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THE LAY OF THE LAND: A POLITICAL GEOGRAPHY OF AN ANCIENT MAYA KINGDOM IN WEST-CENTRAL BELIZE

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Abstract

The Belize Valley figures prominently in the history of Maya archaeology as the birthplace of settlement pattern surveys, where Gordon R. Willey and his colleagues conducted their pioneering research project, from 1954 to 1956. Six decades on, settlement surveys are an integral part of archaeological research strategies not only across the Maya area, but globally. With the advent of LiDAR technology, settlement surveys enter a new developmental phase, and we take this opportunity to review the history and progress of these surveys in the Belize Valley. We focus on one particular archaeological site, Baking Pot, so as to better illustrate the methods and technological advances that have been brought to bear in the mapping of one ancient Maya city-state. Now that the survey of this ancient settlement is nearing completion, we veer from traditional settlement surveys that in principle focus on unbounded central places and centroids, in an attempt to tackle an important question, which to date has remained conspicuously understudied, that of borders and boundaries. Using a series of geospatial analyses, we investigate the potential of these approaches for reconstructing ancient polity boundaries and as lessons learned we explore which methods are of greater utility and can be applied to other surveys in the Maya lowlands.

Keywords: LiDAR, GIS, boundaries, Maya, Baking Pot, Belize

Resumen

El valle de Belice ocupa una posición privilegiada en la historia de la arqueología maya como el lugar de nacimiento de los estudios de patrón de asentamiento, donde Gordon R. Willey y sus colegas llevaron a cabo su proyecto de investigación pionera, de 1954 a 1956. Seis décadas después, los estudios de patrón de asentamiento forman partes integrales de las estrategias de investigaciones arqueológicas no sólo en todo el área maya, sino a nivel mundial. Con el advenimiento de la tecnología LiDAR, los estudios de patrón de asentamiento entran en una nueva fase de desarrollo, y aprovechamos de esta oportunidad para revisar la historia y el progreso de estos levantamientos en el Valle de Belice. Nos centramos en un sitio arqueológico particular, Baking Pot, para ilustrar mejor los métodos y avances tecnológicos que se han llevado a cabo en el mapeo de una antigua ciudad-estado maya. Ahora que el levantamiento este antiguo asentamiento está a punto de ser completado, nos alejamos de los estudios de patrón de asentamiento tradicionales que en principio se centran en lugares centrales y centróides ilimitados, en un intento de abordar una cuestión importante, que hasta la fecha ha permanecido claramente subestimada, la de fronteras y límites. Utilizando una serie de análisis geo-espaciales, investigamos el potencial de estos enfoques para reconstruir antiguas fronteras políticas y en base de estos resultados exploramos qué métodos son de mayor utilidad y pueden aplicarse a otras prospecciones en las tierras bajas mayas.

Palabras clave: LiDAR, GIS, límites, maya, Baking Pot, Belice

INTRODUCTION

The Upper Belize River Valley is best known as the place where Gordon R. Willey first introduced settlement pattern surveys to Maya archaeology. Now, six decades on, the Belize Valley remains at the forefront of settlement research through the application of the most recent advances in geospatial technologies. These tools are revolutionising settlement archaeology in the Maya lowlands (Awe *et al*. 2015; Chase *et al*. 2013, 2014a, 2014b; Ebert 2015; Ebert and Awe 2014; Ebert *et al*., in press; Hare *et al*. 2014; Hutson 2015; Prufer *et al*. 2014) and elsewhere in Mesoamerica (Fisher *et al*. 2011; Rosenswig *et al*. 2013, 2014), and greatly improve our understanding of the relationships between large urban centres and their hinterlands (see Chase and Chase 2003; Chase *et al*. 2012). The Belize Valley Archaeological Reconnaissance (BVAR) Project, under the direction of Jaime Awe, has been conducting settlement surveys at a several important Belize Valley sites, but especially at the archaeological site of Baking Pot where the project initiated its settlement research in 1992. These efforts have continued more or less unabated over the past two decades, relying predominantly on laborious and time-consuming instrument surveys.

Partly in response to these instrument surveys, as of 2002, the authors, in collaboration with Andrew Bevan (Institute of Archaeology, University College London), began using high-resolution Othorectified Radar Images (ORI) as the basis for creating digital elevation models (DEM) of terrain at Baking Pot, as well as in the Roaring Creek Valley and at the site of Pacbitun. The ORI data allowed us to focus on mapping archaeological features and derive other topographic data from the resulting DEMs (see Helmke *et al*. 2004; Healy *et al*. 2007). Whereas surveys of cleared lands was relatively forthright, one major drawback was readily apparent: whereas the radar signals employed in the ORI surveys provided cloud-free views, they reflected off dense rainforest canopies, thereby inhibiting our research protocol in heavily forested areas.[1] In addition, heavily forested areas adversely affected the quality of satellite signals and their reception by hand-held GPS receivers, thereby introducing significant position errors for features surveyed under dense canopy. These drawbacks have now finally been overcome with the advent of accurate and high-resolution airborne light detection and ranging (LiDAR) remote sensing data, which has allowed for rapid acquisition of spatial data not previously obtainable in areas with thick vegetation. Within Geographic Information Systems (GIS), LiDAR data can be used to create "bare earth" models that visually highlight archaeological features on the ground in three dimensions. The LiDAR coverage of the Belize Valley that we integrate in this piece of research was acquired in 2013, by the National Center for Airborne Laser Mapping for a consortium of archaeologists working in West-Central Belize (Chase *et al*. 2011, 2013, 2014a, 2014b; Awe *et al*. 2015). In this paper, we present new methods for integrating systematic quantitative analyses of LiDAR data using GIS for identifying settlement patterns, in particular the extent of ancient polities and their borders, by focusing on one ancient kingdom centred on the archaeological site of Baking Pot.

BAKING POT

The monumental epicentre of Baking Pot is situated on the southern bank of the Belize River, along the broad alluvial plain that is bordered by rainforest-covered limestone hills (Figure 1). The valley bottom, which still exhibited rainforest up until the 1960s is now completely denuded and predominantly given over to pasture for the herds of the nearby Running W Ranch, as well as to

[1] Although of limited utility in determining the exact location and configuration of archaeological features and sites, the ORI data tiles exhibiting larger expanses of unaffected primary forest, could be used to extrapolate gross DEMs, by subtracting the average canopy height in the forested areas.

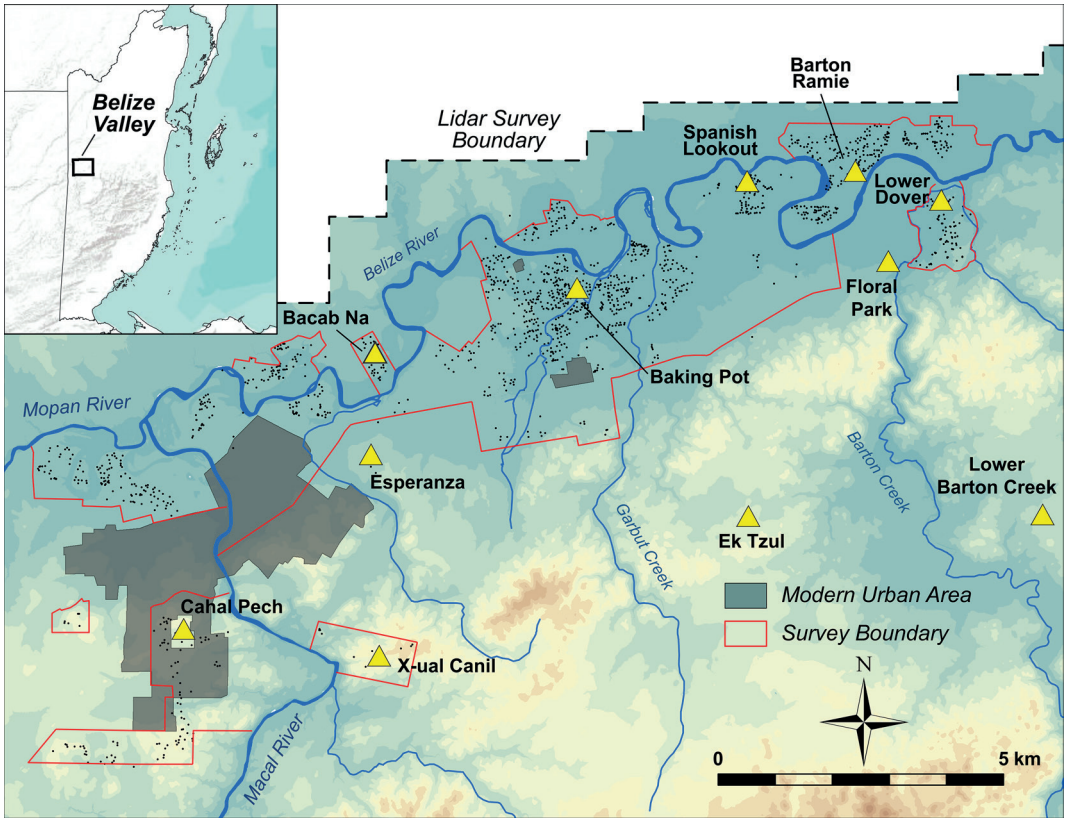

Figure 1. Map of the upper Belize Valley showing the extent of the LiDAR survey, salient archaeological sites, and ancient settlement documented to date. Modern urban areas are shown in grey. The inset shows the extent of the BVAR study area covered by the West-Central Belize LiDAR survey (map by Claire Ebert).

cultivation by the Belize Government's Central Farm Research Station and Agricultural College, which has its headquarters close to the archaeological site. The archaeological site of Baking Pot is a major centre, where an affluent royal court was established that interacted with polities both near and far through tribute and trade (e.g., Audet 2007; Hoggarth *et al*. 2014b; Reents-Budet *et al*. 2005). Based on the number of structures that comprise the epicentre, the areal extent of its architecture, and volumetric assessments it is clear that Baking Pot is one of the largest archaeological sites in west-central Belize (Helmke and Awe 2008; Andres *et al*. 2014: 49). The extent and relative density of the mounded remains of domestic structures, which extend in wide swathes around the epicentre, testify to the importance of the community that once thrived there (Figure 2a). The surveys completed to date also make it apparent that there are several ways of demarcating the territorial extent of the Baking Pot polity, depending on the scale of the survey. These all result in different sets of boundaries and interfaces, such as the monumental epicentre and the adjoining settlement, the boundaries between the dense settlement and the surrounding countryside, and further afield the borderlands between major centres (Figure 2b). The most visible boundary is that which defines the urban core of Baking Pot versus the more sparsely populated hinterlands, since the number of housemounds rapidly drops off

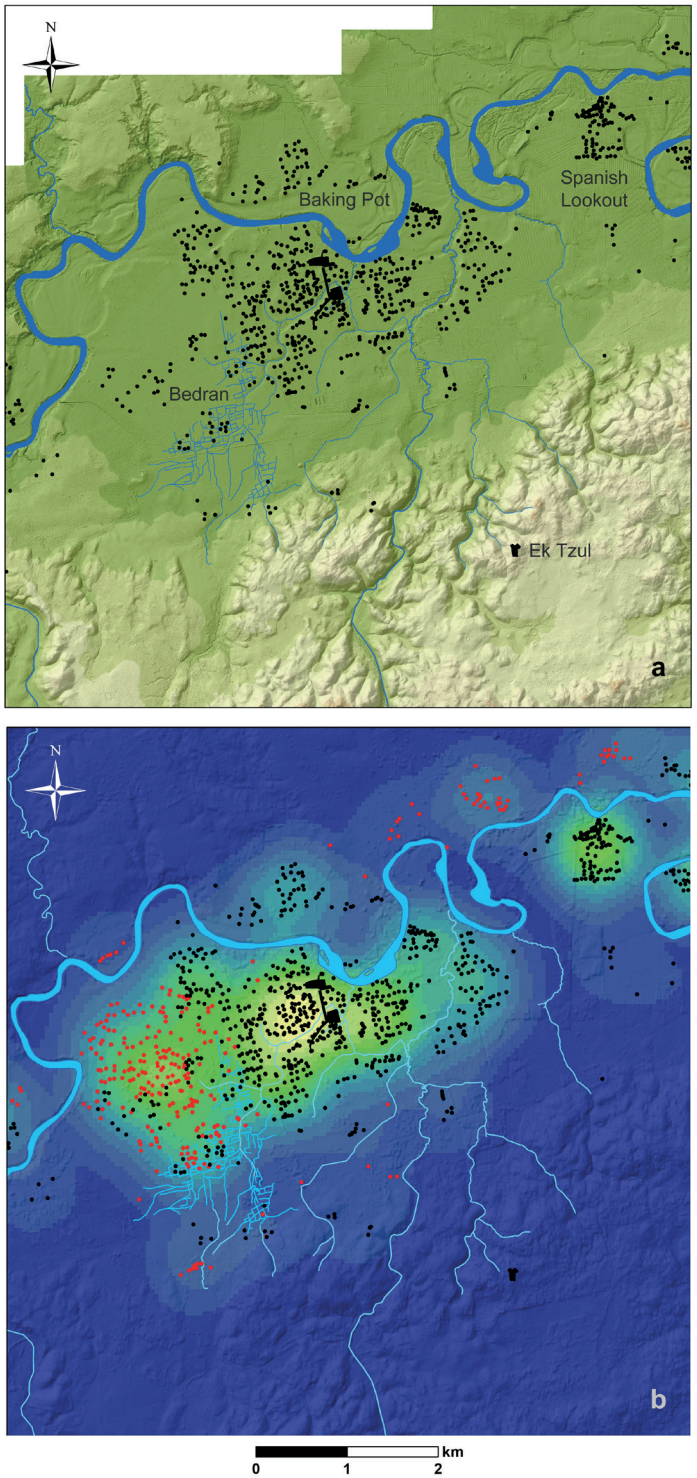

Figure 2. a) The ancient settlement surrounding the monumental epicentre of Baking Pot. **b)** kernel density shading that represents the relative urban density of Baking Pot. These maps make it clear that the peripheral settlement is separated from the settlement of minor centres, such as Spanish Lookout, by empty or very sparsely populated hinterlands (maps by Claire Ebert).

along the margins of the settlement. This boundary is one of the most important features revealed by the settlement survey and one that exemplifies the configuration of the low-density urbanism that predominates in the area (see Awe *et al*. 2014; Hoggarth *et al*. in prep.). As such, it follows that we need to distinguish Baking Pot as an urban conglomeration with clearly defined boundaries vs. Baking Pot as a city-state or kingdom with more fluid and intangible boundaries. At an intervening level we can see the settlement clusters around the minor centres that are located at the perimeter of the kingdom's hinterlands.

Our surveys reveal that Baking Pot's settlements form several discrete neighbourhoods, that are rather analogous to the Aztec *kalpoolli* system (Conlon and Ehret 2001: 304-306; Hoggarth 2009, 2012: 53-59; Hoggarth *et al*. in prep.; Jobbová 2009: 98-101; Smith 2011: 57-58) (Figure 3). The topography reveals that these groupings are delimited by streams and drainage ditches that channel water away during riverine inundations (Kirke 1980; Conlon and Awe 1995; Ebert *et al*. 2015).

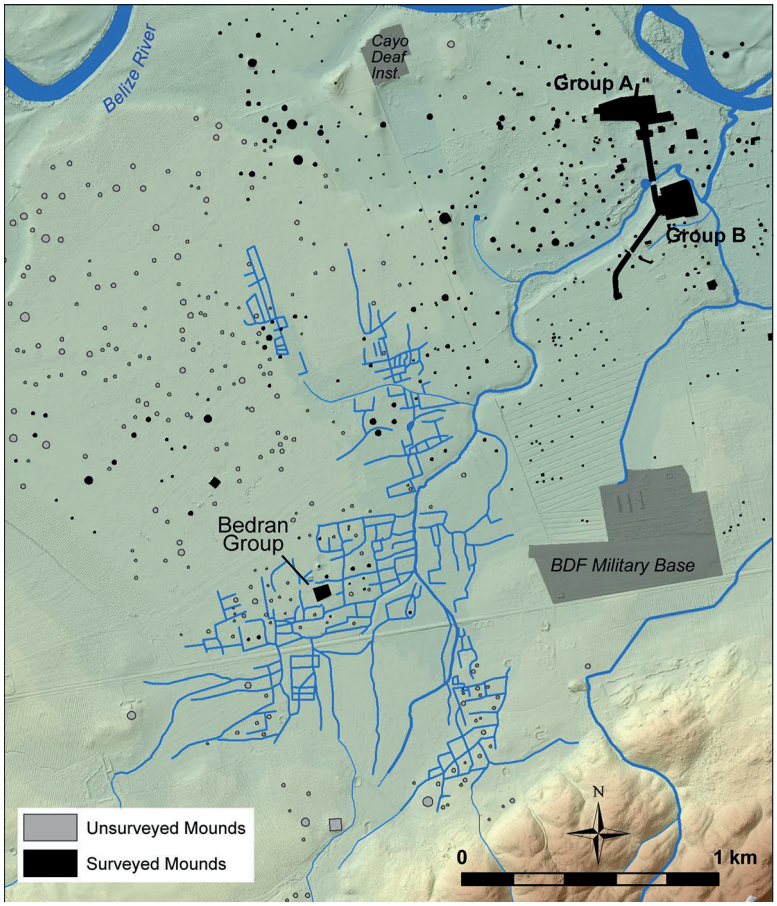

Figure 3. Map with partial view of the western settlement continuum at Baking Pot, showing the distribution of mounds into discrete neighbourhoods, the linear arrangement of mounds, as well as the extensive ditched field system to the southwest of the site centre. Ground-truthed mounds are solid, whereas mounds extrapolated from the LiDAR data are outlined (map by Claire Ebert).

Interestingly, housemounds in some neighbourhoods form nearly linear configurations, indicating that these were built along the edges of even quadrangular plots, presumably separated by regular paths or walkways (Hoggarth *et al*. 2008: 175-176; Jobbová 2009: 104-107; Bevan *et al*. 2013). This pattern was also recognised by members of Willey's team in the 1950s within the settlement at Spanish Lookout, a neighbouring minor centre (Willey *et al*. 1965: 296). Significantly, the orientation of the alignments at Baking Pot corresponds in large measure with that of the monumental architecture within the epicentre, at an azimuth of c. 324° ± 1.3° (Bevan *et al*. 2013: 2378-2379). These features imply that the domestic structures in these neighbourhoods were established as part of one or more urban planning schemes at the site. Whether such a scheme was devised and implemented at the community level, or a plan initiated within the royal household is unclear, although some of the evidence supports the former since the putative grid plan is only discernible in select neighbourhoods. This may also be supported by the chronological data since the dating of neighbourhoods is variable and there is no evidence that the orthogonal plan was part and parcel of the initial urban plan (Hoggarth *et al*. in prep.). Although it runs counter to conventional wisdom, the evidence from Baking Pot demonstrates that orthogonal urbanism, one of the hallmarks of central Mexican urban centres (Millon 1973; Smith 2014), was also implemented in the construction of at least some neighbourhoods of Maya centres. As such, the recent discovery of the orthogonal plan that governs the urban fabric of Nixtun-Ch'ich' in the Peten (Rice 2009), and which has been touted in the media (e.g., Jarus 2015; Anonymous 2015), is much less exceptional than may be presupposed.

Baking Pot has the distinction of being one of the sites integrated into Willey's pioneering settlement survey and has subsequently been intensively surveyed and excavated by the BVAR project for more than two decades. With the settlement survey now nearing completion, we are in a privileged position to see the interplay of different types of data and methods, comparing settlement maps produced by traditional survey methods, with those extrapolated from remote sensing technologies. In this paper, we present a series of geospatial analyses conducted in GIS using ORI and LiDAR data, which are cross-referenced to the data obtained by instrument surveys. We apply a series of geospatial analyses and assess their potential for reconstructing the ancient boundaries of the Baking Pot kingdom. Whereas the polity boundaries reconstructed here are idealised, and while these may have been operational during much of the polity's history, it is also clear that these boundaries fluctuated through the ages as a result of the prestige, charisma and aspirations of individual rulers as well as the effects of warfare and environmental degradation. These analyses are preceded by synoptic remarks on boundaries in early civilizations and some reflections on territoriality in hegemonic systems. At the outset, however, we provide a historical overview of the archaeological investigations conducted at Baking Pot, so as to better contextualise the evolution of the wide variety of surveying techniques that have been brought to bear in the mapping of this ancient kingdom.

AN HISTORICAL OVERVIEW OF ARCHAEOLOGICAL INVESTIGATIONS AT BAKING POT

The archaeological site of Baking Pot has been the object of archaeological investigations since 1924. Much of the research history can be divided into two parts, an early phase of investigations spanning four decades during which research was sporadic and intermittent. In contrast the second part started in earnest in 1992, and represents the efforts of the BVAR project (Table 1). Much of the work has been equally divided between intensive excavations within the monumental epicentre as well as the peripheral settlement. Below we provide a review of the research history to better situate the great strides that have been made in the surveying techniques employed over the past decades, spanning from transits, to high-precision ORI and LiDAR data, via theodolites and hand-held GPS receivers.

Table 1. Tabulation of the settlement surveys conducted at Baking Pot to date, listed chronologically as to progress achieved by the end of a given field season. Note that the figures tabulated below represent the totals for the entire survey area. For figures pertaining to the epicentral settlement see Hoggarth *et al*. (in prep)

Year	Area (ha)	# of Mounds	Cumulative Area (ha)	Cumulative Mounds
1924	6	1	6	1
1956	63	115	69	116
1992	18	20	87	136
1994	85	119	172	255
2000	276	181	448	436
2007	286	237	734	673
2008	405	185	1 139	858
2015	213	16	1 352	874

1924-1961: Early Investigations

Baking Pot has been researched by five major archaeological projects. The first was of short duration (March – May 1924), headed by Oliver Ricketson Jr. and focused on Group A and the human interments of Str. A17 (Str. G) in particular (Ricketson 1929; Willey *et al*. 1965: 303-304). As part of these investigations Ricketson only saw to the transit mapping of the northern Group A of the monumental epicentre, but did not extend the survey to include the remainder of the site epicentre, with the exception of one nearby housemound (Ricketson 1929: 5).[2]

Following these preliminary investigations, excavations of the site did not resume until 1941, and this was primarily in response to the partial destruction of Str. B1 (Str. A) as a result of quarrying activities by the Public Works Department (Bullard and Bullard 1965: 11; Willey *et al*. 1965: 304) (Figure 4). A. H. Anderson, as Archaeological Commissioner of then British Honduras, promptly responded by stopping the quarrying and initiated salvage operations focused on Str. B1. As part of this salvage operation the area affected by quarrying was cleared, the lower western facade of the structure was exposed, and the building was partly tested. Despite these interventions, no additional mapping or surveying was conducted at the site.

Between 1954 and 1956, Baking Pot was once again the focus of investigations, this time as part of Gordon Willey's pioneering settlement survey in the Belize Valley. As part of this work the monumental epicentre and a 48.5 ha portion of the adjoining settlement was mapped by William R. Bullard Jr. (Willey *et al*. 1965: 301, 305; Bullard and Bullard 1965: 7; Coe 1966) (Figure 5). The settlement survey recorded a total of 89 mounds (excluding monumental architecture) within the mapped areas of the site (Willey *et al*. 1965: 301), resulting in a density of 183 mounds per square kilometre (1.83 mounds per hectare). In addition, between late February and early March 1956 four test excavations were conducted by Willey's team, three in nearby housemounds, and another in Plaza 1 of Group A (Willey *et al*. 1965: 305-309, Fig. 177).

Seven years later, in 1961, William Bullard and Mary Ricketson-Bullard returned to Baking Pot and conducted further investigations of Str. B1 (Str. A) and the southern group. Their excavations

[2] This mound was designated as Mound I by Ricketson (1929: 5) and corresponds to Str. M-001 in the designations of the BVAR settlement survey.

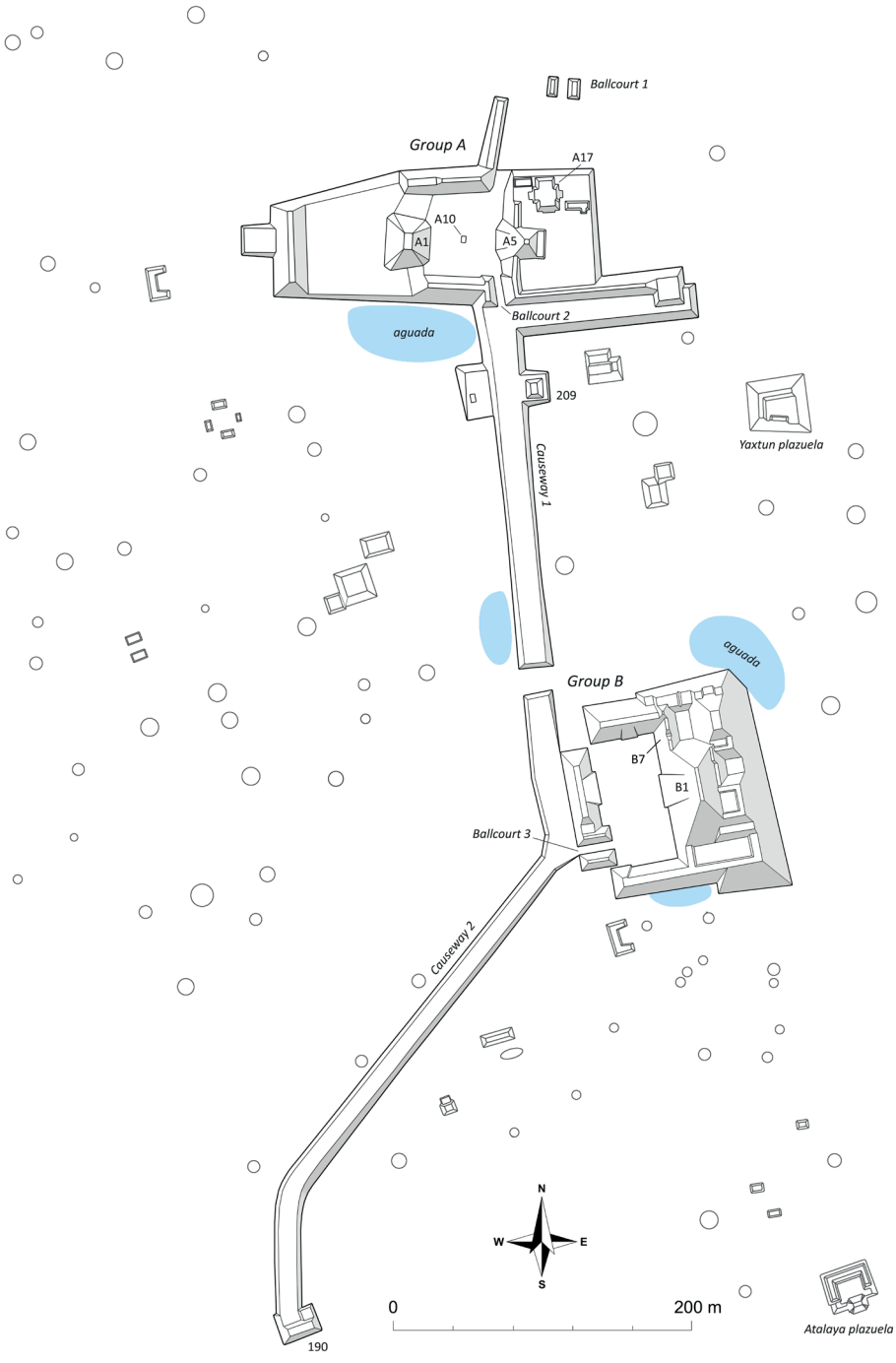

Figure 4. The monumental epicentre of Baking Pot (map by Christophe Helmke, based on surveys by James Conlon, Christophe Helmke and William Bullard; plan is aligned to grid north).

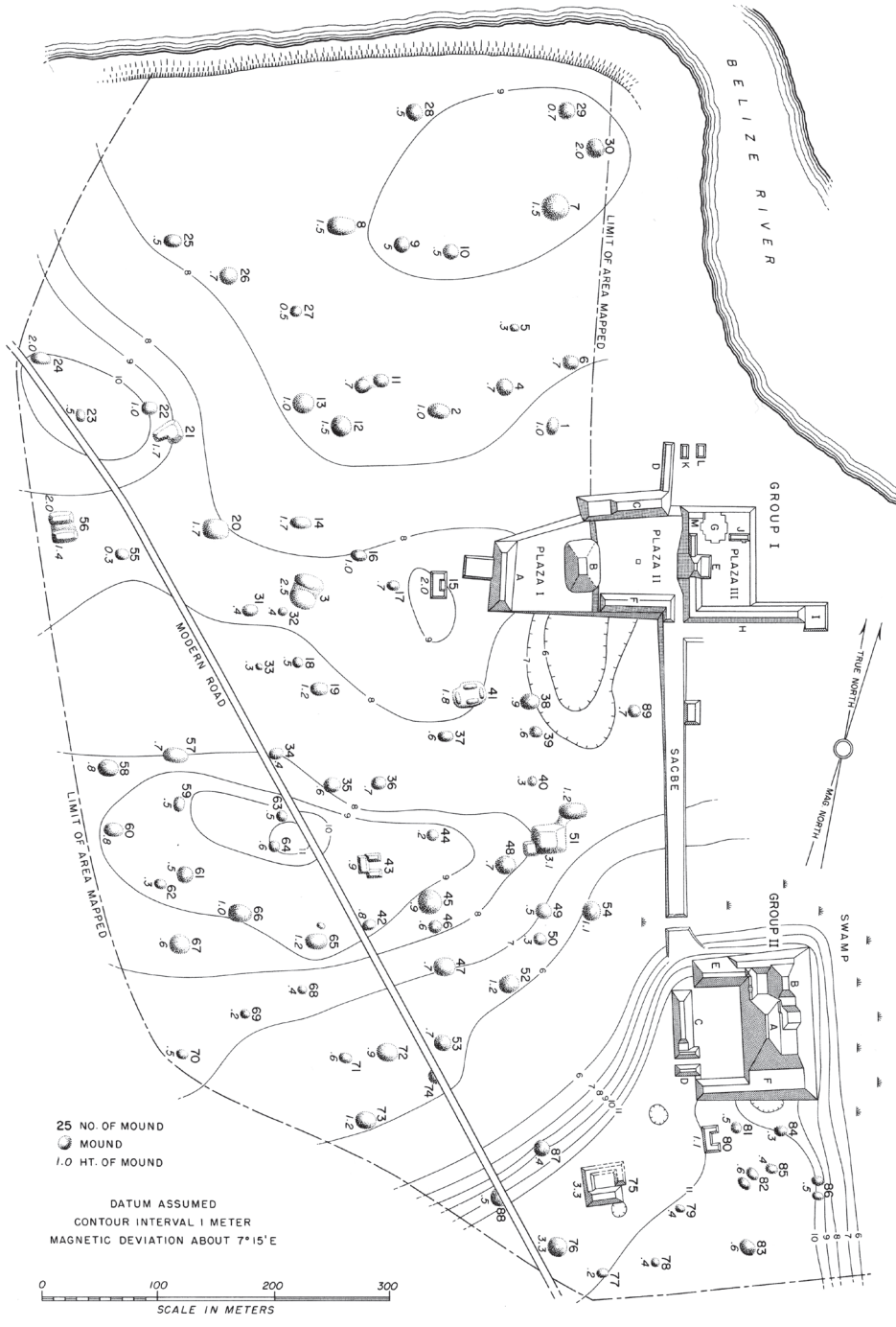

Figure 5. Map of the epicentre and associated settlement completed in 1956 as part of the Willey settlement survey of the Belize Valley (map by William R. Bullard, Jr. after Willey et al. 1965: Fig. 177).

documented the architecture exposed by Anderson in 1941, they trenched the summit of the temple, and continued testing of exposed architecture (Bullard and Bullard 1965; Willey *et al*. 1965: 304-305). In addition, the eastern half of Ballcourt 3 was exposed and the alleyway partially cleared. These investigations were again of short duration spanning only from mid-August to the end of September (Bullard and Bullard 1965: 5). Thus, by the end of the fourth research project a total of approximately six months of investigations had been completed at the site, resulting in a complete map of the site epicentre, partial exposure and testing of select structures within the monumental epicentre, and of four housemounds in the vicinity of the site core.

1992-2000: BVAR – Phase 1

The fifth and most recent archaeological project to focus on the site of Baking Pot is the Belize Valley Archaeological Reconnaissance (BVAR) project, under the direction of Jaime J. Awe. BVAR research at Baking Pot spans over three major phases.

The first phase of BVAR research at Baking Pot was initiated in 1992 and lasted until 2000, and was focused on the survey and excavation of settlement peripheral to the monumental epicentre. The settlement survey, led by James M. Conlon, was initially focused on excavations of the Bedran *plazuela* group (1992-1994) in the south-western periphery (e.g., Conlon 1993; Conlon and Moore 2003). With the launch of these investigations the site was for the first time subject to optic theodolite survey, with certain traverses surveyed by transit (loaned from the Xunantunich Archaeological Project—which was rumoured to be that used by Ian Graham to map Seibal in the 1970s). The work around Bedran also confirmed the existence of a series of water management features, especially a lattice-like system of canals (Conlon and Awe 1995; Conlon *et al*. 1995), which were first described by Charles Kirke in 1980 on the basis of aerial photographs (see Figure 3).

Upon completion of the Bedran excavations, attention shifted to the comprehensive mapping of Baking Pot's eastern settlement continuum (1995-1997 and 1999-2000). This survey expanded on that initiated by Bullard and began in 1994, extending the settlement survey to the east of Group B and by season's end led to the identification of an additional 119 mounds in a 85 ha area. It was not until 2000 that the settlement survey continued even further east to encompass the North Caracol Farm settlement area, thereby extending the survey by another 276 ha and adding another 181 mounds (Figure 6). By the close of the 2000 field season, the survey resulted in the identification of a total of 436 housemounds, thereby almost doubling the number of known structures for the site (Conlon 1995; Conlon and Awe 1995; Conlon and Ehret 2000, 2001; Golden and Conlon 1996). The total area covered by the combined Willey/Bullard and BVAR settlement survey completed in 2000, covered approximately 4.48 km^2, resulting in an average mound density of 97.3 mounds per square kilometre (0.97 mounds per hectare). As part of the BVAR settlement survey, a sample of 16% of all mounds were extensively surface-collected in the eastern periphery and within the North Caracol Farm area (Colon and Ehret 2000, 2001). In addition, exhaustive excavations of the Atalaya *plazuela* (M-161 through M-164) were undertaken by Allan Moore (Moore 1999; Conlon and Moore 2003) and Jennifer Piehl extensively excavated a series of smaller housemounds (M-102, M-129, M-131, M-193 and M-194) (Piehl 2006). Thereafter, Carolyn Audet initiated excavations of the Yaxtun *plazuela* (M-198 through M-200) (Audet 2000; Audet and Awe 2000).

Concurrent to this settlement research, a variety of excavations were conducted in and around the northern Group A of Baking Pot. These excavations were initiated by testing Causeway 1 (Cheetham 1995). Subsequently, the playing alley of Ballcourt 2 was excavated in search of ballcourt markers and associated special deposits (Conlon 1996), Structures A5 (Str. E), A9 (Str. F), A10 (Str. N) and the sloping benches of Ballcourt 2 were investigated (Aimers 1997), and Ballcourt 1 was tested by axial excavations (Ferguson 1998, 1999).

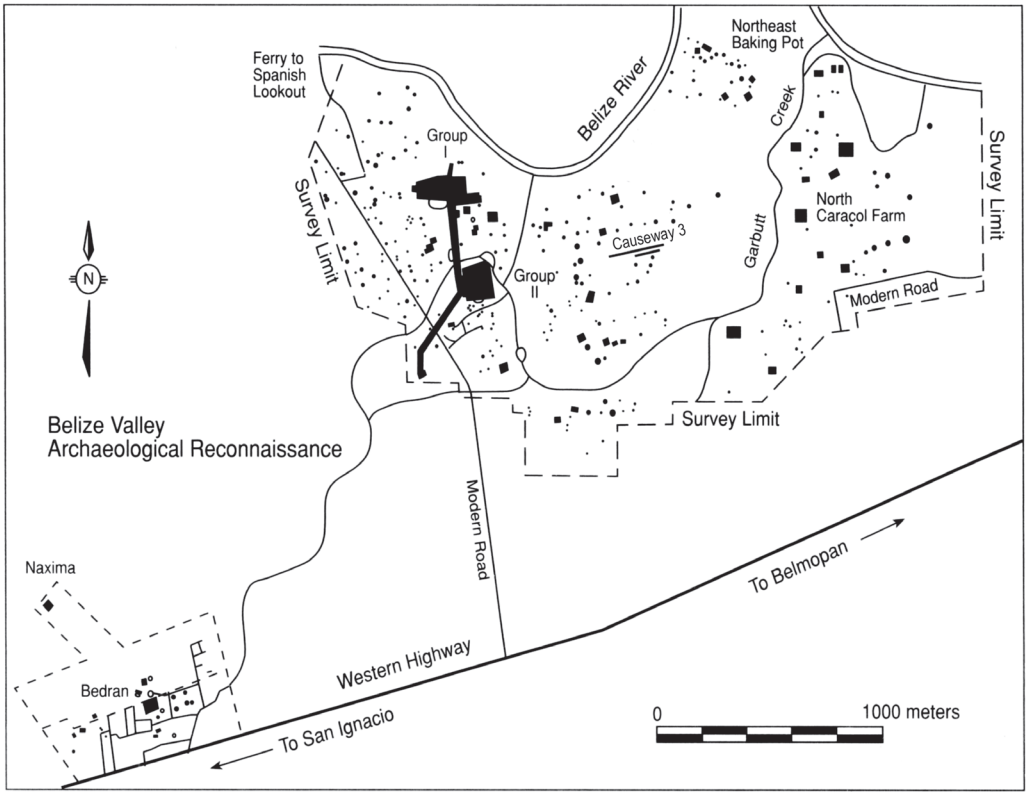

Figure 6. Map of the Baking Pot settlement survey at the end of 2000 season (after Conlon & Powis 2004: Fig. 5.1).

2001-2004: BVAR – Phase 2

With the completion of Jim Conlon's settlement survey and the doctoral researches of Allan Moore (1999), Jim Aimers (2002) and Jennifer Piehl (2006), the second phase of BVAR investigations began in 2001 and lasted until 2004. As part of this second phase, survey work focused on establishing intervisable permanent datums, with Universal Transverse Mercator coordinates secured by high precision D-GPS surveys (Poe 2001, 2002). These datums have subsequently been used to lock in the locations of excavation units and as control points for pedestrian surveys. Concurrently, Carolyn Audet completed the thorough excavations of the Yaxtun *plazuela* (Audet 2002) and a variety of housemounds of the site's core settlement were partly exposed and tested by excavations (M-51, M-188, M-197, M-203) (see Helmke and Awe 2008b: 93). With Yaxtun completed, Audet went on to expose and trench the important ritual structures associated with Causeways 1 and 2 (M-190 and M-209) (Audet 2007: 221-271). The summits of Strs. A1 (Str. B) and A5 (Str. E) of Group A were also investigated in search of tombs and special deposits, which yielded surprising finds (Audet 2007: 175-214; Audet and Awe 2003, 2005). At this juncture William Poe tepidly continued the settlement survey of the epicentral area, employing experimental survey methods, including vehicular D-GPS topographic mapping, with limited results (Poe 2004, 2005). The last year of Phase 2 was focused on Strs. B8 and B9 (Strs. B and G), two palatial structures of Group B (Audet 2005, 2007: 271-290) as

well as testing of the plazas of Groups A and B (Swain 2005) and Court 1 of Group A (Hoggarth 2005) to refine our understanding of the dating of epicentral constructions. As part of Phase 2 investigations an electromagnetic survey was also conducted by Tracy Sweely in search of buried "hidden mounds" (Sweely and Trainor 2005). To follow-up on results of this survey, limited test excavations were conducted, revealing that many of the anomalies identified by the electromagnetic survey were not cultural features, but rather dense clay levels retaining high moisture contents (Hoggarth and Swain 2005; Sweely 2007).

2007 - present: BVAR – Phase 3

The third phase of BVAR investigations was launched during the 2007 field season. Continued excavations of the monumental epicentre were reinitiated as part of this phase, with special focus on the palatial architecture of Group B (Helmke 2008). Most important, however, was the ambitious settlement survey programme that was designed to extend the previous survey boundaries and to complete the 9 km^2 settlement survey centred on the epicentre of Baking Pot. That settlement survey programme was headed by Julie Hoggarth as part of her doctoral research, under the continued direction of Jaime Awe. The settlement survey was not only designed to complete the mapping of the settlement continuum around Baking Pot, but also to assess its temporal evolution, by means of extensive surface collections and excavations of a sample of 20% of all documented housemounds (see Hoggarth *et al*. 2008: 190-191; Hoggarth *et al*. in prep.). With the start of Phase 3, the settlement survey abandoned the use of the slow and cumbersome theodolites that were the mainstay of Phase 2, and for the first time made extensive use of hand-held GPS receivers. Data received were calibrated for drift by recording the UTM coordinates of fixed stations, at various points of the day. The drift errors were cancelled out, by applying correction factors that were correlated to the internal chronometer, thereby implementing an elementary D-GPS system (see Hoggarth *et al*. 2008: 164-165, 2010: 53-54). Teams composed of at least five field walkers covered the terrain and upon encountering a mound, the leader of the team and an assistant recorded it, while the remaining personnel conducted artefactual surface collections. These methods of settlement survey were initially devised and eventually implemented during the settlement survey conducted by BVAR in the Roaring Creek Valley, between 2001 and 2003, with great success (see Helmke *et al*. 2004). To expedite the mapping process and to focus our efforts on the survey of archaeological features, we wished to generate topography more expediently and began experimenting with a variety of sources. That which eventually proved most viable and effectual was the use of high-resolution geo-referenced data tiles, to extract DEM models. These raster tiles exhibited a horizontal pixel accuracy of ± 2.5 m (1 σ) on slopes of less than 20° and a vertical accuracy of ± 3 m. This radar dataset was acquired by Intermap Technologies in 1999 using Sideways-Looking Airborne Radar, mounted on a Learjet flying at about 10 000 ft and was acquired under academic license via its commercial arm, Global Terrain.

Implementing these methods at Baking Pot, the settlement survey was successfully extended by 286 ha at the end of the first season in 2007, increasing the number of documented housemounds by 237 (Hoggarth *et al*. 2008; Hoggarth 2008) (Figure 7). The same methods were applied during the subsequent 2008 season, expanding the settlement survey by another 405 ha and 185 housemounds (Hoggarth 2009, 2012: 53-59; Hoggarth and Awe 2009: 26-86; Hoggarth *et al*. in prep.; Jobbová 2009). Thus, by the close of the 2008 season, and after just two seasons of intensive settlement surveys the total settlement area was expanded two and half times to c. 4 km^2, and the number of mounds mapped was again doubled to 858 (Figure 7).[3] This testifies to the relative expediency of surveys conducted by pedestrian teams equipped with handheld GPS receivers, over a duration of just three months.

[3] This total refers to the entirety of the survey area. For figures pertaining to the epicentral settlement see Hoggarth *et al*. (in prep).

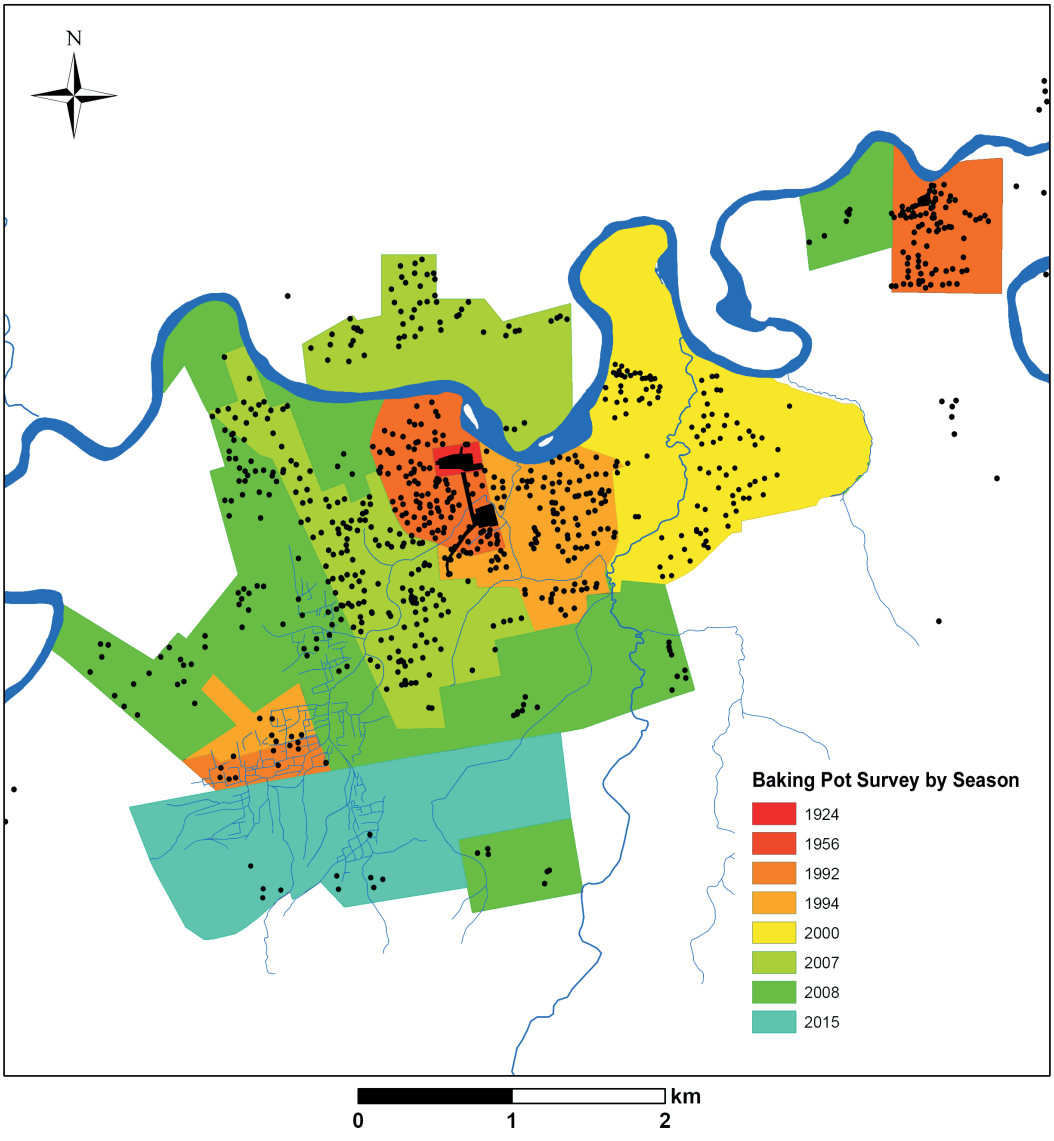

Figure 7. Chronological overview of the Baking Pot settlement survey, with survey blocks defined as those completed by a given season of investigation (map by Claire Ebert and Christophe Helmke).

Research in 2009 and 2010 was focused exclusively on the excavations of housemounds in the epicentral neighbourhood designated as Settlement Cluster C. This was implemented, according to a hierarchical stratified sampling design that selected house groups for testing based on architectural volume (as a proxy for status) and spatial location (to ensure spatial variability across the site). This sampling was devised to ensure that domestic structures of each of the three recognised tiers were adequately represented (Hoggarth and Awe 2010: 11-69, 2011: 29-75), the results of which this research

were presented in the doctoral thesis of Julie Hoggarth (2012) and subsequent publications (Hoggarth *et al*., in prep.). These investigations tested a total of 132 mounds, accounting for at least 20% of groups in each of the spatial areas of the site, to build an occupational history that is comparable across the epicentral settlement (Hoggarth *et al*., in prep.). An extension of the survey program encompasses the area east of Baking Pot, including North Caracol Farms and Spanish Lookout (see Conlon and Ehret 2000, 2001; Jobbová 2009), reaching the edge of the settlement associated with the major centre of Lower Dover. The settlement survey was also extended to the west to include the minor centre of Bacab Na (Hoggarth *et al*. 2008), Esperanza, and the ditched field area surrounding the Bedran Group (Ebert *et al*. in prep.). Other settlement excavations continued in Baking Pot's western settlement for another two seasons (Zweig 2012, 2013), before the palatial contexts of Group B were once again the focus of excavations, from the 2013 season onwards. These palatial excavations, are now in their fifth season and have yielded a wealth of data on the final phases of occupation, especially due to the abundance of archaeological materials found in artefact-rich deposits, consisting mainly of decorated serving wares, specialised forms, as well as other domestic and food-processing implements (Helmke *et al*. 2017a; Hoggarth *et al*. 2014b; Hoggarth and Sullivan 2015; Sullivan and Hoggarth 2015). Since 2013, Hoggarth and Awe have initiated a targeted research program of excavation and high-precision radiocarbon dating in the monumental epicentre of Baking Pot to date the collapse of political systems and abandonment of the site (Hoggarth *et al*. 2014a).

In 2014, BVAR integrated visual and quantitative spatial analyses of LiDAR data within the settlement survey program at Baking Pot, as well as at the sites of Cahal Pech and Lower Dover, to identify and better understand the settlement as well as the ecological features around these sites. The survey of the Belize Valley was conducted in 2013 as part of the West-Central Belize LiDAR Survey to provide a detailed model of the local topography and to help plan more efficient, targeted, and cost-effective survey programs.

At Baking Pot, LiDAR analyses identified several areas to the west and south of the monumental epicentre with previously undocumented mounds (Ebert *et al*., in press). Additional analyses indicated that the ditch system around the Bedran Group, was much more extensive than previously documented. Approximately 27 km of ditches have been visually identified, and additional 4.25 km were documented through analysis of LiDAR data within a GIS (Awe *et al*. 2015; Ebert *et al*. 2015) (Figure 3). The system extends from the southern karstic foothills, with ditches flowing towards the Belize River, suggesting that the primary function of the system may have been drainage, especially during the rainy season when the area is prone to flooding. The newly identified mounds and ditches were the focus of ground-truthing during the 2015 BVAR field season. Approximately 23.5 km of ditches and 16 mounds were verified through pedestrian survey (Ebert *et al*. 2015) (Figure 7). Several small residential mounds are interspersed between ditched areas, perhaps indicating intervening plots delineated by the ditches that were associated with specific households (Awe *et al*. 2015). Based on this data, water management at Baking Pot became increasingly important during the Late Classic Period (A.D. 600–900) in the face of population increase, anthropogenic degradation of the landscape, and climate change. Understanding the construction of this and other complex water management systems in the Belize Valley, their use in relation to changing environmental conditions, and political cycling are the focus of an upcoming research project by the three junior authors (Alexander *et al*. 2015).

Analysis of LiDAR data has also allowed BVAR archaeologists to document several previously unknown centres in the region (Awe *et al*. 2015). One of these, to the southeast of Baking Pot, has been named Ek Tzul and was clearly an important minor centre within the polity (Figure 1). The site is composed of three contiguous plazas and a ballcourt located on a ridge overlooking smaller settlements in the valley below. Lower Barton Creek, another minor centre, which also exhibits a ballcourt, was likewise located using LiDAR data, and is helping to clarify the territorial organisation of sites in the

Belize Valley area. Through the application of Thiessen polygons, the existence of a site at roughly this location had been suspected by Helmke and Awe for nearly a decade (2012: 72), but it was not until the availability of LiDAR that the site was actually revealed. Surprisingly, the site turned out to be a minor centre, although we had hypothesised that a major centre should be found in this location, based on the relatively even distribution pattern of major centres in the upper Belize Valley. Similarly, we have long supposed the existence of larger sites to the north of Baking Pot and although the site of Aguacate Uno was reported in the 1990s, archaeological excavations at the site were only initiated in 2009. Similarly, we surmise the existence of another as yet undiscovered site to the northeast, but this falls outside the range of the LiDAR survey and will have to taunt us for some time still (Awe *et al*. 2015; Ebert *et al*., in press).

Quantitative and visual analyses of LiDAR across the BVAR study area in the Belize Valley indicate that there is much to learn about settlement patterns in the region. At the regional scale, spatial analyses and ground-truthing of LiDAR data at Baking Pot and at Cahal Pech has suggested a pattern of nucleated settlement around major centres, with sparsely populated areas likely acting as buffer zones, with minor centres often located between the larger settlement areas. One hypothesis is that these gaps may have acted as borderlands between centres of power (see Driver and Garber 2004: 303), which we will discuss further below. Future BVAR research will be aimed at ground verification of the results of LiDAR analysis around other major and minor centres, wherein spatial analyses serve as hypothetical models to be tested against ground-truthing efforts.

BORDERS AND BOUNDARIES

Borders, as the geographic boundaries of politically sovereign states, are conceptual entities and in the Western Hemisphere were rarely made explicitly manifest (e.g., Anaya *et al*. 2003; Iannone 2006). As such, in Pre-Columbian times, most borders were left open and unguarded as in most early civilizations (Trigger 2003: 125). In contrast, borders could at times be partially controlled by guards and paths of travel obstructed, or marked by fortified structures, to better control the ingress and egress of peoples and goods (Trigger 2003: 94, 109, 125). In such antagonistic situations, buffer zones developed in order to maintain a safe distance between the armed factions on opposite sides of a border (Trigger 2003: 112; a feature also seen in warring tribal societies see Abbink 1993, 1998). Such buffer zones were historically known as *marchlands*, and were essentially neutral areas between seats of power. In Medieval Europe, such borderlands were known as *march* or *mark*, originally meaning ‘edge, margin, boundary’ and from the features used to designate such borders we have the term *mark* as in a ‘visible sign, a trace’ denoting the physical markers of boundaries (Donald 1872: 310). Such marchlands formed in areas between realms, which served a distinct political purpose, since the authorities that eventually oversaw these areas served to forewarn and shield against military incursions as well as regulate trade. It is from the governance of these borderlands that certain titles originate, including that of *marquis* in French, of *marquess* in English, *Markgraf* (a.k.a. *Grenzgraf*, lit. ‘border-earl’) in German (Donald 1872: 310-311; Kluge 1899: 259-260). Historically, we see the term applied to the *Marca Hispanica*, the Catholic realms that defined the northern border of the Cordoban Emirate in the eighth and ninth centuries (e.g., Chandler 2002). Equally we see survivals of the term in the names of countries, such as *Danmark*, as the southernmost part of Scandinavia bordering on continental Europe, and in *Ostmark* attributed to Austria after the *Anschluss* of 1938.

The fortifications, fences and barriers that typify some borders – and here we can think of the Roman fortifications in Britain such as Hadrian’s Wall or the Great Wall of China – are all typically conceived as the manifestations of later civilizations (Trigger 2003: 48-51). Nevertheless, traces of fortifications are known for the Maya area, especially the palisades and moats around monumental

epicentres documented in the Pasión and at Becan (Cortes Rincon 2007). Farther afield we find examples of large earthworks that define boundaries, such as those to the north and west of Tikal (Puleston and Callender 1967) and in the Usumacinta area, where the remains of defensive features have been documented in the borderlands between a large number of sites (Golden and Scherer 2006). Interestingly, the earthworks at Tikal are c. 4.5 km to the north and 9.0 km to the west of the epicentre and in the Usumacinta case one is c. 5.5 km east of Yaxchilan (ibid.). Such exceptions aside, we surmise that most borders in the Maya area were, as these were in most Early Civilizations, unmarked and open, leaving marchlands between centres of power, aligning to natural physiographic features of the landscape, especially rugged terrain, ridges, hills, escarpments, rivers, lakes, marches and dense forests (see Golden and Scherer 2006; Trigger 2003: 94). Although recent scholarship stipulates that natural boundaries do not in themselves constitute borders, since borders are conceptual entities that are imposed on the natural world as nonphysical fiat margins (Robinson 2012), we would nevertheless maintain that many of the more perdurable borders have and continue to follow prominent physiographic features (see also Bevan 2010: 29-30). As such, any attempt to reconstruct borders in archaeology must recognise and make the most of the tangible features that serve as obstacles to communication and transport, especially since these often form the natural borders between realms.

But where should we draw the boundaries in the case at hand? Where did the ancient kingdom of Baking Pot extend to, especially as we know that the ruling elite of this site interacted not only with the rulers of neighbouring and adjoining polities, but also with sites located farther away, including Caracol, located some 50 km to the south, and with Naranjo in particular, located just 30 km to the west (Helmke and Awe 2008a, 2012). Systemically, many of the sites in central Belize interacted with Naranjo, either directly or indirectly, from at least the sixth to the ninth centuries and may have been vassal states of their larger neighbour. Thus, at Buenavista del Cayo, the Jauncy vase implies relations with Naranjo during the reign of *K'ahk' Tiliiw Chan Chaahk* (A.D. 693–728+) (Houston *et al*. 1992), as do sherds of nearly identical vases found at Xunantunich and Baking Pot (Figure 8a). A miniature vase discovered in a tomb within Str. A1 at Baking Pot may have been gifted to the local rulers as a means of cementing an alliance with *K'ahk' Ukalaw Chan Chaahk* (A.D. 755–780+), the son of *K'ahk' Tiliiw* (see Helmke and Awe 2008a: 79-80; Hoggarth *et al*. 2014a: 1065; see Martin and Grube 2000: 80-81) (Figure 8b). And a fragmentary vase, discovered in a palatial refuse deposit associated with Courtyard 4 at Baking Pot (Hoggarth *et al*. 2014b: Fig. 6), indicates ties to *Waxaklajuun Ubah K'awil* at the start of the 9th century (see Martin and Grube 2000: 83; see also Helmke *et al*. 2010: 109-110) (Figure 8c). Incidentally, this vase also provides added information on the reign of *Waxaklajuun Ubah K'awil*, since it records his commemoration of *both* the 810 (9.19.0.0.0) and 820 (9.19.10.0.0) Period-Endings, thereby indicating that he wielded some influence, four years prior to his accession, but unfortunately this vase does not provide added information on the latter part of his reign.[4]

[4] Of the two Period-Endings recorded on the fragmentary vase discovered at Baking Pot, it seems that the second contains an error in its notation, since it was written as 8 Ajaw 13 Xul (instead of 8 Xul), a Calendar Round for which there are no good anchors for a k'atun on either side of 10.0.0.0.0. Prior to the discovery of this vase, we knew that Waxaklajuun Ubah K'awil had acceded to power in 814 (9.19.4.1.1) and to have celebrated the half-k'atun Period-Ending of 820 (9.19.10.0.0), possibly at Xunantunich (Helmke *et al*. 2010). The main monument of his reign, Stela 32 of Naranjo, also cites him in relation to a palanquin event and mentions Ucanal (Martin and Grube 2000: 83; see also Savchenko 2015).

Figure 8. Ceramics from Naranjo found at Baking Pot: a) sherds of a Holmul Dancer Vase, b) miniature vase found in the tomb of Str. A1, bearing what may be the name of *K'ahk' Ukalaw Chan Chaahk*, c) fragmentary vase found in a peri-abandonment deposit associated with Str. B17, bearing the name of *Waxaklajun Ubah K'awil* (photographs by Julie Hoggarth and Christophe Helmke).

SPATIAL ANALYSIS AND MODELLING

The integration of Geographic Information Systems for spatial analyses has formed an important part of archaeological research for several decades (for overviews, see Wheatley and Gillings 2002; Ebert 2004; Conolly and Lake 2006; McCoy and Ladefoged 2009). The advent of systematic quantitative analyses on high-resolution spatial datasets, such as remotely sensed airborne LiDAR data, has proved invaluable for settlement studies in tropical environments (Chase *et al*. 2014a, 2014b; Evans *et al*. 2013). Analyses of LiDAR data and other spatial datasets for the Belize Valley was conducted within a GIS, to understand the factors that may have influenced the formation of borders around major polities in the Belize Valley.

Regional-scale spatial analyses for the larger Belize Valley area were conducted on a smoothed DEM extracted from ORI data tiles. Smaller scale site-level analyses focused on Baking Pot and its immediate environs were based on the LiDAR obtained from the West-Central LiDAR Survey (Chase *et al*. 2014a). Pre-processed LiDAR point cloud data (see Chase *et al*. 2014a, 2014b for classification methods) were analysed using the LAS data set tools in ArcGIS 10.3. A high-resolution (1 m) digital terrain model (DTM) for the study area was created from first and second LiDAR ground return points. Both regional and site level analyses were conducted using the ArcGIS Spatial Analyst and 3D Analyst extensions.

Site Size and Hierarchy

Settlement pattern studies have been instrumental in recognising the gamut of settlement architecture. Based on work by Willey and his colleagues, we have a model for settlement hierarchy in the Belize Valley that divides sites into two main categories. In addition to the so-called "isolated housemounds" that constitute the very bottom of the settlement hierarchy, and *plazuelas*, otherwise known as patio-focused groups (see Ashmore 1981) – which sometimes function as the focal groups of communities (see Yaeger 2000) – the two types of sites at the opposite end of the settlement spectrum are major centres (which they called major ceremonial centres) and minor centres (which they called minor ceremonial centres) (Willey *et al*. 1965: 561). In earlier studies by Helmke and Awe (2008a, 2012: 60-62), we defined major centres on the basis of a range of architectural features, including: 1) nucleated monumental epicentres; 2) pyramidal temple structures; 3) eastern triadic temples (resembling E-group configurations); 4) royal palatial groups; 5) ballcourts; 6) monolithic monuments such as stelae and altars (some of which are carved); 7) intrasite processional causeways (*sacbeob*); 8) causeway termini groups; and in some cases 9) royal tombs. In contrast, minor centres are sites that are considerably smaller than major centres and which exhibit only a few of the aforementioned architectural features, and rarely if ever exhibit monuments (see Iannone 2004). This definition evidently hinges on relatives and one should therefore attempt to qualify what is meant by larger and smaller. For one, we recognise the existence of three superordinate sites that in large measure frame and define the extent of the Belize Valley as a whole. These are the sites of Caracol to the south, Naranjo to the west, and Lamanai to the north. Caracol and Lamanai are the two largest known archaeological sites in Belize and also the sites that exhibit the largest constructions and some of the highest concentrations of carved monuments, all indices of the power and affluence of the royal courts established at these sites (see Martin and Grube 2000: 84-99; Helmke and Awe 2008: 66-67).

Using the LiDAR data, we have been able to recalculate the total contiguous surface areas occupied by the monumental architecture of the sites in the Belize Valley, thereby updating the figures originally at our disposal, which were based on published site plans (see Helmke and Awe 2008: 69, 2012: 64; see also Andres *et al*. 2014: Table 1) (Table 2). Surface areas were computed as planar areas digitised from a combination of geo-referenced site plans and LiDAR interpretation. Sites falling outside of the purview of the LiDAR catchment area were computed on the basis of the ORI-derived DEM. In order to generate comparable figures we have focused on the epicentral areas exhibiting contiguous monumental architecture, excluding causeways, terminus groups and nearby monumental groups. In a case such as Cahal Pech, where the monumental architecture is dispersed across the summits of a series of adjoining hills, the total area comprised by the monumental architecture may approximate a planar area of 3.94 ha, if we include the Cas Pek and Tzinic groups as well as the causeway and Zopilote terminus. This should be compared to the c. 3 ha area tabulated below, that solely encompasses the contiguous epicentre. As such all figures presented below (Table 2) are to be considered as strict minima and do not reflect the total accretion of monumental architecture of a given site. Also, in the case of Aguacate the size of this site has not been satisfactorily resolved, since it falls outside the

Table 2. The areal and volumetric assessments of a selection of sites in the Upper Belize River Valley, from largest to smallest, according to total area. The sites in the upper half are designated as major centres, whereas minor centres occupy the lower half

Site Name	Planar Area (ha)[a]	LiDAR Area (ha)	Volume (m^3)[b]	Max. Elevation (masl)
El Pilar	6.72	7.20	1 537 580	253
Buenavista	5.60	5.84	1 139 570	124
Pacbitun	5.33	5.54	882 880	247
Baking Pot	3.99	4.20	640 920	66
Lower Dover	2.91	3.05	312 060	68
Cahal Pech	2.80	3.05	473 470	179
Yaxox	2.21	2.30	283 965	101
Lower Barton Creek	1.93	1.98	183 680	122
Aguacate[c]	1.29	---	*121 765	136
Ek Tzul	0.94	0.97	87 995	181
Spanish Lookout	0.55	0.58	34 710	54
Bacab Na	0.53	0.54	19 265	76
Esperanza	0.37	0.39	14 380	104

[a] Planar area is derived from surface area calculated in square meters, rounded to the nearest multiple of 5 and then converted to hectares.
[b] Rounded to the nearest multiple of 5 m.
[c] This site falls outside the LiDAR survey and we have thus relied on planar area, based on what appear to be incomplete surveys.
* This figure is reconstructed and based on a polynomial correlation between planar area and volume derived from the arrays presented here, and thereby liable to correction.

LiDAR survey, leaving us to rely on extant plans. Whereas the instrument surveys completed today suggest that the site is a minor centre, personal observations lead us to believe that it may have been larger since the survey is as yet incomplete. With added coverage and continued surveying we will be able to amend our assessment of Aguacate. Nevertheless, by focusing on contiguous surface areas of epicentral monumental architecture we hope to devise a measure that is comparable between sites that are quite diverse in terms of their configuration and architectural complexity.

In addition to surface area, we have been able to extrapolate approximate volumetric assessments for each of these sites in order to take architectural bulk into consideration.[5] Volume was calculated based on contiguous surface area of epicentral architecture and plazas, and interpolated from the DEM to include 3D topography. The volumetric assessments thereby represent the total cubic area between the surface area of the horizontal plane and a *z* variable, specified as the corresponding height

[5] Since certain sites fall outside of the LiDAR survey boundary, we have resorted to data in the ORI tiles, to determine volume. This means that the values obtained from the ORI data are necessarily of lesser accuracy than those determined from LiDAR. Nevertheless, in the present study this only affects the values obtained for Aguacate and should therefore be updated in the future, were additional LiDAR data to be forthcoming.

parameter. Here we opted for selecting the maximal elevation of the tallest structure at a given site, and used the specific topography from the LiDAR data to refine the volumetric values.

Thus, considering surface area and volume we have been able to substantiate the division of sites in the Belize Valley into two major categories. Based on surface area we can see that sites that have been categorised as major centres are all in excess of circa 3 ha – with El Pilar at over 6 ha – but with all minor centres occupying less than 3 ha. Similarly, with architectural volume we can see that all major sites exhibit in excess of 450 000 m^3 of architecture up to in excess of a million cubic meters in the case of El Pilar and Buenavista, whereas minor centres fall below that range. Therefore the thresholds of c. 3 ha and half a million cubic meters appear to be meaningful in the context of the Belize Valley, yet, how readily these statistics can be applied elsewhere in the Maya area remains to be seen (see Turner *et al*. 1981). Plotting planar area against volume (Figure 9) suggests that the two variables are highly correlated using a polynomial regression ($R^2 = 0.9866$ with zero-intercept). On the basis of these results, it is plausible that this correlation has wide applicability throughout the Maya lowlands, but this is evidently a statistic that will have to be subject to more ample research (see Menze and Ur 2012 for promising results in Mesopotamia). For the time being, based on the work conducted by Juan Pedro Laporte (2001; see also Laporte and Mejía 2006; Laporte *et al*. 2003) in adjoining parts of the Peten, especially at sites in the Mopan Valley, we surmise that the figures presented here prove pertinent. In the analyses presented below, we thereby maintain the dichotomy between major and minor centre, since these sites and their presumed functions serve as a basis against which to test the results of the geospatial analyses. In order to better ascertain the spatial relationship between Baking Pot and neighbouring sites, we have focused especially on major centres, but have also taken into consideration intervening minor centres, as well as smaller centres that appear to define marginal lands to the northwest and southeast of Baking Pot (i.e., Aguacate and Lower Barton Creek, respectively). As nodes, these minor centres are thus treated spatially on equal footing as nearest neighbours, which help to clarify the territorial configuration of the Baking Pot polity.

Terrain and Viewshed

Of primary interest in our reconstructions of territorial organisation is topographic terrain and how the physical landscape shaped natural borders between polities. Several geographic features likely functioned as natural boundaries to the Baking Pot polity, including rivers, creeks, the headwaters streams, mountain ranges, and escarpments (Figure 10). Examining the terrain in the immediate vicinity of Baking Pot we can appreciate that the site was established in the middle of the alluvial plain. Group B of the monumental epicentre established atop an elevated fluvial terrace, which connects by a causeway to Group A, in the lower alluvial plain below. Most of the settlement is dispersed throughout the alluvial bottomlands surrounding the monumental epicentre. Less than 2.5 km to the south, is a range of Early Tertiary limestone hills, that form the valley shoulder and the southern edge of the greater Belize Valley proper (see Cornec 2003). Due to the paucity of limestone in the valley bottom, most structures at Baking Pot use alluvial matrices, clays, pebbles and cobbles as core and fill materials, with only the outermost faces being built of dressed limestone facings. As such the mountain range to the south was important not only as a clear natural border, but also as the primary source of limestone used in construction works, perhaps explaining in part the importance of Ek Tzul. The Belize River aside, other streams that are nearly equidistant and represent natural borders, are the Barton Creek to the east (5.6 km) and Red Creek to the southwest (5.2 km). Although neither stream was navigable in antiquity – nor in modern times – they provide natural borders that could have been used as part of martial defence tactics. To the north of Baking Pot, the valley seems to extend in an uninterrupted fashion, and smaller creeks and tributaries to the Belize River extend to the northwest until their headwaters at the foothills of another karstic range. This range is known as Fowlers Work

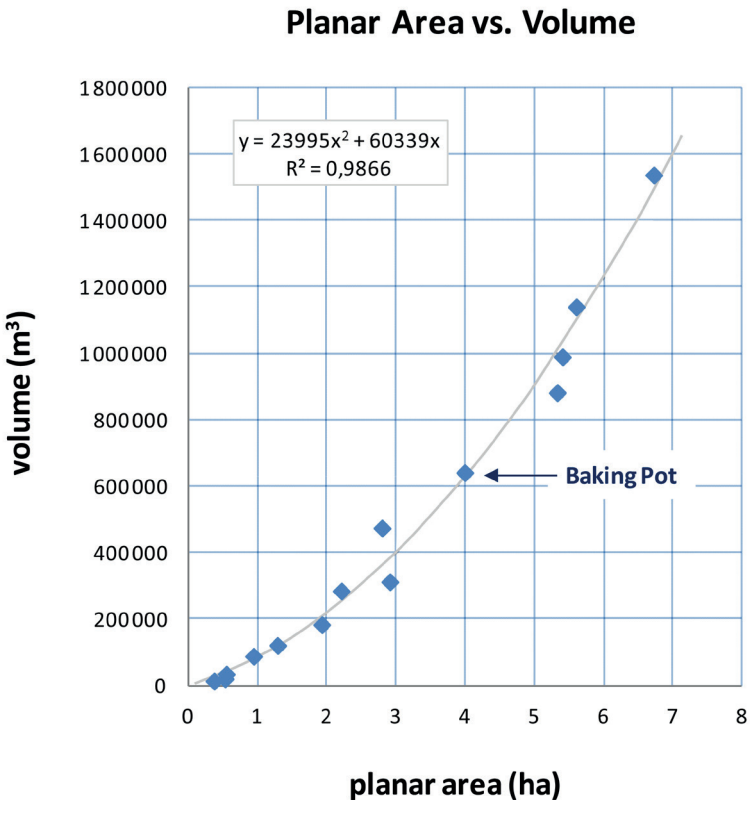

Figure 9. Graph plotting planar area vs. volume of a selection of archaeological sites in the Upper Belize Valley (Graph by Christophe Helmke).

and to the south defines the shoulder of the narrow Mopan Valley (before the confluence with the Belize River) and to the east forms a striking and steep escarpment that runs along Cadena Creek. To the northeast the terrain is essentially open and there are no clear natural boundaries. The situation is complicated here also by the presence of the large Mennonite settlement of Spanish Lookout. If an archaeological site had existed to the northeast of Baking Pot we surmise that it could have been dismantled during the founding of Spanish Lookout and conversations with the local community largely support this suspicion.

In reviewing the local terrain and landscape surrounding Baking Pot, we have identified a series of potential natural borders. Building on this review we have conducted a series of viewshed analyses, which use the elevation value of raster cells in the smoothed DEM derived from the ORI data to determine visibility to or from a particular cell, or archaeological site in this case (Lee and Stucky 1998; Kvamme 1999). Recognising the ribbon-like distribution of sites in the Belize Valley and their relative proximity, one of the hypotheses that has been formulated by researchers to account for the distribution of sites was to stipulate that these were inter-visible (Willey *et al*. 1965: 561, 573; Driver and Garber 2004; see also Chase *et al*. 2014a: 216). Inter-visibility implies either a degree of collaboration and cooperation on the part of site founders to foster communication, or alternatively a high degree of distrust with communities needing to keep an eye on their neighbours due to offensive

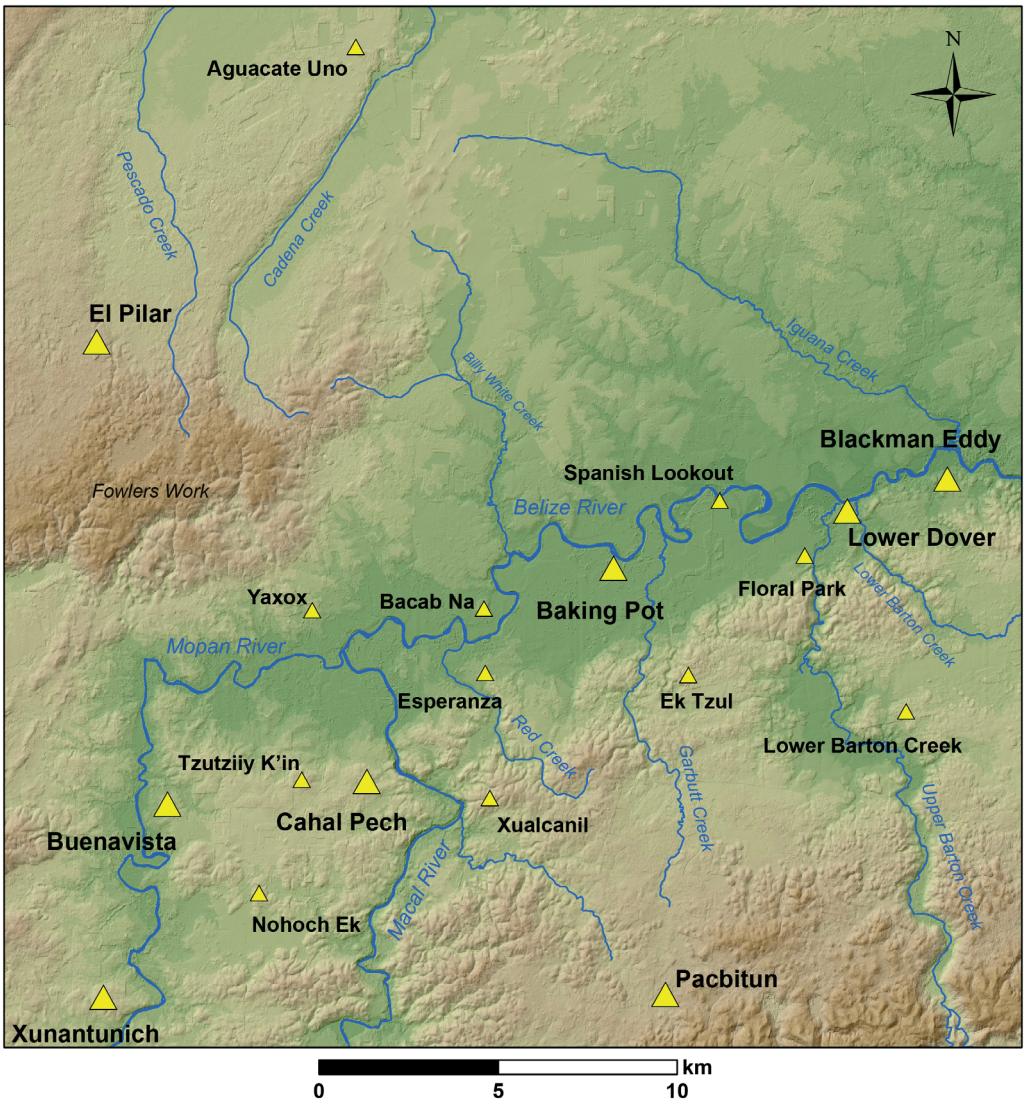

Figure 10. Map of the upper Belize River Valley showing the archaeological sites discussed in the text in relation to prominent physiographic features of the area (map by Claire Ebert).

and martial motivations (see Doyle *et al*. 2012). We feel that neither of these explanations are entirely convincing. As such we conducted a series of viewshed analyses, first considering the viewsheds of individual centres and thereafter a cumulative viewshed analysis (see Lake *et al*. 1998; Ruggles *et al*. 1993; Wheatley 1995). Here we have opted for using a DEM that shows terrain as denuded and deforested to maximise the degree of visibility and we have also used the summit of the highest structure at each site as the most prominent observation point. Naturally, coevalness of sites, the height of individual structures and superstructures, and the degree of forest cover present in antiquity cannot

be adequately assessed at present, but sufficient excavations have taken place to ensure that all of the sites considered here were inhabited contemporaneously during the Classic period. Nevertheless, we should stress that based on present evidence it is clear that certain sites are settled much earlier than others, with Cahal Pech, Blackman Eddy and Xunantunich as clear examples, since the earliest ceramic deposits at these sites can be dated to about the 13th century BC (e.g., Awe 1992; Garber *et al*. 2004; Brown 2009; Sullivan *et al*. 2009; Sullivan and Awe 2013). As such, earlier sites may have preferentially been established at the summit of higher elevations, leaving sites located in alluvial bottomlands to be established subsequently in the Middle to Late Preclassic periods (see Willey *et al*. 1965: 306; Ball and Taschek 2004; Hoggarth 2005; Audet 2006).

While one can often wonder as to the utility of viewshed analyses in archaeological studies, the results for the individual sites are surprising, since these suggest that none of the major centres were directly inter-visible. That being said, we should bear in mind that visibility is not the same as inter-visibility, since El Pilar is at the very edge of the viewshed of Aguacate, and Xunantunich is visible from Buenavista and Cahal Pech, but these are exceptions to a greater pattern. In addition, the viewsheds for each site were not the same in terms of aspect and predominant azimuth, since Cahal Pech for example exhibits a more dominant north-eastern viewshed, whereas that of Baking Pot and Buenavista are predominantly western (Figure 11). A more detailed consideration of the viewsheds, suggests that we can identify a dichotomy between what can be referred to as the primary viewshed – the visible portion that is in the foreground, closest to and adjoining a site proper – and a secondary viewshed – that which extends farther away at the horizon and is often separated by a large and intervening area, hidden from sight (Figure 11). This is especially the case for Lower Dover, Pacbitun and Baking Pot, which have markedly distinct primary vs. secondary viewsheds, exhibiting relatively little overlap (on average < 10%). The situation is rather different for the sites along the Guatemalan border, which have much more continuous and extensive viewsheds, particularly those of Aguacate, El Pilar and Buenavista, and exhibit larger overlaps (on the order of > 40%). As a result we can recognise and treat the boundaries between viewsheds as one set of borders that did exist in antiquity even if these were not always apparent (Figure 12a). Interestingly, the viewshed borders are quite different from those produced by Thiessen polygon analyses of earlier studies (see Helmke and Awe 2008, 2012) (see Figure 12b-c). Cahal Pech, due to its acropoline location at the summit of a hill has the largest viewshed of any site in the area, double that of Pacbitun, the nearest datum. One added peculiarity is that Cahal Pech has a very extensive secondary viewshed and essentially no primary viewshed, since it is hidden by the architecture of the site and the surrounding hill (Table 3).

In considering these viewsheds cumulatively, we have been able to determine that primary viewsheds define areas that are for the most part site-specific and are predominantly non-overlapping with the viewsheds of other sites. This is particularly true for the sites in the Belize Valley proper and contrasts to the sites of El Pilar and Aguacate that share a great deal of their viewsheds. These two exceptions aside, the extent of primary viewsheds can be used as an alternate means of demarcating what might have been the optimal martial surveillance and marching areas of particular polities. Evidently, many of these boundaries cluster along natural features in the terrain and in the case of Baking Pot include the range of mountains to the south, the foothills of Fowlers Work to the west and northwest. Interestingly, much of the area to the east and north of Baking Pot is essentially hidden; did these areas not constitute a threat in antiquity? Taking into account the location of minor centres we can note that Ek Tzul, Spanish Lookout and Bacab Na – three sites that have usually been regarded as part of the Baking Pot polity – are in hidden areas, outside of the viewshed, and as such are not visible from Baking Pot proper. In contrast, the minor centres of Esperanza, Yaxox, and Xualcanil nearly so, are all at the very edge of Baking Pot's viewshed, perhaps betraying that these sites were affiliated with the Cahal Pech polity as has been independently suggested elsewhere, on the basis of archaeological data (Iannone 2004; Driver and Garber 2004). Based on these observations it would seem that minor

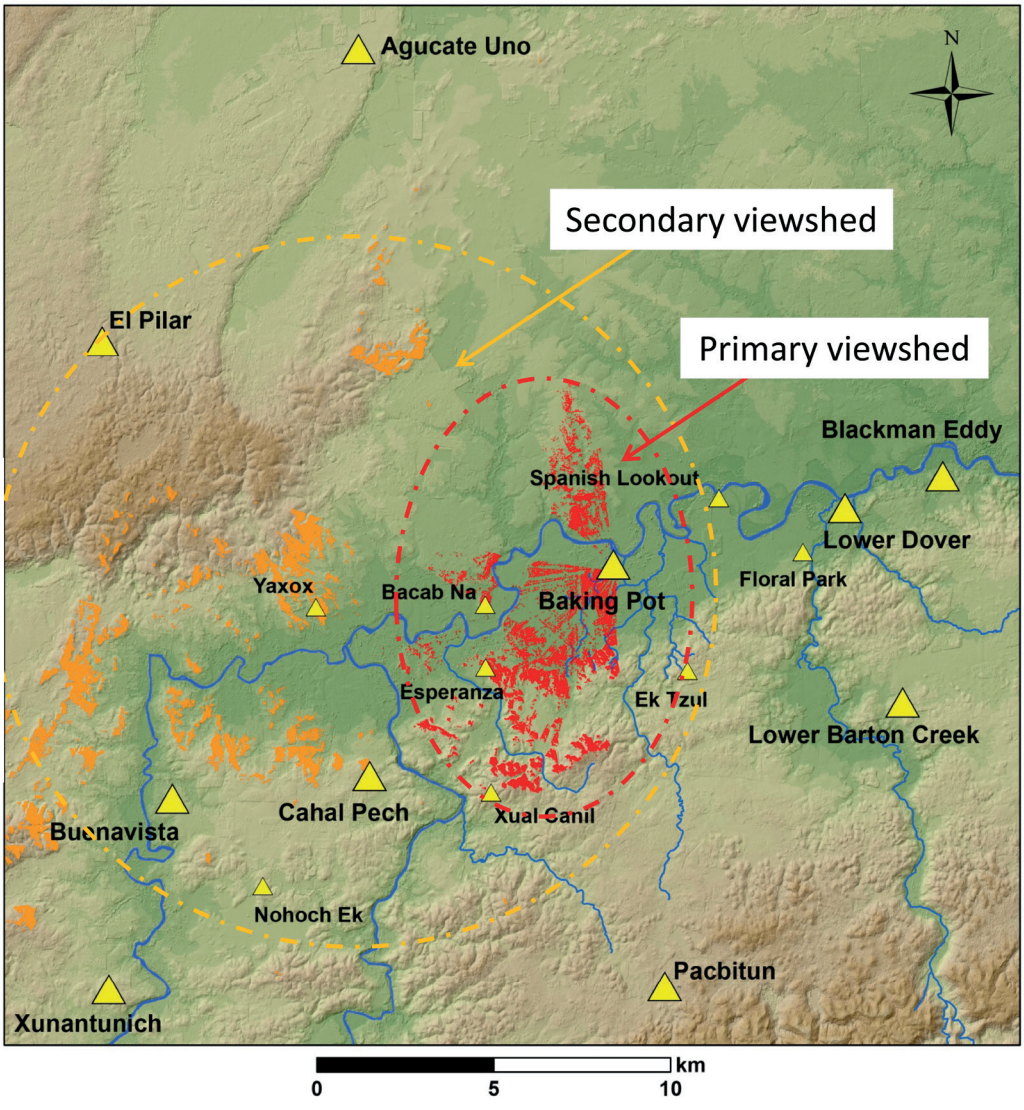

Figure 11. Distinction between primary vs. secondary viewshed, illustrating the case of Baking Pot (map by Claire Ebert and Christophe Helmke).

centres, as satellites of major centres, were deliberately established in hidden parts of a capital's viewshed in order to increase the surveillance potential and to alert of the activities of neighbouring sites, such as surprise attacks and raids (see Helmke *et al*. 2012). The strategic positioning of minor centres thereby greatly expanded the viewshed of a given major centre, by distributing vantage points throughout the polity. The pervasiveness of this settlement pattern will have to be tested against the distribution of other sites in the Maya lowlands in order to assess the relationship between major and minor centres, but this offers a promising foray into the applications of viewsheds as these relate to offensive and defensive purposes (see Doyle *et al*. 2012).

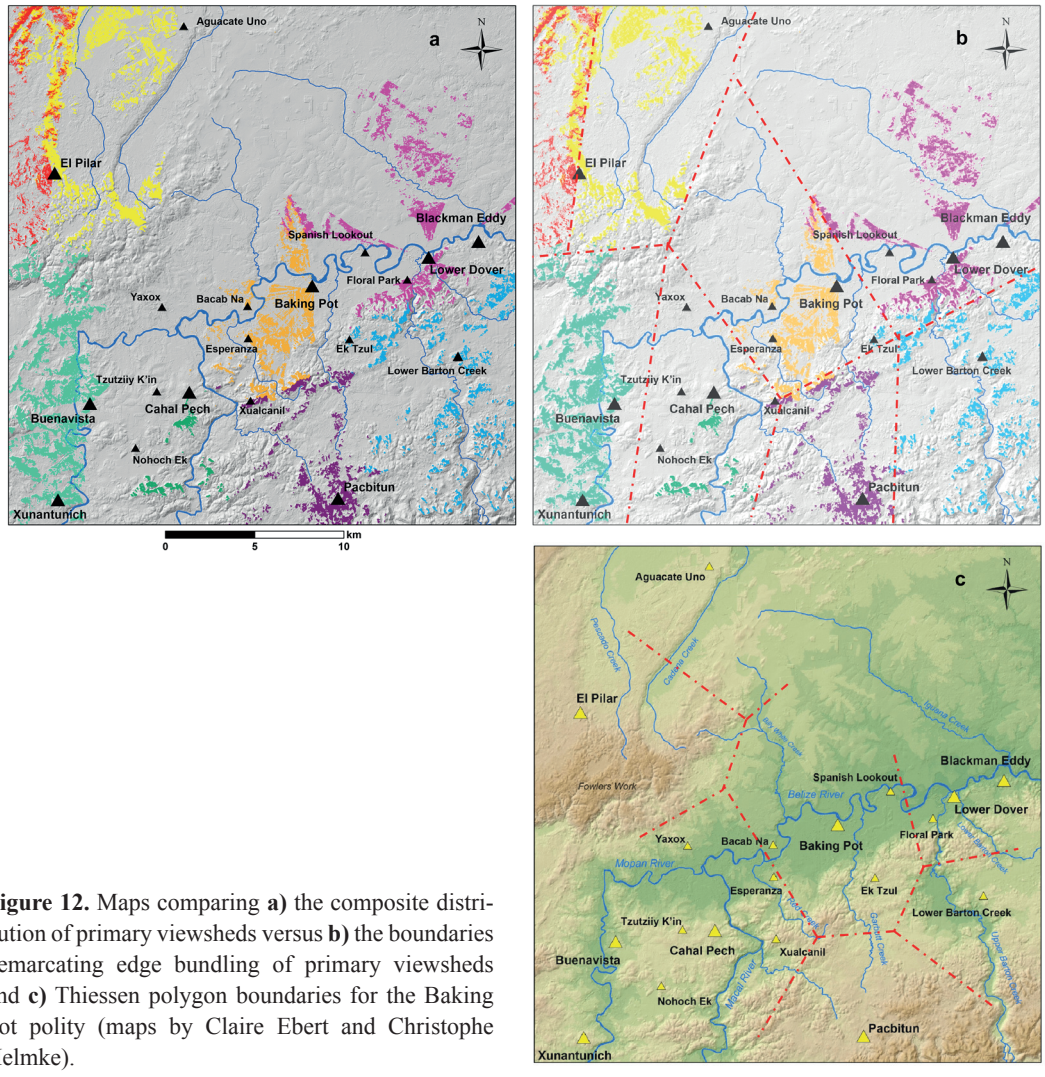

Figure 12. Maps comparing **a)** the composite distribution of primary viewsheds versus **b)** the boundaries demarcating edge bundling of primary viewsheds and **c)** Thiessen polygon boundaries for the Baking Pot polity (maps by Claire Ebert and Christophe Helmke).

Least Cost Paths

Continuing to investigate the relationships maintained between sites, all the while taking topography into account, we have conducted a series of least cost path analyses. These analyses have allowed us to gain a better understanding of probable paths of travel used by the ancient Maya inhabitants of Baking Pot, in the absence of well-defined and extensive *intersite* causeways. Whereas such causeways stand as stunning testimonies to the resources and labour that were invested into roadways in antiquity, these are conspicuously absent for most sites bordering on the Belize River. Accounting for the absence of intersite causeways at the sites under investigation is their very proximity to the Belize River and its tributaries, which undoubtedly served as major arteries of transport and trade. Another reason is that causeways tend to be constructed in areas exhibiting rugged topography, which also renders these

Table 3. Viewshed statistics for a selection of neighbouring minor and major centres that are nearest to Baking Pot, from largest to smallest, according to total area

Site Name	Total VS (km²)[a]	Primary VS (km²)[b]	VS Overlap (%)[c]
Cahal Pech	52.8	1.4	8.3
Pacbitun	28.0	6.7	9.7
Buenavista	19.3	17.5	1.1
Lower Barton Creek	17.5	7.6	3.9
Baking Pot	16.3	5.1	12.7
Aguacate	15.8	14.9	41.6
Lower Dover	11.5	5.7	8.8
El Pilar	10.8	10.3	42.7

[a] Total viewshed area derived from surface area, extending out of the boundaries of the DEM, rounded to the nearest tenth. Note that viewshed area is contingent on the topographic prominence of a particular site, not its absolute elevation.
[b] Primary viewshed area excludes the entirety of secondary viewshed area. For sites where no dichotomy was found the total and primary areas are treated as one.
[c] This category takes into consideration the overlap of a local primary viewshed with other primary viewsheds, irrespective of how many different viewsheds overlap in a given area.

constructions all the more visible archaeologically (see Chase and Chase 2001; see also Andres *et al*. 2011). And lastly, intersite causeways are constructed in very specific historical contexts, by capitals aspiring to physically and architectonically integrate satellite sites into the monumental epicentre that defines the heart of a given polity (ibid.; see also Folan 1991). Nevertheless, *intrasite* causeways are known at Baking Pot that link the monumental architecture to causeway termini and Causeway 3 has been documented extending eastwards of the site to one of the peripheral settlement clusters (Helmke and Awe 2008b: 84-85) (see Figures 4 and 6). Other sites in the valley, such as Cahal Pech and Xunantunich, also have *intrasite* causeways linking their epicentres to termini groups (Awe 2008).

In the first set of analyses we have modelled a series of least cost paths from Baking Pot to the nearest neighbouring major centre as well as to the nearest minor centres (Figure 13a). The least cost paths are equally weighted cost in terms of time and distance, on the basis of the surface raster of the DEM, accounting for both slope and aspect. Slope was determined according to a five-tiered classification of terrain accounting for the degree of inclination from 0° to over 33°,[6] whereas aspect was divided into 8 categories, corresponding to the four cardinal and internal directions. The resulting paths are those that are deemed to provide the greatest ease of travel. As part of this modelling we have focused exclusively on overland travel, although we recognise that the Belize River and many of its tributaries served as viable and certainly primary routes for much of their breadth. Another element that could have been considered are paths of travel during the dry and wet season, since these provide alternate route plots (see Doyle *et al*. 2012). The least cost paths to the four nearest major centres from Baking Pot range between 7.2 km to Lower Dover to the east and up to 17.5 km to both El Pilar and Aguacate to the northwest (Figure 13a). Two important aspects of the least cost paths analysis are worth mentioning: 1) The initial portion of the path drawn between Baking Pot and Lower

[6] The slope classification (in degrees) employed in the least cost paths is as follows: 1) 0-6°; 2) 6-15°; 3) 15-24°; 4) 24-33°; 5) > 33°.

Dover closely follows Causeway 3 that extends eastwards of Group B (see Figure 6); and 2) the path to Aguacate runs northward out of Group A, and crosses the Belize River at the juncture where the ancient harbour is suspected to have been. These features do suggest that at least some of the least cost paths can be partially substantiated by independent archaeological features. However, despite accounting for topography, the least cost paths are, in most cases, quite linear constellations, giving Baking Pot the appearance of a distinctive roadway configuration resembling the spokes of a wheel. Nevertheless, we should bear in mind that the least cost paths are just that and the actual roadways that once connected Baking Pot to its neighbours are subject to archaeological testing and ground-truthing. Furthermore, assuming some sort of continuity between ancient roadways and these least cost paths, do not, in and of themselves, amend our understanding of the possible boundaries of the Baking Pot polity, were the border to bisect the median of each path.

Considerably more interesting is the placement of minor centres in relation to the hypothetical least cost paths. In several cases the minor centres are located in close proximity to the least cost paths connecting major centres, suggesting that the smaller sites were indeed integrated into the communication and transport network of a given polity. As such, minor centres appear to have served as boundary sites, demarcating the extent of a polity and possibly helping the royal court to define and protect its territorial extent as well as to collect tribute from trade and agricultural production in the periphery (see Willey *et al*. 1965: 580; Chase and Chase 2003; Driver and Garber 2004: 292-302; Iannone 2004: 280-281; Helmke and Awe 2008: 67-68, 77-78). If the functions of these minor sites has been correctly adduced, these would be the seats of lesser members of the royal court, perhaps more distant members of the extended royal family, holding one of the lesser titles documented epigraphically, such as *sajal* or *lakam* (see Houston 1993: 128-130; Houston and Stuart 2000: 61-64, 69; Lacadena García-Gallo 2008). Of particular interest are the locations of: 1) Floral Park to the east on the path to Lower Dover; 2) Ek Tzul to the south near the path to Pacbitun – and it is possible that

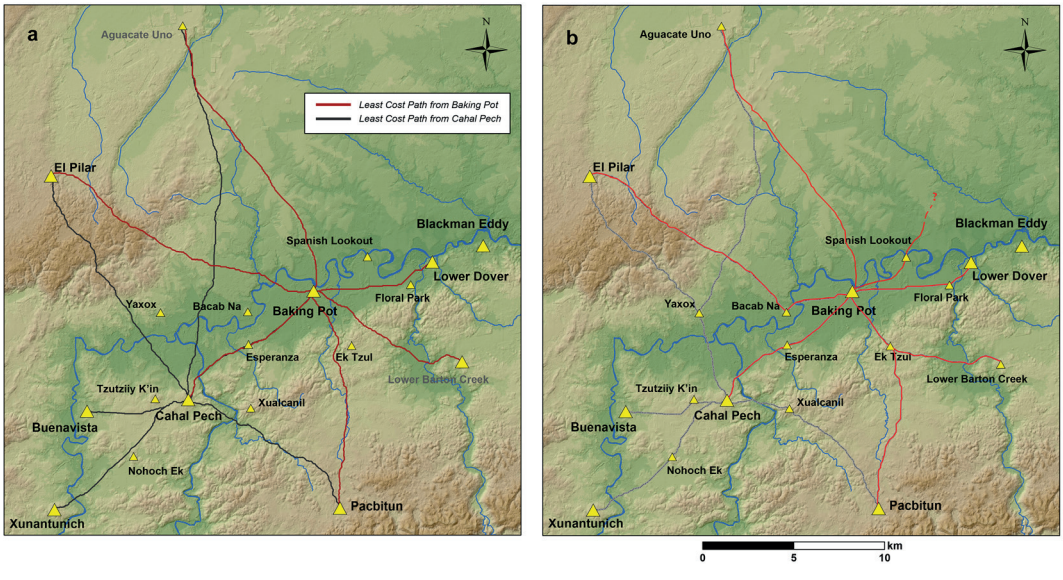

Figure 13. a) Least cost paths connecting the epicentre of Baking Pot with the nearest neighbouring major and minor centres and **b)** least cost paths to the nearest neighbours, via intervening minor centres (maps by Claire Ebert).

Ek Tzul also served as the gateway site to Lower Barton Creek (also plotted); and 3) Esperanza to the southwest on the path to Cahal Pech. At present it is unclear if the placement of Bacab Na to the west signals that the path to El Pilar was routed through that site, but this seems plausible, based on the placement of other minor centres. In much the same way the minor centre of Spanish Lookout may mark a path extending to the northeast to another as yet unidentified major centre. Similarly, and turning to Cahal Pech as the central node, it would seem as though Xualcanil was located on the path connecting to Pacbitun, in much the same way as Nohoch Ek is on the path to Xunantunich, Tzutziiy K'in on the way to Buenavista, while Yaxox may mark the path to El Pilar (Figure 13a). Computing least-cost paths from major centre to major centre has yielded one particular set of potential paths. This analysis has been compared to another, wherein indirect least-cost paths were made to intersect minor centres (Figure 13b). This comparison reveals the great degree of cohesion between the initial path plots connecting major centres and the revised ones via minor centres (Table 4). In fact, the differences in path lengths are negligible, on the order of c. 9.8% ± 3.7 (1 σ), indicating that the least cost paths in all probability duplicate the course of ancient roadways, even if only in part.

Table 4. Least cost paths for the major centres of Baking Pot and Cahal Pech, connecting to a selection of conterminous major centres in the Upper Belize River Valley, from largest to smallest according to total length. The first column presents least cost paths to largest conterminous major centres without considering the location of minor centres, whereas the second provides paths that intersect minor centres

BKP Least-Cost Path	**Major-Major centre Distance (km)**	**Via Minor centre Distance (km)**	**Difference (%)**
El Pilar	17.51	18.48	5.7
Pacbitun	13.28	13.88	7.5
Cahal Pech	9.71	9.74	10.3
Lower Dover	7.24	7.36	13.8
CHP Least-Cost Path			
El Pilar	15.88	16.25	6.3
Pacbitun	11.78	11.95	8.5
Xuanatunich	10.31	10.63	9.7
Buenavista	6.06	6.19	16.5

Walking Speeds and Cost Distribution Histograms

Without wanting to limit us to the linear paths of travel, we have sought to model potential foot traffic from each major centre, using available data on walking speeds in the Maya lowlands. More than three decades ago, Robert Drennan suggested an average speed of 36 km per diem (i.e., c. 8 hrs) for the Maya lowlands, on relatively even terrain (Drennan 1984: 105; see also Adams 1978: 27, 32). More recently, Arlen and Diane Chase have emphasised the daily marching threshold of armies that they refer to as the "60 kilometre rule" and have applied this figure to select lowland Maya centres in an attempt to model the potential reach and maximal military bearing of a given centre (Chase and Chase

1998; see also Chase *et al*. 2009: 177-178). These figures can be contrasted to the average walking speed of modern, adult individuals at c. 5 km/h, which intimately compares to the preferred walking speed of anatomically modern humans, with the same mean and a very narrow standard deviation. These more recent figures can be contrasted to known marching speeds of the Roman army for which good written sources exist. These indicate that the average speed of the Roman legionnaire during a loaded march, which is a relatively fast march, over distance while carrying a load, was 20 Roman miles (c. 30 km) bearing 20.5 kg in "five summer hours" (c. 6.35 hrs) (Watson 1969: 54-55).[7] Based on these parameters we calculate that legionnaires were expected to be able to march c. 4.7 km/h. While these statistics all give us a starting point for the Maya data, these are inadequate in that they fail to take into account any textual evidence that we have at hand for the ancient Maya. Going through the glyphic corpus, we are fortunate to find a small set of texts that record both the start and end date of a particular sojourn, as well as the start and end points of the journey. However, to be of utility it also requires us to know the geographic placement of the ancient toponyms cited in these texts. We have been able to identify three such cases, one in the texts of La Corona (Panel 1), one at Seibal (HS, Tab. 3-4) and another from Tikal (Temple IV, Lin. 2). The first, records a journey undertaken to Calakmul by K'inich Yook of La Corona, in January A.D. 664, which according to the text took 6 days (see Guenter 2005) (Table 5). The second records the ritual circuit covered by K'awiil Chan K'inich of Dos Pilas, in the days preceding the Period-Ending of 746 (9.15.15.0.0) (Houston 1993: 106, 116), as he travelled to the city-states under his control, dutifully performing the appropriate scattering rituals at each location. Here the text records that it took K'awiil Chan K'inich two days to travel between Seibal and Tamarindito, before returning home to Dos Pilas (Table 5). The last example records the surprise attack executed by soldiers of Yik'in Chan K'awiil of Tikal against Naranjo, on New Year's day in February 744. On the last day of the solar year the raiding party marched from Tikal and encamped at a locality named *Tubal*, within striking distance of Naranjo, attacking at sunrise of New Year's day (Zender 2005: 14; Helmke *et al*. 2012). These texts therefore provide us a with tangible information about three very different types of journeys, one conducted by a vassal to an audience with his overlord, the other part of a ritual circuit and the last one as part of a fast-pace surprise attack, or raid. Whereas the texts do not relate precisely how much of each day was given to travels, we have assumed that the operative walking hours amount to the number of daylight hours, or c. 11 hours at this latitude (ignoring the seasonal fluctuations of 7 to 12 minutes), based on seasonal almanac data.

Table 5. The journeys documented in the glyphic corpus with known start and end dates as well as known points of origin and destination. Dates are expressed in the Long Count calendar and operative hours correspond to 11 hours of daylight, and distances are expressed in kilometres

Journey	Start date	End Date	Operative hours	Distance (linear)	Distance (LCP)	LCP km/h
La Corona – Calakmul	9.11.11.7.12	9.11.11.7.18	66	103.0	119.7	1.3
Seibal – Tamarindito	9.15.14.17.18	9.15.15.0.0	22	18.9	29.3	1.8
Tikal – Naranjo	9.15.12.11.12	9.15.12.11.13	11	42.3	43.9	4.0

[7] The five summer hours are computed on the basis of sunrise and sunset at midsummer's eve, which in Rome rises around 5:35 and sets at 20:49 on that day. The longest summer day thus comprises 15 hrs and 14 min. Since Roman days were divided into twelve equal parts, this means that "five summer hours" correspond to c. 6 hrs and 21 min.

In order to compute usable walking distances and to apply these into our models of polity size in the Belize Valley, we have also taken into consideration the distance separating the sites named in these texts. Rather than focusing on the linear distances – that are of limited applicability in this area, with few straight lines of travel – we have computed the distances using least cost paths based on DEMs (Table 5). On this basis we have obtained three statistics for average walking speeds, computed in km/h, using the distances of the least cost paths and the operative hours multiplied by the number of days. What we can see are two main pace categories, the lower speeds relating to diplomatic and ritual sojourns and the faster one reflecting strategic military actions. These differences are not in themselves unexpected, but what is surprising is how low the civic-ceremonial travelling speeds are, averaging at only 1.6 km/h in comparison to average human walking speeds 5 km/h.[8] As such we wonder if these do not reflect the average walking speed of human portage, by means of palanquins, since we have good epigraphic and iconographic evidence that lords were carried on such litters (see Martin 1996; Stone and Zender 2011: 98-99; Andres *et al*. 2014: 59-60; Helmke *et al*. 2019: 18-26). This is not to say that porters actually carried the palanquins at such slow speeds, since ethnographic evidence on this matter from 19th century India, suggests that effective travel time per diem was restricted, or at least significantly reduced, due to the frequent stops required along the way. What is particularly revealing is that average portage speed for palanquins in India was 1.7 km/h, which is highly analogous to the figures obtained from the civic-ceremonial speeds documented in the glyphic corpus.[9] On the other hand, the military marching speed of 4 km/h is quite similar to the figure for legionnaire loaded marches, again suggesting close equivalence. On the basis of these average walking speeds we have thus been able to compute the varying travel times from Baking Pot to the nearest neighbouring major centres (Table 6).

Using these parameters as well as those employed in the least cost paths we have conducted analyses producing an output raster visualising the least-cost distances from selected centroids in relation to the source cell, providing cumulative cost surfaces in terms of distance. In these analyses we have modelled walking distances from each major centre and more distant minor centres (such as

Table 6. Average travel times from Baking Pot to nearest major centres applying average travel times documented epigraphically to least cost path distances

Baking Pot to …	LCP length in km	Palanquin speed in hrs (1.6 km/h)	Marching speed in hrs (4.0 km/h)
El Pilar	17.51	11.3	4.4
Pacbitun	13.28	8.6	3.3
Cahal Pech	9.71	6.3	2.4
Lower Dover	7.24	4.7	1.8

[8] An additional possibility to consider is that travelling was undertaken preferentially during the cool early morning hours before the onslaught of midday heat, with the remainder of the day left to other activities, thereby reducing the number of daily operative hours, a pattern that is still seen in conservative communities today, where travellers will leave their homes at dusk, in partial darkness (Nikolai Grube, pers. comm. 2015).

[9] Ethnographic data from India suggests that porters could carry a palanquin c. 10-15 miles per day, with frequent stops along the way (Arnold 2006: 19-20), which is to say 16-24 km per diem, resulting in portage speeds of c. 1,3 to 2,0 km/h. Interestingly, comparable sources indicate that simple palanquins were carried by a group of 2-6 porters, known as "palky-bearers", over short distances and with additional teams of similar sizes for longer distances (Hiney 2011), and in Bengal where this practice subsists to this day, there are 2-4 porters to a palanquin (Anonymous 2002).

Aguacate and Lower Barton Creek), resulting in a histogram presenting surfaces as concentric arcs, in hourly increments from each node (Figure 14). The histogram takes into account the topography and terrain and provides a remarkably lucid model since it allows us to confirm the affiliation of minor centres in a way that is much more conclusive than any of the previous analyses. Based on this cost path histogram we can see that Bacab Na, Ek Tzul and Spanish Lookout are all found along a neat arc, and that these are all nearly equidistant from Baking Pot's royal court in terms of walking distances ranging between 2.3 and 2.4 hours and marching speeds of just under an hour. Similarly, the sites of Yaxox, Esperanza and Xualcanil are also nearly equidistant from Cahal Pech, being located between 2.2 and 3.2 hours walk away and a little over an hour's march.

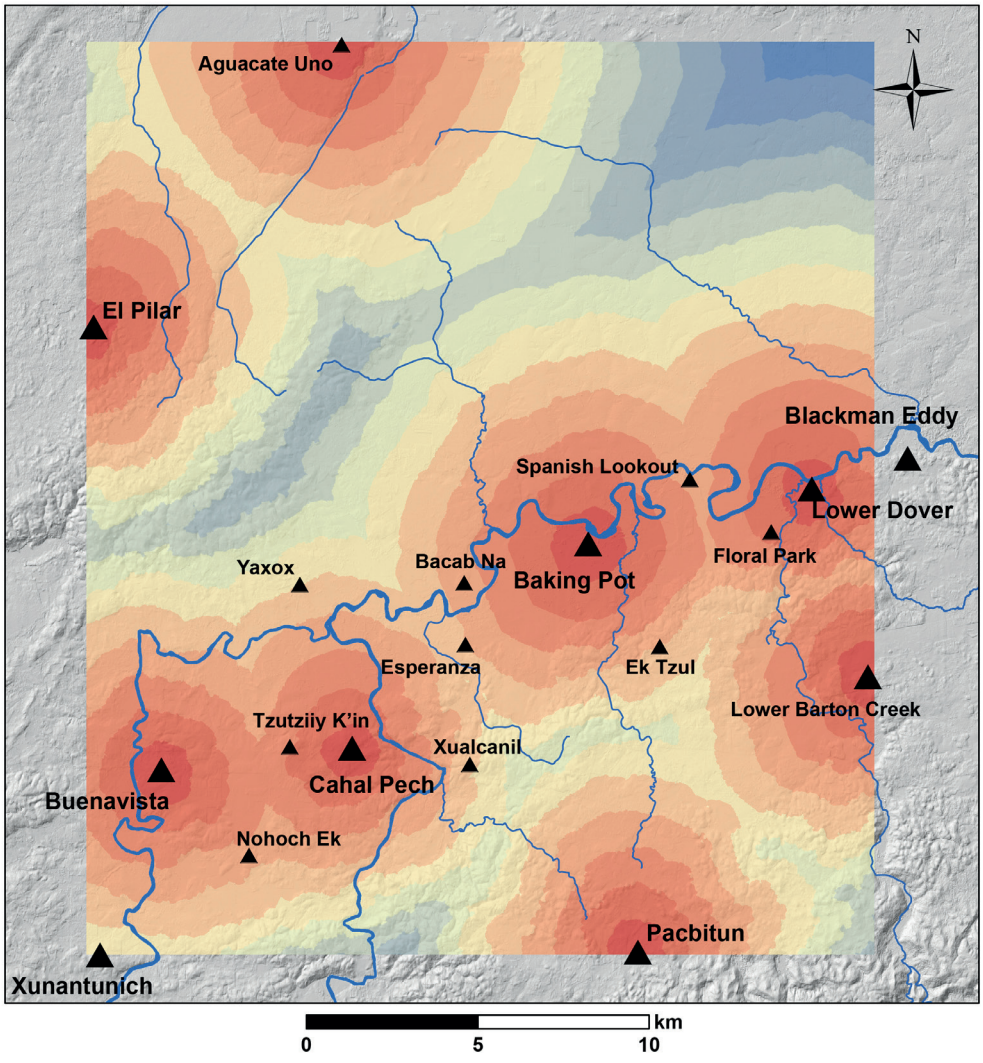

Figure 14. Cumulative cost-surface histograms, modelling walking times from central nodes as concentric arcs (map by Claire Ebert).

In addition, this model gives a good indication of where marchlands would have been located, such as the broad strip between the valley sites, and the upland sites of El Pilar and Aguacate to the northwest, as well as the broad crescent surrounding Pacbitun to the south. This model therefore not only represents several different areas, but also a variety of distinct boundaries, such as the difference between the urban core and the periphery of Baking Pot and the intervening hinterlands associated with minor centres. Areas of intensive human occupation and interaction surround major centres, whereas mostly vacant marchlands extend in between sites as wild forested areas and savannahs. In fact, focusing on the extent of the settlement distribution surrounding the epicentre of Baking Pot, and particularly the well-defined boundaries to the north, east and south, it is clear that these all occur within a 1.6-hour walk and 0.6-hour march range, as modelled in the surface cost histogram. Beyond this the settlement density diminishes dramatically and we find ostensibly unpopulated buffer areas until the minor centres are reached. As a result it would seem that in addition to the marchlands between polities, there were buffer zones between the settlements surrounding major and minor centres, areas that may have been dedicated to agricultural production. The larger inter-polity marchlands, in addition to being resource-rich areas, providing access to wild flora and hunting grounds, may also have been the setting of open battles as those recorded in the glyphic texts (see Helmke and Kettunen 2011: 42; Kettunen 2012). The perimeters surrounding the major centres also provide a heuristic model for seeking out the location of minor centres along the edges of the 1-hour marching threshold, since the majority of sites of this type are found along this margin, even in the central lowlands, where satellite sites are also located along even arcs around a capital, such as Tikal. As such, the planar geometry assumed by the Thiessen polygons that have been the impetus of much of these analyses has been partly superseded by accounting for topography and its interplay with the human corporal dimension.

SYNTHESIS AND FINAL THOUGHTS

The Baking Pot settlement survey is at an important threshold. The majority of the area encompassed by the Baking Pot settlement has been mapped through block pedestrian survey and by the recent application of LiDAR remote sensing technology. Despite this promising situation, the LiDAR survey does not extend appreciably to the north of the Belize River. In part this is due to the fact that this waterway in practice serves as the northern boundary of the remote sensing survey, since the area has been extensively disturbed by ploughing and modern development. Thus, whereas the urban fabric of Baking Pot to the south of the Belize River is surprisingly well-preserved, adequately documented and covered by the LiDAR survey, the northern extent of Baking Pot's peripheral settlement, by contrast, remains poorly known and only partially documented (Hoggarth *et al*. in prep.). By comparing LiDAR data in previously surveyed areas with as yet unsurveyed areas to the west of Baking Pot, leading up to the site of Bacab Na, potential mounds have been interpolated, which will be subject to ground-truthing in upcoming field seasons (see Awe *et al*. 2015; Ebert *et al*. in press) (see Figure 2b). Based on this advantageous situation we can assess the accuracy of earlier surveys and also plan more efficient, targeted, and cost-effective survey programs, by establishing parameters that account for the verification of features identified in the LiDAR survey. As such, defining the boundary of the greater urban fabric of Baking Pot as a low-density urban node is within our reach (see Awe *et al*. 2014). This is especially true to the south of the Belize River and is one of the few instances wherein an ancient Maya settlement will be mapped in its entirety. As a result we have been able to define an urban conglomeration with clearly defined boundaries that is Baking Pot proper, surrounded by a thinly populated hinterland. Within these hinterlands are a series of minor centres with their own settlement clusters that are located in proximity to the ancient boundaries of the polity.

At the larger scale, defining the boundaries of the polity remains problematic, partly due to the differential coverage of topographic data generated by remote sensing. To the south of the Belize River, the LiDAR data have revealed the existence of two additional minor centres that were completely unknown to archaeologists before 2013 (Awe *et al*. 2015; Hoggarth *et al*. in prep.). It has been rewarding to see these sites materialise, especially since Lower Barton Creek, occurs at a location where we suspected the existence of a major centre (Helmke and Awe 2012: 72). Nevertheless, the existence of these sites, at precisely these locations, helps to define the territorial organisation of sites in the Belize Valley, and with it the boundaries of the Baking Pot polity. The boundaries to the east, south and west of the Baking Pot polity have been estimated on the basis of the spatial relations between Baking Pot and nearest neighbouring major centres and intervening minor centres. At times, the boundaries clearly align to natural physiographic features, such as the limestone hills to the south and northwest, as well as creeks that are paired off with minor centres, to the east and west. To the north, the boundaries are more difficult to establish, particularly since the archaeological sites that are presumed to exist in the area remain undocumented. This is especially the case with regard to the northeast and also partially to the northwest, although the relatively recent discovery of Aguacate helps to refine the picture. Much like Lower Barton Creek, the location of Aguacate agrees with that projected for a neighbouring site, although its size remains to be properly established (Awe and Helmke 2012: 72). The large Mennonite settlement of Spanish Lookout and associated modern agricultural infrastructure, which extends to the north of Baking Pot, has affected the archaeological sites in this area. While it is possible that the remains of minor centres, once under the control of Baking Pot, exist in and around Spanish Lookout, it is equally plausible that these have now disappeared on the whole.

In spite of these challenges we have been able to estimate the extent of the Baking Pot polity, through a series of geospatial analyses including viewsheds, least cost paths, cost distribution histograms and epigraphically attested walking speeds. Although the perimeter and disposition of borders varies between the different analyses, the results of our study are remarkably coherent and suggest that the Baking Pot polity was relatively small and covered anywhere between 110 and 118 km^2. The great congruity of these surface areas, despite the variations in the methods and their output, suggests that a relatively high degree of accuracy can be attained by applying these geospatial analyses to the study of ancient settlements. This is not to say that the territorial reconstructions are uniform, or even symmetrical, since the Baking Pot polity appears to extend within territorial arcs with radiuses ranging between 3.6 and 8.2 km. And yet, despite the implementation of a variety of analyses, the basic configuration remains somewhat reminiscent of that produced by Thiessen Polygons (Helmke and Awe 2008, 2012), with probable boundaries emerging along the interstice of the polygons. The similarity between the results of our spatial analyses can be attributed to the emphasis that has been placed in all of these models on the centre and centroid, which inherently affects the range of the boundaries. Whereas this is an acknowledged problem and one exacerbated in riverine contexts, such as the Belize Valley, where the river, as a major artery of transport and communication that bisects most of the adjoining realms, the modelling accounts for the topography, but not potential distortions and warps brought about by the river. In addition, without focusing on the centroid, how can we properly define the outlines, from the outside in? Addressing these issues will require a methodological advance, especially since ancient roadways continue to remain undocumented for most parts of the Maya lowlands. Roadways, could inform us as to the location of termini groups and farthest connection points from major centres, and thereby provide us with a clearer blueprint of borders (see Bevan and Wilson 2013).

Considering the Mesoamerican cartographic tradition, especially that which is attested in the codical sources of the early colonial period, we can see that most Native American maps or cartograms, represent the capital of a city-state in the geometric centre and define boundaries as a string of toponyms, especially of borderland settlements (see Mundy 1998; Solari 2010; Helmke *et al*. 2017b).

Defining boundaries of a given territory, maintaining them and reaffirming them in times of dispute was actualised by means of a large ritual circuit, undertaken by the head of a polity, along with a requisite number of witnesses, priests and courtiers, drawn from the local court as well as neighbouring city-states and from more distant lands, serving as arbitrators, as well as imbuing solemnity and authority to such procedural circumambulations (Mundy 1998: 205-206, 219; Solari 2010: 156-158; Helmke *et al*. 2017b). Defining boundaries at the location of peripheral settlements is, therefore, a sound approach that is firmly rooted in emic conceptions of borders. As such, converse borders running through adjoining minor centres, such as those to the east and west of Baking Pot, reflect a Pre-Columbian reality, where borders are defined by paired sets of minor centres.

Thinking of how borders may have been conceived in emic terms, we can examine lexical entries that are found in lowland Maya languages for 'border, frontier'. In Yukatek Maya, for example, the term for 'frontera' is *táan*[10] (Barrera Vásquez 1980: 769), which has a broader semantic domain, meaning 'front' / 'in front of' as well as 'middle' / 'in the middle', all probably ultimately stemming from the lexeme for 'chest, breast', based on the Mesoamerican practice of deriving locatives and spatial terms from lexemes for human body parts (Campbell *et al*. 1986: 549). Relatedly we find the spatial expression *táankab*, lit. 'front-earth', which is glossed as 'afuera, outside' (Bastarrachea *et al*. 1992: 9). The lexeme *táan* for 'border' is highly interesting since it implies that borderlands were conceived of as being 'in the middle', which is precisely what we have observed in the case of Baking Pot. We are therefore encouraged by the identification of unpopulated borderlands and marchlands surrounding Baking Pot, where the settlement continuum rapidly dissipates at the margins. As tangible and material markers for the extent of an ancient settlement these borderlands provide us with important avenues to continue future research in the Belize Valley, especially concerning the territorial organisation of ancient city-states.

While much work remains, our analyses constitute a starting point for understanding the territorial organisation in this part of the Belize Valley, and have valuable implications for understanding ancient settlement patterns throughout the Maya lowlands.

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[10] An alternate construction is *xuul* as seen in *xuul u lu'umil junp'éel kaaj*, or 'the edge of the land of a settlement' (Bastarrachea *et al*. 1992: 36, 132), although this appears to be a neologism since it is not readily found in the colonial dictionaries of Yukatek.

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REFERENCES

ABBINK, JON

1993 Ethnic Conflict in the 'Tribal Zone': The Dizi and Suri in Southern Ethiopia. *Journal of Modern African Studies* 31: 675-682.

1998 Ritual and political forms of violent practice among the Suri of southern Ethiopia. *Cahiers d'études africaines* 38 (150/152): 271-295.

ADAMS, R.E.W.

1978 Routes of Communication in Mesoamerica: The Northern Guatemalan Highlands and the Peten. *Mesoamerican Communication Routes and Cultural Contacts*, edited by Thomas A. Lee Jr. and Carlos Navarette, pp. 27-35. Papers of the New World Archaeological Foundation 40. Provo: Brigham Young University.

AIMERS, JAMES J.

1997 Preliminary Investigations of Architecture in Plaza 2 of Group I at Baking Pot. *Belize Valley Archaeological Reconnaissance Project: Progress Report of the 1996 Field Season*, edited by Jaime J. Awe and James M. Conlon, pp. 21-45. Peterborough: Department of Anthropology, Trent University.

2002 Cultural Change on a Temporal and Spatial Frontier: Ceramics of the Terminal Classic to Postclassic Transition in the Upper Belize River Valley. Ph.D. dissertation. New Orleans: Department of Anthropology, Tulane University.

ALEXANDER, SARA E., JULIE A. HOGGARTH AND JOSEPH D. WHITE

2015 Climate Change, Socioecological Conditions, and Human Responses in Belize: Predicting the Future Based on the Past. Grant proposal submitted to the National Science Foundation, Arlington.

ANAYA HERNANDEZ, ARMANDO, STANLEY P. GUENTER AND MARC U. ZENDER

2003 Sak Tz'i', a Classic Maya Center: A Locational Model Based on GIS and Epigraphy. *Latin American Antiquity* 14 (2): 179-191.

ANDRES, CHRISTOPHER R., CHRISTOPHE HELMKE, SHAWN G. MORTON, GABRIEL D. WROBEL AND JASON J. GONZÁLEZ

2014 Contextualizing the Glyphic Texts of Tipan Chen Uitz, Cayo District, Belize. *Latin American Antiquity* 25 (1): 46-64.

ANDRES, CHRISTOPHER R., SHAWN G. MORTON, JASON J. GONZÁLEZ AND GABRIEL D. WROBEL

2011 Causeways and Sociopolitical Integration in the Caves Branch Region. *The Caves Branch Archaeological Survey Project: A Report of the 2010 Field Season*, edited by Christopher R. Andres and Gabriel D. Wrobel, pp. 127-147. Oxford: Belize Archaeological Research and Education Foundation.

ANONYMOUS

2002 Where Palanquin is Still in Use to Display One's 'Class'. *Travel Times*: http://www.indiatraveltimes.com/special/oct.html

2015 "Shiny" Maya City Was Laid Out on a Grid. *Archaeology*: http://www.archaeology.org/news/3259-150504-maya-grid-city

ARNOLD, DAVID

2006 *The Tropics and the Travelling Gaze: India, Landscapes, and Science, 1800-1856*. Seattle: University of Washington Press.

ASHMORE, WENDY

1981 Some Issues of Method and Theory in Lowland Maya Settlement Archaeology. *Lowland Maya Settlement Patterns*, edited by Wendy Ashmore, pp. 37-70. Albuquerque: University of New Mexico Press.

AUDET, CAROLYN M.

2000 *Excavations at the Yaxtun Group, Baking Pot, Belize*. Honors thesis. Princeton: Department of Anthropology, Princeton University.

2002 Excavations of Structure 198, Baking Pot, Belize. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2001 Field Season – Volume 1*, edited by Jaime J. Awe and Cameron S. Griffith, pp. 91-109. Belmopan: Belize Department of Archaeology, Ministry of Tourism.

2005 Excavations of Structures B and G, Plaza 2, Group 2, Baking Pot. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2004 Field Season*, edited by Christophe G.B. Helmke and Jaime J. Awe, pp. 1-12. Belmopan: Institute of Archaeology, National Institute of Culture and History.

2007 Political Organization in the Belize Valley: Excavations at Baking Pot, Cahal Pech and Xunantunich. Ph.D. dissertation. Vanderbilt University: Department of Anthropology.

AUDET, CAROLYN M. AND JAIME J. AWE

2000 Preliminary Investigations at the Yaxtun Group, Baking Pot. *The Western Belize Regional Cave Project: A Report of the 1999 Field Season*, edited by Cameron S. Griffith, Reiko Ishihara and Jaime J. Awe, pp. 1-14. Department of Anthropology, Occasional Paper No. 3. Durham: University of New Hampshire.

2003 Excavations of Structure E of Group 1, Baking Pot, Belize. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2002 Field Season*, edited by Jaime J. Awe and Carolyn M. Audet, pp. 31-51. Belmopan: Institute of Archaeology, National Institute of Culture and History.

2005 The Political Organization of the Belize Valley: Evidence from Baking Pot, Belize. *Research Reports in Belizean Archaeology* 2: 357-364.

AWE, JAIME J.

1992 Dawn in the Land between the Rivers: Formative Occupation at Cahal Pech, Belize and its Implication for Preclassic Developments in the Maya Lowlands. Ph.D. thesis. London: Institute of Archaeology, University of London.

2008 Architectural Manifestations of Power and Prestige: Examples from Classic Period Monumental Architecture at Cahal Pech, Xunantunich and Caracol, Belize. *Research Reports in Belizean Archaeology* 5: 159-174.

AWE, JAIME J., CLAIRE E. EBERT AND JULIE A. HOGGARTH

2015 Three K'atuns of Pioneering Settlement Research: Preliminary Results of Lidar Survey in the Belize River Valley. *Breaking Barriers: Proceedings of the 47th Annual Chacmool Conference*, pp. 57-75. Calgary: University of Calgary.

AWE, JAIME J., JULIE A. HOGGARTH AND CHRISTOPHE HELMKE

2014 Prehistoric Settlement Patterns in the Upper Belize River Valley and their Implications for Models of Low-Density Urbanism. *A Celebration of the Life and Work of Pierre Robert Colas*, edited by Christophe Helmke and Frauke Sachse, pp. 263-285. Acta Mesoamericana, Vol. 27. Munich: Verlag Anton Saurwein.

BALL, JOSEPH W. AND JENNIFER T. TASCHEK

2004 Buenavista del Cayo: A Short Outline of Occupational and Cultural History at an Upper Belize Valley Regal-Ritual Center. *The Ancient Maya of the Belize Valley: Half a Century of Archaeological Research*, edited by James F. Garber, pp. 149-167. Gainesville: University Press of Florida.

BARRERA VÁSQUEZ, ALFREDO

1980 *Diccionario Maya Cordemex: Maya – Español, Español – Maya*. Merida: Ediciones Cordemex.

BASTARRACHEA, JUAN R., ERMILIO YAH PECH AND FIDENCIO BRICEÑO CHEL

1992 *Diccionario Básico: Español / Maya / Español*. Merida: Maldonado Editores.

BEVAN, ANDREW

2010 Political Geography and Palatial Crete. *Journal of Mediterranean Archaeology* 23 (1): 27-54.

BEVAN, ANDREW, EVA JOBBOVÁ, CHRISTOPHE HELMKE AND JAIME J. AWE

2013 Directional layouts in central lowland Maya settlement. *Journal of Archaeological Science* 40: 2373-2383.

BEVAN, ANDREW AND ALAN WILSON

2013 Models of settlement hierarchy based on partial evidence. *Journal of Archaeological Science* 40: 2415-2427.

BROWN, M. KATHRYN

2009 The Preclassic in the Mopan River Valley: Preliminary Investigations at Nohoch Ek and Xunantunich. *Research Reports in Belizean Archaeology* 6: 63-72.

BULLARD, WILLIAM R., JR. AND MARY RICKETSON-BULLARD

1965 *Late Classic Finds at Baking Pot, British Honduras*. Art and Archaeology Occasional Paper, No. 8. Toronto: Royal Ontario Museum.

CAMPBELL, LYLE, TERRENCE KAUFMAN AND THOMAS C. SMITH-STARK

1986 Meso-America as a Linguistic Area. *Language* 62 (3): 530-570.

CHANDLER, CULLEN J.

2002 Between Court and Counts: Carolingian Catalonia and the *aprisio* grant, 778-987. *Early Medieval Europe* 11: 19-44.

CHASE, ARLEN F. AND DIANE Z. CHASE

1998 Late Classic Maya Political Structure, Polity Size, and Warfare Arenas. *Anatomía de una civilización: Aproximaciones interdisciplinarias a la cultura maya*, edited by Andrés Ciudad Ruiz, Yolanda Fernández Marquínez, José M. García Campillo, A. Josefa Iglesia Ponce de León, Alfonso L. García-Gallo, and Luís T. Sanz Castro, pp. 11-29. Madrid: Sociedad Espanola de Estudios Mayas.

2001 Ancient Maya Causeways and Site Organisation at Caracol, Belize. *Ancient Mesoamerica* 12 (2): 273-281.

2003 Minor Centers, Complexity, and Scale in Lowland Maya Settlement Archaeology. *Perspectives on Ancient Maya Rural Complexity*, edited by Gyles Iannone and Samuel V. Connell, pp. 108-118. Los Angeles: Cotsen Institute of Archaeology, University of California.

CHASE, ARLEN F., DIANE Z. CHASE AND MICHAEL E. SMITH

2009 States and Empires in Ancient Mesoamerica. *Ancient Mesoamerica* 20: 175-182.

CHASE, ARLEN F., DIANE Z. CHASE AND JOHN F. WEISHAMPEL

2013 The Use of LiDAR at the Maya Site of Caracol, Belize. *A Primer on Space Archaeology: In Observance of the 40th Anniversary of the World Heritage Convention*, edited by D.C. Comer, pp. 179-189. Springer Briefs in Archaeology 5. New York: Springer.

CHASE, ARLEN F., DIANE Z. CHASE, JAIME J. AWE, JOHN F. WEISHAMPEL, GYLES IANNONE, HOLLEY MOYES, JASON YAEGER AND M. KATHRYN BROWN

2014a The Use of LiDAR in Understanding Ancient Maya Landscape: Caracol and Western Belize. *Advances in Archaeological Practice* 2 (3): 208-221.

CHASE, ARLEN F., DIANE Z. CHASE, JAIME J. AWE, JOHN F. WEISHAMPEL, GYLES IANNONE, HOLLEY MOYES, JASON YAEGER, KATHRYN BROWN, RAMESH L. SHRESTHA, WILLIAM E. CARTER AND JUAN FERNANDEZ DIAZ

2014b Ancient Maya Regional Settlement and Inter-Site Analysis: The 2013 West-Central LiDAR Survey. *Remote Sensing* 6: 8671-8695.

CHEETHAM, DAVID T.

1995 Excavations on the Main Causeway at Baking Pot: A Brief Note. *Belize Valley Archaeological Reconnaissance Project: Progress Report of the 1994 Field Season, Volume 2*, edited by James M. Conlon and Jaime J. Awe, pp. 33-40. London: Institute of Archaeology, University College London.

COE, WILLIAM R.

1966 Review of *Prehistoric Maya Settlements in the Belize Valley* by Gordon R. Willey, William R. Bullard, Jr., John B. Glass, James C. Gifford. *American Journal of Archaeology* 70 (3): 309-311.

CONLON, JAMES M.

1993 Corporate Group Structure at the Bedran Group, Baking Pot, Belize: Preliminary Comments on Excavation Results from the 1992 Season of Investigations. *Belize Valley Archaeological Reconnaissance Project: Progress Report of the 1992 Field Season*, edited by Jaime J. Awe, pp. 178-211. Peterborough: Department of Anthropology, Trent University.

1995 The Final Frontier: Settlement Survey at the Ancient Maya Site of Baking Pot. *Belize Valley Archaeological Reconnaissance Project: Progress Report of the 1994 Field Season, Volume 2*, edited by James M. Conlon and Jaime J. Awe, pp. 81-102. London: Institute of Archaeology, University College London.

1996 Investigations at the Lost Ballcourt of Group I, Baking Pot, Belize. *Belize Valley Archaeological Reconnaissance Project: Progress Report of the 1995 Field Season*, edited by James M. Conlon, pp. 39-53. London: Institute of Archaeology, University College London.

CONLON, JAMES M. AND JAIME J. AWE

1995 Estimates of Population and Agrarian Potential for the Ditched Field Irrigation System at Baking Pot, Belize. *Belize Valley Archaeological Reconnaissance Project: Progress Report of the 1994 Field Season, Volume 2*, edited by James M. Conlon and Jaime J. Awe, pp. 63-80. London: Institute of Archaeology, University College London.

CONLON, JAMES M. AND JENNIFER J. EHRET

2000 Ancient Maya Settlement at Baking Pot, Belize: Results of the Continually Expanding Survey Program in the Search for the End of the Final Frontier. *The Western Belize Regional Cave Project: A Report of the 1999 Field Season*, edited by Cameron S. Griffith, Reiko Ishihara and Jaime J. Awe, pp. 43-54. Department of Anthropology, Occasional Paper No. 3. Durham: University of New Hampshire.

2001 Ancient Maya Settlement at Baking Pot, Belize: Final Results of the North Caracol Farm Survey Program. *The Western Belize Regional Cave Project: A Report of the 2000 Field Season*, edited by Reiko Ishihara, Cameron S. Griffith and Jaime J. Awe, pp. 301-308. Department of Anthropology, Occasional Paper No. 4. Durham: University of New Hampshire.

CONLON, JAMES M., KERRI K. FINLAYSON AND TERRY G. POWIS

1995 Archaeological Investigation of an Architectural Communicative Template of the Ancient Maya. *Belize Valley Archaeological Reconnaissance Project: Progress Report of the 1994 Field Season, Volume 2*, edited by James M. Conlon and Jaime J. Awe, pp. 41-62. London: Institute of Archaeology, University College London.

CONLON, JAMES M. AND ALLAN F. MOORE

2003 Identifying Urban and Rural Settlement Components: An Examination of Classic Period Plazuela Group Function at the Ancient Maya Site of Baking Pot, Belize. *Perspectives on Ancient Maya Rural Complexity*, edited by Gyles Iannone and Samuel V. Connell, pp. 59-70. Monograph 49. Los Angeles: Cotsen Institute of Archaeology, University of California.

CONLON, JAMES M. AND TERRY G. POWIS

2004 Major Center Identifiers at a Plazuela Group near the Ancient Maya Site of Baking Pot. *The Ancient Maya of the Belize Valley: Half a Century of Archaeological Research*, edited by James F. Garber, pp. 70-85. Gainesville: University Press of Florida.

CONOLLY, JAMES AND MARK LAKE

2006 *Geographical Information Systems in Archaeology*. Cambridge: Cambridge University Press.

CORNEC, JEAN H.

2003 *Geology Map of Belize with Bathymetry, 1:750,000*. Belmopan: Geology and Petroleum Department, Ministry of Energy, Science and Technology and Public Utilities, Government of Belize.

CORTES RINCON, MARISOL

2007 A Comparative Study of Fortification Developments Throughout the Maya Region and Implications of Warfare. Ph.D. dissertation. Austin: University of Texas.

DONALD, JAMES

1872 *Chambers's Etymological Dictionary of the English Language*. London and Edinburgh: W. and R. Chambers.

DOYLE, JAMES A., THOMAS G. GARRISON AND STEPHEN D. HOUSTON

2012 Watchful realms: Integrating GIS analysis and political history in the southern Maya lowlands. *Antiquity* 86: 792-807.

DRENNAN, ROBERT D.

1984 Long-Distance Transport Costs in Pre-Hispanic Mesoamerica. *American Anthropologist* 86(1): 105-112.

DRIVER, W. DAVID AND JAMES F. GARBER

2004 The Emergence of Minor Centers in the Zones between Seats of Power. *The Ancient Maya of the Belize Valley: Half a Century of Archaeological Research*, edited by James F. Garber, pp. 287-304. Gainesville: University Press of Florida.

EBERT, CLAIRE E.

2015 Airborne Lidar Mapping and Settlement Survey at Cahal Pech, Belize. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2014 Field Season*, edited by Julie A. Hoggarth and Jaime J. Awe, pp. 138-165. Belmopan: Institute of Archaeology.

EBERT, CLAIRE E. AND JAIME J. AWE

2014 Integrating Airborne Lidar and Settlement Survey at Cahal Pech, Belize. Paper presented at the *5th Annual South-Central Conference on Mesoamerica*. New Orleans: Tulane University.

EBERT, CLAIRE E., JULIE A. HOGGARTH AND JAIME J. AWE

2015 Prehistoric Water Management in the Belize River Valley: Lidar Mapping and Survey of the Ditched Field System at Baking Pot, Belize. Paper presented at the *13th Annual Meeting of the Belize Archaeology and Anthropology Symposium*. San Ignacio: San Ignacio Hotel.

in press Integrating Quantitative Lidar Analysis and Settlement Survey in the Belize River Valley. 'Problems and Issues in the Mesoamerican Geospatial Revolution' Special Issue of *Advances in Archaeological Research*.

EBERT, DAVID

2004 Applications of Archaeological GIS. *Canadian Journal of Archaeology* 28: 319-341.

EVANS, D.H., R.J. FLETCHER, C. POTTIER, J.-B. CHEVANCEC, D. SOUTIF, B.S. TAN, S. IM, D. EA, T. TIN, S. KIM, C. CROMARTY, S. DE GREEF, K. HANUS, P. BÂTY, R. KUSZINGER, I. SHIMODA AND G. BOORNAZIAN

2013 Uncovering archaeological landscapes at Angkor using lidar. *Proceedings of the National Academy of Sciences* 110: 12595-12600.

FERGUSON, JOSALYN

1998 A Marker in Time: The North Ball Court at the Maya Civic Centre of Baking Pot. *The Belize Valley Archaeological Reconnaissance Project: Progress Report of the 1997 Field Season*, edited by James M. Conlon and Jaime J. Awe, pp. 17-34. London: Institute of Archaeology, University College London.

1999 The Ballgame at Baking Pot, Belize: An Analysis of the Ballcourts at a Maya Civic Centre. Master's thesis. Peterborough: Department of Anthropology, Trent University.

FOLAN, WILLIAM J.

1991 Sacbes of the Northern Maya. A*ncient Road Networks and Settlement Hierarchies in the New World*, edited by Charles D. Trombold, pp. 222-229. Cambridge: Cambridge University Press.

GARBER, JAMES, M. KATHRYN BROWN, JAIME J. AWE AND CHRISTOPHER J. HARTMAN

2004 The Terminal Early Formative Kanocha Phase (1100-900 B.C.) at Blackman Eddy. *Research Reports in Belizean Archaeology* 1: 13-25.

GOLDEN, CHARLES W. AND JAMES M. CONLON

1996 Archaeology in the Plow Zone: Results of the Salvage Operations at the North Caracol Farm Settlement Cluster, Cayo, Belize. *Belize Valley Archaeological Reconnaissance Project: Progress Report of the 1995 Field Season*, edited by James M. Conlon, pp. 19-38. London: Institute of Archaeology, University College London

GOLDEN, CHARLES W. AND ANDREW SCHERER

2006 Border Problems: Recent Archaeological Research along the Usumacinta River. *The PARI Journal* 7 (2): 1-16.

GUENTER, STANLEY P.

2005 La Corona Find Sheds Light on Site Q Mystery. *Mesoweb Reports and News*: http://www.mesoweb.com/reports/SiteQ.html

HEALY, PAUL F., CHRISTOPHE G.B. HELMKE, JAIME J. AWE AND KAY S. SUNAHARA

2007 Survey, Settlement, and Population History at the Ancient Maya Site of Pacbitun, Belize. *Journal of Field Archaeology* 32 (1): 17-39.

HARE, T., M. MASSONG AND B. RUSSELL.

2014 High-Density LiDAR Mapping of the Ancient City of Mayapán. *Remote Sensing* 6: 9064-9085.

HELMKE, CHRISTOPHE G.B.

2008 Excavations of Structures B1 and B7 at Baking Pot, Belize. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2007 Field Season*, edited by Christophe Helmke and Jaime J. Awe, pp. 109-143. Belmopan: Institute of Archaeology, National Institute of Culture and History.

HELMKE, CHRISTOPHE AND JAIME AWE

2008a Organización territorial de los antiguos mayas de Belice Central: confluencia de datos arqueológicos y epigráficos. *Mayab* 20: 65-91.

2008b New Site Description and Structure Designations of Baking Pot, Belize. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2007 Field Season*, edited by Christophe Helmke and Jaime J. Awe, pp. 81-102. Belmopan: Institute of Archaeology, National Institute of Culture and History.

2012 Ancient Maya Territorial Organisation of Central Belize: Confluence of Archaeological and Epigraphic Data. *Contributions in New World Archaeology* 4: 59-90.

HELMKE, CHRISTOPHE, JAIME AWE AND NIKOLAI GRUBE

2010 The Carved Monuments and Inscriptions of Xunantunich. *Classic Maya Provincial Politics: Xunantunich and Its Hinterlands*, edited by Lisa J. LeCount and Jason Yaeger, pp. 97-121. Tucson: University of Arizona Press.

HELMKE, CHRISTOPHE, ANDREW BEVAN AND JAIME AWE

2004 Roaring Creek: Life along an Ancient Maya Valley. *Current World Archaeology* 4: 10-16.

HELMKE, CHRISTOPHE, GAIL HAMMOND, THOMAS GUDERJAN, PIETA GREAVES and COLLEEN HANRATTY

2019 Sighting a Royal Vehicle: Observations on the Graffiti of Tulix Mul, Belize. *The PARI Journal* 19(4): 10-30.

HELMKE, CHRISTOPHE, CHRISTOPHE, JULIE A. HOGGARTH, JAIME J. AWE, SARAH E. BEDNAR, AMBER LÓPEZ-JOHNSON, SYDNEY LONAKER AND J. BRITT DAVIS

2017a Some Initial Comments on the Komkom Vase Discovered at Baking Pot, Belize. *Research Reports in Belizean Archaeology* 14: 227-240.

HELMKE, CHRISTOPHE AND HARRI KETTUNEN

2011 *Where Atole Abounds: Naranjo during the Reign of K'ahk' Tiliw Chan Chahk*. 1st Cracow Maya Conference. Cracow: Jagiellonian University.

HELMKE, CHRISTOPHE, SHAWN G. MORTON AND MEAGHAN PEURAMAKI-BROWN

2012 Raiding among the Classic Maya? *45th Annual Chacmool Conference: War and Peace – Conflict and Resolution in Archaeology*, University of Calgary, Calgary, Nov. 10th.

HELMKE, CHRISTOPHE, JESPER NIELSEN AND ÁNGEL IVÁN RIVERA GUZMÁN
2017b Tras las huellas de la tradición cartográfica en el altiplano central de México. *Estudios de Cultura Náhuatl* 54: 79-133.
HINEY, TOM
2011 *On the Missionary Trail*. New York: Random House.
HOGGARTH, JULIE A.
2005 Test Excavations of Patio H, Group 1, Baking Pot, Belize. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2004 Field Season*, edited by Christophe G.B. Helmke and Jaime J. Awe, pp. 21-22. Belmopan: Institute of Archaeology, National Institute of Culture and History.
2008 Settlement Excavations at Baking Pot, Belize: Results of the 2007 Season. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2007 Field Season*, edited by Christophe G.B. Helmke and Jaime J. Awe, pp. 189-204. Belmopan: Institute of Archaeology, National Institute of Culture and History.
2009 Settlement and Community Organization in the Classic to Postclassic Transition: Research Methodology and Aims of the 2007 to 2010 Settlement Research at Baking Pot, Belize. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2008 Field Season*, edited by Julie A. Hoggarth and Jaime J. Awe, pp. 1-25. Belmopan: Institute of Archaeology, Museum and Archaeological Research Center.
2012 Social Reorganization and Household Adaptation in the Aftermath of Collapse at Baking Pot, Belize. Ph.D. dissertation. Pittsburgh: Department of Anthropology, University of Pittsburgh.
HOGGARTH, JULIE A. AND JAIME J. AWE (EDS.)
2009 *The Belize Valley Archaeological Reconnaissance Project A Report of the 2008 Field Season*. Belmopan: Institute of Archaeology, Museum and Archaeological Research Center.
2010 *The Belize Valley Archaeological Reconnaissance Project A Report of the 2009 Field Season*. Belmopan: Institute of Archaeology, Museum and Archaeological Research Center.
2011 *The Belize Valley Archaeological Reconnaissance Project A Report of the 2010 Field Season*. Belmopan: Institute of Archaeology, Museum and Archaeological Research Center.
HOGGARTH, JULIE A., JAIME J. AWE AND CLAIRE E. EBERT
in prep. Settlement and Community Organization at Baking Pot, Belize. *Journal of Field Archaeology*.
HOGGARTH, JULIE A., JAIME J. AWE, EVA JOBBOVÁ AND CHRISTOPHER SIMS
2010 Beyond the Baking Pot Polity: Continuing Settlement Research in the Upper Belize River Valley. *Research Reports in Belizean Archaeology* 7: 171-182.
HOGGARTH, JULIE A., BRENDAN J. CULLETON, JAIME J. AWE AND DOUGLAS J. KENNETT
2014a Questioning Postclassic Continuity at Baking Pot, Belize, Using Direct AMS ^{14}C Dating of Human Burials. *Radiocarbon* 56 (3): 1057-1075.
HOGGARTH, JULIE A., EVA JOBBOVÁ, CHRISTOPHE HELMKE AND ANDREW BEVAN
2008 Settlement Survey At Baking Pot, Belize: Results of the 2007 Season. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2007 Field Season*, edited by Christophe Helmke and Jaime J. Awe, pp. 157-187. Belmopan: Belize Institute of Archaeology, National Institute of Culture and History.
HOGGARTH, JULIE A. AND KELSEY J. SULLIVAN
2015 It's Getting Hot in the Palace: Discovery of a Sweatbath in Group B at Baking Pot. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2014 Field Season*, edited by Julie A. Hoggarth and Jaime J. Awe, pp. 222-229. Belmopan: Institute of Archaeology, Museum and Archaeological Research Center.
HOGGARTH, JULIE AND LESLIE SWAIN
2005 Preliminary Report on the Excavations of Test Units to Assess the Electromagnetic Induction Method at Baking Pot. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2004 Field Season*, edited by Christophe G.B. Helmke and Jaime J. Awe, pp. 63-66. Belmopan: Institute of Archaeology, National Institute of Culture and History.

HOGGARTH, JULIE A., CHRISTINA M. ZWEIG AND MAY MZAYEK
2014b Preliminary Findings from the 2013 Excavations in the Royal Palace Complex at Baking Pot. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2013 Field Season*, edited by Julie A. Hoggarth and Jaime J. Awe, pp. 160-173. Belmopan: Institute of Archaeology, Museum and Archaeological Research Center.
HOUSTON, STEPHEN D.
1993 *Hieroglyphs and History at Dos Pilas: Dynastic Politics of the Classic Maya*. Austin: University of Texas Press.
HOUSTON, STEPHEN D. AND DAVID STUART
2000 Peopling the Classic Maya Court. *Royal Courts of the Ancient Maya, Volume 1*, edited by Takeshi Inomata and Stephen D. Houston, pp. 54-83. Boulder: Westview Press.
HOUSTON, STEPHEN D., DAVID STUART AND KARL TAUBE
1992 Image and Text on the Jauncy Vase. *The Maya Vase Book, Volume 3*, edited by Justin Kerr, pp. 504-523. New York: Kerr Associates.
HUTSON, SCOTT R.
2015 Adapting LiDAR data for regional variation in the tropics: A case study from the Northern Maya Lowlands. *Journal of Archaeological Science: Reports* 4: 252-263.
IANNONE, GYLES
2004 Problems in the Definition and Interpretation of 'Minor Centers' in Maya Archaeology with Reference to the Upper Belize Valley. *The Ancient Maya of the Belize Valley: Half a Century of Archaeological Research*, edited by James F. Garber: 273-286. Gainesville: University Press of Florida.
2006 Archaeological Approaches to Ancient Maya Geopolitical Borders. *Space and Spatial Analysis in Archaeology*, edited by Elizabeth C. Robertson, Jeffrey D. Seibert, Deepika C. Fernandez and Marc U. Zender, pp. 205-214. Calgary: University of Calgary Press.
JARUS, OWEN
2015 Early Urban Planning: Ancient Mayan City Built on Grid. *Live Science Contributor*: http://www.livescience.com/50659-early-mayan-city-mapped.html
JOBBOVÁ, EVA
2009 Comparative Settlement in the Central Belize Valley: GIS Analysis of Baking Pot, Spanish Lookout and Barton Ramie. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2008 Field Season*, edited by Julie A. Hoggarth and Jaime J. Awe, pp. 89-121. Belmopan: Belize Institute of Archaeology, National Institute of Culture and History.
KETTUNEN, HARRI
2012 Struggle for Supremacy: Armed Conflicts in the Eastern Peten during the Late Classic Period. *Contributions in New World Archaeology* 3: 127-134
KIRKE, CHARLES M. ST G.
1980 Prehistoric Agriculture in the Belize River Valley. *World Archaeology* 11 (3): 281-286.
KLUGE, FRIEDRICH
1899 *Etymologisches Wörterbuch der deutschen Sprache*. Straßburg: Trübner.
KVAMME, KENNETH L.
1999 Recent Directions and Developments in Geographical Information Systems. *Journal of Archaeological Research* 7: 153-201.
LACADENA GARCÍA-GALLO, ALFONSO
2008 El titulo lakam: Evidencia epigráfica sobre la organización tributaria y militar interna de los reinos mayas del Clásico. *Mayab* 20: 23-43.
LAKE, MARK W., P. E. WOODMAN AND S. J. MITHEN
1998 Tailoring GIS Software for Archaeological Applications: An Example Concerning Viewshed Analyses. *Journal of Archaeological Science* 25 (1): 27-38.

LAPORTE, JUAN PEDRO

2001 Dispersión y estructura de las ciudades del sureste de Petén, Guatemala. *Reconstruyendo la ciudad Maya: el urbanismo en las sociedades antiguas*, edited by Andrés Ciudad Ruiz, Maria Josefa Ponce de Léon and Maria del Carmen Martínez Martínez, pp. 137-162. Madrid: Sociedad Española de Estudios Mayas.

LAPORTE, JUAN PEDRO AND HÉCTOR E. MEJÍA

2006 La Cuenca Baja del río Mopan: el asentamiento arqueológico en Guatemala y Belice. *Mexicon* 28 (3): 52-57.

LAPORTE, JUAN PEDRO, HÉCTOR E. MEJÍA AND JORGE E. CHOCÓN

2003 La cuenca del río Chiquibul en Petén, Guatemala: su asentamiento prehispánico. *Mexicon* 25 (3): 78-87.

LEE, JAY AND DAN STUCKY

1998 On Applying Viewshed Analysis for Determining Least Cost Paths on Digital Elevation Models. *International Journal of Geographical Information Science* 12 (8): 891-905.

MARTIN, SIMON

1996 Tikal's 'Star War' against Naranjo. *Eighth Palenque Round Table, 1993*, edited by Martha J. Macri and Jan McHargue, pp. 223-236. San Francisco: Pre-Columbian Art Research Institute.

MARTIN, SIMON AND NIKOLAI GRUBE

2000 *Chronicle of the Maya Kings and Queens: Deciphering the Dynasties of the Ancient Maya*. London: Thames and Hudson.

MCCOY, MARK D. AND THEGN N. LADEFOGED

2009 New Developments in the Use of Spatial Technology in Archaeology. *Journal of Archaeological Research* 17: 263-295.

MENZE, BJOERN H. AND JASON A. UR

2012 Mapping Patterns of Long-term Settlement in Northern Mesopotamia at a Large Scale. *Proceedings of the National Academy of Sciences* 109 (14): E778–E787.

MILLON, RENÉ

1973 *Urbanization at Teotihuacán, Mexico – The Teotihuacán Map, Part One: Text, vol. 1*. Austin: University of Texas Press.

MOORE, ALLAN F.

1999 Micro-Settlement Analysis in the Belize River Valley: Archaeological Investigations at Atalaya, a Formal Patio Group at Baking Pot. Ph.D. dissertation. London: Institute of Archaeology, University of London.

MUNDY, BARBARA E.

1998 Mesoamerican Cartography. *The History of Cartography, Volume 2, Book 3: Cartography in the Traditional African, American, Arctic, Australian, and Pacific Societies*, edited by David Woodward and G. Malcolm Lewis, pp. 183-256. Chicago: University of Chicago Press.

PIEHL, JENNIFER C.

2006 Performing Identity in an Ancient Maya City: The Archaeology of Houses, Health and Social Differentiation at the Site of Baking Pot, Belize. Ph.D. dissertation. New Orleans: Department of Anthropology, Tulane University.

POE, WILLIAM CLAY

2001 Global Positioning System Survey, 20 June - 14 July 2000. *The Western Belize Regional Cave Project: A Report of the 2000 Field Season*, edited by Reiko Ishihara, Cameron S. Griffith and Jaime J. Awe, pp. 127-150. Department of Anthropology, Occasional Paper No. 4. Durham: University of New Hampshire.

2002 Archaeological Map of Belize (ArchMapBZ): A Geographic Information System for the Recording and Analysis of Archaeological Information. *The Belize Valley Archaeological Reconnaissance Project: A*

Report of the 2001 Field Season, edited by Jaime J. Awe and Cameron S. Griffith, pp. 1-17. Belmopan: Belize Department of Archaeology, Ministry of Tourism.

2004 Surveying and Mapping at Baking Pot, 2003. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2003 Field Season*, edited by Carolyn M. Audet and Jaime J. Awe, pp. 3-14. Belmopan: Institute of Archaeology, Occasional Paper No. 1, National Institute of Culture and History.

2005 Baking Pot, Settlement Survey. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2004 Field Season*, edited by Christophe G.B. Helmke and Jaime J. Awe, pp. 47-50. Belmopan: Institute of Archaeology, National Institute of Culture and History.

PRUFER, KEITH M., AMY E. THOMPSON AND DOUGLAS J. KENNETT

2015 Evaluating Airborne LiDAR for Detecting Settlements and Modified Landscapes in Disturbed Tropical Environments at Uxbenká, Belize. *Journal of Archaeological Science* 57: 1-13.

PULESTON, DENNIS E. AND DONALD W. CALLENDER, JR.

1967 Defensive Earthworks at Tikal. *Expedition* 9 (3): 40-48.

REENTS-BUDET, DORIE, RONALD L. BISHOP, CAROLYN AUDET, JAIME J. AWE AND M. JAMES BLACKMAN

2005 Act locally, think internationally: The pottery of Baking Pot, Belize. *Research Reports in Belizean Archaeology* 2: 365-386.

RICE, PRUDENCE M.

2009 Mound ZZI, Nixtun-Ch'ich', Petén, Guatemala: Rescue Operations at a Long-Lived Structure in the Maya Lowlands. *Journal of Field Archaeology* 34 (4): 403-422.

RICKETSON, OLIVER G.

1929 *Excavations at Baking Pot, British Honduras*. Contributions to American Anthropology and History, No. 1. Publication 403. Washington D.C.: Carnegie Institution of Washington.

ROBINSON, EDWARD HEATH

2012 Reexamining Fiat, Bona Fide and Force Dynamic Boundaries for Geopolitical Entities and their Placement in DOLCE. *Applied Ontology* 7: 93-108.

ROSENSWIG, ROBERT M., RICARDO LÓPEZ-TORRIJOS AND CAROLINE E. ANTONELLI

2014 Lidar data and the Izapa polity: New results and methodological issues from tropical Mesoamerica. *Journal of Archaeological and Anthropological Sciences.* DOI 10.1007/s12520-014-0210-7.

ROSENSWIG, ROBERT M., RICARDO LÓPEZ-TORRIJOS, CAROLINE E. ANTONELLI AND REBECCA R. MENDELSOHN

2013 Lidar mapping and surface survey of the Izapa state on the tropical piedmont of Chiapas, Mexico. *Journal of Archaeological Science* 40: 1493-1507.

RUGGLES, C.L.N., D.J. MEDYCKYJ-SCOT AND A. GRUFFYDD

1993 Multiple viewshed analysis using GIS and its archaeological application: a case study in northern Mull. *Computing the Past: Computer Applications and Quantitative Methods in Archaeology*, edited by J. Andresen, T. Madsen and I. Scollar, pp. 125-132. Aarhus: CAA.

SAVCHENKO, IVAN

2015 The Last Monument of Naranjo, Peten, Guatemala: A Reconstruction of the Late Dynastic History of the Naranjo Polity. *Mexicon* 37 (2): 36-39.

SMITH, MICHAEL E.

2011 Classic Maya Settlement Clusters as Urban Neighborhoods: A Comparative Perspective on Low-Density Urbanism. *Journal de la Société des Américanistes* 97 (1): 51-73.

2014 City Planning: Aztec City Planning. *Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures*, pp. 1-18. Dordrecht: Springer Netherlands.

SOLARI, AMARA L.

2010 Circles of Creation: The Invention of Maya Cartography in Early Colonial Yucatán. *The Art Bulletin* 92(3): 154-168.

STONE, ANDREA AND MARC ZENDER
2011 *Reading Maya Art: A Hieroglyphic Guide to Ancient Maya Painting and Sculpture*. London: Thames and Hudson.
SULLIVAN, KELSEY J. AND JULIE A. HOGGARTH
2015 Archaeological Investigations on Structure B-17, Baking Pot: A Preliminary Report. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2014 Field Season*, edited by Julie A. Hoggarth and Jaime J. Awe, pp. 230-240. Belmopan: Institute of Archaeology, Museum and Archaeological Research Center.
SULLIVAN, LAUREN A. AND JAIME J. AWE
2013 Establishing the Cunil Ceramic Complex at Cahal Pech, Belize. *Ancient Maya Pottery*, edited by James J. Aimers, pp. 107-120. Gainesville: University Press of Florida.
SULLIVAN, LAUREN A., JAIME J. AWE AND M. KATHRYN BROWN
2009 Refining the Cunil Ceramic Complex at Cahal Pech Belize. *Research Reports in Belizean Archaeology* 6: 161-168.
SWAIN, LESLIE
2005 Test Excavations of Plaza 2, Group 1, Baking Pot. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2004 Field Season*, edited by Christophe G.B. Helmke and Jaime J. Awe, pp. 13-20. Belmopan: Institute of Archaeology, National Institute of Culture and History.
SWEELY, TRACY L.
2007 Electromagnetic Survey Follow-up Excavations at Baking Pot, Belize. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2005 Field Season*, edited by Christophe G.B. Helmke and Jaime J. Awe, pp. 27-36. Belmopan: Institute of Archaeology, National Institute of Culture and History.
SWEELY, TRACY AND GERALD TRAINOR
2005 Geophysical Exploration at Baking Pot. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2004 Field Season*, edited by Christophe G.B. Helmke and Jaime J. Awe, pp. 51-62. Belmopan: Institute of Archaeology, National Institute of Culture and History.
TRIGGER, BRUCE G.
2003 *Understanding Early Civilizations: A Comparative Study*. Cambridge: Cambridge University Press.
TURNER, ELLEN SUE, NORMAN I. TURNER AND R.E.W. ADAMS
1981 Volumetric Assessment, Rank Ordering, and Maya Civic Centers. *Lowland Maya Settlement Patterns*, edited by Wendy Ashmore, pp. 71-88. Albuquerque: University of New Mexico Press.
WATSON, G.R.
1969 *The Roman Soldier*. Ithaca: Cornell University Press.
WHEATLEY, DAVID
1995 Cumulative Viewshed Analysis: A GIS-based Method for Investigating Intervisibility, and its archaeological application. *Archaeology and Geographical Information Systems: A European Perspective*, edited by Gary Lock and Zoran Stančič, pp. 171-185. London: Taylor and Francis.
WHEATLEY, DAVID AND MARK GILLINGS
2002 *Spatial Technology and Archaeology: The Archaeological Applications of GIS*. New York: CRC Press, Taylor and Francis.
WILLEY, GORDON R., WILLIAM R. BULLARD JR., JOHN B. GLASS AND JAMES C. GIFFORD
1965 *Prehistoric Maya Settlements in the Belize Valley*. Papers of the Peabody Museum of Archaeology and Ethnology, No. 54. Cambridge: Harvard University.
YAEGER, JASON
2000 Changing patterns of social organization: The Late and Terminal Classic communities at San Lorenzo, Cayo District, Belize. Ph.D. dissertation. Philadelphia: University of Pennsylvania.
ZENDER, MARC
2005 The Raccoon Glyph in Classic Maya Writing. *The PARI Journal* 5(4): 6-16.

ZWEIG, CHRISTINA M.

2012 Preliminary Investigations of M-410, Baking Pot, Belize. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2011 Field Season*, edited by Julie A. Hoggarth, Rafael A. Guerra and Jaime J. Awe, pp. 1-19. Belmopan: Institute of Archaeology, Museum and Archaeological Research Center.

2013 A Continuation of Investigations at Lubul Huh (M-410), Baking Pot, Belize. *The Belize Valley Archaeological Reconnaissance Project: A Report of the 2012 Field Season*, edited by Julie A. Hoggarth, Reiko Ishihara-Brito and Jaime J. Awe, pp. 302-330. Belmopan: Institute of Archaeology, Museum and Archaeological Research Center.