THESIS

SURVEILLANCE, SOCIAL CONTROL, AND STATE INTEGRATION: A GIS VISIBILITY ANALYSIS AT THE ANCIENT PURÉPECHA CITY OF ANGAMUCO, MICHOACÁN, MEXICO

Submitted by

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In partial fulfillment of the requirements

For the Degree of Master of Arts

Colorado State University

Fort Collins, Colorado

Spring 2023

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ABSTRACT

SURVEILLANCE, SOCIAL CONTROL, AND STATE INTEGRATION: A GIS VISIBILITY ANALYSIS AT THE ANCIENT PURÉPECHA CITY OF ANGAMUCO, MICHOACÁN, MEXICO

The Purépecha Empire was a pre-Hispanic civilization that consolidated in the Lake Pátzcuaro Basin (LPB) of Mexico during the Mesoamerican Middle Postclassic Period (1100 – 1350 CE). The specifics of how the Purépecha Empire developed are poorly understood. This thesis focuses on visibility, and how it's manipulation in the built environment may have contributed to processes of social control and state integration in the LPB. At the ancient city of Angamuco, this study investigates whether Purépecha rulers may have used an ancient form of Panopticism (i.e., surveillance as a form of social control) to establish power and authority over pre-existing populations and integrate them into the emergent state.

This study focuses on high-status structures at Angamuco (pyramids, elite complexes, ballcourt) and examines if they were made to be highly visible on the landscape in a way that would have been favourable for Panoptic surveillance. The visibility of the high-status structures was modelled in a GIS using LiDAR visualizations and several archaeological datasets. Viewsheds were generated from the high-status structures, then various attributes were recorded for the viewsheds within two independent study areas.

The viewshed attribute data was then statistically compared to equivalent viewshed data from multiple samples of random points. The results show that high-status viewsheds were larger and encompassed greater areas of occupation and activity than we would expect from random

chance. This suggests that visibility was important in determining the location of these structures, which fits with the idea of Panoptic planning. The results also show that intervisibility was important in the placement of high-status structures. More fieldwork is needed to ground-truth existing data and extend its coverage over larger areas of the site.

ACKNOWLEDGEMENTS

I would like to thank my advisor Chris Fisher for giving me the opportunity to pursue my interests in archaeology, GIS, and remote sensing as part of the CARS lab. I want to thank my committee members Elizabeth Tulanowski and Stephen Leisz for your guidance and feedback. I also want to thank the other current members of the CARS lab, especially our lab manager Lawrence 'Bear' Beals for always being quick to help with technical issues. Special shout out to former lab members Alex Friedl, Edwin Harris, Louise Steele, and Rodrigo Solinis Casparius, who allowed me to use their data. Finally, I would like to thank the other members of my graduate cohort, the faculty and staff in the department of Anthropology and Geography, as well as my friends and family outside the department.

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CHAPTER 1: INTRODUCTION

The Purépecha, or Tarascan, civilization was a prehispanic empire that consolidated in West Central Mexico during the Mesoamerican Middle Postclassic (1350 – 1525 CE) period. At its height, the Purépecha empire rivalled that of the better known Aztecs, covering an area that incorporated much of the modern Mexican province of Michoacán. The geopolitical core of this empire was located in a region called the Lake Pátzcuaro Basin (from here on referred to as the LPB).

The specifics of how the Purépecha Empire developed are poorly understood. This thesis uses social theory and archaeological data to explore this topic. I propose that visibility, and it's manipulation in the built environment, may have contributed to processes of social control and state integration in the LPB. In chapter 2 of this thesis, I provide theoretical background explaining how certain aspects of the built environment, such as visibility, can communicate sociocultural meaning to observers. I draw on the work of Amos Rapoport (1990) who explains that the built environment can communicate different levels of meaning. Most pertinent to this thesis are middle-level meanings, which involve messages related to identity, status, and power, as well as low-level meanings, which direct behavior. I argue that in ancient cities, monumental constructions such as pyramids could communicate middle and low-level meaning in part through their visibility. Because these structures were tall, highly visible, and impressive to look at, they could easily communicate middle-level messages reinforcing the power and legitimacy of the rulers and elites who had them constructed. At the same time, the presence of these structures on the landscape could create a sense of perpetual surveillance for commoners which could act as a disciplinary mechanism, leading them to self-regulate their behavior. This latter concept is called Panoptic surveillance, which comes from Foucault (1995). It is a mechanism of social control that relies on visibility and the feeling of being watched to influence behavior. I argue that Monumental constructions could communicate low-level meaning through a Panoptic gaze. I suggest that by communicating middle-level messages and facilitating Panoptic surveillance, monumental constructions could reinforce the social order and coerce people into sustaining that social order. Together these processes worked as a strategy of social control and domination for ancient rulers.

In chapter 3, I provide background information about the Lake Pátzcuaro Basin, and the Purépecha Empire. I also introduce my study site, the ancient city of Angamuco, a large urban center in the eastern LPB. I discuss many topics including geographic context, the history of pre-Hispanic occupation, archaeological research, and current understandings of urbanism at Angamuco. Of particular importance is my description of the architectural forms at Angamuco, which include monumental constructions such as pyramids, as well as other imperial structures such as elite complexes.

Chapter 4 applies the concepts from the theoretical discussion to Angamuco. I hypothesize that Purépecha rulers could have used an ancient form of Panopticism as a mechanism of power to bring populations under control and integrate them into the emergent state. This centers around the 'high-status structures' at Angamuco, including the pyramids and elite complexes. I believe these structures could have facilitated Panoptic surveillance and middle-level messaging through their physical presence and visibility on the landscape. This hypothesis can be narrowed down into the specific research question below.

- Do the locations of high-status structures at Angamuco suggest that they were made to be highly visible on the landscape in a way that would have been favourable for Panoptic surveillance and the communication of middle-level meaning?

To answer this research question, I modeled visibility from high-status structures at Angamuco. I did this using Geographic Information Systems (GIS) software and various spatial data products that I created or acquired for the site. Chapter 5 details this methodology. At Angamuco, this involved generating viewsheds for high-status structures across the site. A viewshed is a spatial dataset that shows which areas of the landscape have a line of sight to one or more observer points. I recorded several attributes for these viewsheds such as their area, the number of archaeological features contained within them, and the total length of roads within them. I then generated viewsheds from three samples of random points over the landscape and recorded the same attribute data for them. I statistically compared the high-status and random viewshed attribute data to look for significant differences which would indicate whether these structures were or were not positioned randomly in relation to their visibility.

Chapter 6 presents the results of my visibility analysis. I show how viewshed attributes varied among different high-status structures at Angamuco, how high-status and random viewshed attributes differed, and the results of the statistical tests.

Finally, chapter 7 presents a discussion of the results as well as my conclusions. I offer my interpretations and relate the viewshed data back to my initial research questions. I also discuss the limitations of my analyses and the potential for future work.

CHAPTER 2: THEORETICAL BACKGROUND

Central to this thesis is the idea that the built environment can convey meaning. I draw heavily on the work of Amos Rapoport (1990) who proposed a model for different levels of meaning within the built environment. In archaeological contexts, these meanings can be decoded to interpret the social significance of ancient architecture and urban planning.

According to Rapoport, the environment has both *perceptual* and *associational* aspects (1990: 19). Perceptual aspects are those that have to do with beauty and aesthetic quality, while associational aspects are those that communicate sociocultural meanings (1990: 26). Physical elements of the built environment, like its form, layout, and planning, are encoded with meaningful information that is communicated to observers in a non-verbal manner. This communication of meaning is important because it can directly and indirectly affect behavior. The environment essentially acts as a mnemonic device, providing cues that elicit and guide appropriate behavior within a given sociocultural context. Observers read environmental cues, interpret/decode the meanings communicated by them, and adjust their behavior accordingly (Rapoport 1990). Earlier studies in psychology (Maslow and Mintz 1956; Mintz 1956; Rosenthal 1966) have shown that aspects of the environment – the size, decoration, and furnishings of a room – will affect how people interpret their social context, and thus how they act. This is obvious in daily life, for example, think about how you would act differently in a nightclub as opposed to an upscale restaurant. The capability of the built environment to communicate meaning and influence behavior pertains not only to rooms or individual buildings, but also to larger urban forms, like entire settlements, and settlement systems. The spatial organization of buildings, structures, and settlements in relation to the larger environment is meaningful and can guide or constrain human action (Rapoport 1990:27). Cities themselves, whether ancient or modern, structure human action through a limited range of configurations of the built environment (Smith 2003). This fits with Giddens' theory of structuration (Giddens 1984), as the organization of the built environment (done through human practice) is informed by structures existing at the level of practical consciousness. At the same time, the process of organizing the built environment reproduces these structures to enact a certain social system, which affects practice. Ultimately, what all of this means is that urban forms and whole landscapes can be interpreted. As archaeologists (assuming we have an apt understanding of the cultural context), we can try and decode the meanings embedded in the ancient built environment. In doing so, we can hope to get into the headspace of those who once designed and inhabited it – to understand how the built environment both shaped their social experience and was also shaped by it (Giddens 1984; Moore 2005; Richards-Rissetto 2017).

Up to this point, I have referred to the 'meanings' communicated by the built environment in a somewhat general manner. In the next section, I will explain the different kinds of meaning that can be communicated.

Different Levels of Meaning

According to Rapoport (1990), the built environment can actually convey three distinct types of meaning: high, middle, and low. High-level meanings are those related to cosmological, sacred, and supernatural significance. Middle-level meanings are those related to identity, status, and power. Finally, low-level meanings are those that identify the intended use of a particular setting and the intended behavior within it. This relates to movement, accessibility, privacy, and other information that gets users to act predictably and appropriately (Rapoport 1990:221).

While I differentiate them here, these three levels of meaning are actually “ideal types structuring a continuum” (Rapoport 1990:221) which implies that aspects of the built environment, such as buildings, can communicate one or multiple kinds of meaning simultaneously. High-level meanings are culturally specific and often understood by only a small group of individuals (Rapoport 1990). Studies of high-level meaning often take a symbolic approach and may examine, for example, how city planning was influenced by cosmological beliefs and worldviews (Eliade 1959; Friedl 2019; Lynch 1984; Wheatley 1971). However, since high level meanings are so culturally specific and relate to the particular religious, cosmological, and sacred beliefs of ancient rulers, they have been seen as controversial and hard to confirm without some sort of primary evidence, like textual support (Smith 2007:33). On the other hand, middle and low-level meanings exhibit cross cultural regularities and should be easily understood by the populace and easily discerned by the researcher (Rapoport 1990; Smith 2007). These are the most relevant to this thesis.

What aspects of the ancient built environment communicated middle and low-level meanings? According to Smith (2007), middle-level meaning could be communicated through many architectural and spatial features, especially through their size, form, and location on the landscape. These features would be reflective of the power of the state, it’s control of labor, and the place of commoners in society. Many of these architectural and spatial features would have simultaneously communicated low-level meaning if they helped direct behavior (Smith 2007). While many features of the built environment communicated both types of meaning, in this thesis I am particularly concerned with *monumental constructions*. My use of the term monumental constructions refers to any kind of monumental architecture, like pyramids, but also smaller standing monuments like stelae. The term encompasses a range of architectural forms that reflect the intentionality of elites. In the next section I will explain how monumental constructions communicated middle-level meaning.

Monumental Constructions and Middle-level Meaning

Some of the clearest expressions of middle-level meaning in ancient cities came from monumental constructions. These features were built by ancient rulers to communicate ideological messages related to the power and legitimacy of the state, including its ability to carry out large projects (DeMarrais et al. 1996; Smith 2007). This is not to say that these features were built to *exclusively* communicate these kinds of meanings. As stated previously, features of the built environment often communicated multiple kinds of meaning simultaneously. Here I restrict my discussion to middle-level meaning.

The notion of monuments communicating ideological messages is discussed by Elizabeth DeMarrais and her co-authors (DeMarrais et al. 1996). They see monumental construction as one form of the materialization of ideology - the process through which certain ideas, values, myths, and stories are given concrete physical form, allowing them to become effective sources of power. The materialization of ideology is often taken up by dominant social groups as a strategic act which allows them to extend their ideology to a broader populace and communicate their authority and power in physical form (DeMarrais et al. 1996). This becomes especially useful in situations where territorially expansive states come to incorporate broad populations into their domains. For example, the Inka Empire and the southern Moche both conquered diverse ethnic populations whom they ruled somewhat indirectly. In both cases, they used monumental construction as a way to materialize their state ideologies and export them to distant regions. Moche pyramids and Inka infrastructure served as symbols of state control and power across the landscape. They promoted a common state identity while also legitimizing inequality (DeMarrais et al. 1996). While these authors don't mention Rapoport's middle-level meaning, it seems obvious that the ideological messages materialized and communicated by monuments are in many cases the same middle-level meanings that Rapoport discusses.

The ability of monumental constructions to communicate middle-level meaning is also discussed by Trigger (1990). He agrees with (Wilson 1988) and sees monumental structures as "helping to convince the spectator of the reality of the power that brought them into existence" (Trigger 1990:122). Through their splendor, monumental constructions reinforced and glorified the status of rulers, their gods, and the state. They embodied the ability of elites to harness large amounts of human energy, and thus naturalized their right to rule (Hutson 2002; Trigger 1990).

Before proceeding it should be noted that while monumental constructions were clearly designed to communicate ideological messages relating to power and status, it should not be assumed that these messages were always communicated effectively. We cannot assume that non-elites were simply passive consumers of ideology. Instead, we must remember that these people had agency to contest, reinterpret, or simply ignore elite ideological messaging (Giddens 1979; Hutson 2002; Scott 1985, 1990). We should also take the advice of (Marcus 2003) who warns against uncritically equating monumentality with power. We should not assume that large monuments were always built under the order of powerful rulers. For example, Stonehenge is a large monument that seems to have been constructed without powerful leaders or a state level of organization. Ultimately, while monumental constructions usually communicated middle-level meaning from high status to lower status individuals, this was not *always* the case.

If we accept that monumental constructions communicated middle-level meaning (with the above caveats in mind), it stands to ask, *how* they went about doing this. What was it about pyramids, temples, palaces, etc. that made them conducive to projecting these kinds of messages? For this thesis, I am particularly concerned with two related features: height and visibility.

Height, Visibility, and Middle-level Meaning

Rapoport himself (1990:106–111, 115–117), discusses the ability of height to project middle-level meaning. In his view, height is an environmental cue that almost universally seems to convey meaning related to status, power, and importance. Indeed, differences in height nearly always reflect differences in prestige, power, status, and sacredness. Usually, the higher off the ground something is, the higher the status (although inversions do exist). Rapoport explains that "to get attention, distortions of perception and cognition are used…the built environment is one of these strategies, and in trying to establish prestige, height is in fact, a very commonly used cue" (Rapoport 1990:116). He goes on to say, "If we examine how space and physical objects communicate rank and power, we find height frequently used…this kind of cue is, I suspect, almost universally understood" (Rapoport 1990:116–117). Rapoport mentions medieval cathedrals and churches as examples. While these structures certainly communicated high-level meanings related to sacred belief, their imposing verticality on the landscape also reflected the authority and resourcefulness of the rulers who had them constructed. Rapoport provides additional examples from traditional Thailand and Cambodia where buildings and settlements were designed to make commoners physically lower than nobles and everybody lower than the king (Rapoport 1990:111). Height carried similar meaning at Maya dynastic centers where the positioning of people in vertical space – who got to sit or stand at certain elevations or vantage points – especially during rituals, corresponded to their status and social standing. Indeed, during important rituals at the site of Copan, the relative height of participants on the steps of Maya buildings seems to have correlated with their social status (Fash 1998).

I believe that if height is an environmental cue that communicates middle-level meaning, then so is visibility. While this is not explicitly discussed by Rapoport, height and visibility are intimately related properties of the built environment - when something is tall and elevated, it is usually, by extension, highly visible. Nonverbal communication of the type Rapoport describes inherently depends on visibility to allow messages to reach observers. A structure might be very tall, but if it is not visible to anyone, it cannot communicate middle-level messages. Elevating something above a common ground level will most effectively communicate messages of prestige, status, and power if, through its elevation, it becomes more visible to larger groups of people than it was previously. Visibility is also related to attention and importance. Structures that are highly visible garner more constant attention, and things that garner lots of attention come to be seen as important.

Monumental constructions made use of height and visibility to project middle-level meanings effectively. In most cases, they were elevated and made to be highly visible. Some obvious examples would be the Pyramids of Giza, the Pyramid of the Sun at Teotihuacan, the temples of Angkor, and the Templo Mayor at Tenochtitlan. The scale of these monumental constructions greatly exceeded the requirements of any practical functions they were meant to perform (Trigger 1990). I believe that the scale itself was associational, communicating middle-level meaning. Unlike the specific high-level symbolism of these structures, which may not have been understood by the casual observer, the middle-level meanings would have been readily apparent, just as they are to the modern observer (Smith 2007). Anyone who has observed a monumental construction at an archaeological site will understand what I mean. These structures were, and still are, simply impressive to look at – on a psychological level they project the power of the rulers and elites who built them. In ancient times, these constructions would have stood out on the landscape, towering over people and other structures alike. Being tall and highly visible, they would have drawn the gaze of observers, constantly reminding them of the power, importance, and all-seeing nature of the rulers who had them constructed. At the same time, they would have reminded observers of their own insignificance.

Ancient Maya sites present a good example of this. At Maya sites, monumental constructions were made to be tall and highly visible. Maya temples were the tallest and most restricted structures on the landscape (Fash 1998). At centers like Tikal and Yaxchilan, multiple royal temples rose above their surroundings, sometimes being built atop hills to emphasize their verticality (Richards-Rissetto 2017). Maya royal compounds – another form of monumental construction - were also elevated above their surroundings. The towering nature of these structures made them highly visible and brought them closer to the heavens (Richards-Rissetto 2017). I would argue that this emphasis on height and visibility was meant to communicate middle-level meaning to the populace - it reinforced the power of the Maya kings, legitimated the social hierarchy, and highlighted the all-seeing nature of Maya rulers. The latter point is especially important. Maya rulers needed to give the impression that they were all-seeing because for them, to be all-seeing was to be all-knowing (Houston et al. 2006; Richards-Rissetto 2017). For the Classic Maya, the act of seeing was agentive - sight had an authorizing function and a visual field that was always oriented down, from someone of high status (a ruler or deity), to people of lesser status (Houston et al. 2006). Visibility and power were linked, so monumental constructions, as embodiments of elite power, had to be elevated and made highly visible. This can also be seen with Maya stelae. These carved stone monuments commonly depicted the rulers of particular sites, acting as stand-ins for their physical presence. The stelae were usually quite tall and imposing – one at Quiriguá being upward of 7 m – with carved figures being scaled to the monument (Jackson and Wright 2014). As a result, these figures, who embodied ultimate political and religious authority, would have "towered over real-life viewers, emphasizing the importance and perpetual presence of an omniscient ruler" (Jackson and Wright 2014:133–134).

In this section I have tried to show how monumental constructions communicated middle-level meaning through height and visibility. By elevating structures and making them highly visible, ancient rulers projected their power, status, and all-seeing nature to a wide audience of lower status subjects. However, this was only part of the picture. Ultimately, ancient rulers wanted to uphold the social order that kept them in power. This required common people to play into the social order, enacting it through their daily practice. Middle-level messaging could remind people of that social order and help to naturalize it, but as I mentioned, people had the agency to disregard, contest, or alter these messages. Getting large amounts of people to actively reproduce the social order required influencing their behavior directly. This lies in the domain of low-level meaning.

Monumental Constructions and Low-level Meaning

As a reminder, low-level meanings are those that identify the intended use of a particular setting and the intended behavior within it. They direct people to act predictably and appropriately in a certain context (Rapoport 1990:221). I suggest that monumental constructions could communicate low-level meaning in multiple ways. In a direct sense, monumental constructions could situate people physically – they could demarcate physical space, oftentimes according to sociopolitical divisions, affecting movement and other kinds of behavior within that space (Jackson and Wright 2014). For example, Maya stelae sometimes acted as boundary markers, partitioning space into political realms and delineating political affiliation (Jackson and Wright 2014:126–128). On the Mongolian steppe, monuments called *khirigsuurs* consisted of arrays of spatially organized standing stones. They marked key locations on the landscape and directed habitation and movement, including herding routes, within it (Jackson and Wright 2014:125–126). As another example, a monumental system of walls existed at the site of Monte Albán in Oaxaca, Mexico. These walls would have directed and restricted movement through the city (Hutson 2002).

I argue that monumental constructions could also communicate low-level meaning in another way, directly relating to their visibility. As I've already discussed, monumental constructions dominated the landscape so that common people, when looking up, would constantly be able to see them on the horizon. Through this visual connection, observers would read and internalize middle-level messages that reinforced the power, status, and all-seeing nature of ancient rulers and elites. I argue that this visual connection also had another effect - it created a kind of *panoptic gaze*, in a Foucauldian sense (Foucault 1995), whereby individuals felt as if they were always under the watchful eye of the rulers and elite. This was perpetuated by the fact that monumental constructions often served as locations where rulers and elites resided or conducted activities. It is known that within temples, select groups of high status officials and ritual specialists would often perform secretive rituals (Trigger 1990). Other monumental constructions, like palaces and royal compounds, functioned as the residences and administrative centers for rulers and high-status elites. For example, at the Moche site of Pampa Grande, the main platform mound of Huaca Grande (a monumental construction) was located in the center of the site and is believed to have been topped by a highly restricted elite residence (Haas 1985;

Moore 1992:98). The literal presence of high-status individuals on and within these monumental constructions would have enhanced the feeling on the part of commoners that they were being watched from them. This constant threat of surveillance would have made compliant individuals conform their behavior to societal expectations. In other words, monumental constructions directed behavior (communicated low-level meaning) through their Panoptic gaze. Ultimately, middle-level messaging and the Panoptic gaze worked hand in hand to affect people's daily practice, which in turn served to reproduce and enact the very social order that ancient rulers sought to uphold. This operates in the sense of (Giddens 1984) relationship between agents and society, where human practice is both informed by structures, and also acts to reproduce those structures.

The idea of the Panoptic gaze is integral to this thesis. It provides a way of connecting two important ideas: on the one hand, how rulers and elites projected their ideologies of power to large numbers of people, and on the other, how these ideological messages actually established compliance and control. This concept needs further elaboration, so in the next section I will describe the Panoptic gaze, and more generally the concept of Panopticism, in greater depth.

Panopticism

The concept of Panopticism is derived from the Panopticon. This was a prison design envisioned by the British philosopher and political economist Jeremy Bentham in the 18th century (Bentham 1843, 2011; Moore 1992). Bentham was a pioneer in prison reform who realized that surveillance could be used as an effective means of social control. The Panopticon prison is a circular building with cells along the outer ring facing inwards to a central observation tower (see Figure 2. 1 and Figure 2. 2). The cells are illuminated and have windows on the side of the tower so that their occupants can be kept under constant surveillance (Foucault 1995:200; Johnston 1973; Moore 1992). Importantly, the central observer in the tower is concealed, such that the Panopticon maximizes observation while restricting the prisoner's knowledge of when they are actually being watched. Because the tower is always visible, the prisoners are put into "a state of conscious and permanent visibility" (Foucault 1995:201) where they feel as if they are constantly being observed. This allows power to be exerted in an automatic and anonymous way – there does not have to be anyone physically present in the tower, the mere threat of constant

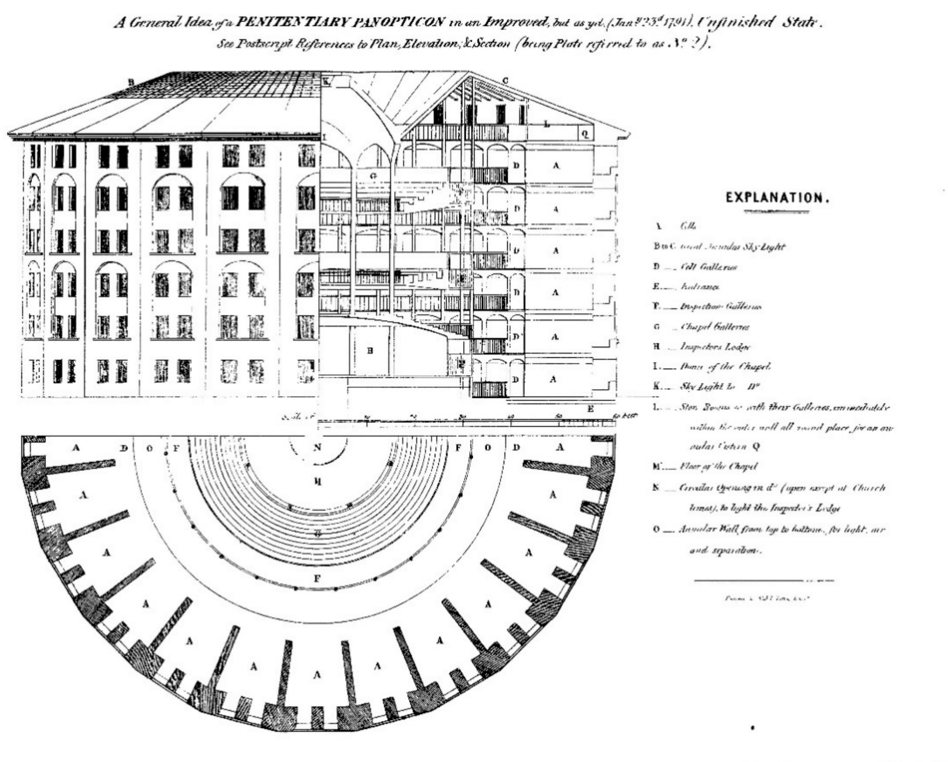

Figure 2. 1: The original plan of Bentham's Panopticon prison. Originally from (Bentham 1843:172-173). Image is now under Creative Commons Public Domain Mark 1.0. PD-US-expired. Retrieved https://commons.wikimedia.org/wiki/File:Penetentiary_Panopticon_Plan.jpg

Figure 2. 2: Panopticon style prison in Arnhem, The Netherlands. Photo by Rob Oo on Flickr, retrieved from https://tinyurl.com/27xcbyy8. Accessed under Creative Commons Attribution 2.0 Generic license https://creativecommons.org/licenses/by/2.0/

surveillance generates a self-consciousness among the prisoners that gets them to conform their behavior to acceptable standards. This acts as a disciplinary mechanism that coerces people into self-regulation without the need for physical force (Foucault 1995:201–203; Pierce and Matisziw 2021; Semple 1993). As described by Foucault (1995:202-203), "he who is subjected to a field of visibility, and who knows it…inscribes in himself the power relation in which he…becomes the principle of his own subjection". In practice, Panoptic design is applicable in any space that requires people to be supervised (Bentham 2011). Examples of Panoptic architecture can be seen in 19th century churches, domed capitol buildings, insane asylums, schools, and prisons (Graves and Van Keuren 2011; Leone 1995). If we think of monumental constructions functioning as a kind of Panopticon, it implies that rulers and high-status elites did not even have to be physically present or visible at the top of these structures. The threat of their potential but obscured presence – the mere pereception of being watched - would have been enough to affect people's behavior.

The philosopher and social theorist Michel Foucault (1995) extended the idea of the Panopticon from an architectural design to a broader social theory – what I am calling Panopticism – which he saw as a "generalizable model" or "mechanism of power" (Foucault 1995:205) describing how states use visibility and surveillance to control their populations. States aim to make their populations visible because it makes them easier to supervise and control (Scott 1998). Unsupervised spaces of discourse and assembly can allow for hidden transcripts of resistance (Scott 1990), so states create discipline by distributing and organizing individuals in space (Foucault 1995:143). This can involve the imposition of spatial divisions like neighborhoods and districts, but it also involves the manipulation of these landscapes to enhance the visibility of certain areas. In other words, it involves the creation of Panoptic landscapes. In this sense, Panopticism functions as a disciplinary technology, used by those in power as part of a strategy of domination to preserve a hierarchical social order. Entire urban layouts can be seen as Panoptic if they elicit compliance from subjects and mold their behavior in ways that conform to social expectations (Foucault 1995; Graves and Van Keuren 2011). Leone (1995) provides examples of Panoptic city planning in his discussion of late 18th and early 19th century Baltimore and Annapolis. In Baltimore, a number of centrally domed buildings and a towering monument to George Washington were constructed during the Federal Era. These structures were forms of panoptic architecture. They were visible from nearly everywhere, gazing out over the population in all directions (Leone 1995:257–259). Similarly, in Annapolis, a towering dome was added to the Maryland statehouse in the 1780's that facilitated Panoptic surveillance (Figure 2. 3). The dome contained many windows that looked out and down onto the radiating streets of the city in a Panoptic fashion (Leone 1995:256). In both cases, these buildings appeared at a delicate time when an unequal class hierarchy was being solidified and fixed into the structure of the new federal democracy. In Leone's view, Panoptic buildings were designed to help sustain this hierarchy.

Figure 2. 3: The Maryland statehouse. Photo by fishfoot on Flickr, retrieved from https://tinyurl.com/yc7cycvt. Accessed under Creative Commons Attribution-NonCommerical 2.0 Generic license https://creativecommons.org/licenses/by-nc/2.0/

Panopticism in Non-Western/Non-Capitalist Contexts

Foucault (1995:221–222) ties the rise of Panopticism to the growth of capitalism and the enlightenment. In his view, there was a historical transformation in the 17^{th} and 18^{th} centuries that involved a gradual extension of Panoptic mechanisms of discipline in Europe. This led to the formation of a disciplinary society, where generalized surveillance became the norm. Because Foucault ties Panoptic surveillance to post-enlightenment Europe, it has been argued that

Panopticism, with its modern conceptions of subjectivity and privacy, may not be appropriate to apply to pre-modern societies (Handsman and Leone 1989). The same could be said of non-Western or non-capitalist societies. I challenge this notion by drawing on a number of studies that apply a Panopticon perspective, or a similar focus on the social impact of visibility, to non-Western and non-capitalist contexts.

Hutson (2002) discusses potential Panoptic planning at the pre-Hispanic site of Monte Albán in Oaxaca, Mexico. He cites Blanton (1978), who noted that monumental constructions (large mounds) were spaced evenly throughout the site, in a regular plan that exposed almost all residential households to at least one of them. The mounds were also constructed on naturally elevated areas, which would have been ideal for surveillance. In all, they seem to have been positioned in a way that made them highly prominent symbols of domination on the landscape (Hutson 2002:62).

Kantner and Hobgood (2016) conduct a GIS viewshed analysis of Ancient Puebloan tower kivas in New Mexico. These structures emerged in the late 11th century CE associated with monumental buildings known as great houses. Viewsheds from these towers do not support the traditional interpretation that they were observation posts built for defense or communication. Instead, they suggest that they were built to be seen from surrounding households. They argue that the towers enhanced the monumentality and visual status of great houses, helping to define them as the social and political centre of their communities. While this paper does not explicitly mention Panopticism, what they are describing is essentially an ancient version of it.

Finally, Pierce and Matisziw (2021) apply a Panopticon perspective to the Mississippian site of Cahokia, exploring how the built landscape may have been utilized to facilitate social control. They model visibility using viewsheds from the top of Monks Mound to explore potential elite surveillance of commoners. They find that lower status areas were highly visible from the high status areas atop the mound. They argue that this would have created a Panoptic gaze, causing people to self-regulate their behavior, which would have helped to maintain and naturalize social inequalities.

In all of these examples, the Panoptic gaze originates from monumental constructions. I see these ancient structures functioning in the same way as the domed buildings and monuments of Baltimore and Annapolis. They all projected middle-level messages that reinforced the social order, and they all got people to conform to this social order through Panoptic design. These examples also demonstrate that Panoptic surveillance was not limited to capitalist or Western societies. Pierce and Matisziw (2021) argue this point, saying "though the precise modalities of Bentham's Panopticon model (and Foucault's subsequent social theory) may be grounded in modern Western worldview, the effectiveness of self-surveillance based on a panoptic gaze is both aspatial and atemporal" (222). They provide many examples to support this, going back to the Old Testament where Hebrews 4:13 incentivizes proper behavior by referring to the omnipresent watchfulness of God (Pierce and Matisziw 2021:221). As another example, they discuss how Roman and Greek watchtowers were used for surveillance and to reinforce class hierarchy. They also explain how the Western Apache see the mountains as extending a perpetual oversight onto the land which remedies bad behavior (see Pierce and Matisziw 2021:221–222 for their citations and more examples).

From the discussion above, it seems clear that some kind of Panopticism may be, and may have been, operating in many contexts, including in ancient societies. To be clear, in ancient times, this was not the *exact* Panopticism described by Foucault. His specific model was grounded in Western society, and we should not arbitrarily seek to extend it back in time.

However, this does not preclude us from identifying similar Panoptic systems of surveillance in the past and using a comparative perspective to speculate about their operation, and how they may have affected behavior. This is the approach I take in this thesis. I apply a Panopticon perspective to the ancient city of Angamuco in the Lake Pátzcuaro Basin of Mexico. I investigate whether Panoptic surveillance may have been utilized in this study area as a mechanism of power which contributed to processes of social control and state integration. Again, this is not the exact Panopticism described by Foucault. It is something similar, operating with the same underlying principles.

I should also note that a Panopticon perspective can make it seem like power and domination are absolute and all-encompassing. After all, Foucault's theory did not exactly address the potential of resistance. Previously, I mentioned that middle-level messages were not necessarily internalized as unquestioned truth by passive subjects. I believe this is also true for the Panoptic gaze. While the constant threat of surveillance may have coerced many people into appropriate behavior, this was certainly not the case for everyone. People could choose to act differently. They could choose to resist, contest, negotiate, and demystify elite ideologies in many outright or subtle ways (Giddens 1979; Hutson 2002; Scott 1985, 1990). Hidden transcripts of resistance could underly masks of compliance. These could include actions like speaking with double meanings, creating fantasy spaces in myth and legend, footdragging, and sabotage (de Certeau 2011; Scott 1985, 1990). Instead of seeing monumental constructions as projections of elite ideology, Hutson (2002:66) mentions how commoners might instead have celebrated them as products of their own labor, or the labor of their ancestors. In other words, the messages projected by monumental constructions may have been interpreted in varying ways. Even if monumental structures did successfully project middle-level messages and a Panoptic gaze, Hutson (2002:66-68) gives an example of how commoners may have counteracted this. At Monte Albán, during a time of rising inequality and elite domination, the domestic architecture shifted to private, enclosed, inward looking structures. Hutson sees this shift as evidence of commoners purposely taking large monuments out of view – physically averting the effectiveness of Panoptic surveillance. In general, focusing on domination and resistance tends to simplify and dichotomize the nuanced reality of politics and power relations (Brown 1996; Hutson 2002; Ortner 1995). This thesis, however, does not focus on the nuanced activities of commoners but rather broad strategies of social control and the intentionality of elites. While this may emphasize a top down perspective of domination, I am not dismissing the possibility of resistance and other forms of agency on the part of commoners. I want to acknowledge, but not focus on, this side of the story. In this thesis, when I talk about Panoptic surveillance and the projection of middle-level meaning, I am stating an ideal case. These were not all-encompassing processes that affected everyone in the same way. The reality was more complex, but I cannot address these details here.

Chapter Summary

I started this chapter by drawing on Rapoport (1990) and explaining how the built environment has associational aspects that communicate meaning. As archaeologists, when examining the ancient built environment, we try and decode these meanings to understand how the built environment shaped the social life of its inhabitants. According to Rapoport (1990), there are different levels of meaning communicated by the built environment. Most relevant to this thesis are middle-level meanings, which relate to power and status, and low-level meanings, which direct behavior. I argued that in ancient contexts, monumental constructions communicated middle-level messages about the power and status of rulers and the elite. They did this in part through their height and visibility. These messages reinforced the social hierarchy and naturalized ideological control. I also argued that monumental constructions communicated low-level meaning through Panoptic design in a Foucauldian sense (Foucault 1995). Just like the domed buildings and monuments in Baltimore and Annapolis, monumental constructions were positioned on the landscape in a way that maximized their visibility. This created a sense of perpetual surveillance for commoners even if nobody was physically watching them. This threat of constant surveillance acted as a disciplinary mechanism that could lead people to conform their behavior to acceptable standards. I suggested that by communicating middle-level messages and facilitating Panoptic surveillance, monumental constructions were able to both reinforce the social order and coerce people into sustaining the social order. Together, these processes operated as a strategy of social control and domination for ancient rulers, although resistance and alternative actions were certainly possible.

In this thesis, I will apply these theoretical concepts to the ancient city of Angamuco, located in the Lake Pátzcuaro Basin of Mexico. From the Middle to Late Postclassic period (1100 - 1525 CE), this area was under the dominion of the Purépecha Empire, which makes it an appropriate case for investigating processes of social control and state integration, especially relating to the built environment and visibility. Before doing this however, it is important to provide necessary background information about the Lake Pátzcuaro Basin, Angamuco, and the Purépecha Empire. This will be covered in the next chapter.

CHAPTER 3: THE LAKE PÁTZCUARO BASIN AND THE CITY OF ANGAMUCO

Geographic Context

The Lake Pátzcuaro Basin is a small closed intermontane basin in the volcanic highlands of the Central Mexican Altiplano. Located in the modern Mexican province of Michoacán (Figure 3. 1), the lake basin covers an area of around 928 Km^2 with elevations ranging from around 2033 to 3000 m above sea level (asl) (Fisher et al. 2003). The basin is believed to have been formed by volcanic activity, specifically lava flows that dammed drainages of the Río Lerma during the Pleistocene (Bradbury 2000). The region is characterized as humid temperate with rainy summers and dry winters. Average temperature varies between 12°C and 18°C, and rainfall averages 900 – 1250 mm per year (Pollard 1993). The lake itself is eutrophic to hypereutrophic with an average depth of 4.6 m (O'Hara et al. 1993). It also has no significant surface inflow or outflow and seems to be largely maintained by groundwater and rainy season runoff. While it's water level and salinity have fluctuated over time, the lake has never been dry throughout the Holocene, thus its deposits preserve a valuable and well documented sedimentary record of past lake changes, climate, and human occupation (Bradbury 2000). The area surrounding the lake is characterized by sloping volcanic cones and lava flows of predominantly basaltic composition (Figure 3. 2). The natural vegetation consists mainly of pine-oak woodland on the lower slopes and fir forest with some pine on the upper slopes above 2250 m asl (Street-Perrott et al. 1989; Watts and Bradbury 1982). Pollard (1993:63-73) divides the LPB into six environmental zones that would have been present during the mid 16th century. In order of increasing elevation these are: open water, tule-reed marsh, lakeshore, lower Sierra slopes (pine-oak forest), upper Sierra slopes (pine-oak forest), and the alpine (fir forest). The lower slopes of

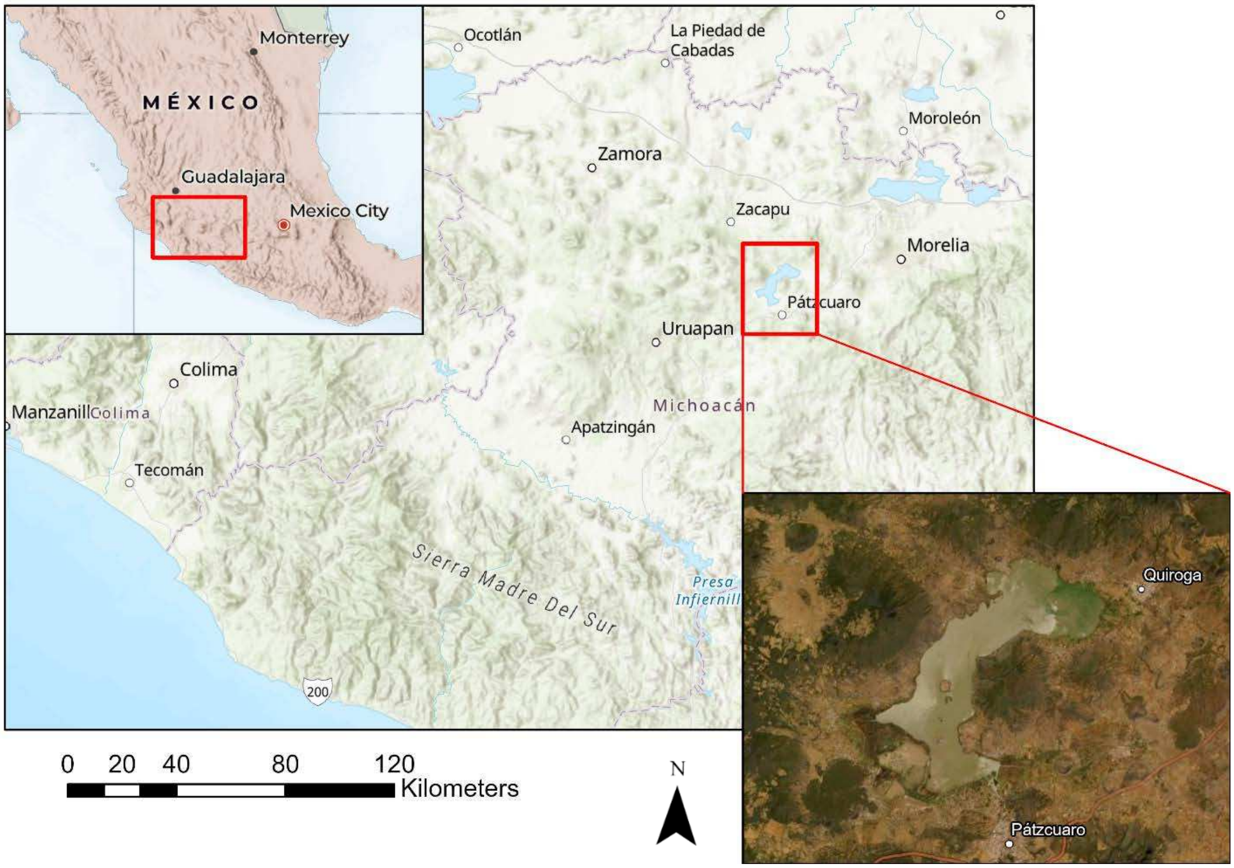

Figure 3. 1: Location of the Lake Pátzcuaro Basin in Mexico

the basin are characterized by dark reddish-brown clayey soils known as *charanda* or 'red-earth'. These are formed from the weathering of volcanic rock and they are highly susceptible to erosion when cultivated (Pollard 1993; Street-Perrott et al. 1989). The basin also contains yellow-brown humic andosols on the upper slopes, and *t'upuri* or 'yellow-earth' soils, the latter of which are the most productive due to their moisture retention properties (Pollard 1993).

Figure 3. 2: Aerial view of the Lake Pátzcuaro Basin (© 2009 LORE-LPB Project)

Pre-Hispanic Occupation

Our knowledge of the pre-Hispanic occupation of the LPB comes mainly from two sources: archaeological investigations and ethnohistoric documents. The primary ethnohistoric document is the *Relación de Michoacán* (RM) (Alcalá 2000). This invaluable document is believed to have been written between 1540 and 1541 by Fray Jerónimo de Alcalá, a Franciscan priest who lived in Michoacán for several years translating and recording the official narratives of the Purépecha. The document was only written about twenty years after the arrival of the Spanish in Michoacán. The RM contains three parts: the first, which is mostly lost, discusses the state religion. The second part is an official history of the Purépecha Empire from its founding to the Spanish conquest, and the third part discusses aspects of Purépecha society such as governorship, marriage customs, and death practices. The RM also contains 44 illustrations that depict pre-Hispanic Purépecha life. While the RM has been an integral resource in the study of the Purépecha Empire, its accuracy and authenticity have been questioned. The second part of the text is a transcription of a speech that was given by the chief priest every year at a monthly festival. In this speech, the priest would relate the origin story, or official history, of the Empire (Haskell 2008a). According to this narrative, there were migrations of semi-nomadic “Chichimec” populations into the LPB sometime during the Middle Postclassic (see Table 3. 1). These populations split into factions, and one of these – the *uacúsecha* (eagle) lineage – came to dominate the region, defeating several other chiefdoms under the leadership of the culture hero Tariacuri. The nephews and descendants of Tariacuri then expanded their territory and established the Purépecha Empire in Western Mexico (Alcalá 2000; Haskell 2008a).

This narrative should not be taken as a literal representation of past events as it was likely meant to justify and legitimate the rule of the royal dynasty. It should be seen as a selective representation of historical events, probably infused with some mythology. In this sense, the testimony of the indigenous narrators should certainly be seen as biased (Haskell 2008a). We have developed a better understanding of the occupational history of the LPB and the formation of the Purépecha Empire through less-than literal readings of the RM, integrated with archaeological evidence from several research programs. These include archaeological projects carried out in the LPB (Fisher et al. 2003; Fisher and Leisz 2013; Pollard 2008; Pollard and Cahue 1999), as well as by the Centre d´Etudes Mexicaines et Centraméricaines (CEMCA) in the nearby Zacapu Basin (Michelet 1998; Michelet et al. 2005), and salvage programs carried out by the Mexican Instituto Nacional de Antropologíae Historia (INAH) in the region. This archaeological research has also been supplemented by other colonial documents such as the *Relaciones Geográficas* of 1579-1580, the Caravajal Visitation of 1523-1524, and the early encomienda grants of 1523-1525 (see Pollard 1993:18 for citations of these documents).

Table 3. 1: Chronology of general pre-Hispanic periods across Mesoamerica and corresponding local phases in the LBP.

Period	**Local Phases**
Late Postclassic	Tariacuri (1350 – 1525 CE)
Middle Postclassic	Late Urichu (1000/1100 – 1350 CE)
Early Postclassic	Early Urichu (900 – 1000/1100 CE)
Epiclassic	Lupe-La Joya (600/700 – 900 CE)
Middle Classic	Jarácuaro (550 – 600/700 CE)
Early Classic	Loma Alta 3 (350 – 550 CE)
Late/Terminal Preclassic	Loma Alta 1 & 2 (150 BCE – 350 CE)
Middle Preclassic	Chupicuaro (≥500 – 150 BCE)

The earliest potential evidence of human occupation in the LPB comes from a sediment core extracted from Lake Pátzcuaro. Watts and Bradbury (1982) analyzed the core and noted a significant decrease in Alder pollen around 5000 cal B.P. Reanalysis of the same core in (Bradbury 2000) reaffirmed the decline. They suggested that this could indicate the clearing of Alder trees, potentially for agricultural purposes. However, they also noted that the decline could have been caused by abnormally dry climate. The earliest evidence of maize agriculture in the LPB comes from Zea pollen found in the same core dating to 3500 B.P (1550 BCE), which falls into the Early Middle Preclassic period (Bradbury 2000; Watts and Bradbury 1982). The appearance of Zea was accompanied by an influx of iron rich red clay and a rich aquatic flora, suggesting that the introduction of agriculture resulted in a phase of soil erosion. They speculated that once pine forests were burned to make room for agriculture, eroded soil surface material would have moved downslope and accumulated on the lakebed, causing lake eutrophication (Bradbury 2000; Street-Perrott et al. 1989; Watts and Bradbury 1982). The presence of this pollen suggests that the region was probably inhabited by sedentary or semi-sedentary farmers, although no archaeological evidence has been found in the LPB to confirm this. Pollard (2008) believes this population was culturally part of the Chupícuaro tradition, whose sites have been found in the Bajío region and the Cuitzeo Basin. They are best known from the site of Chupícuaro in Guanajuato (Darras et al. 1999; Porter Weaver 1969), where 400 burials were excavated from a cemetery (Beekman 2010:60). Although no Chupícuaro sites have been found in the LPB, their material culture seems to indicate continuity with later Purépecha inhabitants.

The Late Preclassic and Early Classic periods correspond to a new local phase called Loma Alta (150 BCE – 550 CE). Loma Alta material culture has been found in the Pátzcuaro Basin, the Zacapu Basin, Morelia, the Cuitzeo Basin, and other areas of central and northern Michoacán (Pollard 2008). In the LBP, Loma Alta materials have been identified at the sites of Erongarícuaro (Pollard 2005a, 2005b; Pollard and Haskell 2006), Urichu, and possibly at Tzintzuntzan (Cohen 2016:43; Pollard 2008). The Loma Alta type site is located in the Zacapu Basin, where researchers have found an architectural complex with a sunken plaza, a central platform and altar, distinctive burial practices, and evidence of long distance trade (Arnauld et al. 1993; Carot 2001; Carot and Fauvet Berthelot 1996; Pollard 2008). Pollard (2008) sees this as indicative of the emergence of social ranking in small scale agrarian societies. The documentation of Loma Alta in many parts of Michoacán suggests this was a period of transition between the earlier Chupícuaro societies and the later societies of the Late Classic and Postclassic (Pollard 2008). There is also evidence that Loma Alta societies had connections to Teotihuacan. This is seen from Teotihuacan style ceramics in Michoacán that may have been imported or emulated, and the presence of Loma Alta phase artifacts identified at Teotihuacan (Beekman 2010:66).

The Middle Classic and Epiclassic periods correspond to the local Jarácuaro and Lupe phases, respectively (550/600 CE – 900 CE). In general, this was a period of great change across Western Mexico (Beekman 2010). In the LPB and surrounding areas, this time span is defined by increasing populations, increased number of settlements, and the emergence of ranked polities with local elites engaged in macroregional exchange systems that imported luxury goods. From 500 – 700 CE, local elites throughout central Michoacán shared a heritage from the earlier Chupícuaro and Loma Alta societies. This is reflected in the dominance of primary extended burials (Pollard 2008). By the Epiclassic there was a dramatic shift as elites started to be buried in group tombs with imported prestige goods from all over Mesoamerica (Pollard and Cahue 1999). There is also evidence of soil erosion around settlements in the southwestern area of the LPB. This seems to be indicative of land degradation which was subsequently managed and repaired using strategies like terracing (Fisher et al. 2003). During the Epiclassic, the Zacapu Basin experienced a significant increase in population and settlements including the appearance of multiple sites with plazas and ballcourts (Cohen 2016; Pereira 1999). Around this time, we also see the appearance of ceremonial centers throughout Michoacán at places like El Otero, Tres Cerritos, and Tingambato (Pollard 1993). These centers show a continued influence from Teotihuacan in their artifacts and architecture. They variably contain *talud-tablero* architecture, plazas, pyramids, large group tombs, and ballcourts (Oliveros 1975; Piña Chan and Oí 1982; Pollard 1993:7–10). All of this suggests increased processes of social differentiation and the emergence of territorially discrete and competing polities throughout the region (Pollard 1993).

The Early to Middle Postclassic corresponds to the local Urichu phase (900 – 1350 CE). In the LPB we again see the number of sites and area of occupation increase (Pollard 2008), with new settlements being located on islands and lacustrine soils that were exposed due to a major lake regression (Fisher et al. 2003). Geoarchaeological research in the LPB indicates that lake levels were at their lowest since the first human occupation of the basin and soil erosion was low and centered around settlements (Fisher et al. 2003; Pollard 2008). During the Late Urichu phase (the Middle Postclassic, 1100 – 1350 CE) there was an expansion of settlements onto defensible upland zones like the rough and barren landforms derived from ancient lava flows, locally known as *malpaís* (bad land). This was probably caused by population pressure and competition for resources (Cohen 2016:47; Pollard 2008). Similar developments occurred in the nearby Zacapu Basin, where a great increase in the number of upland *malpaís* sites is documented (Michelet 1998; Michelet et al. 2005; Pollard 1993:13). By 1200 CE, the Zacapu *malpaís* is believed to have contained up to 20,000 people living in 13 sites, covering around 5 km^2 (Migeon 1998). Sunken patio architecture also disappeared and was replaced by densely packed square rooms with porticos (Pollard 2008). According to Pollard (2008:224), during this period, the Purépecha cultural heartland really emerged, composed of several competing chiefly/small state societies with patterns of leadership and control in flux. The RM claims that during the Middle Postclassic, there were a series of migrations of non-Purépecha populations into central Michoacán, including the ancestors of the royal Tarascan lineage, the *uacúsecha* (Alcalá 2000; Pollard 1993:13). These migrations are not specifically visible in the archaeological record, although recently it has been theorized that the movement of settlements onto the Zacapu *malpaís* may represent a migration of new populations into the area (Cohen 2016:68; Jadot 2016). This could potentially correspond to the RM narrative which tells of outside populations moving into the Zacapu area during the Middle Postclassic, then leaving to go settle in the Pátzcuaro Basin where they helped establish the Purépecha Empire. There may be some merit to this theory, especially since the Zacapu *malpaís* sites were indeed abandoned, although more archaeological research is necessary to determine how much of this origin story is myth vs history (Cohen 2016:68). In any case, the Middle Postclassic is apparently when the Purépecha state formed. The legendary history attributes this to the warrior leader Tariacuri (one of the *uacúsecha* elite) who united the independent polities of the LPB in the first half of the fourteenth century after a series of wars between local elites over resources. Tariacuri's descendants then apparently expanded the state beyond the borders of the LPB (Alcalá 2000; Pollard 1993).

During the Late Postclassic Tariacuri phase (1350 – 1525 CE) lake levels in the LPB rose significantly, with low lying areas being flooded and occupation being restricted to locations above 2040 m asl (Fisher et al. 2003; Metcalfe et al. 2007; O'Hara et al. 1993). Survey data suggests that population density in the LPB reached its highest level during this period, while soil erosion remained low due to large scale landscape modifications such as terracing (Fisher et al. 2003; Gorenstein and Pollard 1983; Pollard 2008). During this period, the Purépecha state greatly expanded its borders beyond its geopolitical core in the LPB, setting up a centralized tributary network that funneled resources into the lake basin. According to the RM, this was done through conquest, tribute collection, political marriages, aggressive acculturation, and other methods (Alcalá 2000; Pollard 1993). This top-down narrative of political integration is questioned by Cohen (2016), who analyzes ceramics from the city of Angamuco and argues for a more bottom-up process of imperial incorporation that involved the imperial elite negotiating with existing leaders through processes of consolidation.

Pollard (2008) bases her model for the emergence of the Purépecha state on the archaeological evidence and the narrative in the RM. She argues that with the reduction of resources due to the lake transgression, competition between existing polities would have grown fierce, and new economic mechanisms were required to support local populations in the LPB (Pollard 2008:225). The import and export of goods and services may have undergone a reorganization that involved an increase in the scale of production and the possible restriction of the control of technology, raw materials, and goods by a group of core elites who would become the royal dynasty (Pollard 2008:225). In this view, the existing polities in the LPB were unified in a top-down fashion under a centralizing authority. She argues that this may have occurred as a "perfect storm", in which the polities of the LPB were driven to conditions of *emergence*, leading to the formation of a complex system during the Middle Postclassic (Pollard 2008:227).

By the late 15th century, the Purépecha Empire had reached its maximum extent, covering over 75,000 km^2 from the Lerma River in the north to the Balsas River in the south (Figure 3. 3). During this time, the Purépecha fought a number of wars against the neighboring Aztec Empire which essentially resulted in a stalemate and a heavily fortified eastern border (Pollard 1993). When the Spanish arrived in the region in the early 16th century, the Purépecha refused to help their Aztec enemies fend off the Europeans. After the fall of Tenochtitlan, the Spanish general Crostóbal de Olid led an expeditionary force to the Purépecha capital, arriving in 1522. Because of political instability, the Purépecha were not able to mount a proper defense, and their king Tangáxuan II submitted to the Spanish without a fight. However, while Cortés believed that the empire had been conquered, the Purépecha king continued to rule in Tzintzuntzan and continued to receive tribute. This lasted until 1530, when the conquistador Nuño de Guzmán had the king executed, and Michoacán was incorporated into the Viceroyalty of New Spain (Cohen 2016; Pollard 1993; Warren 1985).

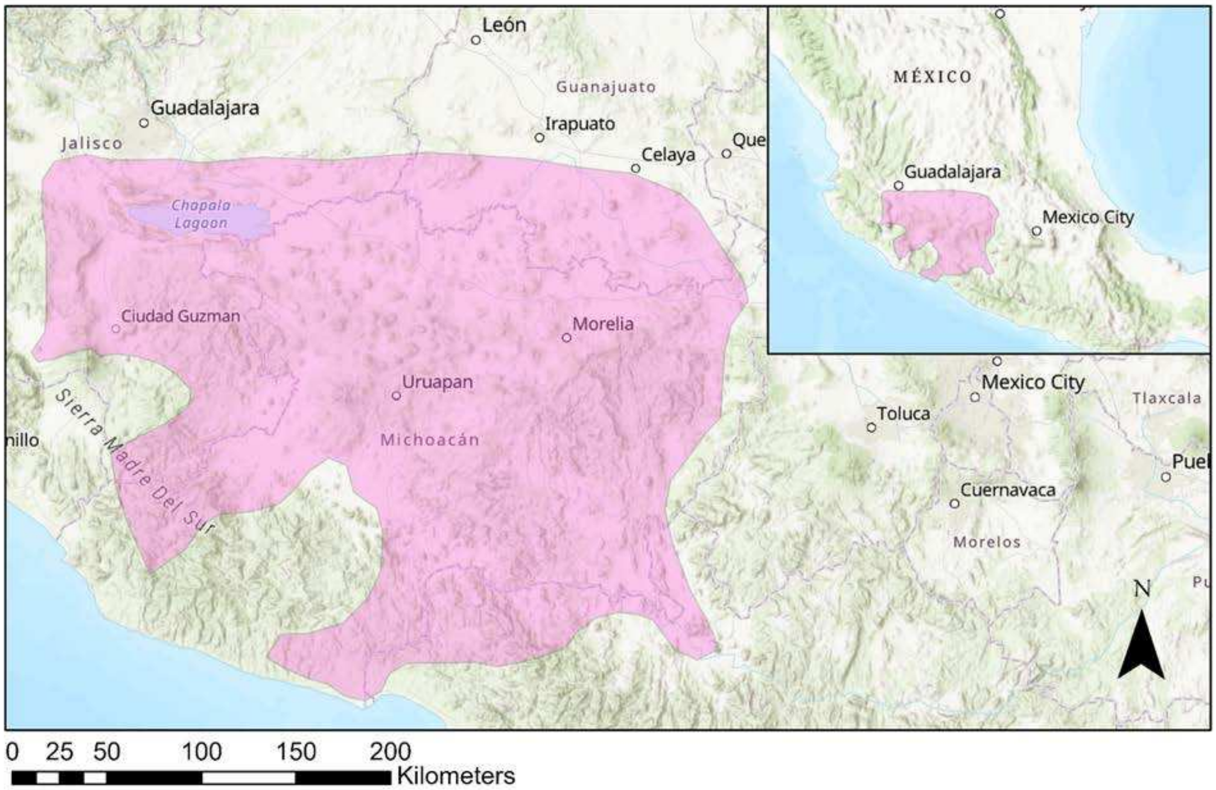

Figure 3. 3: Map showing the approximate extent of the Purépecha Empire at its height in the early 16th century. Adapted from (Pollard 1993).

The LPB During the Late Postclassic Empire

The specifics of how the empire formed, including the mechanisms that Purépecha rulers used to subjugate and integrate existing communities, are still debatable and not fully understood. In any case, during the Late Postclassic we see widespread evidence of the Purépecha Empire. This is apparent in the construction of keyhole shaped *yácata* pyramids (Figure 3. 4) and other standardized architectural forms like plazas and altars (see Fisher et al.

2019). We also see the appearance of a common elite material culture consisting of artifacts like polychrome globular tripod bowls, spouted polychrome vessels, metal rattles, ear and lip plugs,

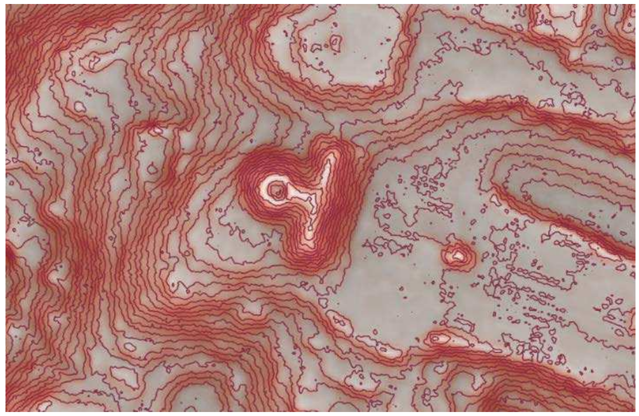

Figure 3. 4: (Top) Traditional keyhole shaped yácata pyramid at Angamuco, shown from above in pseudo Red Relief imagery with 40 cm contours. (Bottom) yácata pyramid as seen from the ground (© 2009 LORE-LPB Project)

and pipes (Cohen 2016:256; Pollard 1993). These artifacts were exported throughout the empire and consumed by regional elites which helped to forge a common Purépecha identity synonymous with imperial rule.

This kind of imperial material culture appears at centers throughout the LPB during the Late Postclassic. At the imperial capital of Tzintzuntzan, five *yácata* pyramids dedicated to the sun god Curicaueri were constructed on a large platform overlooking the lake (Figure 3. 5).

Excavations carried out at the base of these pyramids uncovered artifacts associated with the Late Postclassic empire (Cohen 2016:50; Pollard 2003). Other sites in the LPB such as Urichu,

Figure 3. 5: Aerial photo of the 5 yácatas of Tzintzuntzan (© 2009 LORE-LPB Project)

Erongarícuaro, and Ihuatzio also contain imperial artifacts and architecture suggesting the incorporation of pre-existing independent polities into the empire. Whether this process was more top-down or bottom-up is still debatable as already mentioned. At Urichu, pyramid-plaza complexes have been documented, and elite burials dating to the Late Postclassic have been excavated. This has revealed elite artifacts characteristic of the Purépecha Empire such as polychrome ceramic vessels, decorated pipes, copper/bronze tools and ornaments, spindle whorls, and lip plugs (Pollard and Cahue 1999). About 2 km north, survey and excavation were also carried out at Erongarícuaro, revealing cultural deposits dating to the Taríacuri phase in the northern section of the site. These deposits contained copper bells, ceramic pipes, finely decorated ceramics, and spindle whorls, all of which indicate occupation by imperial elites (Haskell 2008b). At Ihuatzio, a walled ceremonial zone contains two large rectangular pyramid platforms, a long plaza, and three *yácata* pyramids (Pollard 2003:371).

Socially, the creation of the empire led to the greatest inequalities of the pre-Hispanic era. There was a sharp division between the nobility and commoners, with the nobility being further categorized into the royal dynasty, the upper nobility, and the lower nobility (Pollard 2008). Local elites from previously autonomous centers were unified into a new stratified upper social class. Their identity was no longer based so heavily on the import of foreign prestige goods, but rather on locally produced goods distinctive of the Purépecha Empire (Pollard 2008:225). This transition in elite material identity has been documented in the elite burials at the site of Urichu (Pollard and Cahue 1999). This upper social class – the royalty and the nobility – acted as the political and administrative leadership of the state. They secondarily functioned as priests and religious leaders, performing important ceremonies and rituals (Pollard 1993). The creation of the Purépecha state also saw the establishment of a new ideology that made the Pátzcuaro Basin the center of cosmic power. This ideology reinforced the power and legitimacy of the upper class, tying it to their personal relationship with the god Curicaueri, and justifying it through an official creation myth (the narrative in the RM) and state cults (Pollard 1993). This new ideology went hand in hand with the creation of a state religion where the patron gods of the dominant elite were elevated to celestial power, while the many patron deities of formerly autonomous communities were incorporated in elevated or marginalized ways. For example, the ethnic Purépecha goddess Xarátanga was joined to the *uacúsecha* god Curicaueri, reinventing them as husband and wife. Similarly, patron deities of other communities were incorporated into the state religion as the four brothers of Curicaueri (Pollard 1993:134–135). The elevation of Curicaueri as patron god of the state is reflected in the construction of the *yácata* pyramids at major religious centers (Pollard 2008).

Pollard (1980, 1993, 2003) believes that during the time of empire, the settlements in the LPB were organized into a centralized hierarchical system, with administrative centers overseeing dependent communities. This settlement model is largely based on descriptions in the RM. According to her, there were 91 settlements in the LPB during this time (Pollard 1993:77). She sees Tzintzuntzan, the imperial capital, as the main administrative center and the only true urban settlement. In her view, it functioned as an important central place and the head of a pyramidal tribute network whereby smaller settlements passed goods and services on to larger settlements. According to Pollard (1993:82), these administrative centers would have divided the basin into discrete administrative units. Much of the evidence for this comes from the Caravajal Visitation of 1523-1524, and the first Encomienda Grants of 1523-1525, which describe pre-Hispanic tribute networks (Warren 1977, 1985).

Pollard's view of the Purépecha state and her model for its development have been highly influential, yet they have limitations due to their heavy reliance on the RM. As mentioned previously, the RM establishes a biased narrative that focuses on the royal dynasty and the centers of settlement that were important to their story, like Tzintzuntzan. Archaeological research by Pollard and others has been limited to a handful of sites in the LPB that were mentioned in the RM, with little attention paid to sites that fall outside the narrative. Archaeological research at other sites has also been hindered by the fact that most are located underneath modern settlements. This has led scholars like Pollard to the potentially erroneous conclusion that Purépecha urbanism was a direct result of the unification of the empire, and that Tzintzuntzan was the only true urban center (Urquhart 2015). However, new discoveries have complicated our understanding of urbanism and imperial consolidation in the LPB. Recently, a new settlement was discovered in the lake basin, which has been called Angamuco. This ancient city was occupied from at least the Classic to the Late Postclassic (350 – 1525 CE), meaning it was occupied before, during, and after the consolidation of the Purépecha state. Importantly, it demonstrates that large urban centers existed in the LPB before the formation of the empire, which makes it invaluable for studying processes of urban development and imperial incorporation (Fisher, Bush, et al. 2011; Fisher et al. 2012, 2014, 2016, 2017; Fisher and Leisz 2013). In the next section I will discuss the city of Angamuco in more depth.

The Ancient City of Angamuco

Geographical Context and Ethnohistoric References

Angamuco is located in the eastern area of the LPB, approximately 9 km from the city of Tzintzuntzan and 13 km from Pátzcuaro (Figure 3. 6). The site occupies two major lava flows, a *malpaís* which probably formed during the Early to Middle Holocene (Neuendorf et al. 2011), although recent research suggests it may have been as early as the Late Pleistocene (Ramírez Uribe 2017). The rugged topography and forest canopy limit modern land use, resulting in well preserved architectural remains such as house foundations, pyramids, terraces, and platforms (Fisher and Leisz 2013). Nearly the entire *malpaís* has been modified by people. This is reflected in the widespread presence of anthrosols, or soils modified by human activity. The upper areas of the site are dominated by yellow *t'upuri* mountain soils, which are moisture retentive and productive for agriculture. Red clay *charanda* soils, formed from the weathering of volcanic rock, are common in the lower areas of the site. The *malpaís* is covered by brush and scrubs, with lakeshore vegetation dominant in lower areas, and pine, oak, and some fir woodland prevalent on upper slopes (Gorenstein and Pollard 1983; West 1948). In the Late Postclassic, when Lake Pátzcuaro was at its highest, the settlement would have been as close as 2.5 km from

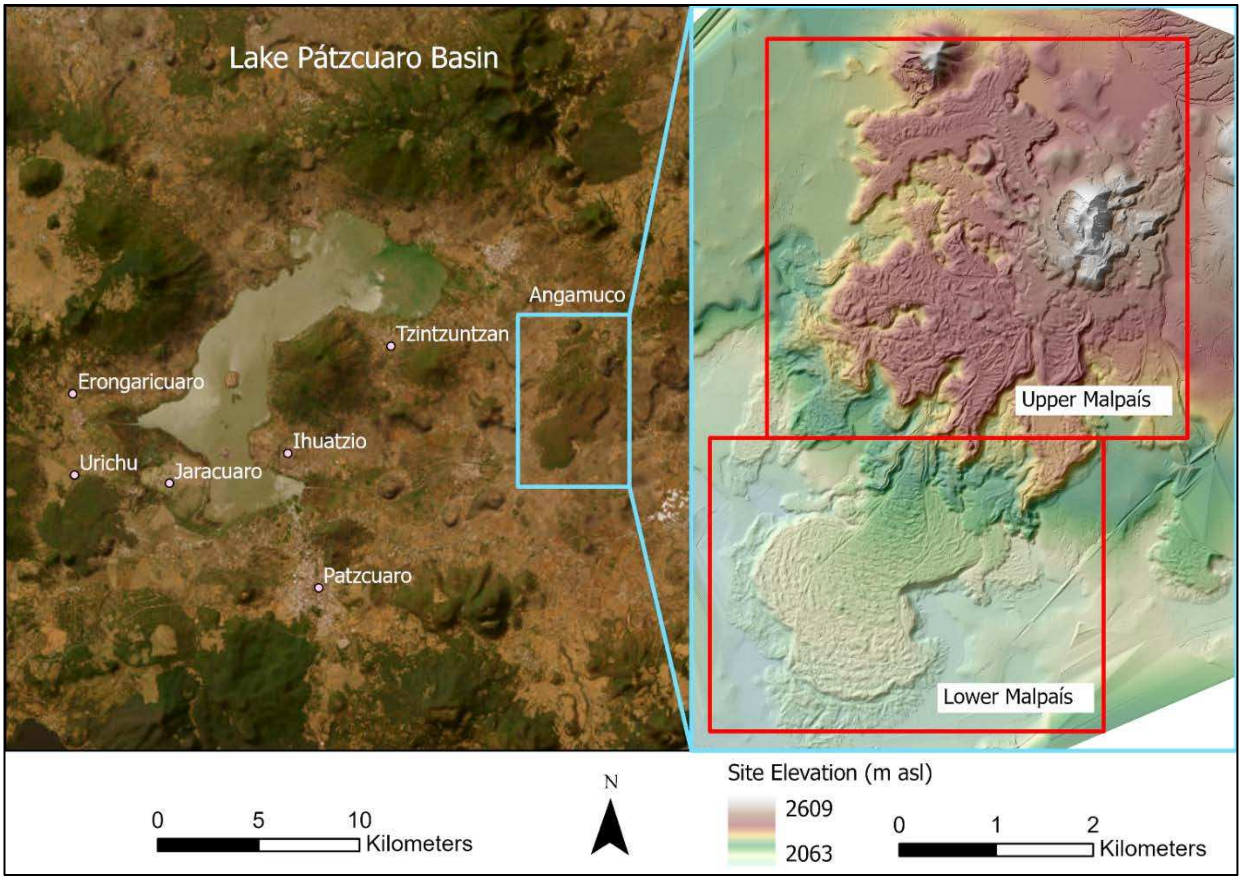

Figure 3. 6: (left) location of the Angamuco malpaís in the LPB in relation to other major pre-Hispanic settlements. (right) close up of the site, showing the division of the upper and lower malpaís, as well as elevation (meters above sea level) draped over a multidirectional hillshade.

the water. Today, it is at least 8 km from the shore.

The name Sacapu Angamuco (shortened to Angamuco) was selected for the site based on ethnohistoric references. A colonial settlement with this name appears in roughly the correct location on the maps of Pablo Beaumont (1932[c. 1740s]), although 'Angamuco' was probably not the actual name of the pre-Hispanic settlement. The RM mentions two settlements in this area of the lake basin – Corínguaro and Itziparamucu – the latter of which was supposedly located on the *malpaís* (Alcalá 2000; Urquhart 2015). It is possible that Angamuco is in fact one of these polities, although it might be something completely different.

Archaeological Research at Angamuco

Angamuco was first discovered in 2007 while surveying in the eastern portion of the LPB as part of the *Legacies of Resilience: The Lake Pátzcuaro Basin Archaeological Project* (LORE-LPB), directed by Chris Fisher. Architectural remains were discovered on a *malpaís* landform, but their extent was unknown. Over the course of 2009 and 2010, the LORE-LPB team conducted two field seasons of full coverage pedestrian survey to better understand the extent, layout, and age of the structures on the lower *malpaís* (Fisher et al. 2009; Fisher, Bush, et al. 2011). Using traditional survey methods and sub-meter GPS receivers, team members were able to map and categorize over 2,500 architectural and landscape features in an area just over 2 km^2 (Figure 3. 7). While this was an impressive accomplishment, due to the rugged topography, dense vegetation, and dense coverage of archaeological features, the team estimated that it would take at least a decade to map the known area of the settlement with intensive methods (Fisher, Bush, et al. 2011; Fisher, Leisz, et al. 2011; Fisher and Leisz 2013). To aid future fieldwork efforts and better understand the full extent of the site, high resolution LiDAR data was collected over an area of 9 km^2 by Merrick and Company in 2010. An additional LiDAR flight was also conducted in 2015, resulting in total coverage of over 35 km^2. The LiDAR point clouds were processed to create a digital elevation model (DEM) at a resolution of 25 cm which revealed minimally 40,000 buildings and landscape features covering the entire extent of the *malpaís* – an area of around 26 km^2 (Fisher et al. 2017; Fisher, Leisz, et al. 2011; Fisher and Leisz 2013). In 2011, another survey was conducted to field verify the initial LiDAR results. This time, LiDAR derived products such as hillshades and high resolution digital elevation models (DEMs) were used in real time by field crews, which allowed them to double the area covered and number of archaeological features documented (Fisher et al. 2012; Fisher and Leisz 2013). Overall, the three years of survey documented over 7,900 architectural features covering an area of 3.5 km^2, mainly in the western and southern portions of the site (Fisher et al. 2016, 2017) (see Figure 3. 7)

Due to the prevalence of distinct, standardized, and recurrent architectural forms at the site, an extensive architectural typology was created (see Fisher et al. 2019). Features are initially categorized as above ground; ground level; prepared open zone; or landscape feature. This is followed by a number of sub-classifications including different kinds of platforms, mounds, room foundations, plazas, terraces, and roadways (Fisher, Bush, et al. 2011; Fisher et al. 2019). Two different pyramid forms were identified at Angamuco – rectilinear pyramids, and the semi-circular *yácata*, both of which mainly occur on the lower *malpaís*. The rectilinear pyramids are the more common type, occurring in a range of sizes and configurations (Figure 3. 8). They are believed to be temporally earlier than the *yácatas*, probably being constructed in the Middle Postclassic. The *yácata* pyramids are distinctive of the Purépecha Empire, dating to the Middle-Late Postclassic (Acosta 1939; Fisher et al. 2019; Rubín de la Borbolla 1941) (see Figure 3. 4). Structural variations of the traditional *yácata* form, termed "pseudo" or "proto-*yácatas*", have also been documented at the site. Both kinds of pyramids are believed to have been topped by perishable structures, possibly made out of wood and thatch. An I-shaped ballcourt has also been identified at Angamuco. This probably dates to the time of empire, although earlier construction is also possible (Fisher et al. 2019).

While it is not defined in the architectural typology, Chris Fisher has alluded to the presence of a specific kind of architectural form - the elite complex/residence - at Angamuco

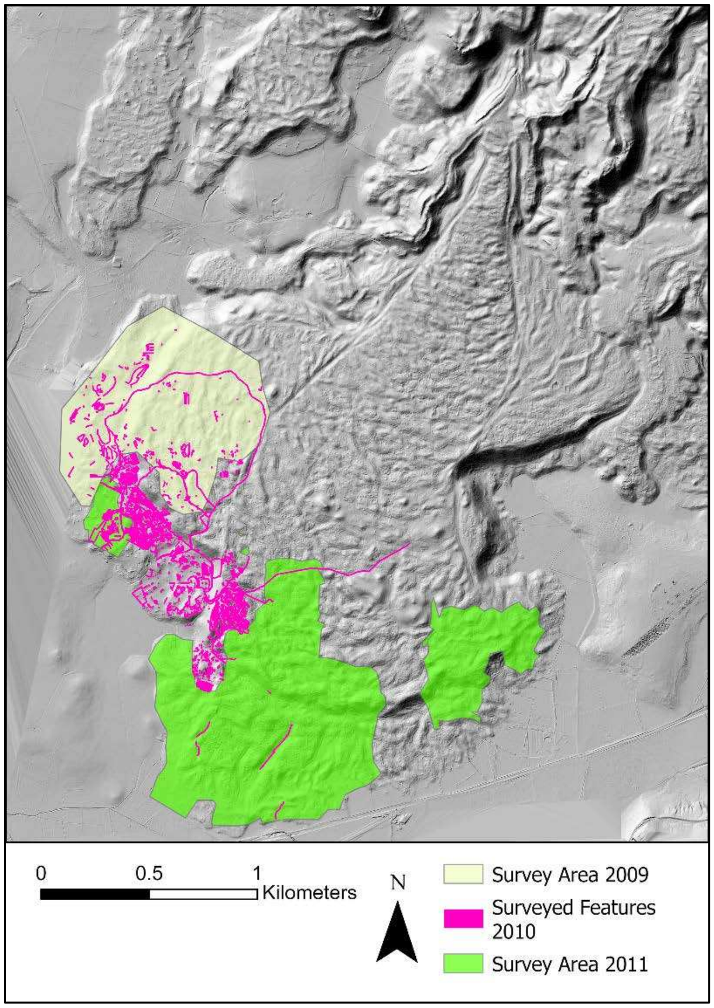

Figure 3. 7: Areas surveyed at Angamuco in 2009 and 2011 with survey features shown for 2010, displayed over a shaded relief.

(Chris Fisher, personal communication 2022). These complexes were often walled, made up of one or multiple buildings, and located near monumental architecture. These complexes may have functioned in a similar manner to the Aztec *tecpan*. In Aztec villages, the tecpan, meaning “lord place” in Nahua, was the residence of the local administrator or headman (Evans 1991). The tecpan was the center of village political authority, being described as the chief’s office, the lord’s residence, the government house, and a meeting place (Evans 1991:65). It seems to have

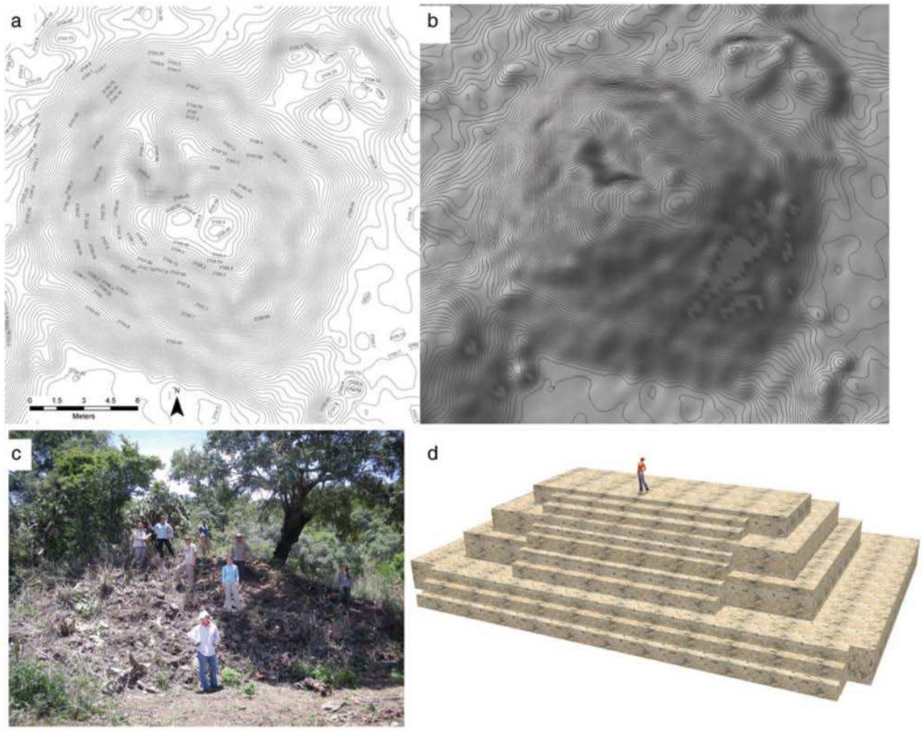

Figure 3. 8: Example of a large rectilinear pyramid at Angamuco. a) plan view with 5 cm contours, b) contours overlaid over a hillshade, c) field photo of the pyramid, d) reconstruction based on mapping. Taken from (Fisher et al. 2019:519) with permission.

housed the nobility/elites of the settlement, combining residential and political-administrative functions. Evans (1991) excavated a large structure in the Aztec village of Cihuatecpan which she believes was a tecpan. This building was four times larger than the other houses near it and was quite affluent in construction and decoration (see Evans 1991:89 for a depiction of what the structure would have looked like). Smith (1992), excavated a similar structure at the Aztec town of Cuexcomate, which he interpreted as an elite residential compound. This compound contained houses that were larger than commoner dwellings made with superior materials, construction methods, and decoration (Smith 1992). I believe Purépecha elite complexes would have been similar to these Aztec structures, containing larger more elaborate buildings that served as residential and political-administrative centers for the local elites.

In 2013 – 2014, excavations were conducted at seven areas of Angamuco. In total, 88 units were documented, representing private and public, as well as elite, commoner, and multi-purpose contexts (Fisher et al. 2014, 2016). Four excavation areas (A, B, C, D) were located on the lower *malpaís*, and three (E, F, G) were located in upper areas (Figure 3. 9). According to Cohen (2016), area A was an elite domestic space dating primarily to the Late Postclassic; area B was a multipurpose building dating primarily to the Late Postclassic; and areas C and D (located next to a large *yácata*) were part of an elite public ritual space dating to the Middle and Late Postclassic. Area C contained several human burials in front of the pyramid, and area D contained an enclosed room considered a private elite zone. The latter was probably an elite occupation area associated with the *yácata*. On the upper *malpaís*, areas E and G were pre-imperial commoner domestic contexts, while area F was a commoner ritual space, possibly containing a proto- *yácata* structure.

The Angamuco Settlement Model

Based on data acquired through survey and excavation, Fisher and Leisz (2013) (see also Fisher et al. 2017; Cohen 2016) proposed an occupational sequence/settlement model for the site with three major phases. The first phase is the Epiclassic-Early Postclassic (900 – 1200 CE), where residents mainly occupied the upper area of the *malpaís* with a focus on sunken patio complexes similar to those documented from the same time period in the Bajío region of Mexico (Cárdenas García 1999; Darras and Faugère-Kalfon 2005). Monumental architecture does not seem to have been common during this period, and the uniformity of sunken patio groups does not reflect clear social stratification through architecture. During the Middle Postclassic (1200 – 1350 CE), there was major growth and expansion centered around several nodes of monumental

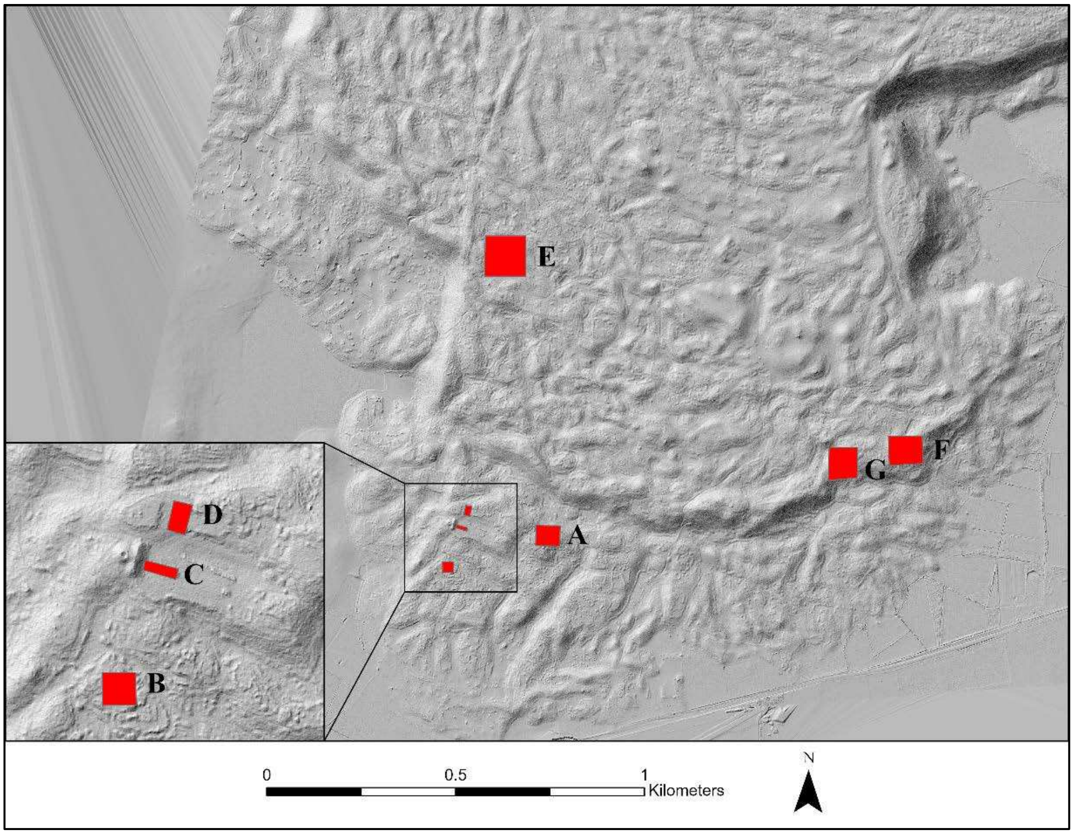

Figure 3. 9: General location of the 7 excavation areas at Angamuco. This map does not show individual units. Adapted from (Cohen 2016:76, 182).

architecture with distinct rectilinear pyramid complexes similar to those documented in the Zacapu Basin (Arnauld and Faugère-Kalfon 1998). During this period there seems to have been a significant increase in population throughout the upper and lower areas of the site with more variation in architectural form, and elites tending to settle in the lower areas of the site (Solinis-Casparius 2019). During the Late Postclassic (1350 - 1530 CE), settlement area contracted to the lower *malpaís* and became focused around several nodes of imperial Purépecha architecture such as *yácatas*, altars, and plazas. The greater variety of architectural types (see Fisher et al. 2019) suggests higher levels of social stratification and an emphasis on public ritual activities. At this time, Angamuco seems to have been organized like other Late Postclassic imperial centers throughout the LPB, indicating that it was incorporated into the Purépecha Empire.

Angamuco may have been occupied over a longer time span than what is suggested by Fisher and Leisz (2013). Radiocarbon dates and associated material culture from excavation areas A and B on the lower *malpaís* indicate a possible occupation during the Early Classic period. While the evidence is quite limited, it could mean there was a Loma Alta phase presence in the lower area of the site long before the later imperial occupation (Fisher et al. 2014, 2016).

Spatial Organization at Angamuco

The spatial organization of Angamuco is fairly unique compared to other Mesoamerican settlements. It has been called a multi-nucleated city (Fisher et al. 2017), meaning it is organized around several discrete nodes instead of around a single center (Harris and Ullman 1945). There are only a few other examples of cities with this form of organization in Mesoamerica, such as Tula, El Palacio, and Cantona (Steele 2021). Angamuco was not organized around a single civic-ceremonial compound, and the majority of the site does not conform to an orthogonal pattern. Instead, the city has a more organic and ad-hoc structure (Urquhart 2015). Nevertheless, its size, complexity, and the presence of recurrent urban forms is indicative of planned urbanism and the large scale coordination of space (Steele 2021).

Survey, excavation, and LiDAR data from Angamuco have been used to identify a nested hierarchy of spatial divisions within the city that are believed to have had social significance (Fisher and Leisz 2013). This was further investigated by Urquhart (2015), who detailed 3 nested categories – districts, neighborhoods, and complejos - based on perceived patterns in the grouping of architecture. The smallest identifiable unit above the level of individual structures is the complejo (Figure 3. 10). According to Urquhart (2015:49), complejos are "clusters of architecture that are separated from each other by roads, plazas, walls, or major topographic changes". Later interpretation by Steele (2021) describes complejos as walled, multi-room complexes containing a clear plaza and altar, that were occupied by a wide range of socio-economic classes. Fisher and Leisz (2013) state that complejos were probably composed of people related by kinship, socio-economic status, or occupation. Urquhart (2015) used object-based image analysis to identify complejo boundaries at Angamuco. When compared to hypothesized complejo boundaries for the survey area which were derived by Chris Fisher, there was some relatively good alignment. This reinforces the utility of the complejo as a unit of spatial analysis.

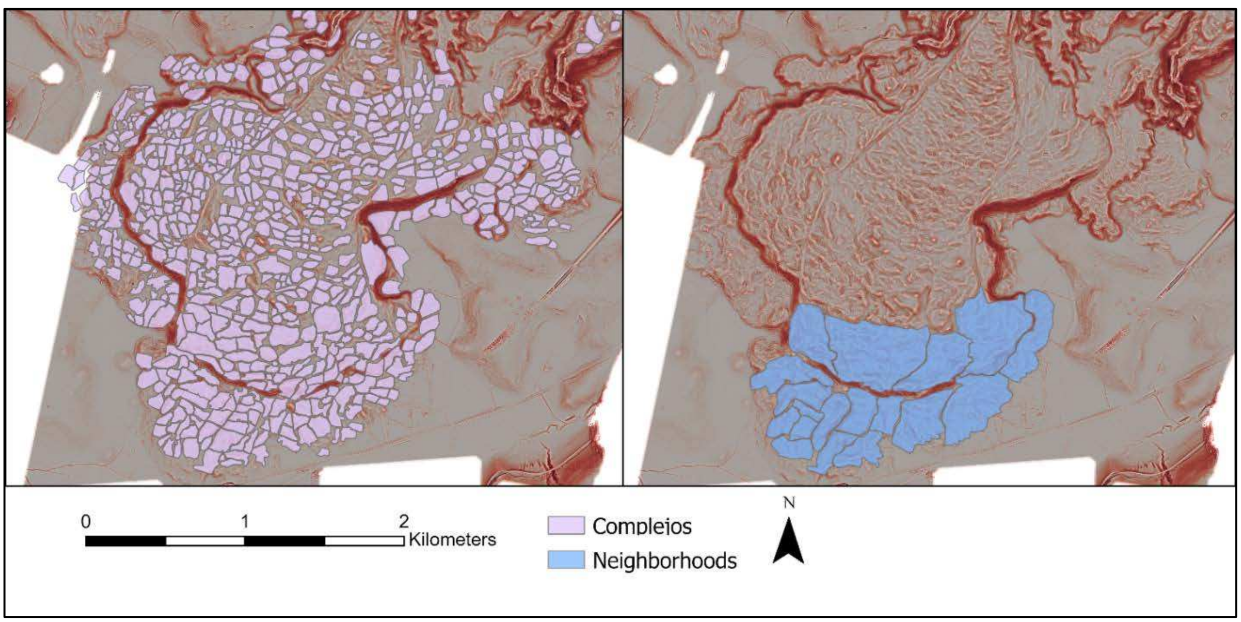

Figure 3. 10: (left) complejos, (right) neighborhoods at Angamuco shown over pseudo Red Relief imagery.

On a larger scale, multiple complejos can be grouped together into neighborhoods (Figure 3. 10). These neighborhoods are bounded by larger roads, major topographic changes, walls, platforms, and terraces, and each contains an elite residence and a centralized public space which includes a civic-ceremonial compound with a pyramid-plaza complex. Neighborhoods are also multifunctional and contain both commoner and elite architecture (Fisher and Leisz 2013; Urquhart 2015).

Fisher and Leisz (2013) suggest that a third spatial unit – the district – also exists at the site. As the largest spatial unit below the level of the polity, districts contain neighborhoods with major civic-ceremonial zones.

Urquhart (2015) interprets the spatial divisions at Angamuco in relation to the concept of the Purépecha *ireta*. The *ireta* was a Purépecha political entity which the Spanish colonial sources called a 'pueblo'. An *ireta* was essentially an indigenous community with a discrete territory and political identity, ruled by a hereditary lineage - kind of like a city state (Urquhart 2015:54). Each *ireta* was composed of smaller neighborhood subdivisions that the Spanish called 'barrios', which were ruled by their own secondary hereditary lineages. Both neighborhoods within cities and satellite communities in the hinterland were conceptualized as 'barrios' – there does not seem to have been any hierarchical distinction between them (Urquhart 2015:52–54). Purépecha cities were essentially the urban component of the larger *ireta* polities. Urquhart (2015) argues that this form of Purépecha organization is similar to the Nahua (Aztec), who had the *altepetl*, which was subdivided into *calpolli* (Lockhart 1992). The *altepetl* and *calpolli* were also referred to as 'pueblos' and 'barrios' by the Spanish, respectively.

Urquhart (2015:56-69) draws on Van Zantwijk (1967) and Pollard (1980, 1993, 2003), who point out that the Purépecha *ireta* actually contained two different types of 'barrios' (neighborhood divisions) that were described in early colonial sources. The first was a larger territorial neighborhood-level unit called an *uapátzequa* (plural *uapátzequecha*). This unit was involved in organizing public labor and religious ceremonies, it probably had some role in marriage regulation, and it probably included satellite communities and urban neighborhoods. Urquhart equates these *uapátzequecha* units to the Aztec *calpolli* and believes they correspond to the neighborhoods identified at Angamuco. Neighborhood level units of this kind are mentioned in the RM and have been identified by Pollard (2003:365-367) at Tzintzuntzan.

The second type of 'barrio' identified in colonial sources was smaller than the *uapátzequa*, and probably a subdivision of it. In the RM, this unit is associated with the indigenous tax collectors called the *ocámbecha*. It consisted of 25 households and was used for tribute collection, labor for public works, and the census (Pollard 1980:685, 2003:367; Urquhart 2015:62). Pollard (2003:367-369) states that at Tzintzuntzan there is no archaeological evidence for these units. She believes they were created by the administrators of the kingdom in order to increase central control (through the collection of taxes, tribute, and labor) in a way that bypassed the pre-existing *uapátzequecha* units, which were primarily religious in function. Urquhart (2015:63) disagrees and argues that the *ocámbecha* units existed prior to the formation of the empire as an informal subdivision of the larger neighborhood. In his view, the *ocámbecha* officials were appointed by the Purépecha state to manage units that already existed. Urquhart (2015:66-67) reasons that the complejos at Angamuco became the basis for the units administered by the *ocámbecha*. In other words, since Angamuco and its complejos predate the formation of the empire, and since the complejos are similar to descriptions of the *ocámbecha* units, it is reasonable to suggest that the complejos became the *ocámbecha* units during the time of empire – they were co-opted by the imperial administration.

Chapter Summary

This chapter was meant to provide necessary context/background information about the LPB, Angamuco, and the Purépecha Empire. I started by reviewing the geographic context of the LPB, its history of pre-Hispanic occupation, as well as the data sources (the RM and archaeological research projects) that have informed our current understanding of this area. Next, I described the LPB during the Late Postclassic Purépecha Empire. I discussed the appearance and spread of imperial material culture, the imperial social structure, and the imperial ideology and religion. I also described and critiqued Pollard's model of the Purépecha state, including her understanding of Purépecha urbanism and the different polities in the LPB. I then discussed the city of Angamuco, including its geographic context, ethnohistoric references, chronology of archaeological research, and the current settlement model. Lastly, I discussed the spatial organization of the city and how it relates to the concept of the Purépecha *ireta*.

With this context established, I will now tie everything together. The next chapter will apply the concepts from the theoretical discussion to this study area, connecting visibility and the built environment to processes of social control and state integration at Angamuco.

CHAPTER 4: SURVEILLANCE, CONTROL, AND STATE INTEGRATION

The city of Angamuco complicates existing models of the Purépecha state, its formation, and Purépecha urbanism (Pollard 1980, 1993, 2003, 2008). Angamuco clearly existed as an urban center before, during, and after Purépecha imperial development. This contradicts Pollard's notion that Purépecha urbanism was a result of the unification of the empire. It also makes Angamuco a very important site. The city's most extensive occupation seems to have been during the Middle Postclassic, when the Purépecha state was developing and expanding throughout the LPB. This is a rather obscure and understudied period in the LPB, mainly due to a lack of preserved evidence and a tendency to focus on the later established empire. Because much of the evidence from this period is buried under later imperial, or modern deposits, our main source of information is the RM, which, as mentioned previously, is not wholly reliable. In general, the RM provides very little information about the nature of Purépecha polities prior to, and during, the formation of the unified state. Based on the narrative, we know these polities were centered around individual settlements, ruled by hereditary lineages, and engaged in frequent warfare and alliances (Urquhart 2015). They are portrayed as a series of competing small-scale chiefdoms ruled by highly ranked local chiefs. It is still somewhat unclear how these polities were consolidated into a unified Purépecha state during the Middle Postclassic. This is why Angamuco is so important. Because it is so well preserved, it provides a window into how this emerging political regime secured its authority and integrated local populations in the LPB.

Cohen (2016) studied ceramics collected from Angamuco and argues that since ceramic form and decoration become more diverse in domestic and public contexts over the timeframe of state formation, it suggests that the city went through a bottom-up process of state integration.

Ceramic diversity is higher in Middle and Late Postclassic elite contexts than in earlier commoner contexts. Cohen takes this to mean that a wider variety of pottery forms and decoration were used during the time of empire, indicating that leaders of the emergent state negotiated with existing elites and communities, exploiting existing ceramic systems as they established their control over the LBP. This stands in contrast to a top-down centralizing process of political economic integration, which would be reflected in an increased standardization of pottery forms and decoration. Cohen (2016:255) argues that this bottom-up process of integration would have involved the rulers of the Purépecha state establishing their authority through co-option and manipulation of other local elites. It is unclear who these Purépecha rulers actually were. According to the RM, they were high ranking members of the migrant *uacúsecha* lineage, although there is no archaeological evidence to support this. Nevertheless, the appearance of distinctive elite material culture like elaborate spouted vessels, and the construction of new kinds of imperial architecture, were an important part of the integration process. Imperial artifacts were used during ritual activities such as feasts, offerings, and burials, which would have taken place on or near imperial architecture. Local elites were put in charge of these practices and given high status items as a way of co-opting them and incorporating their local populations into the new Purépecha ideological system (Cohen 2016:255–256).

I agree with Cohen's argument that pre-existing populations in the LPB were incorporated into the state through bottom-up processes. I also agree that imperial architecture played a role in this. However, I think it is possible that processes of state formation and incorporation *also* occurred in a top-down manner. These are not mutually exclusive options. I suggest that on one hand, the emergent Purépecha elite negotiated with local elites and commoners, co-opting their allegiance through ritual activity, and co-opting existing systems of production in a bottom-up manner as Cohen argues. At the same time, I believe that populations could have been brought under state control through the top-down exercise of power. I do not mean through warfare or violent conquest, rather I am referring to more subtle and indirect mechanisms of power that coerce local populations into subjugation. These include Panoptic surveillance and the projection of middle-level meaning through the built environment (see chapter 2). The construction of imperial architecture during the Middle to Late Postclassic would have been key to this. The most effective kind of imperial architecture for projecting middle-level meaning and facilitating Panoptic surveillance would have been monumental constructions like pyramids. Survey and excavation at Angamuco and other sites suggest that pyramids were associated with the Purépecha elite, and thus were probably built under their order. These structures certainly helped co-opt local elites and their populations through the ritual activity that was performed at them (as Cohen suggests), but I believe the structures themselves (as opposed to the activities taking place in or near them) also may have facilitated a kind of top-down social control through their physical presence. My hypothesis is that starting in the Middle Postclassic, emergent Purépecha rulers may have placed monumental constructions on the landscape in a way that was favourable for Panoptic surveillance and middle-level messaging. This could have been accomplished by placing the structures in highly visible locations, emphasizing their verticality, and enlarging their viewsheds. Observers caught in these viewsheds would look up at these structures and internalize messages about the power of the state. The visual connection would also generate a Panoptic gaze – a perpetual sense of being watched - that would encourage observers to conform their behavior to acceptable standards within the new social order. I believe this could have started with the construction of the rectilinear pyramids across the *malpaís* and continued with the later construction of the *yácatas*.

I imagine this functioning in a similar manner to the temples at Maya sites which, as discussed in chapter 2, were made to be highly visible. In Maya inscriptions, the glyph “to see” (*ila-aj* or *y-ila-ji*) was always associated with someone of high-status, like an overlord. The power of Maya rulers was associated with their ability to see and be seen (Houston et al. 2006:172–173). If there was a similar connection between visibility and power among the Purépecha, we would expect their monumental constructions to be placed strategically on the landscape such that their viewsheds would be large and encompass commoner areas. It would be reasonable to suggest that these viewsheds would also encompass areas of high traffic flow, like major roads, as well as areas of congregation and activity. If the data from Angamuco support this, it would suggest that these mechanisms of power – Panoptic surveillance and the projection of middle-level meaning – may have been used to help incorporate populations at Angamuco into the Purépecha state, and to sustain imperial control thereafter. It would suggest that when Purépecha rulers began to take control of the region in the Middle Postclassic, they manipulated the built environment – by constructing new forms of architecture and making them highly visible - to emphasize symbols of state control on the landscape, subjugating existing populations through an indirect, yet top-down, exercise of power.

The site of Tzintzuntzan conforms well to this hypothesis based on evidence collected by Pollard (1972, 1980, 1993, 2003). At Tzintzuntzan, Pollard noticed patterning in features of the built environment which allowed her to divide her survey sites into spatially discrete land use zones (residential, manufacturing, and public), including three kinds of residential zones: low, medium, and high-status. Pollard believes that the ‘Santa Ana platform’, located in the largest high-status residential zone, once contained the residence of the Purépecha king and his family. She bases this assertion on illustrations and text in the RM, which indicate that the houses of the king were located on a large artificial platform or patio separate from the main temple complex (see Pollard 2003:351). Material remains found around this platform and in other high-status residential areas include items characteristic of elites such as ear/lip plug fragments and highly decorated ceramics in unusual forms (Pollard 1993:35). The main public zone at Tzintzuntzan is located on the northwest slopes of a mountain called Cerro Yaguarato and includes another large artificial platform. This platform exhibits careful planning and contains the main temple complex with five *yácata* pyramids (Figure 3. 5), several burial chambers, and a series of rooms and mounds which probably stored ritual paraphernalia and served as housing for priests (Acosta 1939; Cabrera Castro 1987; Gali 1946; Noguera 1931; Piña Chan 1963; Pollard 2003:357; Rubín de la Borbolla 1939, 1941). Religious ceremonies are believed to have taken place on this platform, and high-status individuals were buried within and near the *yácatas* with elite artifacts like pipes, ear and lip plugs, and polychrome ceramics (Pollard 2003:351, 357). Pollard (1993:53) states that the main platform at Tzintzuntzan can be seen from all parts of the pre-Hispanic settlement. While no viewshed analysis has been done to verify this, it does seem indicative of Panoptic planning. The decision to place the five *yácata* pyramids on an elevated platform on the slopes of a mountain, enhancing their visibility across the site, was certainly not random. While these pyramids obviously had religious significance, they were also symbols of imperial power and domination. I believe their location on the landscape supports my hypothesis. Pollard's assertion that the houses of the king were located on the Santa Ana platform further supports this hypothesis. Elevating the king's residence on a large platform would have made it highly visible. This could have generated an effective Panoptic gaze emanating from the king himself which surely could have encouraged 'appropriate' behavior.

With this knowledge of Tzintzuntzan, it stands to ask whether similar evidence can be found at Angamuco. Were monumental constructions positioned in a way that was favourable for Panoptic surveillance and middle-level messaging? I am interested in both the rectilinear pyramids and the *yácatas* at Angamuco. The rectilinear pyramids are believed to have been built during the Middle Postclassic when the Purépecha state was first consolidating in the LPB. Consequently, I believe they may have been designed and planned, at least in part, to reinforce state power and social control. The *yácatas* were constructed during the Middle to Late Postclassic and seem to have become the main symbols of imperial power on the landscape, so It would be reasonable to think that they might exhibit Panoptic planning. Analysis of the Angamuco pyramids by Friedl (2019) suggests that their locations are indicative of coordinated urban planning with celestial processes in mind. In other words, they were positioned to communicate high-level meaning (Rapoport 1990). Friedl restricts her analysis to high-level meaning, but I believe the pyramid locations may have also been chosen to communicate middle and low level meaning, especially based on her statement that pyramids tend to be located in naturally elevated areas (Friedl 2019:45).

The other obvious monumental construction at the site is the ballcourt. It is unclear whether this structure was built during the time of empire, but it was certainly important during this period. Since it was probably a significant area of congregation and ceremonial activity, I am interested in examining its visibility as well. I also want to broaden my analysis to include other forms of imperial architecture, specifically elite complexes. It seems unlikely that these constructions were 'monumental' in scale, but they are nevertheless important. They were built under imperial rule (probably during the Late Postclassic) and were associated with the Purépecha elite, who probably would have spent a great deal of time within them. They too may have acted as symbols of imperial power on the landscape, so I want to investigate whether they were positioned in highly visible locations.

Chapter Summary

In this chapter I have presented a hypothesis relating the visibility of monumental constructions and other forms of imperial architecture to processes of social control and state integration at Angamuco which I will now review. I hypothesize that monumental constructions and other forms of imperial architecture may have been positioned to be highly visible on the landscape in a way that was favourable for Panoptic surveillance and middle-level messaging. If the data support this, an argument can be made that these mechanisms of power were used as a form of top-down social control that helped integrate existing populations into the emergent Purépecha state. This would suggest that the exercise of power and control in the Purépecha state did have top-down and hierarchical aspects, and that visibility, and its manipulation in the built environment, were integral to this. In order to test this hypothesis, I performed a GIS visibility analysis using ArcGIS Pro software (versions 2.8 and 3.0). In the next chapter, I describe my methodology.

CHAPTER 5: METHODS

The preceding chapters have established a hypothesis about visibility, and how its manipulation can be used as a mechanism of social control and state integration. From a methodological standpoint, at Angamuco I needed to determine whether high-status structures were made to be highly visible on the landscape. This task required modelling visibility from specific locations at Angamuco, which was accomplished using GIS and various spatial data products. Before going into the details, I need to establish some background information about LiDAR and archaeological visibility analysis.

LiDAR

LiDAR is an acronym for Light Detection and Ranging. This thesis is concerned with airborne LiDAR, commonly referred to as airborne laser scanning (ALS). This is an active remote sensing technology where a sensor, usually mounted on a plane or helicopter, emits laser pulses (up to hundreds of thousands per second) that travel down and hit targets on the Earth’s surface, bounce off, then get reflected back to the sensor. The time that it takes for the laser pulses to travel to the target and back is recorded by the sensor. When multiplied by the speed of light, the range to the target is computed. After the laser pulses exit the sensor, they interact with different objects such as trees and buildings, as well as the ground. Modern LiDAR systems usually record multiple ‘returns’ per laser pulse, one for each level of surface reflection (for example, canopy, understory, and ground), as well as the intensity of the reflected signal. The position of the aircraft and its precise coordinates are also recorded using an Inertial Measurement Unit (IMU) and differentially corrected GPS, often integrated into the scanner itself. The data collected by the LiDAR sensor are stored as a 3D point cloud, where each laser return is stored as a point with, minimally, X, Y, Z coordinates and intensity. Raw point clouds are then processed using various algorithms that classify the returns based on the target they were reflected from. The classified point clouds are then used to create raster datasets (grids of pixels) that can be used in subsequent geospatial analysis. One of the most common raster datasets created from LiDAR data is the ‘bare earth’ digital elevation model (DEM), also called a digital terrain model or DTM. A bare earth DEM is generally created using the ground returns from the point cloud, such that the overlying vegetation is removed, allowing landscapes to be digitally ‘deforested’. The DEM surface is created through the interpolation of elevation values from the points so that each pixel of the raster stores an approximate elevation value for that point on the landscape (Fernandez-Diaz et al. 2014; Harris 2019). The resolution of these datasets can be much finer than products derived from space-based remote sensing platforms, making them useful for detecting the kinds of subtle topographic features that often make up the archaeological record.

LiDAR has been successfully applied to detect archaeological features all over the world (Devereux et al. 2005; Evans et al. 2013; Johnson and Ouimet 2014; Sadr 2016), but it has been especially effective in Mesoamerica because of its ability to penetrate the dense forest canopy (Chase et al. 2012; Chase and Weishampel 2016; Fisher et al. 2017). In these contexts, LiDAR provides complete documentation of the landscape rather than a sampling of its area. This allows archaeologists to interpret their regions of interest in their entirety (Chase et al. 2012).

Archaeological Visibility Analysis

Visibility studies in archaeology have a long history which greatly predates the use of GIS. Early studies were quite informal, usually based around a particular researchers field observations of what could be seen from one or many locations (Lake and Woodman 2003). Over time,

archaeological visibility studies became more statistically focused, and then more humanistic, focusing on cognition and experience, which mirrored the processual and then postprocessual turns in the discipline (Lake and Woodman 2003). These latter studies saw visibility less as an attribute of the environment and more as a human perceptual act (Wheatley and Gillings 2000). GIS visibility studies really started in archaeology during the 1990's and their development followed the same trajectory. Early studies were quite informal, with later studies becoming more statistically rigorous, addressing processual, then cognitive-perceptual concerns (Lake and Woodman 2003). This thesis combines quantitative and statistical methods with a theoretical focus on cognition. I take the position of Wheatley and Gillings (2000:2) who believe that visibility refers to "past cognitive/perceptual acts that served to not only inform, structure, and organise the location and form of cultural features, but also to choreograph practice within and around them". In this sense, studying visibility is a means of studying past cognition (Lake and Woodman 2003).

The backbone of GIS visibility analysis is the *viewshed*, defined as "the portions of a landscape that are visible from a single point or a particular set of locations" (Pierce and Matisziw 2021:224). The computation of viewsheds is straightforward and user-friendly in modern GIS software. The simplest form of viewshed is generated using a tool that takes as input a raster DEM and a single observer point. With the click of a button, a binary output raster will be generated, where cells are assigned a value of 1 if they have a line of sight to the observer point, and 0 or NoData if they do not (Figure 5. 1). In the classic interpretation, the viewshed shows all the areas of the landscape (the raster surface locations) that are visible from the observer point, but it can also be interpreted in the reversed sense, as showing all the raster

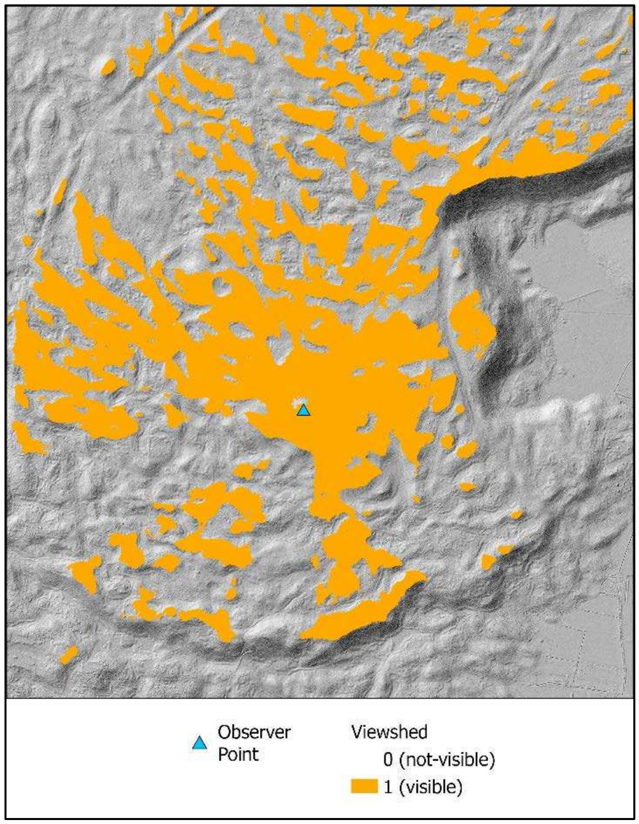

Figure 5. 1: Example of a simple viewshed with one observer point. All cells in orange have a value of 1, meaning they are visible to the observer/they can see the observer point. All cells with a value of 0 (turned transparent in this example) are not visible and cannot see the observer point. Viewshed is displayed over a shaded relief.

surface locations that can see the observer point. This is because In most visibility analyses, there is an assumption of intervisibility between the observer and the observed (Wheatley and Gillings 2000:7). However, this in itself is a limitation of many viewshed analyses because in reality, intervisibility does not always exist between the viewer and the viewed (Wheatley and Gillings 2000:7).

In ArcGIS Pro, viewsheds are often calculated using the *Visibility* tool in the Spatial Analyst toolbox. This tool has additional input parameters that provide more control over the analysis. First, you specify an input surface raster (a DEM), as well as a feature class of one or many observer locations. The analysis type can be set to *Frequency*, where each cell of the output raster records the number of observer points it can see, or *Observers*, where each cell of the output raster is coded to identify which specific observer points are visible from it. Additionally, non-visible cells can be assigned a value of 0 or NoData; a Z factor can be specified which adjusts the measure of the Z units if they are different from the X and Y units; a correction for the Earth's curvature can be applied; and a refractivity coefficient for visible light in air can be specified or left with a default value of 0.13. Three elevation/offset parameters can also be specified that affect the results (Figure 5. 2). Let's say you are generating a viewshed from a point at location X. First, you have to set the surface offset or OFFSETB, which is a vertical distance to be added to the z-value of each cell. Then there is the observer elevation or SPOT, which is the surface elevation of the point at location X. Finally, there is the observer offset or OFFSETA, which is an additional elevation to be added to the observer elevation. Adjusting these parameters affects the questions addressed by the analysis. For example, if your goal was to determine where an observer standing at location X would be able to see a person on the landscape, you would set the SPOT equal to the surface elevation at location X, OFFSETA equal to the approximate eye height of the observer, and OFFSETB equal to the height of a person (see Figure 5. 2a). This would be considered a *viewshed from* location X. Alternatively, if your goal was to determine where a person on the landscape would be able to see a specific structure at location X, say a tower, then the SPOT would be equal to the surface elevation at the tower, OFFSETA would be equal to the height of the tower above the ground, and OFFSETB would be equal to the eye height of a person on the ground looking at the tower (see Figure 5. 2b). This would be considered a *viewshed to* location X. In both cases, the viewshed is generated from a point at location X, but the interpretation varies depending on whether you are interested in *views to* or *views from* the point.

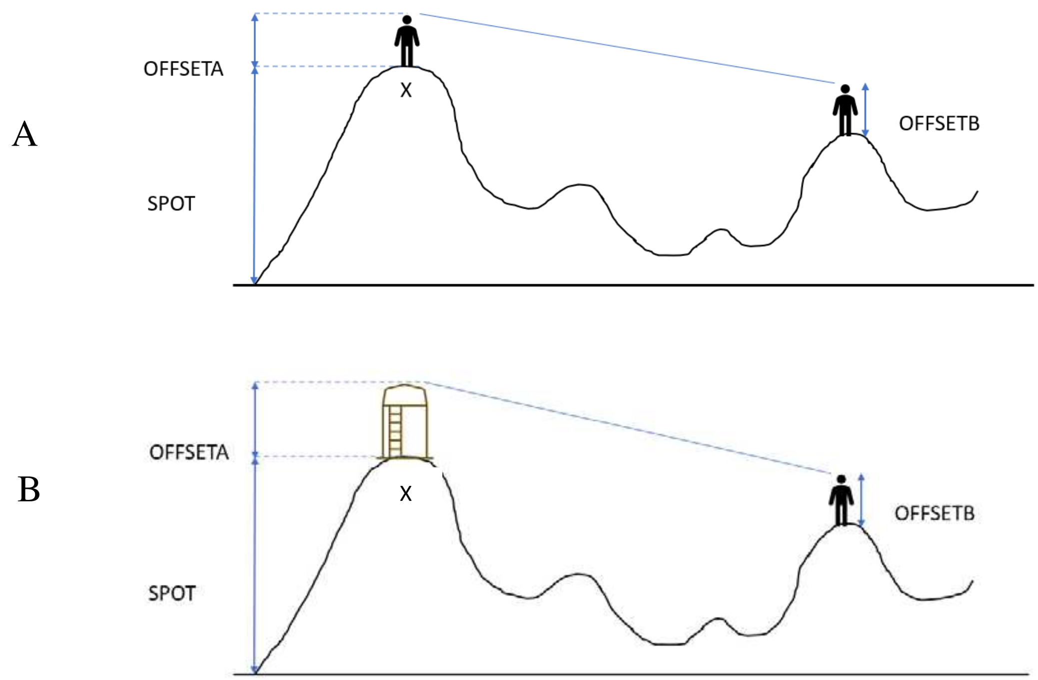

Figure 5. 2: Main observer parameters for visibility analysis in ArcGIS Pro. (a) assessing visibility of an observer at location X. (b) assessing visibility of a tower.

With the Visibility tool, you can also specify an inner radius or outer radius, so that cells within or beyond that limit, respectively, will not be visible, as well as horizontal and vertical start and end angles.

When the Visibility tool is used with multiple observer points as input and the analysis type set to Frequency, the result is a cumulative viewshed surface (Figure 5. 3). As described by

Wheatley (1995), this is essentially taking viewshed maps for each observer point and summing them to create one surface that represents, for each cell, the number of observers with a line of sight to that cell. If, however, the visibility tool is used with just a single observer point as input, and the analysis type is set to Frequency, the result is a single binary viewshed map for that observer point (Figure 5. 1).

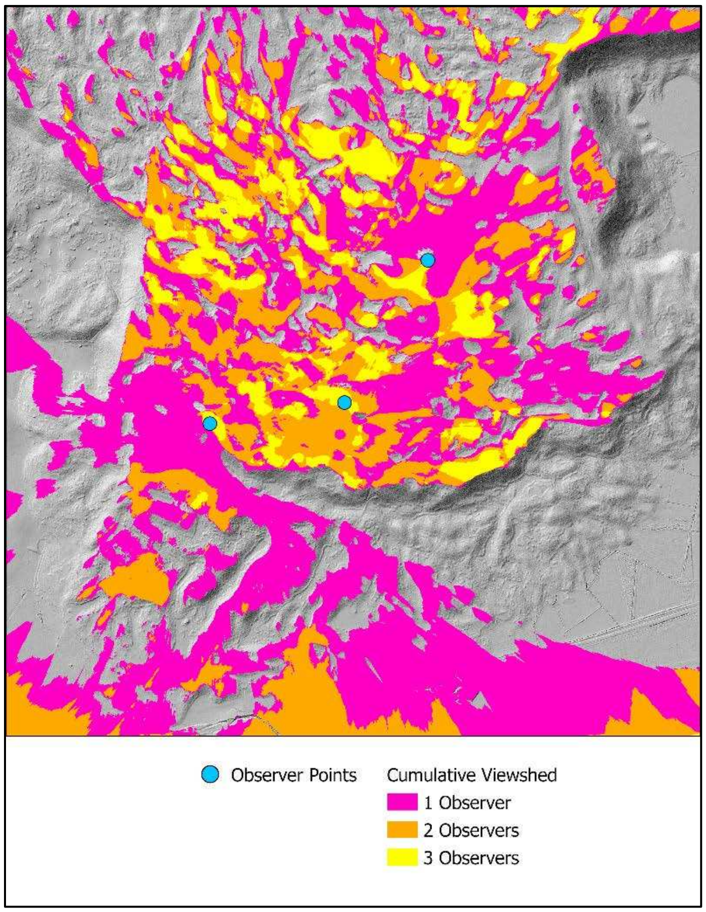

Figure 5. 3: Example cumulative viewshed surface displayed over a shaded relief. Each cell is coded with a value that represents the number of observer points that can see it/number of observer points it can see. Transparent areas do not have a line of sight to any observer points.

It is important to note that viewshed analysis is not without its flaws and limitations. Wheatley and Gillings (2000) describe many different critiques and issues. One of the major issues is with palaeoenvironment and palaeovegetation. Viewshed analysis is almost always based on a DEM of the modern landscape with the effects of palaeovegetation either ignored or left as a caveat. This can be problematic, as the landscape may have been significantly different in the past, with more or less trees and other vegetation that could have affected what was visible from where. Other issues include temporal dynamics, like changing seasons and climate, and the previously mentioned issue of assumed intervisibility between the observer and the observed, which is not always realistic (Wheatley and Gillings 2000:6–7).

Another big issue is that of object-background clarity. Unless specified, viewsheds are generated with no outer limit to visible distance. They show what would be theoretically visible from a certain point without considering the fact that visibility diminishes with distance and is affected by differences in eyesight (Wheatley and Gillings 2000:5). The visibility of objects is also influenced by environmental effects, such as lighting conditions, weather, and atmospheric extinction (the combined effects of atmospheric scattering and absorption of light) (Ogburn 2006:406–407). The physical properties of an object, such as its size, color, and contrast with its surroundings, also affect its visibility, as well as the placement/positioning of the object on the landscape (Ogburn 2006:407). Issues of object background clarity and diminishing visibility have been addressed in various ways. Wheatley and Gillings (2000:13–16) suggested breaking up binary viewsheds into different visual ranges that define foreground, middle-ground, and background distances. A similar approach is the use of 'fuzzy viewsheds', where rather than generating a binary raster with values of either 0 or 1, the raster is assigned values ranging from 1 (clearly visible) to 0 (not visible). Intermediate values reflect lower levels of clarity (Fisher 1994; Ogburn 2006:408). Fisher (1994) generated fuzzy values using a distance decay function, where clarity drops off with increased distance from the observer. In his model, there is an area of perfect clarity (the foreground) close to the observer where fuzzy values equal 1. This is represented by the distance b_1 in Figure 5. 4. As you cross the foreground limit, you get into the middle-ground, which extends up until the point b_2 called the "crossover point" (Figure 5. 4). Past this point you get into the background, where clarity drops off substantially, and fuzzy

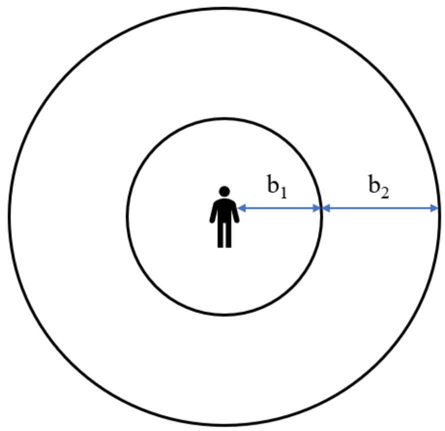

Figure 5. 4: Distance variables used in the creation of fuzzy viewsheds. First b_1 is the limit of the foreground, where visibility is greatest, then b_2 is the distance added to reach the crossover point, after which visibility degrades substantially. Adapted from (Ogburn 2006:409).

values get closer and closer to zero. Ogburn (2006) modified this fuzzy viewshed model to account for object size. In his version, the distance $b_1 + b_2$ reflects the distance at which an object of a certain size reaches the standard limit of recognition acuity for 20/20 vision. This is the distance at which it subtends a visual arc of 1' (1 minute of arc). Ogburn (2006:410) found that if you take the width of an object and multiply it by 3440 (a distance multiplier that he derived), it provides the distance ($b_1 + b_2$) at which the object subtends 1 minute of arc. Past this distance, most people, under ideal conditions, would not be able to recognize the object. Ogburn (2006:410) suggested using this model to reclassify binary viewsheds based on decreasing clarity.

Issues in visibility analysis can also come from the DEM itself. The accuracy of the DEM in capturing the true terrain surface ultimately determines the accuracy of the resultant viewsheds. It is important to use high resolution DEMs in viewshed analysis, as they are often more accurate. Even so, DEMs can have sources of error such as sinks and edge effects (Kantner and Hobgood 2016). The use of filters on the DEM can also affect the topography, for example, a mean filter can lower hills and raise valley bottoms, which will affect viewsheds in later analysis (Wheatley and Gillings 2000:9).

Other critiques of visibility analysis tend to be more theoretical, seeing GIS viewshed analysis as a kind of technological determinism, or arguing that it places too much emphasis on vision as the primary mode of perception over the other senses (Wheatley and Gillings 2000).

It is important to be aware of these issues, limitations, and critiques when attempting to carry out a GIS visibility analysis. It is the researcher's responsibility to carry out their analysis in a way that addresses and accounts for these concerns as best as they can.

Angamuco Visibility Analysis

Spatial Datasets for Angamuco

Before I dive into the actual steps of my methodology, I need to review the various spatial datasets for Angamuco that I used in my analysis. Most of these datasets were created through previous theses and dissertations by other members of the LORE-LPB team. Descriptions of how and why I used these datasets will come in the following sections.

One essential dataset that I used was a 0.5 meter bare-earth DEM of the entire site. I generated this DEM from the high-resolution LiDAR point clouds collected for Angamuco over two flights. The first flight was conducted in 2010 by Merrick & Company (Fisher, Bush, et al.

2011; Fisher et al. 2012; Fisher, Leisz, et al. 2011; Fisher and Leisz 2013), encompassing about 9 km^2 of the lower *malpaís*. The second flight was conducted in 2015 by the National Center for Airborne Laser Mapping (NCALM), based at the University of Houston. This second flight encompassed a total area of 35 km^2, covering the entire Angamuco *malpaís*, as well as the *malpaís* of Itzira Ahuacuti to the west. The combined LiDAR point clouds were stored as a collection of LAS tiles which I processed myself using Global Mapper software (version 21.0). In order to visualize archaeological features, I filtered the combined point cloud down to the ground returns, then used this to generate a 0.5 meter DEM of the entire site. I experimented with both 0.5 m and 0.25 m resolutions and found that 0.5 m produced a smoother visualization with fewer artifacts. This DEM was projected into WGS 1984 UTM Zone 14N, then exported from Global Mapper as an ESRI float grid, which was converted into a TIF file in ArcGIS Pro (version 2.8). To improve visual interpretation of the elevation data, I also created a shaded relief map, commonly called a hillshade, using the Hillshade tool in ArcGIS (Figure 5. 5a). This is the most commonly used visualization technique for DEMs as it is easy to derive and interpret. A hillshade is created by illuminating a DEM from an artificial light source which creates the impression of depth and texture (Fernandez-Diaz et al. 2014; Kokalj et al. 2013). This does have limitations, as the directionality of the light source will affect the results, very dark or bright areas may be perceived with little detail, and linear features that lie parallel to the azimuth of the light source will be obscured.

Another dataset/visualization technique that I used was the Red Relief Image Map (RRIM), as described in (Chiba et al. 2008; Chiba and Hasi 2016). This is created through the layering of different visualizations to enhance and emphasize certain topographical features (Kokalj and Somrak 2019). The RRIM is a combination of 3 layers: topographic slope, positive openness, and negative openness. Slope is simple to derive from a DEM and represents the maximum rate of change between each cell and its neighbors (Figure 5. 5c). Positive openness represents the convexity of a surface, while negative openness represents the concavity of a surface (Chiba et al. 2008). To create the RRIM, positive and negative openness are combined in the expression below to produce a new layer called the I-factor (Figure 5. 5b), where O_p is

$$I = (O_p - O_n)/2$$

positive openness and O_n is negative openness. The I-factor eliminates dependency on light direction and expresses concavity and convexity at the same time in a gray scale layer. Next, topographic slope is produced, given a red color ramp, then layered over the I-factor and made semi-transparent. The resulting image expresses fine to large scale topographic structures, all with no shadows (Chiba et al. 2008) (Figure 5. 5d). While the original methodology for the

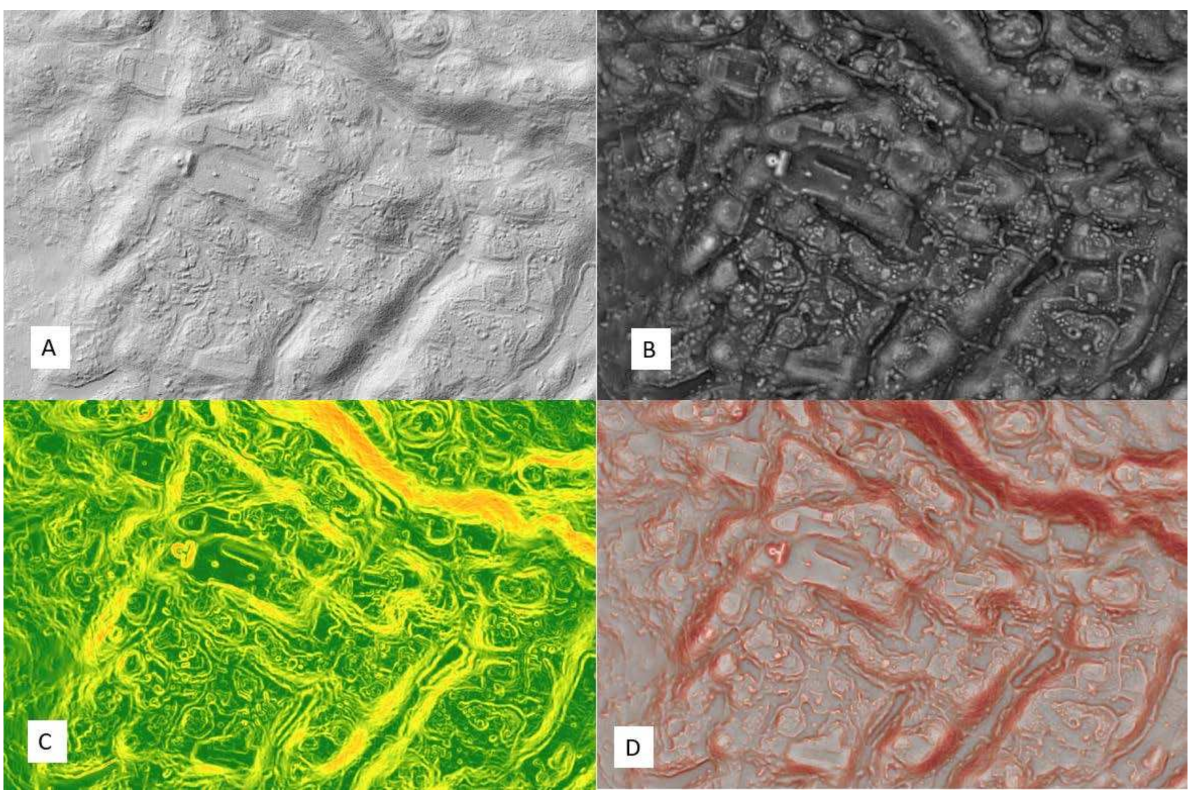

Figure 5. 5: LiDAR visualization techniques. a) standard hillshade, b) I factor, c) slope, d) pseudo RRIM

RRIM is patented, a pseudo RRIM can be produced using the Relief Visualization Toolbox (RVT) (Kokalj and Somrak 2019; Zakšek et al. 2011) found here: https://iaps.zrc-sazu.si/en/rvt. In ArcGIS Pro (version 2.8), I smoothed my Angamuco DEM using the Focal Statistics tool (3 cell circular kernel with statistic type set to MEAN), which produced a new DEM with a reduction in extreme values. The smoothed DEM was then input into the RVT, which was used to create raster layers for positive and negative openness. These layers were combined using the Raster Calculator in ArcGIS Pro to create an I-factor raster. Next, I used the Slope tool to create a slope raster from the smoothed DEM. To create the pseudo RRIM layer, the slope raster was symbolized with a stretched red color ramp and layered over the I-factor with a transparency of around 40 %.

I also used five spatial datasets representing archaeological features at the site. One of these was a point shapefile of 26 pyramid locations and 2 ballcourt locations across the entire site (Figure 5. 6) which had been created by former MA student Alex Friedl for her thesis (Friedl 2019). It included the pyramids identified during survey and excavation as well as additional pyramids identified manually using remote sensing imagery (see Friedl 2019 chapter 3 for her methodology). It is important to note that the additional pyramid locations identified by Friedl have for the most part not been ground-truthed. They are believed to represent monumental constructions, but we cannot be certain about this until more fieldwork is done. Additionally, one of the points designated as a ballcourt by Friedl was apparently misinterpreted, and is actually an elite complex (Chris Fisher, personal communication 2021). The dataset thus had 26 pyramids, 1 elite complex, and 1 ballcourt.

Another dataset that I used was a shapefile of complejo boundaries for the lower portion of the *malpaís* (Figure 5. 7a). This dataset combined complejo boundaries identified by Urquhart (2015) through an object-based image analysis approach, and complejo boundaries drawn out by Chris Fisher based on survey work at the site. I also used a dataset for roads covering the lower portion of the *malpaís* (Figure 5. 7b), a shapefile of built up archaeological features for the lower portion of the *malpaís* (Figure 5. 7c, Figure 5. 7d), and a shapefile for reservoirs covering the entire site (Figure 5. 6). The roads dataset was created by Solinis-Casparius (2019) through a manual digital identification process (see Solinis-Casparius 2019:113–130). The reservoir dataset was created by Simpson (2019) using the Hydrology toolbox in ArcGIS Desktop 10.x, and the dataset of archaeological features was created by Harris (2019) using LiDAR visualizations and an open source toolbox for DEM manipulation (see Harris 2019 chapter 4).

Adding More High-Status Points

As I mentioned before, at Angamuco I needed to determine whether monumental constructions and elite complexes were made to be highly visible on the landscape so as to facilitate Panoptic surveillance and project middle-level meaning. This required modelling the visibility of these structures which I did by generating viewsheds from them. Using the viewshed interpretation from Figure 5. 2b, any area of the site falling within one of these viewsheds would be a location where a person with height equal to OFFSETB could theoretically stand and be able to see the respective structure on the landscape. In other words, each ‘high-status viewshed’ delineates the area where that respective structure could be seen and thus project middle-level meaning and a Panoptic gaze.

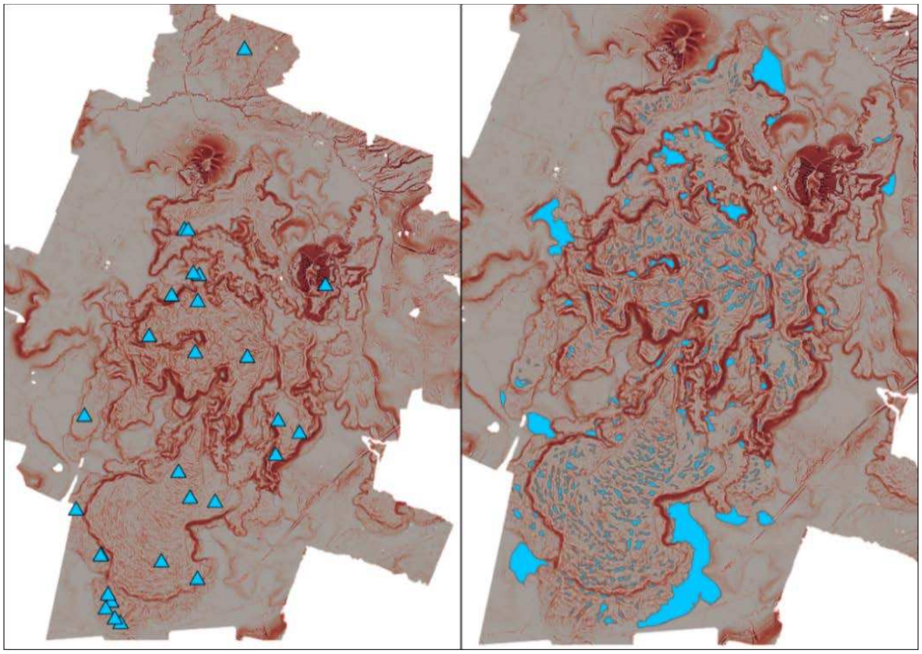

Figure 5. 6: Archaeological datasets for the entire site of Angamuco. (left) pyramids, (right) reservoirs, displayed over pseudo RRIM.

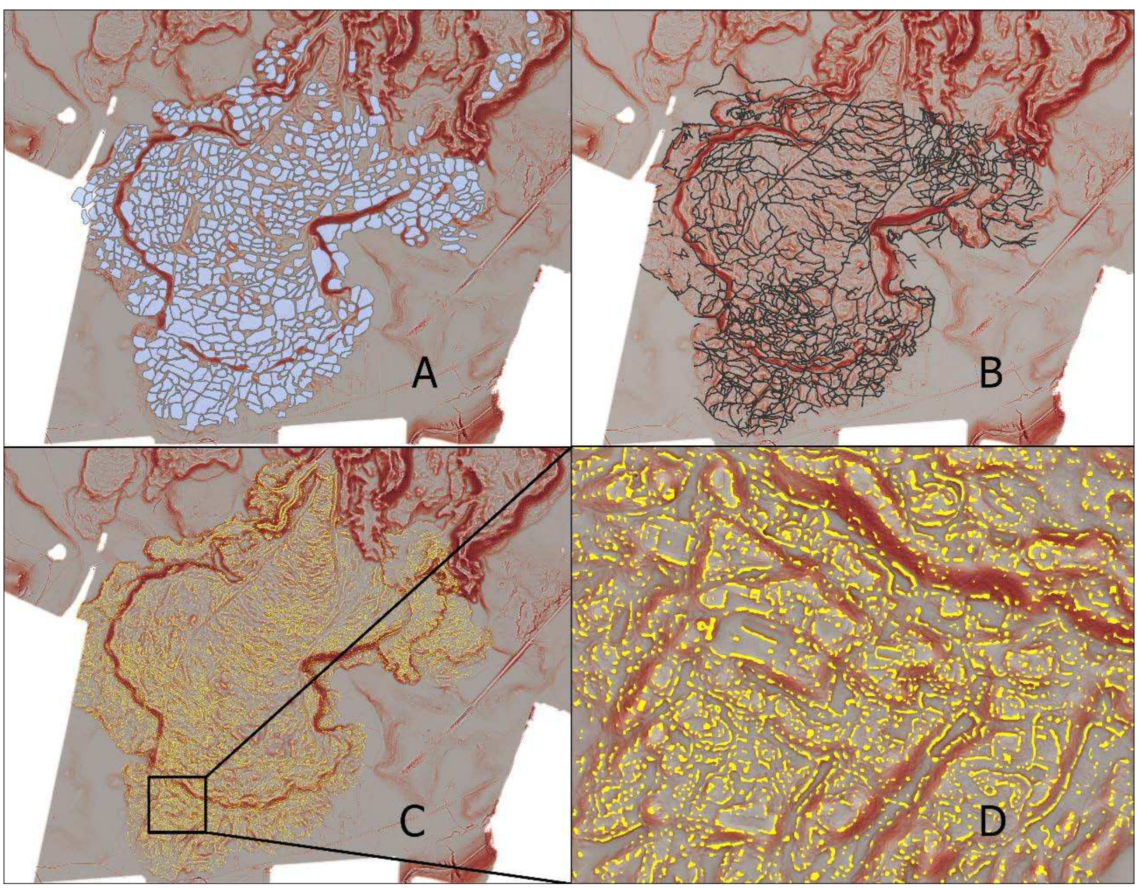

Figure 5. 7: Archaeological datasets for the lower malpaís of Angamuco. a) complejos, b) roads, c) archaeological features full extent, d) archaeological features close-up. Data is displayed over pseudo RRIM.

In order to generate these viewsheds, I needed two essential datasets: 1) a DEM of the site, and 2) a point shapefile with the locations of the high-status structures across the site. As described in the previous section, I created a 0.5 meter DEM for the entire site by processing theraw LiDAR data, and I acquired a point shapefile of high-status points from a previous thesis project (Friedl 2019). However, I felt this dataset of high-status points was not extensive enough for my analysis, especially since it only contained one elite complex, so I enriched it with additional points. First, I assigned designations to each of the high-status points using a 500 x 500 meter block grid covering the extent of Angamuco (Figure 5. 8). Each block in this grid had an alphanumeric name which Friedl (2019) had used to label the points in her shapefile. I adopted her naming system with slight modifications. I assigned each point a name based on the block it fell into, what kind of feature it was (pyramid = Py, ballcourt = Ball, elite complex = Ec), and whether it was the first, second, third, etc. feature of that kind Identified in that block. For example, the first pyramid identified in block AG76 was named AG76-Py-1, and the elite complex in the dataset was found in block AN73, so it was named AN73-Ec-1. In her thesis, former MA student Lucy Steele had also identified another potential large rectilinear pyramid at the site (Steele 2021:57), so I decided to place a point at it's location to add it to the dataset. This new pyramid was named AK74-Py-1, bringing the total number of points to 29 with 27 pyramids, 1 elite complex, and 1 ballcourt. I also slightly repositioned some of the high-status points, making sure they were at a spot on each structure that made sense for the generation of viewsheds. For example, I placed points at a high spot on each pyramid, and within the building foundations of the elite complexes. For the ballcourt, the point in the original dataset was positioned down within the pit of the ballcourt. For my purposes it made sense to reposition it directly adjacent to the pit where someone would be standing to look down into the court as well as out across the site.

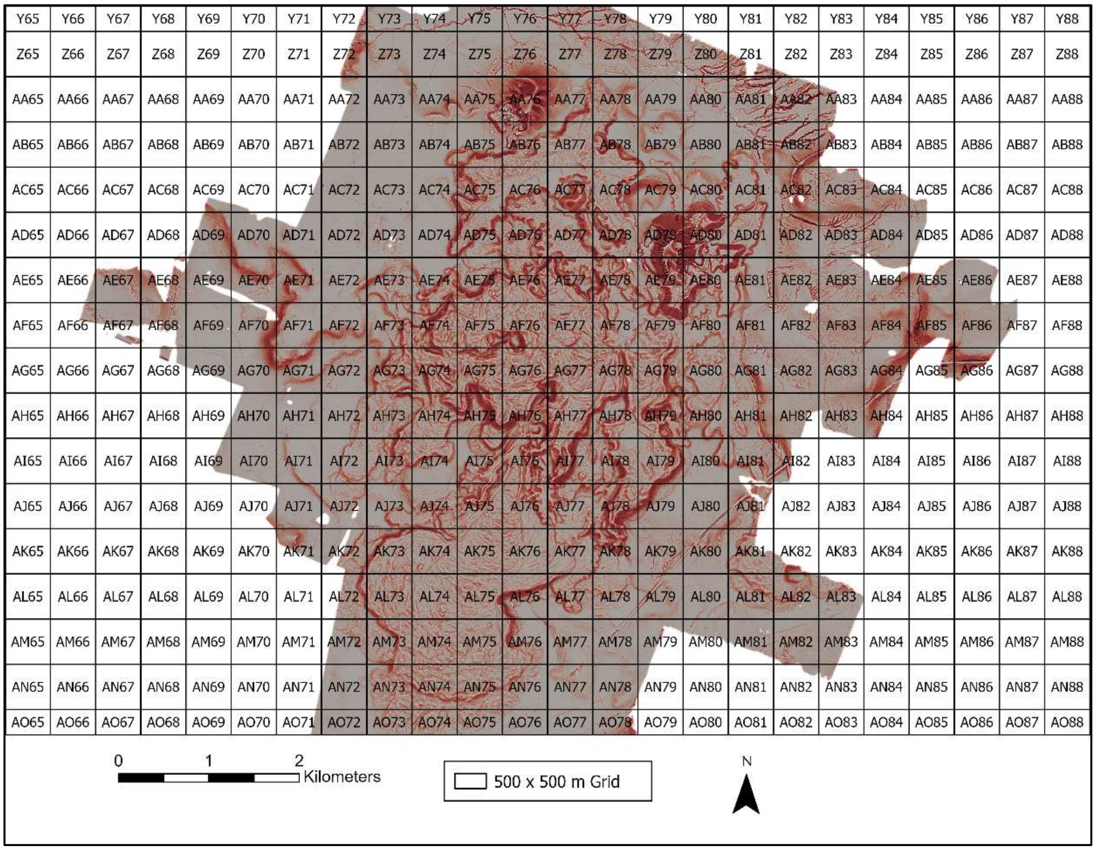

Figure 5. 8: The 500 x 500 meter block grid for Angamuco displayed over pseudo RRIM.

A major part of 'enriching' my dataset was adding more elite complexes. As I mentioned in chapter 4, I wanted to assess visibility from places where high-status people would have resided and operated, which would have included these elite complexes. Since they were built under the rule of the Purépecha elite, I was interested in whether they might have served as symbols of imperial power on the landscape. I was able to determine the locations of two additional elite complexes in Cohen's description of the Angamuco excavations (Cohen 2016). As I described in chapter 3, seven areas of Angamuco were excavated in 2013-2014 (Figure 3.

9), including areas A and D. Cohen (2016:74) describes area A as an elite domestic space "comprised of large buildings and enclosed plazas, patios, and rooms…only accessible on top of a terraced hill". Evidence suggests there was an elite occupation in this area primarily during the Middle to Late Postclassic (Cohen 2016:182). After talking to Chris Fisher, I verified that this area was indeed an elite complex, so I placed a new point here, giving it the designation AN74-Ec-1 (Figure 5. 9). There was also excavation area D, which contained a private elite zone with evidence of occupation during the Middle to Late Postclassic (Cohen 2016:184–186). According

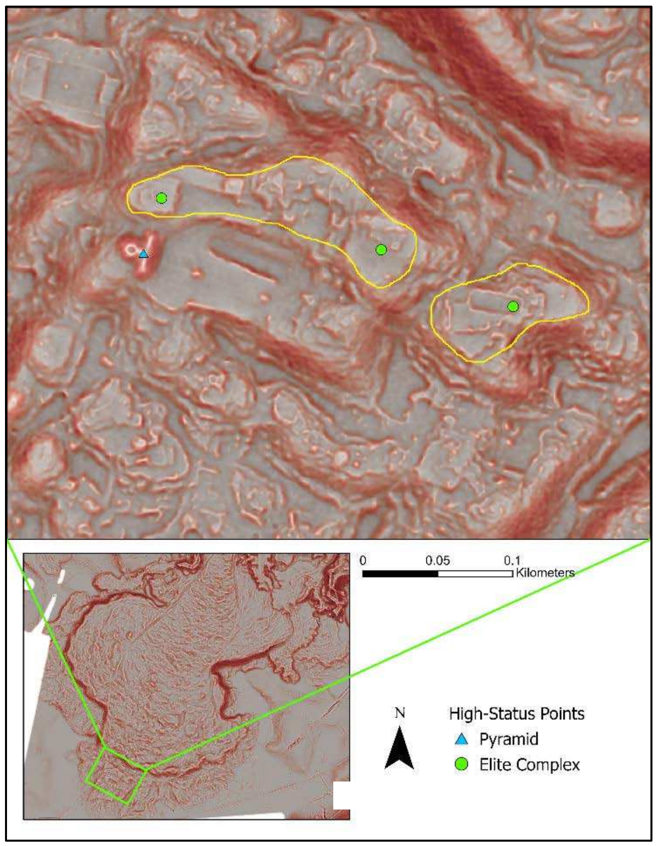

Figure 5. 9: Green circles are the three points placed at the locations of elite complexes documented during excavation. The yellow polygons trace the approximate outlines of the elite complexes. From left to right the points are AN73-Ec-2, AN73-Ec-3, and AN74-Ec-1.

to Chris Fisher, this area was a large elite complex with multiple buildings. I placed two new points at opposite ends of this area adjacent to different building foundations (Figure 5. 9).

I wanted to add more elite complexes to my dataset, but no others had been formally documented for the site. To get around this, I came up with a methodology to identify the locations of new elite complexes using the characteristics of the complejos that they occupied. According to Chris Fisher (personal communication 2022), complejos containing elite complexes would be distinguishable from complejos primarily occupied by commoners based on their attributes. This would include their area, number of archaeological features, distance to monumental architecture, and number of intersecting roads. I was able to quantify all of these attributes using the various GIS datasets for Angamuco described in the previous section, namely the datasets for complejo boundaries, archaeological features, pyramids, and roads. I also chose to look at another complejo attribute called *closeness*. This is a measure of integration and centrality that reflects how close a location is to all other locations within a defined radius. It essentially calculates how intimate locations are to each other as measured along a network. "The lower the closeness level of a complejo…the shorter the average distance from that complejo to any other surrounding complejo" (Solinis-Casparius 2019:261). Closeness values had been previously calculated by Rodrigo Solinis-Casparius as part of his PhD dissertation (Solinis-Casparius 2019:261–265). He used the complejo boundaries and calculated a closeness value for the centroid of each feature using both 250 and 500 m radii. I was able to acquire these datasets and found that the 250 m radius dataset was more suitable as it led to more noticeable groupings of complejos with similar closeness values (see Solinis-Casparius 2019:262).

Based on discussions with Chris Fisher, it was determined that complejos with elite complexes, or those associated with 'high-status', would generally be larger in area, closer to monumental architecture, and highly integrated (low closeness values with many intersecting roads), possibly with a high number of archaeological features. These criteria were based on observations of elite complexes at the site during survey and excavation. To identify complejos fitting these criteria, I first calculated the area of each complejo in ArcGIS Pro (version 3.0 from here onwards). Next, I computed the number of archaeological features within each complejo, and the number of roads intersecting each complejo using the Spatial Join tool. I used the Near tool to calculate the planar distance between each complejo and the nearest pyramid. For the closeness values, I took the dataset of complejo centroids acquired from Rodrigo Solinis-Casparius and joined it to the other complejo dataset based on matching IDs. In the end, every complejo polygon was enriched with data for area, number of archaeological features, number of intersecting roads, closeness, and distance to the nearest pyramid.

I had an expectation for the kinds of attribute values that complejos with elite complexes would have, but I didn't have any specific data ranges or cut-off values in mind. Also, not enough elite complexes had been identified to separate out a training dataset of representative complejos for a supervised classification. Instead, I decided to look for patterns and possible groupings in the attribute values amongst the complejos. I would then see if any of the groups matched the expected criteria described above. In ArcGIS Pro, I applied an unsupervised learning technique called multivariate clustering to the complejos shapefile. I used the Multivariate Clustering tool in the Spatial Statistics toolbox to identify natural clusters of features based solely on their attribute values. I used the K-means algorithm and let the tool determine the optimal number of clusters to generate. This resulted in the complejos being grouped into five clusters based on similarities in attribute values (Figure 5. 10). I analyzed the attribute values in each cluster (Figure 5. 11, Figure 5. 12) and determined that clusters 2 and 5 seemed the most likely to contain elite complexes based on the criteria defined earlier. Complejos in cluster 2 had the largest average number of archaeological features and the largest average size. They also had low closeness values, intersected a large number of roads, and were located close to pyramids. Complejos in cluster 5 were similar, containing a large number of features, having a large area, intersecting many roads, having low closeness, and being close to pyramids, except most of their values tended to be lower than the values of cluster 2. None of the other clusters had attribute values that matched the desired criteria. For example, the complejos in cluster 3 tended to have small areas, very large closeness values, and tended to be very far away from the nearest pyramid. This does not fit our expectations of where high-status elites would have resided at this site.

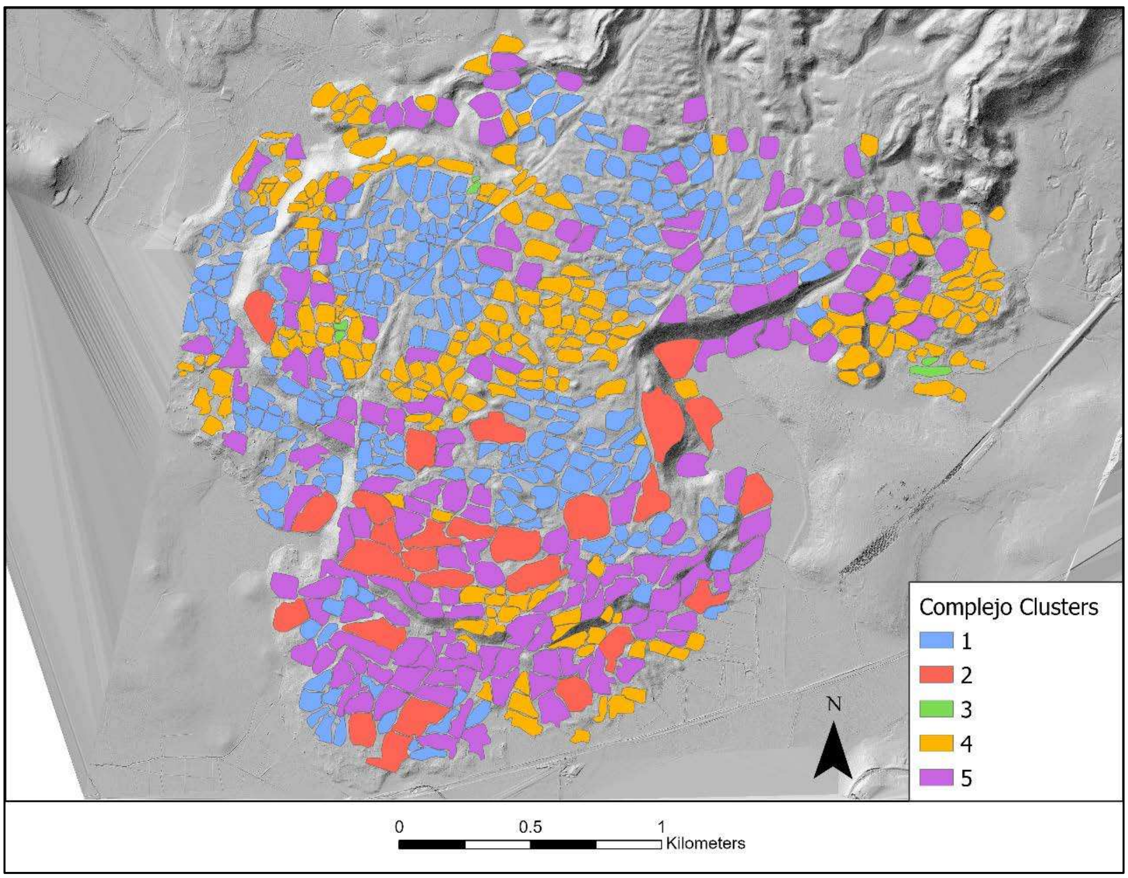

Figure 5. 10: Complejos grouped into five clusters, representing similarities in attribute values, from the Multivariate Clustering tool.

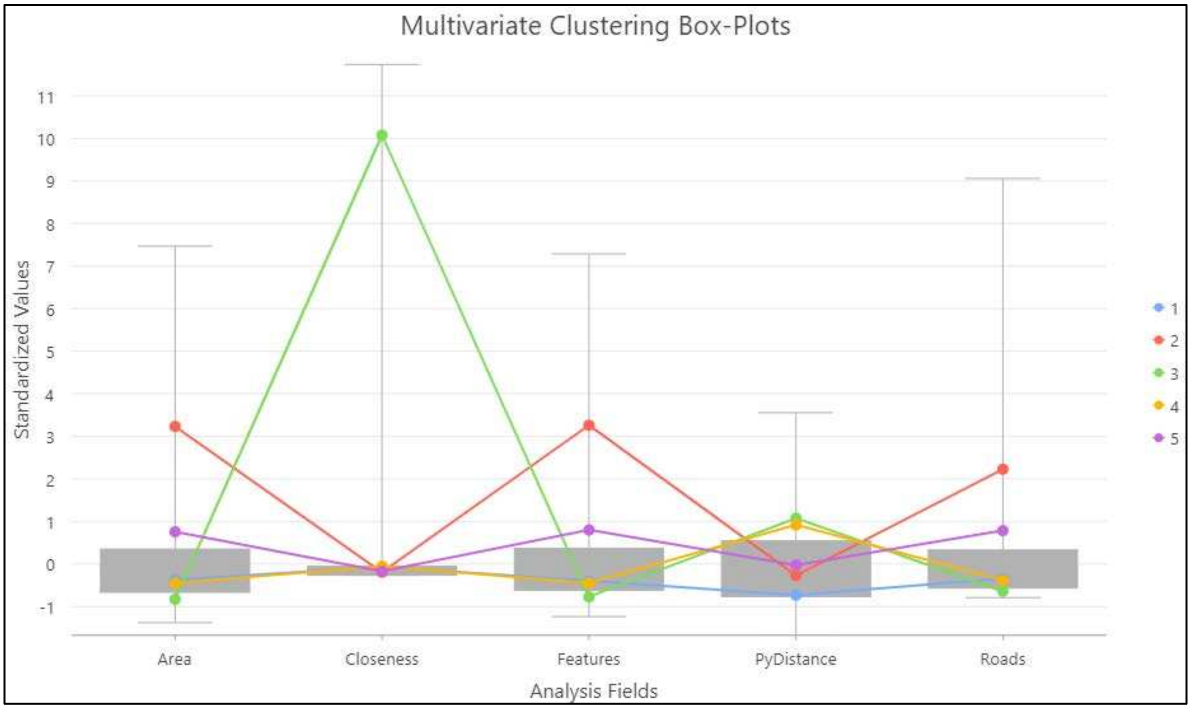

Figure 5. 11: Boxplots showing the distribution of values for each complejo attribute. The colored lines show the average values for each attribute in each cluster.

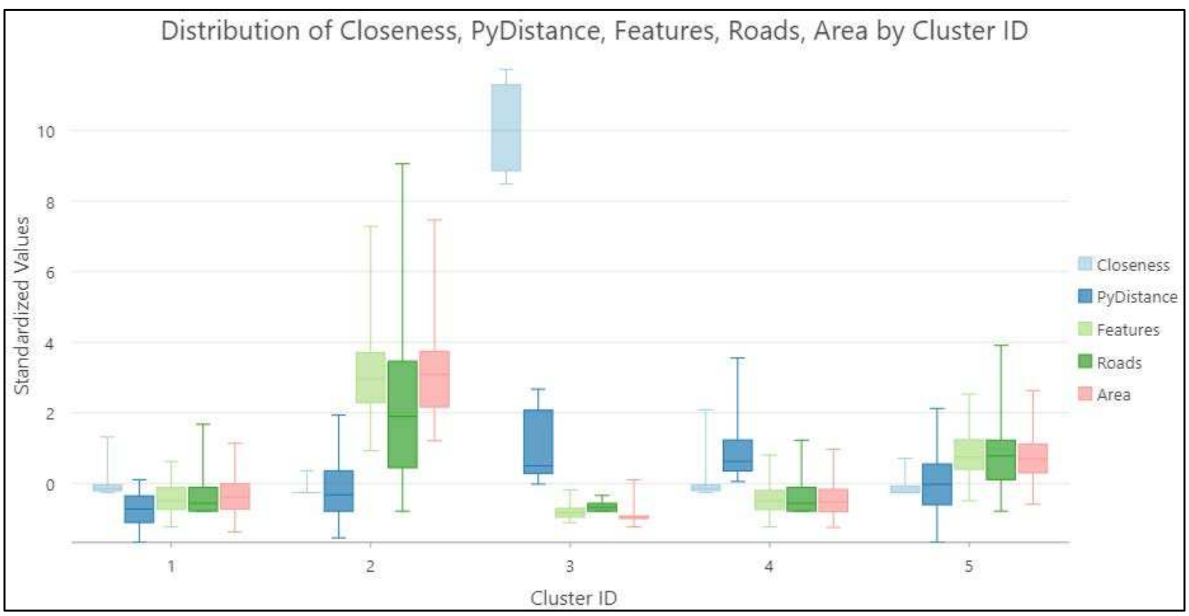

Figure 5. 12: Boxplots showing the distribution of values for each complejo attribute for each of the five clusters.

Using pseudo Red Relief imagery, I manually examined the complejos in clusters 2 and 5 looking for the remains of any elite complexes. I flagged a number of architectural features based on their size, walls/enclosed nature, complexity, and location. After showing these to Chris Fisher for verification, I ended up identifying what we believe are 13 new elite complexes. I placed new points at each of these locations which increased my high-status points dataset to 44 points in total: 27 pyramids, 1 ballcourt, and 16 elite complexes (Figure 5. 13). Unfortunately,

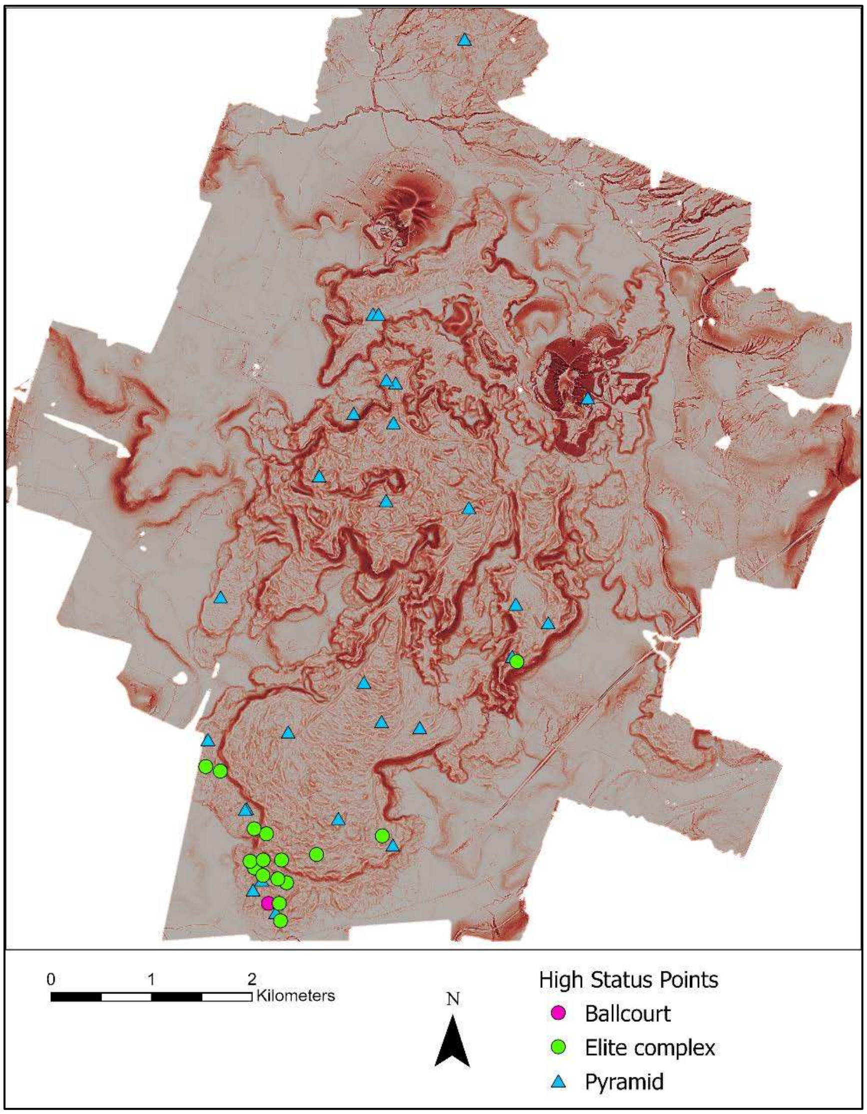

Figure 5. 13: Map showing the locations of all 44 high-status points overlain on pseudo RRIM.

since the complejo data was only available for the lower portion of the *malpaís*, elite complexes could only be identified in this area. A close up of this lower area is shown in Figure 5. 14.

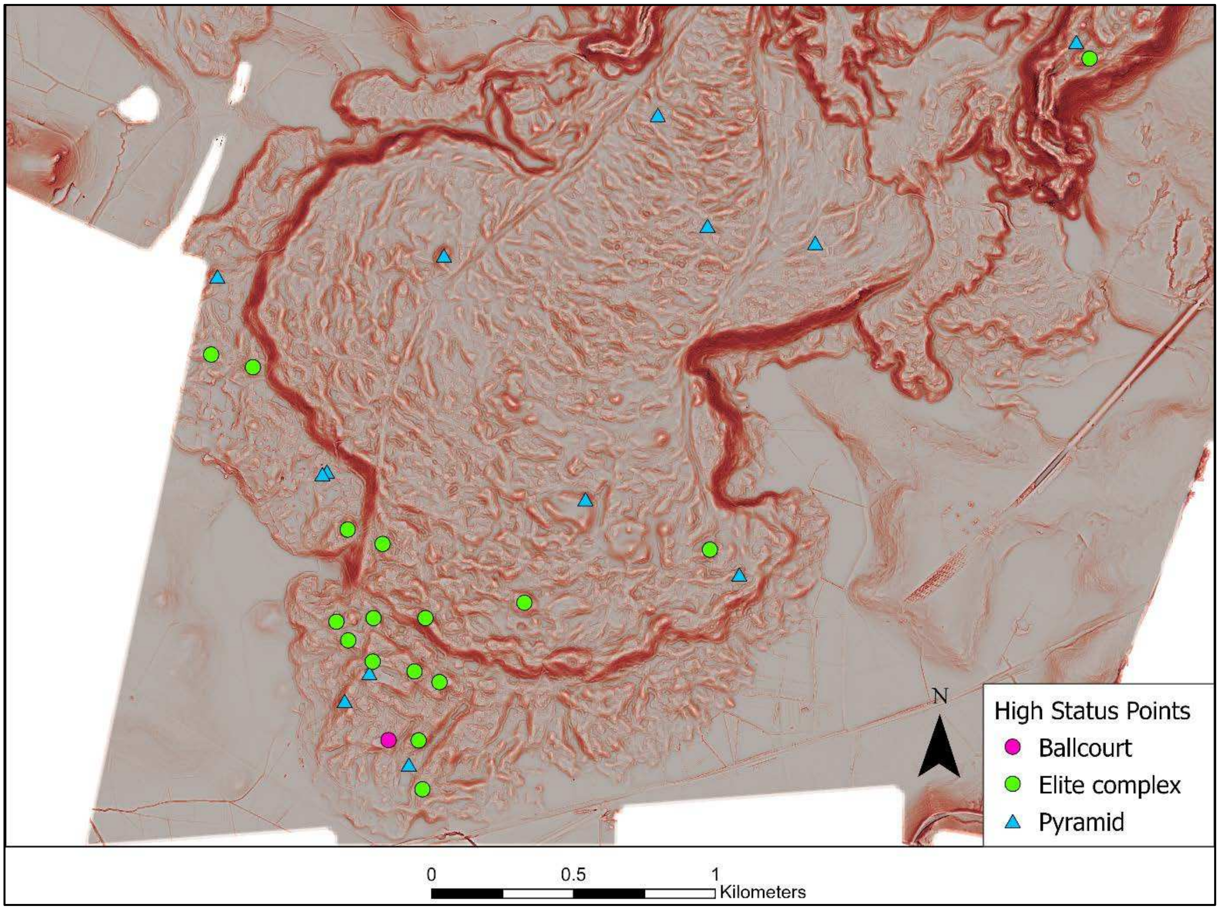

Figure 5. 14: Map showing a close up of the high-status points on the lower malpaís. All elite complexes were identified within this area.

Adding Observer Parameters to the High-Status Points

Now that I had created an enriched dataset of 44 high-status points, I needed to do one more thing before I could generate my viewsheds - I needed to assign appropriate observer parameters to each point for use in the Visibility tool in ArcGIS Pro. The only observer parameters that I used were SPOT, OFFSETA, and OFFSETB (see Figure 5. 2). To understand why I chose certain values for these parameters, it is important to restate the viewshed interpretation that I employed for this analysis. I chose to interpret my viewsheds like Figure 5. 2b, with an emphasis on *views to* the observer point. For each of my high-status points, I was interested in modelling where a person standing on the landscape would be able to see that respective structure. I was *not* modelling visibility from an observer standing at the top of each structure. It is unlikely that elites would have been continuously standing atop their pyramids or looking out the windows of their complexes keeping the population under constant surveillance. With this kind of Panopticism, it is not really about a physical observer standing and watching you, it is more about the perception that someone could be watching even if nobody is visible. This perception can be caused by the presence of a structure itself, especially when it is tall and highly visible. This could have been true for the elite complexes at Angamuco as well as for the pyramids because the latter are believed to have been topped with perishable structures that could have concealed potential observers. Illustrations of these perishable structures can be seen in the RM (Figure 5. 15). A similar situation exists in modern cities with security cameras – they might not

Figure 5. 15: Illustration from the Relación de Michoacán. On the left side you can see a pyramid with a perishable structure on top. This image was retrieved from

https://rbdigital.realbiblioteca.es/s/rbme/item/13166#?c=&m=&s=&cv=296&xywh=-531%2C-75%2C1959%2C1497

even work, but their presence alone (without seeing an actual observer behind the camera) is enough to make most people think twice about their actions. As another example, think about a police station. Would you commit a crime within view of a police station? Probably not. It is unlikely that you would be caught by someone looking out the window in that exact moment, but the presence of the building itself is a powerful incentive to act in a certain way. The building itself projects the power of the rule of law. This creates a Panoptic gaze and is also a form of middle-level messaging. It makes sense to use this viewshed interpretation when thinking about the projection of middle-level meaning because this comes directly from observing certain structures in the built environment.

I had to assign each high-status point a SPOT, OFFSETA, and OFFSETB value. All of these parameters are shown in Figure 5. 16. For the SPOT values, I extracted the DEM height at each point using the Extract Values to Points tool. This provided the height in meters asl (distances in red in Figure 5. 16). For the OFFSETB values, I was able to approximate the average height of a Purépecha male during the time of empire. I got this estimate from (Cook and Borah 1979:144), who listed average male heights from numerous indigenous tribes in Mexico. They listed the average height of Tarascan Janitzio males as 160 cm, and Tarascan Paracho males as both 161.4 cm and 162.4 cm (from two different sources). While these records were compiled in the 1940s to 1960s, they were the best estimates I could find for the average height of pre-Hispanic populations. I took the average of the three height measurements which came out to 161.3 cm or 5 feet and 3.5 inches. I decided to round this up to 5 feet 4 inches, or 1.63 meters, which I used as the OFFSETB value for each high-status point (Distance E in Figure 5. 16).

For OFFSETA I assigned different values depending on the kind of high-status structure. Since the pyramids are still physically standing at the site, their actual heights were recorded on the DEM surface and were thus already accounted for in the SPOT values. Since each pyramid point was placed at the top of each structure, the SPOT values actually recorded the height of the pyramid on the ground + the elevation of the ground surface above sea level (Distance A below the pyramid in Figure 5. 16). As an additional height to be added to the SPOT value, I assigned each pyramid an OFFSETA value of 1 meter (Distance B in Figure 5. 16). This extra meter was to account for the fact that these structures have degraded over time and have likely become shorter than their original stature. It's also believed that they would have been topped with perishable structures (Figure 5. 15), which would have increased their height and visibility. These perishable structures would have been taller than 1 meter, which makes my OFFSETA value a conservative estimate for additional height.

In the case of elite complexes, these are no longer standing structures but rather stone foundations on or under the ground surface. Thus, the SPOT values do not record the standing height of these structures (Distance A below the elite complex in Figure 5. 16). To get an OFFSETA value I needed to come up with a general estimate of how tall these elite complexes would have stood. Illustrations in the RM show that buildings associated with the nobility were single story with tall, peaked thatch roofs (Figure 5. 17). I also drew on more recent descriptions of native Purépecha commoner houses which state they were constructed of adobe or stone with four-shed roofs of grass or palm thatch (Beals et al. 1944; West 1948). Additionally, Smith (1992) described the construction of a traditional commoner house in the village of Tetlama, Morelos, Mexico. He described the stone foundations being built up to a max height of 1 meter, with walls that were built up to a height of 3 meters. A peaked thatch roof made of palm was then built up with gables about 1 meter high. Overall, the house would have stood about 4 meters tall. Based on all this information, I conjectured that the buildings within Purépecha elite complexes would have been single story, made of stone or adobe, with thatched roofs of straw or palm. If traditional commoner houses in Mexico could be up to 4 meters tall, I would imagine that buildings in elite complexes - like the Aztec tecpan - would have been larger with more elaborate decoration and taller roofs. As a general estimate, I took the height of 4 meters and added another meter giving me a height of 5 meters to use as an OFFSETA value for the elite complexes.

For the ballcourt, I assigned an OFFSETA value of 1.63 meters, which was the same as my OFFSETB value, reflecting the estimated average height of a Purépecha male. I did this because the ballcourt was not really a standing structure, instead it occupied an I-shaped depression in the ground. Being able to see the ballcourt would really mean being able to see a person standing at the edge of the court. Since the SPOT value recorded the ground surface at this location, it made sense to make the OFFSETA value equal to the height of a person standing on this ground surface (Distance D in Figure 5. 16).

At the end of this process, all 44 high-status points had values for SPOT, OFFSETA, and OFFSETB stored in the attribute table. Now I could proceed with the generation of viewsheds.

Generating Viewsheds from High-Status Points

First, I assessed the overall visibility of high-status structures across the whole site. To do this, I generated a cumulative viewshed surface. As I mentioned in the section on archaeological visibility analysis, a cumulative viewshed surface is basically like taking individual viewsheds for each observer point and summing them. Every cell in the raster is assigned a value that shows how many observer points it can see (Figure 5. 3). Cells with high values can see a large number of observer points. With the assumption of intervisibility this means they can also be seen by a

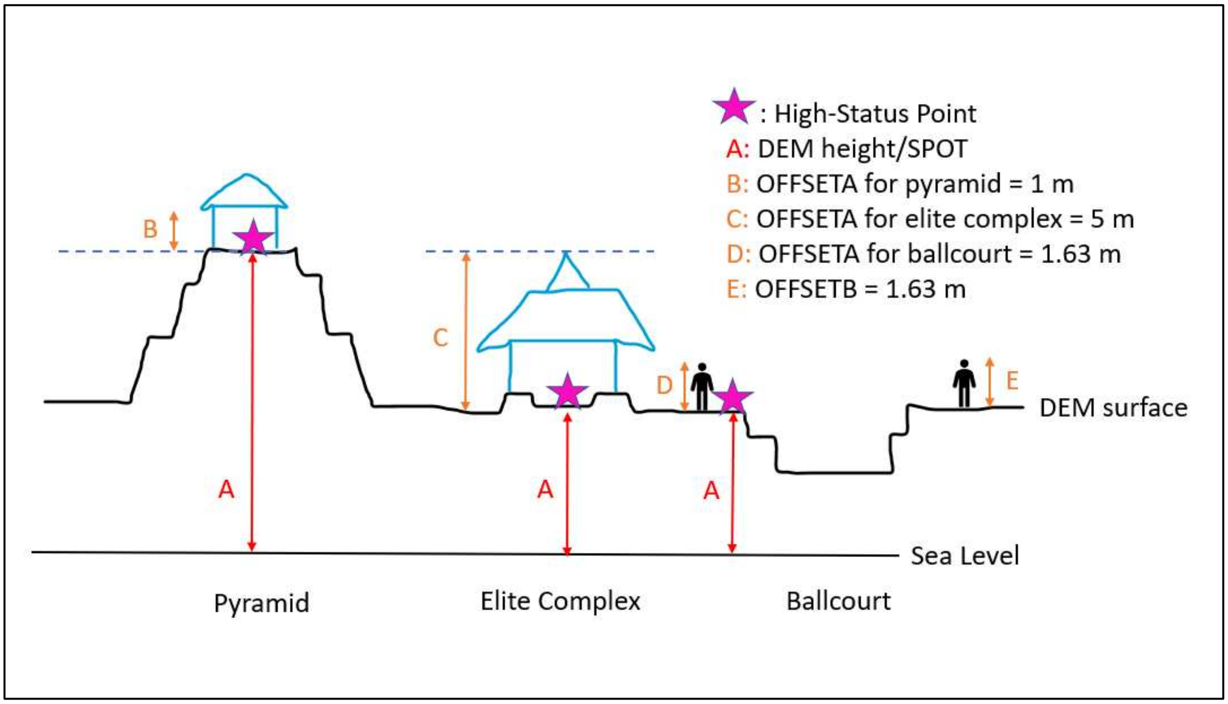

Figure 5. 17: Diagram showing the observer parameters for the different kinds of high-status structures. Hypothetical locations of the GIS data points are also shown. Notice how the DEM height is measured in meters asl. In reality, only the DEM surface is visible to an observer in the field. The buildings in blue are no longer standing. Distances and relative heights are not shown to scale.

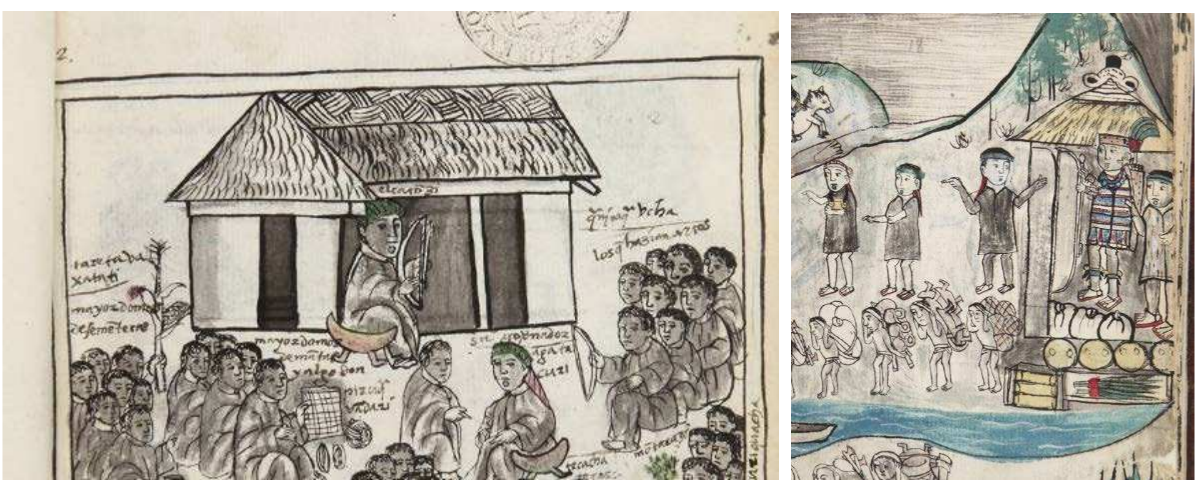

Figure 5. 16: Illustrations from the Relación de Michoacán showing buildings associated with the nobility. Images were retrieved from https://rbdigital.realbiblioteca.es/s/rbme/item/13166#?c=&m=&s=&cv=296&xywh=-531%2C-75%2C1959%2C1497

large number of observer points, meaning they are highly visible areas. Cells with a value of 0 cannot see or be seen by any observer points. At Angamuco, areas with high values on the cumulative viewshed surface represented places where a person standing at 5 ft 4 would be able to see many high-status structures. In these areas, there would be a strong perception of surveillance and a great deal of middle-level meaning being communicated. I generated the cumulative viewshed surface using the Visibility tool in ArcGIS Pro. I input the 0.5 m DEM and the high-status points shapefile, and I made sure the tool used the values for SPOT, OFFSETA, and OFFSETB in the attribute table. I also used earth curvature corrections with the default refractivity coefficient of 0.13 because it made the viewshed generation more realistic. I also calculated the total visible area by taking the total number of cells in the cumulative viewshed surface and multiplying this by the area of one pixel which was 0.25 m^2.

The next step was to generate individual viewsheds for each high-status point. Since there were 44 points, it would have taken a long time to manually generate each viewshed, so I wrote a Python script that automated the process. The script selected each point one by one and ran the Visibility tool each time. Since only one point was selected at a time, the tool only output a single viewshed for that point on each run. For the tool parameters I used earth curvature corrections with the default refractivity coefficient, and I selected the appropriate attribute fields for SPOT, OFFSETA, and OFFSETB. This produced 44 viewsheds.

At this point I had the idea of classifying each viewshed based on distance. This was meant to resolve the issue of object background clarity. As discussed in the section on archaeological visibility analysis, viewsheds are usually generated with no outer limit to visible distance, thus ignoring the fact that visibility diminishes with distance and is affected by the size of the object. I realized that I could address this by applying the fuzzy viewshed method from

(Ogburn 2006) where you take the width of an object and multiply it by 3440 to get the distance at which it would subtend 1 arcminute. Past this distance, the object would theoretically be unrecognizable under normal conditions. It seemed quite difficult to discern the width of each high-status structure, so I decided to use the height of each structure instead. Multiplying the height by 3440 would give the distance at which the structure would become vertically unrecognizable. This could be used to classify each viewshed into two distance classes – within and beyond this limit of recognition. This would make each viewshed more realistic, as it would account for the drop-off in visibility with increased distance. Cells falling beyond this limit could still be coded as 'visible', but it would be unlikely that someone standing at that location would be able to recognize the structure with normal eyesight under normal conditions. In order to do this, I had to get the standing height of each high-status structure. For the pyramids, I already had the DEM height of each structure (the SPOT value), but this was in meters asl. If I could calculate the base surface height of each structure – the height of the topography at the base of the structure – then I could subtract this from the SPOT to get the standing height in meters. In order to get the base surface heights, I generated a 0.4 m contour layer for the site. For each pyramid I manually examined the contours and found the elevation that best defined the base of each structure (Figure 5. 18), then I used the formula below to calculate the standing height of each pyramid.

$$Standing\ Height = SPOT - Surface\ Height$$

For the elite complexes, the standing heights were the same as the OFFSETA value of 5 m that I had derived earlier. Since the ballcourt was not really a standing structure, the standing height was also set to the OFFSETA value of 1.63 m.

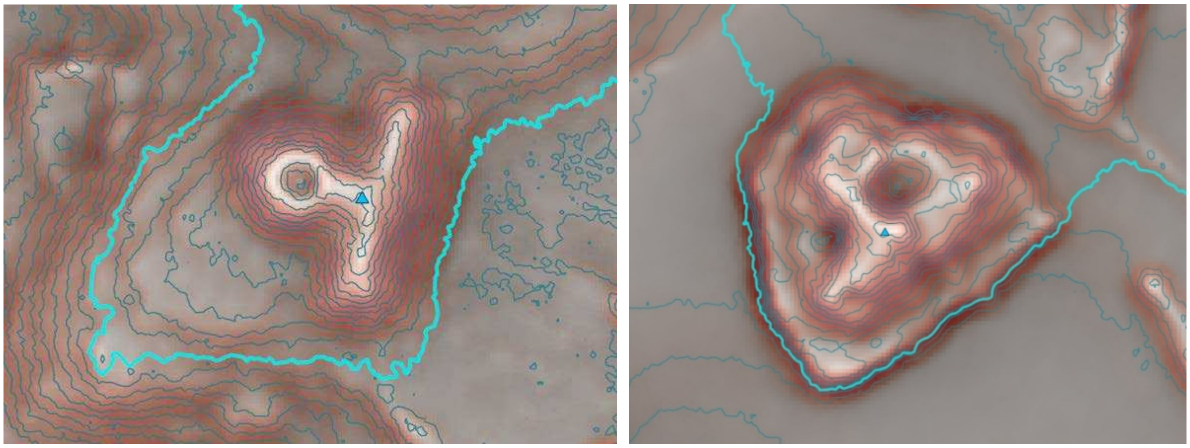

Figure 5. 18: Examples of 0.4 m contours generated for two pyramids (left) main yácata AN73-Py-1 and (right) yácata AC75-Py-1. The highlighted contours are the one's chosen as the base surface height.

Even though I had calculated standing heights for all my points, I did not end up classifying the viewsheds by distance. This is because the shortest high-status structure (except for the ballcourt) came out to be 2.15 m tall, and when multiplied by 3440 this gave a distance of 7396 m. If you measure straight line distances from this point in any direction you find that a distance of 7396 m is always off the *malpaís*. Since every other point except the ballcourt was taller than this, their outer limits of recognition would be even further away. For the ballcourt, a standing height of 1.63 led to a recognition limit of 5607.2 m. After measuring straight line distances from the ballcourt, only three pyramids at the far northern end of the site fell beyond this limit. This made classifying the viewsheds somewhat pointless because in every case except for the ballcourt, the break between distance classes would be off the *malpaís* and beyond the area of the DEM.

Recording Attributes for the High-Status Viewsheds

Now that I had viewsheds for my high-status points, I needed a way to quantify the visibility of each structure. One obvious approach was to calculate the area of each viewshed. Structures with large viewsheds would be visible from a greater area of the site, which would be better for Panoptic surveillance and the communication of meaning. However, I was also interested in examining the kinds of landscape and architectural features falling within these viewsheds. Going back to my hypothesis, if high-status structures really were positioned to facilitate Panoptic surveillance and communicate middle-level meaning, we would not only expect their viewsheds to be large, but we would also expect them to encompass specific areas and features, especially areas of occupation and activity. After all, a viewshed might be large, but if it mostly covers areas with little human presence, it would be quite useless as a means of social control. In this sense, the size of the viewshed is important, but also its contents.

To determine the kinds of features that I could quantify within the viewsheds, I explored the spatial datasets available for Angamuco. I ended up using the same ones that I had used to identify complejos with elite complexes. These datasets were 1) complejo boundaries for the lower *malpaís*, 2) roads for the lower *malpaís*, 3) built up archaeological features for the lower *malpaís*, and 4) reservoirs for the entire site (see Figure 5. 6, Figure 5. 7). These datasets together represented areas of occupation and activity across the site, so if the high-status structures really were positioned for Panoptic surveillance and middle-level messaging, it would make sense for their viewsheds to encompass large numbers of these features.

I was also interested in looking at intervisibility between high-status structures – would their viewsheds encompass large numbers of other high-status structures? If so, it would indicate that visual communication was maintained between high-status areas across the site. Overall, for each viewshed, I needed to calculate the attribute data below.

- Viewshed area (Km^2)
- Total length of roads within the viewshed (m)
- Total complejo area within the viewshed (Km^2)
- Number of built up archaeological features within the viewshed
- Number of reservoirs within the viewshed
- Number of other high-status points within the viewshed

I had data available for all the attributes of interest, meaning I could quantify them for each viewshed. However, the various datasets did not all cover the same area of the site, so this had to be done in two independent study areas: 1) the entire site, and 2) the lower *malpaís*. The reservoir dataset was the only one available for the entire site (Figure 5. 6), while the roads, complejos, and archaeological features were only available for the lower portion of the *malpaís* (Figure 5. 7*)*. This presented an issue because a viewshed generated from a point at the northern end of the site would likely cover little of the lower *malpaís*. As a result, it would have low counts for roads, complejos, and archaeological features. This could lead to the interpretation that the structure was not positioned well for surveillance and the communication of meaning. However, this would be a skewed interpretation, as the low data count in the viewshed was actually caused by a lack of data in the northern area of the site. There were probably complejos, roads, and many archaeological features in this area, they just haven't been mapped or digitized yet. To get around this, I decided to record different attributes for each study area. For the entire site (using the entire sample of 44 high-status points) I only recorded attribute data that was available for this area. These attributes were 1) the area of each viewshed, 2) the number of other high-status points within each viewshed, and 3) the number of reservoirs within each viewshed.

The methodology that I used to record these attributes is shown in Figure 5. 19. The area of each viewshed was calculated using the number of cells and the area per cell (0.25 m^2), which was then converted to Km^2. I modified the script that created the viewsheds so that it would run this calculation each time, exporting the area values to a text file. I manually examined each of the 44 viewsheds to count the number of other high-status points falling within. To get the number of reservoirs within each viewshed I used the Spatial Join tool. Since this tool only takes in feature classes, I wrote a Python script that converted each of my raster viewsheds into a polygon shapefile using the Raster to Polygon tool. A second script ran the Spatial Join tool on each polygon viewshed with the reservoirs as the join features and the match option set to

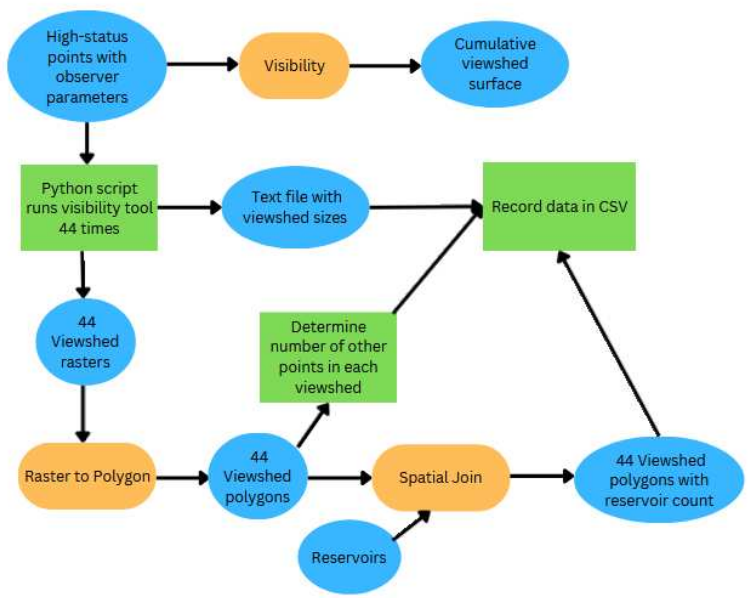

Figure 5. 19: Flowchart showing how viewshed attributes were recorded for the entire site.

CONTAINS. This output 44 new viewshed polygons, each one with a join count that recorded the number of reservoirs within the respective viewshed. All of these data were recorded in a CSV file specific to this study area.

For the lower *malpaís*, I drew a bounding box around this study area (Figure 5. 20) then worked with the 30 high-status points within this box as an independent sample. I wrote a new Python script that took the 30 viewshed polygons for these points and clipped each one to the bounding box. This was meant to restrict the analysis to this area. For each of the clipped viewshed polygons I recorded 1) viewshed area, 2) the number of other high-status points within the viewshed, 3) the number of reservoirs within the viewshed, 4) the number of built up archaeological features within the viewshed, 5) total road length within the viewshed, and 6)

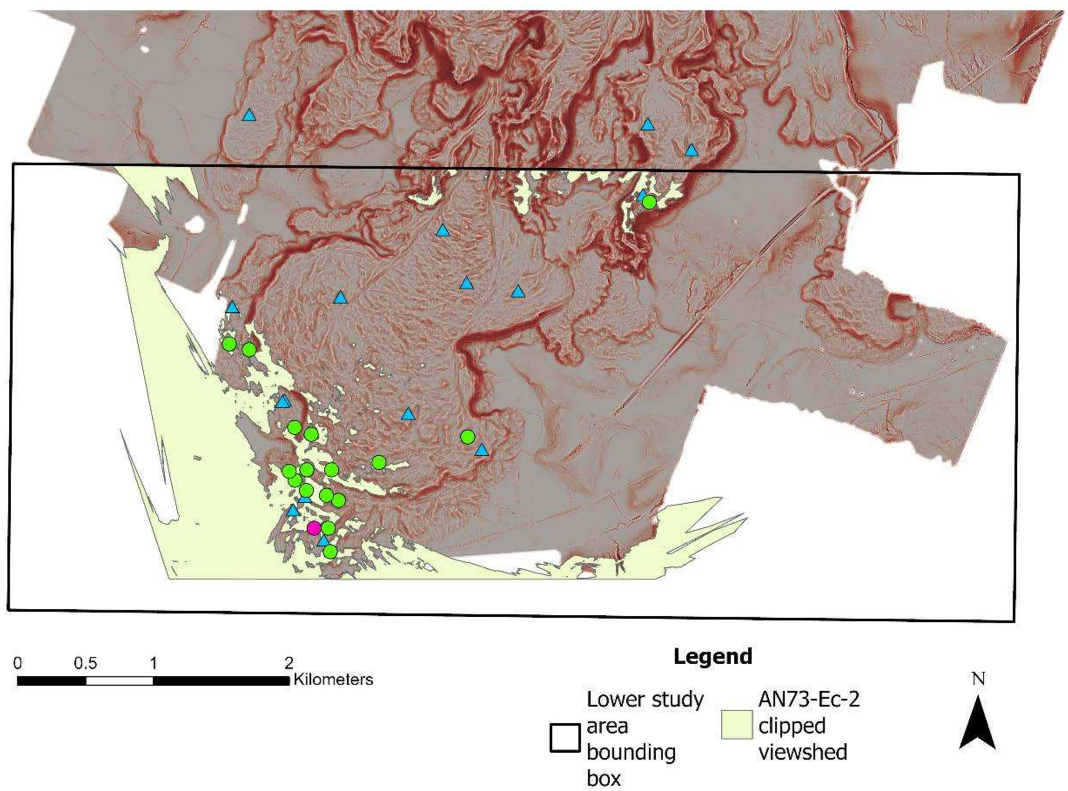

Figure 5. 20: Map showing the bounding box used to delineate the lower malpaís study area. There are 30 high-status points within this box. The viewshed polygon for one of these points (AN73-Ec-2) is shown after being clipped to the box.

total complejo area within the viewshed. The values for viewshed area, number of other high-status points, and number of reservoirs were calculated independently from the values in the other study area. In this case they were calculated using the clipped viewsheds (instead of the unrestricted viewsheds), so they were constrained to the area within the bounding box. The methodology for recording these attributes is shown in Figure 5. 21. The area of each clipped viewshed was calculated using the Calculate Geometry Attributes tool, and the number of high-status points was found by manually examining each clipped viewshed. To get the number of

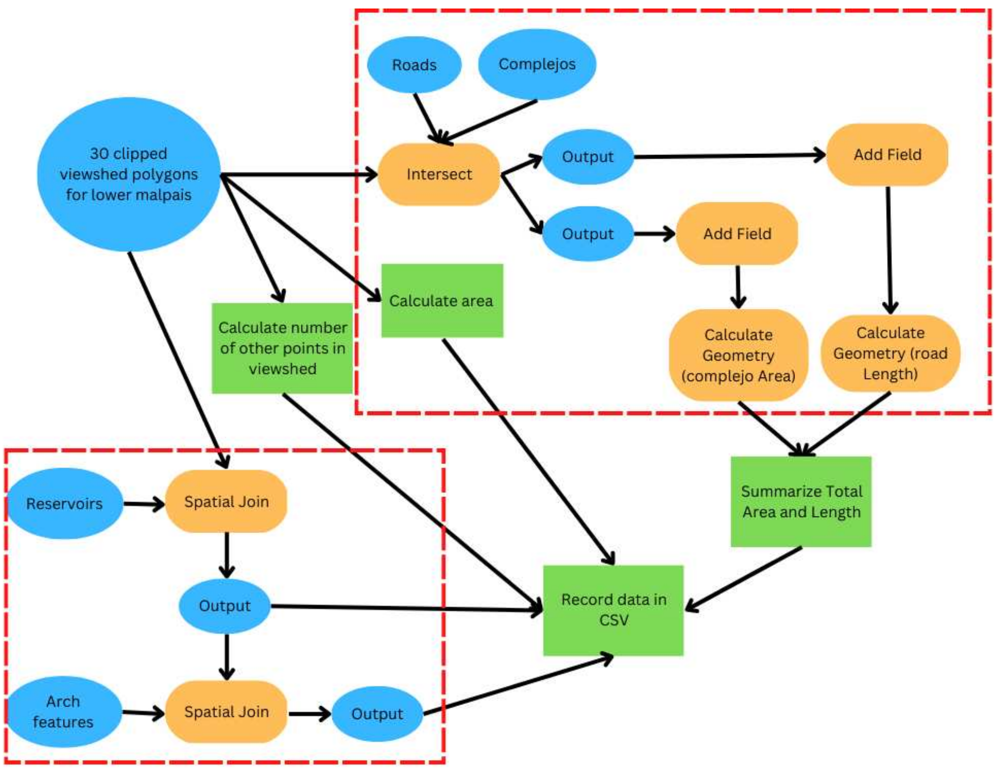

Figure 5. 21: Flowchart showing how viewshed attributes were recorded for the lower malpaís study area. All processes within a red dotted box were automated through a Python script.

reservoirs and archaeological features, I wrote a new Python script that ran successive spatial joins on each clipped viewshed. Each output contained join counts for both attributes. To get the total road length within each viewshed, I wrote another Python script that intersected each clipped viewshed with the road’s dataset. Each resulting layer contained only the road segments within the viewshed area. The script then added a new field, calculated geometry on this field to get the length of each road segment, then summed the total length of all the segments and wrote this to a text file. To get the total complejo area within each viewshed, I wrote another Python script that repeated this process, except it intersected each clipped viewshed with the complejo dataset, then calculated and summed area values rather than length. All of these data were then recorded in a new CSV file specific to the lower study area.

Isolating the lower *malpaís* as a separate study area also helped address another issue – since the additional elite complexes were identified using the complejos, and since the complejo data was only available for the lower area of the site, these elite complexes were only identified in this lower area. The dataset of high-status points across the entire site was therefore potentially biased, with a disproportionate number of points being identified on the lower *malpaís* simply because this is where most of the fieldwork, and therefore most of the data was from. Consequently, these points might not be representative of the true distribution of high-status structures across the site. However, by using the lower *malpaís* as a separate study area, the viewsheds, and the quantification of their attributes, were constrained to this area. Since this lower area has been well documented through survey and excavation, we know that the high-status points identified here are pretty representative of the reality on the ground. Because of this, the bias is essentially removed when focusing solely on this lower area. Therefore, analysis in the lower study area should provide more reliable results than that of the entire site. Even so, analyzing points across the entire site should not be disregarded. The aforementioned bias – the higher density of high-status points on the lower *malpaís* – might not be that problematic in a temporal sense. The lower *malpaís* was the main area of elite occupation during the late Middle and Late Postclassic while the upper areas of the site were mainly occupied earlier in time.

Therefore, it would make sense to find more imperial high-status structures, especially elite complexes, on the lower *malpaís*. Overall, it was still important to look at both study areas.

Even with of all of this attribute data recorded, it still wasn't that useful for addressing my research question. After all, I could analyze all of the viewshed data, but the results would be quite uninformative without a comparison to some baseline. This is where I drew inspiration from a paper by Jacob Bongers and co-authors (Bongers et al. 2012). They looked at funerary towers in the Lake Titicaca Basin known as chulpas and investigated the extent to which they visually dominated the landscape. There was an implicit assumption amongst past researchers that these towers were made to be highly visible on the landscape, so they decided to formally test this through spatial analysis. They generated individual viewsheds for each chulpa, then combined them into a cumulative viewshed map. Next, they generated a sample of random points within their study area and did the same for these. They statistically compared the sizes of the viewsheds from the chulpas with the sizes of the viewsheds from the random points and found them to be significantly different. They interpreted this as suggesting that visibility did play a role in determining chulpa location – the towers were not positioned randomly in relation to visibility, rather they were placed in highly visible locations, allowing them to have a strong social impact (Bongers et al. 2012).

I decided to conduct my analysis in a similar manner. I wanted to statistically compare the attributes of high-status viewsheds to the attributes of viewsheds generated from random points to look for significant differences. If found, this would indicate that high-status structures were not positioned randomly in relation to their visibility, or in other words that visibility played a role in determining their locations. I expected that if the high-status structures really were positioned to facilitate Panoptic surveillance and the communication of middle-level meaning, their viewsheds would be larger, they would include more reservoirs and built up archaeological features, and they would contain a greater length of roads and a greater complejo area than the viewsheds from random points. In other words, I would find evidence that the structures were highly visible across the site, especially from areas of dense occupation and activity.

Viewsheds from Random Points

In order to have a fair comparison with the high-status points, I needed to generate two samples of random points – a sample of 44 points across the whole site, and a sample of 30 points within the lower *malpaís* bounding box. I would generate viewsheds and record attributes for these two samples independently. I started by generating points across the entire site. To do this, I created a new polygon feature class that covered the main area of the Angamuco *malpaís* (Figure 5. 22), then I used the Create Random Points tool to generate 44 random points within the bounds of this polygon area (Figure 5. 22 right). I set the minimum distance between points to 18 meters as this was about the closest that any two high-status points were to each other. Next, I assigned the random points SPOT values from the DEM using the Extract Values to Points tool. I also assigned each random point an OFFSETB value of 1.63 m to match those of the high-status points. For the OFFSETA values, I needed to assign the random points the same standing height values as the high-status points. This was essential for a fair comparison. If I had just left them as they were, the viewsheds from the high-status points would have ended up being larger simply because they were generated from structures that were taller. To do this, I used the standing height values for the high-status points that I had calculated earlier in my attempt to classify the viewsheds by distance. I randomly distributed these 44 standing height values to the

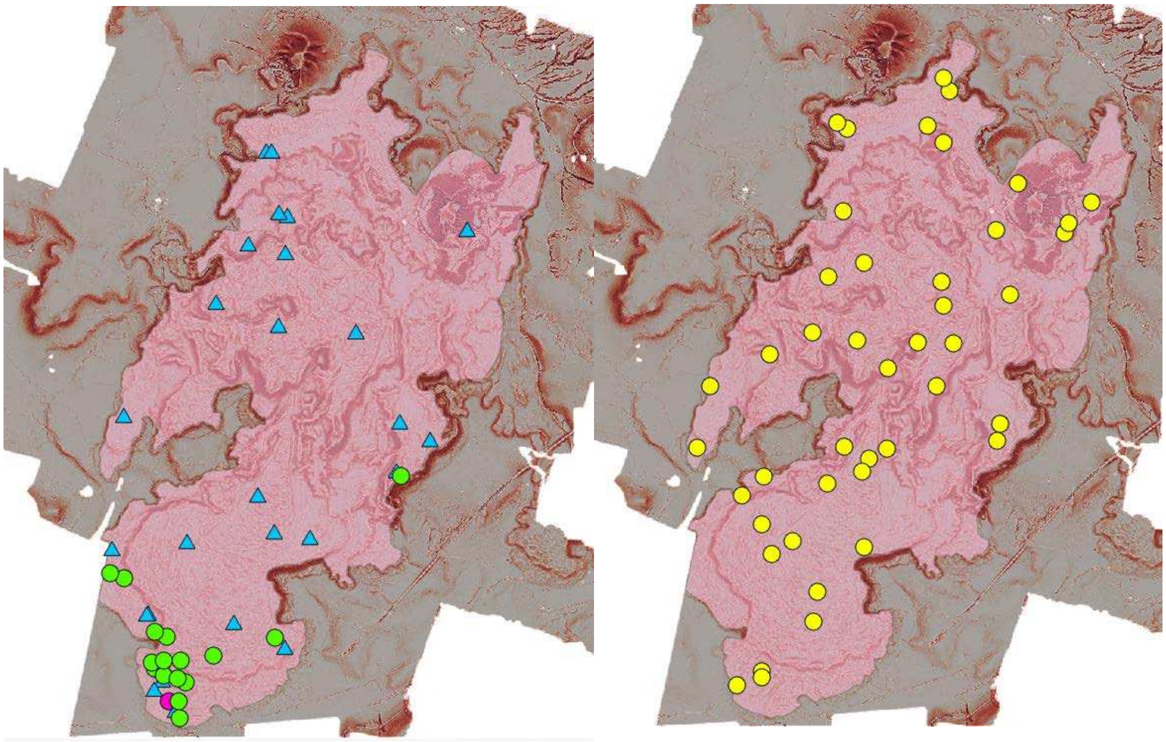

Figure 5. 22: (left) polygon covering the main malpaís area of Angamuco with high-status points shown inside. (right) the sample of 44 random points generated within this area.

44 random points. This was done by generating a random number between 1 and 44, then going to the attribute table of the high-status points shapefile and taking the standing height value in that respective row. This value was then placed in the attribute table of the random points shapefile. Next, I generated a random number between 1 and 43 and got another standing height value after crossing out the row that I had previously used. This was repeated until all height values had been assigned. I also added an extra 1 meter to any random point that received its height value from a pyramid. This was to account for the 1 meter OFFSETA value that was added to the height of every pyramid. Once this process was completed, each random point had an OFFSETA value in its attribute table that was directly equivalent to the standing height of a high-status structure. This was basically like taking the high-status structures and randomly

distributing them across the landscape – the only thing that changed was the elevation of the ground surface beneath them.

Now that the random points had observer parameters assigned, I could proceed to generate viewsheds. Since I had generated a cumulative viewshed surface for the high-status points across the whole site, I did the same with the 44 random points for comparison. I used the Visibility tool with the random points and the 0.5 m DEM as input, and I made sure to use the same settings that I had used previously.

The next step was to generate individual viewsheds for the random points. I did this using a modified version of the Python script that had generated viewsheds for the high-status points. The script ran the Visibility tool on each random point with the same parameters used for the high-status points. This produced 44 raster viewsheds. The script also calculated the area of each viewshed in Km^2 and wrote these values to a text file. I recorded the same attributes for these viewsheds that I had recorded for the high-status viewsheds across the entire site: viewshed area, the number of other random points in each viewshed, and the number of reservoirs in each viewshed. The process for quantifying these attributes was the same as for the high-status points. In order to count the number of reservoirs within each viewshed I had to re-run the script that converted each raster viewshed into a polygon shapefile, as well as the script that ran the spatial joins. All of this attribute data was recorded in a new CSV.

Now I generated a sample of 30 random points for the lower *malpaís* study area. Unlike for the high-status points, I couldn't just separate out the 30 southernmost points from the total sample because there were less than 30 of them within the lower bounding box. Previously, I had created a polygon covering the main area of the Angamuco *malpaís* (Figure 5. 22). I clipped this polygon to the lower study area bounding box, then I used the Create Random Points tool to generate a sample of 30 random points within this area (Figure 5. 23). Once again, I set the minimum distance between points to 18 meters. I assigned SPOT, OFFSETB, and OFFSETA values to the points in the same way that I had for the other sample of random points. First, the SPOT values were taken from the DEM with the Extract Values to Points tool, then the OFFSETB values were set to 1.63 m. For the OFFSETA values, I took the standing height values of the 30 high-status points in the lower study area and randomly distributed them to the 30 random points.

I generated viewsheds for the 30 random points using the same Python script as before. All of the parameters for the Visibility tool were the same as the previous runs. This created 30 new viewshed rasters. In order to compare these to the viewsheds from the high-status points, they needed to be clipped to the lower study area bounding box. I did this by re-running two

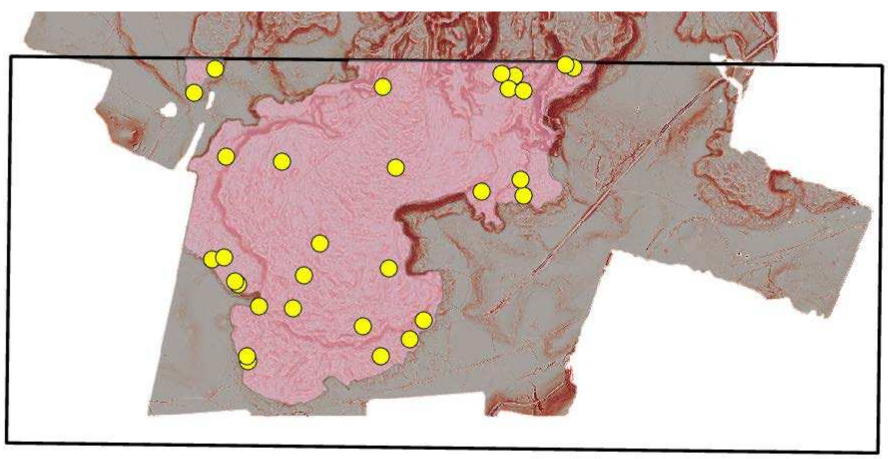

Figure 5. 23: The polygon shapefile for the main area of the Angamuco malpaís after being clipped to the lower study area bounding box (seen in black). 30 random points have been generated within this clipped area.

of my Python scripts to convert each raster into a polygon shapefile, then clip each shapefile to the bounding box.

Just like with the high-status viewsheds, I recorded attribute data for viewshed area, number of other random points within each viewshed, number of reservoirs within each viewshed, number of built up archaeological features within each viewshed, total length of roads within each viewshed, and total complejo area within each viewshed. These attribute values were quantified in the same way as for the high-status viewsheds, and the data were recorded in a new CSV file.

It might be argued that clipping the viewsheds to the lower bounding box can still lead to skewed results in the attribute data. If we look at points located at the northern edge of the bounding box, it is likely that their viewsheds will have large areas extending out of the box to the middle and upper *malapaís*. These areas will be clipped out. As a result, these viewsheds might have a smaller area inside the bounding box with lower counts for archaeological features, roads, and complejos, simply because most of their area extends outside of the box where none of this data is available. This could be misinterpreted as suggesting that these structures were not positioned well for surveillance and the communication of meaning. While there is no simple fix to this issue, the fact that it pertains to both high-status and random viewsheds makes it less of a concern. Both the high-status and random datasets had points located at or near the northern edge of the bounding box. As a result, both datasets suffered from this issue, and since this analysis was predicated on comparisons between the two datasets, the problem evened out between them.

At this point I had four CSV files with attribute data. Ultimately, my results would hinge on a comparison with two samples of random points. If different samples of random points were used, maybe the results would change? To try and account for some of this random variability, and to test the robustness of the analysis, I decided to generate four more samples of random points – two samples of 44 points across the entire site, and two samples of 30 points in the lower study area – and repeat the process of generating random viewsheds and recording attributes for them. Now instead of two comparisons, the results would be based on six comparisons. If I found that high-status viewsheds had greater attribute values than the viewsheds from *multiple* random datasets, it would provide stronger evidence in support of my hypothesis. The process of creating these new random points, generating viewsheds, and recording attributes for the viewsheds was exactly the same as for the previous random points. In the end I had four more CSV files, giving a total of eight: high-status viewsheds across the entire site; random viewsheds 1, 2, and 3 across the entire site; high-status viewsheds for the lower site; then random viewsheds 1, 2, and 3 for the lower site.

Comparing High-Status and Random Viewsheds

Each of my CSV files was organized so that each row represented an individual viewshed, the first column had the designations for the viewsheds, and each column after that represented a different viewshed attribute. I started by computing summary statistics (mean, median, and standard deviation) for each viewshed attribute. This way I could see, for example, the average area of high-status viewsheds across the whole site and compare this to the average area of random viewsheds across the whole site. I also generated summary statistics for the type of high-status structure to see how attribute values differed between, for example, *yácata* pyramids vs rectilinear pyramids, vs elite complexes. Further data exploration and statistical comparisons were carried out in RStudio. I first generated boxplots comparing the distribution of viewshed attributes between the high-status points, and each dataset of random points. These comparisons were done separately for the two study areas. Next, I statistically compared the viewshed attributes between datasets. I originally wanted to use an unpaired two-sample t-test for this, but some of the boxplots suggested that certain viewshed attributes were not normally distributed. Since the t-test has an assumption of normality in the data, I decided to investigate this further by creating histograms and Q-Q plots for the different viewshed attributes. I found that some of them, like the number of reservoirs within high-status viewsheds across the whole site, were indeed non-normal. This can be seen in Figure 5. 24 (top) where the histogram is heavily right skewed and the values on the Q-Q plot deviate strongly from the diagonal line. The number of archaeological features within high-status viewsheds is also highly right skewed and non-normal (Figure 5. 24 bottom). It was clear that I could not assume normality in the distribution of all viewshed attribute values. If my sample sizes had been very large this could have been okay, but for the lower study area I only had 30 points, which is usually considered the bare minimum for this. Ultimately, I decided to avoid using the t-test for statistical comparisons. Instead, I used the unpaired two-sample Wilcoxon Rank Sum Test, also known as the Mann Whitney U Test. This is a non-parametric alternative to the unpaired two-sample t-test, meaning it does not make any assumptions about the distribution of the data. The test is used to determine whether two independent samples are likely to derive from the same population. The two-sided test determines if a significant difference exists between the two independent samples, while the one-sided test can be used to determine if one population has significantly larger or smaller values than the other. The null hypothesis of the Wilcoxon test is often interpreted as meaning equal medians, so rejecting the null means there is a location shift between the two distributions where the medians differ. In RStudio, I ran the Wilcoxon Rank Sum Test for every viewshed attribute. I statistically compared the attribute values from the high-status viewsheds to the attribute values from the first, second, then third sample of random viewsheds. Comparisons were done separately for each study area. Each comparison produced two p-values (a one sided p-value and a two-side p-value) which I evaluated against a significance level of 0.05. These p-values were recorded in two tables (one for each study area), which can be found in the results chapter.

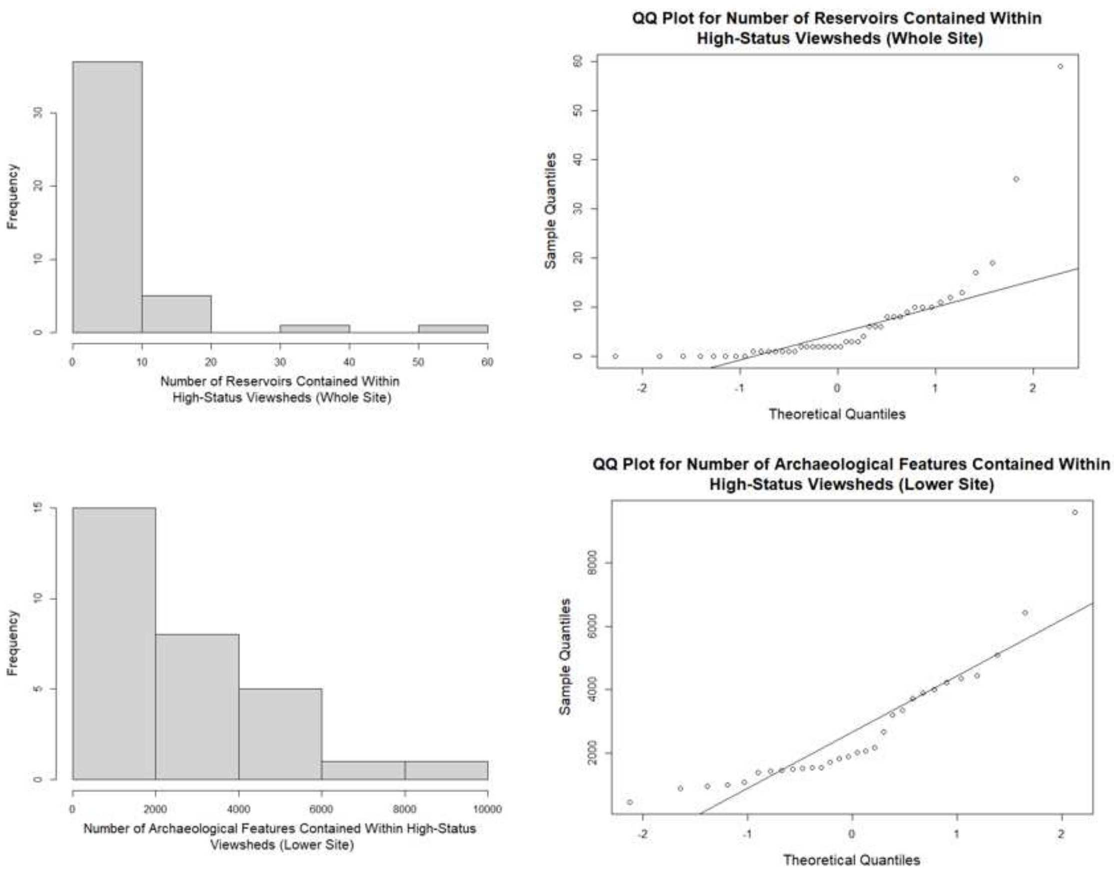

Figure 5. 24: Histograms and Q-Q plots for (top) number of reservoirs in high-status viewsheds across the entire site, and (bottom) number of archaeological features in high-status viewsheds for the lower site

Visibility of High-Status Structures from Southern Road Into the LPB

I was informed that just south of the Angamuco *malpaís* there was a road that served as an important entrance into the LPB in pre-Hispanic times (Chris Fisher, personal communication

2022). This road still exists as an unpaved track that is visible in satellite imagery (Figure 5. 25). As an additional part of my analysis, I wanted to assess the visibility of the high-status structures on the lower *malpaís* from this road. You can see that the road passes quite close to some of the high-status points on the lower *malpaís*, so it is reasonable to think that these structures may have been highly visible from it. This could have been a purposeful act of planning on the part of Purépecha rulers at Angamuco, making it so that travelers entering and exiting the LPB would be placed under the watchful gaze of these symbols of imperial power. This could have made for a

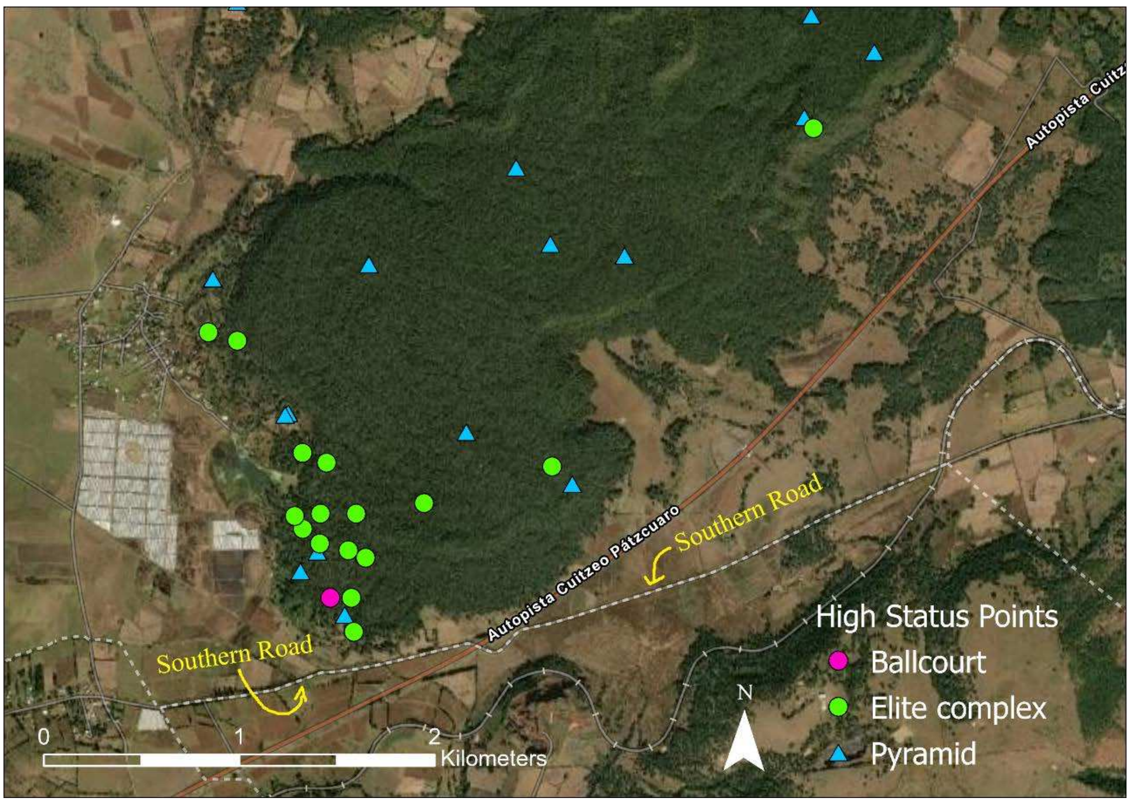

Figure 5. 25: Satellite imagery of the Angamuco malpaís with high-status points displayed overtop. To the south, you can see the main pre-Hispanic road leading into the LPB (dotted line) which is now crossed by the modern Autopista Cuitzeo Pátzcuaro highway.

good intimidation tactic, especially for emissaries or tributaries entering the LPB.

I first digitized a portion of the road (red line in Figure 5. 26) then decided to assess visibility by calculating the total length of this line (in meters) falling within each of the viewsheds for the 30 high-status points on the lower *malpaís*. However, these viewsheds were constrained to the extent of the Angamuco DEM, which did not cover the full length of the road segment (Figure 5. 26). To get around this, I generated new viewsheds from the high-status

Figure 5. 26: Digitized portion of main southern road is shown as a red line. This is overlain on the Angamuco 0.5 m DEM. Note that the DEM extent does not cover the full length of the road segment.

points on the lower *malpaís* using a 2.5 meter resolution DEM that covered the full extent of the LPB. I acquired this DEM from Dr. Stephen Leisz, a LORE-LPB project member, who had created it through digital photogrammetry using panchromatic images from the PRISM sensor aboard the ALOS satellite. I projected this dataset into the WGS 1984 UTM Zone 14N coordinate system, then used it in the Visibility tool in ArcGIS Pro to create 30 new viewshed rasters. Using the viewsheds from this DEM presented its own issues because unlike the DEM for Angamuco, this dataset recorded more than the bare earth terrain surface. In technical terms it was a Digital Surface Model (DSM), a specific type of DEM that records the elevation of natural and human made features on the earth’s surface such as modern trees and buildings. Since the *malpaís* is heavily forested in modern times, visibility was obstructed more than it would have been in the past. In other words, viewsheds generated using the Angamuco bare-earth DEM were more realistic on the *malpaís*. I came up with a solution to use the viewsheds from both DEMs together. For each high-status point on the lower *malpaís*, I took the viewshed generated from the LPB DEM, and the viewshed generated from the Angamuco DEM, then converted both of these into polygon shapefiles. I then used the Merge tool in ArcGIS Pro to combine the viewsheds. An example for one of the points is shown in Figure 5. 27. You can see that the viewshed from the LPB DEM covers much less of the *malpaís* area, probably because of

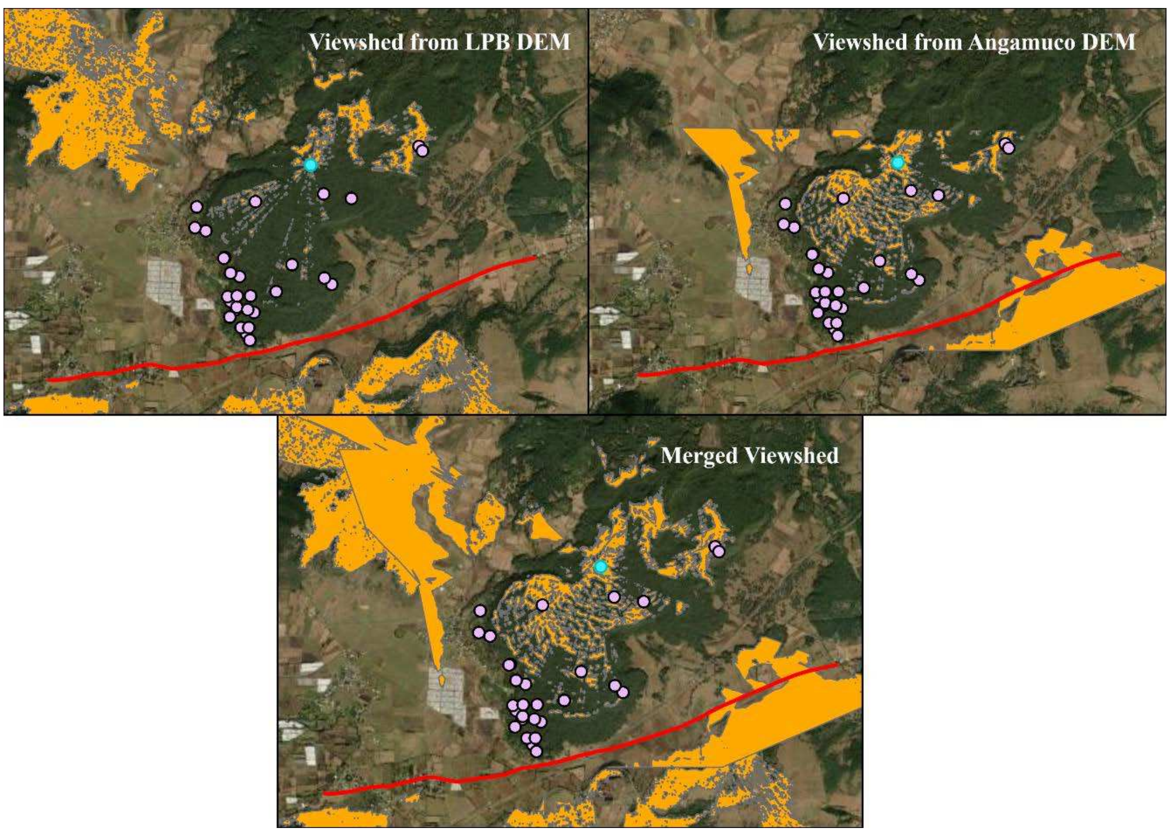

Figure 5. 27: Viewsheds for point AJ75-Py-1. (Top left) viewshed generated using the 2.5 m DEM for the LPB. (Top right) viewshed generated using the 0.5 m DEM for Angamuco. (Bottom) both viewsheds merged together into a single polygon feature class.

obstructions from modern trees, but it is useful for areas beyond the extent of the Angamuco DEM.

Each merged viewshed was intersected with the line shapefile of the main southern road. This was automated in a Python script which also added a new field to each resulting intersect layer and ran Calculate Geometry to get the length of each line segment in meters. These values were then summed for each dataset. I then calculated summary statistics (mean, median, SD) for the different kinds of high-status structures, to see how the visible length of the road differed between them.

Chapter Summary

I started this chapter by reviewing background information on LiDAR, and archaeological visibility analysis. Next, I described the methodology for my Angamuco visibility analysis. This involved acquiring and enriching a point dataset of high-status structures across the site, generating a cumulative viewshed surface for these points, then generating individual viewsheds for each point. I then utilized various other spatial datasets for Angamuco to record key attributes representing areas of occupation and activity for each viewshed. This was done in two separate study areas – the entire site, and the lower *malpaís.* I then created three datasets of random points and repeated this process, generating viewsheds for them, and recording the same viewshed attributes. The attribute data from high-status viewsheds were then statistically compared to those from random viewsheds.

Additionally, I generated new viewsheds for the high-status points on the lower *malpaís* using a 2.5 m DEM for the entire lake basin. These were merged with the viewsheds generated using the Angamuco DEM and then intersected with the main southern road leading into the LPB to find the total length of this road contained within each viewshed.

CHAPTER 6: RESULTS

This chapter presents the results of the Angamuco visibility analysis. I will show the cumulative viewshed surfaces for the high-status and random points, then I will show how certain viewshed attributes varied across the site. Next, I will present the summary statistics and boxplots for the high-status and random viewshed attributes, as well as the p-values for the statistical comparisons. I will also show the results for the visibility of the main southern road into the LPB.

Cumulative Viewshed Surfaces

The first cumulative viewshed surface was generated using the sample of 44 high-status points across the entire site. This is shown in Figure 6. 1. Below this you can see the cumulative viewshed surface for the first sample of random points across the entire site (Figure 6. 2), as well as the cumulative viewshed for the third sample of random points (Figure 6. 3). I am not showing the cumulative viewshed for the second sample of random points because it is very similar to Figure 6. 2.

Figure 6. 1 shows the overall visibility of high-status structures across the site. A person standing in one of the grey areas would not be able to see any high-status structures. On the other hand, someone in one of the red areas would theoretically be able to see the greatest number of high-status structures. You can also think of these areas as being the most visible from high-status structures. There are zones of very high visibility off the *malpaís* to the west, southwest and southeast, as well as about midway up the *malpaís* where the landscape increases in elevation. There is also a tall mountain at the northeast end of the site that is highly visible. The

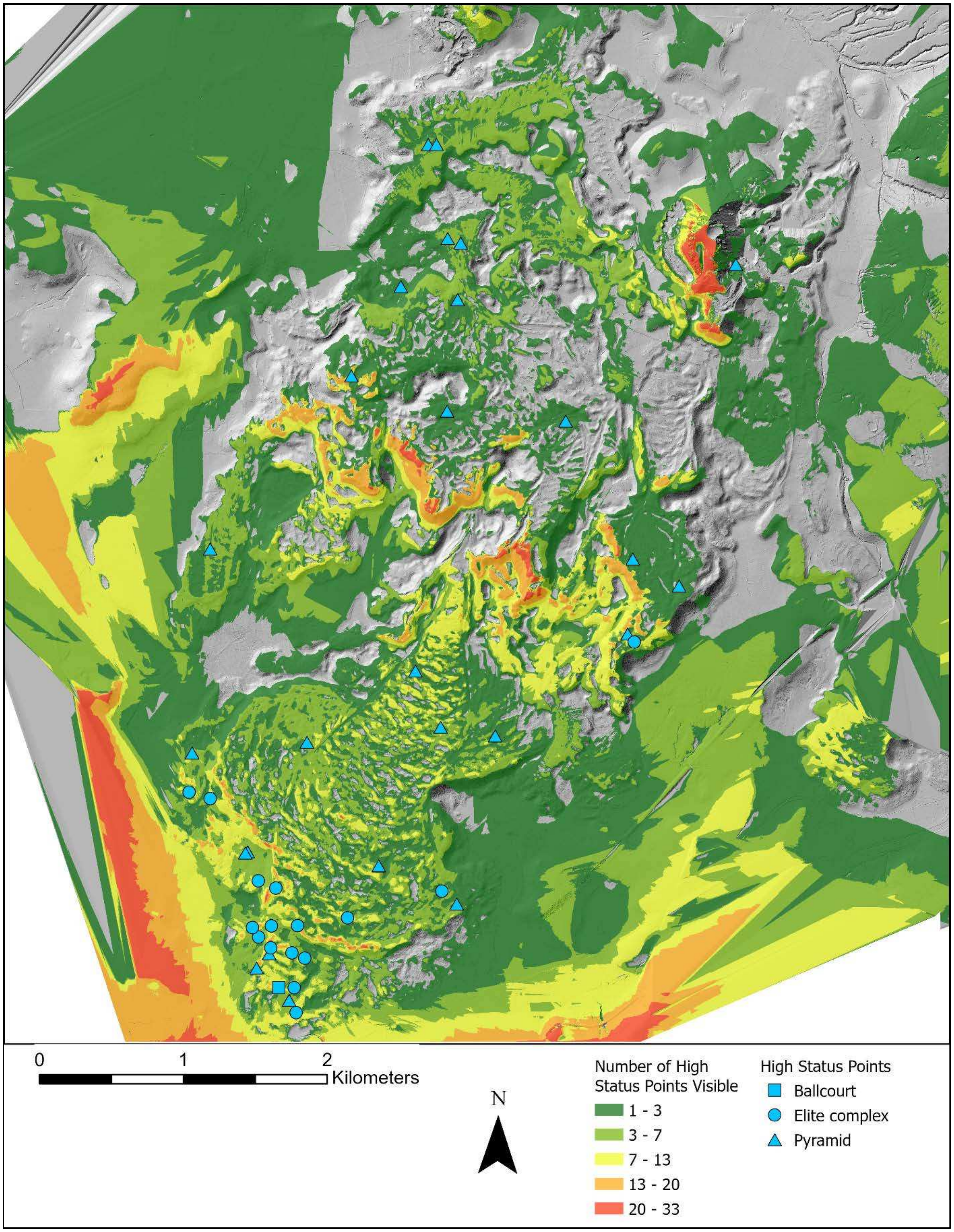

Figure 6. 1: Cumulative viewshed surface for 44 high-status points across the entire site of Angamuco.

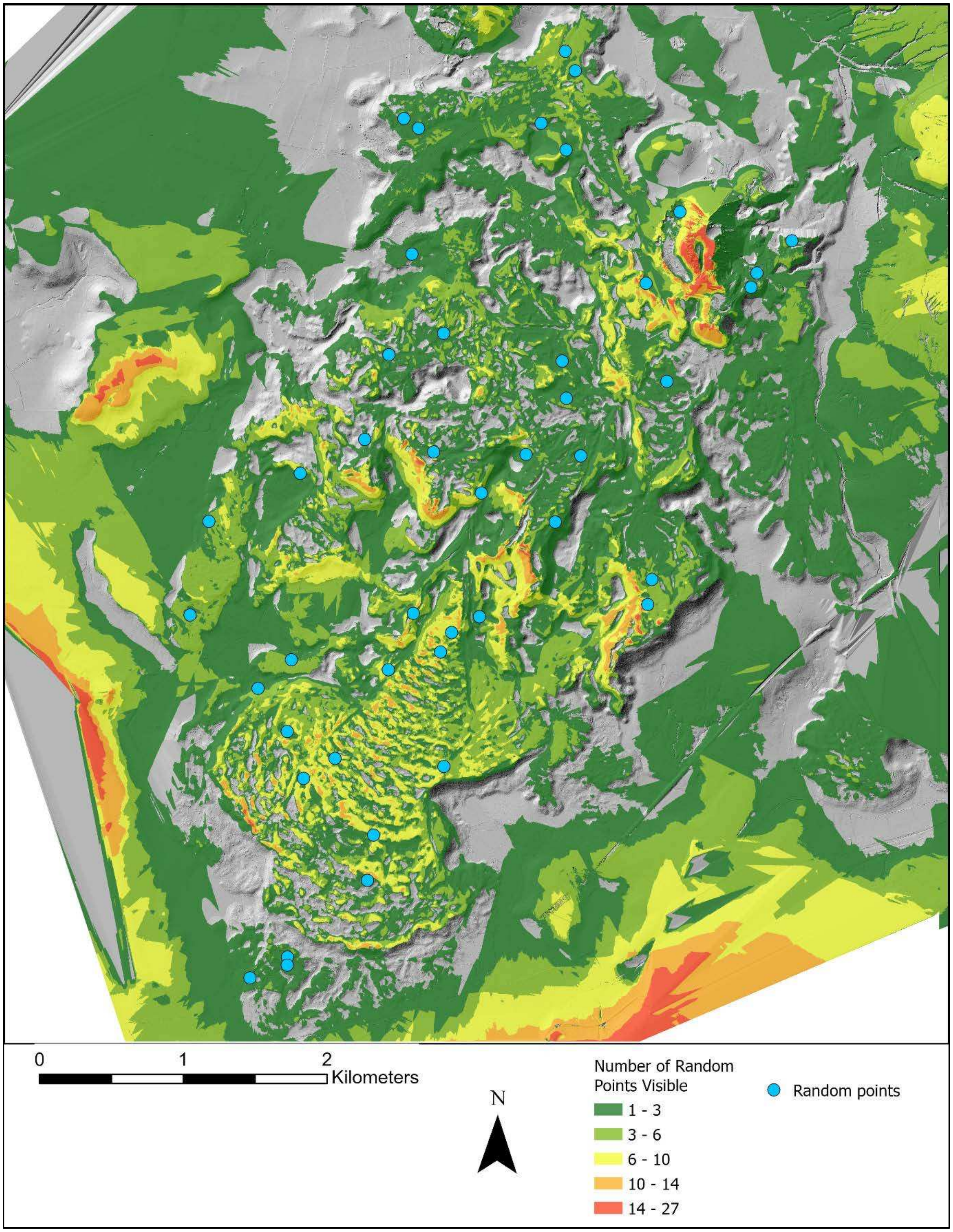

Figure 6. 2: Cumulative viewshed surface for the first sample of 44 random points across the entire site of Angamuco.

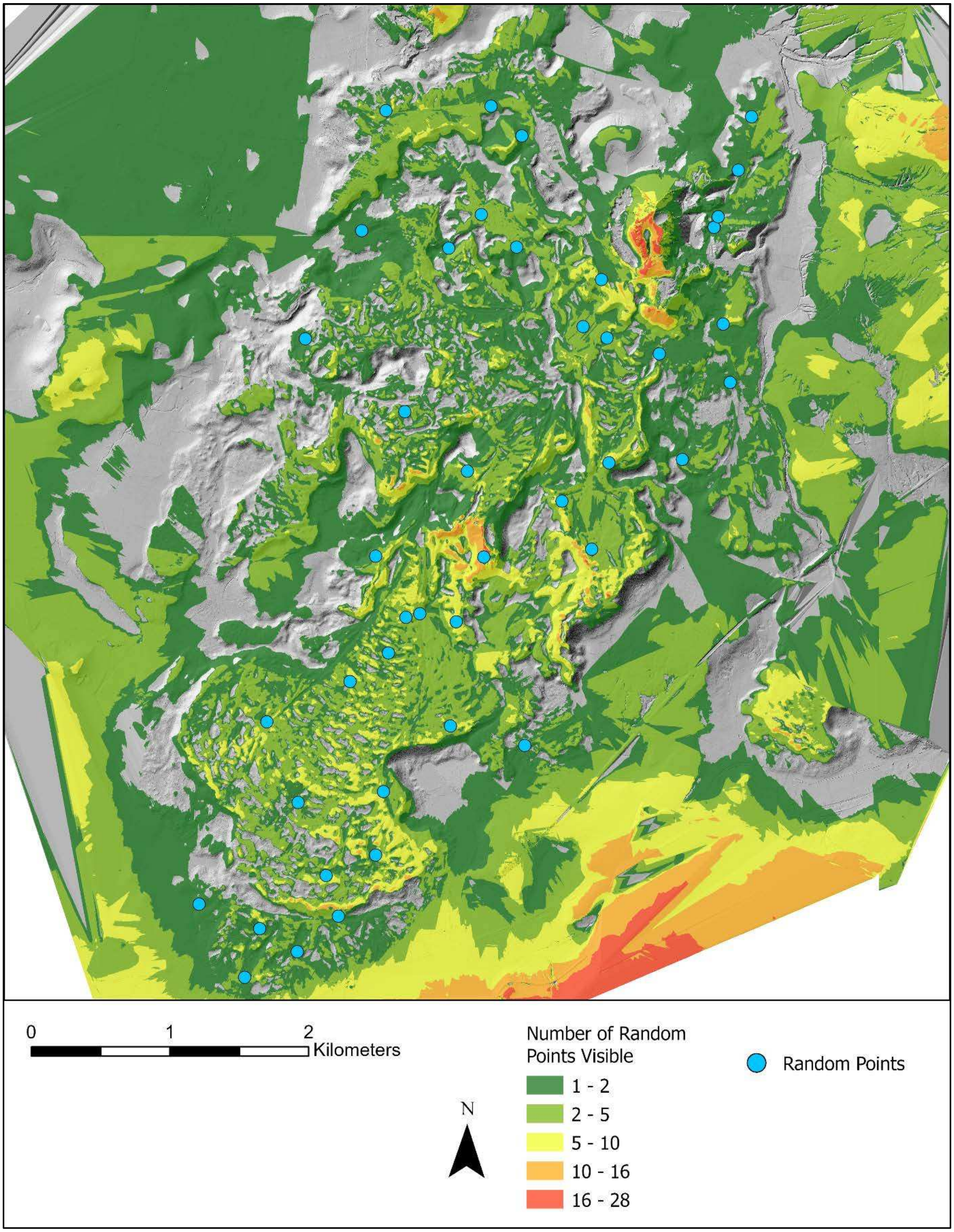

Figure 6. 3: Cumulative viewshed surface for the third sample of 44 random points across the entire site of Angamuco.

lower *malpaís*, especially the southwestern edge and the area around the main *yácata*, also have some very high visibility values. A close up of this area is shown in Figure 6. 4. The locations with the greatest visibility tend to be on hills and ridges that are elevated relative to their surroundings. This is also where high-status structures tend to be located. To show this better, I created Figure 6. 5. On top you can see the high-status cumulative viewshed surface focused on this area. On the bottom you can see the same area but with a 2 m contour layer to emphasize the

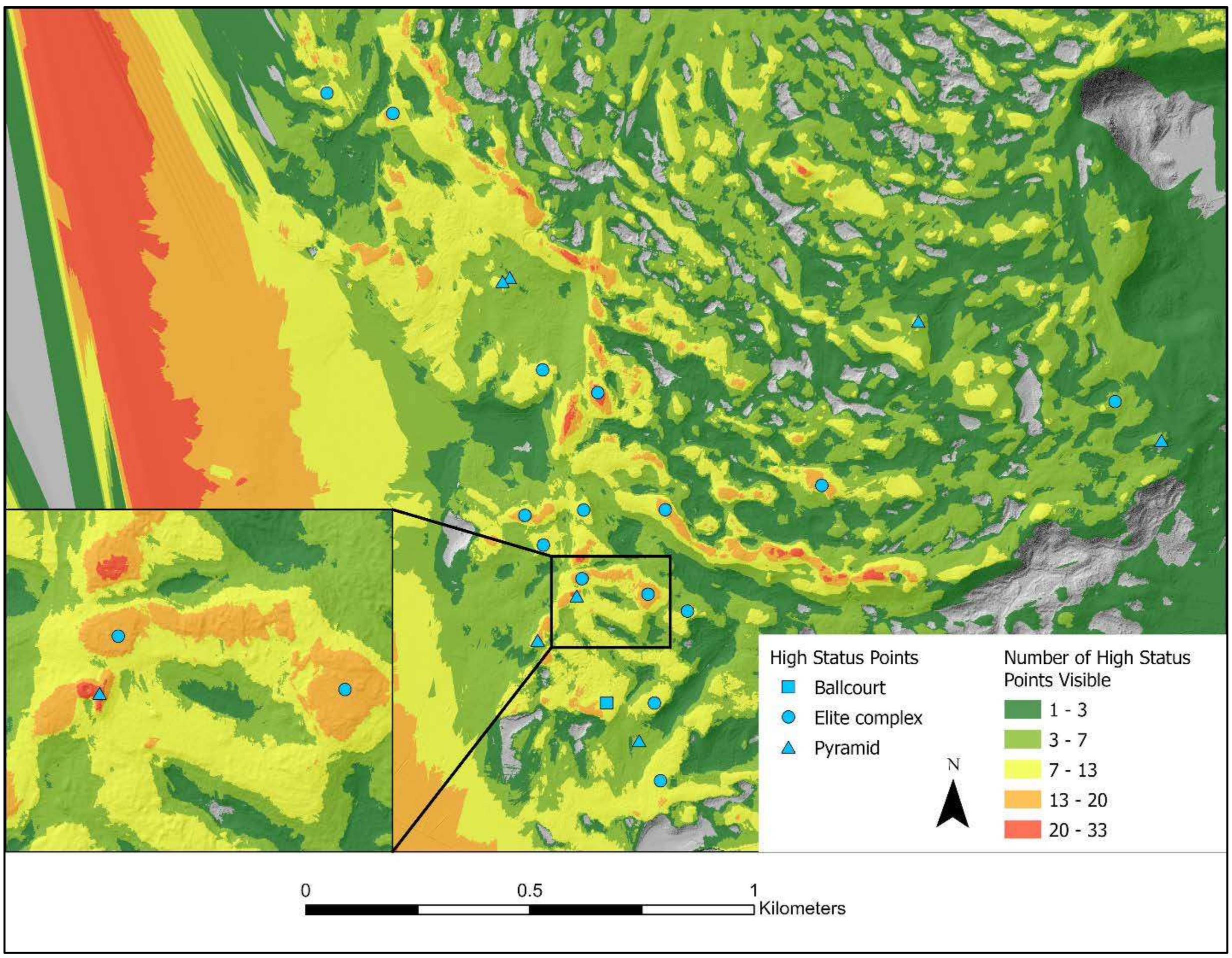

Figure 6. 4: Closeup of high-status cumulative viewshed surface on the lower malpaís. Bottom left corner is an inset showing the main lower yácata pyramid (in red) and two neighboring elite complexes.

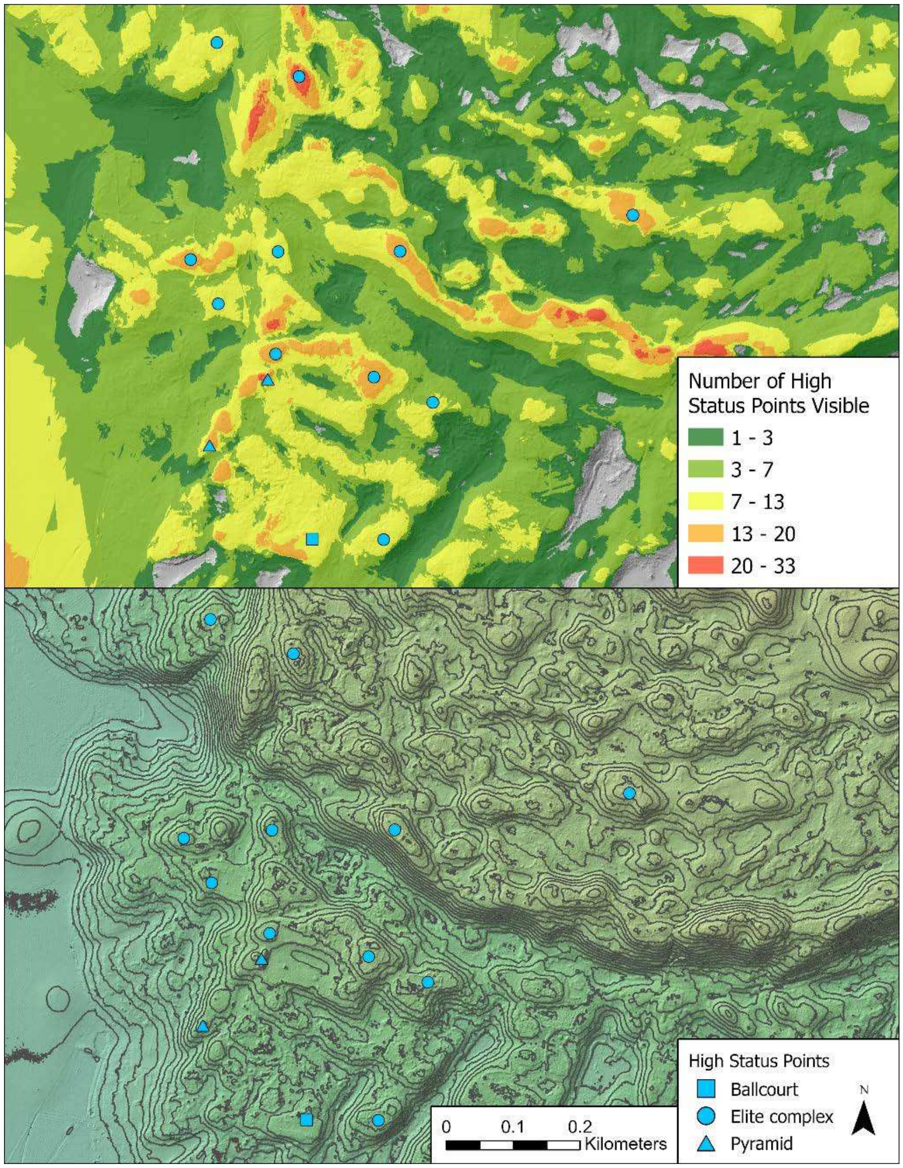

Figure 6. 5: (top) cumulative viewshed surface for high-status points on the lower southwestern malpaís. (bottom) the same area with a 2 m contour layer displayed over a shaded relief map.

elevation differences. Basically, on the lower *malpaís*, high-status structures tend to be located in places that can see many other high-status structures. Almost every high-status point in this area can see at least 7 – 13 other high-status points (symbolized in yellow). Some structures, such as the main lower *yácata,* are symbolized in red, meaning they can see 20 – 33 other high-status structures (see the bottom left inset in Figure 6. 4). In general, there is high intervisibility among the high-status structures in this area of the site. It's clear that overall, the lower *malpaís* also has far greater visibility than the northern end of the site. Figure 6. 1 shows that on the upper *malpaís*, in most areas, you can only see 1 - 3 or 3 - 7 high-status structures (symbolized in dark and light green). In many areas, you cannot see any (transparent grey areas).

There are some similarities between the high-status and random cumulative viewsheds. In Figure 6. 2, areas with very high visibility are once again found off the *malpaís* to the west, southwest, and southeast, as well as in the middle section of the *malpaís*, and on the large mountain to the northeast. Figure 6. 3 has similarly high visibility values off the *malpaís* to the southeast and in the central area. In general, every cumulative viewshed seems to have higher visibility values (more yellow, orange, and red cells) on the lower and middle *malpaís* than in the upper areas.

There are also noticeable differences between the high-status and random cumulative viewsheds. For both samples of random points, the southwestern edge of the *malpaís,* and the lower area around the main yácata, do not have the high visibility values that are seen with the high-status points. While high-status points on the lower *malpaís* were located in places that could see many other high-status points, this is not the case with the random points. In Figure 6. 2, the points do not seem to be preferentially located in yellow, orange, or red areas – their positioning seems, as expected, quite dispersed and random. The same can be said for the random points in Figure 6. 3. For the high-status points, it's clear that on the lower *malpaís*, they tend to fall in places with high visibility values (Figure 6. 4). In general, the random cumulative viewsheds seem to have less of a disparity in visibility between the upper and lower *malpaís*. They have a greater visible area (fewer grey cells) on the upper *malpaís*, and their high visibility values (yellow and orange cells) also seem to be more evenly spread out across broader areas.

For the high-status cumulative viewshed, the total visible area (the total area of the site that could see at least one high-status point) was equal to 41,871,750 m^2. For the first sample of random points, the total visible area was 43,168,589.75 m^2. For the second sample, the total visible area was 41,760,956.75 m^2, and for the third sample it was 43,374,847.5 m^2.

High-Status Viewshed Attributes

In this section I will show how the viewshed attributes varied spatially and by the type of high-status structure. In Figure 6. 6, each high-status point is color coded to reflect the area of its viewshed (left) and the number of other points within its viewshed (right). Figure 6. 7 shows

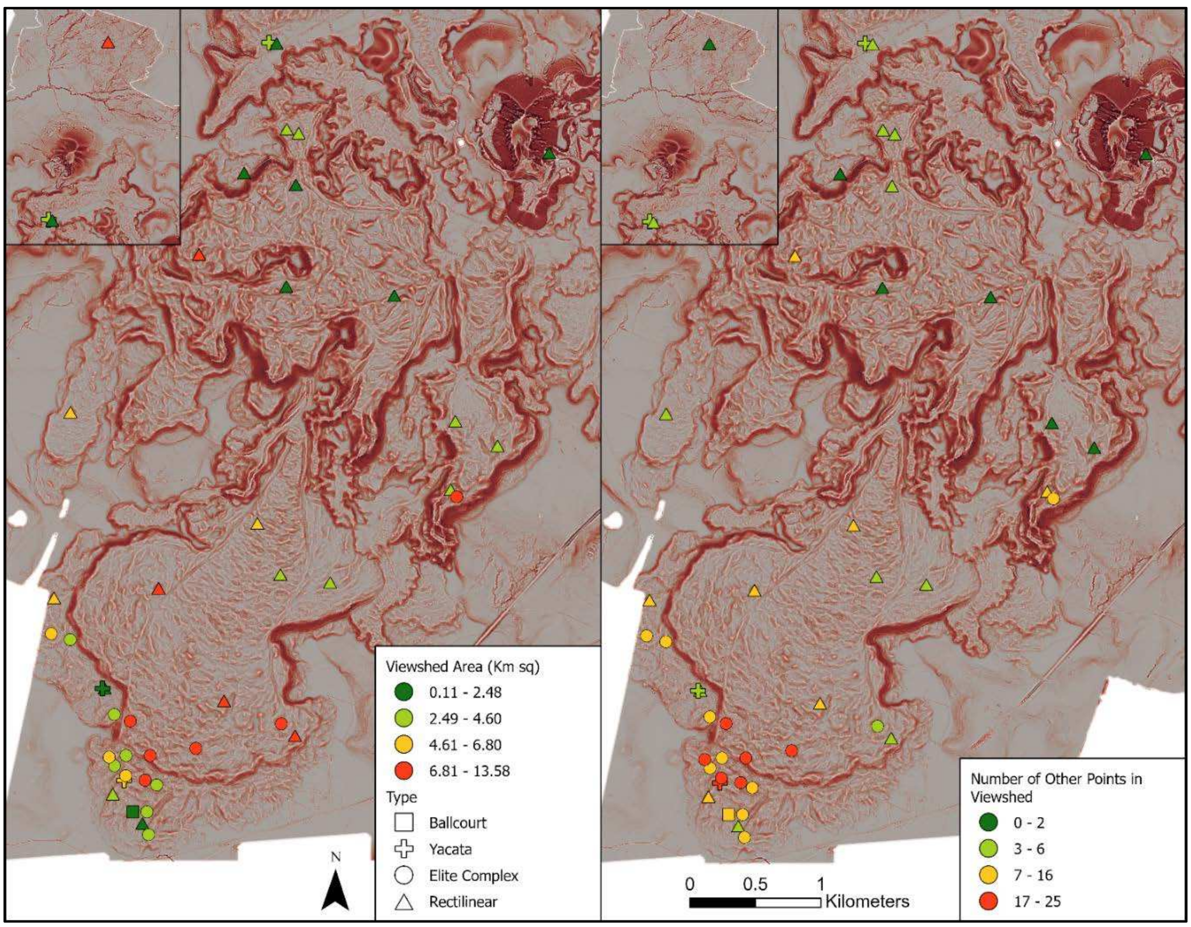

Figure 6. 6: High-status points across the entire site. Graduated colors show viewshed area (left) and the number of other points within each viewshed (right), and the shape of the points reflects the type of high-status structure. Inset map in top left shows pyramid X77-Py-1 which is off the malpaís to the north. Points are displayed over pseudo RRIM.

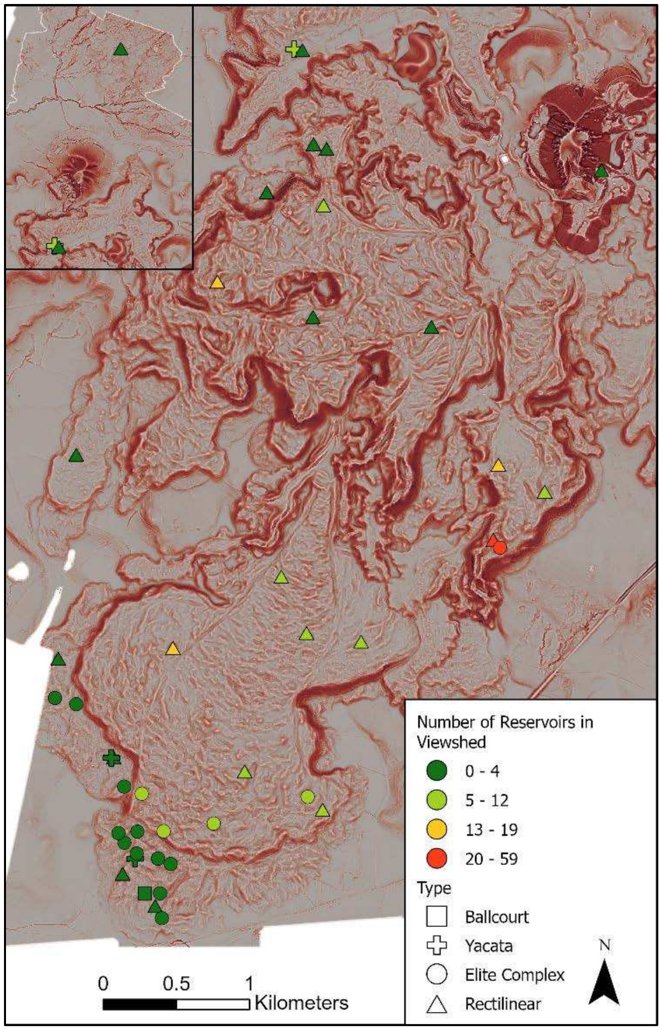

Figure 6. 7: High-status points across the entire site. Graduated colors show the number of reservoirs within each viewshed, while the shape of the points reflects the type of high-status structure. Inset map in top left shows pyramid X77-Py-1 which is off the malpaís to the north. Points are displayed over pseudo RRIM.

the same thing except for the number of reservoirs within each viewshed. The shape of each point reflects the type of high-status structure.

The structures with the largest viewsheds are almost all found on the lower *malpaís*. Within the greatest area class (red points), five of the points are pyramids (all rectilinear) and six of the points are elite complexes. Within the two greatest area classes (yellow and red points), nine of the points are pyramids (eight rectilinear and one *yácata*), and nine of the points are elite complexes. When it comes to the two smallest area classes (dark and light green points), 18 of the points are pyramids (sixteen rectilinear and two *yácatas*), seven are elite complexes, and one is the ballcourt. Overall, there is basically an even number of pyramids and elite complexes with large viewsheds, but there are many more pyramids with small viewsheds. Both the rectilinear pyramids and the *yácatas* have a range of viewshed sizes, although the pyramids with the largest viewsheds are all rectilinear. As we saw on the high-status cumulative viewshed surface, the points on the lower *malpaís* tend to have the greatest intervisibility. This is especially true of the main lower *yácata* and it's surrounding elite complexes. In general, most of the high-status viewsheds do not contain many reservoirs. The highest counts for reservoirs (orange and red) belong to points located around the middle section of the *malpaís* in spots that have high relative elevations.

For comparison, Figure 6. 8 displays the first sample of random points symbolized to show viewshed area and the number of other points within each viewshed. Figure 6. 9 shows the same thing except for the reservoirs. There does not seem to be as obvious spatial patterning for the attributes, especially the highest values in the red class. They tend to be more evenly spread out across the *malpaís*. The maximum values for each attribute are also lower than for the high-status points. The variability of attribute values for the other two samples of random points looked very similar which is why they are not shown here.

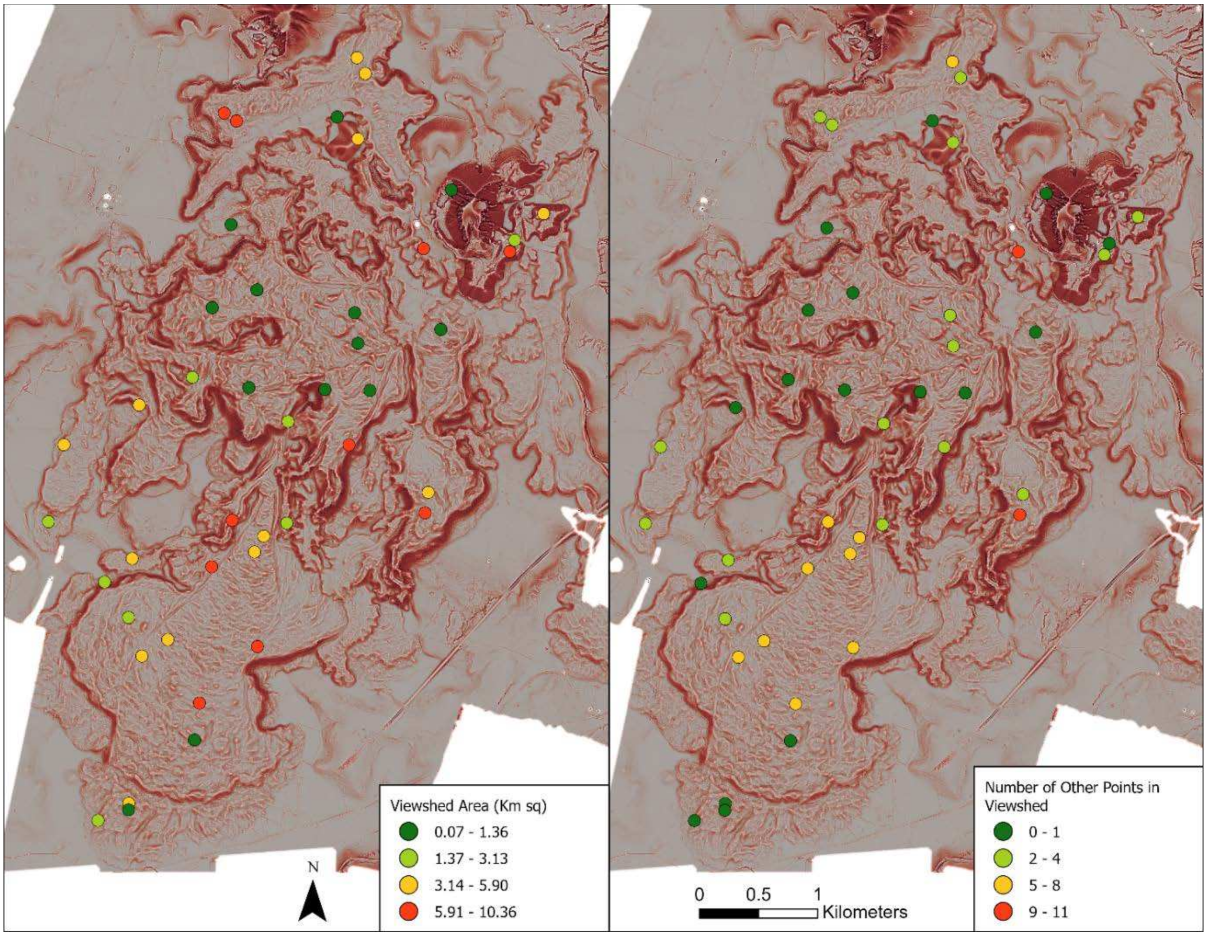

Figure 6. 8: Random points (first dataset) with graduated colors showing viewshed area and number of other points within each viewshed. Points displayed over pseudo RRIM.

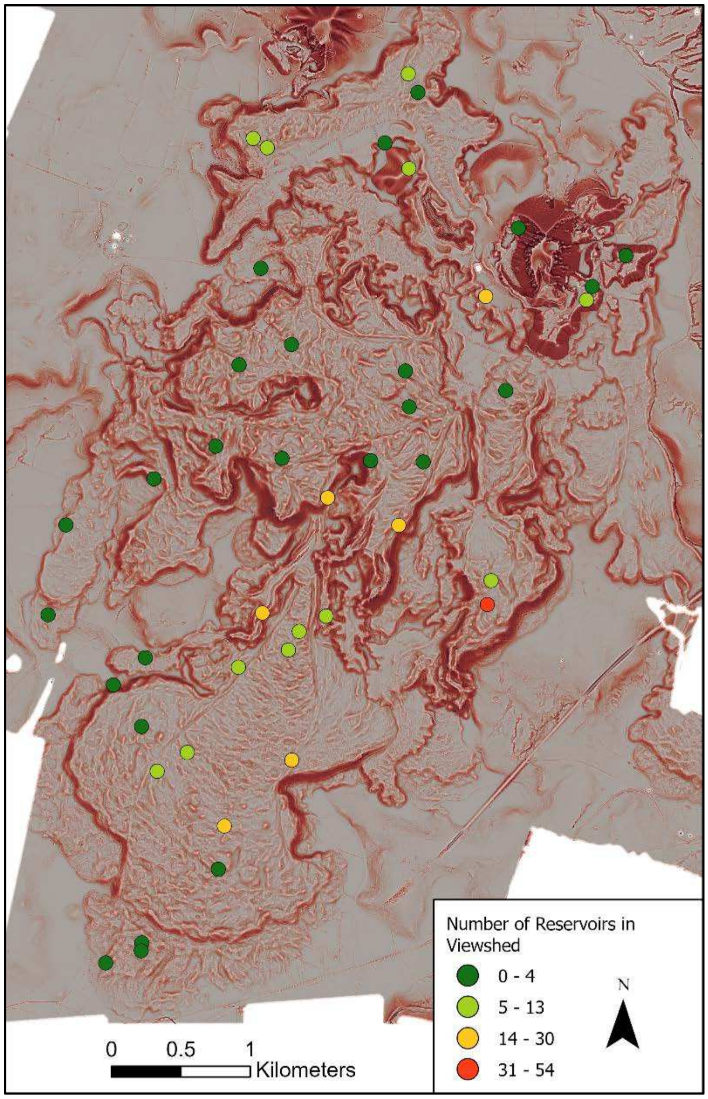

Figure 6. 9: Random points (first dataset) with graduated colors showing the number of reservoirs contained within each viewshed. Points displayed over pseudo RRIM.

The same kind of figures were produced for the lower *malpaís* study area. Figure 6. 10 shows the high-status points with graduated colors showing viewshed area, the number of other points within each viewshed, total road length within each viewshed, and the number of archaeological features within each viewshed. Figure 6. 11 shows the same thing except for the number of reservoirs within each viewshed and the total complejo area within each viewshed. For analytical purposes, I will break up the lower study area into two zones – the upper elevation zone, or the *malpaís* proper, which makes up the bulk of the lava flow. This zone is roughly outlined in blue in the top left panel of Figure 6. 10. Then there is a drop-off that leads down to a lower elevation zone extending narrowly to the west and south. This zone is outlined in yellow in the top left panel of the same figure. This lower elevation zone includes the main lower *yácata*, the ballcourt, and many of the elite complexes. The points with the largest viewsheds are all

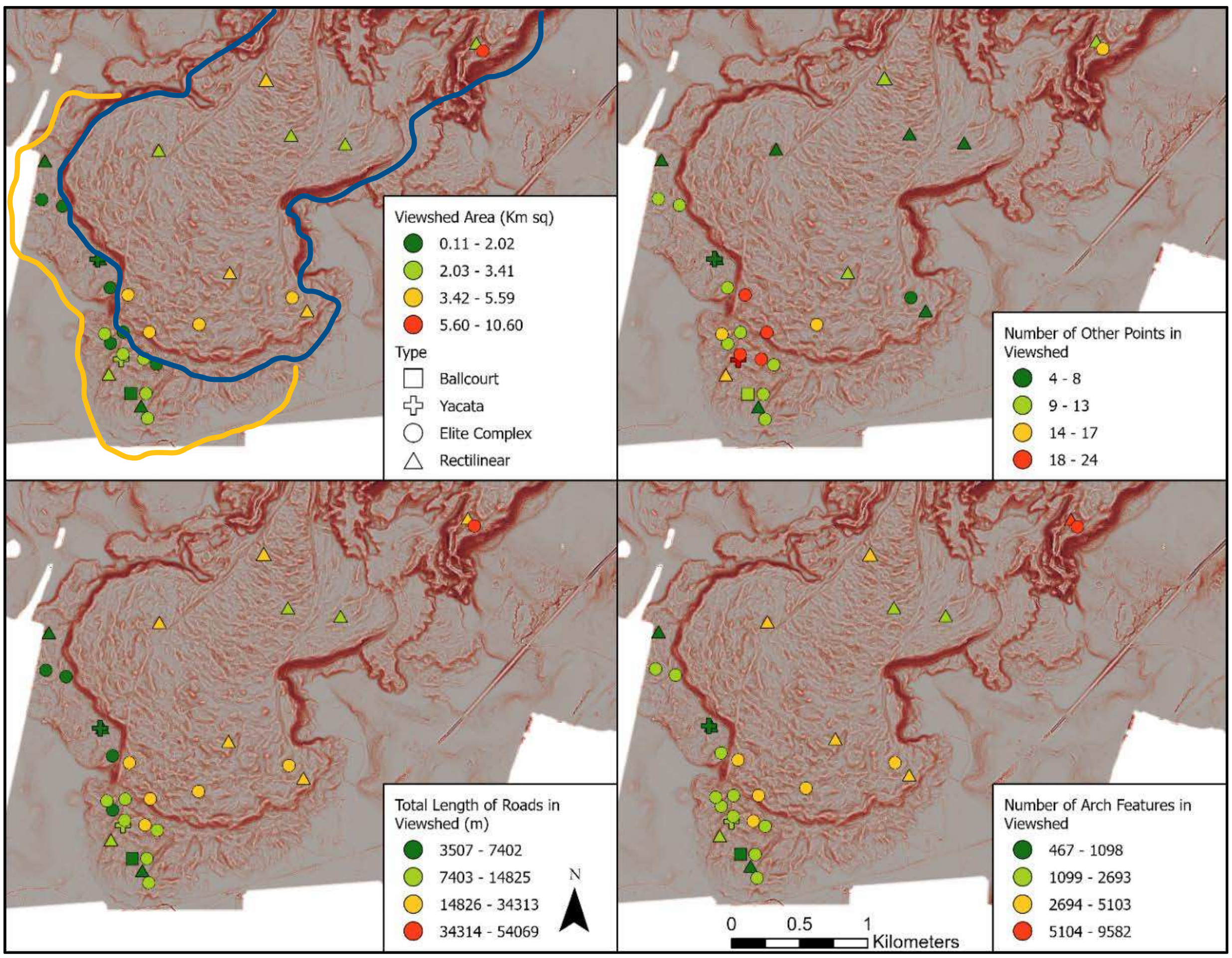

Figure 6. 10: High-status points (lower study area) with graduated colors showing viewshed area, number of other points within each viewshed, total road length within each viewshed, and number of archaeological features within each viewshed. Shape of the points reflects the type of high-status structure. Upper left panel shows partitioning of the lower malpaís into an upper elevation zone (blue) and lower elevation zone (yellow). Points displayed over pseudo RRIM.

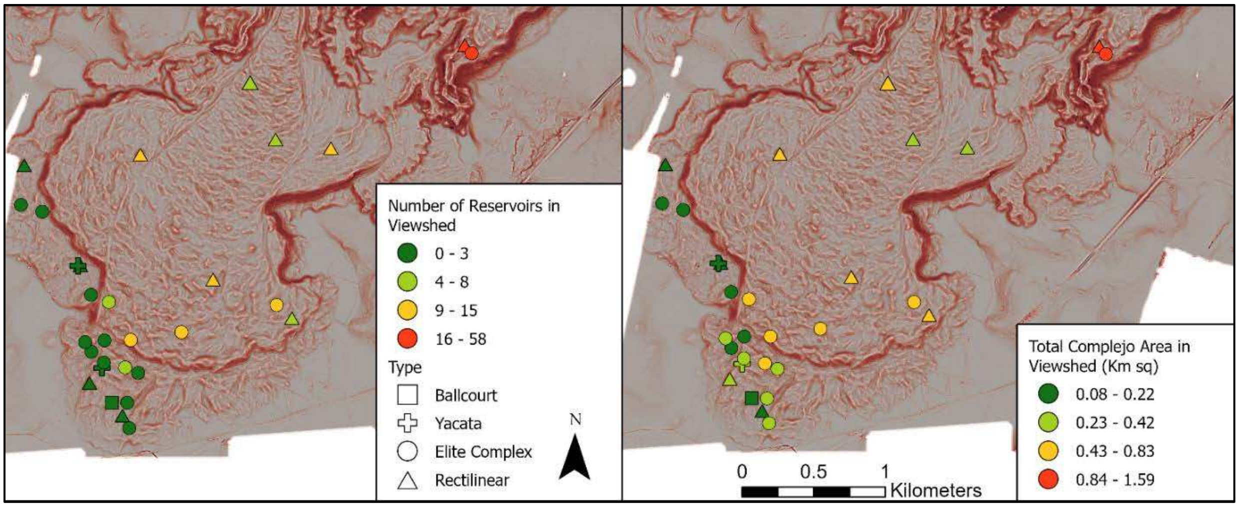

Figure 6. 11: High-status points (lower study area) with graduated colors showing the number of reservoirs within each viewshed and total complejo area within each viewshed. Shape of the points reflects the type of high-status structure. Points displayed over pseudo RRIM.

located in the upper elevation zone. Many of the orange points are located very close to the drop-off while the red point with the greatest viewshed area is located further north. This latter point is an elite complex sitting in a highly elevated spot in the northeast corner of the study area. In this upper elevation zone, more of the points with large viewsheds are elite complexes, and more of the points with smaller viewsheds are rectilinear pyramids.

Most of the points with the greatest intervisibility (yellow and red) are clustered in the lower elevation zone, or at the drop-off right above it. Almost all of these points are elite complexes with the addition of the main lower *yácata* and one rectilinear pyramid.

For the total road length and number of archaeological features, the points with the highest counts tend to be located in the upper elevation zone. In both cases, the red point (or points) with the greatest value is up in the northeastern corner of the study area. The counts for the number of reservoirs and complejo area have very similar spatial patterning. The points with the highest counts (orange and red) are almost all in the upper elevation zone.

For all of these attributes, the high-status points displayed more noticeable spatial patterning than the random points. Figure 6. 12 and Figure 6. 13 show the results for the first sample of random points on the lower *malpaís*. You can see that the orange and red points tend to be spread out over broader areas.

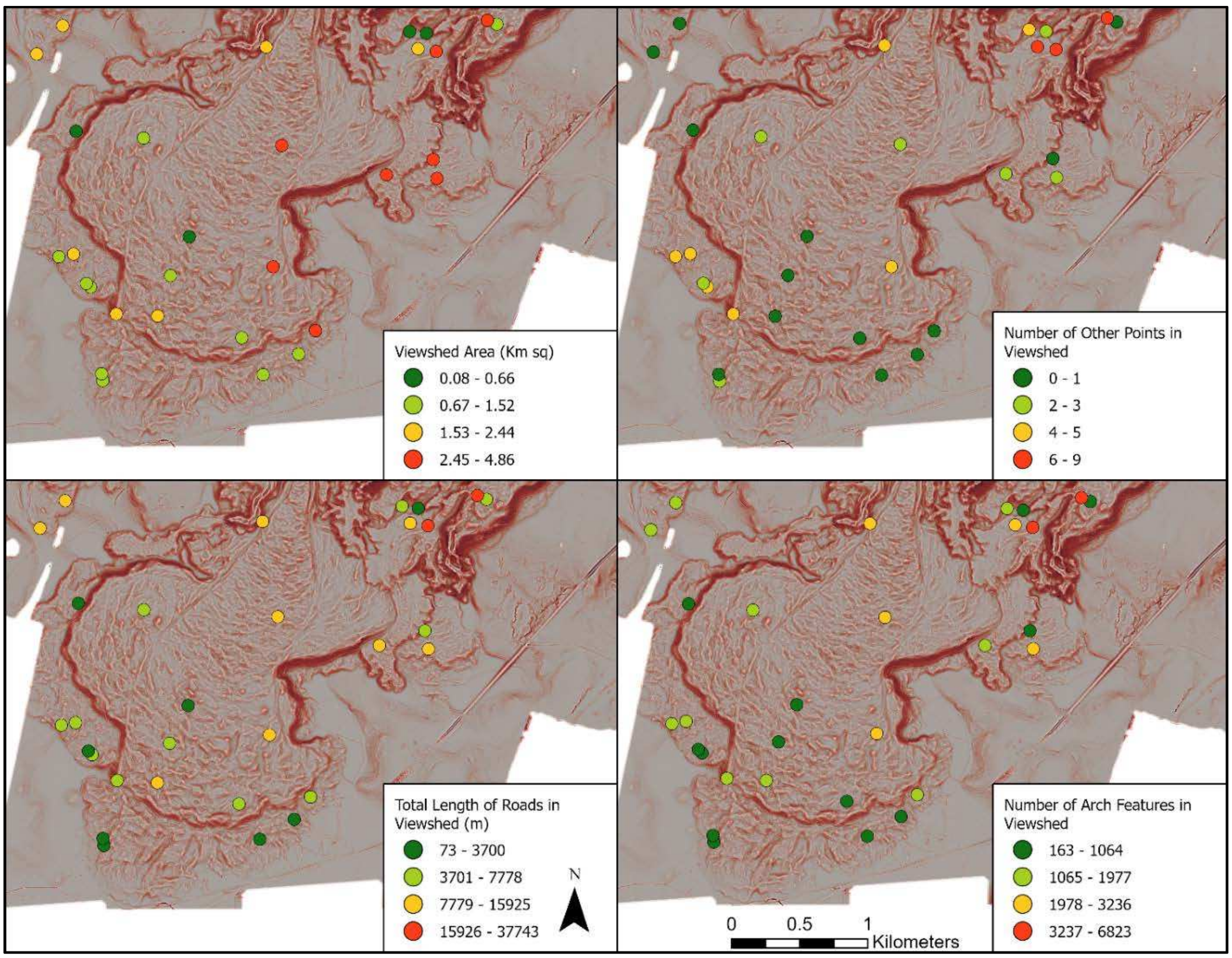

Figure 6. 12: First sample of random points on lower malpaís. Graduated colors show viewshed area, number of other points in each viewshed, total road length in each viewshed, and number of archaeological features in each viewshed. Points displayed over pseudo RRIM.

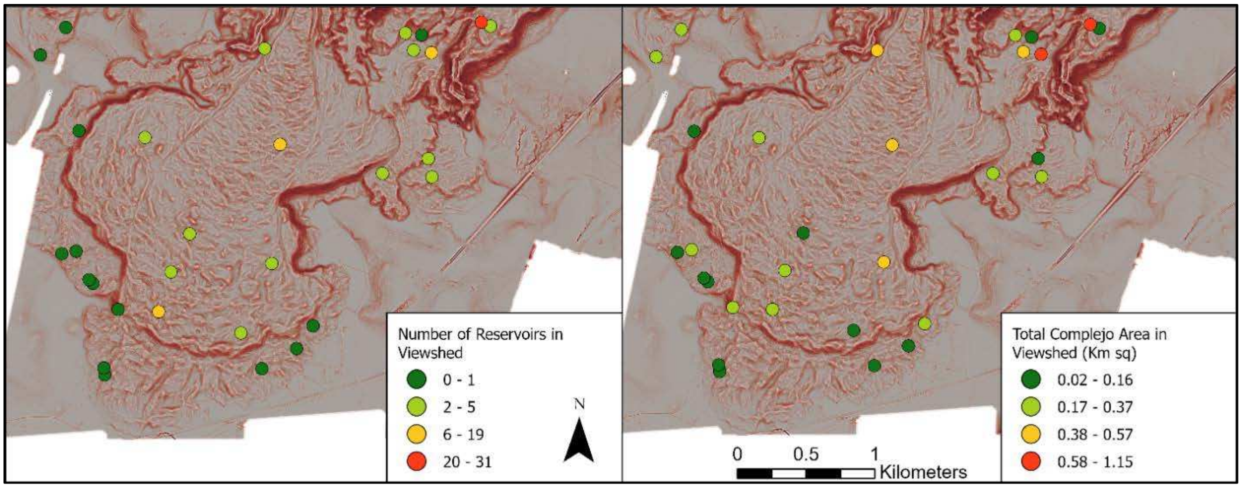

Figure 6. 13: First sample of random points on lower malpaís. Graduated colors show the number of reservoirs in each viewshed and the total complejo area in each viewshed. Points displayed over pseudo RRIM.

Summary Statistics and Boxplots for Viewshed Attributes

Results for the Entire Site

In this section I will display summary statistics and boxplots for the high-status and random viewshed attributes. Separate summary statistics and boxplots were generated for each study area. Table 6. 1 shows the mean, median, and standard deviation for viewshed attributes across the entire site. Each colored row corresponds to a different dataset.

High-status viewsheds have greater mean and median values for area and number of other points than all samples of random viewsheds. The standard deviation for viewshed area is pretty similar across all datasets, but high-status viewsheds have a larger standard deviation for the number of other points, meaning there is greater variability around the mean. The second sample of random viewsheds has the greatest mean, median, and standard deviation for the number of reservoirs. Between the three samples of random viewsheds, the third one has the

Table 6. 1: Summary statistics (mean, median, standard deviation) calculated for high-status and random viewshed attributes across the entire site.

Viewshed Dataset	Summary Statistic	Viewshed Area (km^2)	Number of Other Points in Viewshed	Number of Reservoirs in Viewshed
High-Status Viewsheds	Mean	4.96	9.45	6.45
	Median	4.18	10.5	2
	SD	3.12	6.66	10.56
Random Viewsheds 1	Mean	3.77	3.02	6.91
	Median	3.36	3	3.5
	SD	3.02	2.74	10
Random Viewsheds 2	Mean	3.91	4.23	7.32
	Median	3.64	3	5
	SD	3.14	3.88	11.95
Random Viewsheds 3	Mean	3.42	2.43	5.80
	Median	2.53	2	1.50
	SD	2.87	2.52	10.76

greater values for everything except for the median number of other points, which was equal with the first sample at 3.

Figure 6. 14 shows boxplots comparing the distribution of each viewshed attribute between high-status and random viewsheds for the entire site. The same relationships that were in the summary table are evident - high-status viewsheds have the highest median values for area and number of other points, and the second sample of random viewsheds has the highest median value for number of reservoirs. While the distributions for viewshed area and number of reservoirs have a fairly similar spread between the three datasets, the distribution for the number of other points has a clear difference between high-status and random viewsheds. The distribution for the high-status viewsheds has a much greater median, but also a much greater spread which reflects the high standard deviation for this dataset.

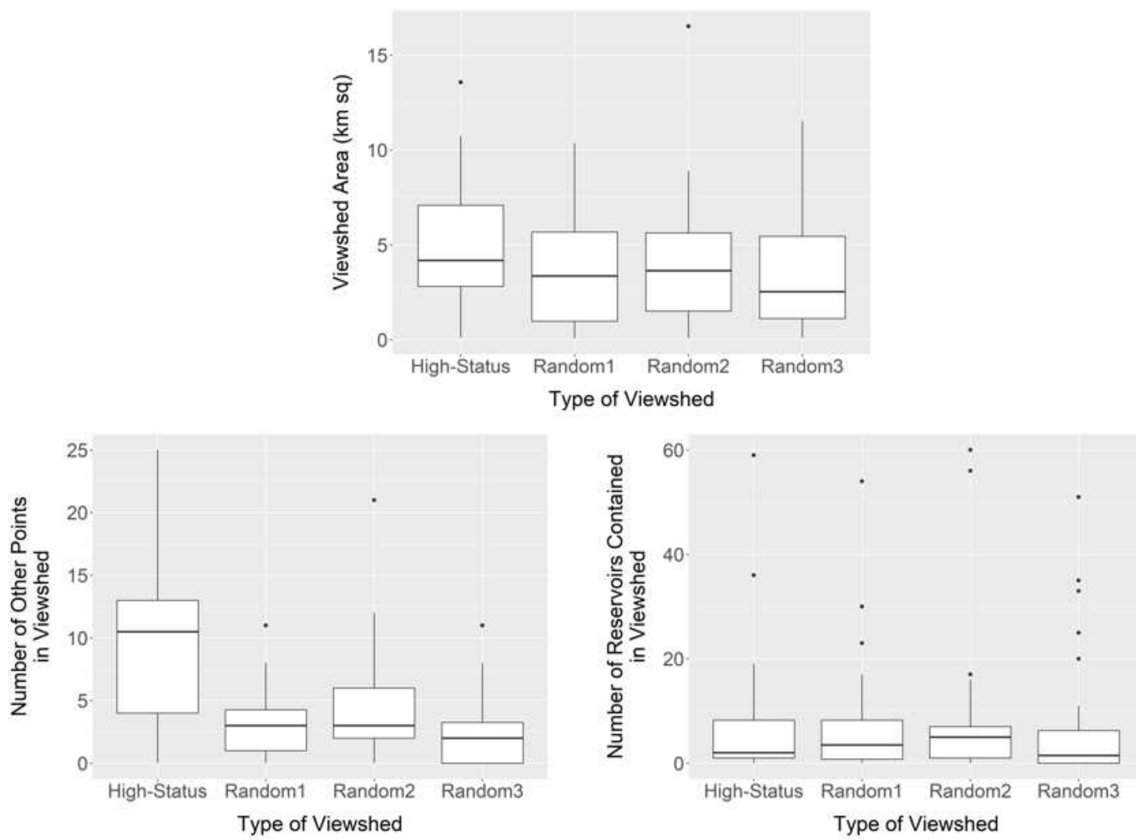

Figure 6. 14: Boxplots showing the distribution of each viewshed attribute for the 44 high-status viewsheds, and three samples of 44 random viewsheds across the entire site.

Table 6. 2 shows summary statistics for viewshed attributes across the entire site, except this time the attributes are summarized by the type of high-status structure. For viewshed area, the elite complexes have the greatest mean and median values, as well as the largest standard deviation. Between the pyramids, the *yácatas* have greater mean and median values than the rectilinear pyramids, as well as a smaller standard deviation. For the number of other points, the elite complexes again have the greatest mean and median values overall, with the *yácatas* having greater mean and median values than the rectilinear pyramids. The *yácatas* also have the greatest

Table 6. 2: Summary statistics (mean, median, standard deviation) calculated for viewshed attributes across the entire site by the type of high-status structure.

Type of High-Status Structure	Summary Statistic	Viewshed Area (km^2)	Number of Other Points in Viewshed	Number of Reservoirs in Viewshed
All Pyramids (n=27)	Mean	4.15	6.19	6.26
	Median	3.76	5	3
	SD	2.84	5.40	7.93
Yácata (n=3)	Mean	4.10	10.33	3.33
	Median	4.50	5	1
	SD	2.24	10.12	4.04
Rectilinear (n=24)	Mean	4.00	5.39	6.17
	Median	3.59	4.00	3
	SD	2.89	4.54	8.15
Elite Complex (n=16)	Mean	6.47	14.81	7.19
	Median	5.39	13.50	2.00
	SD	3.11	5.11	14.39
Ballcourt (n=1)	Value	2.48	12	0

standard deviation, and the ballcourt is visible from many other structures. For the number of reservoirs, the elite complexes have the greatest mean value, but there is lots of deviation about that value. The pyramids together have the greatest median value. The rectilinear pyramids contain a greater mean and median number of reservoirs than the *yácatas*.

Results for the Lower Study Area

In the remainder of this section, I will show the summary statistics and boxplots for the high-status and random viewsheds constrained to the lower study area. Table 6. 3 displays the mean, median, and standard deviation for these viewshed attributes. Once again, each colored row represents a different dataset. High-status viewsheds have the greatest mean and median values for viewshed area and number of other points. The standard deviation for these attributes is pretty similar and small between the samples. For the number of reservoirs, the third sample of random viewsheds has greatest mean and median values. For the number of archaeological features, total road length, and total complejo area, the high-status viewsheds have the greatest

Table 6. 3: Summary statistics (mean, median, standard deviation) calculated for high-status and random viewshed attributes in the lower malpaís study area.

Viewshed Dataset	Summary Statistic	Viewshed Area (km^2)	Number of Other Points in Viewshed	Number of Reservoirs in Viewshed	Arch Features in Viewshed	Length of Roads in Viewshed (m)	Complejo Area in viewshed (km^2)
High-Status Viewsheds	Mean	3.03	11.93	6.93	2724.37	14185.18	0.44
	Median	2.71	11	2	1962.5	11431.15	0.31
	SD	1.94	5.35	11.92	1951.32	10693.72	0.33
Random Viewsheds 1	Mean	1.91	2.7	3.6	1707.17	8763.08	0.27
	Median	1.61	2	2	1472	6534.5	0.21
	SD	1.23	2.58	6.53	1486.52	8090.6	0.25
Random Viewsheds 2	Mean	1.92	2.9	3.8	1642.63	8579.79	0.28
	Median	1.52	3	3	1219	7097.52	0.22
	SD	1.36	2.41	3.7	1248.3	7024.57	0.22
Random Viewsheds 3	Mean	2.55	4.97	7.23	2493.37	13572.41	0.41
	Median	2.23	5	6	2413.5	12596.07	0.4
	SD	1.40	3.48	7.21	1449.75	8318.05	0.24

mean values and standard deviations, but the third sample of random viewsheds has the greatest median values. The differences between the samples can also be seen in the boxplots below

(Figure 6. 15). The greatest difference between datasets is again seen with the number of other points within each viewshed. The high-status viewsheds tend to have greater values for this attribute than the random viewsheds.

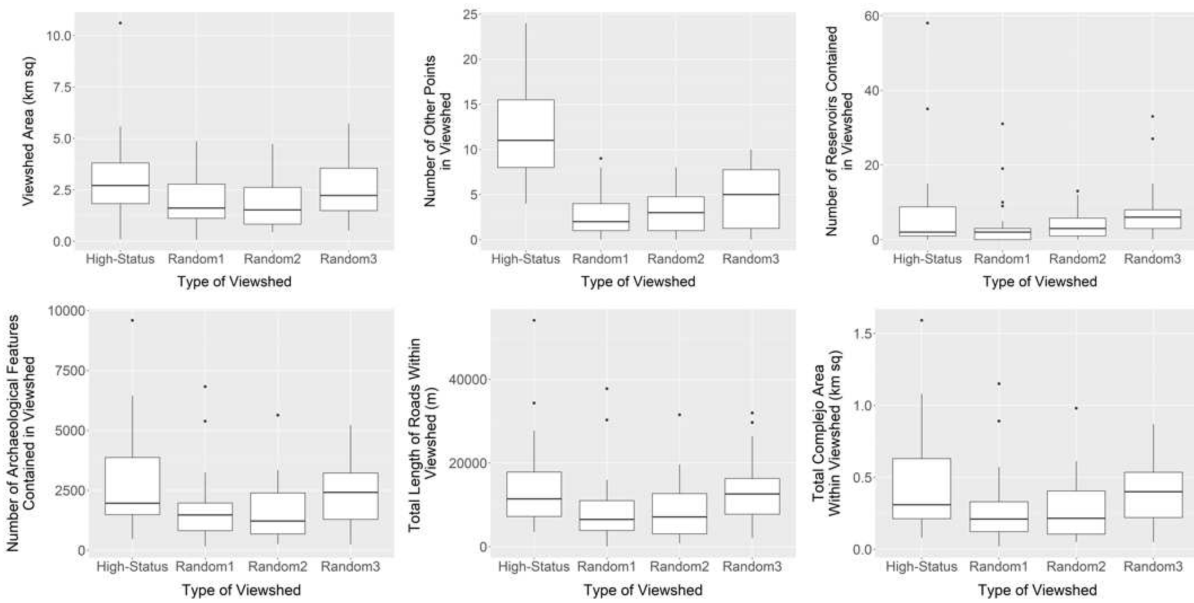

Figure 6. 15: Boxplots showing the distribution of each viewshed attribute for the 30 high-status viewsheds and three samples of 30 random viewsheds in the lower study area.

Table 6. 4 shows summary statistics by the type of high-status structure for the lower study area. For viewshed area, the elite complexes have the greatest mean value while the pyramids have the greatest median value. Rectilinear pyramids have greater values than the *yácatas*. For the number of other points, the elite complexes have greater mean and median values than the pyramids, but among the latter, the *yácatas* have greater mean and median values than the rectilinear pyramids. For the number of reservoirs, the pyramids, specifically the rectilinear structures, have the greatest mean and median values. For the number of archaeological features, total road length, and complejo area, the elite complexes have the

greatest mean values while the pyramids have the greatest median values. In all three cases, the rectilinear pyramids have greater mean and median values than the *yácatas*.

Table 6. 4: Summary statistics (mean, median, standard deviation) calculated for viewshed attributes in the lower study area by type of high-status structure.

Type of High-Status Structure	Summary Statistic	Viewshed Area (km^2)	Number of Other Points in Viewshed	Number of Reservoirs in Viewshed	Arch Features in Viewshed	Length of Roads in Viewshed (m)	Complejo Area in viewshed (km^2)
All Pyramids (n=13)	Mean	2.68	9.08	7.38	2564.39	12807.54	0.41
	Median	2.95	8	5	2084	11580.65	0.32
	SD	1.41	4.84	9.47	1741.68	8724.73	0.30
Yácata (n=2)	Mean	1.82	13.5	1.00	1547.00	7630.33	0.23
	Median	1.82	13.5	1.00	1547.00	7630.33	0.23
	SD	1.11	10.61	0	910.75	5586.60	0.16
Rectilinear (n=11)	Mean	2.84	8.27	8.55	2749.36	13748.85	0.45
	Median	3.04	8.00	6.00	2084	14824.66	0.32
	SD	1.44	3.50	9.90	1820.04	9049.23	0.31
Elite Complex (n=16)	Mean	3.40	14.31	7.00	2956	15728.49	0.47
	Median	2.64	12.5	2.00	1923	11295.86	0.30
	SD	2.30	4.84	14.12	2163.09	12366.80	0.36
Ballcourt (n=1)	Value	1.62	11.00	0.00	1098.00	7401.70	0.19

Statistical Comparisons

This section will show the results of the Wilcoxon Rank Sum Tests that were performed between high-status and random viewshed attributes in each study area. For each comparison, a one-sided test and a two-sided test were performed, producing two p-values.

Table 6. 5 contains the results from viewsheds across the whole site. The blue columns show the resultant one and two sided p-values from the comparison between high-status viewsheds and the first sample of random viewsheds. The green and grey columns show the same thing, except for the comparison between high-status viewsheds and the second and third sample of random viewsheds, respectively. Each two-sided test was done to look for any significant difference between the high status and random attribute values, with the null hypothesis being that no significant difference existed. Each one-sided test was a 'greater than' test, meaning it was done to see if the high-status attribute values were significantly greater

Table 6. 5: Results of Wilcoxon Rank Sum Tests between high-status and random viewsheds across the entire site. For each viewshed attribute, six tests were performed. Blue columns show results from one and two sided tests between high-status viewsheds and the first sample of random viewsheds. Green columns show the same between high-status viewsheds and the second sample of random viewsheds. Grey columns show the same between high status viewsheds and third sample of random viewsheds. Asterisks next to p-values indicate significance at an alpha level of 0.05.

Viewshed Attribute	Two-sided p-value	One-sided p-value	Two-sided p-value	One-sided p-value	Two-sided p-value	One-sided p-value
Viewshed Area (km^2)	0.052	0.026*	0.086	0.043*	0.007*	0.004*
Number of other points in viewshed	8.397e-07*	4.199e-07*	8.522e-05*	4.261e-05*	4.807e-08*	2.404e-08*
Number of reservoirs contained by viewshed	0.863	0.572	0.450	0.778	0.198	0.099

than the random attribute values. In this case, the null hypothosis was that the values were not significantly greater. Each time an asterisk (*) appears next to a p-value it means the null hypothesis was rejected at the 0.05 significance level. Looking at the blue columns, the one-sided p-value for viewshed area, and both p-values for number of other points in the viewshed are significant. The results in the green columns mirror the results from the first comparison – the one-sided p-value for area, and both p-values for number of other points are signficant. For the third comparison, both the one and two sided p-values are significant for area and number of other points. None of the p-values for reservoirs are significant.

A separate table was created for the viewshed comparisons in the lower study area. This can be seen below in Table 6. 6. The format is the same, except comparisons were done for a greater number of attributes. For the comparisons between high-status viewsheds and the first sample of random viewsheds (blue columns), both the one and two-sided p-values are significant for all of the attributes except for the number of reservoirs. For the comparisons with the second sample of random viewsheds (green columns), all the same p-values are significant. For the comparisons with the third sample of random viewsheds (grey columns), the one and two-sided p-values are insignificant for all attributes except for the number of other points. Throughout all comparisons in both study areas, the high-status viewsheds never contained a significnatly different or greater number of reservoirs than the random viewsheds. Additionally, the lowest p-values in both study areas are from the tests comparing the number of other points in each viewshed.

Table 6. 6: Results of Wilcoxon Rank Sum Tests between high-status and random viewsheds in the lower study area. For each viewshed attribute, six tests were performed. Blue columns show results from one and two sided tests done between high-status viewsheds and the first sample of random viewsheds. Green

columns show the same between high-status viewsheds and the second sample of random viewsheds. Grey columns show the same between high-status viewsheds and the third sample of random viewsheds. Asterisks next to p-values indicate significance at an alpha level of 0.05.

Viewshed Attribute	Two-sided p-value	One-sided p-value	Two-sided p-value	One-sided p-value	Two-sided p-value	One-sided p-value
Viewshed Area (km^2)	0.006*	0.003*	0.007*	0.004*	0.328	0.164
Number of other points in viewshed	6.18e-10*	3.09e-10*	8.905e-10*	4.453e-10*	4.598e-07*	2.299e-07*
Number of reservoirs contained by viewshed	0.114	0.057	0.688	0.344	0.156	0.924
Number of archaeological features contained by viewshed	0.008*	0.004*	0.009*	0.004*	0.947	0.474
Length of roads in viewshed (m)	0.010*	0.005*	0.006*	0.003*	0.982	0.515
Complejo area in viewsheds (km^2)	0.011*	0.005*	0.024*	0.012*	0.790	0.611

Visibility from Southern Road into the LPB

Table 6. 7 shows the length of the main southern road within the high-status viewsheds on the lower *malpaís*, summarized by the type of high-status structure. Viewsheds from elite complexes contain a greater mean and median road length than the viewsheds from pyramids. Among the pyramids, the viewsheds from the *yácatas* contain a greater mean and median road length than the viewsheds from the rectilinear structures. However, the standard deviation values are quite high so there is a lot of variability among the individual viewsheds. Table A. 9 in the appendix shows the road length within each of the 30 high-status viewsheds. The viewsheds

Table 6. 7: Summary statistics (mean, median, standard deviation) for the length of the main southern road within high-status viewsheds on the lower malpaís. Data is summarized by type of high-status structure.

Type of High-Status Structure	Summary Statistic	Length of Main Southern Road in Viewshed (m)
All Pyramids (n=13)	Mean	975.76
	Median	599.33
	SD	862.18
Yácata (n=2)	Mean	1127.30
	Median	1127.30
	SD	862.18
Rectilinear (n=11)	Mean	948.21
	Median	599.33
	SD	909.17
Elite Complex (n=16)	Mean	2711.50
	Median	2479.39
	SD	2077.44
Ballcourt (n=1)	Value	1688.16

containing the eight greatest road lengths all belong to elite complexes. The first five of these points are shown highlighted in red in Figure 6. 16. The point labelled '1' has the viewshed containing the greatest length of the southern road, the point labelled '2' has the viewshed containing the second greatest road length, and so on. You can see that these points are all located on the eastern or southeastern side of the lower *malpaís*. Figure 6. 17 shows the five pyramids whose viewsheds contain the greatest road lengths. All of these pyramids are rectilinear except for one, and the pyramids that are most visible tend to be near the eastern or southeastern side of the *malpaís*.

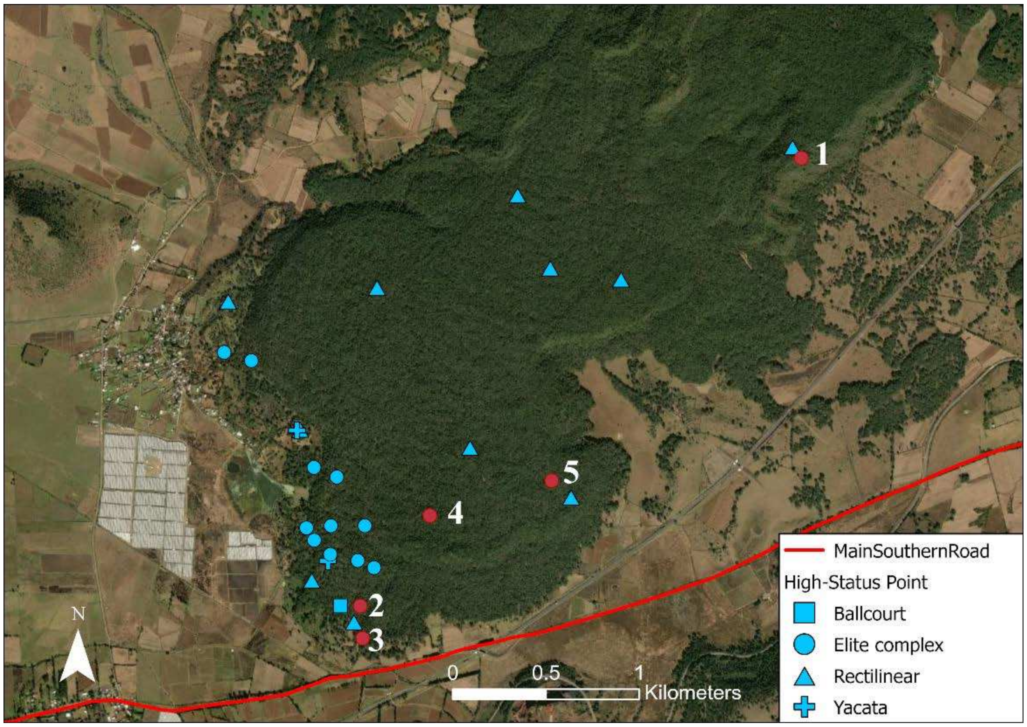

Figure 6. 16: High-status points whose viewsheds contain the five greatest lengths of the main southern road are highlighted in red. All five points are elite complexes.

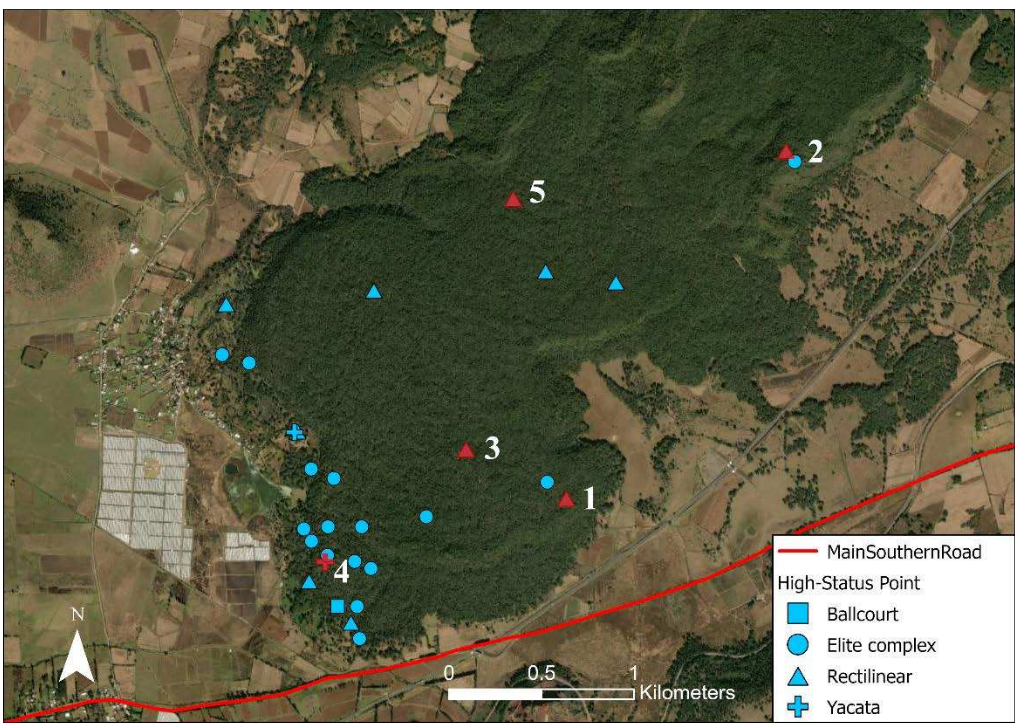

Figure 6. 17: The five pyramids whose viewsheds contain the greatest length of the main southern road are highlighted in red.

CHAPTER 7: DISCUSSION AND CONCLUSIONS

In the previous chapter I presented the results of my visibility analysis for Angamuco. Now I will expand on these findings, describing how I believe they relate to my broader research question and what conclusions can be drawn from them. I will also discuss the limitations of the analysis and the potential for future work.

Results for the Entire Site

Looking at the cumulative viewshed surface for the high-status points (Figure 6. 1), there is a clear disparity in visibility between the lower and upper *malpaís*. There are particularly high visibility values (symbolized with yellow, orange, and red) on the lower southwestern edge of the *malpaís* and the area around the main lower *yácata* (see closeup in Figure 6. 4). In contrast, the upper *malpaís* is dominated by large areas that can see few, or no high-status structures, symbolized with dark and light green, or grey (transparent), respectively. This disparity seems to be caused in part by the fact that there are many more high-status points within a small area on the lower *malpaís*. In the upper areas of the site, there are fewer points, and they are much more spread out. However, density of points is not the only factor contributing to high visibility, as evidenced by the middle section of the *malpaís*, which has very high visibility values but almost no points. This area does, however, increase greatly in elevation. Overall, it seems that if you were standing at the site, the number of high-status structures you would be able to see would be determined by the density of the structures around you, and/or your relative elevation.

In general, the high-status cumulative viewshed is noticeably different from the random cumulative viewsheds. It seems to have more obvious spatial patterning, especially with the disparity in visibility values between the upper and lower *malpaís*. This supports the notion that high-status structures were not positioned randomly in relation to their visibility. I also found that the first and third random cumulative viewsheds had greater total visible areas than the high-status cumulative viewshed. This is probably due to their greater coverage on the upper *malpaís*. If you compare this area in Figure 6. 1 and Figure 6. 2, you can see a lot more non-visible space on the high-status viewshed. While the total visible area tends to be smaller for the high-status structures, the locations where they are visible tend to have greater values than the random points. If you look at the legends on the cumulative viewshed maps, you can see that yellow, orange, and red cells on the high-status map have greater maximum values than on the random maps.

The summary statistics and boxplots show that across the entire site, there are some clear differences between high-status and random viewshed attributes, especially with viewshed size and the 'number of other points' (Table 6. 1 and Figure 6. 14). Table 6. 5 tells us whether these differences were significant. It shows that high-status points had viewsheds that were significantly larger than all three samples of random points and contained a significantly different and significantly greater number of other points than all three samples of random points. In other words, the viewsheds from high-status points were larger and contained a greater number of other points than we would expect from random chance. This suggests that across the entire site, high-status structures were not positioned randomly in relation to their visibility – they were preferentially built in locations with large viewsheds, where you could see many other high-status structures. However, the placement of the structures does not appear to have been influenced by their visibility from reservoirs. Indeed, the high-status viewsheds did not contain a significantly different or significantly greater number of reservoirs than any sample of random viewsheds (Table 6. 5). I initially thought that projecting a Panoptic gaze over the reservoirs would have been important, as they stored an important resource, but maybe this was not a priority. Reservoirs are located in low lying areas and depressions across the *malpaís* (Simpson 2019), so topographically speaking, it makes sense that visibility from them would be limited. It may not have been feasible to build high-status structures in locations that were visible from reservoirs, as well as from other areas of occupation and activity such as roads and complejos. In having to choose between the two, visibility from roads and complejos probably would have taken precedence. It's also possible that reservoirs were not areas of high activity as I had initially implied. People would have visited them periodically to collect water and wash their goods, but maybe they did not spend extended amounts of time there. Also, these results are based on comparisons of reservoir counts from all viewsheds across the whole site. There is certainly localized variability that we are simply not detecting. It is likely that certain reservoirs, especially those used by high-status people, would have been kept under surveillance, while others were not. The statistical tests simply do not show us this level of detail.

The statistical results for viewshed area fit with the idea of Panoptic planning, but what about the results for intervisibility? It seems that high-status structures were made to be highly intervisible, but what purpose could this serve? There are many possible reasons, for example, it could have allowed for easy communication between elites, especially if this was done through signalling. It also could have created a system of Panoptic surveillance and middle-level messaging to keep different factions of elites in check. This could have been important because when Angamuco was incorporated into the Purépecha state, pre-existing local elites were brought under Purépecha control. It's hard to imagine that all of them would have eagerly joined without any tension or ill feelings. Placing these elites under the Panoptic gaze of other elites, Purépecha rulers, and imperial architecture would have encouraged them to conform to the new ideological system. It would have created what Foucault (1995:177) calls a self-sustaining network of calculated gazes. In this kind of network, everyone is watched by everyone else, which reinforces discipline and compliance. This could have been used to hold the system of power in place because if these local elites were kept in line, their subject populations would likely follow suite. Throughout this thesis, I have focused on surveillance and middle-level messaging directed at commoners, but it makes sense that they could have been targeted at local elites as well.

In this view, the statistical results for the entire site could fit with the idea that high-status structures were positioned to facilitate Panoptic surveillance and middle-level messaging. These processes could have been targeted at commoners, elites, or both. However, there is important spatial variability to these results that is not revealed by the Wilcoxon Rank Sum tests. The statistical results tell us that overall, high-status structures had larger viewsheds and greater intervisibility than random chance, but they do not reveal which specific structures had the greatest values, or where these structures were located. We can investigate this by looking at Figure 6. 6. You can see that high-status structures on the lower *malpaís* tend to have higher values for viewshed area and 'number of other points' than those on the upper *malpaís*. Almost all the orange and red points are located in this area for these attributes. As I discussed at the beginning of this section, the high-status cumulative viewshed surface also shows a disparity in values between the upper and lower areas of the site. There is generally greater visibility on the lower *malpaís* (Figure 6. 1), which lines up with the greater viewshed attribute values here. It is likely that the high values for viewshed area and 'number of other points' on the lower *malpaís* are what led to the significant results in the statistical comparisons. If we isolated the structures on the upper *malpaís* and compared their low viewshed attribute values to those from random points, we might see different, maybe even insignificant, results. This would be important to test in the future, as it would allow us to assess the viewshed size and intervisibility of structures on the upper *malpaís* without the influence of the high values from the lower area. Overall, there is a clear disparity in values between the upper and lower areas of the site. The positioning of high-status structures on the lower *malpaís* does seem to fit with the idea of Panoptic planning and middle-level messaging, but it is unclear if this is the case with those on the upper *malpaís*. In this area, the low values for viewshed area and 'number of other points' make this questionable.

What could cause such a disparity? Well, it starts to make sense when you consider the timeline of occupation at Angamuco and remember that the high-status structures were not all built or used during the same period. According to the Angamuco settlement model (see chapter 3), during the Middle Postclassic (1100 – 1350 CE), there was major growth and expansion centered around several nodes of monumental architecture across the *malpaís* as a whole. This is also when the Purépecha state began to take control. Later, at the end of the Middle-Postclassic and into the Late Postclassic (1350 – 1525 CE), state control became more entrenched, and settlement contracted to the lower *malpaís*. It is possible that during the Middle-Postclassic, in the early days of state integration, systems of top-down control may not have been highly developed. Processes of state integration may have initially functioned more through bottom-up negotiation and co-option, as described by Cohen (2016). If this was the case, then pyramids built during this time would not have been constructed with an emphasis on surveillance and middle-level messaging. As Cohen (2016) suggest, they were probably built to help co-opt local elites through ritual activity that took place at them. The pyramids that we see on the upper *malpaís* mostly date to this time, which would explain their low intervisibility and small viewshed area – it might reflect a lack of concern with surveillance and middle-level messaging.

I should note that the low density and intervisibility of these structures on the upper *malpaís* may have to do with the fact that these areas have not been surveyed or excavated, so we might be getting an incomplete picture. Additional structures might exist that have simply not been identified yet. However, this cannot be verified without more fieldwork. In general, it is important to understand that my interpretations and conclusions in this thesis are only based on the data that we have available. If more data is collected, they might very well change. For now, the best that I can do is make sure these limitations are stated and kept in mind.

At the end of the Middle Postclassic and into the Late Postclassic, state control became more entrenched, and settlement at Angamuco contracted to the lower *malpaís*. Any new high-status structures built during this time would have been built in this area. It is likely that during this period, top down mechanisms of power and control, including Panoptic surveillance and middle-level messaging, became more important in processes of state integration. This would explain why most of the high-status structures with high intervisibility and large viewsheds are found on the lower *malpaís* – they were built later with a greater emphasis on surveillance and middle-level messaging.

Do the results for the different types of high-status structures line up with this? Well, Table 6. 2 shows that across the entire site, elite complexes had the greatest mean and median values for viewshed area and ‘number of other points’. This fits with my previous discussion, as we know that these elite complexes were built on the lower *malpaís*, probably during the Late Postclassic. This is also reflected in Figure 6. 6 where almost all of the red and yellow points on the lower *malpaís* are elite complexes. Some of these points are also rectilinear pyramids, which were probably built near the end of the Middle Postclassic. It's also possible that some of these rectilinear pyramids were built at an earlier time and then later 'renovated' to enhance their visibility.

There are obviously some exceptions to this. For example, the large *yácata* at the northern end of the site was probably built near the end of the Middle Postclassic or during the Late Postclassic (just based on the fact that it is a *yácata*), yet it is located on the upper *malpaís* and has a small viewshed and low intervisibility. It is difficult to interpret anomalous cases like this without more fieldwork to investigate the structures in detail and get a better idea of when they were built.

Another interesting case is rectilinear pyramid X77-Py-1 located off the *malpaís* to the north (see top left inset of Figure 6. 6). This pyramid has a very large viewshed, but it is not located on the lower *malpaís* like many of the others. The viewshed for this pyramid can be seen in Figure 7. 1 below. It covers a large area off the northern *malpaís* which includes a long segment of a road symbolized with a dotted line in the satellite imagery. This road looks quite similar to the main southern road leading into the LPB, so it's likely that it served a similar purpose. I was told that a main northern road did exist leading into the LPB during pre-Hispanic times (Chris Fisher personal communication, 2023), so this might be it. I believe that this pyramid was probably built near the end of the Middle Postclassic to serve as a symbol of state power, and project a Panoptic gaze in the areas north of the *malpaís*. It was placed in a location with a large outward facing viewshed that encompassed much of the northern road leading into the LPB.

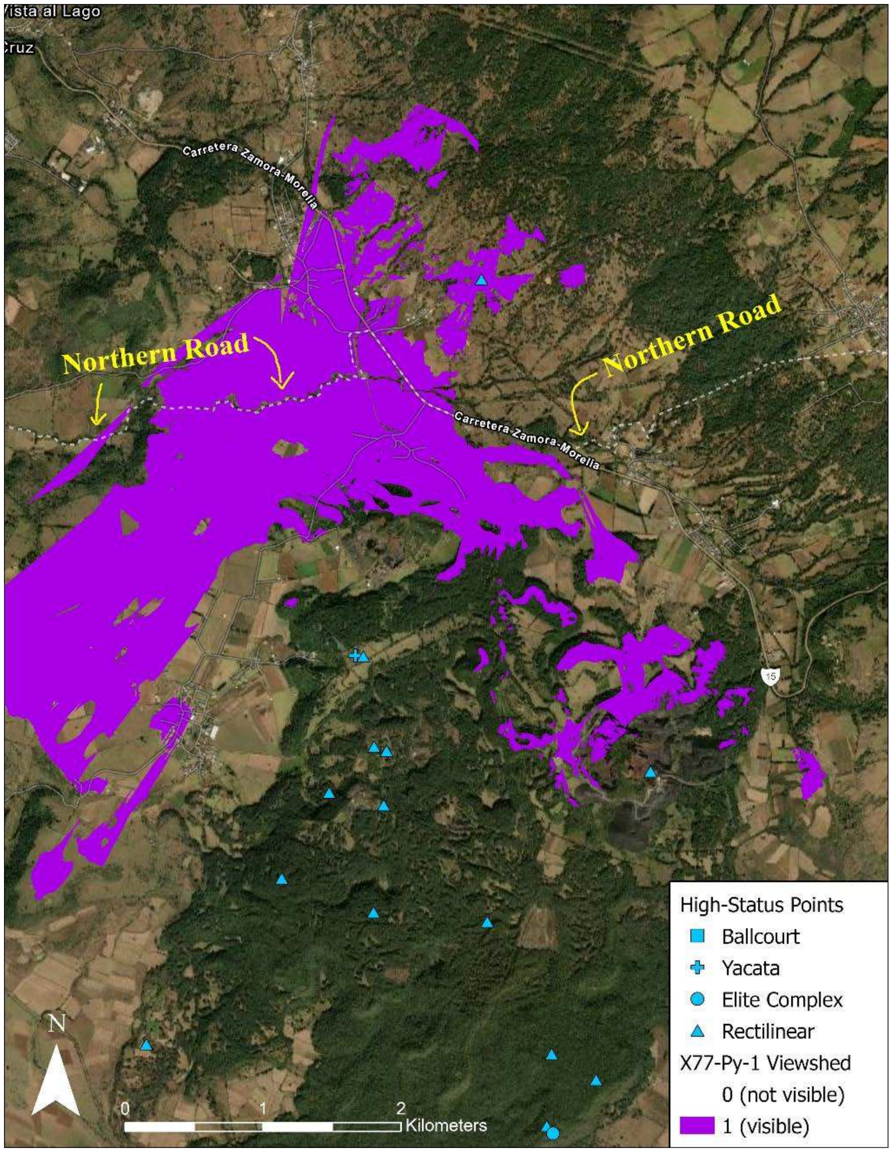

Figure 7. 1: Viewshed for pyramid X77-Py-1. The pyramid is the furthest blue triangle to the north. Annotations show the location of a possible main road leading into the LPB.

Results for the Lower Study Area

When looking at the lower *malpaís* in isolation, the results generally line up with those for the entire site. Table 6. 3 and Figure 6. 15 show that high-status viewsheds (after being constrained to the lower bounding box) once again had greater mean and median values for viewshed area and 'number of other points' than all of the random viewsheds. For the additional attributes, the high-status viewsheds had greater mean values than all samples of random viewsheds, but they only had greater median values than the first two samples.

Table 6. 6 shows whether these differences were significant or not. Viewsheds from high-status points had significantly different and significantly larger area values than the viewsheds from the first and second sample of random points, but not the third. High-status viewsheds also contained a significantly different and significantly greater number of other points than all samples of random viewsheds. Additionally, they contained significantly different and significantly greater values for archaeological features, road length, and complejo area than the first two samples of random viewsheds, but not the third. Once again, the high-status viewsheds did not contain a significantly different or significantly greater number of reservoirs than any sample of random viewsheds. This is probably due to the same reasons that I described previously. The insignificant results for viewshed area, archaeological features, road length, and complejo area against the third sample of random viewsheds is probably due to the nature of the Wilcoxon Rank Sum Test. As stated in chapter 5, this test is interpreted as comparing sample medians. Table 6. 3 and Figure 6. 15 show the median values for these attributes. The median values for the high-status viewsheds are smaller or just slightly greater (in the case of viewshed area) than the median values for the third sample of random viewsheds. This explains why the results were insignificant. It also suggests that if a different test had been used, like a t-test, which compares sample means, the results might be significant. This is because the mean values for the high-status viewsheds are always greater than the mean values for the third sample of random viewsheds (see Table 6. 3).

Because the high-status viewsheds contained significantly greater attribute values than two out of the three samples of random viewsheds, I think it still suggests that on the lower *malpaís*, high-status structures were not positioned randomly in relation to their visibility. For the most part, they seem to have been preferentially located in places that were highly intervisible with large viewsheds that encompassed more archaeological features, roads, and complejos than we would expect from random chance. However, a greater number of comparisons would have to be done to say this with a higher level of certainty. Once again, visibility from reservoirs does not seem to have been a concern.

I believe these results support my hypothesis about Panoptic planning and middle-level messaging. High-status structures on the lower *malpaís* do seem to have been positioned in a way that would have been favourable for Panoptic surveillance and the communication of middle-level meaning. However, just like with the entire site, there is important spatial variability that must be discussed. In chapter 6, I broke up the lower *malpaís* into an upper and lower elevation zone. Figure 7. 2 shows the rough boundaries of these zones in blue and orange, respectively. It also shows a third zone in green, which I am calling the high-status monumental zone. This consists of a dense clustering of high-status structures centered around the main lower *yácata*, and it corresponds to what Fisher and Leisz (2013:203) call a “node” of Purépecha imperial architecture. These zones are just rough analytical boundaries and should not be seen as fixed or absolute. This is why overlap can exist between them.

If we look at Figure 6. 10 and Figure 6. 11, the viewsheds that have the greatest area and the highest values for road length, archaeological features, reservoirs, and complejo area, almost all belong to high-status structures in the upper elevation zone. When it comes to intervisibility however, most of the structures in this zone have lower values. This suggests that the high-status structures in this zone would have been highly visible from areas of occupation and activity, but more so from commoner areas, rather than elite areas. They can be said to have broad inward

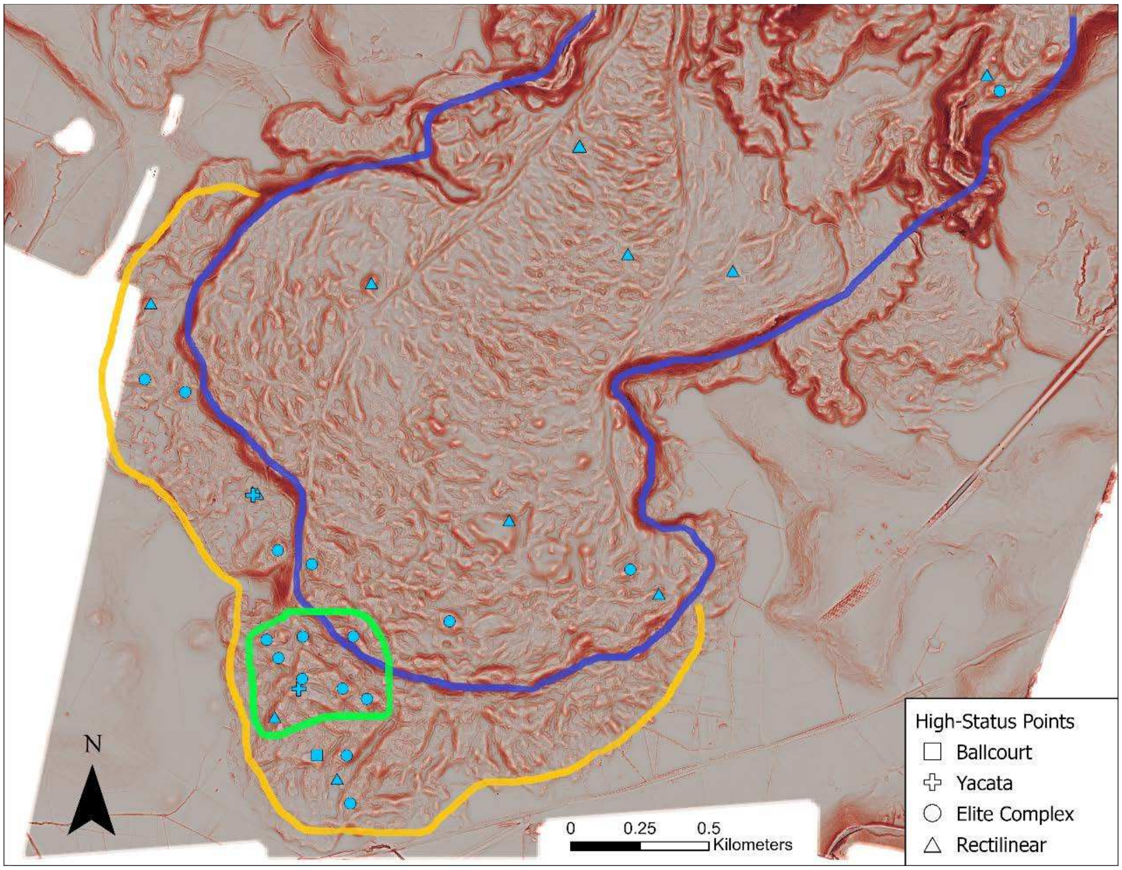

Figure 7. 2: Map of the lower malpaís showing the high-status points and the rough boundaries of the three analytical zones. The blue line delineates the upper elevation zone, the orange line delineates the lower elevation zone, and the green area is the high-status monumental zone. Data displayed over pseudo RRIM.

facing viewsheds relative to the *malpaís* - they project across broad areas but are mostly concentrated on the *malpaís* proper. This would have been favourable for Panoptic surveillance of commoner areas. In other words, if these structures really were positioned to facilitate Panoptic surveillance and middle-level messaging, this suggests that these processes would have been targeted at the general populace, especially commoner areas. The structures in this zone are either rectilinear pyramids or elite complexes. For viewshed area and 'number of other points', most of the yellow and red points with high values are elite complexes. This fits with Table 6. 4 which shows that elite complexes have greater mean values for these attributes than the pyramids. For the rest of the attributes, there are equal numbers of elite complexes and rectilinear pyramids symbolized with yellow or red. This implies that within this zone, the elite complexes tend to have greater intervisibility and larger viewsheds than the rectilinear pyramids, but there does not seem to be a major difference for the other attributes.

If we focus on the high-status monumental zone, most of the structures have smaller viewsheds that encompass fewer archaeological features, roads, and complejos. However, these structures tend to have greater intervisibility (Figure 6. 10 and Figure 6. 11). Four out of the five red points for ‘number of other points in viewshed’ are located in this zone. This suggests that these structures were not positioned to be highly visible from broad areas of occupation and activity, rather, they were positioned to be highly visible from each other within a localized area. In other words, these structures seem to have localized inward facing viewsheds. You can also see this in Figure 6. 4 where high-status structures around the main *yácata* tend to be located on hills and ridges that are elevated relative to their immediate surroundings with the highest visibility values (symbolized in orange and red). There are many possible reasons for this emphasis on intervisibility, but as I mentioned before, one of these could have been to direct a Panoptic gaze and middle-level messages at areas of elite occupation and activity in order to keep local elites in line. As Purépecha state control became more entrenched, it could have made sense to move a large number of local elites into this zone to keep them in line. This interpretation lines up with the fact that in Figure 6. 10, almost all of the points in this zone are elite complexes. There was clearly an emphasis on intervisibility for the elite complexes at this site.

If we look at the rest of the lower elevation zone, the remaining points tend to have low values for all viewshed attributes (Figure 6. 10 and Figure 6. 11). This might lead you to think that surveillance and middle-level messaging were simply not important for these structures. However, we must remember that they were located right at the edge of the site, so most of their viewshed area was likely cut off and would have extended off the *malpaís*. This is supported by the high-status cumulative viewshed surface (Figure 6. 1), which has areas of very high visibility (symbolized in red and orange) off the *malpaís* to the southwest and southeast. This is further supported by Figure 7. 3 below. It shows the viewsheds from two of the points in the lower elevation zone. As you can see, both viewsheds cover very little of the actual *malpaís* with much of their area extending off to the west, southwest, south, and southeast. This suggests that the high-status structures in the lower elevation zone may have been positioned to be highly visible off the *malpaís*. In other words, they have broad outward facing viewsheds. One possible reason for this could have been to project a Panoptic gaze and middle-level messages onto smaller communities in the city's hinterland. This would make sense if Angamuco was an administrative center that oversaw tributary communities. This also could have been done to project a Panoptic gaze over the main southern road into the LPB, which will be discussed in more detail later. If you exclude the points in the high-status monumental zone, there are about an equal number of elite complexes and pyramids in the lower elevation zone. This is also where the ballcourt is located.

It is possible that a temporal sequence exists for these results on the lower *malpaís*. At the end of the Middle-Postclassic, the upper elevation zone may have been the main area of occupation. During the Late-Postclassic this may have shifted down to the monumental zone and the lower elevation zone. Elites who formerly occupied the upper elevation zone may have relocated, or been relocated, to the high-status monumental zone. This could have been a way for the Purépecha rulers to tighten the grip of imperial control, consolidating the lower nobility and

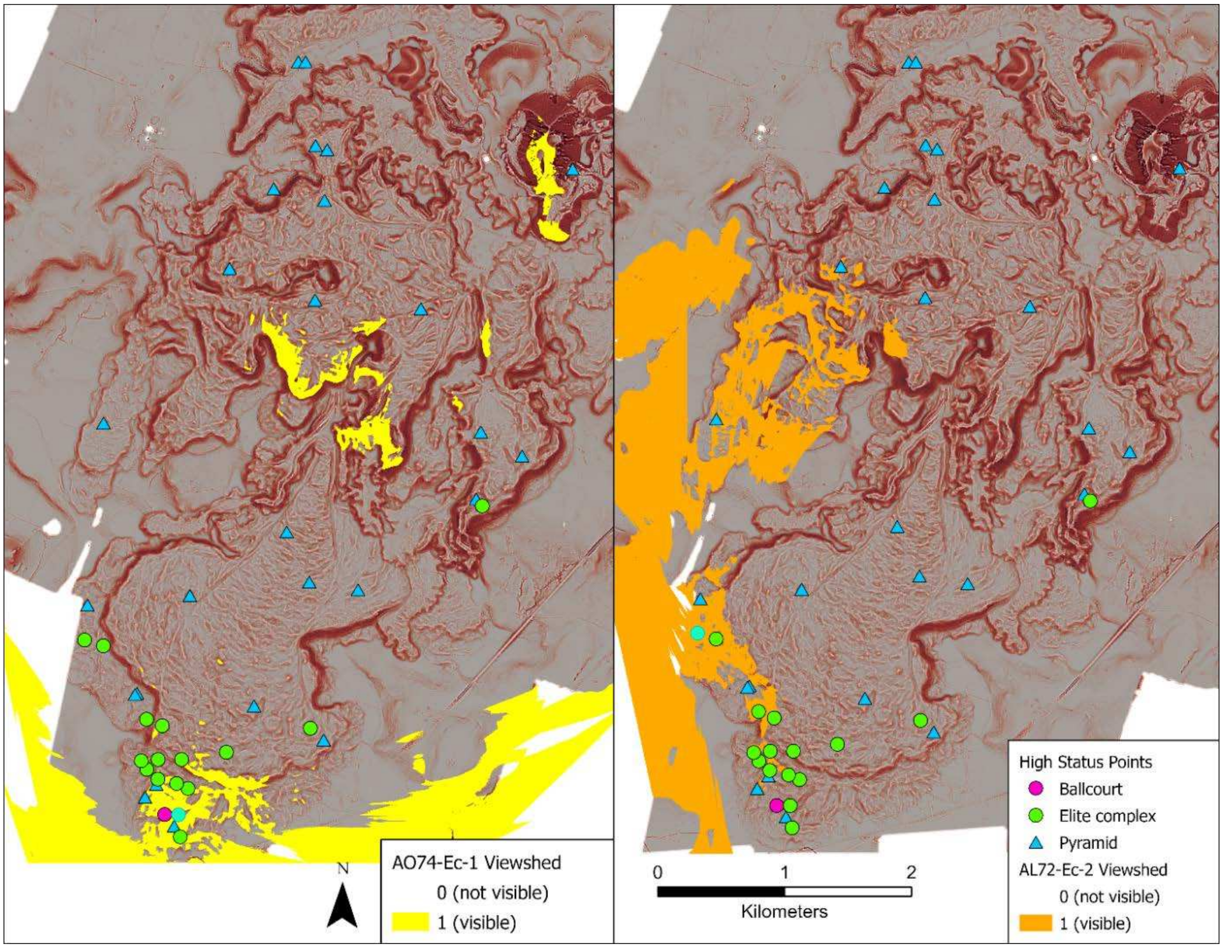

Figure 7. 3: Viewsheds for two high-status points – A074-Ec-1 and AL72-Ec-2 - in the lower elevation zone of the lower malpaís.

elites into a smaller area to better keep them in line. At the same time, this shift might reflect an increased interest in projecting power and control over settlements and transport routes off the *malpaís*. This potential transition from broad inward facing viewsheds, to localized inward facing and broad outward facing viewsheds might signify a shift in strategies of surveillance at the site.

Overall, these results illuminate a potential narrative of social control and state integration at Angamuco that shifts over time and space. It is important to note that this narrative is only based on the data currently available, most of which was only available for the lower study area. If the various datasets were mapped and digitized across the whole site, then all of the viewshed attributes could be quantified across the whole site. As a result, the attribute counts for each viewshed would change, potentially leading to different results that may or may not support this narrative. Unfortunately, without more fieldwork, interpretations have to be based on an incomplete picture of the site.

Before moving on, I quickly want to address some of the other limitations of this analysis. I already mentioned issues with incomplete data coverage, but I should also acknowledge issues with the available datasets themselves. The dataset of pyramid point locations was certainly not perfect. Only a small number of these pyramids have actually been ground-truthed, and these are all on the lower *malpaís*. Some of the 'pyramids' on the upper *malpaís* may not even be actual pyramids. We cannot be certain without more fieldwork. This is another reason why the results from the lower *malpaís* are generally more reliable than the results across the entire site. Additionally, the datasets for complejos and roads are not perfect as both were created through somewhat subjective processes. All viewsheds generated in this analysis were also subject to the limitations of the Angamuco DEM. Elevation surfaces, even with a fine resolution of 0.5 m, are still a simplification of the true ground surface. I also ignored the effects of past vegetation. The Angamuco *malpaís* was certainly less forested than it is today, but it still would have had trees and vegetation that could have obscured visibility. Additionally, I used fixed estimates for the viewshed parameters (OFFSETA and OFFSETB). In reality, not all elite complexes or people would have been the same height, so this would have affected visibility. An avenue of future work could be to vary these parameter values by using, for example, a minimum, median, and maximum value, to see how the results would be affected.

Visibility from Southern Road into the LPB

Table 6. 7 shows that the viewsheds from elite complexes contained a greater mean and median length of the main southern road than the viewsheds from the pyramids. This makes sense considering there are more elite complexes than pyramids on the lower *malpaís*, and the elite complexes also tend to be closer to the edges of the *malpaís*. In the same table, viewsheds from the *yácatas* contained a greater mean and median length of the road than the viewsheds from the rectilinear pyramids. However, there were only two *yácatas* in the study area opposed to 11 rectilinear structures, so this is probably a somewhat unfair comparison. There is great variability among the rectilinear viewsheds, with some containing a large road length and some containing a very small road length. From Table A. 9 you can see that all but two high-status structures on the lower *malpaís* would have been visible from a portion of this road. Both of these non-visible structures are rectilinear pyramids. All of the elite complexes and both *yácatas* would have been visible. I was particularly interested in the visibility of AN73-Py-1, the main lower *yácata*, as this is one of the most prominent symbols of imperial power at the site. The viewshed from this point is shown in Figure 7. 4. This is the combined viewshed from the Angamuco DEM and the LPB DEM. In total, this pyramid would have been visible for about 1.7 km of this road segment. In general, I do not believe the high visibility of these structures from the road is a coincidence. These results suggest that high-status structures on the lower *malpaís*, particularly the elite complexes near the eastern and southeastern edge, were positioned at least in part to be visible from this road. Since Angamuco is located on the far eastern side of the LPB, it may have served as a kind of 'gateway' to the Purépecha heartland, using its high-status

structures to project a Panoptic gaze and middle-level messages onto travellers moving into and out of the LPB.

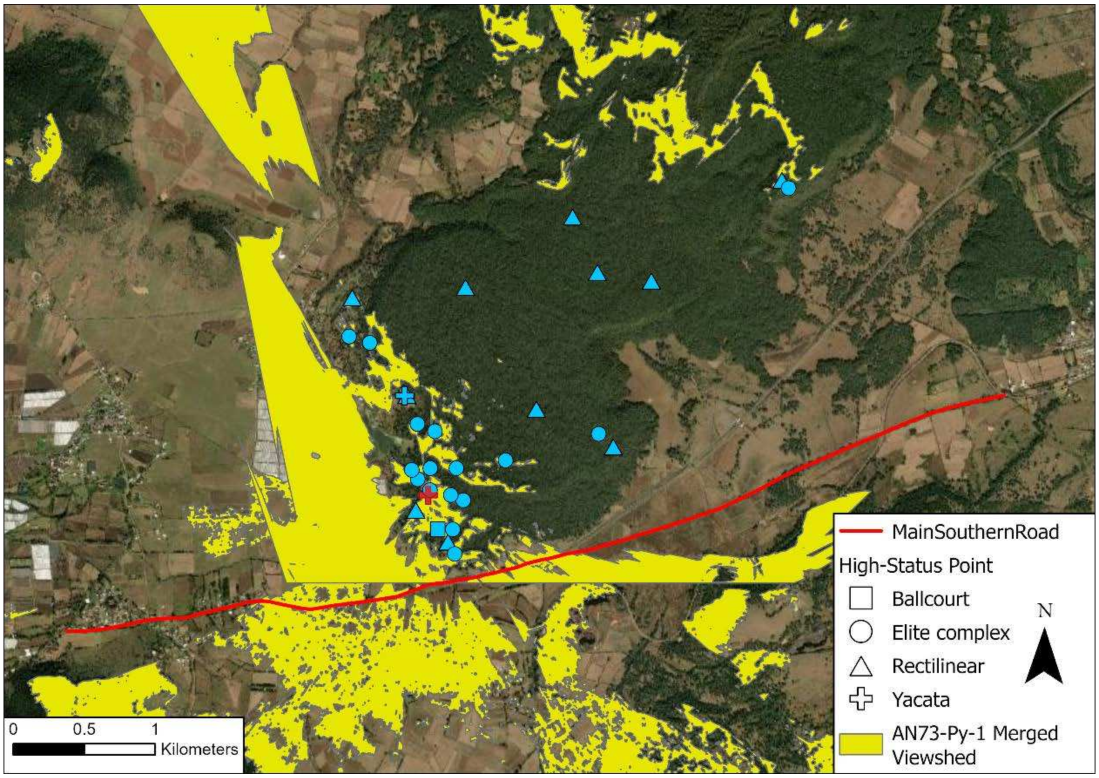

Figure 7. 4: Merged viewshed from AN73-Py-1, the main lower yácata pyramid, which is highlighted in red.

Overall Conclusions

In my introductory chapter, I laid out a specific research question that I hoped to address with this thesis. This section will take the major points of my discussion and use them to answer each this research question.

- *Do the locations of high-status structures at Angamuco suggest that they were made to be highly visible on the landscape in a way that would have been favourable for Panoptic surveillance and the communication of middle-level meaning?*

My overall answer, based on the results of this analysis, is yes. High-status structures at Angamuco do not appear to have been located randomly in relation to their visibility. Across the site as a whole, statistical tests showed that their viewsheds were significantly larger in area, and contained a significantly greater number of other structures than the viewsheds from multiple samples of random points. This suggests that they were preferentially located in places with large viewsheds and high intervisibility. There is also important spatial variability to these results. The high-status structures with the largest viewsheds and greatest intervisibility were almost all found on the lower *malpaís.*

In isolation, statistical tests showed that the high-status structures on the lower *malpaís* had viewsheds that were significantly larger in area, contained a significantly greater number of archaeological features, and encompassed a significantly greater road length and complejo area than the viewsheds from two samples of random points. These high-status viewsheds also contained a significantly greater number of other high-status structures than three samples of random viewsheds. This suggests that these structures would have been highly visible from broad areas of commoner occupation and activity, and that intervisibility was also very important in determining their locations. Important spatial variability also existed across the lower *malpaís*. Structures in the upper elevation zone tended to be less intervisible, but more visible from areas of commoner occupation and activity. They tended to have broad inward facing viewsheds relative to the *malpaís*. Structures falling into the high-status monumental zone had much greater intervisibility but were less visible from commoner areas. They tended to have localized inward viewsheds. Finally, the remaining structures in the lower elevation zone had broad outward facing viewsheds that extended off the *malpaís*. Almost all of these viewsheds encompassed a portion of the main southern road into the LPB, indicating that these high-status structures would have been visible from it.

All of this fits with the idea of Panoptic planning and middle-level messaging, but it suggests a nuanced picture. On the upper *malpaís*, there is not enough evidence to suggest that high-status structures were positioned to facilitate these processes. In contrast, on the lower *malpaís*, high-status structures do seem to have been positioned in a way that was favourable for Panoptic surveillance and middle-level messaging. If we focus on the lower *malpaís* in isolation, in the upper elevation zone, these processes seem to have been targeted at areas of commoner occupation and activity. In the high-status monumental zone, the emphasis on intervisibility suggests that these processes may have been targeted at areas of elite occupation and activity. Throughout the rest of the lower elevation zone, surveillance and middle-level messaging appear to have been targeted off the *malpaís* onto surrounding communities and the main southern road leading into the LPB.

These results suggest a potential narrative of social control and state integration that shifts over space and time. During the Middle-Postclassic, in the early days of Purépecha state integration, there was major growth and expansion across the *malpaís* as a whole. Monumental constructions were built across the site, but they were not planned with a strong emphasis on surveillance or middle-level messaging. This is because during this period, Purépecha state integration mainly operated through bottom-up processes of negotiation and co-option, with pyramids being constructed to help co-opt local elites through the ritual activity that took place at them (see Cohen 2016). Most of the pyramids on the upper *malpaís* were probably built during this time, which would explain why they are less visible and intervisible than pyramids on the lower *malpaís*. Some of the pyramids on the lower *malpaís* probably date to this period as well, they are just interspersed with newer constructions and may have been 'renovated' over time.

Continuing with the narrative, at the end of the Middle-Postclassic and into the Late-Postclassic, state control became more entrenched, and processes of state integration increasingly began operating through top-down mechanisms of power and domination. These mechanisms included Panoptic surveillance and the communication of middle-level meaning. During this time, settlement contracted to the lower *malpaís* and new pyramids and elite complexes were built in this area with an emphasis on these mechanisms of power. In the upper elevation zone, which may have been occupied first, high-status structures were made to be highly visible from areas of commoner occupation and activity. In this zone, surveillance and middle-level messages were targeted at the general populace. At some point, possibly later in time, a high-status monumental zone was created. Local elites may have relocated or been relocated to this zone, and high-status structures seem to have been built here with a strong emphasis on intervisibility. This may have represented a shifting strategy of social control, as surveillance and middle-level messages were now targeted at areas of elite occupation and activity, possibly to keep local elites in line and tighten the grip of imperial control. During this same period, high-status structures were also constructed throughout the rest of the lower elevation zone. These structures were made to be highly visible off the *malpaís,* targeting a Panoptic gaze and middle-level messages at tributary communities in the city's hinterland and the main southern road leading into the lake basin.

Overall, this narrative elucidates changing processes of social control and state integration at Angamuco. It reconciles the arguments about bottom-up vs top-down processes of state integration, showing how both may have been present, just at different times, and how these processes varied spatially. The narrative aligns with the pre-existing settlement model for Angamuco which describes how settlement contracted to the lower *malpaís* during the time of empire. It also generally aligns with the timeline in the RM which places the consolidation of the Purépecha state in the Middle Postclassic. While processes of social control and state integration were certainly complex and multi-faceted at Angamuco, I believe these results, and the narrative they suggest, help illuminate them and can beneficially contribute to our understanding of the site. In a broader sense, I believe these results can contribute to our understanding of top-down mechanisms of social control, and how the manipulation of visibility in the built environment can be an integral part of this.

Future Work

The Angamuco visibility analysis would benefit greatly from additional fieldwork at the site. Because the entire analysis relied on the spatial dataset of pyramid locations, it would be incredibly useful to ground-truth every one of these points. If more of the site, especially areas of the upper *malpaís*, were surveyed, additional pyramids could be discovered, and features like roads, complejos, and elite complexes could potentially be mapped and digitized over a broader area. This would allow for the quantification of a greater number of viewshed attributes across the entire site, instead of just on the lower *malpaís*. Additionally, if the pyramids were ground-truthed, their actual standing heights could be measured in the field, which would be more accurate than deriving them from a DEM. Visiting the pyramids in the field could also help to verify their relative ages, which would be useful for assessing the narrative of social control and state integration that I presented.

Apart from doing fieldwork, I already mentioned how I would like to isolate the pyramids on the upper *malpaís* and compare their viewshed attributes to those from a sample of random points generated in the same area. This would allow me to assess the visibility and intervisibility of these pyramids without the influence of values from the lower *malpaís*. I also mentioned how it would be informative to generate viewsheds from elite complexes using a range of parameter values, say a minimum, median, and a maximum. Furthermore, the robustness of the results could be evaluated by generating additional samples of random points for comparison.

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APPENDIX A

This appendix contains the tables of raw viewshed attribute data. This is the data was that summarized by mean, median, and standard deviation in the results section of the thesis. Table A. 1 contains viewshed attribute data for the 44 high-status points across the entire site. The next three tables contain equivalent data for the first, second, and third samples of random points across the entire site. Table A. 5 contains viewshed attribute data for the 30 high-status points on the lower *malpaís*, and the next three tables contain equivalent data for the first, second, and third samples of random viewsheds for the lower *malpaís*. Finally, Table A. 9 contains the length of the main southern road within each of the 30 high-status viewsheds on the lower *malpaís*.

Table A. 1: Viewshed attribute data recorded for the 44 high-status points across the entire site.

Designation	Type	ViewshedSize	HighStatusPoints	Reservoirs	Comments
AG76-Py-1	Pyramid	1.829	1	2	Rectilinear
AF74-Py-1	Pyramid	10.73	13	19	Rectilinear
AC75-Py-1	Pyramid	4.501	4	8	Northern Yacata
AD76-Py-1	Pyramid	2.727	4	3	Rectilinear
AD76-Py-2	Pyramid	2.84	5	1	Rectilinear
AE76-Py-1	Pyramid	1.722	4	6	Rectilinear
AE75-Py-1	Pyramid	0.429	1	0	Rectilinear
AE80-Py-1	Pyramid	1.402	0	0	Rectilinear
AK76-Py-1	Pyramid	3.757	4	11	Rectilinear
AM73-Py-1	Pyramid	1.919	5	1	Rectilinear
AM73-Py-2	Pyramid	1.686	5	1	Proto Yacata
AN73-Py-1	Pyramid	6.103	22	1	Main lower Yacata
AN73-Py-2	Pyramid	4.545	16	1	Rectilinear
A073-Py-1	Pyramid	0.108	5	1	Rectilinear
X77-Py-1	Pyramid	8.294	0	0	Rectilinear
AC75-Py-2	Pyramid	1.865	4	3	Rectilinear
AI72-Py-1	Pyramid	5.38	4	2	Rectilinear

AI79-Py-1	Pyramid	3.831	1	10	Rectilinear
AI78-Py-1	Pyramid	4.094	2	13	Rectilinear
AK72-Py-1	Pyramid	5.956	10	2	Rectilinear
AN76-Py-1	Pyramid	8.493	6	6	Rectilinear
AM75-Py-1	Pyramid	8.014	11	9	Rectilinear
AJ75-Py-1	Pyramid	6.743	11	6	Rectilinear
AK76-Py-2	Pyramid	3.346	6	8	Rectilinear
AJ78-Py-1	Pyramid	3.587	11	36	Rectilinear
AG77-Py-1	Pyramid	0.324	0	2	Rectilinear
A073-Ball-1	Ballcourt	2.475	12	0	Ballcourt
AN73-Ec-1	EliteComplex	4.237	14	2	
AK74-Py-1	Pyramid	7.953	12	17	Rectilinear
AN74-Ec-1	EliteComplex	3.224	12	2	
AN73-Ec-2	EliteComplex	6.801	21	2	
AO74-Ec-1	EliteComplex	2.973	10	2	
AO74-Ec-2	EliteComplex	3.845	11	0	
AN73-Ec-3	EliteComplex	8.083	20	4	
AN73-Ec-4	EliteComplex	5.237	18	1	
AM73-Ec-1	EliteComplex	9.179	25	8	
AM73-Ec-2	EliteComplex	3.461	11	0	
AL72-Ec-1	EliteComplex	4.598	11	0	
AL72-Ec-2	EliteComplex	5.533	14	0	
AN74-Ec-2	EliteComplex	10.518	18	12	
AJ78-Ec-1	EliteComplex	13.575	13	59	
AM76-Ec-1	EliteComplex	8.671	6	10	
AN73-Ec-5	EliteComplex	4.125	12	3	
AN74-Ec-3	EliteComplex	9.393	21	10	

Table A. 2: Viewshed attribute data recorded for the first sample of 44 random points across the entire site.

Designation	ViewshedSize	RandomPoints	Reservoirs
rand_1	9.273	3	7
rand_2	3.409	5	6
rand_3	7.73	6	17
rand_4	1.845	3	0
rand_5	4.481	3	5
rand_6	0.966	1	0
rand_7	1.921	0	0
rand_8	5.598	4	0

rand_9	0.76	2	0
rand_10	3.549	3	0
rand_11	1.842	3	4
rand_12	3.542	0	2
rand_13	2.849	0	0
rand_14	3.126	1	0
rand_15	3.309	1	2
rand_16	10.217	11	30
rand_17	0.625	1	2
rand_18	4.962	8	13
rand_19	7.142	5	17
rand_20	7.459	6	11
rand_21	0.351	1	3
rand_22	7.19	3	16
rand_23	0.983	1	1
rand_24	0.198	0	1
rand_25	4.024	2	2
rand_26	0.65	1	4
rand_27	3.524	4	8
rand_28	1.935	1	0
rand_29	7.623	3	8
rand_30	3.796	4	4
rand_31	0.605	1	1
rand_32	0.365	0	1
rand_33	9.058	5	23
rand_34	2.352	4	15
rand_35	10.356	3	8
rand_36	4.342	5	5
rand_37	3.618	7	8
rand_38	1.358	0	0
rand_39	0.746	2	3
rand_40	8.767	11	54
rand_41	5.901	5	9
rand_42	0.066	0	0
rand_43	2.693	4	12
rand_44	0.978	0	2

Table A. 3: Viewshed attribute data recorded for the second sample of random points across the entire site.

Designation	ViewshedSize	RandomPoints	Reservoirs

random_1	0.081	1	1
random_2	3.603	8	17
random_3	3.965	1	0
random_4	8.228	9	6
random_5	4.005	7	8
random_6	6.41	9	13
random_7	3.615	4	6
random_8	1.742	4	6
random_9	3.674	3	8
random_10	2.572	0	1
random_11	5.479	4	6
random_12	7.107	8	7
random_13	1.355	5	4
random_14	0.211	1	0
random_15	5.628	0	2
random_16	0.15	0	0
random_17	8.214	5	16
random_18	2.713	3	6
random_19	6.917	8	12
random_20	1.228	1	1
random_21	4.415	2	5
random_22	1.235	3	4
random_23	4.714	7	12
random_24	1.266	3	3
random_25	1.557	3	1
random_26	4.883	0	0
random_27	8.893	12	60
random_28	1.841	6	6
random_29	5.233	5	6
random_30	4.77	7	5
random_31	5.771	1	5
random_32	5.645	3	8
random_33	0.356	2	2
random_34	6.136	3	7
random_35	2.42	2	5
random_36	1.817	2	1
random_37	0.818	5	1
random_38	3.383	2	6
random_39	1.618	6	3
random_40	7.059	5	1
random_41	0.174	0	2
random_42	16.522	21	56
random_43	0.963	3	0

random_44	3.842	2	3

Table A. 4: Viewshed attribute data recorded for the third sample of random points across the entire site.

Designation	ViewshedSize	RandomPoints	Reservoirs
random_1	10.357	6	51
random_2	11.531	8	35
random_3	2.068	2	1
random_4	5.644	5	8
random_5	5.642	1	0
random_6	1.127	3	2
random_7	1.421	0	0
random_8	0.792	3	4
random_9	3.469	3	7
random_10	5.151	0	0
random_11	6.787	2	3
random_12	1.059	0	0
random_13	1.462	3	1
random_14	2.66	0	0
random_15	5.39	1	0
random_16	1.017	2	2
random_17	1.021	0	1
random_18	2.216	0	0
random_19	2.495	3	11
random_20	0.101	0	0
random_21	2.57	3	3
random_22	0.773	1	2
random_23	1.546	4	1
random_24	1.488	2	4
random_25	4.586	1	4
random_26	1.627	2	7
random_27	8.866	11	33
random_28	5.738	3	7
random_29	7.187	0	0
random_30	4.003	2	1
random_31	1.681	4	1
random_32	0.804	1	2
random_33	2.677	0	0
random_34	1.549	0	0
random_35	0.26	0	1
random_36	8.133	7	25

random_37	0.786	1	1
random_38	3.403	0	0
random_39	3.359	4	7
random_40	0.246	0	2
random_41	6.091	6	20
random_42	3.236	4	1
random_43	1.091	3	1
random_44	7.153	6	6

Table A. 5: Viewshed attributes recorded for the 30 high-status points on the lower malpaís.

Designation	Type	ViewshedSize	HighStatusPoints	Reservoirs	ArchFeatures	RoadLength	ComplejoArea	Comments
AK76-Py-1	Pyramid	3.281	4	11	2084	14824.66	0.32	Rectilinear
AM73-Py-1	Pyramid	1.138	6	1	965	3873.57	0.13	Rectilinear
AM73-Py-2	Pyramid	1.042	6	1	903	3680.01	0.12	Proto-Yacata
AN73-Py-1	Pyramid	2.605	21	1	2191	11580.65	0.34	Lower Yacata
AN73-Py-2	Pyramid	2.244	16	1	1730	9370.1	0.25	Rectilinear
A073-Py-1	Pyramid	0.108	5	1	467	3567.51	0.08	Rectilinear
AK72-Py-1	Pyramid	1.816	8	2	1010	3506.92	0.16	Rectilinear
AN76-Py-1	Pyramid	4.969	6	6	3358	18085.4	0.51	Rectilinear
AM75-Py-1	Pyramid	4.532	11	9	4010	16908.9	0.65	Rectilinear
AJ75-Py-1	Pyramid	3.939	10	5	3912	16603.85	0.7	Rectilinear
AK76-Py-2	Pyramid	2.946	6	8	1905	11281.64	0.32	Rectilinear
AJ78-Py-1	Pyramid	3.205	11	35	6435	34313.35	1.08	Rectilinear
A073-Ball-1	Ballcourt	1.618	11	0	1098	7401.7	0.19	
AN73-Ec-1	EliteComplex	1.726	13	2	1433	7170.59	0.21	
AK74-Py-1	Pyramid	3.037	8	15	4367	18901.43	0.72	Rectilinear
AN74-Ec-1	EliteComplex	2.015	11	2	1826	12050.41	0.3	
AN73-Ec-2	EliteComplex	2.82	21	2	2693	13582.54	0.42	
AO74-Ec-1	EliteComplex	2.459	10	2	1561	10541.3	0.27	
AO74-Ec-2	EliteComplex	2.838	11	0	1534	10304.6	0.28	
AN73-Ec-3	EliteComplex	3.407	19	4	3206	17116.94	0.52	
AN73-Ec-4	EliteComplex	2.199	17	1	2020	10001.93	0.29	
AM73-Ec-1	EliteComplex	4.16	24	7	4438	21468.42	0.71	
AM73-Ec-2	EliteComplex	1.693	11	0	1408	5684.11	0.18	
AL72-Ec-1	EliteComplex	1.661	11	0	1507	4842.14	0.21	
AL72-Ec-2	EliteComplex	1.894	12	0	1474	5225.4	0.22	
AN74-Ec-2	EliteComplex	5.587	17	11	5103	27726.93	0.83	
AJ78-Ec-1	EliteComplex	10.604	14	58	9582	54068.98	1.59	
AM76-Ec-1	EliteComplex	5.34	6	10	3738	19792.39	0.57	
AN73-Ec-5	EliteComplex	1.879	12	3	1547	8348.01	0.22	
AN74-Ec-3	EliteComplex	4.071	20	10	4226	23731.15	0.71	

Table A. 6: Viewshed attributes recorded for the first sample of 30 random points on the lower malpaís.

Designation	ViewshedSize	RandomPoints	Reservoirs	ArchFeatures	RoadLength	ComplejoArea
rand_1	1.174	1	3	751	4948.85	0.14
rand_2	0.137	2	0	163	73.32	0.02
rand_3	1.234	4	0	1064	4497.56	0.13
rand_4	0.358	0	0	220	1007.62	0.03
rand_5	1.102	3	0	877	3700.33	0.12
rand_6	1.842	1	1	1584	10508.57	0.22
rand_7	1.702	4	0	1527	7777.8	0.21
rand_8	1.054	0	0	551	3323.3	0.09
rand_9	3.342	2	10	2692	14169.18	0.45
rand_10	0.66	5	2	1428	7617.85	0.25
rand_11	1.52	2	0	830	3513.23	0.11
rand_12	4.147	2	3	2366	12061.93	0.37
rand_13	1.969	1	9	1977	11743.74	0.34
rand_14	2.175	4	2	3001	10949.71	0.55
rand_15	4.861	5	4	3236	13732.99	0.51
rand_16	1.472	5	0	1298	6244.28	0.16
rand_17	1.321	1	0	514	2265.16	0.07
rand_18	3.604	3	3	1964	10446.17	0.3
rand_19	2.887	9	31	6823	37742.66	1.15
rand_20	1.809	8	5	3211	15925.03	0.57
rand_21	2.993	1	3	1019	5178.35	0.16
rand_22	3.505	1	0	1528	7317.74	0.21
rand_23	0.799	0	2	927	5779.11	0.19
rand_24	1.308	0	1	236	1529.38	0.04
rand_25	0.081	0	2	274	1491.25	0.05
rand_26	1.231	1	3	817	4981.16	0.15
rand_27	2.441	1	0	1733	11032.39	0.25
rand_28	1.793	4	1	1707	6432.61	0.22
rand_29	0.93	2	4	1516	6636.39	0.27
rand_30	3.881	9	19	5381	30264.73	0.89

Table A. 7: Viewshed attributes recorded for the second sample of 30 random points for the lower malpaís.

Designation	ViewshedSize	RandomPoints	Reservoirs	ArchFeatures	RoadLength	ComplejoArea
random_1	4.733	7	13	5629	31502.73	0.98
random_2	3.416	5	11	2411	16200.92	0.39
random_3	3.587	1	0	1488	7132.3	0.21
random_4	0.873	1	0	368	1376.8	0.05
random_5	4.562	4	4	2227	11405.84	0.34
random_6	0.611	0	1	760	4015.26	0.14
random_7	1.675	3	4	1040	9959.63	0.16
random_8	1.667	7	6	2139	8746.07	0.38
random_9	1.196	1	0	718	1763.66	0.09
random_10	1.334	1	1	1398	7062.74	0.22
random_11	0.813	0	0	416	2984.68	0.08
random_12	2.53	7	5	3347	13786.62	0.61
random_13	4.063	5	12	3069	19650.54	0.49
random_14	1.756	5	7	2470	9875.09	0.43
random_15	3.372	4	9	2982	18959.53	0.52
random_16	2.38	8	7	2226	8921.13	0.38
random_17	1.972	0	2	720	5181.14	0.12
random_18	2.424	5	2	3070	15372.1	0.57
random_19	0.917	1	1	729	1917.48	0.1
random_20	2.648	3	4	1823	7290.25	0.29
random_21	0.458	0	0	471	3554.28	0.09
random_22	0.563	4	5	889	2659.91	0.15
random_23	0.896	1	2	650	5390.48	0.1
random_24	0.73	3	3	670	3715.57	0.13
random_25	0.584	1	0	524	3295.09	0.12
random_26	1.216	3	3	2333	13110.86	0.41
random_27	1.382	3	6	1037	2992.95	0.22
random_28	0.445	3	2	258	795.97	0.05
random_29	0.444	0	1	385	2905.74	0.06
random_30	4.49	1	3	3032	15868.45	0.47

Table A. 8: Viewshed attributes recorded for the third sample of 30 random points on the lower malpaís.

Designation	ViewshedSize	RandomPoints	Reservoirs	ArchFeatures	RoadLength	ComplejoArea
random_1	3.483	10	8	3598	15125.79	0.58
random_2	1.762	1	5	1254	11270.11	0.19
random_3	3.629	9	15	4667	26165.61	0.79
random_4	2.238	6	33	5214	29665.84	0.87
random_5	5.354	7	27	5216	31964.86	0.83
random_6	1.094	5	7	1385	7111.09	0.25
random_7	1.948	10	7	2223	12053.94	0.39
random_8	1.232	0	0	1063	4388.46	0.13
random_9	3.662	10	10	4813	25965.55	0.82
random_10	3.575	10	6	3119	16279.11	0.54
random_11	2.222	4	3	2013	13056.03	0.35
random_12	1.27	0	1	527	2892.39	0.08
random_13	4.116	7	11	2625	14012.98	0.43
random_14	0.516	1	3	1126	4374.09	0.18
random_15	4.39	4	7	2745	19337.99	0.43
random_16	1.646	0	0	245	2107.03	0.05
random_17	1.503	2	6	1638	13000.69	0.32
random_18	2.224	3	6	2747	16314.72	0.48
random_19	5.715	10	7	4351	26494.95	0.69
random_20	2.386	4	11	3089	10408.06	0.5
random_21	1.551	1	1	1242	9053.87	0.22
random_22	1.351	4	4	1006	3732.86	0.18
random_23	1.193	5	6	1819	7846.47	0.32
random_24	3.108	5	0	1557	7719.71	0.22
random_25	5.015	5	4	2604	12191.45	0.41
random_26	2.751	7	6	3251	16131.53	0.52
random_27	1.489	1	2	2057	10286.61	0.36
random_28	0.657	1	3	396	2100.33	0.08
random_29	3.063	8	8	2873	14218.56	0.47
random_30	2.462	9	10	4338	21901.54	0.74

Table A. 9: Length of main southern road (m) within each of the 30 high-status viewsheds on the lower malpaís.

Designation	Type	RoadLength	Comments
AJ78-Ec-1	EliteComplex	8711.93	
A074-Ec-1	EliteComplex	4263.98	
AO74-Ec-2	EliteComplex	3994.08	
AN74-Ec-2	EliteComplex	3910.88	
AM76-Ec-1	EliteComplex	3787.93	
AN73-Ec-3	EliteComplex	3438.23	
AN74-Ec-1	EliteComplex	3166.89	
AN74-Ec-3	EliteComplex	2924.73	
AN76-Py-1	Pyramid	2754.89	Rectilinear
AN73-Ec-2	EliteComplex	2034.04	
AJ78-Py-1	Pyramid	2028.02	Rectilinear
AM75-Py-1	Pyramid	1953.55	Rectilinear
AO73-Ball-1	Ballcourt	1688.16	
AN73-Py-1	Pyramid	1675.05	Lower Yacata
AM73-Ec-1	EliteComplex	1656.53	
AN73-Ec-4	EliteComplex	1173.32	
AN73-Ec-5	EliteComplex	1117.58	
AM73-Ec-2	EliteComplex	1041.6	
AN73-Ec-1	EliteComplex	1027.71	
AJ75-Py-1	Pyramid	941.25	Rectilinear
AK76-Py-2	Pyramid	915.13	Rectilinear
AM73-Py-1	Pyramid	599.33	Rectilinear
AM73-Py-2	Pyramid	579.55	Proto-Yacata
AL72-Ec-2	EliteComplex	567.36	
AL72-Ec-1	EliteComplex	567.16	
AK76-Py-1	Pyramid	515.76	Rectilinear
AN73-Py-2	Pyramid	479.22	Rectilinear
AK72-Py-1	Pyramid	243.11	Rectilinear
A073-Py-1	Pyramid	0	Rectilinear
AK74-Py-1	Pyramid	0	Rectilinear