

Regional Ways of Seeing: A Big-Data Approach for Measuring Ancient Visualscapes

Natalie M. Susmann 

ABSTRACT

Archaeologists have long acknowledged the significance of mountains in siting Greek cult. Mountains were where the gods preferred to make contact and there people constructed sanctuaries to inspire intervention. Greece is a land full of mountains, but we lack insight on the ancient Greeks' view—what visible and topographic characteristics made particular mountains ideal places for worship over others, and whether worshiper preferences ever changed. This article describes a data collection and analysis methodology for landscapes where visualscape was a significant factor in situating culturally significant activities. Using a big-data approach, four geospatial analyses are applied to every cultic place in the Peloponnesian regions of the Argolid and Messenia, spanning 2800–146 BC. The fully described methodology combines a number of experiences—looking out, looking toward, and climbing up—and measures how these change through time. The result is an active historic model of Greek religious landscape, describing how individuals moved, saw, and integrated the built and natural world in different ways. Applied elsewhere, and even on nonreligious locales, this is a replicable mode for treating the natural landscape as an artifact of human decision: as a space impacting the siting of meaningful locales through history.

Keywords: visualscape, viewshed, prominence, phenomenology, big data, Greece, mountain, vision, open access

Alrededor del mundo, las montañas provocan la creación de lugares religiosos en el paisaje como resultado de sus efectos visuales; los adoradores se inspiran en las cuencas de las montañas y su prominencia física. Los arqueólogos debaten cómo mejor modelar este proceso: si a través de enfoques geospaciales o fenomenológicos, o la integración de los dos. Las metodologías detalladas que involucran múltiples enfoques y grandes conjuntos de datos son raras. Este documento proporciona un marco detallado para integrar análisis geospaciales precisos con la recopilación de datos fenomenológicos, con el fin de determinar qué características topográficas y visuales configuraron los paisajes religiosos. Presenta un estudio de caso sobre las regiones del Peloponeso de Argólida y Mesenia, y explora lugares de culto (es decir, religiosos) utilizados por los griegos entre el 2,800 y 146 aC. Esta metodología, completamente descrita en esta ponencia, combina varias experiencias (observación general, observación hacia el objeto, y la escalada en sí) y compara las preferencias cambiantes a lo largo del tiempo. El resultado es un modelo dinámico del paisaje religioso griego, que articula la movilidad de los antiguos griegos, y de cómo estos vieron e integraron de manera diferente el mundo construido y natural a lo largo del tiempo. Aplicado en otros lugares, e incluso en lugares no religiosos, este es un modo replicable para tratar el paisaje natural como un artefacto de la decisión humana: como un espacio que impacta la ubicación de lugares significativos a lo largo de la historia.

Palabras clave: paisaje visual, cuenca visual, prominencia, fenomenología, grande datos, Grecia, montaña, vision, acceso abierto

MODELING ARCHAEOLOGICAL VISUALSCAPES

Humans are affected by the physical landscape: the physical experience of travel and the sights they encounter along the way (Ashmore and Knapp 1999). These encounters provoke the process of placemaking—where individuals choose to pause and derive meaning (Ashmore 2014; Tuan 1977:179). Challenging terrain, prominence, panoramic views, lines of sight, and even invisibility can therefore provoke the founding of culturally significant places of various functions: power, reverence, defense, and religious significance (Bradley 2000; Eliade 1961;

Llobera 2007:51–53; Scully 1962, 1991; Turner 1979; Van Dyke et al. 2016).

This article explores how to best measure the impact of mountainous landscapes on the siting of religious places. The spatial relationship will differ depending on the mountain's religious function (Bernardini et al. 2013; Boivin 2004; Grove 1999; Reinhard and Ceruti 2010; Williams and Nash 2006). Humans can sacralize mountains, as happens with Hopi and Navajo tribes in the southwestern United States (Bernardini et al. 2013:3951; Jett 1995:41). In the case of the Hopi, their low-lying villages maintained direct lines of sight with whichever mountains were sacred at that time (Bernardini et al. 2013). In the Andes, complexes were

Advances in Archaeological Practice 8(2), 2020, pp. 174–191
Copyright 2020 © Society for American Archaeology
DOI:10.1017/aap.2020.6

constructed on mountain summits, as well as oriented toward higher peaks, and subsequently considered symbols of religious and political power (Williams and Nash 2006). Reverence for mountains could manifest even where these landforms were unavailable. In Mesopotamia, for example, monumental ziggurats acted as artificial barriers; their height reinforced a division between common people on earth and their physically elevated, deified king (Eliade 1961:42; Leick 2002; Scully 1991:23–24).

These examples model the attachment formed between humans and what they see—the “visuallandscape” (Llobera 2003; Richards-Rissetto 2017:4)—and archaeologists have long sought precise, analytical methodologies for its characterization.¹ There is much to consider: the physical and visual effects that observers become culturally attuned to noticing and with which they associate meaning, where observers stand during that process, and how shifting cultural practices might alter visual experience.

Archaeologists studying visuallandscapes largely rely on one of two approaches: digital analyses using geospatial and 3D modeling software or phenomenology. Used separately, either avenue will pose methodological challenges. Some scholars criticize digital landscape models for presenting a Cartesian or God’s-eye perspective (Brück 2005:54; Thomas 1993:25, 2004:198–201; Wickstead 2009:250). Other scholars contend that phenomenology will inaccurately substitute an archaeologist’s experiences for the ancient worshiper’s (De Reu et al. 2011:3435). Many studies have proposed offsetting the objectivity of digital landscape models with the subjectivity afforded by phenomenology (Eve 2012; Fábrega-Álvarez and Parceró-Oubiña 2019; Fitzjohn 2007; Given 2004; Rennell 2012; Seamon 2014; Thomas 1993, 2008; Van Dyke et al. 2016), but full methodological disclosure is rare.

We need a precise, methodical approach for determining how visuallandscapes affected the siting of meaningful places and whether these preferences ebbed and flowed over time. By combining archaeological and historical data and phenomenological observation, as well as precise geospatial analyses, this article provides exactly that: a clearly articulated framework for gauging the cultural salience of natural landscapes.

I designed this methodology with four goals in mind:

- (1) Data collection and analyses should rely on phenomenological observations as well as geospatial technology in order to offset weaknesses in either approach.
- (2) Data collection and analyses should gauge characteristics and perspectives that are culturally relevant to the study area.
- (3) Data collection and analyses should account for contrasting observer experiences: looking toward as well as from significant places.
- (4) A significant span of time should be covered to compare worshiper trends against major cultural and political shifts.

The methodology is applied toward a dataset of cultic (i.e., religious) places in the Peloponnesian regions of the Argolid and Messenia circa 2800–146 BC. The resultant model identifies specific periods when topographical and visual preferences change. It articulates how the ancient Greeks saw and utilized their religious landscape differently through their history. More broadly, this article provides an open-access framework for gauging how

visuallandscapes impact placemaking processes. It can be applied to any period, region, or place type—religious or otherwise.

CASE STUDY: ANCIENT GREEKS AND THEIR MOUNTAINS

There is no question that natural features influenced the siting of cult in the ancient Greek world. Modern scholarship largely draws connections between certain deities and natural settings (e.g., Poseidon and the sea), but every Greek deity was, in fact, connected in some way to natural phenomena (Cole 2000:472–474). The natural world was a space for divine intervention and godly benefits: rest, regeneration and healing, or divine intervention (Håland 2009:119–120; Larson 2010:10; Williams 1991:109).

Mountains were considered spaces of transition between the immortal and mortal worlds. They were not gateways or entrances, as with cultures such as the Maya (Lucero and Kinkella 2014:13–14), but intervening places, providing deities with easy access to the mortal world (Langdon 2000:461). As a result, mortal Greeks were somewhat fearful of mountains. The mountains were frequently visited by the gods, which meant that a mortal’s everyday activities—traveling, hunting, or herding—could potentially go awry (Buxton 1992:7–9, 1994:85–86).

Significant agency was imparted to ancient Greek gods; appearing on a mountain was always their choice. That said, mortals who sought divine intervention would try to entice them. Consequently, the ancient Greeks have left us with a series of archaeologically detectable actions for understanding the mountain–worshiper relationship. Worshipers selected a mountain, defined a temenos (i.e., a sacred boundary), kept that space clean, and there regularly deposited votives and made sacrifices (Cole 2004:35–36).

Greek archaeologists have long focused on situating ancient accounts on the tangible landscape. A significant body of scholarship focuses on pinpointing where on the natural landscape Greek worshipers preferred to practice (Barnett 2007; de Boer and Hale 2008; Driessen 2003; Faro 2008; Goodison 2004; Hannah 2013; Hitchcock 2007; Retallack 2008; Scully 1962; Van de Moortel 2006, 2011; Williamson 1993). Much of this work focuses on mountain top worship. Geospatial analyses measure the worshiper’s viewshed while standing *inside* the temenos (Briault 2007; Hannah 2013; Nixon 2009; Peatfield 1983; Soetens 2009; Soetens et al. 2001; Soetens, Sarris, Topouzi et al. 2002; Soetens, Sarris, Vansteenhuyse et al. 2002; Topouzi et al. 2000; Williamson 1993). These studies often measure whether from there, observers could see another culturally significant place (e.g., a sanctuary; Doxtater 2009; Nixon 2009).

In order to effectively model an ancient visuallandscape, archaeologists need to scrutinize whether their chosen analytical approaches have modern and discipline-specific biases. Archaeologists exploring sacred landscapes in Greece have historically favored sanctuaries located on the highest, steepest peaks. Such studies are arguably impacted by modern topographical definitions, which, although largely lacking standardization, do tend to emphasize elevation and slope as defining factors (Blyth et al. 2002:12). The ancient Greeks were certainly attuned to elevation and slope, but they also cared about prominence—that is, noticeability (Belis 2015:41; Buxton 1992:2;

Langdon 2000:462). A landform does not need either a high elevation or a steep slope in order to be noticeable, and this might explain why some landforms in Greece—being well below the 300 m mark—are described as mountains in ancient texts (Belis 2015:40; Buxton 1992:2; Langdon 2000:462).

Previous archaeological studies suggest that views afforded from mountains and hills could have impacted the founding of cultic places on the ancient Greek landscape—but so too could the views toward them. By comparing these contrasting observer perspectives within a single dataset, we can determine the physical characteristics that inspired the cultic placemaking process on the ancient Greek landscape. My study asks: Were Greek cultic places chosen according to landscape prominence (i.e., noticeability) or visible extent? Did these preferences vary regionally and over time?

SURVEY METHODOLOGY

Defining the Study Area

This study is devoted to two Peloponnesian regions: the Argolid (2,819.38 km²) and Messenia (4,060.21 km²; Figure 1). The Argolid is in the northeast Peloponnese, bound on the eastern side by the Arcadian mountain range. Messenia encompasses the modern

towns of Triphylia, Pylia, Messini, and Kalamata, with the Taygetos Mountains on the east, and Mounts Nomia and Elaeum to the north. Adhering to strict boundary lines such as these does present a conundrum for landscape archaeologists (Cherry 1983:385–386). On the one hand, it provides a manageable space within which to collect data; on the other hand, these lines inaccurately presume that people adhere to a singular notion of boundary.

Questions about vision can further complicate archaeological boundaries. In the observer’s mind, the physical space of their political or social territory can be different based on their visible extent, impacting their sense of spatial ownership and belonging (Bernardini et al. 2013:3948). For research on visualscape, this means considering expanding a study area beyond sociopolitical boundaries. In this study, for example, the boundaries of the Argolid and Messenia were extended because observers could have easily seen—and, in turn, utilized—sanctuaries beyond those lines (e.g., at Bassae and Olympia, as well Skilloundia [Cooper 1996:42, 45; Larson 2007:27; Morgan 1990:89–90]). The boundaries of either region—and the cultural identities contained within them—also change through history. The case study applies the largest known ancient boundaries for either region in order to understand whether and how historic locales were integrated into the lives of contemporary people.

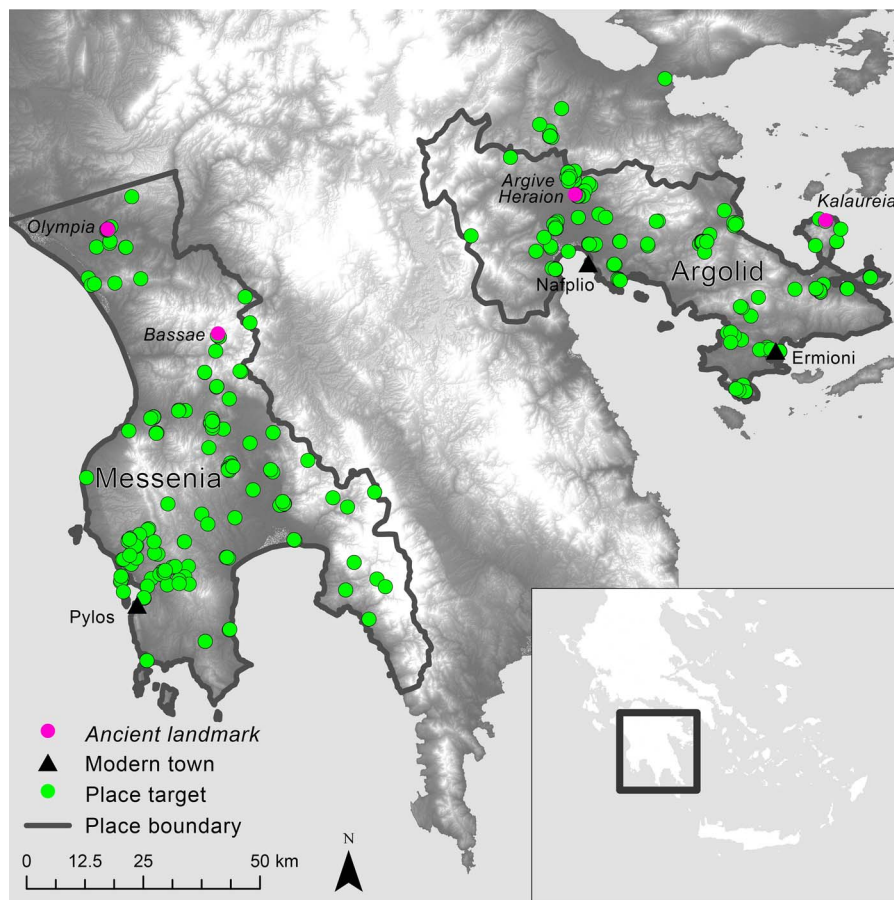


FIGURE 1. The survey recorded all cultic places used between 2800–146 BC in the Argolid (2,819.38 km²) and Messenia (4,060.21 km²).

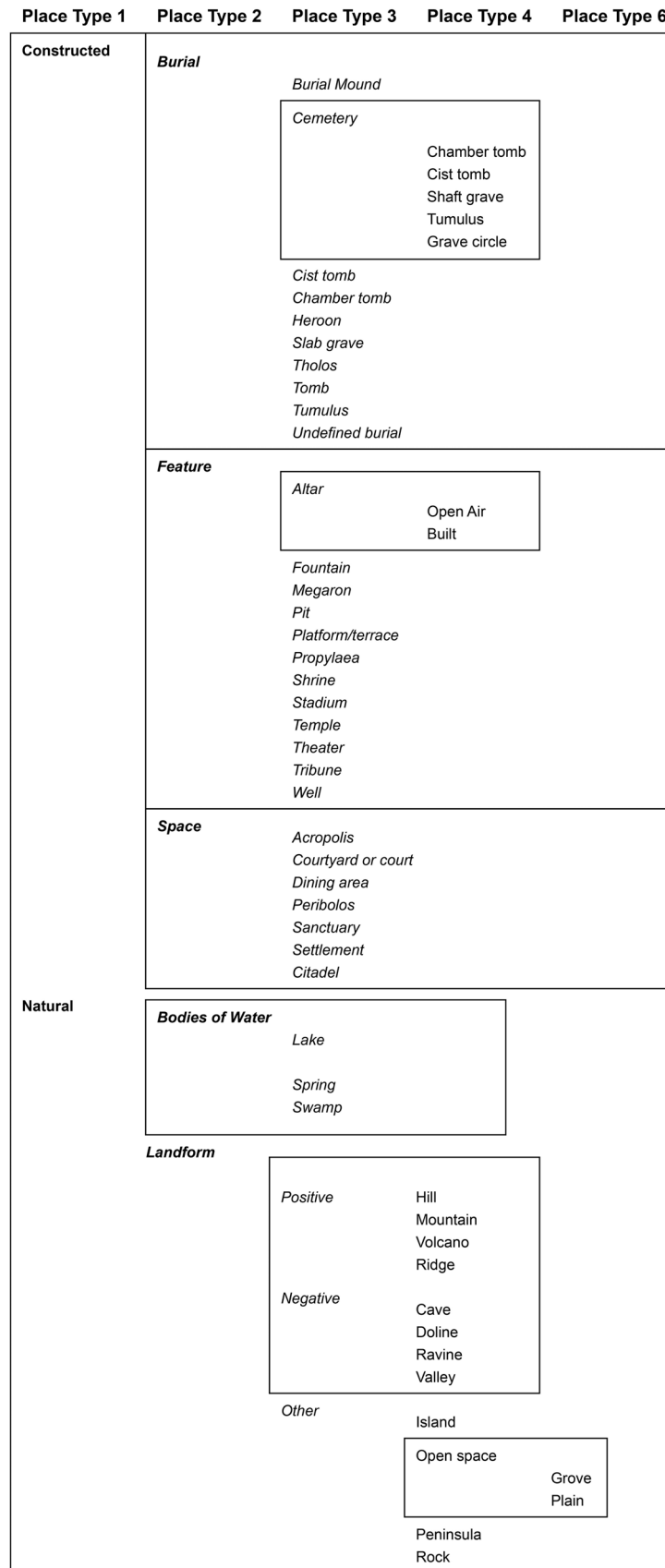


FIGURE 2. A cascading typology was applied to all constructed and natural places, allowing for each place to be both broadly and specifically defined.

Survey Targets

A cultic place is defined as any individual built or natural space to which material remains for repeated religious activity can be attributed. These activities can be unique to a particular time or region (Antonaccio 1994:398).² For each of the study areas, I located all places where previous researchers had discovered material evidence for cultic activity (e.g., burning fires, intentional deposits of objects, sacrifice, or construction of related buildings). Because the study focuses on placemaking as it pertained to group worship, household cultic contexts were excluded. Restrictions set by the Greek Ministry of Culture and Sports meant only published cases could be used. In sum, 401 places were identified.

The data-recording strategy captures every individual act of cult. Instead of representing an entire sanctuary as one cultic place (one database record), every locale inside its boundary dedicated to cultic acts (altar, temple, pit, etc.) is treated as a discrete place as well. Recording data in this way makes it easier to identify changing temenos sizes and functions over time and to measure how these alterations impacted the worshiper's visualscope.

Cultic places located in other environments (e.g., coasts, valleys, plains) are not excluded from the study. The reasons for doing

so are threefold. First, as previously described, there are significant differences between the ancient and modern Greek definition of "mountain." Analyzing all cultic places—regardless of topographical situation—accounts for the archaeologist potentially seeing the landscape differently. Second, analyzing all cultic places encourages inquiries about how the ancient Greeks saw and used their landscape differently across space and through time. Despite the clear importance of mountains in ancient Greek worship, there were still many sanctuaries founded on low-lying, seemingly unnoticeable locations. Many potential influencers could have come into play: social competition and settlement proximity (de Polignac 1994, 1995) and certain cults requiring specialized natural environments (e.g., Poseidon worship occurring near water), as well as changing worshiper preferences.

With all these factors in mind, there is a substantial body of evidence pointing to the importance of mountainous terrain, and by exploring all cases of worship—regardless of their natural environment—we can cross-examine many influencers and determine whether the cultic placemaking process focused on meeting multiple needs. Finally, recording all cultic places responsibly produces a more expansive dataset, leaving room for future analytical improvements and research enquiries.

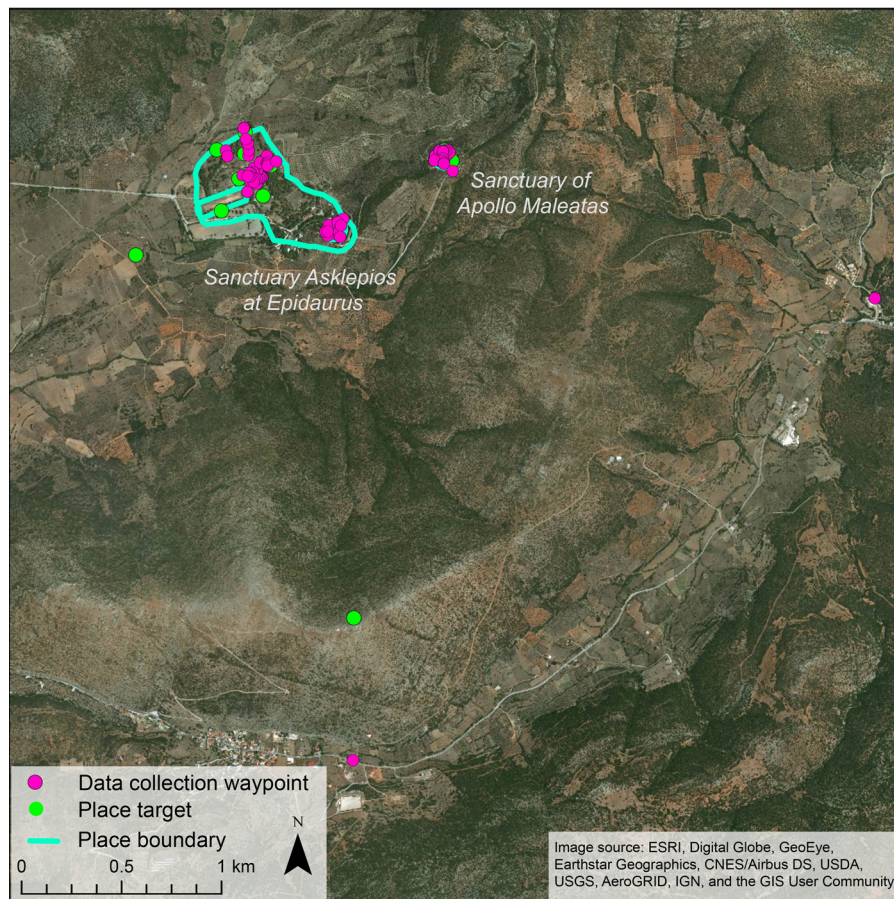


FIGURE 3. Visual data were collected both within cultic place boundaries and around them. For example, data collection (pink points) occurred at various distances around the Sanctuary of Asklepios at Epidaurus and the Sanctuary of Apollo Maleatas in order to understand the surrounding visualscope.

Data Recording

I assigned a unique “Place ID” to each cultic place (every built altar, open space altar, megaron, temple, tomb, terrace, etc.) and stored them in an Access database (Supplemental Database; Supplemental Text). Because this study treats the natural environment as an artifact, I recorded each cultic place’s associated natural feature as a separate entry in the database as well. Each natural and constructed place’s type was categorized via a cascading typology: every place was defined broadly (e.g., “constructed”) as well as specifically (e.g., “open-air altar”), thereby ensuring that the data is flexible and functional, even for analyses beyond the scope of this work (Figure 2).

The database is designed to link places to one another. Linking relationships are functional (e.g., a temple is located *inside* of a sanctuary) or spatial (e.g., the Sanctuary of Apollo at Bassae is *visible from* the Sanctuary of Nomian Pan).³ Additionally, every cultic place is linked to its natural feature through a spatial relationship (e.g., the Sanctuary of Apollo at Bassae is *located on* Kotyliion Mountain).

I recorded additional attributes for every constructed place, such as ancient and modern bibliography, summary of

excavation and survey data, and previous theories regarding motives for its placement. The database includes a timeline table that records the following phases (if any) for every place: (1) cultic use prior to construction of a permanent structure, (2) construction of the cultic place, and (3) cultic reuse following abandonment, thereby indicating a change in practice (e.g., a Mycenaean tholos tomb being converted into an altar during the Geometric period).⁴

Field Survey

The goals of the field survey were twofold. First, substantial visual data were needed to ground-truth the visualscape analyses. Second, I wanted to enact a phenomenological investigation of these cultic places and experience the environment firsthand (Susmann 2019b:1–11, 121–139).⁵ Observing ourselves and others in the modern landscape opens our minds to the potential pathways, views, and perceptions of past users (Barrett and Ko 2009:276; Given 2004:168; Tilley 1994:73–75; Van Dyke et al. 2016). Phenomenology therefore helps us “build a place-based narrative of the [worshiper’s] journey and to explore (through the analogue of our own bodies) the kind of perceptions—and emotions—attendant on moving through such spaces” (Wescoat 2017:69).

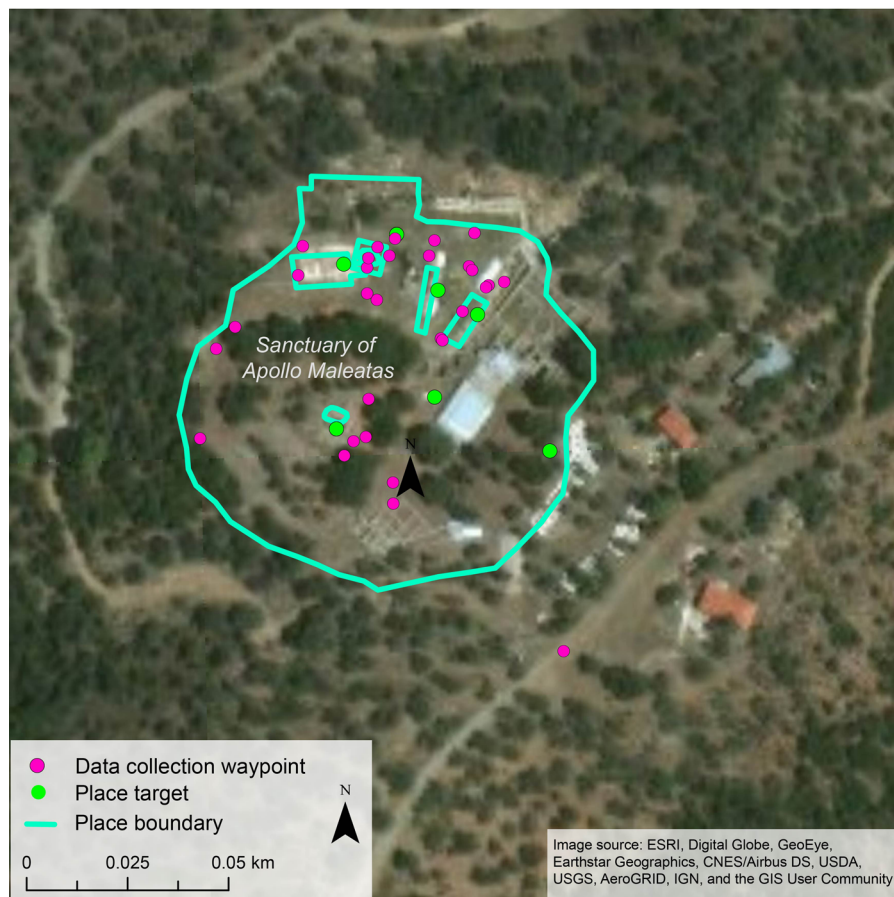


FIGURE 4. Visual data were collected inside the cultic place’s boundaries (i.e., here, at the Sanctuary of Apollo Maleatas). Locations of data collection (pink points) were determined by place type (e.g., temple, open-air altar, pit, etc.), and they model where ancient observers would feasibly stand. Adjustments were occasionally made because of permit restrictions.

TABLE 1. Visualscape Analyses Summary.

	Method	Description	Observer Height (m)	Maximum Visible Distance (m)	Neighborhood Size (pixels)	Required Dataset
Viewshed (visible extent)	CVSL (Cumulative Viewshed of Location)	Cumulative visible extent from the cultic place	1.65			DEM, Place_Bounds, Observer_CVSL
Visual Prominence (noticeability)	CVSO (Cumulative Viewshed of Observer)	Cumulative visual prominence of each cultic place, based on # of times seen	1.65			DEM, Place_Bounds, Observer_CVSO
	CVSO 5K (Cumulative Viewshed of Observer 5K)	Cumulative visual prominence of each cultic place, based on # of times seen within a 5 km radius of observers	1.65	5,000		DEM, Place_Bounds, Observer_CVSO
	VPO (Visual Prominence of Observer)	Visual prominence of each cultic place based on its landform’s shape against the horizon	1.65			DEM, Place_Bounds, Observer_VPO
Topographic Prominence (ruggedness)	TPL (Topographic Prominence of Location)	Topographic ruggedness of each cultic place, based on ruggedness and steepness			3 × 3	DEM, Place_Bounds

The survey was accomplished in two phases. For each study area, I spent approximately two months locating these places remotely in Google Earth; survey and excavation publications often exclude or generalize geographic coordinates. Next, I traveled to Greece, located each cultic place in person, and recorded data for each.⁶ Visual data captured what could be seen, based on multiple vantage points. I photographed panoramas at varying distances and directions, capturing views looking toward the cultic place, and at the cultic place, looking at the surrounding landscape. I recorded videos to convey the experience of walking through and around each place’s boundaries. Then, I marked every video and photograph with a GPS point (Figures 3 and 4). Video narratives and journals recorded my experience of the place: difficulty of access, extent and contents of the viewshed, level of isolation (e.g., if other visitors were present), and my impression of how others utilized the place.

VISUALSCAPE ANALYSES METHODOLOGY

Goals

The Greeks regarded mountains as sources for godly contact, and I hypothesize that this association influenced where cultic activity was located on the landscape. Historical and archaeological data suggest that the Greeks identified mountains based on noticeability and/or vast viewsheds. I decided to test how frequently the survey data reflected these preferences: whether most places were situated to be noticeable or afford worshipers panoramic views of their landscape. By ordering the quantitative results in chronological order—when cultic activity occurred at each place—I modeled how worshiper preferences changed over time.

The selected analyses fall into three categories (Table 1):

- (1) Viewshed, or what can be seen from the cultic place. This was measured via CVSL (Cumulative Viewshed of Location).
- (2) Visual prominence, or whether the place was noticeable to passers by based on characteristics like elevation, slope, and shape against the horizon. This was measured via Cumulative Viewshed of Observer (CVSO and CVSO 5K) and Visual Prominence of Observer (VPO).
- (3) Topographic prominence, or whether the place was noticeable as a result of rugged terrain. This was measured via Topographic Prominence of Location (TPL).

Parameters

This section briefly describes the factors that informed the design of these analyses: representing place targets via polygons and not centroids, number, and placement of observer points, as well as maximum visible distance radii.

Boundaries and Observers. For the sake of easy database recording, I represented each cultic place’s location as a single set of GPS coordinates (Places.shp). I created a second shapefile (PlaceBounds.shp) to represent cultic places’ use areas. This shapefile was utilized in the visualscape analyses. If a single cultic place had multiple extents over time, I recorded each phase as a separate polygon and linked it to respective records in the Access database’s timeline (Figure 5).

The analyses measure a range of visual effects, the majority of which are founded on viewshed principles: measuring what an observer can see, based on the individual’s stature, the elevation, and the elevations of the surrounding landscape. Each analysis necessitated a customized set of observer points, and *PlaceBounds.shp* dictated how these were placed (Tables 1 and 2). For CVSL, which measured a place’s viewshed, I situated observer

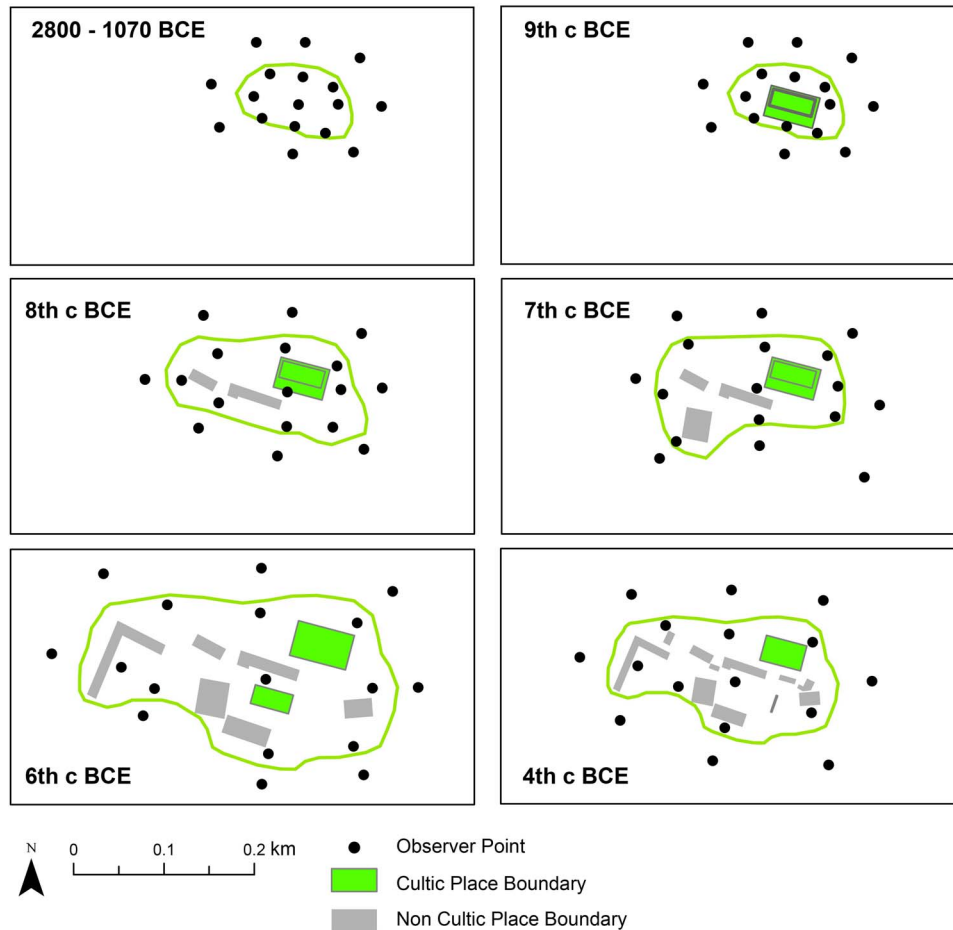


FIGURE 5. Spatial extent affected how analytical outputs were measured. If a place's extent changed over time (green polygons), I made sets of observers per phase (black points) and then ran analyses per each observer point set. Note that the observer points shown here are only for the Argive Heraion sanctuary's temenos. I recorded cultic structures located inside the temenos (i.e., the altar, Old Temple Terrace, Old Temple of Hera, and New Temple of Hera) as individual cultic places, which means they have separate observer point files (not shown) and analyses outputs.

points (*Observer_CVSL.shp*) with respect to these spatial boundaries. For the three visual prominence analyses (CVSO, CVSO 5K, and VPO), I placed random observers across the study area (*Observer_CVSO.shp* and *Observer_VPO.shp*). In these cases, *PlaceBounds.shp* demarcated ineligible placement areas: observers were not permitted to "stand" on top of structures.

Maximum Visible Distance. Vision-focused geospatial tools include an optional outer visible radius setting. If the radius is applied, the observer's ability to see is limited by that distance. Archaeologists tend to favor this setting, and they apply radii somewhere between 3,440 and 5,000 m in order to represent the limitations of 20/20 human vision (Gillings 2015:4). Applying this radius does not guarantee output accuracy. Many potential impediments exist—such as vegetation, light, weather, and poor vision—but archaeologists cannot easily account for them. This is where visual field data comes in handy.

My methodology does not apply maximum visible distance radii (Table 1) for two reasons. First, increased elevation extends an

individual's vision well past the commonly applied 5,000 m threshold, and this was observed with most places recorded in this study. Second, 3,440–5,000 m distance thresholds are based on an individual's ability to see a 1 m wide object (Ogburn 2006:409–410). Recognition of a significant locale is based on not only the sight of the structure but also the landform. Landforms measured in this study are certainly wider than 1 m.

Geospatial Approaches

Visual Prominence. Visual prominence, or a place's noticeability, was measured in two different ways (Table 1). Cumulative Viewshed of Observer (CVSO) assesses how often an individual would see a cultic place. This was calculated via the summation of several thousand viewsheds across the study area. Visual Prominence of Observer (VPO) focuses on horizon lines—which landforms were the most distinctive based on shape.

Cumulative Viewshed of Observer (CVSO). Cumulative Viewshed of the Observer (CVSO and CVSO 5K) gauges noticeability based

TABLE 2. GIS Files Used for the Visualscape Analyses.

File Name	Description	Associated Analyses/ Function	File Type	Placement Rules
Places	Locations of each surveyed cultic place	Survey, data management, and all analyses	Point	Centroid of cultic place
Waypoints	Locations of surveyed visual data; links to <i>Places</i> via unique identifiers	Ground-truthing	Point	GPS locations where data was recorded
DEM	30 m SRTM Digital Elevation Model	All	Raster	
Observer_CVSL	Observers standing in and around each cultic place's boundaries (i.e., <i>PlaceBounds</i>)	CVSL (Cumulative Viewshed of Location)	Point	Location and # standardized per place type. Placement ensures peripheral and foveal vision within and around cultic places. <i>PlaceBounds</i> and site plans used to avoid overlapping contemporary structures. If extent changed over time, multiple sets of observers are made.
Observer_CVSO	Observers across the landscape	CVSO (Cumulative Viewshed of Observer)	Point	One set of observers is created per study area. Placed 200 m apart on all areas >49° in slope. Cannot overlap with <i>PlaceBounds</i> .
Observer_VPO	Observers across the landscape	VPO (Visual Prominence of Observer)	Point	One set of observers is created per study area. Placed 200 m apart on all areas >49° in slope. Cannot overlap with <i>PlaceBounds</i> .

on how easily observers across the study area could see a certain location (Table 1). These analyses use a reverse viewshed: observers are represented as vector points, spread across the entire study area, and viewsheds are calculated for each. The cumulative output represents the number of times every location on the landscape was seen. Reverse viewshed accuracy depends on the number of applied observer points. Ideally, a total viewshed approach should be used: observers are placed on every pixel of the Digital Elevation Model (DEM). Accuracy aside, total viewsheds are unrealistic for large study areas. The high number of observers means decreased processing speeds and virtually unmanageable output data sizes (Llobera 2003:33). Cumulative viewsheds are the next-best approach. Observers are regularly spaced across the DEM, but in much smaller numbers, thereby making the calculation computationally feasible.⁷

Within each study area, I placed observers on a grid, each separated by 200 m (Table 2). I calculated viewsheds for every observer using Boston University's Shared Computing Cluster and *r.Viewshed* (in GRASS GIS). Per study area, I merged the viewsheds into a single raster output. Each pixel quantifies the number of times that 30 m² area was seen by the regional observers. In other words, the raster output quantifies an observer's concatenated view, as that person moves through space (Llobera 2003:33; Figure 6a).

Although regional differences are apparent from the raster, I decided to translate the data into comparable scores representing the number of times each cultic place was seen. To do so, I vectorized the output and intersected it with a shapefile recording each place's boundary. Two scores were calculated (Figure 6b). The first is CVSO, or the number of times that place was seen, with no maximum visible radius set. The second is CVSO 5K. CVSO 5K normalizes the CVSO based on the number of observers within a 5 km radius of the cultic place. It measures prominence on a localized level, and when

compared against CVSO, it determines whether a place's prominence was dependent upon observer proximity.

Visual Prominence of Observer (VPO). VPO measures visible prominence using an alternative perspective. Prominence is based on shape: whether a landform is steep, isolated, and pointed (Bernardini et al. 2013:3948; Figure 7). My approach is based on the methodology pioneered by Bernardini and colleagues (2013:3947), which measures local prominence, or noticeability from fixed locations of interest.

I adjusted their methodology to instead measure global visual prominence—that is, to compare noticeability across the landscape, with no fixed observer location in mind. To do so, I placed gridded observers across the study area, each separated by 2,000 m (Tables 1 and 2)⁸, and I measured the extent and shape of each observer's 360-degree horizon line. This was done using ArcGIS's Skyline tool. Bernardini and colleagues' (2013) customized Python scripts simplified the horizon line to its steepest, pointiest, and most isolated peaks, and gave each a comparative score (Barnash 2011; Bernardini et al. 2013:3948–3951). I merged results from every observer, producing a vector shapefile recording prominent areas in each study area—that is, prominent areas based on Bernardini and colleagues (2013): characteristics of slope, shape, and location (Figure 8). Any score greater than 0 is considered visually prominent. In order to relate these prominent landforms to cultic activity, I intersected the polygonal boundaries with cultic place boundaries (i.e., *PlaceBounds.shp*). Cultic places were, in turn, assigned that score.

Cumulative Viewshed of Location (CVSL). CVSL represents the extent of view from a cultic place. Most archaeological studies measure binary viewsheds—that is, the visible extent available to one or a few observers. This approach can be useful in identifying

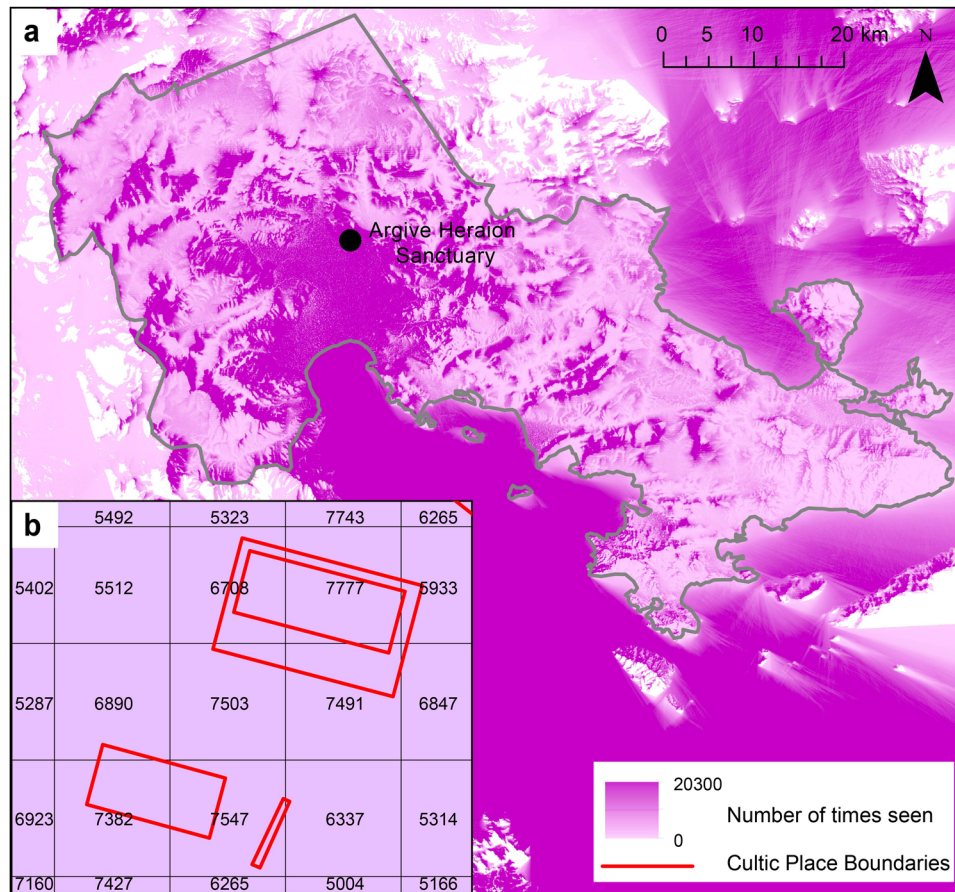


FIGURE 6. (a) CVSO (Cumulative Viewshed of Observer) measurement is performed by creating a grid of observers within the regional study area. For each of these observers, a separate viewshed is calculated. The final merged raster is a continuous dataset comparing regional noticeability. (b) Each place's polygonal boundary or boundaries are intersected with the raster, and the following is calculated: (sum of # times seen/# pixels intersecting the boundary) = prominence.

lines of sight (Danahy 2001)—whether, for example, Minoan peak sanctuaries were visible from one another—but the results are also quite static. A binary viewshed models an unrealistic situation: what a motionless, forward-facing observer sees (Llobera 2003:33).

CVSL addresses these limitations, recalling the logical principles of the CVSO approach: increasing the number of observers will produce a more accurate model of view (Table 2). By situating observers throughout the space of the cultic place, CVSL accounts for both peripheral and foveal vision—it conveys the topographic changes encountered as one moved around and looked about. It models “a sense of the complete scene” (Danahy 2001:126), better than a traditional binary approach does.

The methodology was easily implemented. I created a set of observer points for each cultic place, paying mind to changing boundaries over time, as well as adjacent contemporary structures—cultic or otherwise (Table 2; Figure 5). Using a viewshed tool (e.g., Visibility in ArcGIS or one similar), I calculated the total visible area from each observer point. The resultant raster represents what a worshiper could see while moving through and around the cultic place.

Topographic Prominence of Location (TPL). TPL is the measurable difference between the height of an observer and the surroundings. It gauges noticeability based on a place's physical ruggedness (Llobera 2010:1007). TPL is measured by (1) identifying a pixel of interest, (2) demarcating a neighborhood around that place, and (3) measuring the height differences between the pixel of interest and the pixels in its neighborhood. Although the resultant measurement—differences in altitude—contributes to our understanding of landform noticeability, there are challenges associated with related parameters. The researcher chooses the neighborhood size, thereby impacting whether a locale is determined to be more rugged than its surroundings. In other words, a locale can be exceedingly prominent on a local scale but not regionally.

Due to these methodological challenges, topographic prominence results were described in context with visual prominence: whether slope contributed to visual prominence, and whether any cultic places were situated on rugged but also unnoticeable areas. In the case of the latter, topographic prominence could highlight an alternative—and largely understudied—perspective: whether Greek worshipers ever preferred difficult-to-access locales that were largely invisible to passersby.



FIGURE 7. VPO (Visual Prominence of the Observer) measures visual prominence based on landforms’ comparable elevation, slope, and visual isolation: (a) these landforms yield VPO scores of 0 because they are not distinctive from one another; (b) these landforms yield scores greater than 0 because they are isolated from one another and form distinctive shapes against the horizon.

There are several methods for measuring topographic prominence (Christopherson 2003; De Reu et al. 2011, 2013; Llobera 2003). I chose Focal Statistics in ArcGIS (Tables 1 and 2). As was the case with previous analyses, I intersected the results with the cultic place boundaries shapefile in order to ascertain the average, minimum, and maximum scores within the use area. This article presents average scores.

Data Presentation. I performed each analysis—CVSO, CVSO 5K, VPO, CVSL, and TPL—per cultic place, and if that place’s boundary changed over time, I ran the analyses per each time phase. I normalized the values between 0 and 1, and I graphed them per century using JMP software. The resultant model represents the average visualscape values per century, based on changes on the landscape: new constructions or newly recycled locales (Figure 9). It conveys the sorts of natural environments preferred for worship, and the way these preferences changed over time.

DISCUSSION

The results identify distinctive moments of time when ancient Greeks in Messenia and the Argolid preferred specific types of natural environments for worship—specifically, when they

developed cultic places at locales that were steep, that were noticeable, or that provided a vast viewshed (Figure 9). Their preferences can be contextualized against other historical and archaeological data; we can surmise the motives for preferring specific environs over others throughout their culture history. That discussion is beyond the methodological scope of this article and can be found in Susmann (2019b). Instead, I will engage with both phases of the methodology—fieldwork and geospatial analyses—and discuss the benefits of my confluent approach.

Geospatial Approaches Produce Objective, Comparable Data

This article utilizes Geographic Information Systems (GIS) to measure visual prominence, ruggedness, and visible extent. Although archaeologists highlight phenomenology as an alternative (e.g. Rennell 2012), these approaches produce qualitative data, making site-to-site comparisons extremely difficult. Also problematic is their subjectivity. Cultural context and observer identity will impact how a landscape is seen, experienced, and perceived. Archaeologists’ hypotheses and historical knowledge inevitably impact their descriptions.

My geospatial methodology produces objective, comparable data. It facilitates exploration about whether viewshed or

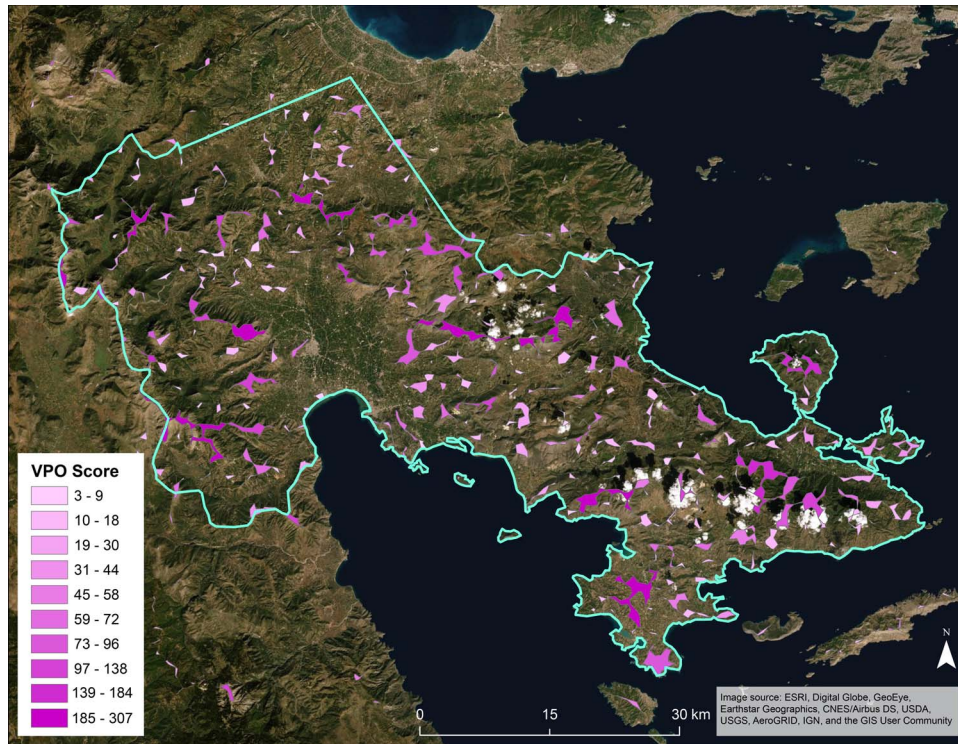


FIGURE 8. VPO (Visual Prominence of the Observer) analysis output is not continuous. Only cultic places that intersect the polygonal boundaries of visually prominent landforms are considered prominent.

prominence—or both—were culturally relevant in the cultic place-making process. In the case of prominence, my methodology also explores how the same place could have been noticed differently. The Argive Heraion sanctuary, located in the central Argive Plain, is an excellent example. Based on the CVSO analysis, this sanctuary is noticeable. Its location midway up Mount Akraia meant that it was visible at ranging distances across the Argive Plain. The VPO analyses tell a different story. The Argive Heraion yields a VPO score of 0; its mid-slope location made it unnoticeable against the horizon (Figure 10). Consequently, the Argive

Heraion was noticeable, provided an observer knew where to look. During fieldwork, I did not notice such a distinction. I anticipated this sanctuary's prominence as a result of previous scholars' work, all of whom highlight a CVSO-way of looking at the landscape (Cole 1986:115–116; de Polignac 1995:33; Foley 1988:135; Kerényi 2015:117).

There are earlier sanctuaries in the region (e.g., Mount Arachnaion) with high VPO scores and CVSO scores close to 0, and here is where comparison against regional datasets, as well as critical

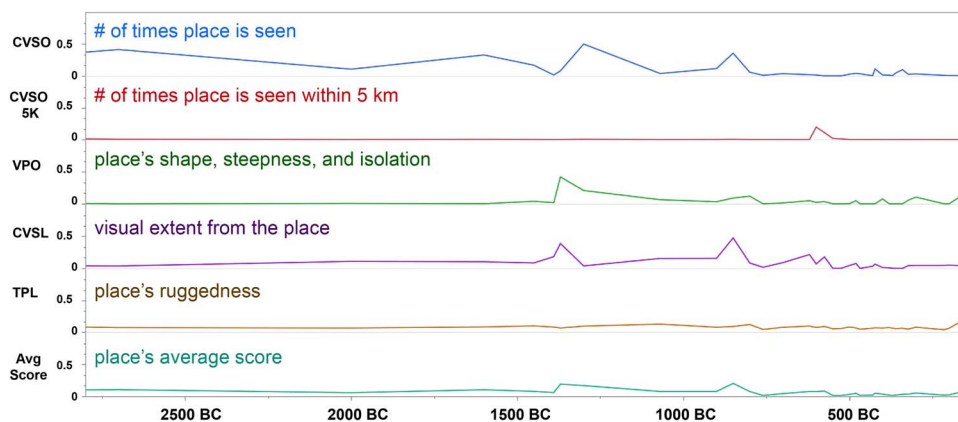


FIGURE 9. I normalized the visualscape analyses' average scores and graphed them per century. These scores reflect new additions to the landscape or revisitations of older cultic places.

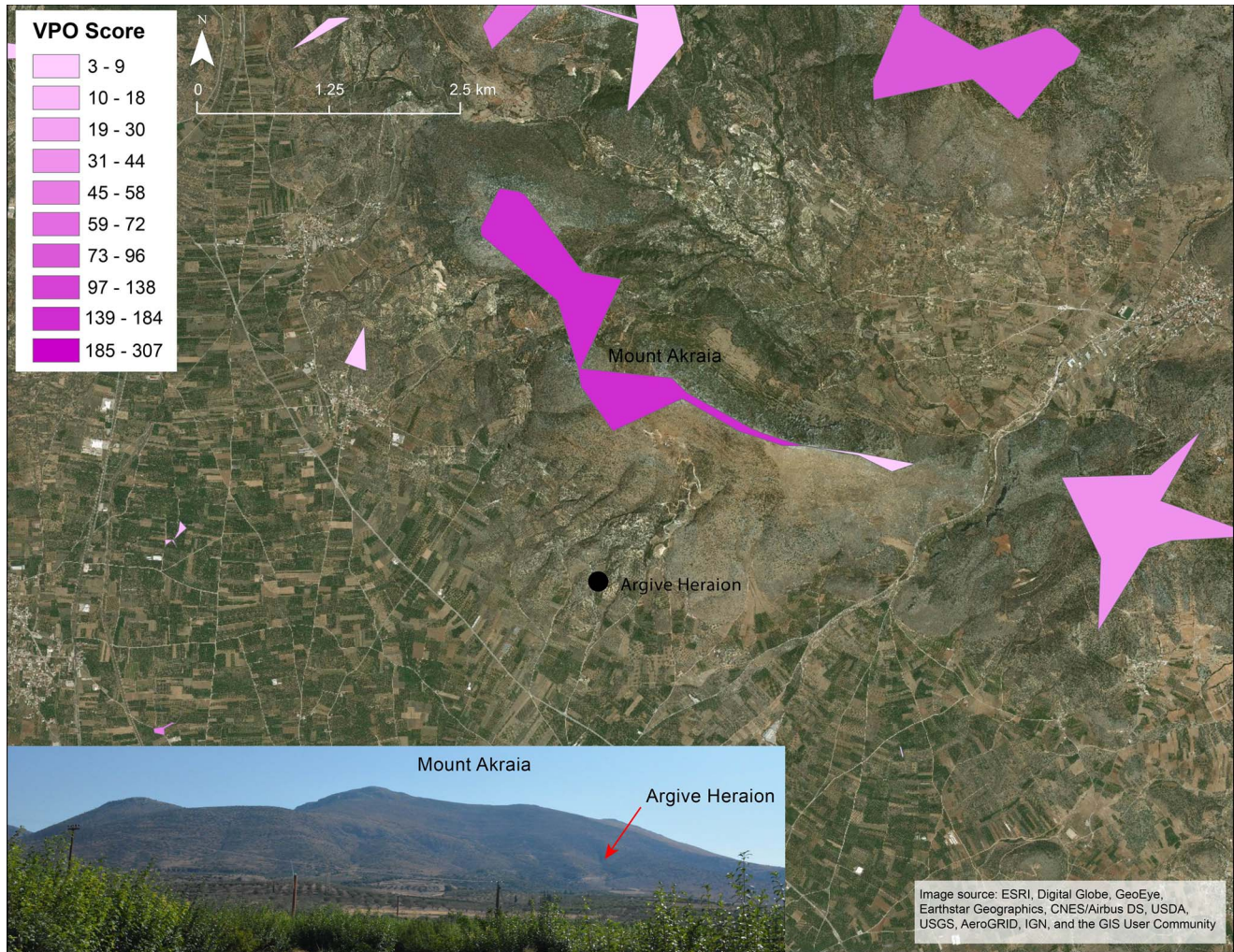


FIGURE 10. The Argive Heraion sanctuary is located midway up Mount Akraia. Although portions of Mount Akraia yield a VPO (Visual Prominence of the Observer) score greater than 1, the sanctuary’s boundaries do not intersect that area.

engagement with excavation and historical data, becomes necessary (Susmann 2019b:140–153). Comparing the Argive Heraion’s CVSO and VPO results against other contemporary sanctuaries in the Argive Plain (Figure 11), I concluded that Argive Plain inhabitants valued accessibility alongside prominence at specific moments, and these preferences are tied to cultural and political shifts (Susmann 2019b:153). Prior to the seventh century BC, sanctuaries such as Mount Arachnaion—located at a noticeable mountain peak—were preferred (Susmann 2019b:80–83).

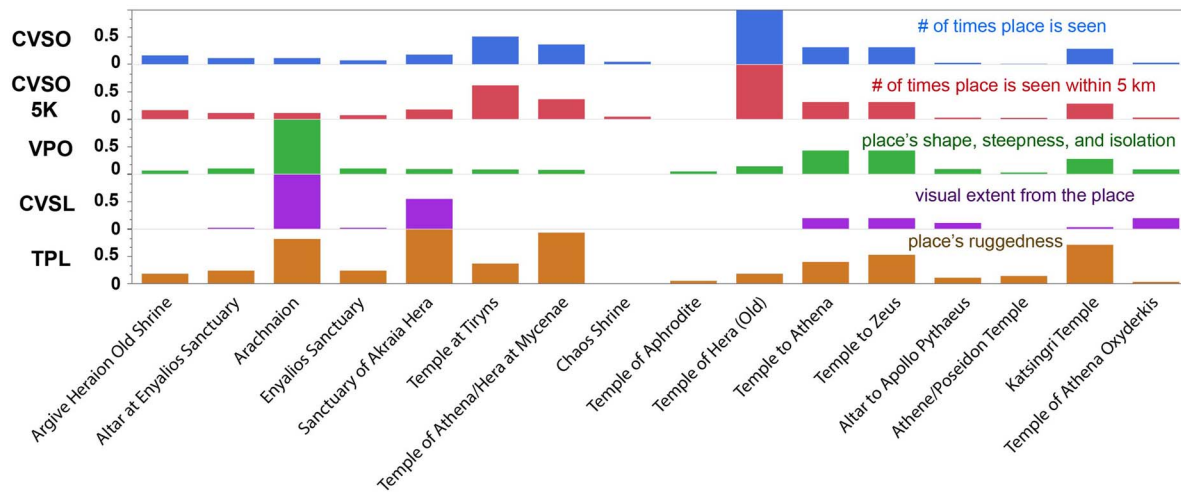
Fieldwork Can Identify Limitations in Analytical Parameters and Data Collection Strategies

Fieldwork provided critical ground-truthing data. Environmental factors such as vegetation, smoke, and light will impact what an observer sees, but archaeologists cannot record geospatial data for them at a regional level. As I collected data at each cultic place, I observed whether my ability to move and see was impeded or enhanced by certain variables.

To that end, fieldwork is necessary for identifying whether certain place types should not be included in the study. Greek archaeologists consider burials as cultic places (Antonaccio 1994:398). My fieldwork experiences drove me to exclude their results from Figure 9.⁹ As I surveyed tholos tombs, for example, I began to recognize their extremely variable prominence. These are subterranean tombs covered with earthen mounds, and my ability to spot them depended on topography, vegetation, travel pathway, and direction of gaze. While Mason (2007) has successfully applied ancient roadway datasets to understand how travel routes impacted tholoi prominence, the study is specifically about the citadel of Mycenae and its surrounding tombs. Similar road datasets are not available for my entire study area.

My chosen geospatial approaches will yield misleading results about burial prominence. Quantitative data do not convey how minor topographic changes impact the observer’s ability to see these small targets, and only fieldwork can provide such context. Consequently, although burials are considered Greek cultic places, their functional relationship to the landscape is very

Visuallandscape of the Argive Plain, circa eighth–sixth centuries BC



Visuallandscape of the Argive Plain, circa fifth century BC

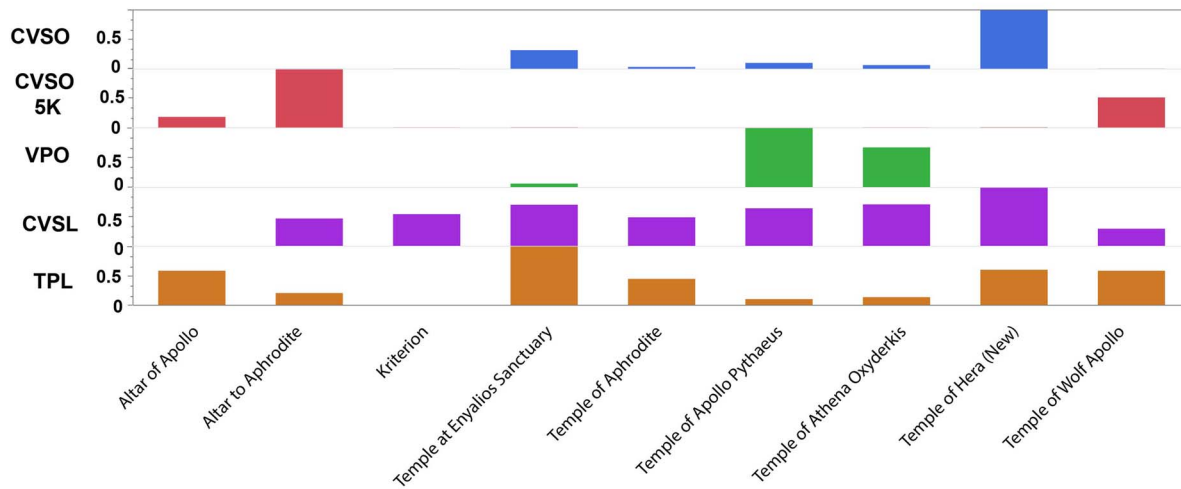


FIGURE 11. Visuallandscape scores can be represented per sanctuary and isolate smaller study areas for detailed comparisons.

different from places such as altars or temples. Burials require a separate geospatial strategy, one that potentially measures degree of invisibility.

Phenomenology Transforms “Hyperclean” Archaeological Sites (Weddle 2013:154) into Active Cultural Spaces

Phenomenology produces real-time data about human engagement with the landscape. At any given site, I encountered tourists, students, archaeologists, and state employees; I witnessed how every person’s pauses, gazes, and movements were a product of their identity. These individuals animated my archaeological data points and transformed them into active cultural spaces (Barrett and Ko 2009:282).

My observations about modern people guided my interpretations about the ancient cultic landscape. Phenomenology reminded me of the precise subjects of my geospatial model. Consider Panhellenic festivals and the diverse group of visitors they attracted to sanctuaries every year. Devotees, athletes, politicians, vendors, and spectators came to the same sanctuary. The way each person engaged with it—their sense of place (Ashmore and Knapp 1999:21)—was based on their identity, goals, and level of piety. This geospatial model measures visual impact as pertains to a worshiping observer. If an observer looked at the same landscape through a different cultural lens (e.g., political, social, defensive, ancestral), their attention could shift toward other places, topographies, and sensory experiences.

The geospatial analyses account for change over broad spans of time. Phenomenology models how visuallandscapes can change

within a few hours. I left my apartment on a Saturday morning to travel to Epidaurus for data collection. It was a peaceful drive, and I had clear views of the surrounding landscape. A Ministry of Culture sign served as a landmark for my exit off the highway. Later that evening, I returned to Epidaurus for a theater performance. I followed the same pathway but my experience traveling drastically changed. Traffic made the route noisy, slow, and filled with exhaust fumes, and it altered the viewshed I had previously encountered. It was difficult to see past these other cars. Instead of a highway sign, the end of my journey was signaled by a grid-locked off-ramp.

This was a paramount—albeit unplanned—phenomenological experience because it forced me to think more creatively about immeasurable and time-sensitive impacts. The activities surrounding cultic practice—processions, lighting smoky fires, and sacrificing animals—would have temporarily increased a place's noticeability (Susmann 2019b:130–131, 134–136). The geospatial analyses do account for change over time, but short-term human impacts cannot be measured without other critical data: festival dates and durations, crowd size and travel patterns, and the number of sacrificial fires and their spatial extent.

CONCLUSIONS

Many archaeologists have discussed the complementary relationship between phenomenological approaches and geospatial analyses (Eve 2012; Fábrega-Álvarez and Parceros-Oubiña 2019; Fitzjohn 2007; Given 2004; Rennell 2012; Seamon 2014; Thomas 1993, 2008; Van Dyke et al. 2016). Geospatial technology produces quantitative, comparable data about the landscape, but these are problematically treated as “finished product[s]” (Brück 2005:54; Thomas 2008:7). Phenomenology explores valuable questions about how humans shape—and are shaped by—the landscape. Critics understandably express concern about imprecise approaches and subjective interpretations (Brück 2005; De Reu et al. 2011; Fleming 1999). There is a wide gap between pixels and people, and archaeologists need clear pathways for bridging it. This reflexive methodology constantly interrogates either dataset's limitations and links. Phenomenology activates the geospatial data; quantitative methods pave the way for systematic examination of cultural behavior.

Ashmore's (2002:1173) life history framework was foundational in developing this approach. Every place's formation, decline, and possible revisitation was accounted for. During both the fieldwork and geospatial phases, I considered how these distinctive phases of use were physically represented in the landscape. I explored whether and why individuals' pathways changed as a result, thereby dictating geospatial parameters. Creating dynamic timelines underscores the complexity of visualscape. What we see is born from individual and collective senses of place.

This is a precise, analytical framework for treating natural features as archaeological artifacts. Scholars can use it to collect, record, and organize archaeological and natural data. They can examine how the landscape impacted the siting of meaningful places—be they for worship or otherwise. That said, interested parties should be cautious in assuming that visibility analyses—and particularly those described here—will always produce meaningful results. Gillings says it best: “Whilst generating them has always been a relatively trivial task, knowing what to do with them once generated

has proven far more difficult” (2017:121). Indeed, visibility-based analyses are only as powerful as the questions they answer. There should be compelling cultural data to inspire their implementation.

This methodology was applied to the ancient Greek Peloponnese, but its impact reaches farther. All data—typological, visual, and methodological—are being moved into an open-access user interface (Susmann 2019a).¹⁰ In addition to survey data, the interface provides access to methodological tutorials and database and interface codes, as well as my daily journals kept during the fieldwork and research phases.

Acknowledgments

I would like to thank Andrea Berlin, Mac Marston, Christopher Roosevelt, Curtis Runnels, and Bonna Wescoat for their guidance. I am indebted to staff at the American School of Classical Studies at Athens (ASCSA) and the Greek Archaeological Service for their cooperation. Data collection at the Sanctuary of Apollo Maleatas was completed in compliance with permit number 6569, granted by the Ephorate of Antiquities of Argolida. Data collection at Bassae was completed under permit number 2427, and data collection at Skilloundia was completed in compliance with permit number 6795, both granted by the Ephorate of Antiquities of Ilia. Data collection at all other sites did not require research permits, confirmed by the ASCSA and Greek Archaeological Service. I am grateful for the invaluable technical support offered by Wes Bernardini, Mark Gillings, Brian Gregor, and Boston University's Hariri Center for Computing and Computational Science & Engineering. This research was completed with the following research grants: Boston University Graduate Research Abroad Fellowship, Boston University Graduate Student Organization travel grant, GeoEye Foundation Award for the Application of High-Resolution Digital Satellite Imagery, and Boston University Digital Humanities Seminar Start-Up Grant.

Data Availability Statement

Spatial and visual data, methodological tutorials, field notes, and research journals from this project are freely available on an open-source interface: <http://gncproj.org>. The interface was launched in mid-September 2019. Readers are also encouraged to contact the author with any questions or data requests.

Supplemental Materials

For supplemental material accompanying this article, visit <https://doi.org/10.1017/aap.2020.6>.

Supplemental Database. Template of the Access database developed to record data for the survey as well as geospatial results. Field descriptions are included in each table's metadata; tables are also populated with sample records.

Supplemental Text. Descriptions of database schema to be used in conjunction with table metadata.

NOTES

1. Visualscape was made popular by Marcos Llobera, who wanted to coin a single phrase capturing the multitude of analytical approaches by which an

- archaeologist could describe all of the visual qualities for a place. See Llobera 2001, 2003, 2004, 2007; Llobera et al. 2010.
- Behaviors include prayer, sacrifice, construction, and intentional deposit of objects, as well as burials. Excluding Bronze Age (ca. 2800–1100 BC) tombs converted into post-eleventh-century BC sanctuaries, burial results are not presented here.
 - See “Links” table in Supplemental Database.
 - See “Place_Period” table in Supplemental Database.
 - “Experiential archaeology” is an equivalent term (Rennell 2012:511–512).
 - See Susmann (2019a, 2019b) for detailed descriptions of field equipment.
 - Lake and Ortega (2013:223–224) employed a 100 km total viewshed to examine the visibility between 306 stone circles in Great Britain, amounting to 29,624 viewsheds calculated in 18 days. Considering my much larger study area, I applied a cumulative approach. I began with observers separated by 1,000 m, using ArcGIS running on two Alienware Area-51 machines. Power outages led me to contact Boston University’s Shared Computing Cluster (SCC), and I was able to decrease observer distance to 200 m apart. For the Argolid, this was 70,378 observers, and for Messenia, 101,278 observers. Total CPU time was seven days and six hours, and 10 days and six hours, respectively.
 - Owing to institutional CPU time restrictions, VPO was not completed using the SCC. The minimum feasible radius for two Alienware Area-51 machines was 2,000 m. Results are consistent with field observations.
 - Certain Bronze Age (c. 2800–1050 BC) burials were reused as altars after the tenth century BC. These burials were included in the analyses, but only as pertains to their new cultic function.
 - Tutorials are publicly available. To protect site locations, researchers can apply for data access.

REFERENCES CITED

- Antonaccio, Carla M.
1994 Contesting the Past: Hero Cult, Tomb Cult, and Epic in Early Greece. *American Journal of Archaeology* 98:389–410.
- Ashmore, Wendy
2002 Decisions and Dispositions: Socializing Spatial Archaeology. *American Anthropologist* 104:1172–1183.
2014 On Ancient Placemaking. In *Of Rocks and Water: Towards an Archaeology of Place*, edited by Ömür Harmanşah, pp. 40–46. Oxbow Books, Oxford.
- Ashmore, Wendy, and A. Bernard Knapp
1999 Archaeologies of Landscape: Constructed, Conceptualized, Ideational. In *Archaeologies of Landscape: Contemporary Perspectives*, edited by Wendy Ashmore and A. Bernard Knapp, pp. 1–25. Blackwell Press, Malden, Massachusetts.
- Barnash, Alicia Nicole
2011 Hopi Horizon Analysis with GIS. Master’s thesis, Geographic Information Systems, University of Redlands, Redlands, California.
- Barnett, Rod
2007 Sacred Groves: Sacrifice and the Order of Nature in Ancient Greek Landscapes. *Landscape Journal* 26:252–270.
- Barrett, John C., and Ilhong Ko
2009 A Phenomenology of Landscape: A Crisis in British Landscape Archaeology? *Journal of Social Archaeology* 9:275–294.
- Belis, Alexis Marie
2015 Fire on the Mountain: A Comprehensive Study of Greek Mountaintop Sanctuaries. PhD dissertation, Department of Art and Archaeology, Princeton University, Princeton, New Jersey.
- Bernardini, Wesley, Alicia Nicole Barnash, Mark Kumler, and Martin Wong
2013 Quantifying Visual Prominence in Social Landscapes. *Journal of Archaeological Science* 40:3946–3954.
- Blyth, Simon, Brian Groombridge, Igor Lysenko, Lera Miles, and Adrian Newton
2002 Mountain Watch: Environmental Change and Sustainable Development in Mountains. UNEP World Conservation Monitoring Centre, Cambridge. <https://www.unep-wcmc.org/resources-and-data/mountain-watch-environmental-change-sustainable-development-in-mountains>, accessed February 20, 2020.
- Boivin, Nicole
2004 Landscape and Cosmology in the South Indian Neolithic: New Perspectives on the Deccan Ashmounds. *Cambridge Archaeological Journal* 14:235–257.
- Bradley, Richard
2000 *An Archaeology of Natural Places*. Routledge, New York.
- Briault, Camilla
2007 Making Mountains out of Molehills in the Bronze Age Aegean: Visibility, Ritual Kits, and the Idea of a Peak Sanctuary. *World Archaeology* 39: 122–141.
- Brück, Joanna
2005 Experiencing the Past? The Development of a Phenomenological Archaeology in British Prehistory. *Archaeological Dialogues* 12:45–72.
- Buxton, Richard G. A.
1992 Imaginary Greek Mountains. *Journal of Hellenic Studies* 122:1–15.
1994 *Imaginary Greece: The Contexts of Mythology*. Cambridge University Press. Cambridge.
- Cherry, John
1983 Frogs Round the Pond: Perspectives on Current Archaeological Survey Projects in the Mediterranean Region. In *Archaeological Survey in the Mediterranean Area*, edited by Donald R. Keller and David W. Rupp, pp. 375–416. BAR International Series 155. Archaeopress, Oxford.
- Christopherson, Gary L.
2003 Using ARC/GRID to Calculate Topographic Prominence in an Archaeological Landscape. In *Proceedings of Arc/INFO User Conference, San Diego, California*.
- Cole, Susan Guettel
1986 The Uses of Water in Greek Sanctuaries: Early Greek Cult Practice. *Proceedings of the Fifth International Symposium at the Swedish Institute at Athens* 4:161–165.
2000 Landscape of Artemis. *Classical World* 93:471–481.
2004 *Landscapes, Gender, and Ritual Space: The Ancient Greek Experience*. University of California Press, Berkeley.
- Cooper, Frederick A.
1996 *The Temple of Apollo Bassitas I: The Architecture Illustrations*. Vol. I. American School of Classical Studies, Athens, Greece.
- Danahy, John W.
2001 Technology for Dynamic Viewing and Peripheral Vision in Landscape Visualization. *Landscape and Urban Planning* 54:125–137.
- de Boer, Jelle Zeilinga, and John R. Hale
2008 The Geological Origins of the Oracle at Delphi. In *The Archaeology of Geological Catastrophes*, edited by W. G. McGuire, D. R. Griffiths, P. L. Hancock, and I. S. Stewart, pp. 399–412. Geological Society of London, London.
- de Polignac, François
1994 Mediation, Competition, and Sovereignty: The Evolution of Rural Sanctuaries in Geometric Greece. In *Placing the Gods: Sanctuaries and Sacred Space in Ancient Greece*, edited by Susan E. Alcock and Robin Osborne, pp. 3–18. Oxford University Press, Oxford.
1995 *Cults, Territory, and the Origins of the Greek City-State*. University of Chicago Press, Chicago.
- De Reu, Jeroen, Jean Bourgeois, Machteld Bats, Ann Zwertvaegher, Vanessa Gelorini, Philippe De Smedt, Wei Chu, Marc Antrop, Philippe De Maeyer, Peter Finke, Marc Van Meirvenne, Jacques Verniers, and Philippe Crombé
2013 Application of the Topographic Position Index to Heterogeneous Landscapes. *Geomorphology* 186:39–49.
- De Reu, Jeroen, Jean Bourgeois, Philippe De Smedt, Ann Zwertvaegher, Marc Antrop, Machteld Bats, Philippe De Maeyer, Peter Finke, Marc Van Meirvenne, Jacques Verniers, and Philippe Crombé
2011 Measuring the Relative Topographic Position of Archaeological Sites in the Landscape: A Case Study on the Bronze Age Barrows in Northwest Belgium. *Journal of Archaeological Science* 38:3435–3446.
- Doxtater, Dennis
2009 Rethinking the Sacred Landscape: Minoan Palaces in a Georitual Framework of Natural Features on Crete. *Landscape Journal* 28:1–21.
- Driessen, Jan
2003 The Court Compounds of Minoan Crete: Royal Palaces or Ceremonial Centers? *Athena Review* 3(3):57–62.

- Eliade, Mircea
1961 *Images and Symbols: Studies in Religious Symbolism*. Sheed & Ward, New York.
- Eve, Stuart
2012 Augmenting Phenomenology: Using Augmented Reality to Aid Archaeological Phenomenology in the Landscape. *Journal of Archaeological Method and Theory* 19:582–600.
- Fábrega-Álvarez, Pastor, and César Parcero-Oubiña
2019 Now You See Me: An Assessment of the Visual Recognition and Control of Individuals in Archaeological Landscapes. *Journal of Archaeological Science* 104:56–74.
- Faro, Elissa Z.
2008 Ritual Activity and Regional Dynamics: Towards a Reinterpretation of Minoan Extra-Urban Ritual Space. PhD dissertation, Classical Art and Archaeology, University of Michigan, Ann Arbor.
- Fitzjohn, Matthew
2007 Viewing Places: GIS Applications for Examining the Perception of Space in the Mountains of Sicily. *World Archaeology* 39:36–50.
- Fleming, Andrew
1999 Phenomenology and the Megaliths of Wales: A Dreaming Too Far? *Oxford Journal of Archaeology* 18:119–125.
- Foley, Anne
1988 *The Argolid 800–600 B.C.: An Archaeological Survey, Together with an Index of Sites from the Neolithic to the Roman Period*. P. Åström, Göteborg, Sweden.
- Gillings, Mark
2015 Mapping Invisibility: GIS Approaches to the Analysis of Hiding and Seclusion. *Journal of Archaeological Science* 62:1–14.
2017 Mapping Liminality: Critical Frameworks for the GIS-based Modelling of Visibility. *Journal of Archaeological Science* 84:121–128. DOI:10.1016/j.jas.2017.05.004
- Given, Michael
2004 From Density Counts to Ideational Landscapes: Intensive Survey, Phenomenology, and the Sydney Cyprus Survey. In *Archaeological Landscapes: Current Issues*, edited by Effie F. Athanassopoulos and LuAnn Wandsnider, pp. 165–182. University of Pennsylvania Museum of Archaeology and Anthropology, Philadelphia.
- Goodison, Lucy
2004 From Tholos Tomb to Throne Room: Some Considerations of Dawn Light and Directionality in Minoan Buildings. *British School at Athens Studies* 12:339–350.
- Grove, David C.
1999 Public Monuments and Sacred Mountains: Observations on Three Formative Period Sacred Landscapes. In *Social Patterns in Pre-Classical Mesoamerica: A Symposium at Dumbarton Oaks*, edited by David C. Grove and Rosemary A. Joyce, pp. 255–299. Dumbarton Oaks, Washington, DC.
- Håland, Evy Johanne
2009 “Take, Skamandros, My Virginity”: Ideas in Connection with Rites of Passage in Greece, Modern and Ancient. In *The Nature and Function of Water, Baths, Bathing, and Hygiene from Antiquity through the Renaissance*, Vol. 11, edited by Cynthia Kosso and Ann Scott, pp. 109–149. Brill Publishers, Leiden, Netherlands.
- Hannah, Robert
2013 Greek Temple Orientation: The Case of the Older Parthenon in Athens. *Nexus Network Journal* 15:423–443.
- Hitchcock, Louise A.
2007 Naturalizing the Cultural: Architectonised Landscape as Ideology in Minoan Crete. *British School at Athens Studies* 15:91–97.
- Jett, Stephen C.
1995 Navajo Sacred Places: Management and Interpretation of Mythic History. *Public Historian* 17(2):39–47.
- Kerényi, Karl
2015 *Zeus and Hera: Archetypal Image of Father, Husband, and Wife*. Princeton University Press, Princeton, New Jersey.
- Lake, Mark, and Damon Ortega
2013 Compute-Intensive GIS Visibility Analysis of the Settings of Prehistoric Stone Circles. In *Computational Approaches to Archaeological Spaces*, edited by Andrew Bevan and Mark Lake, pp. 213–241. Left Coast Press, Walnut Creek, California.
- Langdon, Merle K.
2000 Mountains in Greek Religion. *Classical World* 93:461–470.
- Larson, Jennifer
2007 *Ancient Greek Cults: A Guide*. Routledge, New York.
2010 A Land Full of Gods: Nature Deities in Greek Religion. In *A Companion to Greek Religion*, Blackwell Companions to the Ancient World, edited by Daniel Ogden, pp. 56–70. Wiley-Blackwell, Oxford.
- Leick, Gwendolyn
2002 *Mesopotamia: The Invention of the City*. Allen Lane/Penguin, London.
- Lobera, Marcos
2001 Building Past Landscape Perception With GIS: Understanding Topographic Prominence. *Journal of Archaeological Science* 28:1005–1014. DOI:10.1006/jasc.2001.0720.
2003 Extending GIS-Based Visual Analysis: The Concept of Visualscapes. *International Journal of Geographical Information Science* 17:25–48.
2004 What You See Is What You Get? Visualscapes, Visual Genesis and Hierarchy. In *Digital Archaeology: Bridging Method and Theory*, edited by Thomas L. Evans and Patrick Daly, pp. 148–167. Routledge, London.
2007 Reconstructing Visual Landscapes. *World Archaeology* 39(1):51–69.
- Lobera, Marcos, David Wheatley, James Steele, Simon Cox, and Oz Parchment
2010 Calculating the Inherent Visual Structure of a Landscape (“Total Viewshed”) Using High Throughput Computing. In *Beyond the Artifact: Digital Interpretation of the Past: Proceedings of CAA2004*, edited by Franco Niccolucci and Sorin Hermon, pp. 146–151. Archaeolingua, Budapest, Hungary.
- Lucero, Lisa J., and Andrew Kinkella
2014 A Place for Pilgrimage: The Ancient Maya Sacred Landscape of Cara Blanca. In *Of Rocks and Water: Towards an Archaeology of Place*, edited by Ömür Harmanşah, pp. 13–39. Oxbow Books, Oxford.
- Mason, David J.
2007 The Location of the Treasury of Atreus. *Oxford Journal of Archaeology* 26:35–52.
- Morgan, Catherine
1990 *Athletes and Oracles: The Transformation of Olympia and Delphi in the Eighth Century BC*. Cambridge University Press, Cambridge.
- Nixon, Lucia
2009 Investigating Minoan Sacred Landscapes. *Hesperia Supplements* 42:269–275.
- Ogburn, Dennis E.
2006 Assessing the Level of Visibility of Cultural Objects in Past Landscapes. *Journal of Archaeological Science* 33:405–413.
- Peatfield, Alan
1983 The Topography of Minoan Peak Sanctuaries. *Annual of the British School at Athens* 78:273–279.
- Reinhard, Johan, and María Constanza Ceruti
2010 *Inca Rituals and Sacred Mountains: A Study of the World's Highest Archaeological Sites*. Cotsen Institute of Archaeology Press, Los Angeles.
- Rennell, Rebecca
2012 Landscape, Experience, and GIS: Exploring the Potential for Methodological Dialogue. *Journal of Archaeological Method and Theory* 19:510–525.
- Retallack, Gregory J.
2008 Rocks, View, Soils, and Plants at the Temples of Ancient Greece. *Antiquity* 82:640–657.
- Richards-Rissetto, Heather
2017 An Iterative 3D GIS Analysis of the Role of Visibility in Ancient Maya Landscapes: A Case Study from Copan, Honduras. *Digital Scholarship in the Humanities* 32:195–212.
- Scully, Vincent
1962 *The Earth, the Temple, and the Gods: Greek Sacred Architecture*. Yale University Press, New Haven, Connecticut.
1991 The Sacred Mountain: In Mesopotamia, Egypt, and the Aegean. In *Architecture: The Natural and the Manmade*, edited by Vincent Scully, pp. 23–37. St. Martin's Press, New York.
- Seamon, David
2014 Place Attachment and Phenomenology: The Synergistic Dynamism of Place. In *Place Attachment: Advances in Theory, Methods and*

- Applications, edited by Lynne C. Manzo and Patrick Devine-Wright, pp. 11–22. Routledge, New York.
- Soetens, Steven
2009 Juktas and Kophinas: Two Ritual Landscapes out of the Ordinary. *Hesperia Supplements* 42:261–268.
- Soetens, Steven, Apostolos Sarris, and Sophia Topouzi
2001 Peak Sanctuaries in the Minoan Cultural Landscape. In *9th International Congress of Cretan Studies*, edited by Theodorakis Detorakis and Stella Papdaki-Oekland, pp. 2–13. Society of Cretan Historical Studies, Heraklion, Crete, Greece.
- Soetens, Steven, Apostolos Sarris, Sophia Topouzi, and Achilleas Tripolitsiotis
2002 GIS Modeling of the Minoan Peak Sanctuaries of East Crete. In *Computer Applications and Quantitative Methods in Archaeology: Proceedings of the 29th Conference*, Gotland, Sweden, edited by Göran Burenhult and Johan Arvidsson, pp. 129–138. Archaeopress, Oxford.
- Soetens, Steven, Apostolos Sarris, K. Vansteenhuyse, and S. Topouzi
2002 GIS Variations on a Cretan Theme: Minoan Peak Sanctuaries. In *Metron: Measuring the Aegean Bronze Age: Proceedings of the 9th International Aegean Conference*, Vol. 24, edited by Karen Polinger Foster and Robert Laffineur, pp. 483–488. University of Liège, Belgium.
- Susmann, Natalie M.
2019a Greek Natural Projects Interface. Data and Methods Repository. Boston. <http://gncproj.org>, accessed February 20, 2020.
2019b The Nature of Cult: Visualizing Continuity on the Greek Cultic Landscape in the Argolid and Messenia (c. 2800–146 BCE). PhD dissertation, Department of Archaeology, Boston University, Boston.
- Thomas, Julian
1993 The Politics of Vision and the Archaeologies of Landscape. In *Landscape: Politics and Perspectives*, edited by Barbara Bender, pp. 19–48. Berg, Oxford.
2004 *Archaeology and Modernity*. Routledge, London New York.
2008 On the Ocularcentrism of Archaeology. In *Archaeology and the Politics of Vision in a Post-Modern Context*, edited by Julian Thomas and Vitor Oliveira Jorge, pp. 1–12. Cambridge Scholars Publishing, Cambridge.
- Tilley, Christopher
1994 *A Phenomenology of Landscape: Places, Paths, and Monuments*. Berg, Oxford.
- Topouzi, Sophia, Steven Soetens, Anthoula Gkiourou, and Apostolos Sarri
2000 The Application of Viewshed Analysis in Greek Archaeological Landscape. Paper presented at the 6th Annual Meeting of the European Association of Archaeologists, Lisbon, Portugal.
- Tuan, Yi-Fu
1977 *Space and Place: The Perspective of Experience*. University of Minnesota Press, Minneapolis.
- Turner, Harold W.
1979 *From Temple to Meeting House: The Phenomenology and Theology of Places of Worship*. Mouton Publishers, Paris.
- van de Moortel, A.
2006 A Reexamination of the Pottery from the Kamares Cave. In *Pottery and Society: The Impact of Recent Studies in Minoan Pottery: Gold Medal Colloquium in Honor of Philip P. Betancourt*, pp. 73–93. Archaeological Institute of America, Boston.
2011 The Phaistos Palace and the Kamares Cave: A Special Relationship. In *Our Cups Are Full: Pottery and Society in the Aegean Bronze Age: Papers Presented to Jeremy B. Rutter on the Occasion of His 65th Birthday*, edited by Walter Gauß, Michael Lindblom, R. Angus K. Smith, and James C. Wright, pp. 306–318. BAR International Series 2227. Archaeopress, Oxford.
- Van Dyke, Ruth M., R. Kyle Bocinsky, Thomas C. Windes, and Tucker J. Robinson
2016 Great Houses, Shrines, and High Places: Intervisibility in the Chacoan World. *American Antiquity* 81:205–230.
- Weddle, Candace
2013 The Sensory Experience of Blood Sacrifice in Roman Imperial Cult. In *Making Senses of the Past: Toward a Sensory Archaeology*, edited by Jo Day, pp. 137–159. Center for Archaeological Investigations Occasional Paper No. 40. Southern Illinois University Press, Carbondale.
- Wescoat, Bonna D.
2017 The Sanctuary of the Great Gods, Samothrace. In *Excavating Pilgrimage: Archaeological Approaches to Sacred Travel and Movement in the Ancient World*, edited by Troels Myrup Kristensen and Wiebke Friese, pp. 67–86. Routledge Press, New York.
- Wickstead, Helen
2009 The Uber Archaeologist. *Journal of Social Archaeology* 9:249–271.
- Williams, Mary Francis
1991 *Landscape in the Argonautica of Apollonius Rodius*. Peter Lang, Frankfurt am Main, Germany.
- Williams, Patrick Ryan, and Donna J. Nash
2006 Sighting Theapu: A GIS Analysis of Wari Imperialism and the Worship of Mountain Peaks. *World Archaeology* 38:455–468.
- Williamson, Christina
1993 Light in Dark Places: Changes in the Application of Natural Light in Sacred Greek Architecture. *PHAROS: Journal of the Netherlands Institute at Athens* 1:1–37.

AUTHOR INFORMATION

Natalie M. Susmann ■ History Section, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge MA 02139, USA (nsusmann@mit.edu)