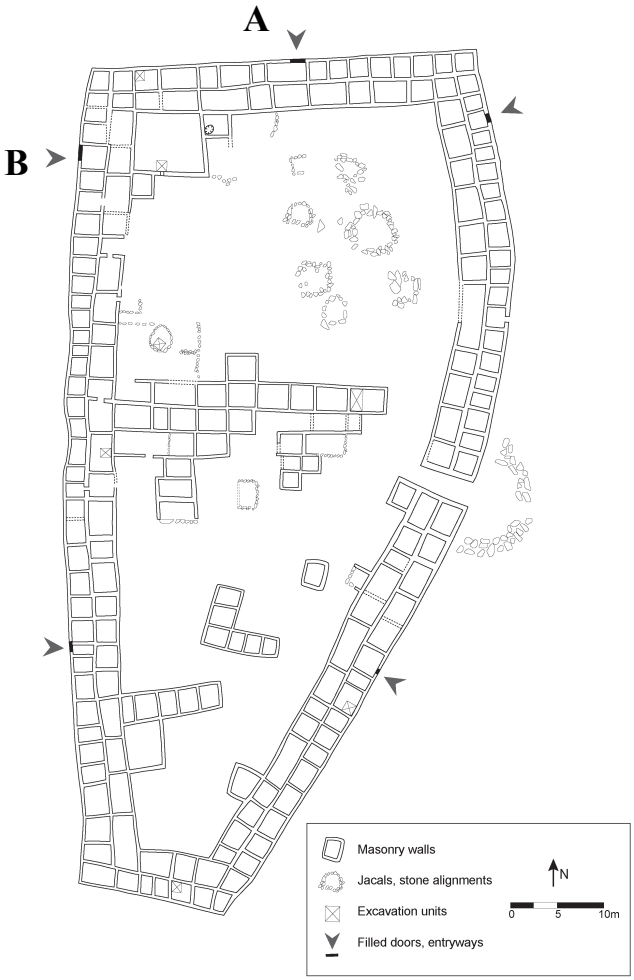
Placement of Sites on Defensive Landforms: Chamberlin (2008) notes in his dissertation that the pueblo plaza villages examined in this study on have long been assumed to occupy positions on the landscape with varying degree of defensibility. LA 9032, LA 120, LA 197 occupy hillsides (Chamberlin 2008). LA 9014 and LA 9016, located on east-west trending ridge on Chupadera Mesa, sit on the edges of the steep ridge tops. LA 2091 located on the Mesa Jumanes is located on a high ridge with a steep-sided flank. However, the placement of LA 9029 on the landscape best indicates an increased concern with defense. LA 9029 sits on a steep finger ridge with access to the pueblo limited to a single narrow path (Chamberlin and Solometo 2009). However, Spielmann (1996) and Chamberlin (2008) note that the majority of the plaza pueblo villages on Chupadera Mesa, except for LA 9029, were erected in the mists of dispersed jacal communities (Chamberlin 2008). This suggests that the construction of full masonry plaza pueblos represents an architectural upgrade in defensibility as the people on Chupadera Mesa sought to control access to their communities even more.

Site Configuration: Another source of evidence for conflict on Chupadera Mesa is site configuration and layout. LeBlanc (1999); Bernardini (1998); Rautman (2000): and (Plog and Solometo 1997) have noted that evidence of village planning is associated with collective action, with threat of conflict and warfare being a possible motivator for collective action. Investigations on the plaza pueblo villages on Chupadera Mesa, including Rautman's investigations of the early Pueblo IV sites of Kite Pueblo and Pueblo de la Mesa, have indicated the importance of the definition of the plaza space (Chamberlin 2008). In this plaza-oriented site configuration, a minimum of four roomblocks would be arranged around one or more square or rectangular plazas (Chamberlin and Solometo 2009; LeBlanc 1999).

Site Remodeling: Rautman and Chamberlin's excavations at LA 9032, in the summer of 2008, revealed two periods of architecture at LA 9032, an earlier plaza-oriented adobe pueblo (Rautman and Chamberlin 2009). Over time though the residents of this early pueblo extensively remodeled the original architecture with different types of masonry elements, including reinforcing the entire exterior of the pueblo. Later masonry additions to this earlier adobe pueblo were designed to limit access to the pueblo. Evidence for site remodeling is also present at LA 9029 (Pueblo Seco). Excavations from the 2010 James Madison University Southwest Archaeological Field School uncovered signs that external doorways at LA 9029 were filled in. There is also evidence that the residents at Pueblo Seco also erected masonry walls beyond the confines of the pueblo to further limit access to the site and upgrade the defensibility of LA 9029. Figure 2.1 depicts the filled in doorways from LA 9029 and the location of those entryways relative to the site's

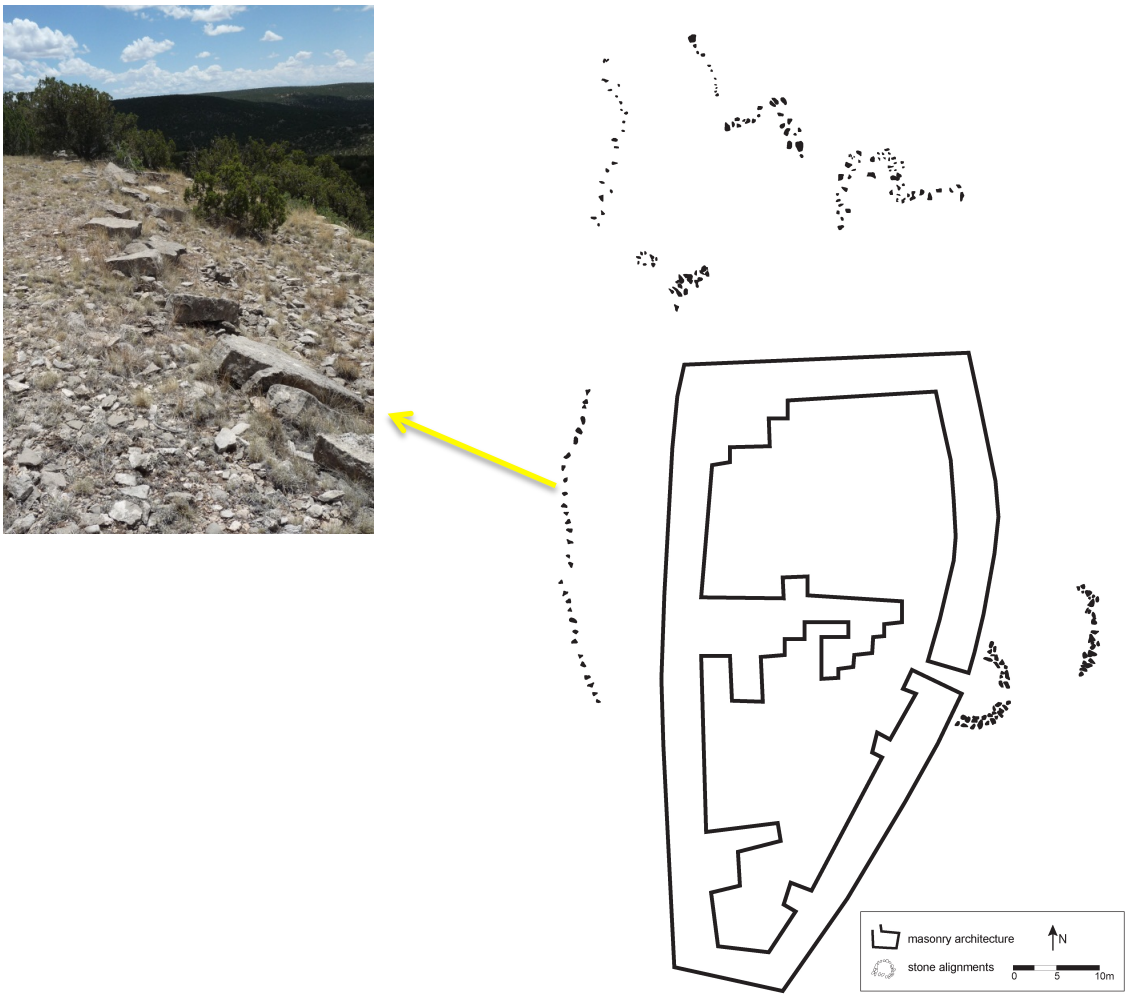
architectural layout. Figure 2.2 depicts the additional 'defensive' masonry walls and LA 9029 and their location on the site.

Figure 2.1 Filled In Doorways From LA 9029 (Pueblo Seco)



(Chamberlin and Solometo 2009)

Figure 2.2 Exterior Defensive Walls From LA 9029 (Pueblo Seco)



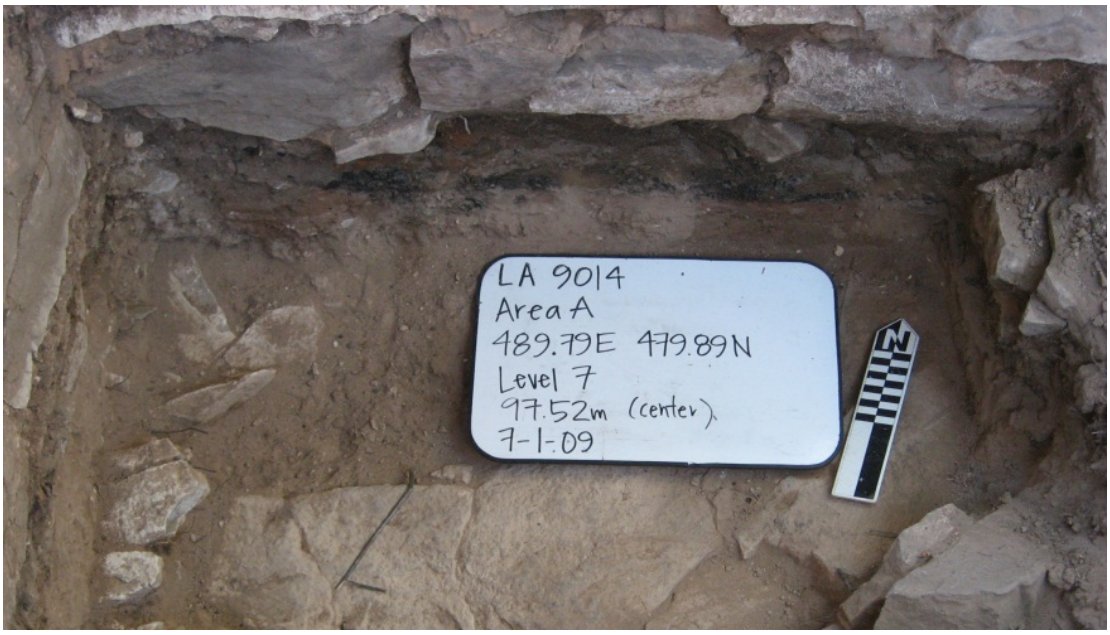
(Chamberlin & Solometo 2009)

The evidence from LA 9032 and 9029 suggests that defensive needs were of importance in the occupant's decision-making strategies regarding site remodeling.

Site Burning: As indicated earlier in this chapter, the patterns of extensive burning, particularly when they contain the presence of burned floor assemblages, are evidence of warfare (Wilcox and Haas 1994). Evidence of burning is present at several sites on Chupadera Mesa including LA 9016, LA 9014, and LA 9029, where burned roofing materials and small quantities of burned foodstuffs have been identified (Chamberlin and

Solometio 2009; Chamberlin and Solometo 2010). Figure 2.3 Depicts a burned corn deposit from LA 9014 (Turkey Ruins West).

Figure 2.3 Burned Corn Deposit from LA 9014 (Turkey Ruins West)



(Chamberlin and Solometo 2009)

However, evidence of extensive of burning is most evident at LA 9032 (Frank's Ruin). Excavations by Chamberlin and Rautman (2009) indicated the presence of extensive burning across all of the sampled areas of the pueblo. Burned elements included roof assemblages, foodstuffs (maize-on-the-cob and shelled Maize), and roofing materials. Figure 2.4 Depicts burned roofing material from Frank's Ruin (LA 9032).

Figure 2.4 Burned Roofing Material at LA 9032 (Frank's Ruin)

(Rautman and Chamberlin 2009)

The evidence above indicates the presence of conflict in Salinas during the transition period from dispersed jacal communities to plaza-oriented pueblos. This period saw villagers taking measures to place their settlements upon defensive landforms and fortify their communities. However, this evidence of conflict does more than simply suggest the presence of conflict on Chupadera Mesa. Rather, this evidence can be used to draw inferences concerning the nature of warfare in Salinas. The evidence presented here suggests that the positioning and structure of plaza-oriented pueblos on Chupadera Mesa involved the cooperation of the whole village to plan and build something that was defensive. Over time the villages on Chupadera Mesa chose to continue to enhance their site defensibility, through site remodeling. However, despite their defensive precautions, several of these sites experienced significant burning, including the loss of stored

foodstuffs. This would likely have caused significant economic hardship and may have at least temporarily driven people from their villages and forced them to move in with neighboring relatives.

Chapter III:

Conflict in the Salinas Pueblo Province: A Geographic Information Systems Approach

The current evidence of warfare on Chupadera Mesa indicates the inhabitants of the southern portion of Salinas Pueblo Province in the late Pueblo III and early Pueblo IV periods prepared for conflict first by adopting the enclosed plaza plan and, second, by remodeling their towns to further limit access. Evidence for burning at several sites, including significant burning at Frank's Ruin, strongly suggests that some Salinas residents experienced violent conflict firsthand, possibly with devastating consequences. The goal of this thesis is to further assess the impact of the threat of war on site selection. In particular, I attempt to determine if the Salinas inhabitants located their seven plaza-oriented villages in order to maximize visibility of each other and/or of the surrounding landscape. I also attempt to determine the relative defensibility of the topography on which they are located; if sites were located to maximize defensibility then they should be found on the most defensible topographic locations, namely at the tops of the steepest slopes. An investigation of these aspects can offer insight into how the plaza-oriented pueblos on Chupadera Mesa prepared their communities for defense and suggest the degree to which the plaza-oriented pueblos on Chupadera Mesa operated in mutually supporting roles to one another. The use of GIS is ideally suited for accomplishing these tasks.

This chapter presents an overview of how archaeologists have approached spatial phenomenon over the history of the discipline and how the field of archaeology is

currently utilizing GIS-based analytical functions. Lastly, the methodology for the visibility analysis and predictive model are presented and discussed.

Thinking Spatially: Spatial Information and Archaeology

In *Spatial Technology and Archaeology: The Archaeological Applications of GIS* by David Wheatley and Mark Gillings, the authors comment on the astounding developments that have occurred within the field of Geographic Information Systems (GIS). GIS has become more than just an exotic toolset utilized by a select group of researchers. It is now a widely available and indispensable tool for archaeologists. Archaeologists have long been concerned with spatial information and GIS and other 'spatial technologies' permit more sophisticated methods of spatial data management and spatial analysis.

How archaeologists have approached spatial phenomenon has shifted throughout the years with the establishment of different theoretical approaches within the discipline. The early 20th century archaeology was dominated by the "culture-historical" theoretical framework, which emphasized a normative view of culture and the diffusion or spread of culture traits from central zones to peripheries (Johnson 2010). Culture historians were concerned with mapping the spatial distribution of culture traits, such as distinctive types of pottery and stone tools, in order to define archaeological cultures, such as "Anasazi" and "Mogollon." Analysis of spatial information primarily entailed the visual interpretation of static regional maps to identify trends and similarities among archaeological assemblages.

The early 1960s saw a dramatic change in how archaeologists approached spatial information and the types of methods that employed to examine spatial patterns and

relationships. The new conceptual framework of members of the New Archaeology viewed culture as a system comprised of a series of distinctive subsystems. Material culture were viewed as the static remains of past dynamic cultural processes and behaviors. The methods of spatial analysis employed by the culture historians were viewed as subjective and did not satisfy the scientific rigor heralded by members of the New Archaeology (Wheately and Gillings 2002). It was no longer enough to describe spatial patterns and relationships, rather archaeologists needed to provide potential explanations for the spatial patterns of archaeological materials and sites. The new quantitative methods employed by members of the New Archaeology offered archaeologists a means to explore the form and shape of spatial patterns in an objective and replicable manner. Archaeologists in this era examined intra-site spatial patterning, as well as inter-site patterning, made possible by a new focus on survey archaeology or the archaeology of entire regions.

Some archaeologists became disenchanted with the ability of quantitative spatial analysis to "test" or "prove" anything. Ian Hodder was one of the leading critics; his own testing of spatial patterning of trade goods and sites dating to the British Iron Age and Roman periods led him to conclude that some spatial patterns in the archaeological record could be interpreted or explained in several different ways. This problem of equifinality meant that there was no absolute way to test between those alternative and competing explanations.

Hodder's archaeological investigations and ethnographic fieldwork indicated to him that people actively manipulate their material culture, which therefore is likely to affect the patterning of material culture in the archaeological record (Johnson 2010). If

material culture is actively used by individuals to express their identity, for instance, than it cannot be viewed as a direct reflection of cultural norms or a unconscious indicator of behavior. Other archaeologists rejected that the New Archaeology belief that space was a neutral canvas on which cultural activity left behind traces, and argued instead space was a meaningful medium for human action. Landscapes and space, they asserted, were not viewed universally in the same manner, but that they would be "read" differently by members of different cultural groups. This understanding of space and landscape is rooted in phenomenology, a school of thought in which space is seen as being endowed with meaning through everyday routine within the landscape. Although changes in archaeological theory have changed the ways archaeologists approach the interpretation of spatial patterns and relationships, GIS nevertheless offers a revolutionary methodological toolkit for exploring ancient spatial patterns and relationships.

Current Usage of GIS within Archaeology

The introduction of computer-based GIS systems has brought about sweeping changes in how archaeologists develop research questions, analyze data, and collect and mange spatial data. However, what defines a GIS and what elements comprise a GIS? Because of its incorporation within a diverse array of disciplinary contexts, GIS is often defined based on the functionality of the GIS for each disciplinary context. Within the field of archaeology, GIS is often understood as spatially referenced databases which record the location of points, such as artifacts or sites, as well as other information about those points (Maschner 1996, Green 1990, and Kvamme 1989).

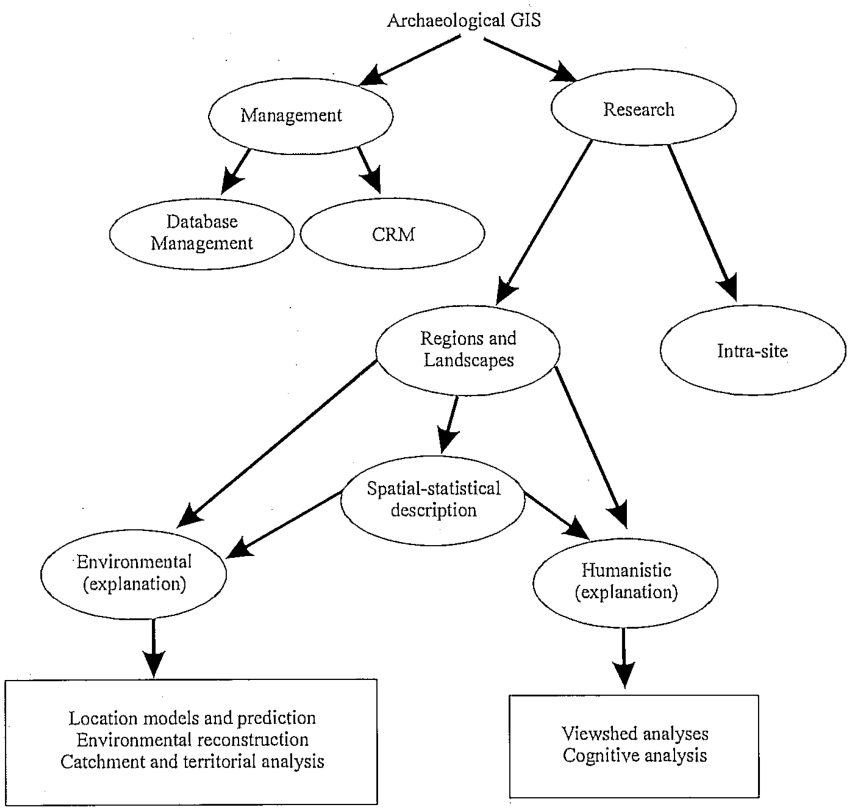
The use of GIS has led archaeologists to alter the way they conceptualize and conceive space. But, in the words of Wheatley and Gillings (2002: 16), "what does GIS do that makes it so attractive to archaeologists?" The data collection and data

management functions of a GIS have allowed archaeologists the opportunity to handle vast amounts of spatial data and integrate various data sets including Global Positioning Systems (GPS), satellite imagery, and geophysical data. Figure 3.1 highlights the current management and research applications of GIS within the field of archaeology. However, within this dichotomous breakdown, archaeologists are utilizing GIS in a variety of contexts and at the intra-site and regional scale. More importantly, GIS has allowed archaeologists a variety of options in the manipulation and transformation of spatial data and the construction of models of how past cultures may have viewed, acted in, and utilized their landscape and the environment.

Presently, there are two ways in which GIS are applied within the field of archaeology: data management and research. Figure 3.1 illustrates the current applications of GIS with archaeology. Within the management area archaeologists are utilizing GIS both to enhance existing database systems by emphasizing the spatial component and to actively manage and protect archaeological resources capitalizing on the benefit of GIS in developmental planning and predictive modeling. Kvamme highlights the benefit of predictive models in cultural resource management. In terms of management of cultural resources, GIS is first a great way to document or inventory archaeological sites, especially for professionals responsible for large areas of land. Second the power of GIS to model factors influencing site location makes it a vital planning tool, allowing land managers to predict where archaeological sites might be found. Wescott and Kuiper's work in predicting prehistoric sites on the Aberdeen proving ground in Maryland and Brandt, Groenewoudt, and Kvamme's work with predicting areas of high archaeological expectation in the Netherlands illustrates how

archaeologists are applying the management functions of GIS (Brandt, Groenewoudt, and Kvamme: 1992) (Wescott and Kuiper: 2000).

Figure 3.1 Current Applications of GIS Within Archaeology



(Wheatley and Gillings 2002)

GIS is also a powerful research tool. GIS has been used on a variety of scales, from studies of individual sites to studies at a regional scale. However, the majority of studies utilizing GIS have focused on inter-site relationships. Specifically landscape-based archaeologists are using GIS to preform catchment analysis, locational and predictive modeling, and viewshed analysis. In this thesis, a GIS based visibility analysis and predictive model were utilized to evaluate the degree to which plaza-oriented pueblos on Chupadera Mesa were intervisible with one another and the degree to which they were situated on defensive landforms. The results of these analyses when combined with other

sources of evidence for warfare can aid in interpreting the nature of the relationship networks between plaza-oriented pueblos on Chupadera Mesa and the degree to which defensive concerns affected the decision making strategies.

Visibility Analysis and Archaeology

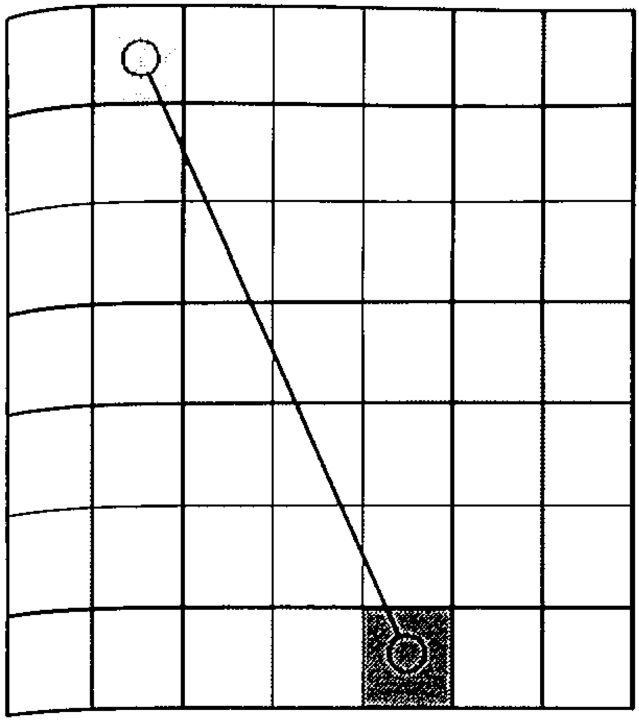
Archaeologists have long been interested in the ideas of visibility and inter-visibility. The widespread of adoption of GIS allowed archaeologists to place a more critical importance of the role of visibility in archaeological interpretations. GIS analysis allows archaeologists with a toolset of standard analytical methodological functions for producing line-of-sight and viewshed visualizations of digital models of topography in a quantifiable and reproducible manner. Wheatley and Gillings note the divers visibility functions that GIS can help archaeologists investigate including, evaluating potential lines-of-sights between archaeological sites and determining the area of landscape visible from a specific archaeological site (Wheately and Gillings 2000).

Calculating Visibility with GIS

GIS offers two methods for utilizing visibility into archaeology analysis, viewshed calculation and line-of-sight determination. Both techniques were incorporated in this analysis, with the specific methodology discussed later on in this chapter. A GIS software package, like ARC GIS 10, GRASS, and Idrisi, has t analytical function that preform a series of calculation that determines the cells from an input raster, generally a digital elevation model, that are visible from one or more observer points. The produced output is a binary image with areas that have a direct line-of-sight with the observer point are coded with a value of 1 and all cells that do not have a direct line-of-sight with the observer point are coded with a value of 0 (Wheately and Gillings 2002). Archaeologists

are also concerned with determining inter-visibility between archaeologists by determining the presence of direct line-of-sights between archaeological sites. Figure 3.2 depicts how this function is calculated in the GIS.

Figure 3.2 Testing For Inter-visibility



(Wheatley and Gillings 2002)

The image to left depicts how a GIS based visibility analysis function calculates visibility between two points. The testing of inter-visibility between archaeological sites involves the interpolation of a straight line between the two observer points and obtaining the elevation values of all the grids between the two observer points. The GIS then calculates if any of the intervening cells between the observer points would block the interpolated line of visibility connecting the two observer points.

The testing of inter-visibility between archaeological sites involves the interpolation of a straight line between the two observer points and obtaining the elevation values of all the grids between the two observer points. The GIS then calculates if any of the intervening sites between the observer points would block the interpolated line of visibility connecting the two observer points.

Visibility Analysis of the Chupadera Mesa Pueblo Plaza Villages

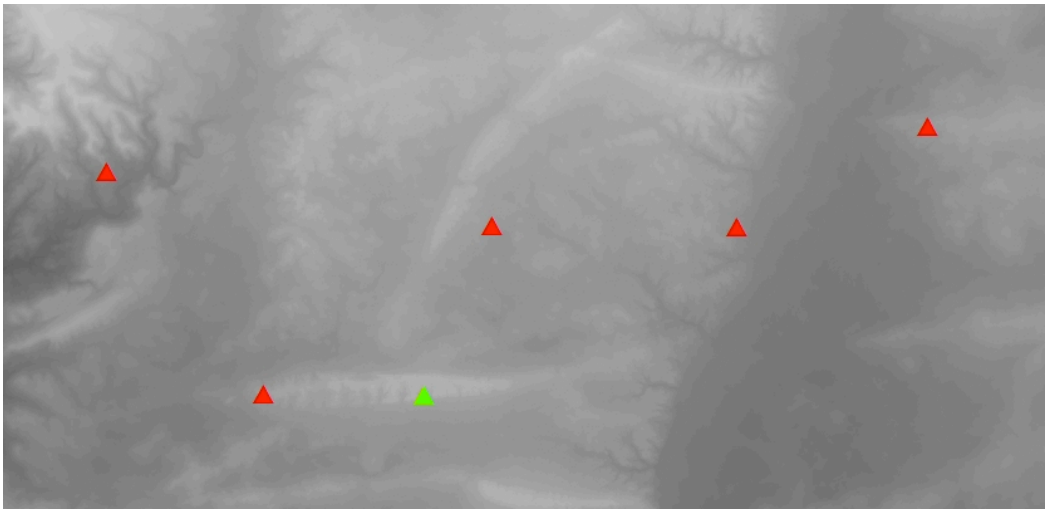
The inter-visibility of sites, like the plaza-oriented villages on Chupadera Mesa, is closely related to the formation of site clusters. The seven plaza-oriented pueblos in the northeastern portion of Chupadera Mesa form a discrete cluster of sites (sites within this cluster: LA 9029, LA 9026, LA 9014, LA 9016, LA 197, LA 9015, and LA 9032) (Chamberlin 2008). If these sites were located so as to be in mutually supporting roles, so as to send call on each other for aid in the event of attack, it would be expected that they would be intervisible with one another. In order to assess the degree to which the plaza-oriented pueblos on Chupadera Mesa were intervisible with each other a GIS based viewhsed analysis was utilized. Individual viewshed maps were constructed for each plaza-oriented pueblo (LA 9029, LA 9016, LA 9014, LA 9032, LA 120, and LA 9029).

GIS based viewed analysis tends to assume perfect reciprocal viewing relationships between an observer point and what is viewed and that all points in a viewshed are equally able to see the observer point. Wheatley and Gillings state that it is important to characterize viwesheds utilizing terms developed by Loots. Projective viewsheds define views from and observer point and reflective viewsheds define views to an observer point (Wheately and Gillings 2000). The critical point is that the projective viewshed may be quantifiably different from the reflexive viewed. In order to account for projective and reflexive viewed analysis in the visibility analysis of the plaza pueblo villages on Chupadera Mesa vertical offsets were determined for both observer points and points being viewed. By adding vertical distance to the bare earth DEM, I was able to acknowledge that the pueblo sites being viewed were also elevated above the landscape. Generally, this offset distance is equal to height of the viewer's eyes or 2 m (Wheatley

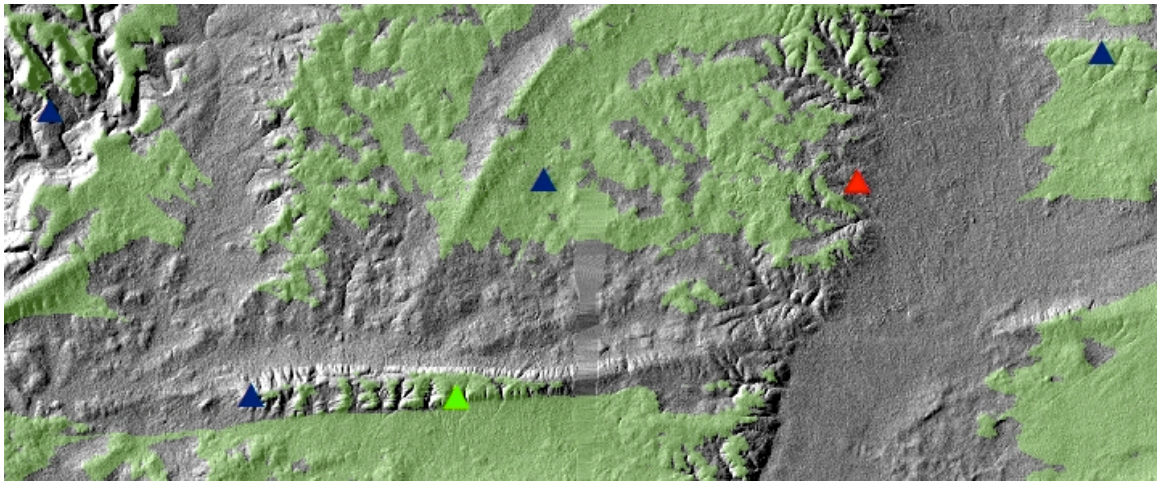
1996). However, I wanted to assess what an individual on top of a pueblo could visualize. I assumed an individual viewer height of approximately 1.6 meters and a height of 3 m for the pueblo, rounding to a total offset of 5 m.

With the offsets set, a viewshed map indicating visible and non-visible areas, was constructed for each pueblo. This was accomplished by using the viewshed function in the Spatial Analysis toolset of ArcGIS 10. Figure 3.3 depicts the inputs and outputs of this function.

Figure 3.3 Constructing a Binary Viewshed in ArcGIS for LA 9016



The above image depicts the inputs for the Viewshed function in ArcGIS 10: a digital elevation model and an observer point (LA 9029 indicated by the green triangle). The location of other plaza-oriented pueblos are indicated by red triangles



The above image depicts the outputted image from the Viewshed function in ArcGIS 10. The green areas indicate areas that were visible from the observer point (LA 9016 indicated by the green triangle). Plaza-oriented pueblos that were visible to LA 9016 are indicated by blue triangles. Plaza-oriented pueblos that were not visible to LA 9016 are indicated by red triangles.

Issues of Visibility Analysis

Although GIS based visibility analysis have become widespread in the field of archaeology, such analysis are not without their methodological problems, which Wheatley and Gillings (2000) have grouped into to two broad categories; pragmatic issues and procedural issues. Some of the pragmatic issues that archaeologists have to be aware of are the effects object background clarity.

Although a binary viewshed indicates areas that an observer point can theoretically see, seeing something is very different from actually being able to recognize the object that you are looking at. Fraser (1983) notes this issue in his explorations of the intervisiblity between of prehistoric cairns on the Scottish island of Orkney, where long sightlines between cairns were feasible, but were difficult to distinguish unless a highly visible feature, like a beacon was present. In order to construct a more realistic understanding of how the residents of the Chupadera Mesa plaza-oriented pueblos visualized their landscape the effects of object-background clarity and loss of visual clarity with distance must be accounted for.

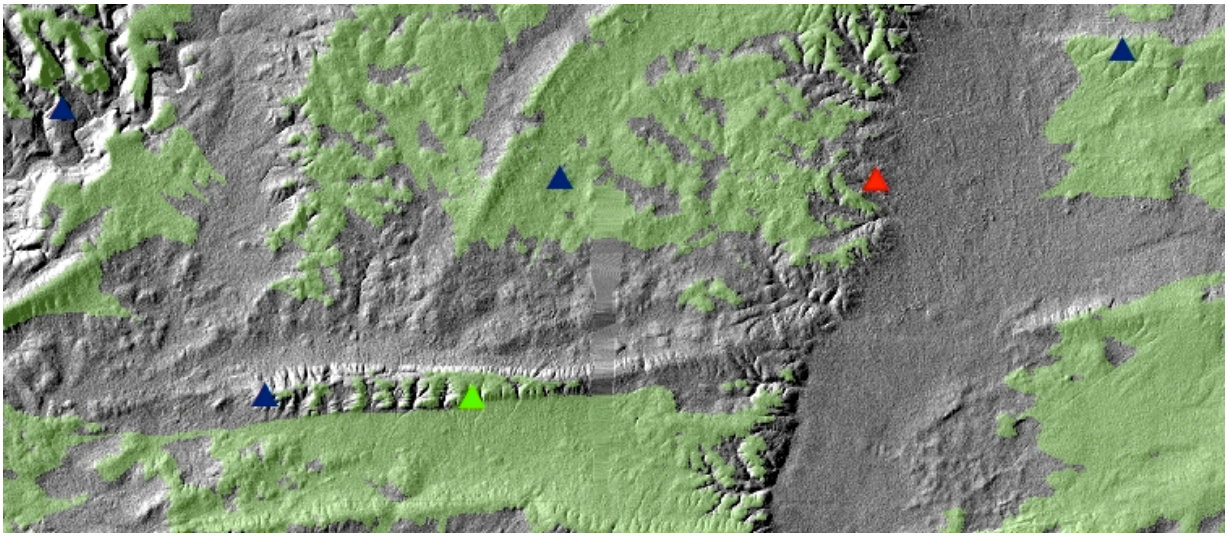
Several researchers have put forth methodologies for accounting for the issue of onject-background clarity and the less realistic 'infinite' view of a binary viewshed, (Wheatley 1996; Ruggles and Medyckyj-Scott 1996; Maschner 1996), currently the leading potential solution is the construction of "fuzzy" viewsheds, where a distance decay function is combined to a standard binary viewshed, thus modeling the degree to which distant objects are actually discernable. However, Tadahiko Higuchi developed the methodology employed in this thesis. This methodology seeks to establish a standard index that quantified the effect of longer/shorter distances, through establishing a series of distance classes based on a standard object, i.e the height of a tree. (Higuchi 1983).

Constructing Higuchi Viewsheds

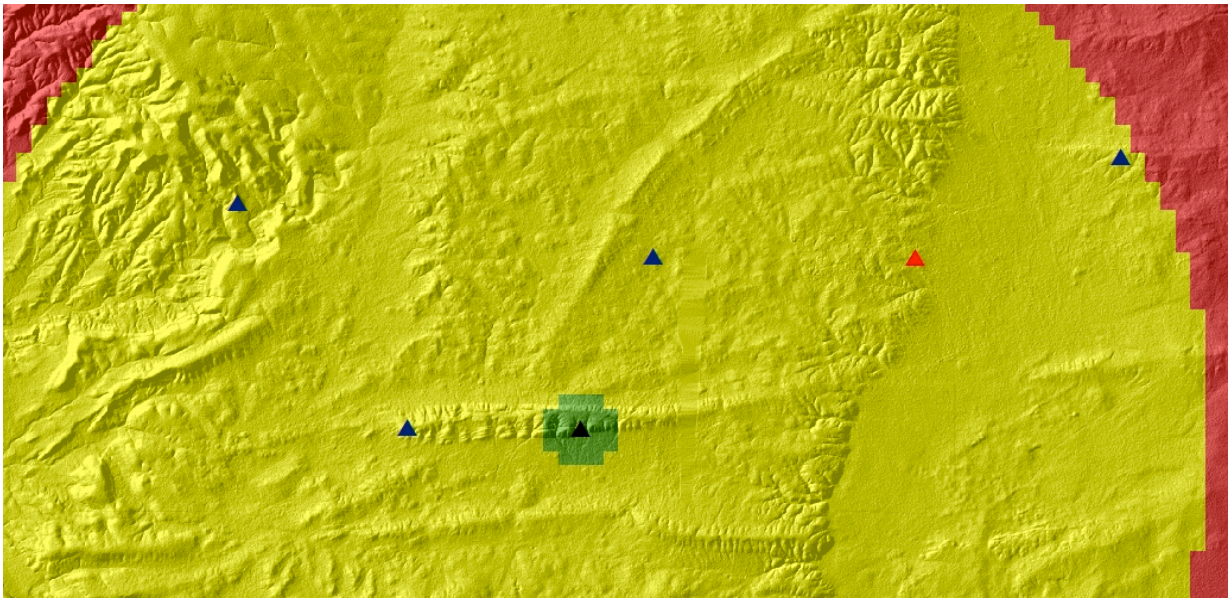
An enhanced viewhsed methodology, developed by Tadahiko Huguchi, attempts to address this issue of clarity in assessing visibility. In practice, this methodology a given field is divided in to three levels of visibility: short-distance, middle-distance, and long distance (Wheatley and Gillings 2000). The short-distance level of visibility is defined by the ability to identify individual trees and features of an individual tree, including leaves and branches. At the middle-distance level of visibility, an observer would no longer be able to identify individual trees, yet the outline of treetops would still be visible. The viewer would be able to see the forest but not the tree. At the long-distance level of visibility, only major topographic features would be discernable and the viewer would only be able to distinguish between darker or brighter patches of a uniform texture of woods. At this distance, there would also no longer be any sense of depth. (Wheatley and Gillings 200).

A Higuchi viewshed is comprised of two elements; a binary viewshed and a Euclidean distance buffer. The initial step in the process was to construct a binary viewshed for each of the identified plaza-oriented pueblos of the study using the Viewshed analysis function in the Spatial Analysis tool bar of ArcGIS desktop 10. The next step was to calculate a distance buffer for each of the plaza-oriented pueblos using the Euclidean distance function in the Spatial Analysis toolbar of ArcGIS 10. The study area digital elevation model (DEM) was used as the processing extent for the Euclidean distance functions. Once the distance buffers were determined, they could then be reclassified according to the three levels of perceptive visibility outlined by Higuchi. Quantitatively, the maximum distance of the short-distance visibility level is equal to a steady horizontal gaze angle of 1 degree, or approximately 60 times the size of the dominate tree species in the study area (Wheatley and Gillings 2000). On Chupadera the dominant vegetation types are pinion and juniper, the average height for the pinion and juniper forest is 35 feet or approximately 10.67 m. For the plaza-oriented pueblos on Chupadera Mesa the maximum extent of the short-distance level of perceptive visibility is approximately 640 meters. The beginning of the long-distance level of perceptive visibility is equal to a horizontal gaze angle of 3 minutes or approximately 1,100 times the size of the dominate tree species (Wheatley and Gillings 2000). For the plaza-oriented villages on Chupadera Mesa this distance was approximately 11.7 km. Figure 3.4 Illustrates the series of steps involved in producing a Higuchi viewshed; binary viewhsed, distance buffer, and enhanced Higuchi viewhsed.

Figure 3.4 Constructing a Higuchi Viewshed for LA 9016



The above image depicts the binary viewshed, one of the inputs for Higuchi viewshed, for the observer point, (LA 9016) indicated by the green triangle. Visible plaza-oriented pueblos are indicated by blue triangles. Non-visible plaza-oriented pueblos are indicated by red triangles.



The above image depicts the Euclidean distance buffer for LA 9016, indicated by the black triangle. The Euclidean distance buffer is classified according to Higuchi's three levels of visibility: short-distance, middle-distance, and long-distance. The short-distance visibility level is classified green and extends to 640 meters from LA 9016. The middle-distance level is classified as yellow. The long-distance level of visibility is classified as red and begins at approximately 11.7 km. Plaza oriented pueblos visible to LA 9016 are indicated by blue triangles. Plaza-oriented pueblos not visible to LA 9016 are indicated by red triangles.

Modeling Plaza-Oriented Pueblos on Defensible Land Forms

Hilltops and other similar topographic features bestow obvious military advantages, height, views of approaching enemies, and limited access for potential enemies. The placement of sites on defensive landforms often represented a conscious choice decision to sacrifice ease of access to arable land and dependable water sources. As stated earlier in chapter I, the plaza-oriented pueblos on Chupadera Mesa occupy topographic features in varying degrees of defensibility. LA 9029 is located an a steep finger ridge on the western edge of Chupadera Mesa; LA 197 and LA 9032 are positioned on hillsides; LA 9014 and LA 9016 are placed on the edges of steep ridge tops (Chamberlin 2008). In Wheately and Gillings' *Spatial Technology and Archaeology: The Archaeological applications of GIS,* Warren and Asch state, "predictive models are tools for projecting known patterns or relationship into unknown times or places" (Wheatley and Gillings 2002: 100). This statement succinctly defines the primary objective of the defensive site predictive model: to model the location of existing defensive sites, assessing previous understandings of the defensibility of plaza-oriented pueblos on Chupadera Mesa. The second objective of the predictive model was to identify potential additional defensive sites on Chupadera Mesa, in the Salinas Pueblo Province

Predictive Model Methodology

The predictive model methodology used in this thesis is derived from Kvamme's predictive model used to identify the location of fortified defensive hilltop sites from the 12th and 13th centuries in the Klethla and Long House Valley of northeastern Arizona. The primary goals of Kvamme studies were to construct a

computer representation of the landforms of the region and use that landform model to identify potential defensive localities. The key component of this method is to as objectively possible define what landform characteristics constitute a defensive position. Kvamme constructed the model around attributes of already identified fortifications: (1) fortified sites occur in places elevated above their surroundings; (2) fortified sites are surrounded by steep slopes, in at least three cardinal directions; (3) fortified sites occur in places where slope is less than 22% (Kvamme 1993). Figure 3.5 depicts the results of Kvamme's predictive model.

In order to construct a predictive model for sites on Chupadera Mesa and across the Salinas Pueblo Province, the aforementioned site attributes noted by Kvamme were utilized. This was accomplished by examining the elevation and slope characteristics from the more defense plaza-oriented sites on Chupadera Mesa, LA 9016, LA 9029, and LA 9014. In order to determine location that are elevated above their surroundings, the raster calculator in ArcGIS 10 was used to determine the areas where the elevation raster > the mean elevation raster. To locate the places surrounded by steep slopes, the raster calculator in Arc GIS 10 was utilized by using the expression mean slope > 20, this expression identified all of the cells where average slope was greater than 20 percent slope. To calculate the third component, the areas of relatively flat slope, the raster calculator in Arc GIS was utilized using the expression slope ≤ 6. In order to identify the location of potential defensive sites, the results from these three calculations had to be pulled into 1 expression in the raster calculator from Arc GIS 10. The results of this calculation would indicate the locations of potential defensive sites in Salinas.

Figure 3.5 Results of Kvamme's Predictive Model

(Kvamme 1993)

Chapter IV: Discussion and Interpretations of Results

During the period of aggregation into plaza-oriented pueblos from dispersed jacal villages, some sites became increasingly defensible. The people responsible for building these plaza-oriented pueblos took full advantage of local topographic features that helped limit access while maximizing inter-site visibility. The results of the GIS analyses described in Chapter 3 indicate that the pueblos in the western portion of the study area were more visually interlinked with their neighbors, and were situated on more defensible lamdforms. This spatial patterning suggests that different decision-making strategies governed site selection in the southern area of the Salinas Pueblo Province.

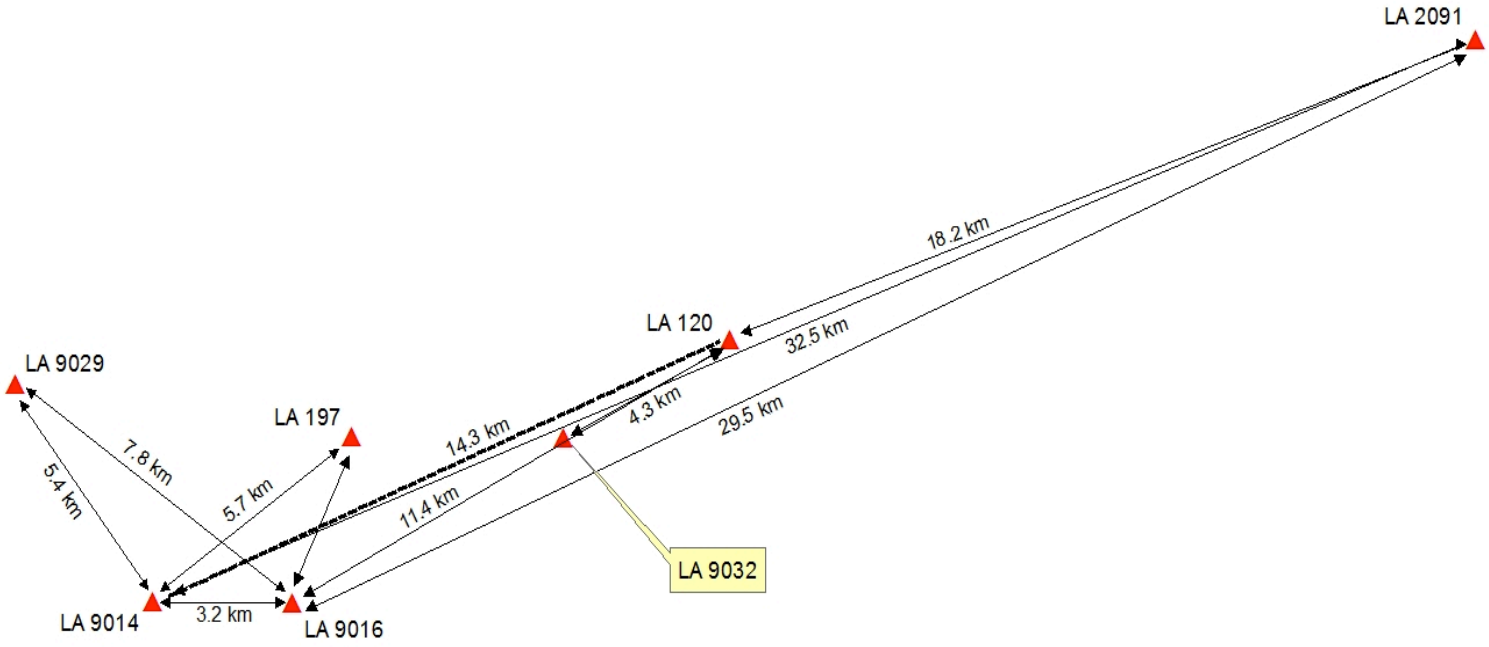
Results of the Binary Viewshed Analysis

The results of the binary viewshed analysis yielded several interesting results concerning the nature of interaction between the plaza-oriented pueblo villages. Figure 4. 1 and Table 4.1 depict the results of the binary viewsheds and the degree to which the plaza-oriented pueblos on Chupadera Mesa and the Jumanes Mesa were intervisible with each other.

Based on Figure 4.1 and Table 4.1, it appears that many of the plaza-oriented pueblos on Chupadera Mesa were intervisible with several other villages. However, upon further examination of the binary viewshed results, distinct patterns of intervisiblity between the plaza-oriented pueblos on Chupadera Mesa and the Mesa Jumanes appear. The plaza-oriented villages on the western portion of the study area; LA 9029, LA 9016, LA 9014, and LA 197 seem to be more visually linked with each other and in addition, LA 9014 and LA 9016 appear to have a visual linkage to communities located east of Chupadera Mesa including LA 120 and LA 2091. In contrast, the plaza-oriented pueblos

in the eastern portion of the study do not possess as many visible links with neighboring sites. LA 9032 is only intervisible with LA 120. In addition, LA 120 is only intervisible with LA 9016 and LA 9014.

Figure 4.1 Intervisibility of Plaza-Oriented Pueblos



The location of plaza-oriented pueblos are depicted by red triangles. The arrows between sites indicates reciprocal visibility between sites. The dashed line between LA 9014 and LA 120 indicates that LA 9014 was capable of seeing LA 120 but that LA 120 was not capable of seeing LA 9014. The distance between sites is also indicated.

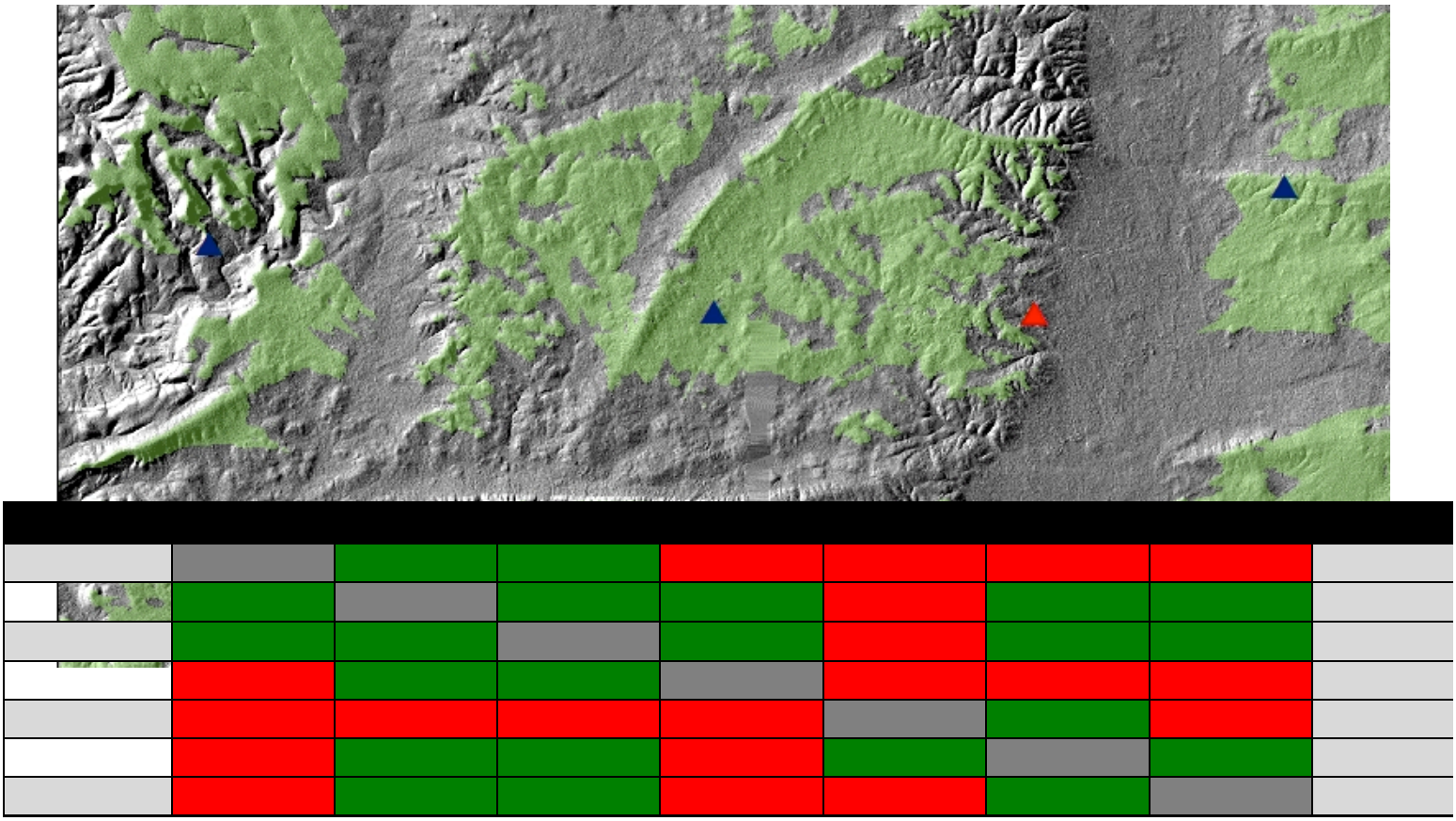
Table 4.1 Visibility Connections Between Plaza-Oriented Pueblos

Site	LA 9029	LA 9014	LA 9016	LA 197	LA 9032	LA 120	LA 2091	Total Links
LA 9029								2
LA 9014								5
LA 9016								5
LA 197								2
LA 9032								1
LA 120								4
LA 2091								3

Green cells indicate the presence of a visible connection. Red cells indicate the absence of a visible connection

The results of the binary viewshed analysis also indicated that the plaza-oriented pueblos were positioned not only to be intervisible with one another, but were also positioned to allow for monitoring the landscape for potential attackers. Figure 4.2 depicts the viewshed areas for LA 9016, one of the more defensible sites on Chupadera Mesa. The image depicts a zoomed in portion of the areas visible to LA 9016, but even at this scale, it is apparent that large areas in all directions would be visible to the occupants of LA 9016.

Figure 4.2 Binary Viewshed Result for LA 9016



The observer point (LA 9016) is indicated by a green triangle. Visible areas are indicated in green with non-visible indicated as clear. Plaza-oriented pueblos that were visible to LA 9016 are indicated by blue triangles.

However, as indicated earlier, infinite visibility is assumed in the binary viewshed calculation, which does not account for the decay in visual resolution with distance. With this in mind, the initial results of the binary viewshed analysis have to be coupled with the results of the enhanced viewshed analysis in order for a more experiential and realistic model of vision.

Results of the Enhanced Viewshed Analysis

When coupled with the results of the binary viewsheds, the enhanced viewshed results allow for a more realistic model of how the residents of Chupadera Mesa experienced their landscape. The enhanced viewshed results from LA 9016 illustrate this. The binary viewshed results indicated that LA 9016 was visibly connected to its nearby neighbors on Chupadera Mesa, LA 9029, LA 197, and LA 9014, and visibly connected to the more distant communities of LA 120 and LA 2091. However, the results of the enhanced viewshed analysis, depicted in Figure 4.2, indicate that the latter sites were beyond the limit of LA 9016's functional visibility. The results from the other plaza-oriented pueblos on Chupadera Mesa are depicted in Table 4.2.

Site	LA 9029	LA 9014	LA 9016	LA 197	LA 9032	LA 120	LA 2091	Total Links
LA 9029								2
LA 9014								3
LA 9016								3
LA 197								2
LA 9032								1
LA 120								1
LA 2091								0

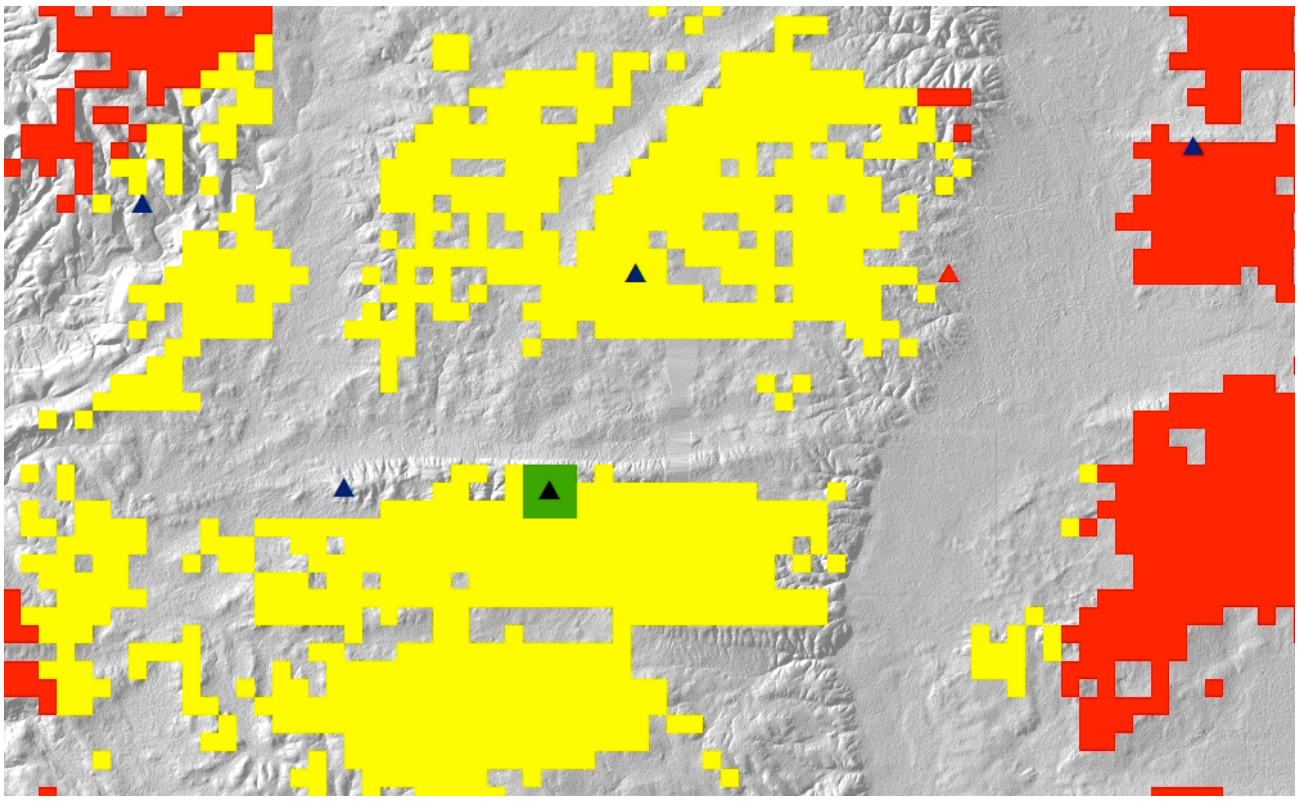
Table 4.2 Results of the Enhanced Viewshed Analysis

This table presents the results of the enhanced viewshed analysis. Sites that were not intervisible with one another are indicated in red. Sites intervisible with each other in the middle-distance level of perceptive visibility (458m – 8.4km) are marked in green. Sites intervisible with each other in the long-distance level of perceptive visibility (8.5km – beyond) are indicated in red. However, these linkages would have been beyond the functional limits of visibility. The total number of links reflects the number of intervisible sites in the middle-distance level of perceptive visibility.

However, the results still suggest high degree of inter-visibility between LA 9029, LA 9016, and LA 9014. The enhanced viewsheds further indicate that identifying approaching enemy attacking groups would have been difficult at a significant distance. The enhanced viewshed results suggest that the residents of the plaza-oriented pueblos on

Chupadera Mesa would have been able to clearly distinguish and identify approaching enemy attacking groups up to a distance of 457 m.

Figure 4.2 Enhanced Viewshed Result for LA 9016



The above image depicts the results of the enhanced viewshed for LA 9016 (depicted by the black triangle). The areas visible to LA 9016 are gradated to depict the three levels of perceptive visibility; short-distance in green, middle-distance in yellow, and long-distance in red. Plaza-oriented pueblos that were visible to LA 9016 in the binary viewshed analysis are depicted as blue triangles

Interpretation of the Visibility Analysis

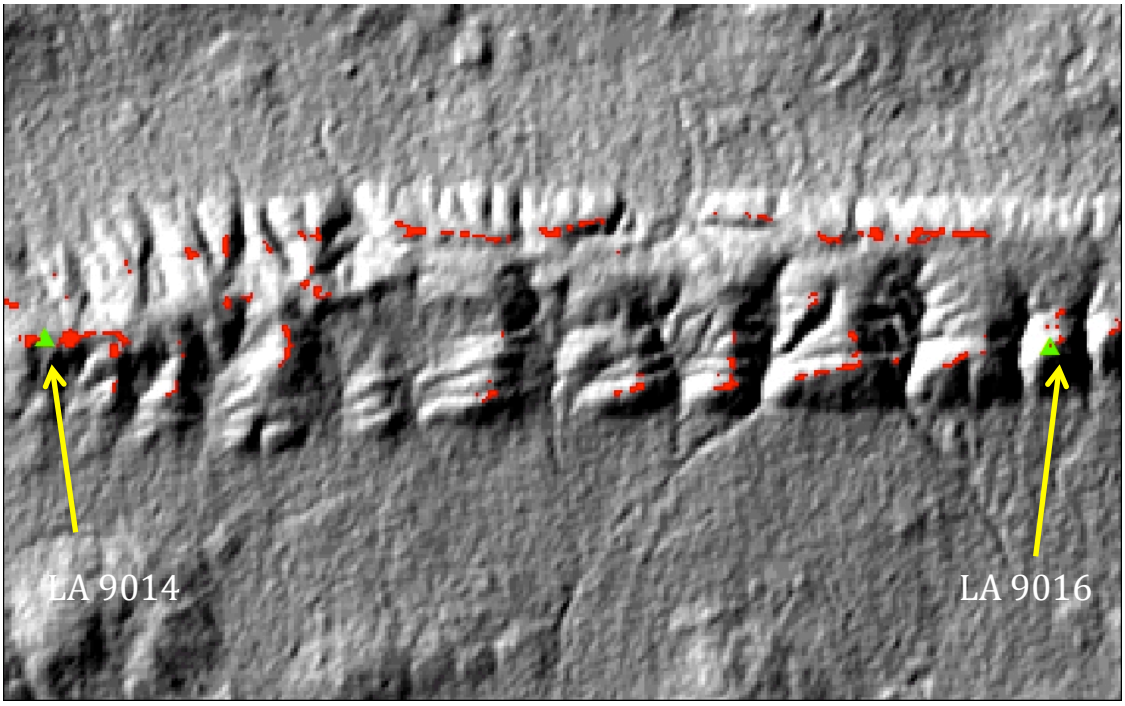
The results of the two viewshed methodologies suggest that the plaza-oriented pueblos on Chupadera Mesa were positioned to enable line-of-sight communication. When sites are intervisible, they are able to signal each other.

Signaling enhances the defensibility of villages because sites can mutually support each other in times of crises, whether by providing advance warning that attackers have been detected in the area, or by requesting assistance while under assault. The plaza-oriented pueblos on Chupadera Mesa were located in such a way that they were able to see from one community to another. However, they were not located close enough on the landscape so as they could actually observe each other or detect potential enemies outside their neighbor's villages. The close spacing between the plaza-oriented pueblos on Chupadera Mesa would increase the number of people available for both defensive and offensive operations against other communities. However, even with the positioning of sites so as to provide a visual link with one another, sites would not be able to clearly observe daily interaction. This suggest that a combination of signaling methods, fire at night and/or smoke during the day would be necessary to maintain the visual connection and mutual support network. In addition, a combination of the binary and enhanced viewshed results suggest that that it would have been difficult to identify approaching attacking groups at a significant distance.

Results of the Predicitve Model

The primary role of the predictive model was to determine the defensiblity of the regional landforms, providing insight into the pueblo inhabitants' site selection process. The results of the predictive model are presented in Figure 4.4, 4.5, 4.6, and 4.7.

Figure 4.4 Assessing Regional Defensive Landforms on Turkey Ridge



In these two images, areas identified by the predictive model are depicted in red. The locations of plaza-oriented pueblos are depicted by green triangles

Figure 4.5 Assessing Regional Defensive Landforms in Area of LA 9029

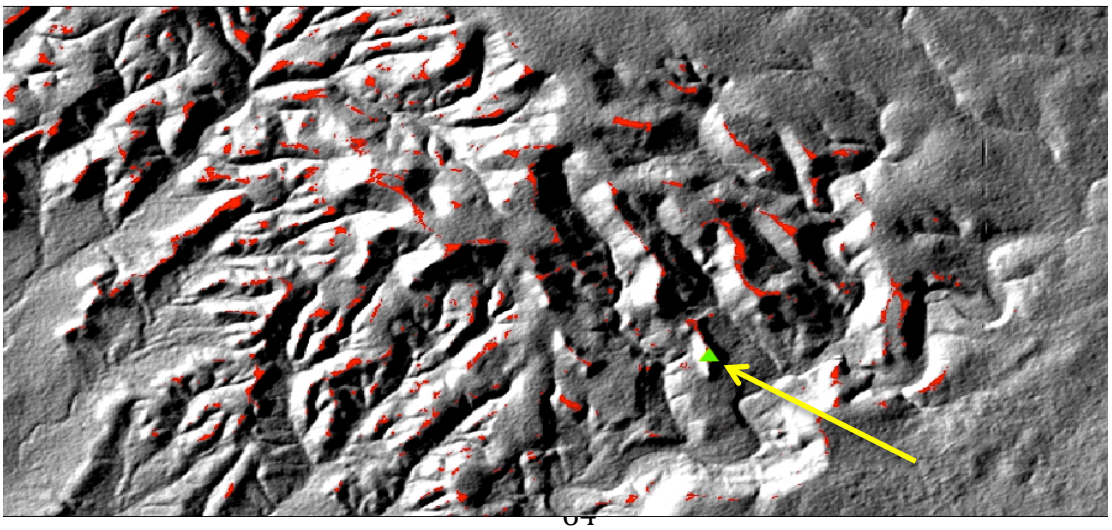
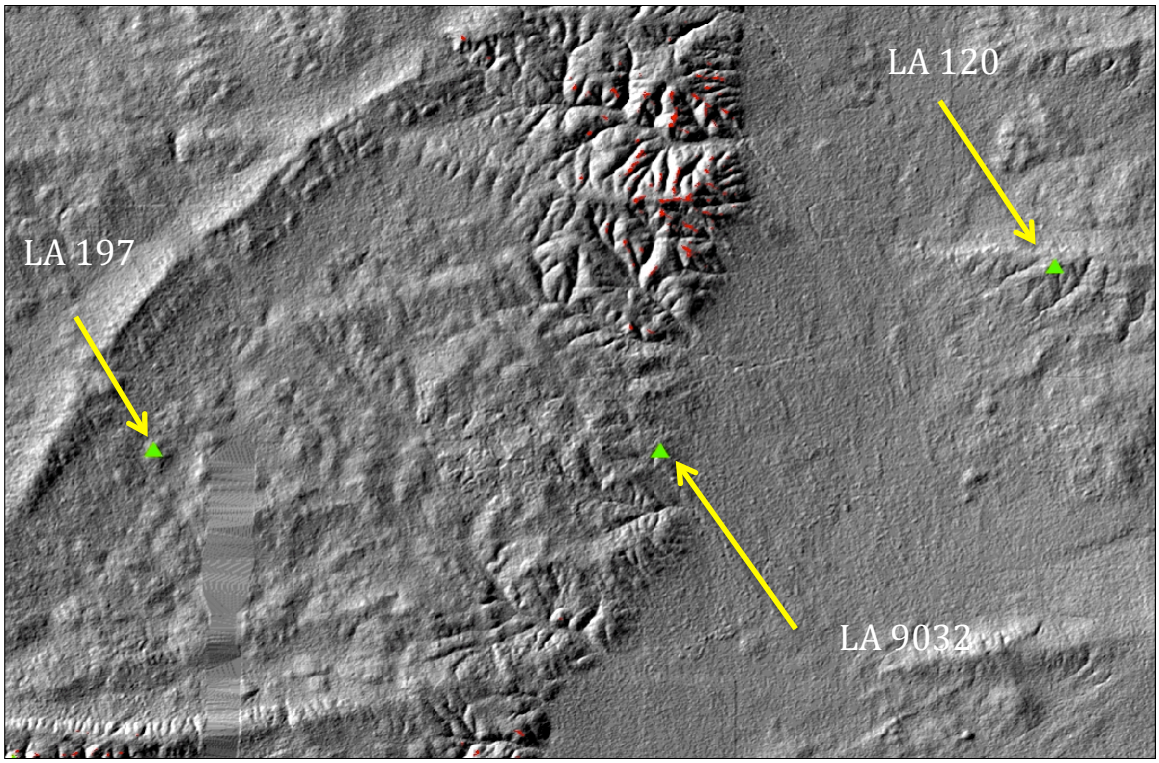
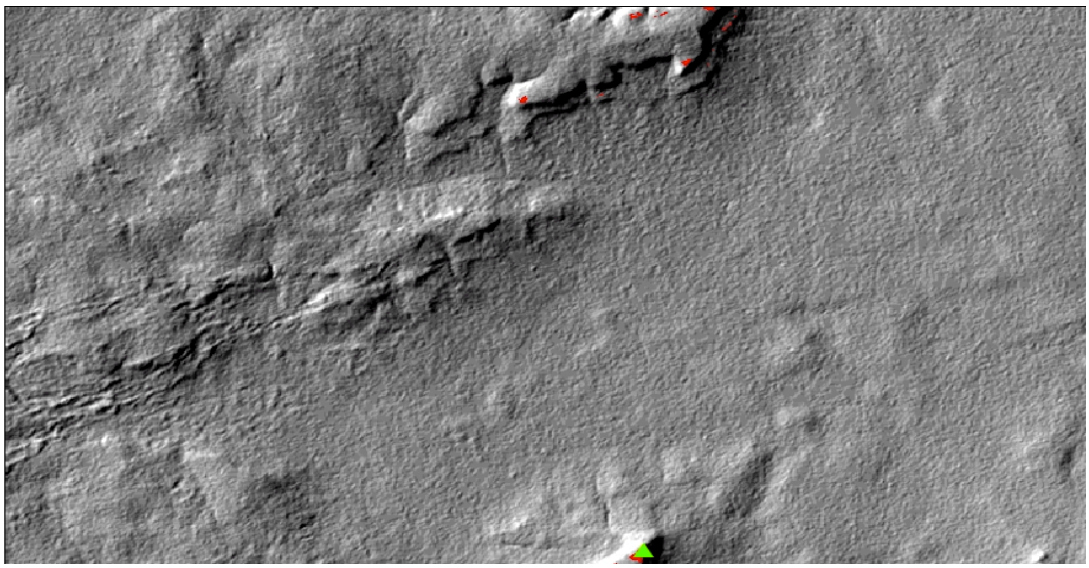


Figure 4.6 Assessing Defensible Landforms on Chupadera Mesa



In these two images, areas identified by the predictive model are depicted in red. The locations of plaza-oriented pueblos are depicted by green triangles

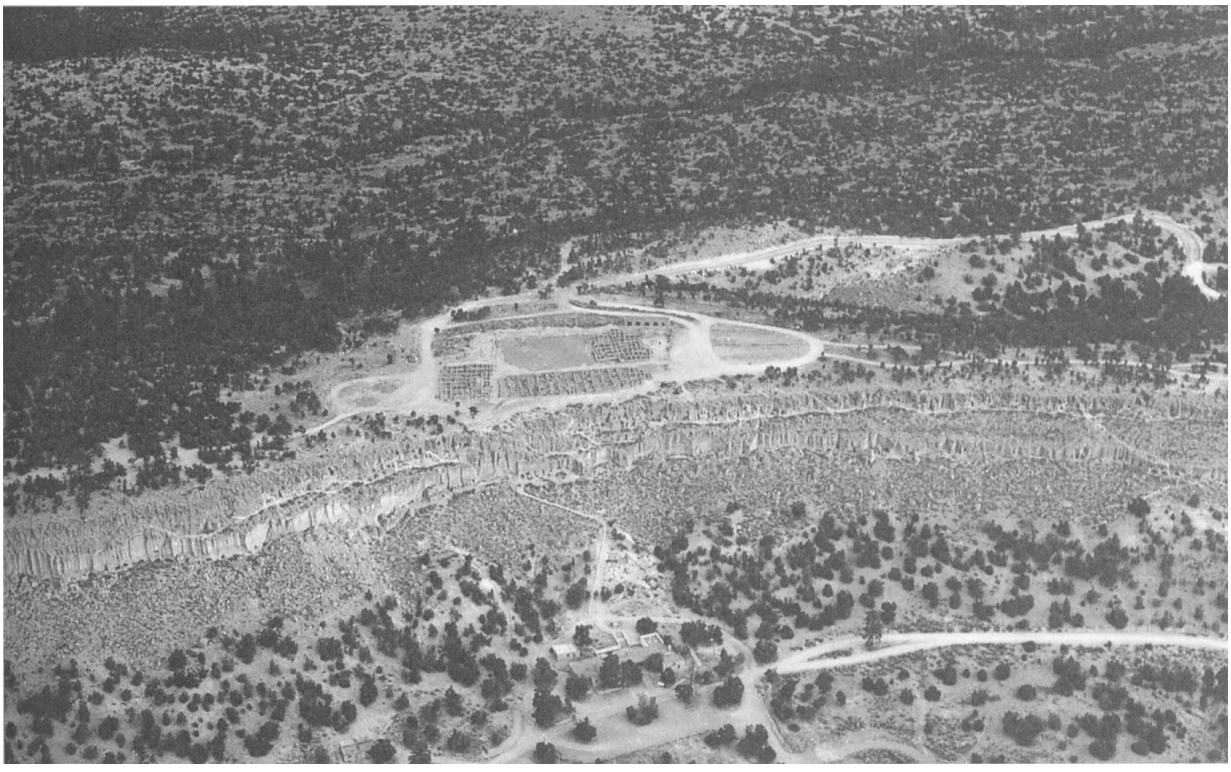
Figure 4.7 Assessing Defensible Landforms in the area of LA 2091



Interpretation of the Predictive Model Results

LeBlanc (1999) notes that humans do not without compelling reasons locate their communities in areas that are difficult to access and compromise access to water sources, fuel, arable land, and other necessities of life. The results of the predictive model indicate the importance of assessing the defensive characteristics of regional landforms. The landforms suited for defense on Chupadera Mesa are different from the landforms situated for defense in the Long House and Klethla valleys. Figure 4.8 depicts the site of Puye in the Jemez Mountains of New Mexico, which is defensively located on the edge of a mesa near a significant drop-off.

Figure 4.8 Example of a Defensively Situated Sit



(LeBlanc 1999)

However, the results of the predictive model indicate that the occupants on Chupadera Mesa took advantage of the most defensive landforms that were located in their region, especially LA 9029, LA 9016, and LA 9014. These sites appear to be the most defensively located sites in the area. In contrast, LA 9032, LA 120, and LA 197 do not occupy landforms that are significantly different in their defensibility. The predictive model indicates that there were some potential defensible landforms within 6 kilometers of LA 9032, LA 197, and LA 120; however, these landforms were not chosen. The positioning of LA 9032, LA 197, and LA 120 suggests that defensive concerns were not prioritized over access to arable land and dependable water sources.

Conclusions

The results from the visibility and predictive model are consistent with other sources of evidence for warfare suggesting that the threat of warfare and the need for defense is one possible explanation for the construction of plaza-oriented villages, whose layout is seemingly intended to limit access. However, the results seemed to indicate a distinct spatial patterning in the defensibility of plaza-oriented pueblos on Chupadera Mesa and the neighboring Jumanes Mesa. This patterning suggests a difference in decision-making strategies between the plaza-oriented pueblos located on Chupadera Mesa,with pueblos located on the western portion of the mesa displaying a greater concern with positioning their settlements in regards to the need for defense.

The plaza-oriented pueblos on Chupadera Mesa were placed, in varying degrees, on the landscape to take advantage of topographic features to control site access and allow for line-of-sight communication. The intervisiblity of sites and the efforts made to fortify sites indicates that residents of Chupadera Mesa were concerned with organizing their communities in mutual support networks and prepping their communities for defense. However, there appears that a spatial patterning exists in defensive decision-making strategies between the plaza-oriented pueblos on the western edge of Chupadera Mesa and plaza-oriented villages located on the eastern extent of Chupadera Mesa

At the time that populations in Salinas were aggregating into plaza-oriented villages, a similar process was occurring in the neighboring Rio Abajo region located to the immediate west along the Rio Grande River (Marshal and Walt 1984). After A.D. 1300, the Rio Abajo experienced a significant seven-fold increase in population (Chamberlin 2008; Marshal and Walt 1984). There is evidence that there was also an increase in more defensive sites during this period. LA 9029 is positioned at the extreme western edge of the settlements on Chupadera Mesa and the Salinas Pueblo Province. LA 9014 and LA 9016 are also located on the western portion of Chupadera Mesa, and possess high degree of defensibility. The increased buildup of population in the Rio Abajo could have represented a potential threat to the residents of Chupadera Mesa. If this were the case, it would be expected that the westernmost settlements on Chupadera mesa would show signs of the greatest concern for defense.

The results of this thesis suggest that the plaza-oriented pueblos on Chupadera were positioned on the landscape so as to facilitate communication in a mutual defense network. Future investigations of the plaza-oriented pueblos on Chupadera Mesa can

continue to offer insight into the development of larger-scale social identity, the development of unique interaction and exchange networks on Chupadera Mesa, and the level of involvement of the plaza-oriented pueblos on Chupadera Mesa in conflict.

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